



**Rotterdam Convention on the Prior
Informed Consent Procedure for
Certain Hazardous Chemicals and
Pesticides in International Trade**

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Chemical Review Committee

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Item 5 (b) (i) of the provisional agenda*

**Technical work: review of notifications of final
regulatory action: acetochlor**

**Acetochlor: supporting documentation provided by Burkina
Faso, Cabo Verde, Chad, the Gambia, Guinea-Bissau, Mali,
Mauritania, the Niger, Senegal and Togo**

Note by the Secretariat

As referred to in document UNEP/FAO/RC/CRC.13/3, the annex to the present note sets out documentation provided by Burkina Faso, Cabo Verde, Chad, the Gambia, Guinea-Bissau, Mali, Mauritania, the Niger, Senegal and Togo to support their notifications of final regulatory action for acetochlor in the pesticide category. The present note, including its annex, has not been formally edited.

* UNEP/FAO/RC/CRC.13/1.

Annex

Acetochlor: supporting documentation provided by Burkina Faso, Cabo Verde, Chad, the Gambia, Guinea-Bissau, Mali, Mauritania, the Niger, Senegal and Togo

List of documents:

1. Decision N° 002/MC/2017 to ban acetochlor.
2. Annex to the decision to ban acetochlor, Sahelian Pesticide Committee.
3. Pesticides risk from sugar cane cultivation in Burkina Faso Ouedraogo, Pare, Toe, and Guissou, Journal of Environmental Hydrology, Volume 20 Paper 16 December 2012.
4. Study of the phytosanitary pressure exerted on the lakes of Burkina Faso by passive sampling method, Soleri Romain Master Internship research, second year dissertation: Contaminants water health), in French.
5. Extract from the study of Soleri Romain, in French and English.
6. Pilot Study on Agricultural Pesticide Poisoning in Burkina Faso, Prof. Adama M. TOE from IRSS/DRO, September 2010.
7. Conclusion on the pesticide peer review of the risk assessment of the active substance acetochlor (EFSA Journal 2011; 9(5):2143) [see UNEP/FAO/RC/CRC.13/INF/7].
8. Cumulative Risk Assessment for the chloroacetanilides. US EPA 2006 -03-29. Retrieved 2010.
9. Acetochlor Human Health Risk Assessment for Proposed New Use of Acetochlor on Cotton and Soybeans. US EPA, 2009.
10. Revised Drinking Water Exposure Assessment for Acetochlor. US EPA, 2006.



LE MINISTRE COORDONNATEUR

Décision n°002/MC/2017

Portant interdiction des formulations pesticides contenant de l'acétochlore

Le Ministre Coordonnateur,

Vu la version révisée de la Réglementation Commune aux Etats membres du CILSS sur l'homologation des pesticides, issue de la Résolution n°08/34/CM/99 prise par le conseil des Ministres du CILSS en 1999 à N'Djaména, Tchad.

Soucieux de la protection de la santé humaine, animale et de l'environnement ;

Sur proposition du Comité Sahélien des Pesticides en sa séance de travail du 24 au 28 novembre 2014 à Ouagadougou (Burkina Faso).

Décide

Article 1^{er} / Les formulations pesticides contenant de l'acétochlore sont interdites dans les Etats membres du CILSS pour les raisons énoncées dans le document joint en annexe, en tenant compte des spécificités agricoles et des délais d'utilisation des stocks existants.

Article 2/ La présente décision qui prend effet à compter de sa date de signature sera communiquée partout où besoin sera.

Fait à Bamako, le **20 MARS 2017**

Le Ministre de l'Agriculture
Ministre Coordonnateur du CILSS

M. Kassoum DENON



AMPLIATIONS :

- Secrétariat Exécutif du CILSS (Original)
- Auditeur interne
- Institut du Sahel (CSP)
- Etats membres du CILSS signataires de la Réglementation Commune (09)

DECISION N° 002/MC/2017

To ban pesticide formulations containing Acetochlor

The Coordinating Minister,

Considering the revised version of the common Regulation of CILSS Member States on the registration of pesticides, following Resolution n° 08/34/CM/99 adopted by the CILSS Council of Ministers in 1999 at N'Djamena, Chad.

Mindful of the need to protect human and animal health and the environment;

On a proposal from the Sahelian Pesticide Committee forwarded at its working session held from 24 to 28 November 2014 in Ouagadougou (Burkina Faso)

DECIDES

Art 1) Pesticide formulations containing Acetochlor are banned in CILSS Member states for the reasons stated in the attached Annex, taking into account agricultural specificities and lag time to use up existing stocks.

Art 2) The present decision which enters into force starting from the date of signature, will be communicated wherever required.

Bamako, 20th March 2017
Minister of Agriculture

M. Kassoum DENON

- CILSS Executive Secretariat (Original)
- Internal Auditor
- CILSS Member States signatories of the Common Regulation (09)



COMITE PERMANENT INTER-ETATS DE LUTTE CONTRE LA SECHERESSE DANS LE SAHEL
PERMANENT INTERSTATE COMMITTEE FOR DROUGHT CONTROL IN THE SAHEL



Institut du Sahel

Comité Sahélien des Pesticides

Annexe à la décision d'interdiction de l'acetochlore

1. Généralités sur l'acétochlore

L'acétochlore (CAS 34256-82-1 et autres identifiants) est un herbicide utilisé pour le désherbage en post semis, prélevée et en post levée contre les graminées en culture de coton et de maïs. Il fait partie de la famille des chloroacetamides. Son nom IUPAC est 2-chloro-N-(éthoxyméthyl)-N-(2-éthyl-6-méthylphényl)acétamide. Il a été introduit en 1985 par la firme CIRCA (Footprint PPDB, 2015). Il est constitué d'un mélange d'isomères dont la formule brute est $C_{14}H_{20}ClNO_2$ (Footprint PPDB, 2015). Il agit de manière sélective et est principalement absorbé par les pousses et les racines des mauvaises herbes. Il provoque l'inhibition des élongases, et des enzymes de cyclisation du géranyl-géranyl pyrophosphate (GGPP) conduisant aux gibberellines (Footprint PPDB, 2015 ; INERIS, 2013).

2. Données toxicologiques

Cette synthèse prend en compte les travaux réalisés par l'Autorité Européenne de Sécurité des Aliments (EFSA) intitulé « Conclusion on the peer review of the pesticide risk assessment of the active substance acetochlor¹ » et les USA (US-EPA).

2.1 Toxicocinétique

L'acétochlore est rapidement et presque entièrement absorbée (> 80% en 48 h) après des doses répétées à 10 mg/kg bw/day chez le rat. Il est largement distribué dans les organes bien perfusés et montre un faible potentiel de bioaccumulation. Il y a une certaine accumulation dans les fosses nasales chez le rat, mais pas chez les souris. L'élimination se fait principalement par voie urinaire (66-72 % en 48 h) et les fèces (12-21 % en 48h, dont 80-85 % est éliminé par la bile) (EFSA, 2011).

La voie métabolique principale est la conjugaison du glutathion et en outre la voie de l'acide mercapturique et la glucuronidation. Dans l'urine, aucune forme inchangée d'acétochlore est trouvée (EFSA, 2011).

Des études de toxicocinétiques sur des rats et des souris ont également été fournies pour les métabolites acide t-oxanilique et acide t-sulfonique, techniquement produits comme un mélange

¹ <http://www.efsa.europa.eu/en/efsajournal/doc/2143.pdf>

racémique, montrant une absorption orale inférieure et aucune distribution dans le tissu nasal. Ces deux métabolites ont été excrétés rapidement, essentiellement inchangés (min 75 % en tant que parent, les ratios isomères n'ont pas été signalés) (EFSA, 2011).

L'acide N-oxamique qui est un métabolite issu de la plante ne se trouve pas dans le métabolisme du rat. Sur la base des données toxicologiques disponibles, il montre une toxicité aiguë inférieure à celle de l'acétochlore

2.2 Toxicité aiguë

La toxicité aiguë de l'acétochlore après administration par voie orale ou par inhalation est modérée (DL_{50} rat = 1929 mg/kg de poids corporel, CL_{50} rat = 3,99 mg/l/4 h). Il est irritant pour le système respiratoire et la peau, ainsi que sensibilisant de la peau (EFSA, 2011).

Les formulations à base d'acétochlore homologuées par le CSP sont de la classe **III de l'OMS (modérément dangereux)** (CSP, 2014).

2.3. Toxicité à court terme

Trois études alimentaires chez le rat, quatre études par voie orale (alimentaires et par capsule) chez le chien et deux études dermiques chez le rat et le lapin sont décrits. Le chien a été l'espèce la plus sensible d'où une NOAEL (de l'étude chez le chien de 52 semaines) de 2 mg/kg pc/j d'après la diminution du gain de poids corporel et les résultats histopathologiques dans les reins et les testicules observés à 10 mg/kg pc /j (EFSA, 2011).

2.4. Génotoxicité

Des résultats positifs et négatifs sont rapportés *in vivo* et *in vitro* avec le matériel technique de pureté faible et élevée (de 89,9 à 96,7 %). Beaucoup d'études *in vitro* montrent des résultats positifs. Le test *in vivo* UDS montre des résultats positifs à des doses toxiques et les résultats clairement négatifs se trouvent dans des essais de micronoyaux et de létalité dominante.

Les experts ont convenu que la substance induit la synthèse de réparation de l'ADN *in vivo*, qui n'a pas été considérée comme une indication claire de mutagénicité *in vivo*, et ils ont conclu que cela ne porte pas atteinte à l'évaluation des risques (EFSA, 2011).

2.5. Toxicité chronique / Cancérogénèse

A partir de trois études chroniques effectuées chez le rat, la NOAEL systémique est de 9,4 mg/kg pc/j d'après la diminution du poids corporel, la toxicité hépatique légère et néphrite chronique. Une incidence accrue des adénomes papillaires de l'épithélium nasal est observée dans toutes les études, chez les deux sexes et est accompagnée par une augmentation de l'incidence de l'hyperplasie de l'épithélium nasal. Basé sur des études mécanistiques sur l'acetochole (et son analogue alachlore), il semble que ces adénomes nasales chez les rats sont liés à la formation d'un métabolite actif (DABQI, dialkylbenzoquinoneimine), augmentée d'une enzyme spécifique de l'épithélium nasal de rat.

Bien qu'il soit peu probable que des concentrations du métabolite actif soient suffisamment atteintes pour initier cet événement, le mode d'action peut encore être pertinent pour les humains.

Les adénomes folliculaires thyroïdiennes et les tumeurs hypophysaires ont été considérés par les experts comme non pertinents pour les humains ou accidentel. Dans la réévaluation de l'étude de rat de 2 ans par Broadmeadow, les tumeurs fémorales ont été confirmées comme des hyperplasies cartilagineuses et non des néoplasmes. Les néoplasmes gastriques dans le préestomac au niveau de la dose élevée (67 mg / kg pc / j) ont été diagnostiqués comme carcinomes épidermoïdes, au-dessus des données de contrôle historiques, et ont été considérés comme des conclusions pertinentes.

Le NOAEL convenu pour les effets cancérogènes est de 9,4 mg/kg de poids corporel/jour.

Dans les deux études chroniques chez la souris (78 semaines et 23 mois), les principaux effets sont une diminution du gain de poids, l'anémie, les reins et la toxicité hépatique. La NOAEL systémique globale a été discutée par les experts, sur la base des effets observés dans les reins des souris mâles dans l'étude de 78 semaines (en utilisant des doses plus faibles). L'apparition de basophilie tubulaire à la faible dose, au-dessus des données de contrôle historiques et accompagné d'un poids des reins a augmenté, a été considéré comme une première étape de néphrotoxicité et le niveau de 1,1 mg de dose/kg de poids corporel/jour a été convenu à la LOAEL systémique.

Dans les deux études, les adénomes pulmonaires et les cancers sont observés avec une incidence accrue chez les femelles, souvent au-dessus des valeurs de contrôle historiques. Dans l'étude de 23 mois (Ahmed, 1983), une augmentation de l'incidence liée à la dose de sarcome histiocytaire de l'utérus est observée, au-dessus des données de contrôle historiques pour les deux groupes de dose élevés. De cette étude, les experts ont convenu que la faible dose (75 mg/kg de poids corporel/jour) est un LOAEL pour les effets cancérigènes, car une incidence légèrement plus

élevée de sarcomes histiocytaires de l'utérus est déjà observée. Dans l'étude de 78 semaines un cancérogène NOAEL claire ne peut être établie à 11,21 mg/kg de poids corporel/jour.

En conclusion, en tenant compte des différentes tumeurs observées chez les deux espèces, la réunion a décidé de proposer le classement Carc. cat.3, R40 preuve d'un effet cancérogène.

Des études toxicocinétiques sur des rats et des souris ont également été fournies pour, techniquement produit comme un mélange racémique, montrant une absorption orale inférieure et aucune distribution dans le tissu nasal. Ces deux métabolites ont été excrétés rapidement, essentiellement inchangé (min 75% en tant que parent, si les ratios isomères ont pas été signalés).

En raison des propriétés cancérogènes de l'acétochlore, les métabolites acide t-oxanilique et acide t-sulfonique ont été considérés comme des métabolites des eaux souterraines sur le plan toxicologique. De même, le métabolite t-norchloro acétochlore est également toxique sur la base de sa génotoxicité cancérogène potentiel (EFSA, 2011).

2.6. Effets sur la reproduction

Le NOAEL parental est de 20 mg/kg pc/j d'après la diminution du poids corporel, des changements dans certains poids des organes, et l'apparition de l'hyperplasie nasale. Le NOAEL pour les paramètres de la reproduction est de 61 mg/kg de poids corporel/jour en fonction de diminution du nombre d'implantations, du nombre de nouveau-nés vivants jour 1, de la distance anogénitale chez les mâles F2 et du retard de l'ouverture vaginale chez les femelles F1 à la dose élevée.

Le NOAEL pour la progéniture est aussi 20 mg/kg pc/j d'après la diminution du poids de la portée au jour 1, une diminution de poids des chiots et une augmentation du poids relatif du cerveau.

D'après les deux études de tératologie chez le rat, la DSENO pour la toxicité maternelle est de 200 mg/kg de poids corporel/jour, et la NOAEL de toxicité pour le développement de 400 mg/kg de poids corporel/jour. L'acétochlore n'est pas considéré comme tératogène chez les rats. Chez le lapin, les études de tératologie donnent un NOAEL parentale de 50 mg/kg de poids corporel/jour en fonction de la réduction du poids corporel, et un NOAEL de 190 mg/kg de poids corporel/jour pour la toxicité pour le développement car il n'y a aucune preuve d'effet tératogène (EFSA, 2011).

2.7. Neurotoxicité

Sur la base de deux études de neurotoxicité chez le rat (une aiguë par gavage, et une subchronique par administration alimentaire), le NOAEL dans l'étude de toxicité aiguë est de 150 mg/kg de poids corporel, basée sur l'activité motrice réduite et des signes cliniques à 500 mg/kg de poids corporel. Dans l'étude subchronique, le NOAEL est de 48 mg/kg de poids corporel/jour en fonction du poids corporel réduit (EFSA, 2011).

3. Données environnementales

3.1. Comportement et devenir dans l'environnement

En cas de rejet dans le sol, l'acétochlore a une mobilité élevée à modérée basée sur une gamme de Koc de 98,5 à 335. La volatilisation à partir des surfaces de sol humides ne devrait pas être un processus important dans le devenir sur la base d'une estimation constante d'Henry de $2,7 \times 10^{-10}$ atm-cu m/mole. L'acétochlore a été dégradé 8 à 15 % dans un sable limoneux au cours d'une période d'incubation de 48 jours, ce qui indique que la biodégradation est un processus de devenir environnemental important dans le sol. La persistance est modérée, $DT_{50} = 2$ à 3 mois.

L'adsorption est facilitée sur les sols vaseux ou argileux, plutôt que sur les sols à faible teneur en argile ou en matière organique, L'acétochlore s'adsorbe peu aux particules du sol, ce qui se traduit par un potentiel important de contamination des eaux de ruissellement et de surface. Le métabolisme conduit à la formation de métabolites toxiques tels **le Nor acétochlore**. Par ailleurs, du fait de sa mobilité modérée, il présente un risque moyen de contamination des eaux superficielles par ruissellement. Cette contamination touche à la fois les cours d'eau, par ruissellement mais aussi les eaux souterraines, par infiltration.

En cas de rejet dans l'eau, l'acétochlore devrait pas adsorber les matières en suspension et les sédiments. La demi-vie de l'acétochlore dans une boue d'épuration a été établie à 17,2 heures, ce qui indique que la biodégradation peut être un processus de devenir dans l'environnement important dans l'eau. La volatilisation à partir des surfaces d'eau ne devrait pas être un processus important dans le devenir sur la base estimée de la loi de la constante de Henry de ce composé. Un FBC estimé de 250 suggère que le potentiel de bioaccumulation dans les organismes aquatiques est élevé, à condition que le composé ne soit pas métabolisé par l'organisme. L'hydrolyse a été décrite comme de premier ordre avec une demi-vie dans l'eau de rivière de 1386, 2310 et 2310 jours à pH 4, pH 7 et 10, respectivement. (SRC)

En cas de rejet dans l'air, une pression de vapeur de $1,67 \times 10^{-7}$ mmHg à 20 °C indique que l'acétochlore existera dans les deux phases de vapeurs et de particules dans l'atmosphère. En phase vapeur l'acétochlore sera dégradé dans l'atmosphère par réaction avec les radicaux hydroxyles produits photochimiquement ; la demi-vie pour cette réaction dans l'air est estimée à 2,6 heures. Les particules de phase acétochlore seront éliminées de l'atmosphère par dépôt humide ou sec. L'acétochlore peut être sensible à la photolyse directe par la lumière du soleil.

3.2. Effets sur les organismes non cibles

L'acétochlore présente une toxicité aiguë modérée pour les oiseaux ($DL_{50} = 928$ mg/kg). Sa toxicité aiguë va de modérée à élevée pour les organismes aquatiques avec un potentiel élevé de bioconcentration ($BCF = 250$) (Footprint, 2015 ; SRC). Ainsi, il est modérément toxique pour les poissons ($CL_{50} = 0,36$ mg/l). Il a une toxicité élevée pour les algues (0,00027 mg/l), les invertébrés aquatiques (8,6 mg/l), les crustacés aquatiques (1,9 mg/l). Concernant les abeilles et les lombrics, il est modérément toxique (respectivement > 100 µg/abeille et 105,5 mg/kg) (Footprint, 2015).

4. Classification de l'acétochlore

WHO and US EPA: hazard class III

EU : According to the harmonised classification and labelling approved by the European Union, this substance is : Suspected of causing cancer (Carc. 2), suspected of damaging fertility (Repr. 2), harmful if inhaled (Acute Tox. 4), may cause respiratory irritation (STOT Single Exposure 3) and may cause damage to organs through prolonged or repeated exposure (STOT RE 2 - kidney), causes skin irritation (Skin Irrit. 2), may cause an allergic skin reaction (Skin Sens. 1), very toxic to aquatic life (Aquatic Acute 1) and very toxic to aquatic life with long lasting effects (Aquatic Chronic 1).

JP : According to the GHS classification approved by Japan, this substance is Carcinogen category 1B, Reprotoxic category 2, Specific target organ toxicity - Repeated exposure : Category 1 (kidney, testis), Category 2 (central nervous system), Hazardous to the aquatic environment (acute and long-term) category 1

5. Homologation et utilisation de l'acétochlore

Au Sahel, plusieurs formulations contenant l'acétochlore ont été autorisées comme **Herbicide sélectif sur la culture de maïs**. par exemple, la formulation ACETO900EC était appliquée à 2 litres à l'hectare.

L'acétochlore bénéficie d'un usage restreint aux USA où est utilisé en pré émergence en l'incorporant au sol pour le désherbage du blé et du maïs. Les taux d'application dépendent de la nature du sol et du type de mauvaises herbes à combattre. Cependant, le taux d'application maximum unique est de 3,0 lb ai/ha. En prévision de son utilisation répandue, plusieurs restrictions d'utilisation ont été mises en œuvre comme des mesures préventives. Plus précisément, l'acétochlore ne peut être appliqué que par des applicateurs certifiés. Il ne peut être appliqué aux sols grossiers (par exemple, sableux avec moins de 3 % de matière organique) où la profondeur de l'eau souterraine est inférieure à 30 pieds. L'acétochlore ne peut pas être appliquée par tout système d'irrigation (y compris l'irrigation par inondation), ni par l'intermédiaire de l'application aérienne. L'acétochlore ne peut être appliqué directement sur l'eau ou dans les zones où l'eau de surface est présente. En outre, l'acétochlore ne doit pas être mélangé ou chargé à moins de 50 pieds des eaux de surface ou des puits, à moins que des mesures de confinement et d'élimination appropriées soient en place. Chacune de ces mesures est destinée à empêcher l'acétochlore de migrer dans les ressources en eau (USEPA, 2006).

Dans l'Union Européenne, l'acétochlore était homologué en culture de maïs. La dose maximale appliquée était de 2 kg/ha avec un volume minimum d'eau de 100 L. Les conditions d'application autorisées étaient le pulvérisateur tracté avec des buses hydrauliques (EFSA, 2011) et le port d'équipements de protection.

L'acétochlore n'est plus inscrit à l'annexe I, de la directive 91/414/CEE, depuis le 5 décembre 2008 (EFSA, 2011). Pour l'Union Européenne l'acétochlore est interdit suite à la publication du Règlement **1372/2011** concernant la décision de retrait de l'acétochlore herbicide du 21 décembre 2011² (**publié au JO de l'UE le 22 décembre 2011**), en raison des risques pour la santé humaine, les oiseaux herbivores et les organismes aquatiques. Les données recueillies dans ce rapport indiquent :

- Un risque élevé de contamination des eaux souterraines par plusieurs métabolites ;
- Le potentiel génotoxique du métabolite Nor acétochlor ainsi que le risque d'exposition liée à la contamination des eaux de surface par ce métabolite toxique ;
- L'effet perturbateur potentiel de la fonction endocrinienne des batraciens ;
- Le risque élevé pour les organismes aquatiques ;

² <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:341:0045:0046:EN:PDF>

- Le risque élevé à long terme pour les oiseaux herbivores ;
- Le risque potentiel pour l'homme en cas d'exposition prolongée.

Les risques pour la santé des opérateurs étaient accentués du fait que malgré l'utilisation du pulvérisateur tracté, l'estimation de l'exposition aux formulations EC donnait des valeurs supérieures (entre 1435 et 5550 %) au niveau d'exposition acceptable de l'opérateur (NEAO) (EFSA, 2011).

Dans les pays du Sahel, les formulations à base d'acétochlore étaient homologuées sur le coton (produit binaire) et le maïs. Depuis 2010, le Comité Sahélien des Pesticides avait donné l'APV à deux formulations contenant l'acétochlore. Il s'agissait de l'ACEPRONET 400 EC (acétochlore 250 g/l + prométryne 150 g/l) en juin 2010 et de l'ACETO 900 (acétochlore 900 g/l) en juin 2012.

L'usage recommandé était l'application, contrairement aux USA et aux pays de l'Union Européenne, en bas volume (pulvérisateur à dos) de la formulation diluée avec de l'eau aux doses comprises entre 2,5 et 3,5 l/ha pour le coton. La fréquence d'application était une seule fois par campagne. Les conditions de protection préconisées étaient le port de vêtement, gants et lunettes de protection. L'évaluation de l'exposition des applicateurs à la dose d'emploi de l'acétochlore dans les conditions d'emploi préconisées au Sahel donnait une valeur comprise entre 15 305 et 20 095 % du NEAO.

Des études sur les pratiques agricoles ont démontré que dans les pays du CILSS, les populations n'utilisaient pas convenablement les pesticides. En effet, les producteurs ne portent pas d'équipements de protection individuels appropriés (Gomgnimbou *et al.*, 2010) Ouedraogo *et al.*, 2009 ; Toe *et al.*, 2002). Le matériel de protection vendu aux producteurs est constitué principalement de masques à poussière, bottes et gants (Toe, 2010). Ces équipements ne sont pas spécifiques pour effectuer des traitements demandant une protection complète des opérateurs (comme c'est le cas pour les formulations à base d'acétochlore).

De plus, dans des pays comme le Burkina Faso, des études ont montré que plus de la moitié des producteurs (67,5 %) possédaient un point d'eau dans leur champ ou à proximité. La majorité des points d'eau est située à une distance inférieure à 100 m des champs (Toe, 2010). Cette proximité des points d'eau aux champs peut être à l'origine d'une contamination par différentes voies de l'eau par les pesticides. L'eau était consommée dans 50 % des cas, utilisée pour la préparation ou la dilution des pesticides dans 29,26 % et destinée à l'abreuvement des animaux 26,96 % (Toe, 2010). D'où la présence de l'acétochlore dans certains cours d'eau au Burkina Faso (Soleri, 2013).

En conclusion, les risques d'exposition des producteurs et de l'environnement à l'acétochlore sont élevés. Au vu de ces risques d'exposition, suite à un rapport documenté et à la lumière des données fournies par le Rapport de réévaluation de l'Union Européenne ayant conduit à la décision d'interdiction de l'acétochlore et vu que les conditions d'utilisation (dose appliquée) sont identiques et que la protection de l'applicateur et de l'environnement est faible au niveau du Sahel, le Comité Sahélien des Pesticides a pris la décision d'interdire l'homologation des formulations à base d'acétochlore pour protéger la santé humaine et l'environnement.

6. Alternatives à l'acétochlore

5.1. Alternatives chimiques

Des solutions de substitution à l'utilisation de formulations à base d'acétochlore existent. Comme alternatives, les formulations d'herbicides sélectifs sont **homologuées** et **autorisées** à la vente dans les pays du CILSS. On retrouve plusieurs formulations d'herbicides sélectifs dans la liste globale des pesticides homologués par le CSP pour le maïs et pour le coton (CSP, 2014). Ces formulations appartiennent aux familles chimiques suivantes : sulfonylurée (nicosulfuron), urées substituées (diuron), toluidine (pendiméthaline), etc.

5.2. Gestion intégrée de la production et des déprédateurs (GIPD)

L'expérience **GIPD** initiée par la **FAO** en collaboration avec les ministères de l'agriculture de plusieurs pays du Sahel permet d'obtenir des résultats importants dans la production agricole et la gestion des déprédateurs. Cette initiative de bonnes pratiques agricoles (**BPA**) permet d'améliorer la productivité agricole et de former plusieurs producteurs qui sont de potentiels facilitateurs. La GIPD repose sur les principes suivants :

- Une utilisation raisonnée et judicieuse des pesticides ;
- L'acquisition de connaissances et pratiques nécessaires pour la gestion des déprédateurs ;
- Le renforcement de la capacité des producteurs à la prise de décision au niveau du champ ;
- La conception d'une meilleure productivité à faibles coûts qui protège l'environnement.

7. Conclusion

L'acétochlore présente des risques pour la santé des populations du fait des risques réels de contamination des ressources en eaux par plusieurs métabolites dont le Nor acétochlor qui a un potentiel génotoxique, le risque élevé pour les organismes aquatiques et à long terme pour les oiseaux herbivores et enfin pour l'homme en cas d'exposition prolongée. Tous ces risques ont justifié son interdiction dans de nombreux pays dans le monde dont tous les pays de l'Union Européenne.

Au niveau des pays du CILSS, le Comité Sahélien des Pesticides a arrêté l'homologation des pesticides à base d'acétochlore compte tenu de tous les risques évoqués en prenant aussi en compte :

- La difficulté des populations à s'approprier les équipements de protection individuelle adaptés ;
- L'écologie fragile des pays du CILSS caractérisée parfois par des pluies diluviennes sur des sols souvent pauvres en matières organiques donc très sujets à l'érosion et au lessivage ;
- L'absence d'un système de gestion environnementale avec respect de bandes tampon entre les champs traités et les cours d'eau ;
- L'utilisation des eaux de surface comme eau de boisson pour les hommes et les animaux ;
- L'utilisation des eaux souterraines comme le seul réservoir d'eau potable ;
- L'existence d'alternatives à l'utilisation de l'acétochlore.

Pour porter à la connaissance du public et ce de façon transparente cette décision d'interdiction des pesticides à base d'acétochlore aux fins d'améliorer la santé des populations et préserver l'environnement dans les pays du CILSS, son Ministre Coordonnateur publie la présente note d'interdiction.

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PERMANENT INTERSTATE COMMITTEE FOR DROUGHT CONTROL IN THE SAHEL

Institut du Sahel

Sahelian Pesticide Committee

Annex to the decision to ban Acetochlor

1. General information on acetochlor

Acetochlor (CAS 34256-82-1 and other identifiers) is a post-sowing, pre-emergence and post-emergence herbicide used in cotton and maize crops. It belongs to the chloroacetamides family. Its IUPAC name is 2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)acetamide. It was introduced in 1985 by the Company CIRCA (Footprint PPDB, 2015). It is a mixture of isomers which molecular formula is $C_{14}H_{20}ClNO_2$ (Footprint PPDB, 2015). It behaves in a selective way and is mainly absorbed by the stems and roots of weeds. Its mode of action is elongase inhibition and inhibition of geranylgeranyl pyrophosphate (GGPP) cyclisation enzymes, part of the gibberellin pathway (Footprint PPDB, 2015 ; INERIS, 2013).

2. Toxicologic data

This summary takes into account the work carried out by the European Food Safety Authority (EFSA) called “ Conclusion on the peer review of the pesticide risk assessment of the active substance acetochlor¹ » and the USA (US-EPA).

2.1 Toxicokinetics

Acetochlore is rapidly and almost entirely absorbed (> 80% en 48 h) after repeated doses at 10 mg/kg bw/day in rats. It is widely distributed in well perfused organs and shows low bioaccumulation potential. There is some accumulation in nasal turbinates in rats, but not in mice. The elimination occurs mainly via urine (66-72 % in 48 h) and faeces (12-21 % in 48h, from which 80-85 % is eliminated through bile (EFSA, 2011).

The major pathway of metabolism is the glutathion conjugation and further mercapturic acid pathway and glucuronidation. In urine, no unchanged acetochlore is found (EFSA, 2011).

Toxicokinetic studies on rats and mice have also been carried out for the metabolite t-oxanilic acid and t-sulfonic acid , technically produced as racemic mixture, showing lower oral absorption and

¹ <http://www.efsa.europa.eu/en/efsajournal/doc/2143.pdf>

no distribution in the nasal tissue. These two metabolites were rapidly excreted, essentially unchanged.(min 75 % as a parent, isomers ratios haven't been reported) (EFSA, 2011).

N-oxamic acid which is a plant metabolite is not found in rats metabolism. Based on available toxicologic data, its acute toxicity is lower than that of acetochlor.

2.2 Acute toxicity

The acute toxicity of Acetochlor after oral or inhalative administration is moderate (LD₅₀ rats = 1929 mg/kg body weight, LC₅₀ rats = 3,99 mg/l/4 h). It is irritating for the respiratory system and for the skin, as well as a skin sensitizer (EFSA, 2011).

Acetochlor based formulations registered by CSP belong to **WHO class III (moderately harmful)** (CSP, 2014).

2.3. Short term toxicity

Three dietary studies in rats, four oral studies (dietary and capsules) in dog and two dermal studies in rats and rabbits are described. The dog is the most sensitive species with a NOAEL (a 52 -week dog study) of 2 mg/kg bw/d based on decreased body weight gain and histopathological findings in kidneys and testes observed at 10 mg/kg bw/day (EFSA, 2011).

2.4. Genotoxicity

Positive and negative results have been reported *in vivo* and *in vitro* with technical material of low and high purity (from 89,9 to 96,7 %). Many *in vitro* studies show positive results. The *in vivo* UDS test shows positive results at toxic dose level and clear negative results are found in micronucleus and dominant lethal studies.

Experts agreed that the substance induces DNA repair synthesis *in vivo*, which was not considered as a clear indication of mutagenicity *in vivo* and they concluded that this does not affect the risk assessment (EFSA, 2011).

2.5. Chronic toxicity/Carcinogenesis

From three chronic rat studies, the systemic NOAEL is 9,4 mg/kg bw/day based on decreased body weight, mild liver toxicity and chronic nephritis. An increased incidence of papillary adenomas in the nasal epithelium is observed in all studies, in both sexes, and is accompanied by increased incidence of hyperplasia of the nasal epithelium. Based on mechanistic studies on acetochlor, (and its analogue alachlor), it seems that these nasal adenomas in rats are related to the formation of an active metabolite (DABQI, dialkylbenzoquinoneimine), increased by a specific enzyme of the rat nasal epithelium.

Although it is unlikely that sufficient concentration of the active metabolite would be achieved to initiate this event, its mode of action can still be relevant for humans.

Thyroid follicular adenomas and pituitary tumours were considered by the expert as non relevant to humans or incidental. In the re-evaluation of the 2-year rat study by Broadmeadow, the femoral tumours were confirmed as cartilaginous hyperplasia and not neoplasms. Gastric neoplasms in the fore stomach at the high dose level (67 mg / kg bw / d) were diagnosed as squamous cell carcinomas, above historical control data and were considered relevant findings.

The agreed NOAEL for carcinogenic effects is 9,4 mg/kg body weight/day.

In the two chronic mouse studies (78 weeks and 23 months), the main effects are a decreased weight gain, anaemia, kidney and liver toxicity. The overall systemic NOAEL was discussed by the experts, based on the effects observed in the kidneys of male mice in the 78-week study (using lower doses). The occurrence of tubular basophilia at low dose, above historical control data and accompanied by an increased kidney weight, was considered as a first step of nephrotoxicity and the dose level of 1,1 mg dose /kg body weight/day was agreed to be the systemic LOAEL.

In both studies, lung adenomas and carcinomas are observed with increased incidences in female, often above the historical control values. In the 23-month study, a dose-related increase of histiocytic sarcoma of the uterus is observed, above the historical control data for the two high dose groups. The experts agreed that the low dose (75 mg/kg bw/day) is a LOAEL for carcinogenic effects because a slightly increased incidence of the histiocytic sarcomas is already observed. In the 78-week study, a clear carcinogenic NOAEL can be established at 11,21 mg/kg bw/day.

In conclusion, taking into account the different tumours observed in both species, the meeting agreed to propose the classification Carc. cat.3, R40 proof of a carcinogenic effect.

Toxicokinetic studies with rats and mice have also been provided, technically produced as a racemic mixture, showing a lower oral absorption and no distribution in the nasal tissue.

These two metabolites have been rapidly excreted, mainly unchanged (min 75% as parent though isomer ratios were not reported).

Due to its carcinogenic properties, acetochlor and t-sulfonic acid have to be considered as toxicologically relevant groundwater metabolite. Similarly, the groundwater metabolite t-norchloro acetochlor metabolite is also toxicologically relevant based on its genotoxic and carcinogenic potential (EFSA, 2011).

2.6. Effects on reproduction

The parental NOAEL is of 20 mg/kg bw/d based on decreased body weight, changes in some organs weight and occurrence of nasal hyperplasia. The NOAEL for the reproduction parameters is 61 mg/kg bw/day based on decreased number of implantation, decreased number of live pups at day 1, decreased anogenital distance in F2 males and delayed vaginal opening in F1 females at high dose.

The NOAEL for offsprings is also 20 mg/kg bw/d based on decreased litter weight at day 1, decreased pup bodyweight and increased brain weight.

From two rat teratology studies, the NOAEL for maternal toxicity is 200 mg/kg bw/day and the NOAEL for developmental toxicity 400 mg/kg bw/day. Acetochlor was not considered teratogenic to rats. From the rabbit teratology study the parental NOAEL is 50 mg/kg bw/day based on reduced bodyweight and the NOAEL for development toxicity 190 mg/kg bw/day as there is no evidence of teratogenic effect (EFSA, 2011).

2.7. Neurotoxicity

From two neurotoxicity studies with rats (one acute by gavage, and one subchronic by dietary administration) the NOAEL in the acute toxicity study is 150 mg/kg bw/day based on reduced motor activity and clinical signs at 500 mg/kg body weight. In a subchronic study, the proposed NOAEL is 48 mg/kg bw/day based on reduced body weight (EFSA, 2011).

3. Environmental studies

3.1. Fate and behaviour in the environment.

When acetochlor enters the soil, it has high to moderate mobility based on a Koc range of 98,5 to 335. Little volatilisation from moist soil surface should occur based on its Henry's constants evaluation of $2,7 \times 10^{-10}$ atm-cu m/mole. Acetochlor degradation is 8 to 15% in loamy sand during 48-day incubation period, which shows that biodegradation is an important environmental fate process in the soil. Persistence is moderate,, $DT_{50} = 2$ to 3 months.

Absorption occurs more easily in silty and clay soils rather than in soils with a moderate content of clay or organic matter, Acetochlor adsorbs little to soil particles which means an important potential of runoff and surface water contamination. Metabolism leads to the formation of toxic metabolites such as **Nor acetochlore**. However, due to its moderate mobility, the risk of surface water contamination by runoff is moderate. This contamination concerns watercourses by runoff but also groundwater by infiltration.

Acetachlor is not expected to absorb suspended matter and sediments if entering the soil. Acetachlor half-life in sewage sludge was set at 17,2 hours, which shows that biodegradation can be an important environmental fate process in water. Little volatilisation from moist soil surface is expected to occur based on the Henry's constants evaluation of that compound. An estimated BCF of 250 suggests that the bioaccumulation potential in aquatic organisms is high, provided that the compound is not metabolised by the organism. A first order hydrolysis has been described with half-life in water of 1386, 2310 and 2310 days at pH 4, pH 7 and 10, respectively. (SRC)

A vapour pressure of acetochlor in the air of $1,67 \times 10^{-7}$ mmHg at 20 °C suggests that acetochlor will exist in vapour and particle phases in the atmosphere. In the vapour phase, acetochlor will degrade in the atmosphere by reaction with chemically produces hydroxyle radicals; air half-life for that reaction is estimated 2,6 hours. In particle phase, acetochlor will be removed from the atmosphere by wet or dry deposition process. Acetochle may be sensitive to direct photolysis by sunlight.

3.2. Effects on non target organisms

Acetochlore is of moderate acute toxicity to birds ($LD_{50} = 928$ mg/kg). It has a moderate to high acute toxicity to aquatic organisms with high bioconcentration potential.(BCF = 250) (Footprint, 2015 ; SRC). It is moderately toxic to fish.($LC_{50} = 0,36$ mg/l). It is highly toxic to algae(0,00027 mg/l), aquatic invertebrates (8,6 mg/l) and aquatic crustaceans (1,9 mg/l). It is moderately toxic to bees and earthworms (> 100 µg/bees and 105,5 mg/kg, respectively) (Footprint, 2015).

4. Classification of l'acetochlor

WHO and US EPA: hazard class III

EU : According to the harmonized classification and labelling approved by the European Union, this substance is: Suspected of causing cancer (Carc. 2), suspected of damaging fertility (Repr. 2), harmful if inhaled (Acute Tox. 4), may cause respiratory irritation (STOT Single Exposure 3) and may cause damage to organs through prolonged or repeated exposure (STOT RE 2 - kidney), causes skin irritation (Skin Irrit. 2), may cause an allergic skin reaction (Skin Sens. 1), very toxic to aquatic life (Aquatic Acute 1) and very toxic to aquatic life with long lasting effects (Aquatic Chronic 1).

JP : According to the GHS classification approved by Japan, this substance is Carcinogenic category 1B, Reprotoxic category 2, Specific target organ toxicity - Repeated exposure : Category 1 (kidney, testis), Category 2 (central nervous system), Hazardous to the aquatic environment (acute and long-term) category 1

5. Registration and use of acetochlor

Several formulations containing acetochlor have been authorised in the Sahel as selective herbicide on maize crops, for example. ACETO900EC formulation was applied at 2 litre per hectare.

The use of acetochlor is restricted in the USA where it is used as a pre-emergence herbicide, mixing it into the soil for weed control in wheat and maize. Application rates depend on the nature of the soil and the type of weed. However, maximum unique application rate is 3,0 lb ai/ha. In view of its widespread use, several restrictions have been adopted as preventive measures. More precisely, acetochlor can only be applied by certified applicators. It cannot be applied to coarse soil (sandy soil with less than 3% organic matter, for example) where groundwater depth is less than 30 feet. Not all irrigation systems can be used to apply acetochlor (irrigation by flooding included), nor can aerial application be used. Acetochlore cannot be applied directly on water or in areas where surface water is present. Furthermore, acetochlor should not be mixed or loaded less than 50 feet from surface water or wells, unless adequate confinement or disposal measures are adopted. Each of these measures prevents acetochlor from migrating into water resources. (USEPA, 2006).

Acetochlor was registered in the European Union for maize crops. The maximum applied dose was 2 kg/ha and the minimum volume 100 L of water/ha. The only supported use was boom application, a tractor mounted field crop sprayer with hydraulic nozzles (EFSA, 2011) and the use of personal protective equipment is required. Acetochlor is no longer listed in Annex I of Directive

91/414/EEC since 5th December 2008 (EFSA, 2011). Acetochlor is banned in the European Union following the publication of Regulation **1372/2011** on the decision of 21 December 2011² to withdraw acetochlor herbicide (**published in the EU OJ of 22 December 2011**), due to the risks to human health, herbivore birds and aquatic organisms. Data collected in this report show:

- High risk of groundwater contamination by several metabolites.;
- Genotoxic potential of the metabolite Nor acétochlor as well as an exposure risk linked to surface water contamination through this toxic metabolite ;
- Potential amphibian endocrine disruptor;
- High risk to aquatic organisms ;
- High long term risk to herbivore birds ;
- Potential risk to humans following prolonged exposure.

Despite the use of tractor mounted sprayer, the risk to operators' health was accentuated since the estimated exposure to EC formulation showed values higher (between 1435 and 5550 %) then the acceptable exposure level for operators. (AOEL) (EFSA, 2011).

In Sahel countries, acetochlor based formulations were registered for cotton (binary products) and maize. The Sahelian Pesticide Committee has given VPA to two formulations containing acetochlor since 20010, l'ACEPRONET 400 EC (acetochlore 250 g/l + prometryn 150 g/l) in June 2010 and l'ACETO 900 (acetochlore 900 g/l) in June 2012.

Contrary to the USA and the EU countries, the recommended uses were low volume applications (knapsack sprayer) of the formulation diluted with water at doses between 2,5 and 3,5 l/ha in cotton. The frequency of application was once per crop year. Recommended protection measures were protective clothing, glasses and gloves. The evaluation of applicators' exposure at the level of use of acetochlor under the conditions of use recommended in the Sahel showed values between 15 305 et 20 095 % of AOEL.

Studies on agricultural practices showed that in CILSS countries people did not use pesticides in a proper way. In fact, farmers don't use appropriate personal protective equipment (Gomgnimbou *et al.*, 2010) Ouedraogo *et al.*, 2009 ; Toe *et al* (Toe, 2010). The protective equipment sold to farmers were essentially masks, boots and gloves. (Toe, 2010). This equipment is not specific to carry out treatments which require the full protection of operators (as for acetochlor based formulations). Furthermore, the study showed that in countries like Burkina Faso, more than half the farmers (67,5 %) have a water point in their fields or nearby. Most water points are less than 100mt from

² <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:341:0045:0046:EN:PDF>

the fields (Toe, 2010). Water pesticide contamination via different routes may result from the proximity of water points to the fields . Water was drunk in 50% of cases, used for the preparation or the dilution of pesticides in 29,26% and for animal drinking in 26,96% (Toe, 2010). Hence the presence of acetochlor in some water courses in Burkina Faso (Soleri, 2013).

In conclusion, the risks of farmers' exposure to acetochlor and the risks to the environment are high. Taking into account these risks, following a documented report and in the light of data provided by the EU review report leading to the decision to ban acetachloer, based on the fact that the conditions of use (applied doses) are the same and that the protection of applicators and the environment is low in the Sahel, the Sahelian Pesticide Committee decided to prohibit the registration of acetochlor based formulations to protect human health and the environment.

6. Alternatives to acetochlor

5.1. Chemical alternatives

Alternatives to the use of acetochlor based formulations exist. As an alternative, formulations of selective pesticides are **registered and authorised** for sale in CILSS countries. Several selective pesticides formulations can be found in the global list of pesticides registered by CSP for maize and cotton. (CSP, 2014). These formulations belong to the following chemical classes : sulfonylurea(nicosulfuron), substituted ureas (diuron), toluidin (pendimethalin), etc.

5.2. Integrated production and pest management (IPPM)

IPPM experience launched by FAO in collaboration with the Ministers of Agriculture in several Sahel countries allows to obtain important results in agricultural production and pest management. This initiative of good agricultural practices (GAPs) allows to enhance agricultural productivity and to train several farmers as potential facilitators. IPPM is based on the following principles:

- A wise and judicious use of pesticides ;
- Acquiring knowledge and practices needed in pest management;
- Strengthening the farmers' decision-making capacity at the field level;
- Improving productivity at reduced costs while protecting the environment.

7. Conclusions

Acetochlor presents risks to people's health due to real risks of water resources contamination from several metabolites among which Nor acétochlor which has genotoxic potential, high risk to aquatic organisms and long term risks to herbivore birds and to human beings following prolonged exposure. All these risks justified its ban in many countries in the world and in all the EU countries. The Sahelian Pesticide Committee terminated the registration of acetochlor based pesticides in CILSS countries considering all the risks described and also taking into account:

- Difficulties met by the population to get adequate personal protection equipment, ;
- The fragile ecology of CILSS countries characterised by torrential rains on soils which are often poor in organic matter and thus highly subject to erosion and leaching ;
- The absence of an environment management system respecting buffer strips between treated fields and water courses ;
- The use of surface water as drinking water for man and animals;
- The use of groundwater as the only reservoir of drinking water;
- The existence of alternatives to the use of acetochlor

CILSS Coordinating Minister publishes this ban to bring to the public knowledge the decision to ban acetochlor based pesticides in a transparent way, with a view to improve people's health and preserve the environment in CLSS countries.

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PESTICIDES RISK ASSESSMENT BY PIRI FOR SURFACE WATER IN SUGAR CANE CULTIVATION IN BURKINA FASO

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One consequence of land use for industrial sugar cane production by the SN-SOSUCO society (Nouvelle Société Sucrière de la Comoé) in the South Western part of Burkina Faso is the application of different pesticides. In our continued work on evaluating the contamination risk of pesticides to water resources, this study aimed to assess the risk of surface water contamination during the season 2007-2008. The risk was evaluated using the Pesticide Impact Rating Index (PIRI) software developed by CSIRO Australia, with the assumption of three scenarios taking into account soil organic matter content and the presence of a buffer zone. The results show that of the 13 pesticides applied, 4 (acetochlor, metribuzin, MSMA, terbufos) had very high potential and 4 (glyphosate, pendimethalin, MCPA, diuron) had high potential to contaminate surface water under actual usage conditions. Likewise, chlorimuron-ethyl, carbofuran, trichlopyr and pichloram had medium potential and triadimefon had very low pollution potential. The risk of contamination is reduced by the organic carbon content of soil and the distance from the pesticides application area to surface water. Promotion of better agricultural practices and the planting of a buffer zone of trees are required in order to prevent surface water pollution in the area.

INTRODUCTION

Among the usage of pesticides, crop protection against pests is one of the largest uses in agriculture. However, besides the desired effects of pest control, non-target organisms, soil and water are contaminated by the applied pesticides with direct consequence on ecosystems (Ramade, 1992) resulting in high risks for human beings. Of the applied pesticides, less than 0.1% effectively reaches the target organisms (Pimentel, 1995) and, consequently, pesticide residues are frequently found in the environment at considerable distances from the original point of their application (Van de Werf, 1996; Sutherland et al., 2002; Siddique et al., 2003; Calvet et al., 2005).

Since the 1960s, many studies were focused on the determination of pesticide residues in water within intensive agricultural practice zones all over the world. These studies have revealed the presence of pesticides in groundwater (Van de Werf, 1996; Ali and Jain, 2001; Traore et al., 2006; ORP, 2011) as well as in surface water (Van de Werf, 1996; Ali and Jain, 2001; Tapsoba et al., 2008; ORP, 2011). Hence, many programs in developed countries have been set up to minimize the impact of diffuse pollution by pesticides (Margoum et al., 2003; ORP, 2011). In developing countries, the risks of pesticides usage on both environment and human health are still an all too common reality and are responsible for a large portion of environmental damages.

Previous studies in Burkina Faso showed the potential risk of water resources contamination by pesticides (Toe et al., 2000; Toe et al., 2002; Toe and Coulibaly, 2006; Gomgnimbou et al., 2009) and the risk for the users (Toe et al., 2000; Toe et al., 2002). Some studies have revealed pesticides contamination in both soils and waters (Toe et al., 2004; Savadogo et al., 2006; Tapsoba et al., 2008) within cotton growing areas.

In the south western part of Burkina Faso, sugar cane is intensively cultivated by SN-SOSUCO (Nouvelle Société Sucrière de la Comoé), on an area covering 3850 ha. SN-SOSUCO is a public-private partnership enterprise and Burkina Faso's largest private employer, with a workforce of over 3,000, including 800 permanent staff, 400 seasonal workers and more than 1,800 day workers. The total sugar cane production per year is about 300,000 tons of which 25,000 to 30,000 tons of the sugar are for domestic consumption (Hema, 2008). The sugar cane farming is a year-round activity. To supplement the annual rains, the cane is irrigated by an 18 x 18 irrigation system pivot front-mounted spray booms and micro-irrigation. Water is fed by gravity from the Comoé, Toussiana and Lobi dams. This intensive agriculture requires SN-SOSUCO to import fertilizers and pesticides for cultivation. These inputs are supplied to all the permanent and temporary farmers, with well schedule application patterns (MEE, 2001). During the 2006/2007 season, 55.2 metric tons of pesticides were used by this society for sugar cane cultivation (Ouattara, 2007), with one application for the whole season. The observation of agricultural practices in the field has shown that good agricultural practices were not followed, including monitoring and management of buffer zones. In 2001, some pesticides residue measurements showed the presence of atrazine in the piped water lines and also in the waters of surrounding lakes at concentrations of 0.39 and 0.72 $\mu\text{g/l}$ respectively (MEE, 2001). In a previous study (Toe et al., 2012) it has been shown that pichloram, carbofuran, trichlopyr, monosodium methanarsonate (MSMA), and the chlorimuron-ethyl have high leaching potential for groundwater contamination.

From the aforementioned cases, the assessment of the surface water pollution in the area is required, both as a part of our previous study (Toe et al., 2012) and to set techniques and strategies for better management of the water resources in the area. The aim of this study was to evaluate the risk of the surface water contamination by pesticides used in the cultivated area of the SN-SOCUCO during the season 2007-2008. To achieve this goal, Pesticide Impact Rating Index (PIRI) software developed by CSIRO Australia (Kookana et al., 2005) were used.

MATERIAL AND METHODS

Description of the study area

The SN-SOSUCO cultivated area is located in the south western part of Burkina Faso, the Cascades Region, which lies between latitude 10°41' to 10°47' north and longitude 4°38' and 4°39' west (Figure 1). The climate is Sudanese Sahelian with an average annual rainfall and temperature from 1974 to 2004 of 1,100 mm and 27 °C, respectively (Millogo et al., 2004). Soil organic matter varied from 1.06% to 1.36% within the perimeter (Direction culture/SN-SOSUCO, 2008).

Soils from the study area are of three types: i) raw mineral soils with sandstone outcrops; ii) tropical ferruginous soils characterized by sandy and sandy clay structure; iii) and hydromorphic soils generally found in swampy areas, while sands are found around the lakes (Millogo et al., 2004).

The study area has two lakes: Lake Karfiguela and Lake Lemouroudougou located 70 and 100 m, respectively, from the cultivated area, as well as two small rivers, River Yannon and River Berega, located 30 m from the cultivated area, which join to form one river (Figure 1).

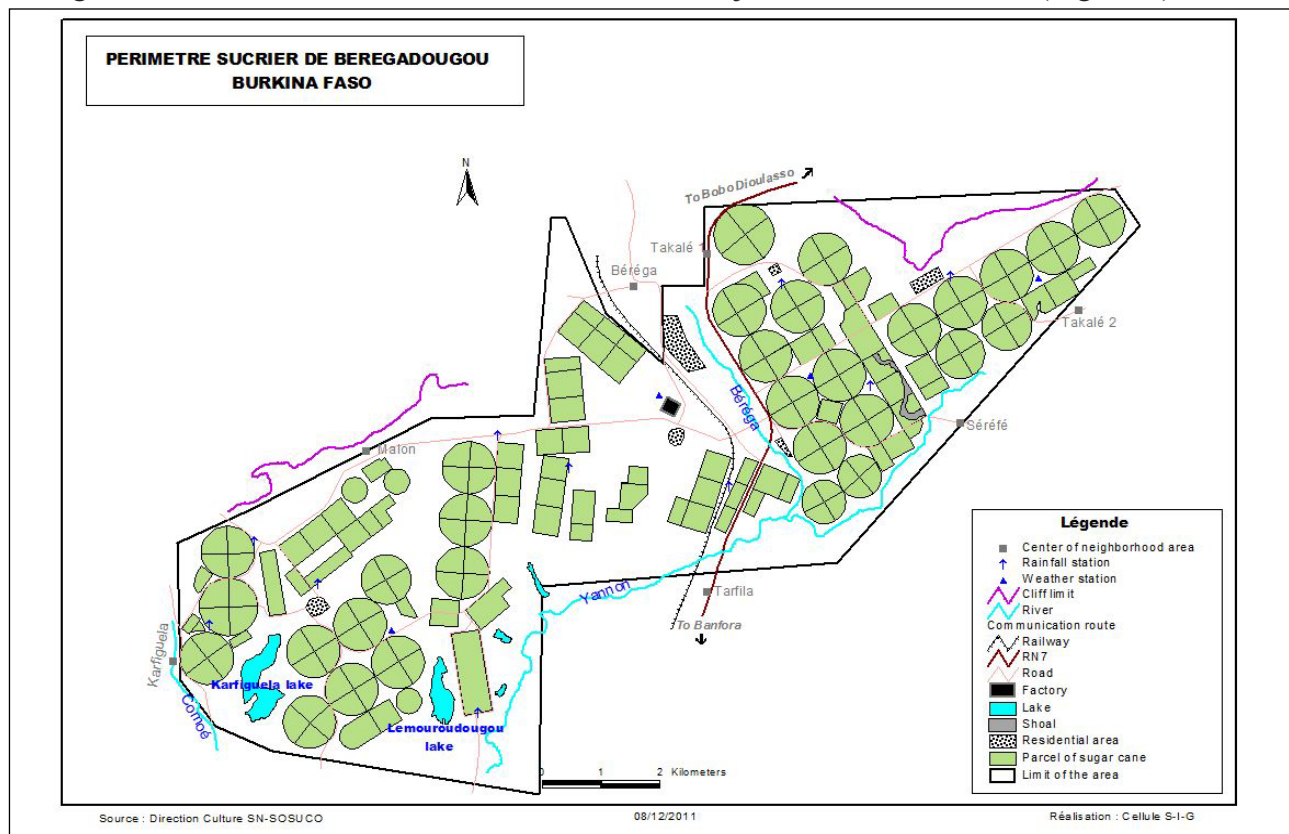


Figure 1. Map of the study area (Redrawn from Direction Culture/SN-SOSUCO, 2011).

Soil in the surroundings of Lake Karfiguela has mean organic carbon (OC) content of 1.24%, while the surrounding of Lake Lemouroudougou has 1.36% organic carbon content. The mean OC in soils near the rivers is equal to 1.06% (Table 1). The slope of the study area is estimated to 4% and yearly soil erosion to 5 t/(ha · year). The total amount of water used for irrigation during the study period was 396 mm and the cumulative rainfall from November 2007 to August 2008 was 800 mm (SN-SOSUCO, Irrigation service, 2008).

Table 1. Some PIRI input information of surface water in the area*

Surface water	Width of the water resource (m)	Distance to the application area (m)	Organic carbon content of soil in the neighborhood (%)
Lake Karfiguela	350	70	1.24
Lake Lemouroudougou	200	100	1.36
Rivers Yannon and Berega	5	30	1.06

* From Direction culture/SN-SOSUCO, 2008

Pesticide Impact Rating Index (PIRI)

The Pesticide Impact Rating Index (PIRI) is a software package developed by CSIRO with support from Land and Water Australia and other agencies. PIRI is a model to predict the potential for pesticides to move off-site and pollute adjacent waterways (CSIRO, 2001) based on quantitative risk management, and taking into account the selected pesticides chemical properties, application rates and frequency, climatic seasons and soil variables. PIRI's objective is to determine which among an array of pesticides has the greatest potential of contaminating the environment and the water pathway.

In this study, the evaluation and calculation of parameters needed for PIRI software are carried out according to the methods developed by Kookana et al., (2005). The concentration of pesticide in receiving waters (C_{SW}) is calculated, as suggested by OECD (1998), from the pesticide load moving into surface water adjacent to the field being treated. This needs consideration of the relative size of the water body as compared to the field being treated (WI) and the depth of water H (m) in it. WI is the water index defined as an approximate ratio of length of shoreline of the adjacent surface water to the perimeter of the field being treated (OECD, 1998).

Thus the predicted concentration (C_{SW} in kg m⁻³) of pesticide in surface water with depth H (m), adjacent to treated area is:

$$C_{SW} = L \times T \times WI/H \quad (1)$$

where L is the mass of pesticide applied to the soil and T is the total surface transport factor for each pesticide, determined according to Kookana et al. (2005).

PIRI ranks pesticide in a following category : 'Very Low', 'Low', 'Moderate', 'High', 'Very High' and 'Extremely High'. These categories are based on a relative ranking of the pesticides for their potential for off-site migration against one another under a selected set of site, soil and environmental conditions. 'Very Low' and 'Low' categories indicate that the probability of off-site migration of pesticides is low and represents a scenario where one would not expect these compounds to be routinely detected in water. 'Moderate' risk implies that the compounds are likely to move off-site and be detected in waterways in close proximity to the site. The higher risk categories ('High', 'Very High', 'Extremely High') progressively show increased probability of the chemicals moving off-site and being detected in waterways. The divide between medium and

high categories is 1.00, and the other categories limits are separated by a factor of 4.64 (corresponding to antilog of 0.667) (Kookana and Correll, 2008).

Pesticides used in the study area during the season 2007-2008 as listed in Table 2 are in the focus of the present study. The need parameters are obtained from the SN-SOSUCO society department in charge of the irrigation, and from Footprint (2008).

Hypothesis and scenarios

To run the software, we set up hypothesis and scenarios as follows: the outputs from PIRI have realistic bounds, which are guided by existing data as described in the material section above and references therein. In order to set up better environmental management plan, we assume two others situations, which are likely to occur. Hence, in total, three scenarios are considered in this study.

Scenario 1 is the actual situation of the area with mean organic carbon content of the soil equal to 1%, without any buffer zone. In Scenario 2, a buffer zone between the treated area and the adjacent surface water is introduced, while the organic carbon content of soil remaining the same, i.e. 1%. The third scenario is the worst case one, likely to occur sometimes within a longer timeframe, with no buffering zone, and mean organic carbon content of soil equal to 0.1%. In fact, according to some survey undertake in the area, the organic carbon content of the soil is already decreasing with the present usage condition.

Table 2. Pesticides used by the SN-SOSUCO during the season 2007–2008 and their application rate.

Pesticide formulation	Usage	Active ingredient (a.i.)	Concentration a.i. (g/L or g/kg)	Application rate of a.i. (kg or L/ha)
EXTREME PLUS WP	Herbicide	Metribuzin / chlorimuron-ethyl	643 / 107	0.76 / 0.13
PARAGON 500 EC	Herbicide	Pendimethalin	500	2.01
VOLCANO acetochlor 900 EC	Herbicide	Acetochlor	900	3.54
DINO 800 W	Herbicide	Diuron	800	1.24
KALACH 360 SL	Herbicide	Glyphosate	360	2.83
VOLCANO MCPA 400 SL	Herbicide	MCPA ^a	400	0.61
MASTER 720 SL	Herbicide	MSMA ^b	720	2.03
TRICLON 480 EC	Herbicide	Trichlopyr	480	0.91
BROWSER	Herbicide	Pichloram	240	0.33
DIAFURAN 10 G	Insecticide	Carbofuran	100	0.03
COSMOPOL 15 G	Insecticide	Terbufos	150	5.00
BAYLETON 250 EC	Fungicide	Triadimefon	250	0.05

^a4-Chloro-2-methylphenoxyacetic acid

^bMonosodium methanarsonate

RESULTS AND DISCUSSION

The results of the pesticide risk assessment for surface water within the SN-SOSUCO area are given in Tables 3-5.

As shown in Table 3, acetochlor, used in all the cultivated area with mean quantity of 3.54 L active ingredient/ha, have very high risk for both River Berega and River Yannon. Even in case of the scenario 2, with a planned buffer zone, the potential risk for this pesticide to contaminated theses adjacent rivers is high as indicated by the PIRI impact rating. In Table 4 and 5, this pesticide, acetochlor has also very high potential for contamination of Lake Lemouroudougou and Lake Karfiguela, respectively, in the actual land use condition by the SN-SOSUCO (Scenario 1), and

Table 3. PIRI risk rating for pesticides used by the SN-SOSUCO during the season 2007–2008 for rivers Berega and Yannon vs scenarios.

Pesticides	PIRI risk rating		
	Scenario 1	Scenario 2	Scenario 3
Acetochlor	Very high	High	Extremely high
Metribuzin	Very high	Medium	Very high
MSMA	Very high	Medium	Very high
Terbufos	Very high	Medium	Very high
Glyphosate	High	Medium	High
Pendimethalin	High	Low	High
MCPA	High	Low	High
Diuron	High	Low	High
Chlorimuron-ethyl	Medium	Very low	High
Carbofuran	Medium	Very low	Medium
Triclopyr	Medium	Very low	Medium
Picloram	Medium	Very low	Medium
Triadimefon	Very low	Very low	Very low

Table 4. PIRI risk rating for pesticides used by the SN-SOSUCO during the season 2007–2008 for Lake Lemouroudougou vs scenarios.

Pesticides	PIRI risk rating		
	Scenario 1	Scenario 2	Scenario 3
Acetochlor	Very high	Very low	Extremely high
Metribuzin	Very high	Low	Very high
MSMA	Very high	Low	Very high
Terbufos	Very high	Very low	Very high
Glyphosate	High	Low	High
Pendimethalin	High	Low	High
MCPA	High	Very low	High
Diuron	High	Very low	High
Chlorimuron-ethyl	Medium	Very low	High
Carbofuran	Medium	Very low	Medium
Triclopyr	Medium	Very low	Medium
Picloram	Medium	Very low	Medium
Triadimefon	Very low	Very low	Very low

Table 5. PIRI impact rating for pesticides used by the SN-SOSUCO during the season 2007–2008 for Lake Karfiguela vs scenarios.

Pesticides	PIRI risk rating		
	Scenario 1	Scenario 2	Scenario 3
Acetochlor	Very high	Medium	Extremely high
Metribuzin	Very high	Medium	Very high
MSMA	Very high	Medium	Very high
Terbufos	Very high	Very low	Very high
Glyphosate	High	Medium	High
Pendimethalin	High	Medium	High
MCPA	High	Very low	High
Diuron	High	Low	High
Chlorimuron-ethyl	Medium	Very low	High
Carbofuran	Medium	Very low	Medium
Triclopyr	Medium	Very low	Medium
Picloram	Medium	Very low	Medium
Triadimefon	Very low	Very low	Very low

extremely high potential in Scenario 3. However, if a buffer zone is arranged as assumed in Scenario 2, the risk is very low and medium for Lake Lemouroudougou and Lake Karfiguela, respectively. The difference between the risk for rivers and lakes, a higher risk for the rivers than the lakes, could be attributable to the distance between the surface water and the cultivated area, as it was noted that buffer zone width has a large impact on risk (Trainer and Volker, 2008). Additionally, there is also a risk related to the high quantity of acetochlor used in the area (10,685 L), since its mobility is low ($K_{oc} = 156 \text{ L/kg}$) and it has a short persistence time in soil ($DT_{50} = 14 \text{ days}$) (Footprint, 2008).

Very high PIRI ratings were shown for the applied pesticides metribuzin, MSMA and terbufos for all the water resources in Scenarios 1 and 3. The plan of a buffer zone, will significantly contribute to the decrease of the impact rating from very high to medium for the rivers and Lake Karfiguela. The PIRI risk rating for terbufos become very low for both Lakes Karfiguela and Lemouroudougou, while MSMA and metribuzin have low risk rating for Lake Lemouroudougou. As previously pointed out, the difference between PIRI risk impact ratings for the two lakes could be attributable to the distance between the lake and the nearest border of the cultivated areas. The plan of buffer area by planting trees will contribute to reduce the impact, mainly if the trees contributes to maintain soil organic carbon content. The risk rating is also linked to the quantity of pesticides used. Indeed, as shown in Table 2, terbufos is not highly mobile, but is widely used in the area, up to 5.00 kg/ha , hence his very high risk rating in Scenarios 1 and 3.

Glyphosate, pendimethalin, MCPA and diuron have high risk rating in the actual condition of usage, Scenario 1. Hence, the importance of planning buffer zone to reduce the impact (scenario 2). Diuron and glyphosate have been often detected in surface water resources in France (ORP, 2011). Atrazine and diuron have been also detected in surface water in USA (USEPA, 2010), showing that these pesticides had potential risk in surface water contamination.

This study, and many others (Holvoet et al., 2007; Calvet et al., 2005) have shown the importance of organic carbon content in soil, and the management of buffer zone between the cultivated area

and the surface water. Scenario 3 clearly shows that the organic carbon content in soil is very important in controlling pesticides transfer from his application point to surface water. In accordance with our findings, Margoum et al. (2003) reported that pesticides transfer through drift to receiving surface water, is reduced as the distance between the surface water body and the application point is increased. The key factors susceptible to reducing or increasing the threat of the products to the surface water seem to be the soil organic carbon content, and a planning of buffer zone.

CONCLUSION

Results from PIRI impact rating find in this study show that of the 13 pesticides applied by SN-SOSUCO during the season 2007-2008, 4 had very high potential to contaminate surface water bodies in the area, and 4 had high rating impact risk in the current usage condition. These depend mainly on the quantity of each pesticide used, the distance between the pesticide application point and surface water as well as the presence of a buffer zone. The setup of a buffer zone would have a positive impact in reducing the contamination risk of pesticide to surface water. In addition, good agricultural practice is a key point to minimize the transfer of the pesticides to surface water. Hence, it is recommended to proceed to the inclusion of a buffer zone, by planting trees as suggested in Scenario 2 in this study. The usage of acetochlor has to be well controlled, if this pesticide cannot be substitute by another one. Analysis of pesticide residues in surface water in the area is being considered in order to set up sustainable environmental management system. However, better agricultural practices have to be set up, such as choosing the best dose and application period, controlling toxic substance impacts, combined with non-chemical practices.

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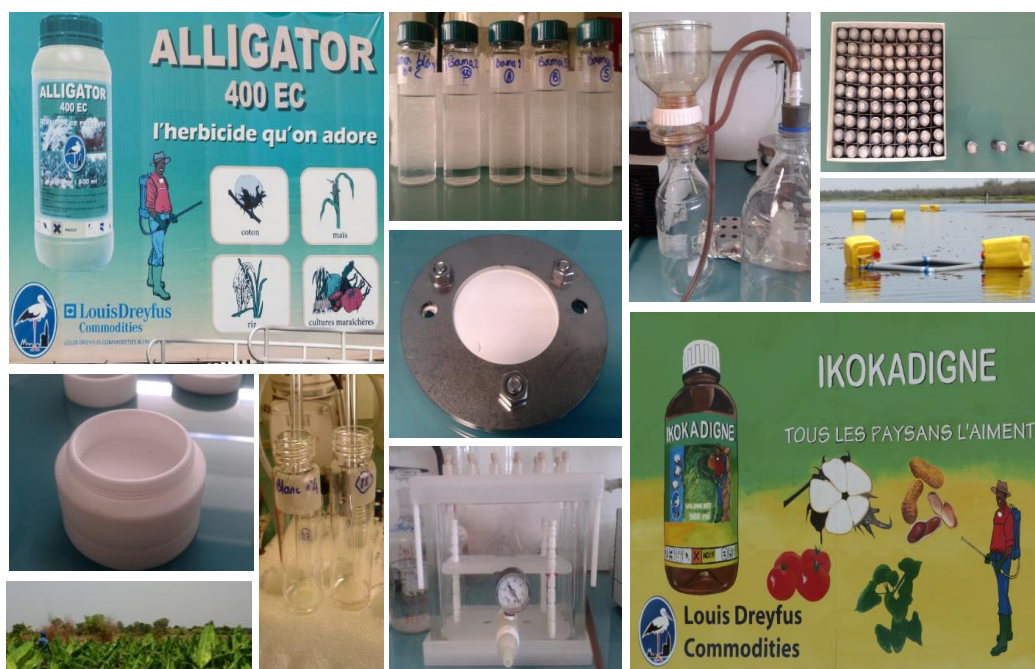
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Etude de la pression phytosanitaire exercée sur différents lacs du Burkina Faso par méthode d'échantillonnage passif



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Mémoire de stage de Master 2^{ème} année

Mention : Contaminants Eau Santé

Responsables du stage : GONZALEZ Catherine, CECCHI Philippe

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1. Introduction

La présente étude s'inscrit dans le cadre d'une initiative internationale de recherche : Challenge Project on Water and Food (CPWF), centrée sur la gestion et l'utilisation de l'eau pour la production alimentaire. Les travaux du CPWF sont concentrés sur 6 grands bassins à travers le monde : les Andes (10 bassins versants répartis sur la Bolivie, la Colombie, l'Equateur et le Pérou), le Ganges, le Limpopo, le Mékong, le Nil et la Volta. Pour le bassin de la Volta, il s'agit de renforcer la gestion intégrée des eaux pluviales et des petits réservoirs afin de contribuer à la réduction de la pauvreté, et au bien-être des populations du Burkina Faso et du nord du Ghana.

L'objectif de cette étude consiste à caractériser la pression phytosanitaire exercée sur 3 différentes retenues d'eau du bassin de la Volta au Burkina Faso (lacs de Bala, Bama et Boura). Le screening des produits phytosanitaires potentiellement présents est réalisé par échantillonnage passif. L'étude repose sur une approche qualitative (screening) et quantitative (détermination de la concentration des pesticides présents de façon significative sur les différents sites sélectionnés).

Ce stage a été réalisé d'une part, au sein de l'équipe Ecodiag (diagnostique et gestion des systèmes anthropiques et naturels) du Laboratoire Génie de l'Environnement Industriel (LGEI) de l'Ecole des Mines d'Alès (EMA), et d'autre part au Burkina Faso pour les missions de terrain encadrées par le CIRAD.

1.1. Présentation de l'entreprise

1.1.1. Ecole des Mines d'Alès

L'Ecole des Mines d'Alès, outre la formation de futurs ingénieurs, possède trois centres de recherche composés de 110 enseignants chercheurs : le Laboratoire de Génie Informatique et Ingénierie de Production (LGI2P), le LGEI (Laboratoire Génie de l'Environnement Industriel) et le Centre des Matériaux des Mines d'Alès (C2MA).

Le LGI2P relève essentiellement du domaine des sciences et technologies de l'information et de la communication, avec la mise en place de procédures et d'outils limitant les contraintes auxquelles sont confrontés les industries et les services.

Les activités du C2MA concernent le développement et l'étude de matériaux innovants dans le domaine des matériaux polymères et de matériaux minéraux ou à matrice minérale pour le génie civil.

Le LGEI est axé sur quatre thématiques dans des domaines de l'environnement industriel et du risque environnemental constituant quatre équipes de recherche (Annexe 1 : Organigramme du LGEI).

- Risques industriels et naturels, proposant une démarche de prévention, de protection et de gestion de crise, dans le cadre d'accident majeur ou de catastrophe naturelle ;
- Odeurs et composés organiques volatils, pour développer et optimiser différents procédés de traitement de gaz chargés en composés odorants et/ou organiques volatils par principes biologiques et physico-chimiques ;
- Structures et hydrosystèmes basés sur la modélisation des structures hydrogéologiques et structures béton ;
- Ecodiag, développant d'une part des méthodes d'analyse et de screening des polluants organiques persistants et d'autre part, des biocapteurs. A partir de ce diagnostic appliqué sur un système donné (système industriel, STEP, bassin hydrographique,...), l'objectif est, par ailleurs, de proposer des procédures de gestion permettant une prise en compte non seulement des aspects environnementaux mais également socio-économiques.

1.1.2. CIRAD

Le CIRAD (Centre de coopération Internationale en Recherche Agronomique pour le Développement) apporte de nouvelles connaissances, pour accompagner le développement agricole des pays du Sud et contribuer au débat sur les grands enjeux mondiaux de l'agronomie. Ses activités relèvent des sciences du vivant, des sciences sociales et des sciences de l'ingénieur appliquées à l'agriculture, l'alimentation et aux territoires ruraux selon 6 axes prioritaires :

- Intensification écologique : Contribuer à inventer une agriculture écologiquement intensive pour nourrir la planète ;
- Biomasse énergie et sociétés du Sud : Etudier les conditions d'émergence et les modalités de mise en valeur des bioénergies en faveur des populations du Sud ;
- Alimentation sûre et diversifiée : Innover pour une alimentation accessible, diversifiée et sûre ;

- Santé animale, maladies émergentes : Anticiper et gérer les risques sanitaires infectieux liés aux animaux sauvages et domestiques ;
- Politiques publiques, pauvreté et inégalités : Accompagner les politiques publiques pour la réduction des inégalités structurelles et de la pauvreté ;
- Agriculture, environnement, nature et sociétés : Mieux comprendre les relations entre l'agriculture et l'environnement et entre les sociétés humaines et la nature, pour gérer durablement les espaces ruraux.

12 unités de recherche, soit le tiers des unités du CIRAD interviennent au Burkina Faso. Cette étude s'inscrit dans le cadre de l'UMR G-Eau (Gestion de l'Eau, Acteurs, usages), qui, outre le CIRAD, regroupe aussi des équipes de l'Irstea, de l'IRD, de Montpellier SupAgro et de L'Institut Agronomique Méditerranéen de Montpellier (IAMM). Cette équipe pluridisciplinaire sur la gestion de l'eau intervient en France, en Europe et dans les pays du Sud. L'UMR G-Eau a participé à l'Institut Fédératif de Recherche (IRF) ILEE (Institut Languedocien de l'Eau et de l'Environnement) avec l'EMA. Toutes deux se retrouvent désormais dans l'IM2E (Institut Montpelliérain de l'Eau et de l'Environnement).

1.2. CPWF-V3

Le CPWF est articulé autour de 5 projets de recherche dont le CPWF-V3. L'objectif de ce dernier est de contribuer à une gestion intégrée des petits réservoirs à vocation multi-usages, en développant des méthodes fondées sur la participation des parties prenantes. Il a notamment pour objectifs de perpétuer les infrastructures et de protéger et/ou améliorer la qualité de l'eau à usages multiples. Cette étude contribue à la détermination des impacts dus à l'intensification des pratiques agricoles sur la santé et l'environnement.

Le réseau hydrographique du Burkina Faso alimente quatre grands bassins fluviaux que sont le Mouhoun, le Nakambé, la Comoé et le Niger (Figure 1). Le bassin du fleuve Volta, faisant l'objet des études du Challenge Project on Water and Food V3 (CPWF-V3), regroupe les bassins du Mouhoun et du Nakambé, et occupe les deux tiers du pays. Il se forme au centre ouest du Burkina Faso, donnant naissance au fleuve Volta, long de 1600 kilomètres, qui termine sa course dans le golfe de Guinée en formant notamment le lac Volta au Ghana. Trois des affluents de ce fleuve prennent leur source au Burkina Faso : Le Mouhoun (Volta Noire), le Nakambé (Volta Blanche) et le Nazinon (Volta Rouge). Le Mouhoun est la branche principale du fleuve Volta, il prend sa source sur le plateau gréseux au Nord de la falaise de Banfora.

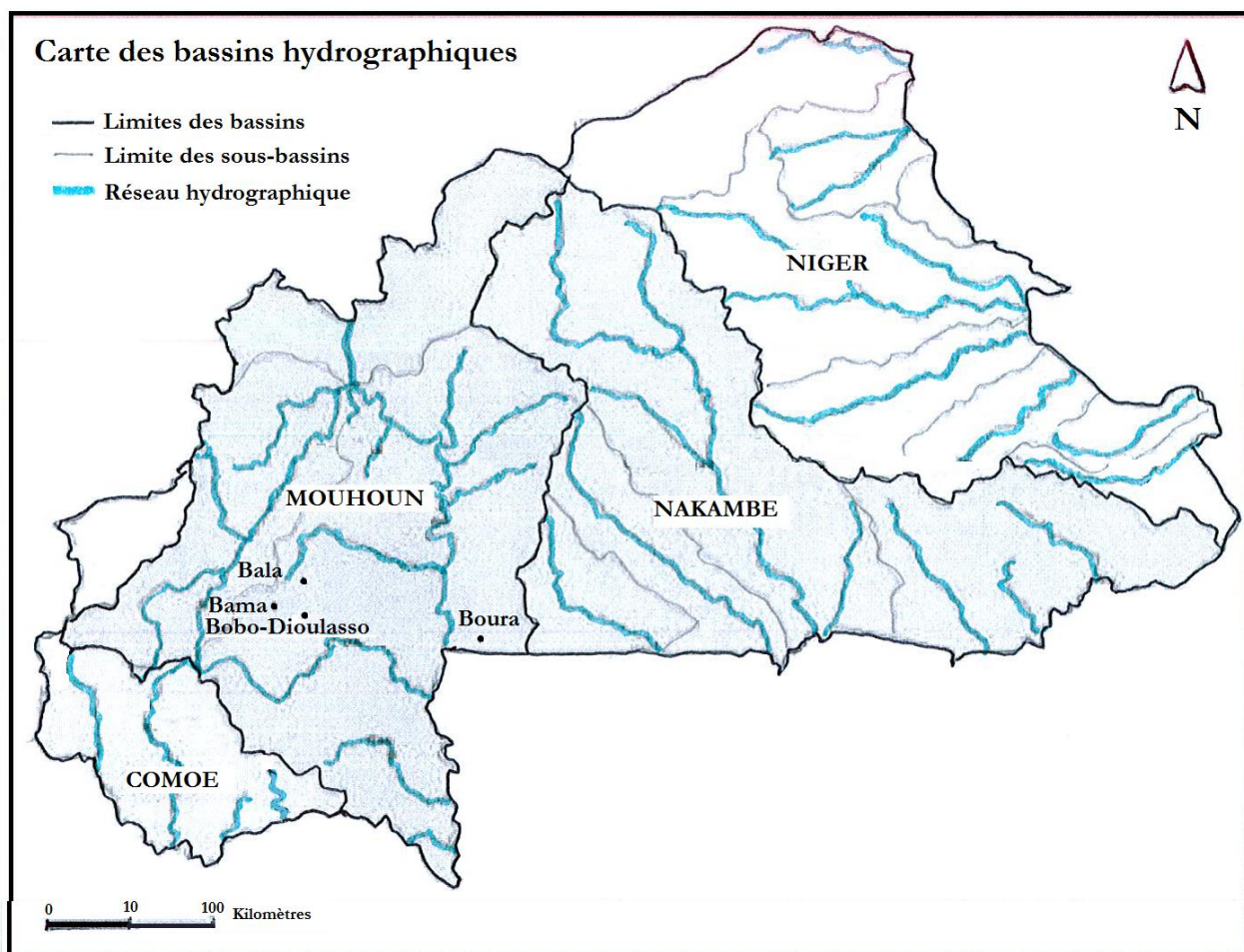


Figure 1 : Carte des bassins hydrographiques du Burkina Faso

Trois lacs ont été sélectionnés pour cette étude:

- Bala, site de référence, considéré comme peu impacté ;
- Bama, centre de nombreuses activités agricoles, considéré très impacté ;
- Boura, un des deux sites pilotes des études conduites par le projet V3 : *Integrated Management of Small Reservoirs* du CPWF.

2. Contexte et problématique

2.1. Agriculture au Burkina Faso

Le secteur agricole occupe une place prépondérante au Burkina Faso, il constitue environ 40% du produit intérieur brut (PIB) du pays et emploie 86 % de la population active. Une large part des exportations du pays (80 %) est représentée par ce secteur. Ceci étant, la plupart des produits sont autoconsommés, on parle d’agriculture de subsistance. Seuls, le coton, le riz,

l'arachide, les produits maraîchers et fruitiers sont commercialisés [1]. 3,6 millions d'hectares sont dédiés à l'agriculture et 85 à 95 % de la population en dépendent. Les céréales représentent environ 82 % de ces cultures, suivies des cultures maraîchères (15 %) [2]. Le coton reste le principal produit de rente du Burkina Faso procurant près de 70 % des recettes d'exportation du pays [3].

Situé sur une zone pédologique sensible et vulnérable, le pays est soumis à une diminution accélérée de ses ressources naturelles. En effet, les aléas climatiques et les déplacements de populations ont eu des conséquences graves sur l'environnement et provoqué un retard économique de plusieurs régions [4]. La dynamique d'occupation des sols est un facteur clé car elle modifie les interactions terre-atmosphère, une forte pression anthropique ou climatique sur les sols entraîne une dégradation du couvert végétal [5]. Dans cette partie du continent africain, l'agriculture est essentiellement pluviale et tributaire des aléas climatiques souvent défavorables [6]. La pluviosité du pays est caractérisée par une irrégularité aussi bien en termes de quantité que de répartition dans l'espace et le temps. Cela a conduit à des sécheresses récurrentes et à des productions agricoles aléatoires [7].

En réponse à ces sécheresses récurrentes, plus de 1700 petits barrages ont été construits afin de mobiliser les eaux de surface. Plus de la moitié des surfaces irriguées du pays dépendent de ces petits barrages [8]. Cette agriculture intensive et l'irrigation entraînent l'apparition de nuisibles pour les cultures (insectes, maladies) mais également de vecteurs de maladies humaines notamment l'anophèle (paludisme) et de parasites. Les maladies et ravageurs des cultures causent des dégâts considérables, pouvant engendrer dans certains cas des pertes en production s'élevant à plus de 30% [9].

2.2. Utilisation des pesticides au Burkina Faso

La lutte contre les ravageurs de culture, implique l'utilisation massive de différents produits phytosanitaires. L'utilisation de ces pesticides représente un réel danger pour l'utilisateur, mais aussi pour le consommateur exposé indirectement aux substances et pour l'environnement.

Une étude sur les facteurs de risques toxicologiques chez les utilisateurs réalisée au Burkina Faso, montre qu'une majorité des utilisateurs de cette région sont analphabètes et ignorent les conséquences sanitaires et écologiques de l'utilisation des pesticides. De plus, les équipements de protection individuels ne sont jamais complets ni adéquats [10]. L'utilisation

des pesticides a un impact négatif direct sur la santé humaine à différentes échelles selon la personne exposée, le type de pesticide et la dose d'exposition [11]. Selon l'OMS, environ 3 millions de personnes sont hospitalisées chaque année dans le monde, suite à ce type d'exposition. Environ 220 000 cas mortels et 750 000 cas de maladies chroniques sont recensés, principalement dans les pays en voie de développement. Parmi ces maladies, nous pouvons citer les troubles respiratoires, des effets sur la reproduction et des cancers. Des troubles neurologiques ont aussi été mis en évidence : dépression, anxiété, difficultés de concentration et de compréhension, désorientation spatiale [12] [13].

Généralement, peu d'agriculteurs sont conscients de l'impact de l'utilisation des produits phytosanitaires sur l'environnement. Le choix du produit de traitement se fait exclusivement sur des critères d'efficacité et de coût : la dangerosité vis-à-vis de l'environnement entre peu en ligne de compte. La contamination de l'environnement est directement liée aux propriétés physicochimiques des substances actives. Les molécules persistantes, solubles dans l'eau, comme la plupart des herbicides se retrouvent dans l'eau, en particulier dans les eaux souterraines, alors que les produits volatils ont tendance à se retrouver dans l'atmosphère. De plus, la localisation des parcelles traitées conditionne très fortement cette contamination. Ces différents facteurs complexifient l'appréhension des impacts environnementaux de manière générale. En effet, à pratiques identiques, les impacts environnementaux peuvent être très différents selon les conditions du milieu (vulnérabilité, organisation spatiale...), le type de substance utilisé, et les relations existantes entre les pesticides et les divers constituants biotiques et abiotiques de l'écosystème en question [14] [15].

La perturbation des organismes aquatiques engendrée par les pesticides est mise en évidence dans plusieurs études. Ces perturbations peuvent se traduire par exemple par une diminution de la biodiversité du milieu contaminé : une étude a été réalisée sur une population de 25 espèces aquatiques différentes, en fonction de la substance utilisée, on observe une diminution allant de 15 à 30 % des espèces présentes dans le milieu [16]. Ces expositions peuvent aussi provoquer un déséquilibre de compétitivité entre les organismes (selon leur sensibilité à la substance) pour l'accès aux ressources du milieu [17]. Dans le contexte du Burkina Faso, une étude d'écotoxicité a été réalisée sur deux pesticides couramment utilisés : le paraquat (herbicide) et la deltaméthrine (insecticide), au niveau de 3 réservoirs du bassin de Nakambé. Le paraquat et la deltaméthrine ont révélé respectivement une toxicité pour les micro-algues et les espèces zoo-planctoniques ce qui concorde avec leurs modes d'action, cependant, le

paraquat présentait aussi une toxicité significative pour les bactéries naturellement présentes dans le milieu : micro-organismes non-cible de la substance [18].

Généralement, les pesticides sont classés selon les cibles auxquelles ils sont destinés (herbicides, fongicides, insecticides...). Ils peuvent également être regroupés en fonction de leurs composants actifs. Nous pouvons citer les familles suivantes : organochlorés (DDT, lindane, endosulfan...); organophosphorés ; carbamates ; triazines (atrazine, simazine...) ; acétamides (acétochlore, alachlore...) et pyréthrinoïdes (deltaméthrine...) [19].

La réalisation d'une synthèse (Annexe2 : Recensement des pesticides utilisés au Burkina Faso) de différentes enquêtes d'utilisation des pesticides au Burkina Faso, (Bobo Dioulasso, Ouahigouya, Ouagadougou, Fada N'Gourma et Kompienga) a permis de recenser les substances susceptibles d'être rencontrés dans ces régions (Tableau 1). Cette liste est non exhaustive puisqu'elle ne représente que 5 régions du Burkina Faso et qu'elle est basée uniquement sur des enquêtes réalisées auprès de producteurs, de commerçants et d'agents de poste de santé. Cette liste ne s'appuie pas sur des résultats analytiques.

Matière active	Famille	Utilisation	Classe OMS		Ville, Région	Source
Azadirachtine	Limonoïdes	Maraîchage	NC	Très dangereuse	Bobo Dioulasso	IFDC 2007
Acéphate	Organophosphorés		III	Peu dangereuse	Ouagadougou	
Acétamipride	Néonicotinoïdes	Coton	II	Modérément dangereuse	Bobo Dioulasso	[10]
Atrazine	Triazines		III	Peu dangereuse	Fada N'Gourma	
Carbofuran	Carbamates	Maraîchage	Ib	Très dangereuse	Bobo Dioulasso	IFDC 2007
Chlorpyrifos-éthyl	Organophosphorés	Coton	II	Modérément dangereuse	Ouagadougou	
Cyhalothrine	Pyréthrinoïdes		II	Modérément dangereuse	Ouahigouya	
Cyperméthrine	Pyréthrinoïdes		II	Modérément dangereuse	Bobo Dioulasso	
Deltaméthrine	Pyréthrinoïdes	Maraîchage	II	Modérément dangereuse	Ouahigouya	
Diméthoate	Organophosphorés		II	Modérément dangereuse		
Diuron	Halogénophénylurés	Coton	II	Modérément dangereuse	Fada N'Gourma	[10]
Endosulfan	Organochlorés		Ib	Très dangereuse	Bobo Dioulasso	IFDC 2007
Glyphosate	Aminophosphonates		III	Peu dangereuse	Kompienga	[3]
Lambdacyhalothrine	Pyréthrinoïdes		III	Peu dangereuse	Bobo Dioulasso	IFDC 2007
Méthidathion	Organophosphorés		Ib	Très dangereuse	Ouahigouya	
Paraquat	Pyridines		II	Modérément dangereuse	Fada N'Gourma	[10]
Profénofos	Organophosphorés		II	Modérément dangereuse	Bobo Dioulasso	IFDC 2007
Propanil	Anylides	Maraîchage	II	Modérément dangereuse	Kompienga	[3]
Thirame	Carbamates	Coton	II	Modérément dangereuse	Kompienga	

Tableau 1 : Pesticides recensés sur différentes régions du Burkina Faso

2.3. Screening de polluants par échantillonnage passif

2.3.1. Généralités sur les échantillonneurs passifs

Pour cette étude la recherche des pesticides sera réalisée en majeure partie par échantillonnage passif. La méthode conventionnelle de détection des polluants aquatiques repose sur l'analyse d'échantillons ponctuels. Cependant, ces analyses ne fournissent pas d'informations sur les variations de concentration des polluants dans le temps, pour cela il faudrait répéter régulièrement les mesures. L'échantillonnage ponctuel ne donne qu'une valeur instantanée de concentration au moment de la prise de l'échantillon. Avec l'évolution des réglementations et des critères de qualité environnementale, les méthodes d'analyses et de surveillance exigées deviennent de plus en plus strictes, fréquentes et donc coûteuses. Dans ce contexte, les échantillonneurs passifs représentent une méthode alternative intéressante pour répondre aux critères de rapidité et d'efficacité des mesures à moindre coût, et pour permettre de détecter des polluants en concentrations faibles et variables grâce à leur capacité d'accumulation. Différents types d'échantillonneurs passifs ont été développés en fonction du type de polluant à analyser :

- DGT (Diffusive Gradient in Thin film) pour les contaminants métalliques ;
- SBSE (Stir Bar Sorptive), SPME (Solid-Phase Microextraction Fibers) et SPMD (Semipermeable Membrane Device) pour les molécules hydrophobes telles que les hydrocarbures aromatiques polycycliques (Benzo[A]pyrène, naphthalène..) et les polychlorobiphényles ;
- POCIS (Polar Organic Chemical Integrative Sampler) pour les molécules polaires, notamment les pesticides ;
- Chemcatcher pour les composés organiques ou inorganiques, polaires ou apolaires et les métaux.

Les échantillonneurs passifs peuvent être utilisés comme indicateurs de la biodisponibilité des polluants chimiques. En outre, contrairement à la plupart des organismes vivants, ils peuvent être exposés à des conditions environnementales difficiles pendant de longues périodes et rester opérationnels. L'analyse en laboratoire de l'échantillonneur passif est généralement plus rapide et moins coûteuse que la plupart des analyses d'eau ou de sédiments [20].

Les échantillonneurs passifs représentent un outil prometteur pour la surveillance de la qualité environnementale mais ils ne sont pas encore adoptés par la législation Européenne. Ceci est due, parmi d'autres facteurs, à un manque de robustesse au niveau des procédures d'assurance et de contrôle qualité pour leur calibration. Pour palier à ce problème il faudrait recourir à des essais inter-laboratoires ou des calibrations en conditions contrôlées (pilote laboratoire). Même s'ils ne peuvent pas être utilisés dans le cadre réglementaire, ils n'en restent pas moins un moyen efficace de contrôle de pollution environnementale, faciles à manipuler et à déployer sur le terrain.

Une étude inter-laboratoire concernant l'utilisation des échantillonneurs passifs pour les eaux de surface a été réalisée en 2010 [21]. Différents capteurs passifs ont été déployés sur 2 fleuves (La Charente et le Rhône) ainsi que sur l'étang de Thau et les résultats obtenus par 24 laboratoires ont été comparés. De manière générale, les concentrations moyennes obtenues par les échantillonneurs passifs sont comparables avec les moyennes obtenues par échantillonnage ponctuel. De plus, les échantillonneurs passifs ont permis une meilleure quantification des contaminants organiques que par échantillonnage ponctuel.

De manière générale, les échantillonneurs passifs fonctionnent tous sur le même principe. Ils sont constitués d'une phase réceptrice ayant une forte affinité avec les polluants ciblés (adsorption ou absorption). Cette phase est séparée de la masse d'eau par la couche limite aqueuse, et par une membrane, qui permet de limiter la vitesse de diffusion et la saturation physique ou biologique de la phase réceptrice (Figure 2).

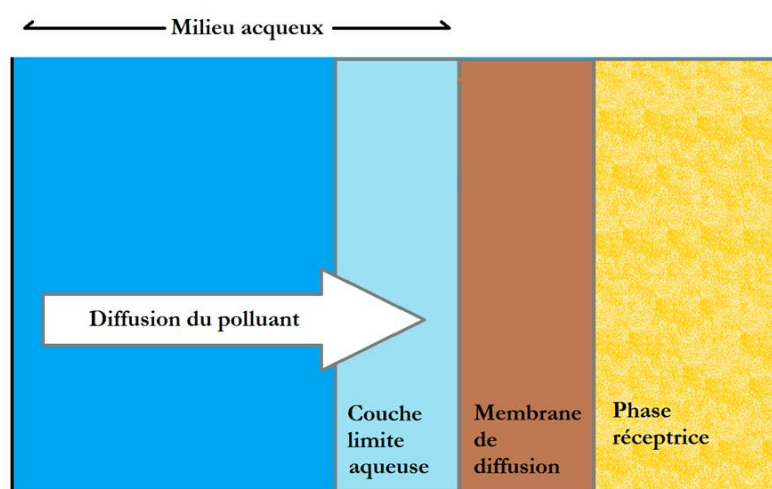


Figure 2 : Diffusion du polluant au travers des différentes phases

Le modèle théorique d'accumulation des polluants au niveau de la phase réceptrice est illustré Figure 3 [22] :

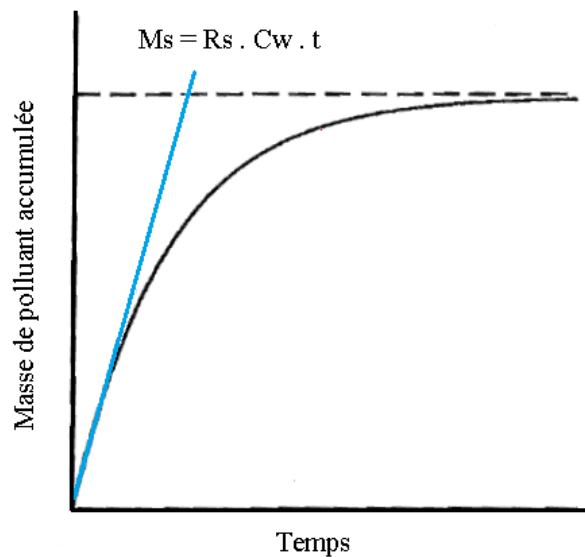


Figure 3 : Modèle théorique d'accumulation de polluant par les échantillonneurs passifs en fonction du temps

On distingue deux régimes d'accumulation durant l'exposition des échantillonneurs passifs. Le premier régime est considéré comme intégratif, en effet, la cinétique d'accumulation des analytes est pseudo-linéaire (première partie de la courbe). Le second régime est curvilinéaire, et atteint un plateau correspondant à la saturation de l'échantillonneur. Le taux d'échantillonnage est déterminé, pour la partie linéaire de la courbe, en appliquant l'équation n°1 :

Equation n°1

$$m_f(t) = m_0 + R_s \cdot C_w \cdot T$$

Où R_s : Taux d'accumulation (l/j)

$m_f(t)$: Masse accumulée sur la phase réceptrice après déploiement (g)

m_0 : Masse éventuellement présente sur la phase avant déploiement (g)

C_w : Concentration en polluant dans l'eau (g/l)

T : Durée d'exposition (j)

La masse de contaminant accumulée dépend principalement de l'efficacité d'accumulation de la phase réceptrice, de la durée d'exposition et du taux d'échantillonnage du capteur (Rs).

2.3.2. Calibration

La calibration des échantillonneurs passifs nécessite la prise en compte des conditions environnementales telles que la température ou les turbulences dans le milieu, pouvant faire varier leur taux d'échantillonnage. Les turbulences perturbent l'échantillonnage en influent sur l'épaisseur de la couche d'eau en contact avec la membrane de diffusion diminuant ainsi la résistance de la couche aqueuse (Figure 2). Les turbulences sont difficiles, cependant, à quantifier sur le terrain (mesure de la vitesse d'écoulement). L'encrassement biologique, « biofouling » peut aussi modifier fortement le taux d'échantillonnage du capteur. Cependant il n'est généralement pas pris en compte dans les méthodes de calibration étant donné qu'il dépend directement des conditions d'exposition (milieu et durée) [23]. Les différents taux d'échantillonnage sont donc déterminés en laboratoire à partir d'un pilote de calibration, les échantillonneurs sont alors exposés dans des conditions contrôlées (température, pH, concentrations en polluants, turbulences).

La présente étude se propose de quantifier la pollution due aux produits phytosanitaires organiques polaires sur 3 lacs au Sud-ouest du Burkina Faso. La recherche de ces produits est réalisée à partir de l'utilisation des Chemcatcher (version polaire) et des POCIS, qui sont les échantillonneurs passifs les plus répandus pour l'analyse des polluants organiques polaires [24]. Cette étude s'appuiera sur les taux d'échantillonnages préalablement déterminé par le LGEI, selon le modèle théorique présenté précédemment pour les 22 pesticides recherchés (Annexe 3 : Taux d'échantillonnage des 22 substances pour les POCIS et les Chemcatcher) [25] [26] [27] [28].

2. Matériel et méthode

2.1. Sites d'étude

2.1.1. Site de référence : Bala

Le lac de Bala, aussi appelé « mare aux hippopotames », se trouve à une soixantaine de kilomètres au Nord-est de la ville de Bobo-Dioulasso (Sud-ouest du Burkina Faso). Il est situé en plein cœur d'une réserve naturelle de 19 200 hectares classée au patrimoine mondial de l'Unesco, où toute activité agricole est bannie (Figure 4). D'une longueur de 2,6 kilomètres et

de 700 mètres de largeur, le lac est alimenté par le Tinamou, prenant lui même sa source au niveau de diverses résurgences phréatiques à 4 kilomètres plus au Sud. Le lac est localisé dans la plaine d'inondation du Mouhoun correspondant à une dépression au niveau de la rive droite du cours d'eau. [29]. La mare aux hippopotames est dans une zone de climat sud soudanien, avec une pluviométrie annuelle de 1200 mm, et sa superficie varie saisonnièrement de 98 à 120 hectares. Sa profondeur varie approximativement de 1 mètre, durant les mois compris entre décembre et juillet, jusqu'à près de 4 mètres courant octobre [30]. Ce lac a été choisi comme référence puisqu'aucune activité agricole n'est autorisée à proximité immédiate.



Figure 4 : Photo aérienne du lac de Bala et points d'échantillonnage

2.1.2. Site impacté par des activités agricole : Bama

Le lac de Bama est situé à proximité du village de la Vallée du Kou 4 (VK4), implanté au centre du périmètre agricole de la vallée du Kou à une trentaine de kilomètres au Nord-ouest de la ville de Bobo-Dioulasso. Le bassin du Kou représente une superficie de 1823 km² associés à la rivière du Kou et ses affluents, et aux sources de Nasso et Pesso. Ce bassin est à l'origine de nombreux conflits entre les différents agriculteurs et villages liés à une utilisation anarchique ainsi qu'à des prélèvements frauduleux de la ressource en eau. Les aménagements

hydro-agricoles couvrent une superficie totale de près de 3000 hectares dont un périmètre rizicole aménagé à Bama de 1260 hectares. Plusieurs types de culture ont été inventoriés en amont de ce périmètre. Une prise d'eau a été aménagée, à Diaradougou pour irriguer de façon gravitaire ce périmètre. A l'étiage, tout le débit du Kou est dévié pour les cultures maraichères et à la saison des pluies, les terrains sont inondés pour la culture du riz, ainsi, la rivière retrouve un écoulement continu. D'une superficie de 50 hectares environ, le lac de Bama est le fruit des déficiences techniques et du manque d'entretien de cet aménagement hydraulique. Plus en amont encore, des parcelles sont également cultivées (bananes, maïs, papayes, choux...) avec les mêmes cultures en hivernage qu'en contre saison [31] [32]. Le lac est ainsi situé au centre de nombreuses activités agricoles et constitue la référence impactée de cette étude.

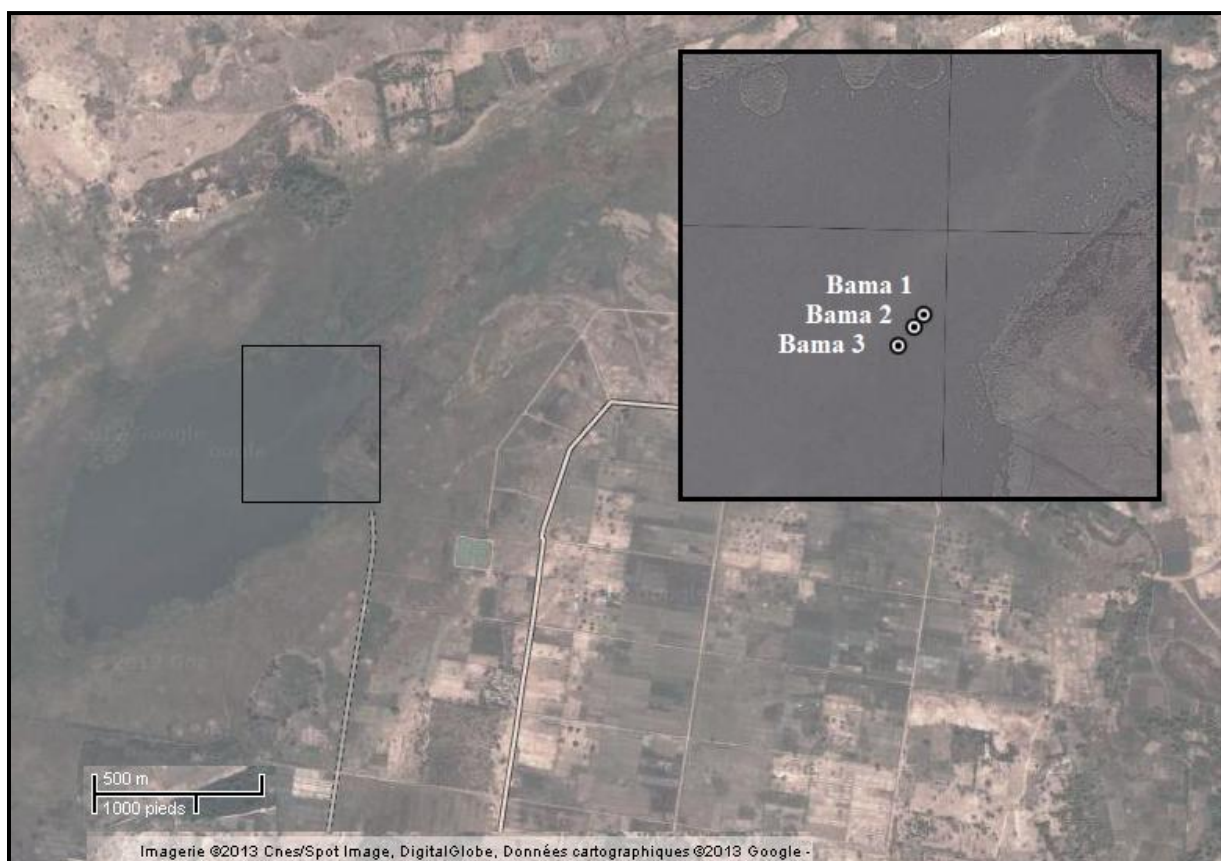


Figure 5 : Photo aérienne du lac de Bama et points d'échantillonnage

Sur cette photo aérienne nous pouvons distinguer les parcelles agricoles à proximité du lac de Bama (Figure 5).

2.1.3. Site de Boura

Le village de Boura est situé à environ 250 kilomètres à l'est de la ville de Bobo-Dioulasso. Avec des précipitations moyennes de 1000 mm/an, l'agriculture pluviale est pratiquée pendant l'hivernage pour la production de riz essentiellement. A proximité du village se trouve un barrage formant le lac de Boura d'une capacité de 4 millions de mètres cube. Il a été construit sur l'affluent principal de la Kabarvaro qui se jette dans le Mouhoun pour répondre aux besoins pastoraux, humains et agricoles. Un périmètre irrigué de 90 hectares a été mis en place à l'aval de ce lac pour permettre aux populations riveraines de continuer leur production agricole (légumes, riz, maïs) en particulier durant la saison sèche. Un autre périmètre hydro-agricole de 20 hectares a été mis en place plus en amont en rive droite à une distance d'environ 400 m de la digue. Une frange minimale de 10 m a été laissée entre la limite du périmètre et celle du plan d'eau à la cote des plus hautes eaux.



Figure 6 : Photo aérienne du lac de Boura et points d'échantillonnage

Sur cette photo nous pouvons distinguer le périmètre irrigué mis en place à l'aval du barrage du lac de Boura (Figure 6).

2.2. Echantillonneurs passifs utilisés

2.2.1. Chemcatcher

2.2.1.1. Description

Les Chemcatcher (Figure 7) sont des boîtiers en téflon constitués d'un support pour déposer la phase réceptrice et la membrane de diffusion fixées par une bague de serrage. Sur cette bague sont fixés soit un couvercle pour le transport et le stockage de l'échantillonneur, soit un anneau de prolongement servant de réservoir lorsque le capteur est immergé.

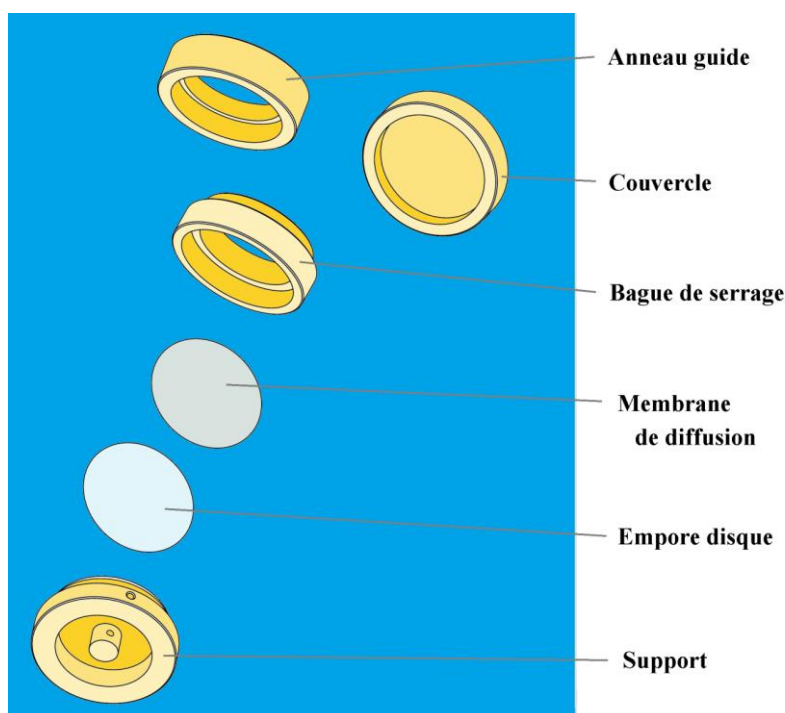


Figure 7 : Chemcatcher en vue éclatée

Le type de polluant retenu (métal, polaire, apolaire...) est conditionné par le choix à la fois de la phase réceptrice et de la membrane de diffusion.

2.2.1.2. Phases de rétention et membranes de diffusion utilisées

La phase de rétention utilisée dans cette étude est un Empore disque C18 composé de fibres de téflons (10%), emprisonnant des particules de silice greffées de groupements octadécyles (90%). Ces disques ont une épaisseur de 0,5 mm et des pores de 6 nm de diamètre. La phase régulatrice de diffusion est une membrane Poly Ether Sulfonée (PES) microporeuse (diamètre des pores : 0,45µm). La surface d'échange est de 17,34 cm².

2.2.2. POCIS

2.2.2.1. Description

Les POCIS (Figure 8) sont constitués d'une phase solide accumulatrice enfermée entre deux membranes de polyéthersulfone (PES), hydrophiles et microporeuses (porosité de 100 nm). Les membranes sont insérées entre deux anneaux métalliques inertes. Il existe à ce jour deux types de phases :

- Une phase spécifique aux pesticides constituée d'un mélange de résine modifiée de polystyrène-divinylbenzène (80 %) et de sorbant carboné, Ambersorb 1500 (20%), déposé sur un copolymère d'exclusion stérique, du styrène divinylbenzène, S-X3) ;
- Une phase plus spécifique des substances pharmaceutiques (Oasis HLB, phase polymérique de divinylbenzène avec un monomère polaire, le N-vinylpyrrolidone) [33].

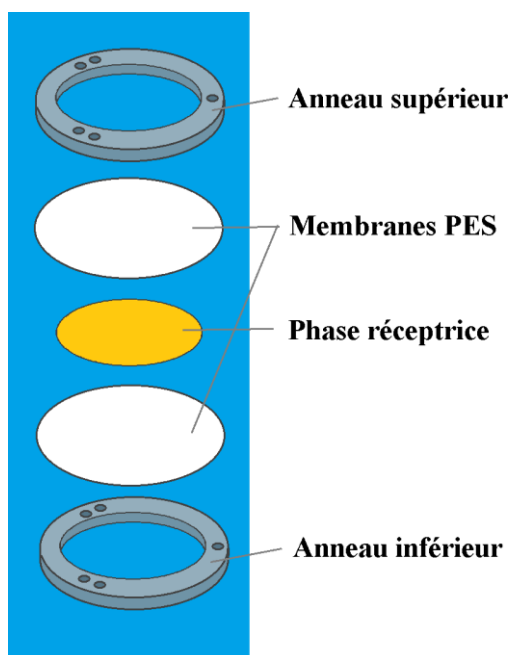


Figure 8 : POCIS en vue éclatée

2.2.2.2. Choix de la phase réceptrice

Les POCIS sont de dimension standard (surface spécifique = 180 cm²/g) avec une surface d'échange de 41 cm². La phase réceptrice utilisée dans cette étude correspond à la phase spécifique aux substances pharmaceutiques, constituée d'environ 230 mg d'OASIS HLB correspondante à la phase utilisée lors de la calibration [25]. Cette phase est plus adaptée à la recherche des composés organiques polaires ayant plusieurs groupes fonctionnels [34] . De

plus, il a été montré qu'elle était la plus appropriée pour l'échantillonnage des herbicides qu'ils soient basiques, neutres ou acides [28] . Enfin cette phase présente plusieurs avantages notamment l'utilisation de solvant en plus faible quantité qu'avec la phase spécifique aux pesticides [35].

2.3. Etapes d'échantillonnage et d'analyses

Les différentes étapes analytiques à réaliser pour l'échantillonnage passif et ponctuel sont présentées Figure 9.

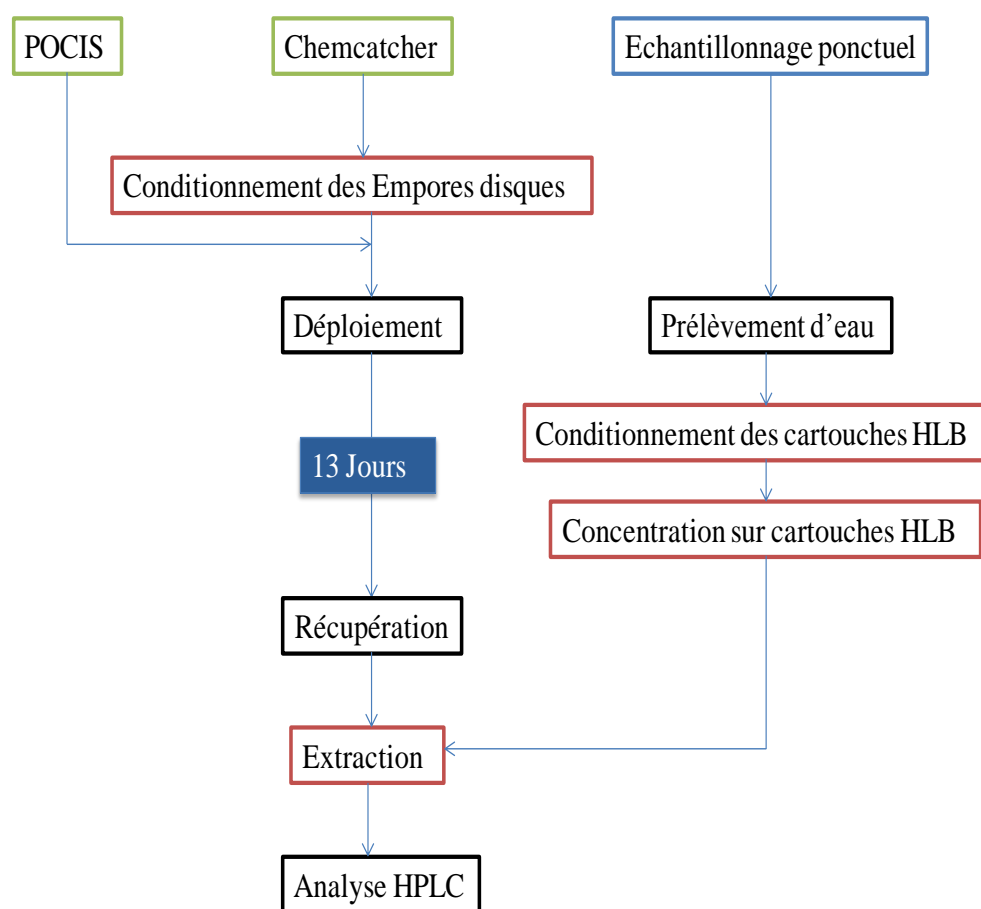


Figure 9 : Synoptique d'échantillonnage et d'analyse

Les étapes de conditionnement et d'extraction sont décrites en annexe : conditionnement des Chemcatcher (Annexe 4), conditionnement et extraction des cartouches HLB (Annexe 5), extraction des Empore disques (Annexe 6), extraction des POCIS (Annexe 7).

2.3. Déploiement des échantillonneurs

Les échantillonneurs passifs sont immergés pendant 13 jours, à une profondeur d'environ 50 cm sous la surface pour les sites de Bala, Bama et Boura amont et de 2 m pour Boura aval : profondeur de la prise d'eau du périmètre irrigué en aval du barrage. Les échantillonneurs sont fixés à l'intérieur d'une nasse de manière à empêcher les poissons ou autres organismes aquatiques de perturber les mesures. La nasse est elle-même fixée à un cadre PVC lesté avec 4 blocs de bétons d'une vingtaine de kilogrammes. De plus, deux bidons en plastique d'un volume de 50 litres sont attachés au cadre par sécurité pour assurer la flottaison. Pour chaque point d'étude, 2 Chemcatcher et 2 POCIS sont déployés. Un Chemcatcher et un POCIS témoins sont utilisés pour détecter d'éventuelles pollutions pouvant intervenir lors de la mise en place ou du retrait des 2 autres échantillonneurs. 24 Chemcatcher et 24 POCIS sont déployés sur les 4 sites sélectionnés. Donc, au total, 28 Chemcatcher et 28 POCIS sont déployés (Tableau 2).

Site	Point	POCIS	Chemcatcher	Echantillonnage ponctuel	
				T1	T13
Bala	<i>Témoïn</i>	<i>BP1</i>	<i>BC1</i>	<i>Témoïn</i>	
	Bala 1	P2	C2	E1	E2
		P3	C3		
	Bala 2	P4	C4	E3	E4
		P5	C5		
	Bala 3	P6	C6	E5	E6
		P7	C7		
Bama	<i>Témoïn</i>	<i>BP8</i>	<i>BC8</i>	<i>Témoïn</i>	
	Bama 1	P9	C9	E1	E2
		P10	C10		
	Bama 2	P11	C11	E3	E4
		P12	C12		
	Bama 3	P13	C13	E5	E6
		P14	C14		
Boura Amont	<i>Témoïn</i>	<i>BP15</i>	<i>BC15</i>	<i>Témoïn</i>	
	Boura Amont 1	P16	C16	E1	E2
		P17	C17		
	Boura Amont 2	P18	C18	E3	E4
		P19	C19		
	Boura Amont 3	P20	C20	E5	E6
		P21	C21		
Boura Aval	<i>Témoïn</i>	<i>BP22</i>	<i>BC22</i>	<i>Témoïn</i>	
	Boura Aval 1	P23	C23	E1	E2
		P24	C24		
	Boura Aval 2	P25	C25	E3	E4
		P26	C26		
	Boura Aval 3	P27	C27	E5	E6
		P28	C28		

Tableau 2 : Identification des échantillons

2.4. Echantillonnage d'eau

En parallèle de la mise en place des échantillonneurs passifs, une campagne d'échantillonnage ponctuel d'eau est réalisée. Environ 500 millilitres d'eau sont prélevés pour chaque point d'étude lors du déploiement (T1) et lors de la récupération des échantillonneurs passifs (T13) soit 24 échantillons au total (Tableau 2). L'eau prélevée est dans un premier temps filtrée (filtres GF/F de 0,7 µm de porosité) puis le pH est ajusté à 8 à l'aide d'une solution d'hydroxyde de sodium à 10^{-3} mol/l. Les échantillons sont ensuite dopés avec 100 µl d'une solution d'atrazine d5 à 1mg/l d'acétonitrile avant d'être pré-concentrés sur des cartouches oasis HLB préalablement conditionnées. 4 autres cartouches sont utilisées en tant que « témoin » de manipulation.

2.1. Substances analysées

Les pesticides étudiés ont été sélectionnés parmi les familles de composés les plus fréquemment retrouvées dans le milieu aquatique, comprenant les substances actives et leurs principaux produits de dégradation. Les molécules retenues sont uniquement des pesticides organiques polaires et semi-polaires (13 herbicides, 4 fongicides et 1 insecticide) et 4 produits de dégradations d'herbicides. Les 22 substances sont recensées Tableau 3 :

Molécule	Type	Famille	Formule
Acetochlor	Herbicide	Chloracetanilides	C ₁₄ H ₂₀ ClNO ₂
Alachlor	Herbicide	Urées	C ₉ H ₁₀ Cl ₂ N ₂ O ₂
Atrazine	Herbicide	Triazines	C ₈ H ₁₄ CIN ₅
Azoxystrobin	Fongicide	Strobilurin	C ₂₂ H ₁₇ N ₃ O ₅
Chlortoluron	Herbicide	Urées	C ₁₀ H ₁₃ CIN ₂ O
DCPU (N-(3,4 dichlorophényl)-urée)	Métabolite	Urées métabolites	C ₇ H ₆ Cl ₂ N ₂ O
DEA (déséthyl atrazine)	Herbicide	Triazines métabolites	C ₆ H ₁₀ CIN ₅
DET (Déséthyl terbuthylazine)	Métabolite	Triazines métabolites	C ₇ H ₁₂ CIN ₅
DIA (Désopropyl atrazine)	Métabolite	Triazines	C ₅ H ₈ CIN ₅
Diuron	Herbicide	Urées	C ₉ H ₁₀ Cl ₂ N ₂ O
DPCMU (N-(3,4 dichlorophényl)-N-(méthyl)-urée)	Métabolite	Urées métabolites	C ₈ H ₈ Cl ₂ N ₂ O
Flazasulfuron	Herbicide	Sulfonyl urées	C ₁₃ H ₁₂ F ₃ N ₅ O ₂ S
Imidaclopride	Insecticide	Néo nicotinoïdes	C ₉ H ₁₀ CIN ₅ O ₂
Isoproturon	Herbicide	Urées	C ₁₂ H ₁₈ N ₂ O
Linuron	Herbicide	Urées	C ₉ H ₁₀ Cl ₂ N ₂ O ₂
Metalaxyl	Fongicide	Amides	C ₁₅ H ₂₁ NO ₄
Metolachlor	Herbicide	Chloracetanilides	C ₁₅ H ₂₂ ClNO ₂
Oxadixyl	Fongicide	Phenylamides	C ₁₄ H ₁₈ N ₂ O ₄
Penconazole	Fongicide	Azoles	C ₁₃ H ₁₅ Cl ₂ N ₃
Propyzamide	Herbicide	Amides	C ₁₂ H ₁₁ Cl ₂ NO
Simazine	Herbicide	Triazines	C ₇ H ₁₂ CIN ₅
Terbutylazine	Herbicide	Triazines	C ₉ H ₁₆ CIN ₅

Tableau 3 : Liste des 22 substances analysées

2.5. Analyse des pesticides sélectionnés

L'analyse des différents extraits est réalisée par chromatographie liquide haute performance (HPLC) couplée à un spectromètre de masse triple quadripôles. Le module de séparation est constitué d'une pompe quaternaire, d'un dégazeur à vide et d'un passeur automatique d'échantillons. La colonne est une Kinetex C18 de 100 mm de long, de 4,6 mm de diamètre et de particules de diamètre 2,6 µm). Le volume d'échantillon injecté est de 25 µl, le débit de la phase mobile est de 0,4 ml/min et le gradient d'élution est représenté Tableau 4.

Temps (min)	Phase A (Eau milli-Q + 0,05 % d'acide formique)	Phase B (Acétonitrile + 0,05 % d'acide formique)
0	60	40
8	20	80
9	0	100
11	60	40
15	60	40

Tableau 4 : Gradient d'élution utilisé pour l'analyse HPLC

Le spectromètre de masse (Micromass Quatro micro, Waters 2695) possède un module d'ionisation electrospray (ESI). La température de la source d'ionisation est de 120°C. La température du gaz de désolvatation (N₂) est fixée à 300°C et son débit à 600 l/h. Le débit du gaz de nébulisation est de 30 l/h. La pression dans la cellule de collision par argon est de 3,2.10⁻³ mbar. La source d'ionisation est utilisée en mode positif pour étudier les cations et l'acquisition des masses d'ions se fait en mode MRM (Multiple Reaction Monitoring) permettant la quantification de plusieurs molécules cibles dans l'échantillon. Les temps de rétention ainsi que les transitions pour la détection des 22 substances à analyser sont présentés en Annexe 8.

Les analyses sont pilotées par le logiciel MassLynx (Waters), plateforme multitâches permettant de gérer l'acquisition et le traitement des données via différentes interfaces tel que QuantLynx pour la quantification. La quantification des composés est faite par étalonnage interne avec la simazine d₅.

Le modèle d'étalonnage est étudié sur une gamme de 5 concentrations comprises entre 0 et 50 µg/L (0-2-10-20-25-50 µg/L) à partir d'une solution étalon à 1 ppm environ dans l'acétonitrile contenant l'ensemble des composés cibles ainsi que l'étalon interne. Les droites de calibration obtenues par le logiciel Qantlynx sont construites en effectuant une régression linéaire par la méthode des moindres carrés à partir de l'injection de différentes solutions étalons.

Les limites de détection (LD) et de quantification (LQ) sont mesurées à partir de l'injection de solutions étalons faiblement concentrées (0,5/1/1,5/2 µg/L) et diluées si nécessaire. La LD est déterminée classiquement à partir de la concentration pour laquelle le rapport de signal/bruit de fond est égal à 3. La LQ instrumentale est obtenue pour un rapport Signal/Bruit égal à 10. Les valeurs des limites de quantification et de détection des composés analysés par HPLC-MS/MS sont présentées Tableau 5 :

	LD (µg/l)	LQ (µg/l)
Imidaclopride	0,9	3
Oxadyxil	0,5	1,8
DET	0,4	1,2
Simazine	0,5	1,5
Chlortoluron	0,9	3
Metolaxyl	0,5	1,5
Isoproturon	1,8	6
Diuron	0,5	1,8
Flazasulfuron	0,5	1,5
Terbutylazine	0,3	1
Azoxystrobine	0,2	0,7
Penconazole	0,2	0,5
DIA	0,9	3
DEA	0,5	1,8
Atrazine	0,5	1,5
DCPU	0,9	3
DCPMU	0,9	3
Acetochlore	6,0	20,0
Alachlore	11,0	36,7
Linuron	0,9	3
Metolachlore	0,5	1,5
Propyzamide	0,8	2,5

Tableau 5 : Limites instrumentales de détection et de quantification pour les 22 substances sélectionnées

3. Résultats et discussion

3.1. Etude qualitative des résultats

3.1.1. Site de référence : Bala

Les Tableaux ci-dessous (Tableaux 6 et 7) représentent les concentrations des extraits analysés par HPLC-MS. Chaque concentration correspond à une moyenne de deux injections HPLC. La colonne « Eau milli-Q » correspond à l'analyse de l'eau utilisée pour le conditionnement des Chemcatcher, des cartouches SPE et des cartouches HLB.

Composé	Echantillons d'eau extraits avec HLB (µg/l)							Extraction POCIS (µg/l)				Extraction Chemcatcher (µg/l)			
	T1			T13			Eau milli-Q	Bala1	Bala2	Bala3	Témoïn	Bala1	Bala2	Bala3	Témoïn
	Bala1	Bala2	Bala3	Bala1	Bala2	Bala3									
Imidaclopride	< LD	< LD	3,3	1,2	nd	1,6	nd	1,6	1,9	1,4	1,2	0,9	0,5	1,6	1,9
Oxadixil	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
DET	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Simazine	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlortoluron	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd	nd
Metalaxyl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Isoproturon	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diuron	1,8	1,5	1,7	2	nd	1,1	10,4	< LD	< LD	< LD	< LD	< LD	< LD	0,5	< LD
Flazasulfuron	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd	nd
Terbutylazine	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	< LD	nd
Azoxystrobine	nd	nd	nd	nd	nd	nd	nd	0,2	< LD	0,2	0,3	0,3	0,3	0,4	0,3
Penconazole	11,3	11,5	11,5	nd	nd	11,5	11,3	1,1	1,0	1	1,0	2,0	1,2	1,4	1,1
DIA	nd	nd	< LD	nd	nd	nd	nd	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD
DEA	nd	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd
Atrazine	nd	nd	nd	nd	nd	nd	2,1	nd	nd	nd	nd	nd	nd	nd	nd
DCPU	1,5	2,3	1,6	< LD	nd	0,9	2,0	< LD	< LD	< LD	nd	nd	nd	nd	nd
DCPMU	< LD	< LD	< LD	< LD	nd	< LD	< LD	nd	< LD	< LD	nd	nd	nd	nd	nd
Acetochlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	10,6	12,2	12,4	nd
Alachlore	nd	nd	nd	nd	nd	nd	< LD	< LD	11,8	< LD	< LD	< LD	< LD	< LD	< LD
Linuron	nd	nd	nd	nd	nd	nd	< LD	3,6	2,2	0,9	3,8	2,3	2,6	2,8	nd
Metolachlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Propyzamide	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD

nd : Non détecté

Tableau 6 : Résultats qualitatifs pour le site de Bala

Sur le site de Bala, 8 substances sont présentes en concentrations supérieures aux limites de détection et/ou de quantification : Imidaclopride, diuron, azoxystrobine, penconazole, atrazine, DCPU, l'acétochlore, et linuron. Concernant les autres substances, les concentrations retrouvées dans les échantillons sont globalement du même ordre de grandeur voir plus faibles que celle retrouvées sur les témoins pour chacune des substances, ce qui laisse supposer que le site ne présente pas de réelle contamination. 4 composés sont détectés par échantillonnage ponctuel (imidaclopride, diuron, penconazole et DCPU), 4 avec les POCIS (imidaclopride, azoxystrobine, penconazole, et linuron) et 5 avec les Chemcatcher (imidaclopride, azoxystrobine, penconazole, acétochlore, et linuron).

3.1.2. Site impacté par des activités agricole : Bama

Les concentrations mesurées sur le site de Bama sont plus significatives au vue des concentrations mesurées sur les échantillonneurs témoins. On constate que, pour un même site d'étude, le nombre de composés détectés par échantillonnage passif est plus important que par échantillonnage ponctuel. De plus, on remarque que les concentrations mesurées sur les extraits provenant des POCIS sont globalement plus importantes que celles des Chemcatcher. Ce qui est prévisible car la surface d'échange pour les POCIS est de 41 cm² contre 17,34 cm² pour les Chemcatcher.

Il est faut noter que pour certaines substances (Imidaclopride, diuron, DEA, atrazine et linuron) les concentrations mesurées à partir des prélèvements d'eau sont différentes selon la date de prélèvement. Ceci indique une variation de la concentration en fonction du temps.

Etant donné que pour le site de Bama le nombre de substances détectées est le plus élevé, nous nous appuyerons sur ces résultats pour déterminer les substances d'intérêt pour l'analyse quantitative, à partir notamment des extraits provenant des POCIS.

D'après les mesures faites sur les extraits de POCIS, 9 substances sont présentes en concentration supérieure à leur limite de détection : L'imidaclopride, le diuron, le penconazole, le DIA, le DEA, l'atrazine, l'acétochlore, l'alachlore et le linuron.

Il convient de mentionner que lors de l'exploitation sur le logiciel Masslynx, les pics d'intégration de l'acétochlore et l'alachlore n'étaient pas bien définis. C'est pour cela qu'ils ne sont pas sélectionnés pour l'étude quantitative. Le penconazole est aussi écarté au regard des concentrations mesurées sur les échantillons témoins. 6 substances sont donc sélectionnées parmi les 22 (surlignées dans le Tableau 7).

Composé	Echantillons d'eau extraits avec HLB (µg/l)							Extraction POCIS (µg/l)				Extraction Chemcatcher (µg/l)			
	T1			T13			Eau milli-Q	Bama1	Bama2	Bama3	Témoïn	Bama1	Bama2	Bama3	Témoïn
	Bama1	Bama2	Bama3	Bama1	Bama2	Bama3									
Imidaclopride	1,3	1	2,7	3,3	5,4	4,1	< LD	5,8	4,7	4,3	nd	2	2,7	3,9	2,4
Oxadixil	nd	nd	nd	nd	nd	nd	nd	2,7	0,9	0,8	nd	nd	1,3	nd	nd
DET	nd	< LD	nd	< LD	nd	nd	nd	< LD	< LD	< LD	nd	nd	nd	nd	nd
Simazine	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	< LD	nd	nd	nd
Chlortoluron	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Metalaxyl	nd	nd	nd	nd	nd	nd	nd	1,0	0,6	0,9	nd	nd	0,7	< LD	nd
Isoproturon	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diuron	4	2,5	2,5	0,9	0,7	0,5	1,2	4,9	6,0	5,4	1	2,5	4,7	3,7	3
Flazasulfuron	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	nd	< LD	< LD	nd
Terbutylazine	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	< LD	< LD	< LD	nd
Azoxystrobine	nd	nd	nd	nd	nd	nd	nd	0,3	0,4	0,4	0,3	0,5	0,5	0,3	0,3
Penconazole	11,3	11,3	11,3	11,3	11,5	11,4	11,2	1,3	1,5	1,4	0,9	0,9	1,7	1,5	0,5
DIA	0,9	nd	< LD	1,0	< LD	< LD	nd	5,1	4,9	5,5	< LD	1,3	< LD	1,7	< LD
DEA	< LD	< LD	< LD	0,6	1,2	1,9	nd	11,5	10,8	10,8	nd	< LD	0,9	0,6	< LD
Atrazine	nd	nd	nd	1,2	1,7	1,9	nd	22,6	20,6	23,8	nd	3,1	3,5	1,2	nd
DCPU	< LD	1,1	1,2	1,7	< LD	1,1	< LD	1,8	< LD	1,9	nd	< LD	< LD	1,1	< LD
DCPMU	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	1,45	nd	< LD	< LD	< LD	nd
Acetochlore	nd	nd	nd	nd	nd	nd	nd	67,8	76,6	78,3	nd	< LD	18,5	17,8	7,4
Alachlore	nd	nd	nd	nd	nd	nd	nd	nd	45,3	53,1	13,5	< LD	14,9	< LD	13,1
Linuron	nd	nd	nd	1	2,4	< LD	1,0	8,6	4,6	13,3	nd	2,4	3,3	1,0	< LD
Metolachlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd
Propyzamide	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD

Tableau 7: Résultats qualitatifs pour le site de Bama

3.1.3. Site de Boura

Sur le site de Boura à l'amont et à l'aval, les substances détectées sont sensiblement les mêmes que celles détectées à Bama. Les tableaux de résultats sont exposés en annexe (Annexe 9, Annexe 10).

3.2. Etude quantitative des résultats

3.2.1. Site de référence : Bala

Les résultats mentionnés Tableau 8 et en annexe (Annexe 11, 12 et 13) représentent les moyennes et les écarts types des concentrations sur les différents sites d'étude. Les valeurs correspondent, pour chaque échantillon, aux moyennes des 2 injections HPLC. Les POCIS et les Chemcatcher étant déployés en duplicats, les valeurs exposées sont des moyennes de quatre concentrations correspondantes aux deux injections des duplicats.

Pour l'échantillonnage ponctuel, les concentrations des extraits présentées paragraphe 3.1 sont ramenées au volume d'eau prélevé. Pour l'échantillonnage passif, ces concentrations sont calculées à partir de la masse accumulée par échantillonneur d'après l'équation 1 correspondant à la partie linéaire du modèle théorique d'accumulation de polluant par échantillonnage passif :

Equation 1

$$m_f(t) = m_0 + C_w \cdot R_s \cdot T$$

Où R_s : Taux d'accumulation (l/j)

$m_f(t)$: Masse accumulée sur la phase réceptrice (g)

m_0 : Masse initialement présente sur la phase (g)

C_w : Concentration en polluant dans l'eau (g/l)

T : Durée d'exposition (j)

L'atrazine et le DEA ne sont pas détectés dans le lac de Bala, que ce soit par échantillonnage ponctuel ou passif (Annexe 11). Le diuron est détecté en faible concentration (de 0,1 à 4,9 ng/l). Concernant l'échantillonnage ponctuel, l'analyse de l'eau milli-Q montre une contamination élevée (30,8 ng/l). Il est probable que les concentrations mesurées dans les

échantillons proviennent de cette contamination et non du lac. Les 3 autres substances (DIA, linuron et imidaclopride) sont mesurées à des niveaux de concentration équivalents dans les extraits, les échantillons témoins et l'eau milli-Q. Il est probable que les concentrations mesurées dans les échantillons proviennent d'une contamination par l'eau milli-Q utilisée pour les étapes de conditionnement et d'extraction. Pour cette raison, nous ne pouvons pas conclure quant à l'état de contamination du lac.

3.2.2. Site impacté par des activités agricoles : Bama

Les résultats quantitatifs pour le site de Bama sont présentés Tableau 8. L'atrazine est mesurée en concentration significative à Bama. Par échantillonnage ponctuel, les concentrations mesurées vont de 3,8 à 5 ng/l pour les prélèvements réalisés lors de la récupération des échantillonneurs passifs (T13). Les concentrations mesurées dans les échantillons provenant des POCIS varient de 9,2 à 10,8 ng/l. Pour les extraits des Chemcatchers, les mesures de concentration varient de 1,1 à 3,2 ng/l. Les POCIS et Chemcatcher témoins sont exempts de contamination.

De même, la quantification des molécules de DIA et DEA montre des valeurs significatives, les molécules n'étant pas détectées chez les échantillons témoins. Ces composés étant des produits de dégradation de l'atrazine, il est normal de les retrouver également dans les échantillons.

Les 3 substances suivantes (diuron, linuron, et imidaclopride) sont présentes dans l'eau milli-Q. Le linuron n'est mesuré par échantillonnage ponctuel que dans les prélèvements effectués lors de la récupération des échantillonneurs passifs (T13), contrairement au diuron que l'on retrouve préférentiellement dans les échantillons prélevés lors du déploiement (T1). Ces deux substances (diuron et linuron) sont mesurées en concentration respectives d'environ 2,5 ng/l et 7 ng/l pour les POCIS, avec des niveaux de contamination négligeables sur les témoins. Environ 2 ng/l de linuron sont retrouvés via les Chemcatcher. Concernant le diuron et l'imidaclopride, les témoins présentent des concentrations du même ordre de grandeur que les échantillons.

	Echantillons	Atrazine		DIA		DEA		Diuron		Linuron		Imidaclopride	
		C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)
Echantillonnage ponctuel	Eau milli-Q	nd	-	nd	-	nd	-	4,5	2,6	3,5	5	2,0	1,8
	Bala 1 (T1)	nd	-	2,9	4,1	0,6	0,5	12,9	5,9	nd	-	4,2	0,5
	Bala 2 (T1)	nd	-	0,0	0,0	2,6	1,8	9,1	3,4	nd	-	3,7	3,7
	Bala 3 (T1)	nd	-	1,7	0,5	0,2	0,2	8,4	5,1	nd	-	9,1	7,0
	Bala 1 (T13)	3,8	1,6	3,1	1,2	1,8	1,6	3,0	1,4	3,3	4,6	10,7	9,0
	Bala 2 (T13)	4,7	0,6	1,1	1,6	3,4	1,2	2,0	1,2	6,7	9,5	15,3	5,4
	Bala 3 (T13)	5,0	1,1	0,1	0,2	4,9	1,3	1,2	0,6	0,5	0,7	10,7	3,6
POCIS	Témoin	nd	-	0,3	0,5	nd	-	0,4	0,1	nd	-	*	*
	Bama 1	10,4	1,5	8,7	2,2	9,5	0,9	2,2	0,6	7,2	7,3	*	*
	Bama 2	9,2	2,0	8,2	1,5	9,2	1,0	2,6	0,5	3,7	2,4	*	*
	Bama 3	10,8	1,5	9,3	3,3	10,0	1,2	2,4	0,9	10,9	4,6	*	*
Chemcatcher	Témoin	nd	-	0,3	0,4	0,5	0,7	2,2	0,8	0,1	0,2	3,7	0,8
	Bama 1	2,9	0,3	3,2	1,5	1,3	1,3	1,8	1,3	2,0	1,3	3,1	2,4
	Bama 2	3,2	0,6	2,1	1,8	2,7	0,5	3,5	3,2	2,8	3,4	4,2	1,2
	Bama 3	1,1	0,5	4,2	3,2	1,7	1,1	2,8	1,4	0,8	0,7	6,1	2,7

* Valeurs de taux d'échantillonnage non disponibles pour le calcul

Tableau 8 : Résultats quantitatifs pour le site de Bama

3.2.3. Site de Boura

3.2.3.1. Boura amont

Les tableaux des résultats quantitatifs pour les sites de Boura amont et aval sont présentés en Annexe 12 et 13. L'atrazine, le DIA et le DEA ne sont pas mesurés dans l'eau milli-Q. Les concentrations en atrazine mesurées par échantillonnage ponctuel sont faibles (entre 0,4 et 2,1 ng/l). Les concentrations de DEA sont plus importantes que pour la DIA que ce soit pour les échantillons prélevés lors du déploiement ou de la récupération des échantillonneurs passifs (échantillonnage ponctuel). Pour ces trois substances, les concentrations mesurées sur les échantillons provenant des POCIS sont plus élevées : jusqu'à 9,1 µg/l pour l'atrazine, 6,9 µg/l pour le DIA et 13,6 µg/l pour le DEA. Les concentrations mesurées sur les extraits de Chemcatchers sont globalement plus élevées que par échantillonnage ponctuel sauf pour le DIA.

Les concentrations en diuron mesurées à partir des prélèvements d'eau sont plus faibles que dans l'eau milli-Q. D'après les extraits provenant des POCIS, les concentrations en diuron sont très faibles avec des valeurs inférieures à 1 ng/l. Enfin, les concentrations mesurées dans les extraits de Chemcatcher sont de l'ordre du ng/l et inférieures à la moyenne des valeurs mesurées sur l'échantillonneur témoin.

Le linuron n'est pas détecté par échantillonnage ponctuel, en revanche il est mesuré avec les POCIS avec des valeurs de concentration comprises entre 2,2 et 5,5 ng/l. Ceci étant, la concentration mesurée avec le POCIS témoin est égale à 2,1 ng/l. De la même manière avec les Chemcatcher, le témoin a une concentration de 1,4 ng/l et les échantillons de 1,5 à 2,1 ng/l.

Les concentrations en imidaclopride mesurées par échantillonnage ponctuel sont très hétérogènes (entre 1,1 et 14,8 ng/l). L'eau milli-Q est contaminée à hauteur de 2,1 ng/l. Les valeurs mesurées sur les extraits de Chemcatcher varient de 2,8 à 3,8 ng/l avec un témoin à 2,7 ng/l.

3.2.3.2. Boura aval

Le tableau de résultat est présenté en Annexe 13. Globalement les remarques concernant les résultats de concentration en atrazine, en DIA et DEA sont les mêmes que pour le site Boura amont. Les seules différences notables concernent les concentrations en diuron dans les prélèvements d'eau, qui sont un peu plus élevées (jusqu'à 5,2 ng/l), avec une contamination

de l'eau milli-Q plus faible (1,5 ng/l). La détection du linuron par échantillonnage ponctuel avec des concentrations hétérogènes varie de 1,1 à 11,9 ng/l.

4. Conclusion

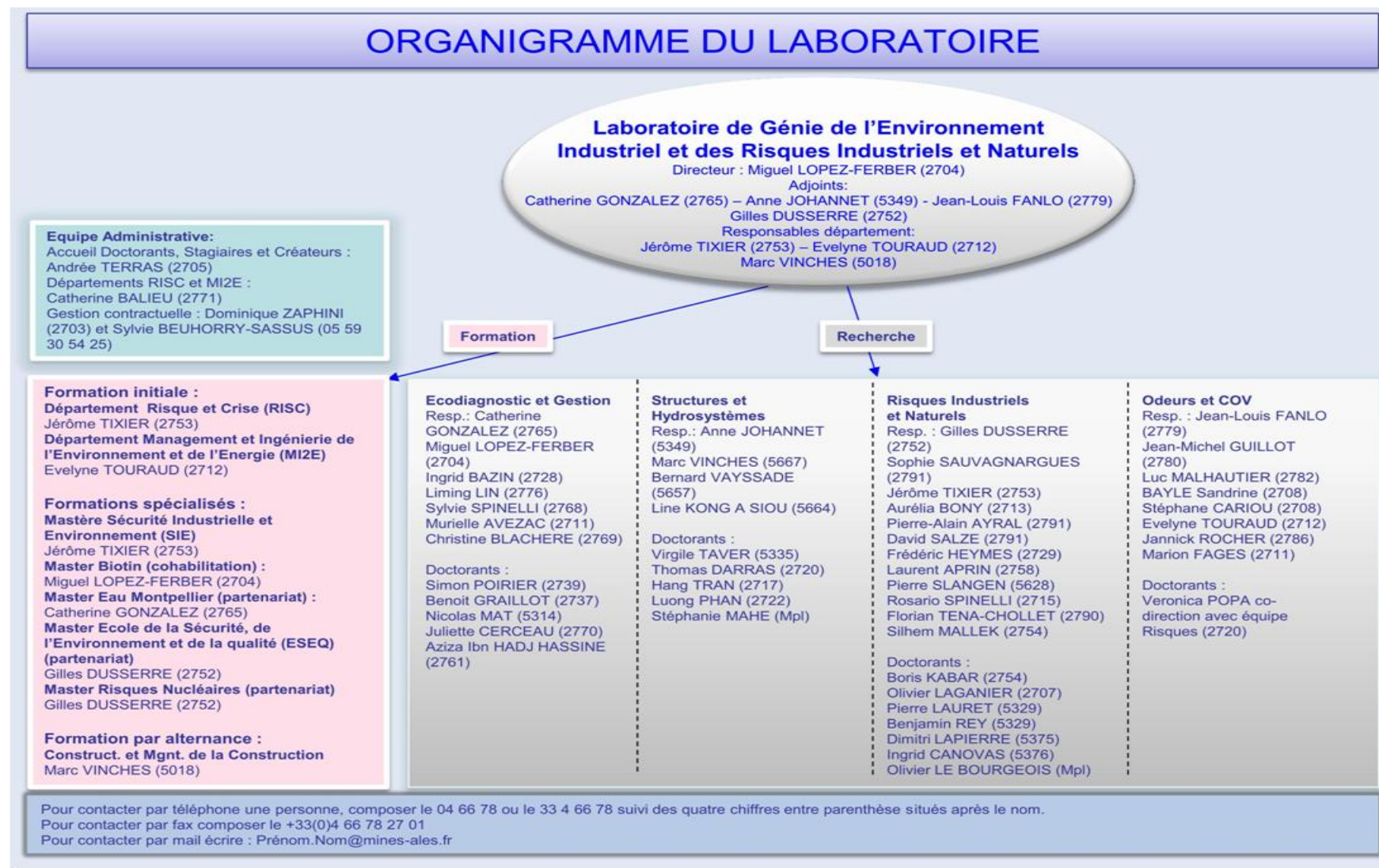
Sur les 22 substances analysées, 6 ont été sélectionnées en comparant les concentrations mesurées aux limites de détection et de quantification (Atrazine, DIA, DEA, imidaclopride, diuron et linuron). L'atrazine et le diuron figurent parmi les substances couramment utilisées au Burkina Faso.

De manière générale, les concentrations maximales observées sont de l'ordre de 15 ng/l. Cette valeur est bien inférieure aux normes de qualité environnementale (NQE) fixés par la Directive Cadre Européenne pour les eaux de surface intérieures (cours d'eau et lacs). Les valeurs de NQE sont fixées à 2 µg/l pour l'atrazine et 1,8 µg/l pour le diuron par exemple (directive 2008/105/CE).

La comparaison des concentrations en pesticides mesurées sur les différents sites met en évidence l'hétérogénéité de la pression phytosanitaire exercée : le site de Bala (site de référence) présente des valeurs plus faibles que le site de Bama (site impacté par les activités agricoles) et le site de Boura (site d'étude du CPWF-V3). Le lac de Boura présente des niveaux de concentration comparables à ceux de Bama. Pas de différence notable est observée entre l'amont et l'aval de ce site malgré les différences de profondeur auxquelles ont été réalisés les échantillonnages (respectivement 50 cm et 2 m sous la surface).

Les mesures réalisées sur les échantillons d'eau prélevés lors du déploiement et de la récupération des échantillonneurs passifs indiquent des variations temporelles de concentration pour un point donné. Ceci constitue un argument en la faveur de l'échantillonnage passif. En outre, cette étude montre l'efficacité de l'échantillonnage passif en comparaison avec l'échantillonnage ponctuel, au regard des valeurs de concentration obtenues. Pour un même site d'étude et dans les mêmes conditions, les concentrations obtenues par échantillonnage passif sont plus élevées que par échantillonnage ponctuel. Pour poursuivre cette étude il faudrait analyser d'autres substances fréquemment utilisées au Burkina Faso telles que le paraquat, ou la deltaméthrine.

Annexe 1 : Organigramme du LGEI



Annexe 2 : Recensement des pesticides utilisés au Burkina Faso

Matière active	Famille	Utilisation	Classe OMS	Ville, Région	Source
Azadirachtine	Limonoides	Maraîchage	NC	Bobo Dioulasso	IFDC 2007
Carbofuran	Carbamates		Ib		
Cyperméthrine	Pyréthrinoïdes	Coton	II		
Acétamipride	Néonicoïnoïdes		II		
Cyperméthrine	Pyréthrinoïdes		II		
Proféno fos	Organophosphorés		II		
Lambdacyhalothrine	Pyréthrinoïdes		III		
Cyperméthrine	Pyréthrinoïdes		II		
Endosulfan	Organochlorés		Ib		
Deltaméthrine	Pyréthrinoïdes		Maraîchage		
Diméthoate	Organophosphorés	II			
Azadirachtine	Limonoides	Coton	NC	Ouahigouya	
Cyperméthrine	Pyréthrinoïdes		II		
Proféno fos	Organophosphorés		II		
Méthidathion	Organophosphorés		Ib		
Lambdacyhalothrine	Pyréthrinoïdes		III		
Acétamipride	Néonicoïnoïdes		II		
Cyhalothrine	Pyréthrinoïdes		II		
Deltaméthrine	Pyréthrinoïdes		Maraîchage		
Azadirachtine	Limonoides	NC			
Acéphate	Organophosphorés	III			
Méthidathion	Organophosphorés	Coton	Ib		
Cyperméthrine	Pyréthrinoïdes		II		
Endosulfan	Organochlorés		Ib		
Proféno fos	Organophosphorés		II		
Chlorpyrifos-éthyl	Organophosphorés		II		
Cyhalothrine	Pyréthrinoïdes		II		
Endosulfan	Organochlorés	Coton	Ib	Fada N'Gourma	[10] Environnement, Risques & Santé 2009
Cyperméthrine	Pyréthrinoïdes		II		
Paraquat	Pyridines		II		
Proféno fos	Organophosphorés		II		
Lambdacyhalothrine	Pyréthrinoïdes		III		
Diuron	Halogénophénylurés		II		
Atrazine	Triazines		III		
Glyphosate	Aminophosphonates		III		
Proféno fos	Organophosphorés	Coton	II	Kompienga	[3] Biotechnology, Agronomy, Society and Environment
Endosulfan	Organochlorés		Ib		
Cyperméthrine	Pyréthrinoïdes		II		
Acétamipride	Néonicoïnoïdes		II		
Thirame	Carbamates		II		
Glyphosate	Aminophosphonates		III		
Atrazine	Triazines		III		
Propanil	Anilides		II		
Acétamipride	Néonicoïnoïdes	Maraîchage	II		
Diméthoate	Organophosphorés		II		
Cyhalothrine	Pyréthrinoïdes		II		
Paraquat	Pyridines		II		

Annexe 3 : Taux d'échantillonnage des 22 substances pour les POCIS et les Chemcatcher

Composé	Rs POCIS (ml/j)	Rs Chemcatchers (ml/j)	Référence
DIA	67,9	44	[25], [26]
DEA	132,9	36	[25]
Simazine	217,7	91	
DET	253,7	97	
Atrazine	253,8	123	
Terbuthylazine	163,3	115	
Acetochlor	223,1	85	
Metolachlor	268,2	122	
Alachlor	255,5	209	
Chlortoluron	251,5	-	
Isoproturon	236,5	94	
Diuron	256,7	152	
Linuron	140,5	133	
Metalaxyl	264,2	101	
Azoxystrobine	153,8	56	
Propyzamide	194,8	154	
Penconazole	279	88	
DCPU	-	66	
DCPMU	266,9	93	[25], [27]
Imidaclopride	-	72	[25]
Oxadixil	-	81	
Flazasulfuron	-	36	

Annexe 4 : Conditionnement des Chemcatcher

Dans un premier temps, les différents éléments en téflon sont nettoyés avec un détergent non-ionique puis rincés à l'eau bi-permutée (5 fois), à l'eau milli-Q (3 fois) puis à l'acétone et sont séchés à l'étuve (60°C). Les phases C18 sont trempées pendant 24h dans du méthanol pour éliminer les éventuelles pollutions, elles sont ensuite placées sur un dispositif d'extraction sous vide où elles sont éluées successivement au méthanol (50ml) et à l'eau milli-Q (150 ml) sans être séchées. Elles sont ensuite placées sur le support en téflon. Enfin les membranes PES sont rincées au méthanol puis trempées dans de l'eau milli-Q avant d'être déposées sur la phase réceptrice. Les différents modules des Chemcatcher sont assemblés, puis remplis avec de l'eau milli-Q avant leur fermeture. Ils sont conservés au réfrigérateur, dans du papier aluminium jusqu'à leur exposition.

Annexe 5 : Conditionnement et extraction des cartouches HLB

Le conditionnement des cartouches se fait par éluations successives à l'acétonitrile (5ml), au méthanol (5ml) et à l'eau milli-Q (5ml) sur un support d'extraction Visiprep. Après conditionnement, les échantillons d'eau sont percolés au travers des cartouches avec un débit de 10 ml/min. Ces dernières sont ensuite séchées sous vide pendant 1h puis stockées au congélateur jusqu'à l'étape d'extraction. L'élution se fait à l'aide du système d'extraction sous vide Visiprep. Trois fois 3 ml sont élués au travers de la cartouche dans une fiole. L'éluat est ensuite évaporé sous flux d'azote puis transféré dans un flacon de 1,5 ml pour l'analyse. De la même manière que précédemment plusieurs rinçages de la fiole sont effectués, le produit est transféré dans un flacon de 1,5 ml et ajusté à 780 µl à l'aide du témoin visuel.

Annexe 6 : Extraction des Empore disques

A la suite de leur immersion, les disques C18 sont séchés pendant 30 minutes sur un support d'extraction SPE sous vide pour éliminer toute trace d'eau. Ils sont ensuite emballés dans du papier aluminium et conservés au congélateur jusqu'à leur extraction. Cette dernière étape est réalisée sur le support d'extraction. Tout d'abord, 5 ml de méthanol sont déposés sur la surface de l'Empore disque, suivi de 100 µl d'atrazine d5, laissés au contact pendant 30 secondes afin de favoriser l'imprégnation. L'élution est ensuite réalisée en appliquant le vide, suivi d'une percolation de 25 ml de méthanol (5 fois 5 ml). L'éluat est ensuite évaporé sous azote et transféré dans un flacon de 1,5 ml préalablement pesé à la balance de précision, par rinçages successifs à l'acétonitrile. Le volume est ajusté à 780 µl avec de l'acétonitrile à l'aide d'un témoin visuel et le flacon est pesé une nouvelle fois pour déterminer le volume réel de l'extrait. Avant de réaliser l'analyse, les échantillons sont dopés avec 120 µl d'une solution de simazine d5 à 100 ppb et 600 µl d'eau milli-Q.

Annexe 7 : Extraction des POCIS

L'extraction se fait en incisant délicatement une des deux membranes, afin de transférer la phase adsorbante avec une pipette pasteur, vers une cartouche SPE. La récupération de la totalité de la phase adsorbante se fait par injection d'eau milli-Q. La cartouche SPE, équipée d'un fritté est placée sur le système d'extraction sous vide Visiprep et séchée pendant 30 minutes. Si l'extraction ne peut pas être réalisée immédiatement, la cartouche est stockée au congélateur dans du papier aluminium. Dans ce cas, elle doit être sortie du congélateur 1 heure avant l'extraction. Dans un premier temps, la cartouche est placée sur le système d'extraction Visiprep, au dessus d'une fiole pour récupérer l'éluat, puis elle est imprégnée avec 100 µl d'atrazine d5 pendant 1 minute. Ensuite, 3 ml d'acétonitrile est ajouté et laissé en contact avec la phase pendant 30 secondes (pour favoriser l'imprégnation) avant d'appliquer le vide. L'élution est répétée deux fois avec 3 ml d'acétonitrile. Les 9 ml obtenus sont réduits à 1 ml par évaporation sous flux d'azote et transférés dans un flacon de 2 ml. La fiole est rincée 3 fois à l'acétonitrile avec une pipette pasteur, le produit de rinçage est injecté dans le flacon, évaporé et l'extrait est ajusté à 780 µl. De la même manière que pour les Chemcatcher, le volume réel de l'extrait obtenu est déterminé par pesée à la balance de précision. Avant l'injection sont ajoutés 120 µl de simazine d5 (standard interne) et 600 µl d'eau milli-Q.

**Annexe 8 : Temps de rétention et paramètres de détection des pesticides
par HPLC-ESI-MS2 (Micromass Quatro micro, Waters)**

	t _r	Transition			Dwell Time	Cone V	E Collision (eV)
Acétochlore	7,42	270,1	>	224,2	0,2	30	8
Alachlore	7,38	270,2	>	238	0,2	24	15
Atrazine	4,19	216	>	174	0,12	35	18
Atrazine d5	4,17	221	>	179	0,12	37	20
Azoxystrobine	5,66	404	>	344	0,12	21	25
Chlortoluron	3,73	213,1	>	72,1	0,12	30	35
DCPMU	3,61	219	>	162	0,2	28	16
DCPU	3,09	205	>	127	0,2	32	19
DEA	2,86	188	>	146	0,2	34	20
DET	3,4	202,1	>	146,1	0,12	30	20
DIA	2,58	174	>	104	0,2	39	23
Diuron	4,13	233	>	72	0,12	27	18
Flazasulfuron	4,17	408,1	>	182,1	0,12	31	21
Imidaclopride	2,72	256,1	>	175	0,12	25	26
Isoproturon	3,97	207	>	72	0,12	32	23
Linuron	5,67	249	>	160	0,12	28	15
Métalaxyl	3,85	280	>	220	0,12	25	19
Métolachlore	7,27	284,1	>	252,2	0,12	40	16
Oxadixyl	3,12	279,1	>	132,1	0,12	21	35
Penconazole	7	284,2	>	159,1	0,12	30	40
Propyzamide	6,56	256	>	190	0,12	27	17
Simazine	3,49	202	>	132	0,12	37	20
Simazine d5	3,49	207,1	>	129	0,12	37	21
Terbuthylazine	5,6	230,1	>	174	0,12	30	25

Annexe 9 : Tableau de résultats qualitatifs du site de Boura Amont

Composé	Echantillons d'eau extraits avec HLB (µg/l)							Extraction POCIS (µg/l)				Extraction Chemcatcher (µg/l)			
	T1			T13			Eau milli-Q	Boura amont1	Boura amont2	Boura amont3	Témoin	Boura amont1	Boura amont2	Boura amont3	Témoin
	Boura amont1	Boura amont2	Boura amont3	Boura amont1	Boura amont2	Boura amont3									
Imidaclopride	< LD	3,2	2,4	nd	3,6	5,2	< LD	5,0	5,1	6,0	2,5	1,8	2,5	1,8	1,8
Oxadixil	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	< LD	nd	< LD	nd
DET	nd	< LD	< LD	< LD	nd	nd	nd	0,7	0,4	< LD	nd	nd	nd	nd	nd
Simazine	nd	nd	nd	nd	nd	nd	nd	0,5	< LD	< LD	nd	nd	nd	nd	nd
Chlortoluron	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd	nd
Metalaxyl	nd	nd	nd	nd	nd	nd	nd	nd	0,5	1,1	nd	nd	nd	nd	nd
Isoproturon	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diuron	1,4	< LD	0,6	0,9	0,8	< LD	1,9	0,6	1,1	0,7	0,85	2,2	1,7	0,8	2,6
Flazasulfuron	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	nd	< LD	nd	nd
Terbutylazine	nd	nd	nd	nd	nd	nd	nd	0,5	0,5	0,8	nd	< LD	< LD	< LD	nd
Azoxystrobine	nd	nd	nd	nd	nd	nd	nd	0,5	0,5	0,5	0,3	0,3	0,3	0,3	0,3
Penconazole	11,3	11,2	11,3	5,7	11,2	11,3	11,3	1,2	1,1	1,2	0,45	1,1	1,2	1,2	0,5
DIA	1,0	1,1	< LD	1,8	< LD	1,0	nd	3,8	4,1	4,2	nd	< LD	1,0	< LD	nd
DEA	0,9	2,4	1,5	2,6	0,5	1,2	nd	16,0	12,4	12,4	nd	< LD	< LD	< LD	nd
Atrazine	< LD	< LD	< LD	0,8	< LD	nd	nd	20,3	16,4	16,8	1,8	2,1	2,5	2,2	nd
DCPU	1,7	< LD	< LD	1,15	< LD	1	< LD	< LD	< LD	< LD	< LD	nd	nd	nd	nd
DCPMU	1,0	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	nd	< LD	< LD	< LD	nd
Acetochlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<LD	7,6	<LD	11
Alachlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<LD	<LD	<LD	<LD
Linuron	nd	nd	nd	nd	nd	nd	nd	4,7	2,7	6,9	2,7	2,5	1,8	1,8	1,8
Metolachlore	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	< LD	nd	nd
Propyzamide	nd	nd	nd	nd	nd	nd	nd	< LD	0,8	< LD	< LD	< LD	< LD	< LD	< LD

Annexe 10 : Tableau de résultats qualitatifs du site de Boura Aval

Composé	Echantillons d'eau extraits avec HLB (µg/l)							Extraction POCIS (µg/l)				Extraction Chemcatcher (µg/l)			
	T1			T13			Eau milli-Q	Boura aval1	Boura aval2	Boura aval3	Témoïn	Boura aval1	Boura aval2	Boura aval3	Témoïn
	Boura aval1	Boura aval2	Boura aval3	Boura aval1	Boura aval2	Boura aval3									
Imidaclopride	4,0	1,7	3,6	2,8	1,9	1,5	< LD	7,4	5,5	5,6	9,7	1,3	2,1	3,1	< LD
Oxadylxil	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	3,3	nd	< LD	< LD	< LD	nd
DET	nd	nd	nd	nd	nd	nd	nd	0,4	0,5	0,6	nd	nd	nd	nd	nd
Simazine	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	nd	nd	nd	nd
Chlortoluron	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	nd	nd	nd	nd
Metalaxyl	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	0,5	nd	nd	nd	nd	nd
Isoproturon	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	< LD	nd	nd	nd	nd
Diuron	1,5	0,9	< LD	< LD	1,3	1,1	< LD	< LD	< LD	< LD	nd	1,4	1,6	1,2	5,1
Flazasulfuron	nd	nd	nd	nd	nd	nd	nd	< LD	0,8	0,8	nd	nd	nd	nd	nd
Terbutylazine	nd	nd	nd	nd	nd	nd	nd	0,5	0,5	0,4	< LD	< LD	< LD	< LD	nd
Azoxystrobine	nd	nd	nd	nd	nd	nd	nd	0,3	1,2	1,0	1,1	0,3	0,5	0,4	0,3
Penconazole	11,2	11,3	11,2	11,3	11,2	11,4	5,6	4,8	7,0	5,7	0,2	0,7	1,0	1,0	1,1
DIA	nd	1	< LD	< LD	< LD	< LD	nd	14,1	16,9	14,2	nd	< LD	< LD	nd	nd
DEA	1,6	1,8	2,2	1,5	1,2	1,9	nd	16,7	15,0	16,1	nd	0,5	0,9	< LD	nd
Atrazine	< LD	< LD	nd	< LD	< LD	nd	nd	< LD	0,65	0,875	nd	2,1	2,2	2,25	nd
DCPU	< LD	1,4	2,1	1,1	< LD	2,5	< LD	< LD	nd	< LD	nd	nd	< LD	nd	nd
DCPMU	< LD	< LD	< LD	< LD	< LD	< LD	< LD	nd	nd	nd	nd	nd	< LD	nd	nd
Acetochlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<LD	<LD	<LD	<LD
Alachlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	<LD	<LD	<LD	<LD
Linuron	0,5	3,3	1,5	nd	3,1	4,1	nd	4,7	6,8	4,0	4,1	0,9	4,5	3,2	nd
Metolachlore	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd	nd	nd
Propyzamide	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	< LD	0,85	< LD	< LD	< LD

Annexe 11 : Tableau de résultats quantitatifs du site de Bala

	Echantillons	Atrazine		DIA		DEA		Diuron		Linuron		Imidaclopride	
		C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)
Echantillonnage ponctuel	<i>Eau milli-Q</i>	nd	-	nd	-	nd	-	30,8	3,6	0,2	0,2	13,0	6,5
	Bala 1 (T1)	nd	-	nd	-	nd	-	4,6	0,7	nd	-	1,0	1,1
	Bala 2 (T1)	nd	-	nd	-	nd	-	3,8	0,7	nd	-	1,8	0,0
	Bala 3 (T1)	nd	-	1,1	1,5	nd	-	4,0	0,5	nd	-	7,9	0,9
	Bala 1 (T13)	nd	-	nd	-	nd	-	4,9	0,3	nd	-	2,8	1,9
	Bala 2 (T13)	nd	-	nd	-	nd	-	2,4	0,8	nd	-	0,0	0,0
	Bala 3 (T13)	nd	-	nd	-	nd	-	2,8	0,4	nd	-	4,1	1,1
POCIS	<i>Témoin</i>	nd	-	0,8	1,1	nd	-	0,1	0,2	3,1	2,7	*	-
	Bala 1	nd	-	0,3	0,3	nd	-	0,2	0,2	2,9	1,5	*	-
	Bala 2	nd	-	0,2	0,2	nd	-	0,2	0,2	1,7	1,4	*	-
	Bala 3	nd	-	0,6	0,7	nd	-	0,1	0,1	0,7	1,5	*	-
Chemcatcher	<i>Témoin</i>	nd	-	0,4	0,5	nd	-	0,1	0,2	nd	-	3,0	0,2
	Bala 1	nd	-	0,3	0,5	nd	-	0,4	0,3	2,0	1,7	1,4	1,6
	Bala 2	nd	-	1,2	0,3	nd	-	0,1	0,2	2,2	3,3	0,7	0,8
	Bala 3	nd	-	1,2	0,3	nd	-	0,4	0,5	2,4	3	2,5	0,6

Annexe 12 : Tableau de résultats quantitatifs du site de Boura amont

	Echantillons	Atrazine		DIA		DEA		Diuron		Linuron		Imidaclopride	
		C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)
Echantillonnage ponctuel	Eau milli-Q	nd	-	nd	-	nd	-	4,9	0,9	nd	-	2,3	3,2
	Bala 1 (T1)	0,4	0,6	2,6	1,0	2,4	1,9	3,8	2,3	nd	-	6,1	1,8
	Bala 2 (T1)	0,7	0,2	2,9	2,2	6,1	3,5	0,8	0,7	nd	-	8,3	2,6
	Bala 3 (T1)	0,5	0,7	1,3	1,1	3,8	0,7	1,5	0,4	nd	-	1,1	1,1
	Bala 1 (T13)	2,1	1,5	4,5	0,5	6,7	0,7	2,2	1,3	nd	-	nd	-
	Bala 2 (T13)	0,9	0,9	0,8	0,2	1,5	2,2	2,3	0,2	nd	-	10,9	5,0
	Bala 3 (T13)	nd	-	2,7	0,2	3,3	1,0	0,7	1,0	nd	-	14,8	1,2
POCIS	Témoin	0,8	0,1	nd	-	nd	-	0,4	0,2	2,1	3	*	*
	Boura am 1	9,1	0,2	6,3	1,3	13,6	0,9	0,3	0,2	3,8	2,7	*	*
	Boura am 2	7,4	1,3	6,9	2,1	10,6	1,6	0,5	0,3	2,2	1,3	*	*
	Boura am 3	7,5	1,9	4,6	2,8	5,8	1,3	0,4	0,2	5,5	5,3	*	*
Chemcatcher	Témoin	nd	-	nd	-	nd	-	1,8	0,9	1,4	2	2,7	0,4
	Boura am 1	1,9	0,4	0,9	0,7	1,4	1,0	1,6	0,1	2,1	3,5	2,8	1,9
	Boura am 2	2,3	0,6	2,4	1,0	1,9	1,3	1,3	0,4	1,5	1,4	3,8	2,2
	Boura am 3	2,0	0,4	0,6	1,1	1,0	0,5	0,6	0,4	1,5	2,2	2,8	0,7

Annexe 13 : Tableau de résultats quantitatifs du site de Boura aval

	Echantillons	Atrazine		DIA		DEA		Diuron		Linuron		Imidaclopride	
		C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)	C/eau (ng/l)	Ecart-type (ng/l)
Echantillonnage ponctuel	Eau milli-Q	nd	-	nd	-	nd	-	1,5	0,2	0,2	0,2	2,8	4,0
	Bala 1 (T1)	1,1	1,6	nd	-	4,1	1,8	3,8	1,8	1,1	1,6	10,0	3,8
	Bala 2 (T1)	0,3	0,4	2,7	0,4	4,7	1,3	2,3	1,0	8,9	5,7	4,5	0,6
	Bala 3 (T1)	nd	-	2,2	1,7	5,8	1,5	5,2	1,1	3,9	5,5	9,3	3,9
	Bala 1 (T13)	0,3	0,4	1,5	2,1	4,4	2,1	0,6	0,4	nd	-	8,2	0,0
	Bala 2 (T13)	0,9	0,0	2,3	0,4	3,3	1,4	3,6	1,0	8,9	12,6	5,3	1,0
	Bala 3 (T13)	nd	0,0	1,3	0,2	5,4	3,5	3,0	1,4	11,9	7,8	4,2	3,5
POCIS	Témoïn	nd	-	0,3	0,2	nd	-	0,2	0,0	3,3	2,7	*	*
	Boura av 1	7,3	1,0	8,0	1,7	11,9	1,4	0,2	0,1	3,7	3,4	*	*
	Boura av 2	6,8	0,5	11,8	2,0	14,6	1,9	0,3	0,2	5,6	2,9	*	*
	Boura av 3	7,2	1,1	9,5	3,3	12,1	0,6	0,2	0,1	3,3	2,9	*	*
Chemcatcher	Témoïn	nd	-	nd	-	nd	-	3,8	0,6	nd	-	1,2	1,7
	Boura av 1	1,9	0,2	0,7	0,4	1,6	1,2	1,0	0,5	0,8	0,5	2,0	0,8
	Boura av 2	2,0	0,4	1,6	1,1	2,9	0,3	1,1	0,8	3,8	2	3,2	1,1
	Boura av 3	2,0	0,5	nd	-	1,4	1,2	0,9	0,4	2,6	2,5	4,7	2,0

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Résumé

Le secteur agricole occupe une place prépondérante au Burkina Faso et la pluviosité est caractérisée par une irrégularité aussi bien en termes de quantité que de répartition. En réponse à ces sécheresses récurrentes, plus de 1700 petits barrages ont été construits afin de mobiliser les eaux de surface. Cette étude porte sur la caractérisation de la pression phytosanitaire exercée sur 3 retenues d'eau du bassin versant de la Volta, par échantillonnage passif. Le lac de Bala, situé au cœur d'une réserve naturelle constitue le site de référence non impacté de l'étude. Le second lac, Bama, considéré comme impacté, est implanté au centre de nombreuses activités agricoles. Le lac de Boura, est lui aussi mobilisé pour la production agricole. Pour cette étude 22 produits phytosanitaires organiques polaires ont été analysés par échantillonnage passif (POCIS et Chemcatcher) et ponctuel. Parmi ces substances, 6 ont été détectées et quantifiées (Atrazine, DIA, DEA, imidaclopride, diuron et linuron). Cette étude a permis d'une part de mettre en évidence les différences de pression phytosanitaire exercées sur les 3 sites, et d'autre part de comparer l'efficacité des échantillonneurs passifs. Il serait intéressant de poursuivre cette étude en analysant d'autres molécules utilisées au Burkina Faso telle que le Paraquat.

Mots-clefs : Pression phytosanitaire, Echantillonnage passif, POCIS, Chemcatcher, Volta, Burkina Faso

Summary

Burkina Faso relies heavily on its agricultural surroundings, however with its characteristic irregular rainfall patterns, including both quantity and distribution, recent droughts have become much more of an issue. In response to the recurrent scarcity of water, an excess of 1,700 small dams were built with the aim of raising the local water level. This study focuses on observing the pesticide selection pressure exerted against the environment amongst three dams, all within the drainage basin of the Volta river, via passive sampling. Bala Lake, at the heart of a nature reserve, is the reference site not affected by the study. The second lake, Bama (considered to be affected by the study), is located at the center of many agricultural activities. Lastly, lake Boura was also used in agricultural production. 22 polar organic pesticides were analyzed via passive sampling (POCIS and Chemcatcher) in conjunction with water extractions. Among these substances, 6 were detected and quantified (atrazine, DIA, DEA, imidacloprid, diuron and linuron). After highlighting the differences in selection pressure upon the 3 sites, the second aim of the study is to compare the efficacy of the passive samplers. Further analysis of other molecules, such as Paraquat used in Burkina Faso, could prove to be an interesting route of research in continuance of this study.

Key Words: Pesticide selection pressure, passive sampling, POCIS, Chemcatcher, Volta, Burkina Faso

Extrait du document intitulé :

Etude de la pression phytosanitaire exercée sur différents lacs du Burkina Faso par méthode d'échantillonnage passif



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Mémoire de stage de Master 2^{ème} année Mention :

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Février, Juillet 2013

3. Résultats et discussion

3.1. Etude qualitative des résultats

3.1.1. Site de référence : Bala

Les Tableaux ci-dessous (Tableaux 6 et 7) représentent les concentrations des extraits analysés par HPLC-MS. Chaque concentration correspond à une moyenne de deux injections HPLC. La colonne « Eau milli-Q » correspond à l'analyse de l'eau utilisée pour le conditionnement des Chemcatcher, des cartouches SPE et des cartouches HLB.

Composé	Echantillons d'eau extraits avec HLB (µg/l)							Extraction POCIS (µg/l)				Extraction Chemcatcher (µg/l)			
	T1			T13			<i>Eau milli-Q</i>	Bala1	Bala2	Bala3	<i>Témoin</i>	Bala1	Bala2	Bala3	<i>Témoin</i>
	Bala1	Bala2	Bala3	Bala1	Bala2	Bala3									
Imidaclopride	< LD	< LD	3,3	1,2	nd	1,6	<i>nd</i>	1,6	1,9	1,4	<i>1,2</i>	0,9	0,5	1,6	<i>1,9</i>
Oxadixil	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
DET	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
Simazine	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
Chlortoluron	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	< LD	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
Metalaxyl	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
Isoproturon	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
Diuron	1,8	1,5	1,7	2	nd	1,1	<i>10,4</i>	< LD	< LD	< LD	<i>< LD</i>	< LD	< LD	0,5	<i>< LD</i>
Flazasulfuron	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	< LD	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
Terbutylazine	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	< LD	nd	<i>nd</i>	nd	nd	< LD	<i>nd</i>
Azoxystrobine	nd	nd	nd	nd	nd	nd	<i>nd</i>	0,2	< LD	0,2	<i>0,3</i>	0,3	0,3	0,4	<i>0,3</i>
Penconazole	11,3	11,5	11,5	nd	nd	11,5	<i>11,3</i>	1,1	1,0	1	<i>1,0</i>	2,0	1,2	1,4	<i>1,1</i>
DIA	nd	nd	< LD	nd	nd	nd	<i>nd</i>	< LD	< LD	< LD	<i>< LD</i>	< LD	< LD	< LD	<i>< LD</i>
DEA	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	< LD	<i>nd</i>	nd	nd	nd	<i>nd</i>
Atrazine	nd	nd	nd	nd	nd	nd	<i>2,1</i>	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
DCPU	1,5	2,3	1,6	< LD	nd	0,9	<i>2,0</i>	< LD	< LD	< LD	<i>nd</i>	nd	nd	nd	<i>nd</i>
DCPMU	< LD	< LD	< LD	< LD	nd	< LD	<i>< LD</i>	nd	< LD	< LD	<i>nd</i>	nd	nd	nd	<i>nd</i>
Acetochlore	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>	10,6	12,2	12,4	<i>nd</i>
Alachlore	nd	nd	nd	nd	nd	nd	<i>< LD</i>	< LD	11,8	< LD	< LD	< LD	< LD	< LD	<i>< LD</i>
Linuron	nd	nd	nd	nd	nd	nd	<i>< LD</i>	3,6	2,2	0,9	<i>3,8</i>	2,3	2,6	2,8	<i>nd</i>
Metolachlore	nd	nd	nd	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>	nd	nd	nd	<i>nd</i>
Propyzamide	nd	nd	nd	nd	nd	nd	<i>nd</i>	< LD	< LD	< LD	<i>< LD</i>	< LD	< LD	< LD	<i>< LD</i>

nd : Non détecté

Tableau 6 : Résultats qualitatifs pour le site de Bala

Sur le site de Bala, 8 substances sont présentes en concentrations supérieures aux limites de détection et/ou de quantification : Imidaclopride, diuron, azoxystrobine, penconazole, atrazine, DCPU, l'acétochlore, et linuron. Concernant les autres substances, les concentrations retrouvées dans les échantillons sont globalement du même ordre de grandeur voir plus faibles que celle retrouvées sur les témoins pour chacune des substances, ce qui laisse supposer que le site ne présente pas de réelle contamination. 4 composés sont détectés par échantillonnage ponctuel (imidaclopride, diuron, penconazole et DCPU), 4 avec les POCIS (imidaclopride, azoxystrobine, penconazole, et linuron) et 5 avec les Chemcatcher (imidaclopride, azoxystrobine, penconazole, acétochlore, et linuron).

3.1.2. Site impacté par des activités agricole : Bama

Les concentrations mesurées sur le site de Bama sont plus significatives au vue des concentrations mesurées sur les échantillonneurs témoins. On constate que, pour un même site d'étude, le nombre de composés détectés par échantillonnage passif est plus important que par échantillonnage ponctuel. De plus, on remarque que les concentrations mesurées sur les extraits provenant des POCIS sont globalement plus importantes que celles des Chemcatcher. Ce qui est prévisible car la surface d'échange pour les POCIS est de 41 cm² contre 17,34 cm² pour les Chemcatcher.

Il est faut noter que pour certaines substances (Imidaclopride, diuron, DEA, atrazine et linuron) les concentrations mesurées à partir des prélèvements d'eau sont différentes selon la date de prélèvement. Ceci indique une variation de la concentration en fonction du temps.

Etant donné que pour le site de Bama le nombre de substances détectées est le plus élevé, nous nous appuierons sur ces résultats pour déterminer les substances d'intérêt pour l'analyse quantitative, à partir notamment des extraits provenant des POCIS.

D'après les mesures faites sur les extraits de POCIS, 9 substances sont présentes en concentration supérieure à leur limite de détection : L'imidaclopride, le diuron, le penconazole, le DIA, le DEA, l'atrazine, l'acétochlore, l'alachlore et le linuron.

Il convient de mentionner que lors de l'exploitation sur le logiciel Masslynx, les pics d'intégration de l'acétochlore et l'alachlore n'étaient pas bien définis. C'est pour cela qu'ils ne sont pas sélectionnés pour l'étude quantitative. Le penconazole est aussi écarté au regard des concentrations mesurées sur les échantillons témoins. 6 substances sont donc sélectionnées parmi les 22 (surlignées dans le Tableau 7).

Composé	Echantillons d'eau extraits avec HLB (µg/l)							Extraction POCIS (µg/l)				Extraction Chemcatcher (µg/l)			
	T1			T13			<i>Eau milli-Q</i>	Bama1	Bama2	Bama3	<i>Témoin</i>	Bama1	Bama2	Bama3	<i>Témoin</i>
	Bama1	Bama2	Bama3	Bama1	Bama2	Bama3									
Imidaclopride	1,3	1	2,7	3,3	5,4	4,1	< LD	5,8	4,7	4,3	nd	2	2,7	3,9	2,4
Oxadixil	nd	nd	nd	nd	nd	nd	nd	2,7	0,9	0,8	nd	nd	1,3	nd	nd
DET	nd	< LD	nd	< LD	nd	nd	nd	< LD	< LD	< LD	nd	nd	nd	nd	nd
Simazine	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	< LD	nd	nd	nd
Chlortoluron	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Metalaxyl	nd	nd	nd	nd	nd	nd	nd	1,0	0,6	0,9	nd	nd	0,7	< LD	nd
Isoproturon	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diuron	4	2,5	2,5	0,9	0,7	0,5	1,2	4,9	6,0	5,4	1	2,5	4,7	3,7	3
Flazasulfuron	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	nd	< LD	< LD	nd
Terbutylazine	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	< LD	< LD	< LD	nd
Azoxystrobine	nd	nd	nd	nd	nd	nd	nd	0,3	0,4	0,4	0,3	0,5	0,5	0,3	0,3
Penconazole	11,3	11,3	11,3	11,3	11,5	11,4	11,2	1,3	1,5	1,4	0,9	0,9	1,7	1,5	0,5
DIA	0,9	nd	< LD	1,0	< LD	< LD	nd	5,1	4,9	5,5	< LD	1,3	< LD	1,7	< LD
DEA	< LD	< LD	< LD	0,6	1,2	1,9	nd	11,5	10,8	10,8	nd	< LD	0,9	0,6	< LD
Atrazine	nd	nd	nd	1,2	1,7	1,9	nd	22,6	20,6	23,8	nd	3,1	3,5	1,2	nd
DCPU	< LD	1,1	1,2	1,7	< LD	1,1	< LD	1,8	< LD	1,9	nd	< LD	< LD	1,1	< LD
DCPMU	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	1,45	nd	< LD	< LD	< LD	nd
Acetochlore	nd	nd	nd	nd	nd	nd	nd	67,8	76,6	78,3	nd	< LD	18,5	17,8	7,4
Alachlore	nd	nd	nd	nd	nd	nd	nd	nd	45,3	53,1	13,5	< LD	14,9	< LD	13,1
Linuron	nd	nd	nd	1	2,4	< LD	1,0	8,6	4,6	13,3	nd	2,4	3,3	1,0	< LD
Metolachlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd
Propyzamide	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD

Tableau 7: Résultats qualitatifs pour le site de Bama

3.1.3. Site de Boura

Sur le site de Boura à l'amont et à l'aval, les substances détectées sont sensiblement les mêmes que celles détectées à Bama. Les tableaux de résultats sont exposés en annexe (Annexe 9, Annexe 10).

Master Internship research, second year dissertation:

Internship coordinator: GONZALEZ Catherine, CECCHI Philippe

February, July 2013

3. Results and debate

3.1. Qualitative study of the results

3.1.1. Reference site: Bala

The tables below (Table 6 and 7) represent the concentrations of extracts analyzed by HPLC-MS. Each concentration corresponds to an average of two injections. The column “Water milli-Q” corresponds to the analysis of water used for Chemcatcher, SPE and HLB cartridges conditioning.

Compound	Water samples extracted with HLB (µg/l)							POCIS extraction (µg/l)				Chemcatcher extraction (µg/l)			
	T1			T13			Water milli-Q	Bala1	Bala2	Bala3	Témoïn	Bala1	Bala2	Bala3	Témoïn
	Bala1	Bala2	Bala3	Bala1	Bala2	Bala3									
Imidaclopride	< LD	< LD	3,3	1,2	nd	1,6	nd	1,6	1,9	1,4	1,2	0,9	0,5	1,6	1,9
Oxadixil	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
DET	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Simazine	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chlortoluron	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd	nd
Metalaxyl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Isoproturon	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diuron	1,8	1,5	1,7	2	nd	1,1	10,4	< LD	< LD	< LD	< LD	< LD	< LD	0,5	< LD
Flazasulfuron	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd	nd
Terbutylazine	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	< LD	nd
Azoxystrobine	nd	nd	nd	nd	nd	nd	nd	0,2	< LD	0,2	0,3	0,3	0,3	0,4	0,3
Penconazole	11,3	11,5	11,5	nd	nd	11,5	11,3	1,1	1,0	1	1,0	2,0	1,2	1,4	1,1
DIA	nd	nd	< LD	nd	nd	nd	nd	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD
DEA	nd	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd	nd	nd	nd
Atrazine	nd	nd	nd	nd	nd	nd	2,1	nd	nd	nd	nd	nd	nd	nd	nd
DCPU	1,5	2,3	1,6	< LD	nd	0,9	2,0	< LD	< LD	< LD	nd	nd	nd	nd	nd
DCPMU	< LD	< LD	< LD	< LD	nd	< LD	< LD	nd	< LD	< LD	nd	nd	nd	nd	nd
Acetochlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	10,6	12,2	12,4	nd
Alachlore	nd	nd	nd	nd	nd	nd	< LD	< LD	11,8	< LD	< LD	< LD	< LD	< LD	< LD
Linuron	nd	nd	nd	nd	nd	nd	< LD	3,6	2,2	0,9	3,8	2,3	2,6	2,8	nd
Metolachlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Propyzamide	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD

nd: Not detected

Table 6: Qualitative results for the Bala site

Eight substances are present at the Bala site at concentrations above the limits of detection and/or quantification: Imidaclopride, diuron, azoxystrobin, penconazole, atrazine, DCPU, l'acétochlore, and linuron. With regard to other substances, concentrations found in samples are generally of the same order of magnitude as the concentrations found in each control substance or lower, suggesting that the site is not really contaminated. 4 compounds were detected by grab sampling (imidaclopride, diuron, penconazole and DCPU), 4 by POCIS (imidaclopride, azoxystrobin, penconazole, and linuron) and 5 by Chemcatcher (imidaclopride, azoxystrobin, penconazole, acetochlore, and linuron).

3.1.2. Site impacted by agricultural activities: Bama

Concentrations measured at the Bama site are more significant in light of the concentrations measured in control samples. It is observed that for the same study site the number of compounds detected by passive sampling is higher than by grab sampling. Furthermore, it can be noticed that concentrations measured in POCIS extracts are generally higher than in Chemcatcher, which is predictable because the exchange surface in POCIS is 41 cm² compared with 17,34 cm² in Chemcatcher.

It should be noted that for some substances (Imidaclopride, diuron, DEA, atrazine and linuron) concentrations measured in water samples vary depending on the date of sampling. This shows a seasonal variation of concentrations.

Since the highest number of substances were detected in the Bama site, we shall rely on those results to determine the substances which are interesting for the quantitative analysis, starting by POCIS extracts in particular.

Based on measures taken from POCIS extracts, 9 substances are present at concentrations above their limit of detection: imidaclopride, diuron, penconazole, DIA, DEA, atrazine, acetochlor, alachlor and linuron.

It should be mentioned that upon operation on Masslynx software, integration peaks of acetochlore and alachlore were not well defined. That is why they were not selected for the quantitative study. Penconazole was also excluded in light of the concentrations measured in control samples. Therefore, 6 substances were selected among 22 (highlighted in Table 7).

Compound	Water samples extracted with HLB (µg/l)							POCIS extraction (µg/l)				Chemcatcher extraction (µg/l)			
	T1			T13			Water milli-Q	Bama1	Bama2	Bama3	Témoïn	Bama1	Bama2	Bama3	Témoïn
	Bama1	Bama2	Bama3	Bama1	Bama2	Bama3									
Imidaclopride	1,3	1	2,7	3,3	5,4	4,1	< LD	5,8	4,7	4,3	nd	2	2,7	3,9	2,4
Oxadixil	nd	nd	nd	nd	nd	nd	nd	2,7	0,9	0,8	nd	nd	1,3	nd	nd
DET	nd	< LD	nd	< LD	nd	nd	nd	< LD	< LD	< LD	nd	nd	nd	nd	nd
Simazine	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	< LD	nd	nd	nd
Chlortoluron	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Metalaxyl	nd	nd	nd	nd	nd	nd	nd	1,0	0,6	0,9	nd	nd	0,7	< LD	nd
Isoproturon	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Diuron	4	2,5	2,5	0,9	0,7	0,5	1,2	4,9	6,0	5,4	1	2,5	4,7	3,7	3
Flazasulfuron	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	nd	< LD	< LD	nd
Terbutylazine	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	nd	< LD	< LD	< LD	nd
Azoxystrobine	nd	nd	nd	nd	nd	nd	nd	0,3	0,4	0,4	0,3	0,5	0,5	0,3	0,3
Penconazole	11,3	11,3	11,3	11,3	11,5	11,4	11,2	1,3	1,5	1,4	0,9	0,9	1,7	1,5	0,5
DIA	0,9	nd	< LD	1,0	< LD	< LD	nd	5,1	4,9	5,5	< LD	1,3	< LD	1,7	< LD
DEA	< LD	< LD	< LD	0,6	1,2	1,9	nd	11,5	10,8	10,8	nd	< LD	0,9	0,6	< LD
Atrazine	nd	nd	nd	1,2	1,7	1,9	nd	22,6	20,6	23,8	nd	3,1	3,5	1,2	nd
DCPU	< LD	1,1	1,2	1,7	< LD	1,1	< LD	1,8	< LD	1,9	nd	< LD	< LD	1,1	< LD
DCPMU	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD	1,45	nd	< LD	< LD	< LD	nd
Acetochlore	nd	nd	nd	nd	nd	nd	nd	67,8	76,6	78,3	nd	< LD	18,5	17,8	7,4
Alachlore	nd	nd	nd	nd	nd	nd	nd	nd	45,3	53,1	13,5	< LD	14,9	< LD	13,1
Linuron	nd	nd	nd	1	2,4	< LD	1,0	8,6	4,6	13,3	nd	2,4	3,3	1,0	< LD
Metolachlore	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	< LD	nd	nd
Propyzamide	nd	nd	nd	nd	nd	nd	nd	< LD	< LD	< LD	< LD	< LD	< LD	< LD	< LD

Table 7: qualitative results for Bama site

3.1.3. Site de Boura

Sur le site de Boura à l'amont et à l'aval, les substances détectées sont sensiblement les mêmes que celles détectées à Bama. Les tableaux de résultats sont exposés en annexe (Annexe 9, Annexe 10).



Secrétariat de la Convention de Rotterdam

sur la procédure de consentement préalable en connaissance
de cause applicable à certains produits chimiques et pesticides dangereux
qui font l'objet d'un commerce international



Secretariat of the Rotterdam Convention

On the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

FINAL REPORT

Pilot Study on Agricultural Pesticide Poisoning in Burkina Faso

With the collaboration of the Designated National Authorities (DNA) of the
Rotterdam Convention in Burkina Faso

Coordinated by Prof. Adama M. TOE from IRSS/DRO

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ABBREVIATIONS AND ACRONYMS

CILSS	: Permanent Interstate Committee for Drought control in the Sahel
CMA	: Medical centre with surgery facilities
CNCP	: National Commission on the Control of Pesticides
CSPS	: Healthcare and Social Advancement Centre
DF	: Dry flowable
DGPV	: o Directorate-General of Plant Production
DNA	: Designated National Authority
DP	: Dustable powder
DPV	: Plant Protection Directorate
DS	: Powder for Dry Seed Treatment
DTE	: Datong Entreprises
E.U.	: European Union
EBCVM	: National Survey on Household Living Conditions
EC	: Emulsifiable concentrate
FAO	Food and Agriculture Organization of the United Nations
FCFA	: CFA Franc
GAP	: Good Agricultural Practices
GDP	: Gross Domestic Product
GR	: Granules
ha	: Hectare
INSD	: National Institute of Statistics and Demography
KAP	: Knowledge, Attitude and Practices
L	: Litre
M	: Metre
MAHRH	: Ministry of Agriculture, Water and Water Resources
MECV	: Ministry of Environment and Living Conditions
MED	: Ministry of Economy and Development
PAN-UK	: Pesticide Action Network – United Kingdom

PIC	: Prior Informed Consent Procedure
PPE	: Personal Protective Equipment
SAPHYTO	: African Pesticide Formulation Company
SC	: Suspension concentrate
SCAB	: Burkina Faso Agro-Chemicals Company
SG	: Soluble granules
SHPF	: Severely Hazardous Pesticide Formulation
SL	: Soluble concentrate
SOFITEX	: Fibres and Textiles Company
SPCP	: Sahelian Pesticide Committee
UAT	: Technical Support Unit
ULV	: Ultra Low Volume
UNPCB	: National Union of Burkina Faso Cotton producers
WG	: Water dispersible granules
WHO	: World Health Organization
WP	: Wettable powder
WS	: Water soluble powder

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We hope that the results obtained meet FAO/PIC expectations and help to reach the expected objectives!

SUMMARY

In order to improve human health and contribute to the protection of the environment, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade supported the conduct of a pilot study on agricultural pesticides poisonings in Burkina Faso which took place in June-July 2010. The study was carried out using retrospective and prospective surveys conducted among different relevant stakeholders, i.e., agricultural producers, pesticide distributors and retailers, as well as health officers, and has provided the following information:

Ninety-seven (97) pesticide distributors and retailers have been identified on 14 survey sites. A total of 153 different pesticide formulations have been identified among the surveyed distributors and retailers. Distributors have various sources of supply;

Six hundred and fifty agricultural producers were surveyed. Among these farmers, 296 poisoning cases resulting from pesticide application operations were recorded. Pesticide formulations containing paraquat (Gramoxone, Calloxone, Gramoquat super, Benaxone) have alone caused 59 incidents, accounting for 20% of the incidents, and those containing cypermethrine + endosulfan have caused 35 poisoning incidents. Overall, the study has shown that farmers did not follow good agricultural practices and especially that they did not wear appropriate personal protective equipment (only 0.31% of farmers use the personal protective equipment recommended);

Forty-two (42) health care centres were visited and a total of 922 poisoning incidents recorded on the basis of symptoms only have been reported. The pesticide formulation implicated in the poisonings and the circumstances under which they occurred have been identified in only 22 cases. Five (5) out of the 22 cases occurred during pesticide applications and the chemicals incriminated were Gramoxone (2 cases), Capt 88 EC (1 case), Conquest 88 (1 case), Procost 40 WS (1 case).

Generally speaking, farmers do not follow good agricultural practices when using pesticides (only about 0.31% of farmworkers use the recommended personal protective equipments)

which explains the high incidence of pesticide poisoning and of acute ones as well in a context where the medical care system is precarious and not easily accessible. Appropriate recommendations intended to foster the safe management of agro-chemicals by the various stakeholders involved have been developed with a view to improving human health and protecting the environment.

Key words: Severely hazardous pesticide formulations, poisoning, safe management.

INTRODUCTION

The agricultural sector is of major importance in the national economy of Burkina Faso. As a matter of fact, it employs 86% of the total population and generates about 40% of the gross domestic product (GDP) (agriculture 25%, livestock 12% and 3% forestries and fisheries) (MAHRH, 2007).

Cultivated land areas, which account for about 3.6 millions hectares, are dominated by cereal crops (about 82%) followed by cash crops (15% - 14% of which are mainly cotton and groundnuts). Vegetable crops including green beans are cultivated on a land area of 700 hectares and account for less than 1% of the cultivated land area.

Disease and animal pests cause major damage in agriculture and can be responsible in some cases for up to 30 % of yield losses. Thus plant protection products are used to eradicate pests affecting crops particularly in the case of intensive cultures such as cash crops, sugarcane, vegetable crops and, to a lesser extent, fruit trees.

In 1997, 2,533 tons of pesticide formulations with a market value of 12,665 billions CFA Francs were estimated to be used in Burkina Faso and that only for the treatment of cotton, vegetables and the consumption of plant protection services (Van Der Valk, Diarra, 2000). The annual growth rate of pesticide consumption has reached 11 %. About 185 commercial brands (more than a hundred active ingredients) are marketed in Burkina Faso, 75 % of which are active ingredients used as insecticides, acaricides or nematicides. Organophosphates and pyrethroids account for about 65% of the active ingredients of the various brands which are offered for sale. Pesticides are considered as one of the main factors of rural development at a time when demographic and economic constraints increase the pressure for productivity growth. They help to reduce the damage caused to crops by pests and even to prevent them. However, pesticides constitute a real threat at the following three (3) levels:

- ☞ The effects of pesticides toxicity on agricultural users and professionals in the pest control industry (Toe *et al.*, 2000 ; Toe *et al.*, 2002);
- ☞ The effects of toxicity on consumers related to the presence of toxic residues (Fournier et Bonderef, 1983);
- ☞ The pollution and contamination of the environment (Ramade, 1992; Toe *et al.*, 2004).

Consequently the sound management of pesticides is of critical importance. The sound management of pesticides which aims at ensuring on the one hand, the protection of users and consumers' health and, on the other hand, that of the environment is a major task which requires the involvement and the contribution of all the stakeholders involved in the production, distribution and use of pesticides. The principle of the safe management of pesticides with a view to improving human health and protecting the environment underlies the work of the present «*Pilot Study on Agricultural Pesticide Poisoning in Burkina Faso* ».

I- BACKGROUND AND STUDY RATIONALE

The use of pesticide should be done in accordance with the recommended good agricultural practices (GAP) in order to improve, on the one hand, users' health and that of consumers of agricultural produce which have undergone pest treatment, and on the other hand, to protect the environment.

Several studies and works carried out in Burkina Faso have shown that agricultural producers did not follow good agricultural practices. (Lendres, 1992, Domo, 1996; Toe *et al.*, 1996; Toe *et al.*, 2000; Toe, 2002). As a matter of fact, an analysis of farmers' agricultural practices revealed that recommended pesticide doses, adequate time of treatments and treatment calendars were not taken into account, inappropriate mixture of products was still very common and that precautionary hygienic measures were not being observed during treatments. Careless disposal of left-over pesticides and of empty containers was also found to be very common among workers.

These sad facts clearly indicate that the sound management of pesticide products is far from being implemented and highlight the major risks incurred by users, consumers and those posed to the environment.

To face the problem, the Rotterdam Convention has supported the conduct of a pilot study on pesticide poisoning in Burkina Faso which took place in June-July 2010.

The Rotterdam Convention is an international agreement on environment which promotes shared responsibilities and cooperative efforts among Parties in the international trade in certain hazardous chemicals in order to protect human health and the environment. Under Article 6 of the Convention, any Party that is a developing country

or a country with an economy in transition that is experiencing problems caused by a severely hazardous pesticide formulation (SHPF) under the conditions of use in its territory may propose to the Secretariat the inclusion of the formulation in Annex III (List of chemicals subject to the Prior Informed Consent Procedure).

The objective of the present study is to collect data on pesticide poisoning incidents particularly from severely hazardous pesticide formulations in order to help to protect human health and the environment.

II- OBJECTIVES OF THE STUDY

II-1. Overall Objective

The overall objective of the study is to achieve health and environmental improvements.

II-2. Specific Objectives

- ✓ Identify pesticide formulations found in the studied zone and those used by farmers;
- ✓ Identify health and environmental risk factors associated with the use of pesticides in general and specifically on severely hazardous pesticide formulations;
- ✓ Identify health problems caused by the use of pesticides;
- ✓ Generate additional data to support decision-making processes related to the possible ban of certain pesticide formulations in the CILSS countries and the proposal for their inclusion in Annex III of the Rotterdam Convention;
- ✓ Study technical itineraries;
- ✓ Develop and implement good agricultural practices (GAP).

III- MATERIAL AND METHODOLOGY OF THE STUDY

III-1. Study Material

- ✓ Socio-economic data;
- ✓ Cotton, maize (corn), rain-fed lowland rice farms;
- ✓ Agricultural inputs (pesticides);

- ✓ Equipment/machinery used for pesticide application;
- ✓ Personal protective equipment (PPE) used during pesticide applications;
- ✓ Data collection tools.

Support used to collect data consisted in survey and interview factsheets. The factsheets were developed on the basis of the forms established by the Rotterdam Convention Secretariat. We also took into account the format of questionnaires which had been developed and used to conduct similar studies at the national level in Burkina Faso. (Toé *et al*, 2000; Toé *et al*, 2002; Toé *et al*, 2010).

III-2. Context of the study

Field work (surveys and interviews) took place in the agricultural areas of the Hauts-Bassins, the Cascades and the Boucle du Mouhoun. This is the biggest agricultural and cotton producing zone of Burkina Faso and the major user of agricultural pesticides. The Hauts-Bassins cotton production of the 2006/2007 agricultural season reached 329,787 tons and accounted for 43.4% of national production while the Boucle du Mouhoun area had a production of 257,430 tons (i.e. 33.9% of national production), which made of those two regions the major cotton producing zone of Burkina Faso with 77.3% of national production (MED, 2007a, c). Consequently, cotton is the main cash crop of those two regions. According to the results of the National Survey on Household Living Conditions (EBCVM) which was carried out in 2003, cotton was the second source of income for the farmers of the Boucle du Mouhoun. It alone accounted for 67.1% of income of that region (INSD, 2003).

The Hauts-Bassins had a population of 1,389,258 inhabitants in 2006, i.e. 10.6% of the national population with a cereal production of 628,907 tons (i.e. 17.1% of the national production) including 379,769 tons of maize which constituted 43.8% of the national production (MED, 2007c). As with the Boucle du Mouhoun, it had a population of 1,478,392 inhabitants in 2006, or 11.3% of the national population with a cereal production of 693,506 tons (i.e. 18.7% of the national production) including 169,755 tons of maize accounting for 19.6% of the national production (MED, 2007a).

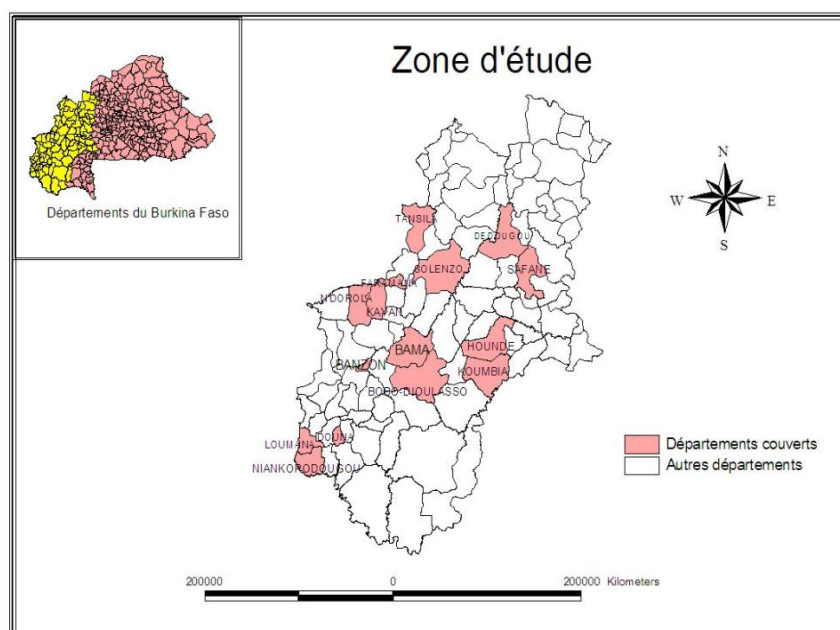
The Cascades area had a population of 430,677 inhabitants in 2006 with a cereal production of 151,434 tons and a cotton production of 71,767 tons in its 2006/2007 agricultural season (MED, 2007b).

Survey sites have been selected on the basis on their agro-climatic characteristics, their geographic situation, the extent of cultivated crops such as cotton, maize and rice on which pesticides are highly used. On the basis of the above-mentioned criteria, the following sites were selected:

Table I: Distribution of survey sites per region

Regions	Provinces	Survey sites	Farming Systems
Hauts-Bassins	Kénédougou	Banzon	Rice, cotton, maize,
		Kayan*	Maize, cotton,
		N'Dorola*	Maize, cotton,....
	Houet	Bama	Rice, cotton, maize,...
		Bobo-Dioulasso	Maize, cotton,....
		Faramana*	Maize, cotton,....
		Missidougou	Maize, cotton,....
	Tuy	Houndé	Maize, cotton,....
		Koumbia	Maize cotton,....
Boucle du Mouhoun	Mouhoun	Dédougou	Maize cotton,....
		Safané	Maize cotton,....
	Banwa	Solenzo	Maize cotton,....
		Tansila*	Maize cotton,....
Cascades	Léraba	Douna	Riz, cotton, maize,...
		Loumana*	Maize, cotton,....
		Niankorodougou*	Maize, cotton,....

* bordering departments (Ivory Coast, Mali)



Map 1: Departments hosting survey sites

(Text in the table Study Zone, Departments covered/Other departments)

III-3. Population of interest for the study

It includes:

- Cotton, maize, (rain-fed or lowland) rice producers;
- Agricultural producers (male and female);
- Health personnel in charge of health care centres in the surveyed zones;
- Regional officers from the Ministry of Agriculture, Water and Water Resources and from the Ministry of Health;
- Pesticide retailers and distributors.

III-4- Study methodology

III-4-1. Types of surveys

Part of the study consisted in undertaking retrospective surveys intended to collect epidemiologic data related to pesticide intoxication cases in rural areas. The relatively short time required for that work, the availability of human and financial resources and the opportunity it gave us to record and identify a large number of poisoning cases led us to opt for this type of investigation method. Previous studies conducted on the subject had confirmed the prevalence of intoxication incidents. (Toé *et al*, 2000, Toé *et al*, 2002).

Prospective studies were conducted to monitor agricultural producers during pesticide application operations and to identify weaknesses and strengths of producers' pesticide management (pesticide acquisition, pesticide doses, precautionary measures, safety measures, management of agro-chemical stocks, left-over pesticides and of empty containers).

III-4-2. Sampling method

Fifty (50) farms were selected in each department. In order to take into consideration the different categories of agricultural producers, a stratified sampling based on the size of the farms was created.

Stratified sampling

Based on the size of farms, the following four groups were taken into account:

- Group I. Less than 1,000 m²
- Group II Between 1,000 and 2,500 m²
- Group III Between 2,500 and 5,000 m²
- Group IV More than 2,500 m²

The total number of farms per department and the number of farms of each group was assessed in order to do the sampling. The representativeness of each group in the department was calculated on the basis of the total number of farms per group as per the following:

$$\frac{\text{Number of farms in the group}}{\text{Total number of farms in the department}}$$

To determine the number of farms from each group that should be part of the 50 farms selected for the sampling, we have multiplied 50 by the group coefficient.

All pesticide distributors and retailers located in rural towns were taken into account. With respect to more populated areas (urban zones/towns) retailers were selected according to their geographical situation (market place, city centre).

As for health care service centres they have all been systematically included in the sampling.

III-4-3. Investigation techniques used among interviewees

III-4-3-1. Investigation techniques used among pesticide distributors and retailers

They consisted in carrying out interviews among the persons who were in charge of the trade and distribution of pesticides in wholesale and retail establishments and in having them filling out the questionnaire attached in Annex 1.

III-4-3-2. Investigation techniques used among farmers

They consisted in collecting data on experienced or observed intoxication cases, the identity of incriminated chemicals, the accounts of accidents and on the evaluation of knowledge, attitudes and practices, (KAP) among agricultural producers through the conduct of retrospective surveys with the help of Questionnaire 2.

They also included a prospective study aiming at monitoring farmers during pesticide applications in the fields.

III-4-3-3. Investigation techniques used among health care centres

Surveys aimed at recording poisoning incidents together with their description were carried out at health centres' level. The investigations were designed to collect reliable and well- documented data along with biological tests results, when available.

III-4-4. Information research

The first step was to identify the political, institutional and legal frame related to the use and trade of pesticides. The second step consisted in determining the number of farms and farmers per site, in drawing a list of the existing health care centers and finding about their vicinity to community groups and finally in compiling data on recorded pesticide formulations and their active ingredients (toxicologic and ecotoxicologic data, registration status, regulations).

III-4-5. Field work

III-4-5-1. Field work preparation

Semi-structured and structured interviews were conducted among resource persons at the Bobo-Dioulasso Cotton Programme and among the Agriculture technical and administrative regional officers. The interviews were designed to collect information to be used to identify survey target sites. (Table I). Sites have been selected taking into account:

- The importance and the nature of commercial crops, (cotton, maize (corn) or rice) which, because of the extent of cultivated areas and permanent threats from pests, require the excessive use of pesticides;
- The geographic situation of the sites to take into consideration uncontrolled and illegal entries of pesticides through land boundaries (Mali, Ivory Coast).

To finalize the questionnaires, a few producers and pesticide retail dealers were interviewed in order to rewrite questions which did not seem to be clear enough at the time of the preliminary surveys.

Once the final version of questionnaires was adopted, a training session aimed at interviewers was organized in order to optimize their survey technique tools and knowledge (sampling, interview techniques, and to give them a better understanding of the objectives of the study (See Training Workshop Report, May, 2010).

III-4-5-2. Field study progress

Each survey interviewer had contacted the relevant administrative and technical services at her/his town/village level (Headquarters (prefectures), townhalls, Technical Support Units (TAU), to collect preliminary data on the number of farms and their different categories.

On the basis of the data obtained, a random sampling was done to identify persons to be surveyed and the latter were subsequently asked to answer the questionnaire attached in Annex 2. As most of the farmers were busy during the day, surveys were conducted early in the morning, in the evening or in the fields during the day.

Interviews were carried out among the persons in charge of pest control products in the distribution, storage and retail premises to obtain information on pesticide management with the help of the questionnaire in Annex 2.

Following the questionnaire presented in Annex 3, interviews were conducted among health agents to record and describe poisoning incidents caused by pesticides, with

special focus on incidents which occurred in the fields during pesticide treatment operations.

III-4-6.Data processing and analysis

After the perusal of survey sheets, data was codified, entered and analysed using the data management software Epi Info 3.3.2 and Excel 2007 software. Results were summarized into descriptive statistics and depicted in graphs summarizing the frequency distribution and average and standard deviation distribution.

The identification of active ingredients together with their concentration, chemical family and hazard class under WHO classification of the recorded pesticide formulations was made with the help of the CPS list of registered pesticides, the PIP Toolkit, the Footprint PPDB database and the ACTA Phytopathologica Journals.

III-4-7. Final report

The final report was written, printed and forwarded to DNA/CNGP and to FAO/PIC for clearance.

III-5. Expected results

- ✓ Technical itineraries will be analysed;
- ✓ Agricultural pesticide formulations used in Burkina Faso will be identified and listed;
- ✓ Health and environmental risk factors related to the use of pesticide and specifically to severely hazardous pesticide formulations will be identified;
- ✓ Health problems associated with the use of pesticides in general and specifically to severely hazardous pesticide formulations will be recorded;
- ✓ Proposals for the inclusion of severely hazardous pesticide formulations listed in Annex III of the Rotterdam Convention will be forwarded;
- ✓ Additional data to support decision-making processes related to the possible ban of certain pesticide formulations in CILSS countries will be collected.

IV- OUTCOME OF THE STUDY AND DISCUSSIONS

IV-1. The use and trade of pesticides and the political, institutional and legal framework

In order to support sustainable development and food security, Burkina Faso has introduced, among others, new legislation and national regulations to strengthen the implementation of sound pesticide management. In doing so, Burkina Faso reiterates its commitment to the international and regional agreements signed under the Basel Convention, the Rotterdam Convention, the Stockholm Convention, the International Code of Conduct on the Distribution of Pesticides, and the Common Regulations for Pesticide Registration scheme in CILSS countries.

The Government has promulgated a series of laws to address the sound management of pesticides and has made provisions for their effective enforcement. They provide for the control and safe storage of pesticides and involve the following three (3) ministerial departments:

☞ Ministry of Agriculture, Water and Water Resources (MAHRH)

Under the Common Regulations for Pesticide Registration in CILSS Countries, Burkina Faso is not entitled to have its own independent pesticide registration body. Pesticide registrations are carried out by the Sahelian Pesticide Committee (SPC). The common regulation applies to pesticides and bio-pesticides. Burkina Faso entered CILSS Common Regulations for Pesticide Registration scheme in 1992. A National Commission on the Control of Pesticides (CNCP) was subsequently created in August 2000 to implement regulatory actions taken by the Sahelian Pesticide Committee.

Under Article 23 of the regulation, the following two Acts together with provisions for their enforcement have been enacted:

- ☞ Law N°041/96/ADP, of 8 November 1996 on Pesticide Control in Burkina Faso;
- ☞ Law N°006-98/AN, of 26 March 1998 – amendment to Law N°041/96/ADP of 8 November 1996 on Pesticide Control in Burkina Faso;

- ☞ Decree N°98-472/PRES/PM/AGRI, of 20 December 1998 on the establishment of the National Commission on the Control of Pesticides (CNCP), its composition and operational procedures;
- ☞ Decree N° 2005- 051 /PRES/PM/ MAHRH of 7 February 2005 - amendment to the decree N°98-472/PRES/PM/AGRI of 20 December 1998 on the establishment of the National Commission on the Control of Pesticides (CNCP), its composition and operational procedures;
- ☞ Decree N° 2008- 679 /PRES/PM/MAHRH/MCPEA of 27 October 2008 establishes conditions for issuance of licenses to pesticide formulators, repackagers, distributors, retailers and pesticide application service providers.

☞ **Ministry of Environment and living conditions (MECV)**

The relevant legal instruments are:

- ☞ Law N°005/97/ADP of 30 January on the Environmental Code of Burkina Faso;
- ☞ Decree N°2001-185/PRES/PM/MEE of 7 May 2001 sets pollutant emission limits in the air, water and soil.
- ☞ Decree N°98 322/PRES/PM/MEE/MCIA/MEM/MS/MATS/METSS/MEF of 28 July 1998 on the regulation related to dangerous, inconvenient and insalubrious establishments/buildings;
- ☞ Decree N°2001-342/PRES/PM/MEE of 17 July 2001 sets out the scope, content, procedure of the environment impact study and statement.

☞ **Ministry of Health**

The relevant legal instruments within the Ministry of Health are:

- ☞ Decree N°99-377 PRES/PM/MS on the establishment of the National Public Health Laboratory (LNSP);
- ☞ Ordinance N°2002/MS/MHAR/MECV/MECV/MFB/MCPEA establishes laboratory control procedures on pesticides and assimilated products before commercialization.
- ☞ Law N°022-2005/AN of 24 May 2005 on the Public Hygiene Code of Burkina Faso.

IV-2. Results of the survey carried out among pesticide distributors

IV-2-1 Pesticide distributors characteristics

Ninety-seven (97) pesticide suppliers distributed in 14 different sites were identified during the study. Figure 1 shows the distribution of pesticide suppliers in the different sites of the study.

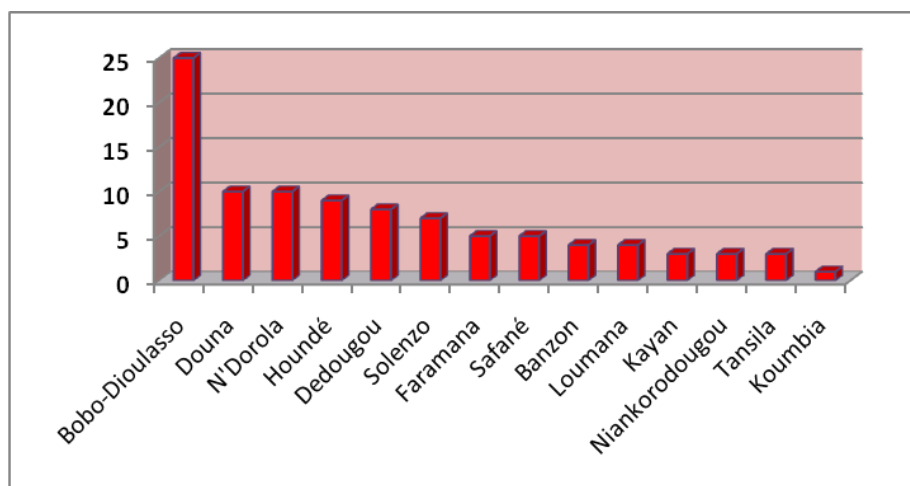


Figure 1: Distribution of pesticide suppliers in the surveyed sites

As shown in Figure 1, twenty-five (25) out of 97 pesticide distributors are found to be located in the town of Bobo-Dioulasso, i.e. 25.77% of them which is explained by the fact that Bobo-Dioulasso is the second most important town of the country and its main economic centre. Among the surveyed pesticide distributors, companies such as SAPHYTO and SCAB stand out as the major and more organized pesticide distribution establishments.

IV-2-2. Main pesticides recorded

One hundred and fifty-three (153) pest control products out of which 49 (i.e. 32 %) have been authorized for sale by the Sahelian Pesticide Committee, were recorded during the survey and 56 active ingredients were identified among the 97 distributors of the 14 survey sites. The main categories of pesticides found are herbicides, insecticides and fungicides. The complete list of recorded chemicals is provided in Annex 6 and the list of active ingredients is given in Annex 4.

Out of the 56 active ingredients which were recorded, thirty (30) are included in the Annex 1 of the European Union and hence are authorized in the European Union countries, eight (8) of them have been resubmitted for consideration and three (3) are banned. The other 15 active ingredients which are not listed in Annex 1, include, among others, paraquat, carbofuran, endosulfan, lindane and profenofos and are found in some of the pesticide formulations under Class Ib and II of the WHO hazard classification.

IV-2-3. Main sources of supply

National wholesale companies such as SCAB, DTE, SAPHYTO (the only pesticide manufacturer), SOFITEX Company, cooperatives, the National Union of Burkina Faso Cotton Producers (UNPCB), constitute the main sources of supply of pesticides to agricultural producers.

Eighty-five percent (85%) of the distributors and retail dealers know about other sources of supply. Ghana, Ivory Coast, Mali, Nigeria and China are by order of importance the major suppliers.

It is common to find inappropriate packaging in registered retailers such as labels containing instructions in English. These products usually come from Ghana and Nigeria.



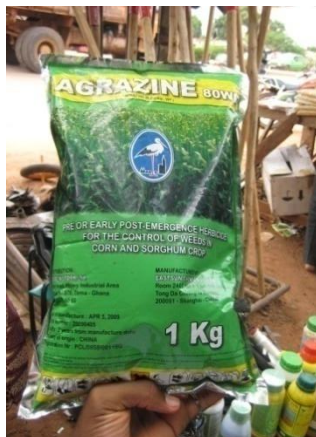
Photos 1, 2 and 3: Chemicals coming from Ghana and found on the market

According to retail vendors, the practice of selling non-registered chemicals and authorized ones (i.e. registered by the Sahelian Pesticide Committee) is due to high competitiveness on the market.

Retail vendors from the area Solenzo have said that the reason why most pesticides come from Ghana, Mali and Ivory Coast is due to the fact that products sold by SAPHYTO are far too expensive.



Photo 4: Formulation containing Paraquat



Photos 5 and 6: Formulations containing atrazine

IV-2-4. Pesticide management

Management of left-over products

About 10% of distributors have reported receiving left-over pesticides from their customers. In 78 % of cases they are unused pesticides which are still in sealed containers and not obsolete, so they offered for re-sale. However, generally speaking, the probability of finding obsolete chemicals is extremely high.

Storage of agro-chemicals

Thirty-seven percent (37%) of the surveyed distributors have a warehouse. In half of the cases, pesticide storage facilities are considered to be appropriate. Adequate storage facilities are found mainly within the largest and most organized establishments such as SOFITEX and SHAPHYTO. In some rural towns (Tansila for example), it has been found that pesticide street vendors store their products in their sleeping rooms.

Orderly storage accounts for 64% of the surveyed cases and non orderly storage accounts for 36% of the remaining ones.



7)



8)



9)

Photos 7, 8 and 9: Storage of pesticides at some vendors' places: 7) Pesticides and goods for sale, 8) Unsegregated Products, 9) Chemicals stored on shelves

Thirty percent (30%) of the surveyed premises had trained warehouse keepers and in 51% of cases, they used storage data sheets. Seventy-nine percent (79%) of the surveyed retailers and distributors were not using safety data sheets.



Photo 10: Example of a storage data sheet from a pesticide vendor

Stock management is carried out as follows: compliance with initial packaging or repackaging. It has been noted that most retail dealers (91%) keep the products in their original containers. Repackaging is done mainly in large pesticide distribution establishments (SCAB, SAPHYTO).

Figure 2 shows the distribution of pesticide distributors and retailers according to their stock management practices.

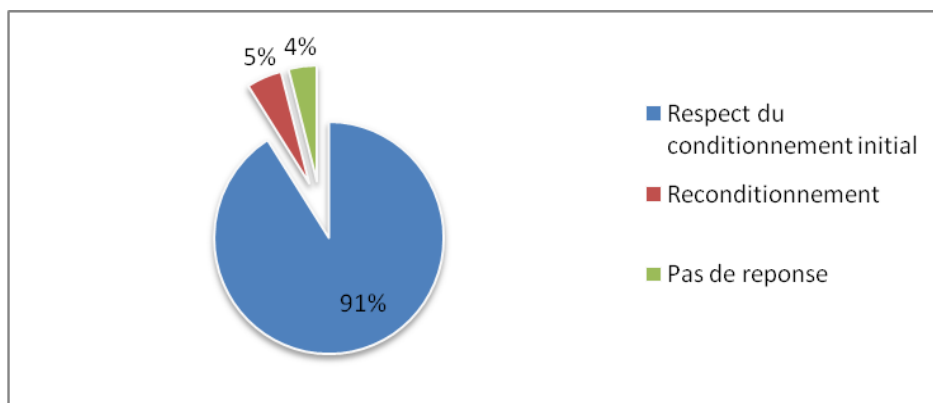


Figure 2: Stock management practices followed by pesticide distributors and retailers

(Text in the table)

Comply with initial packaging

Repackaging

No answer

Availability of First-Aid-Kit

Only 14% of the surveyed premises have a First-Aid-Kit. Products found in the First-Aid-Kits include alcohol, vegetable charcoal, amoxicillin, paracetamol, atropine, *Aloe vera*, soap, ibuprofen, quinine, effergal, pre-cut adhesive strip dressings, active charcoal, gloves, masks, mercurochrome.

Only the main wholesale companies (SCAB, SAPHYTO) have well-equipped First-Aid Kits.

Management of empty containers

In 32% of cases, premises have reported treating their empty containers. The different container management practices and the occurrence of such practices are summarized in Figure 3 hereunder.

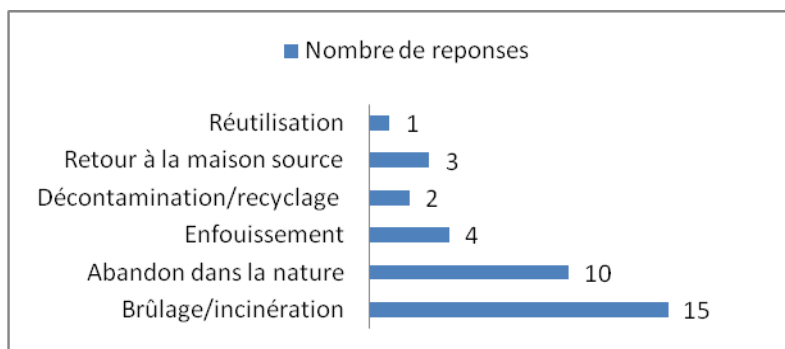


Figure3: Management of empty containers by pesticide distributors

(Text in Table)

Re-use/Return to the original supplier/Decontamination/recycling/Burying/Dumping
into the environment/Burning/incineration

Structures such as SOFITEX store their empty containers and return them to the main pesticide supplier in Bobo.



Photo 11: Empty container abandoned
into nature



Photo 12: Containers stored with goods

Results of the study carried out on empty containers management indicate that, in most cases, pesticide containers are being re-used. Some companies such as SOFITEX return empty containers to their main pesticide suppliers which contribute to reducing risks associated with those chemicals. Other licensed premises such as SPAPHYTO have their decontamination and recycling facilities onsite and are able to treat their own pesticide wastes.

Careless practices such as re-using empty pesticide containers, dumping them into nature or burning them constitute major risks to human and animal health and the environment.

IV-2-5 Risk prevention and protection measures for farmers

Ninety-two percent (92%) of the surveyed distributors have reported to be aware of risks associated with the use and handling of pesticides.

Three quarters (3/4) of the distributors provide their customers with information related to the proper use of pesticides.

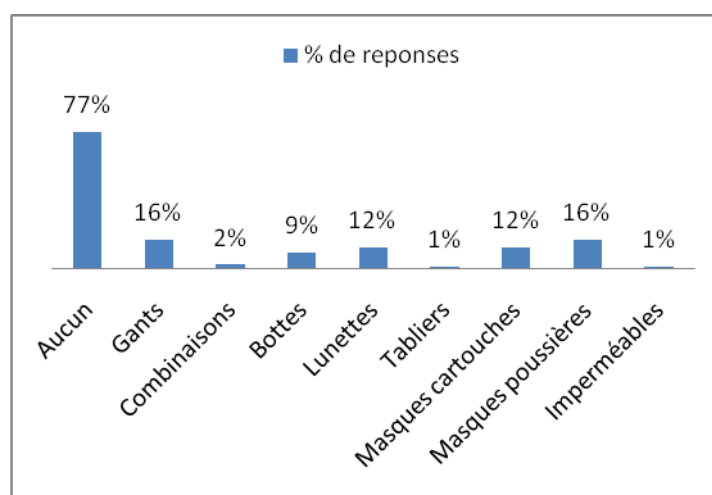
Training sessions on the appropriate use of pesticides aimed at farmers are being organised by the major pesticide distributors. In 16% of cases, training courses are organized by companies themselves with a frequency of once a year in 10 % of cases, and of twice a year in 4% of cases. Training sessions are free in 14% of cases.

Training sessions provided to farmers and distributors usually take place at the beginning of each agricultural season. SOFITEX organises two training sessions per season.

Personal Protective Equipment

In 20 % of cases, pesticide distributors provide PPE to farmers. Main protection gear includes gloves (16%) and dust masks (16%). Overalls are provided in 2% of cases.

Figure 4 shows the different types of personal protective equipments provided to farmers



Text in Table

(None, Gloves, Overalls, Boots, Glasses, Aprons, Cartridge masks, Dust masks, Raincoats)

Figure 4: Personal protective equipments provided to farmers by pesticide vendors

Some establishments do not sell personal protective equipments but have equipped operators to do pesticide treatments for farmers on request. Other places provide gloves or dust masks for free but payment is required for the use of other personal protective gear.

Findings of the survey carried out among distributors

Informal trade accounts for most of pesticide distribution and trade activities and a few private professional establishments are licensed to sell pesticides. Most of the trade activities carried out by distributors and retailers are uncontrolled and illegal and

contribute to increasing risks posed to farmers, communities and the vendors themselves who are not aware of the hazards associated with the products they handle all day long.

Most of the products sold are pesticide formulations in the form of emulsifiable concentrates (EC) or active ingredients belonging to chemical families which have been banned under international agreements or subject to restrictions. They are:

- ✓ Lindane which is included in Annex III of the Rotterdam Convention (chemicals subject to the PIC Procedure), in the LRTAP List and the PAN Dirty Dozen List from PAN UK (List of list, 2009);
- ✓ Paraquat which is included in the PAN Dirty Dozen List of PAN UK (List of list, 2009) and was found in (6) of the recorded pesticide formulations.

Similarly, pesticide formulations containing active ingredients such as atrazine and paraquat, and banned by the CPS are being found in local market places and sold to farmers. Those pesticide formulations have severe adverse effects on users' health (acute intoxication risks related to the use of paraquat) and on the environnement (water contamination risks related to the use of atrazine which is present in 26 of the recorded formulations).

Some banned pesticide formulations containing active ingredients such as endosulfan (ROCKY 386 EC) were not recorded among retail dealers but were found to be commonly used by cotton producers. This can be due to the fact that some vendors managed to hide certain products when they saw interviewers coming or that some farmers rely on sources of supply other than those which have been recorded especially when they are living close to neighbouring countries.

Major concerns related to pesticide management in the private sector can be summarized as follows:

- non-compliance with regulation with respect to the distribution of pesticides by registered vendors;
- lack of knowledge and training of pesticide distributors and vendors who are unable to provide proper advice to their customers;
- lack of knowledge of vendors and customers on pesticide toxicity: pesticides and food commodities are sold in the same shops;
- huge transboundary trade of illegal and banned chemicals.

IV-3- Results of the survey carried out among farmers

IV-3-1 Socio-demographic characteristics of the surveyed farmers

In total, 650 farmers distributed in 16 towns and 6 provinces of the three (3) studied regions were surveyed.

IV-3-1-1. Sex and age of farmers

In the studied zone, pesticide application was found to be predominantly a male activity. In fact, 98.3% of the surveyed persons involved in the application of pesticides were men. Only 1.7% of the applicators were women.

Table II shows the age distribution of farmers

Table II: Age distribution of farmers

Age category (years)	10 – 20	20 - 30	30 – 40	40 - 50	50 – 60	60 – 70	70 - 80	Total
Number	11	125	224	191	80	18	1	650
Percentage	1.7	19.2	34.5	29.4	12.3	2.8	0.2	100

The average age of farmers is 39.58 ± 10.30 years. The youngest person involved in pesticide application operations is 17 years old as the oldest one is 75. Results given in the table indicate that activities related to pesticide applications involved individuals of different age categories. Even though the majority of workers involved are less than 60, some of the operators are over 60 (3%). This raises some concern as it is known that the functional capacity of human vital organs such as kidneys decrease with age. Consequently, it contributes to increasing health risks related to the exposure of pesticides as the elimination of xenobiotics from the human body diminishes considerably in elderly people. Besides, age can be a factor that fosters the recourse to pesticides in that older people seem to have a tendency to use herbicides to eradicate weeds rather than pulling them by hand.

IV-3-1-2. Educational level among farmers

60.5% of the surveyed population had no education at all, 31.8% of them had gone through primary education and 7.7% had a secondary education level. Overall the level of

education of surveyed farmers is low. Illiterate farmers cannot read labels and follow recommended instructions for the proper use of pesticides. This fact does hinder the implementation of a scheme aimed at reducing health risks. However, farmers who have acquired literacy in the indigenous language can constitute an asset for the community. As a matter of fact, training programmes on the management and proper use of pesticides can be designed and provided in the local language. Such programmes could initially target a restricted number of individuals who will eventually be requested to take over training among the other members of the community.

IV-3-1-3. Farmers' extent of experience in the use and handling of pesticides

The results of the study indicating the extent of farmers' experience in handling pesticides are reported in Table III.

Table III: Distribution of farmers according to their experience in pesticide use

Age category (years)	0 -10	10 - 20	20 - 30	30 - 40	40 -50	Total
Number	250	237	113	36	5	641
Percentage	39%	37%	17.6%	5.6%	0.8%	100%

The study has shown that the extent of farmers' experience related to the use of pesticides can vary considerably. Some workers had a short experience of two years in applying pesticides while others have been doing this work for more than fifty years. However, contrary to the idea that experience can be an asset, we have been able to see directly from the fields that pesticide operators with the longest experience did not necessarily give the best example. As a matter of fact, they were applying pesticides without personal protective equipments on the pretence that they did not feel there were any risks in handling pesticides.

IV-3-2. Use and safe management of pesticides by farmers

IV-3-2-1. Pesticide treatment equipment

The study shows that the equipment used were mainly backpack sprayers with a volume capacity of 10 to 20 L (in 96 % of cases) and Ultra Low Volume sprayers (ULV) or

Ultra Bas Volume (UBV) sprayers with a volume capacity ranging from 1 to 5 L (4 % of cases).

IV-3-2-2. Management of left-over pesticides after treatment

Figure 5 shows the distribution of farmers according to their management practices with respect to left-over pesticides after treatment operations in the fields

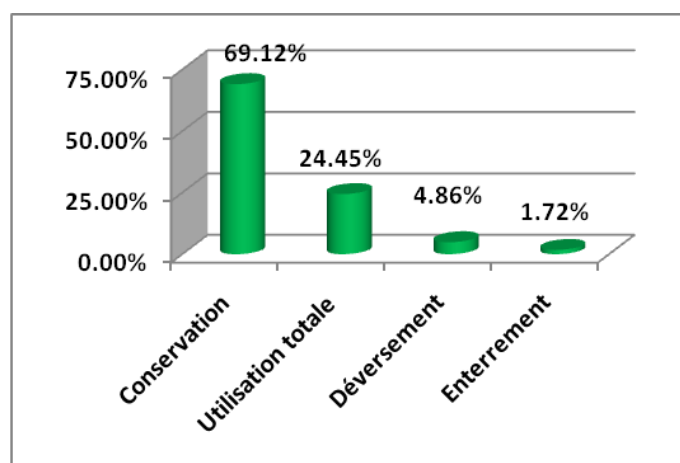


Figure 5: Management practices of left-over pesticides by farmers

24.45% of farmers reported not having any left-over pesticides as they knew the exact quantities required for treatment. Most of the surveyed farmworkers (69.12%) keep their unused pesticides for further applications. They stored them at their place or in the fields. A few of them have declared dumping them into nature (4.86%) or burying them (1.72%). The conclusion drawn on pesticide management practices among farmers is that the careless habit of storing pesticides at home severely exposes family members to risks in terms of health while discharging them into the environment or burying them inevitably leads to environmental contamination.

IV-3-2-3. Management of empty pesticide containers after use

Figure 6 shows the distribution of farmers according to the answer they gave on empty pesticide containers management.

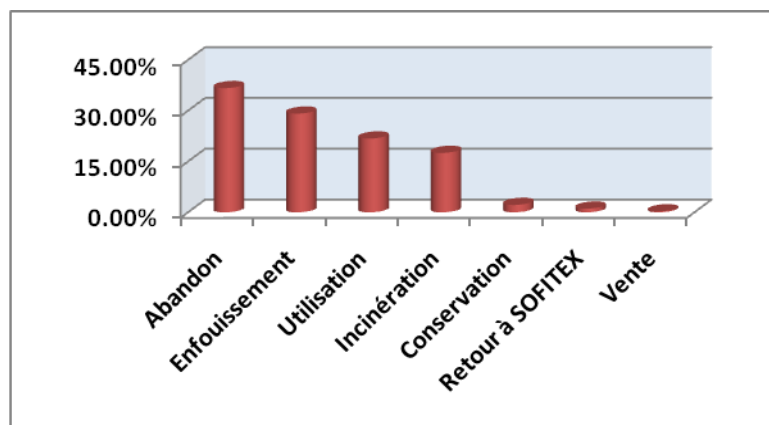
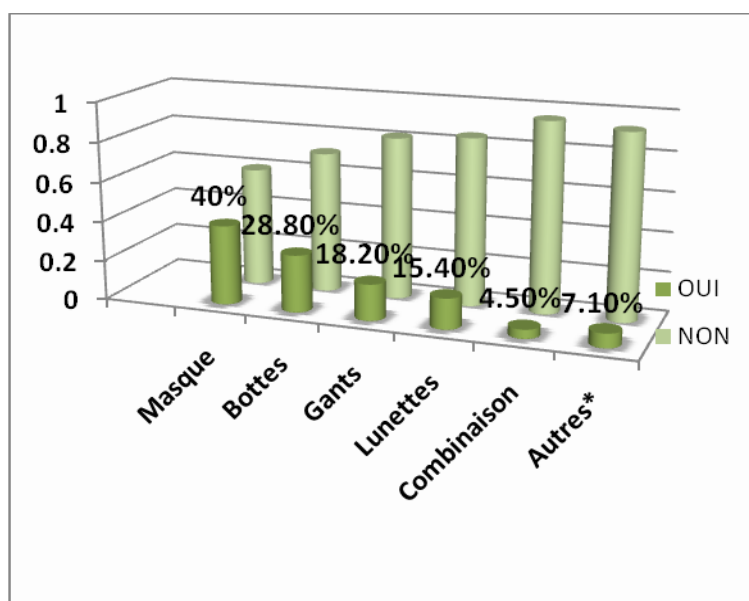


Figure 6: Farmers' management of empty containers

A certain number of farmers (36.68%) abandon empty containers into the environment as they are or after destroying them and leave them either in their fields or place them into holes or lower areas, thus increasing the risk of environmental contamination. In 21.79% of cases, empty packaging was re-used. Re-using empty containers contributes to increasing health risks as pesticide residues cannot be completely eliminated by simply rinsing containers.

IV-3-2-4. Use of protective gear

Figure 6 summarizes the distribution of the different types of personal protective equipment worn by farmers and the frequency with which they are used.



* The caption "Others" refers to *alternative* types of protection worn by individuals applying pesticides when *conventional* gears are not available. Examples of *alternative* equipment are head scarves, bags, old clothes, socks, closed shoes, etc..

Figure 6: PPE worn by the surveyed persons involved in the application of pesticides

Text in Table
(Masks, Boots, Gloves, Glasses, Overalls, Others)

Figure 6 shows that of the protective gear most widely worn by farmers, masks are the most used (40% of farmers use them, 39% of which are dust masks against 1% are masks cartridge filters), followed by boots (28.8%), with the combination of the two are the least used used (4.5%). It stands out that protection is usually incomplete as confirmed in Figure 7 which outlines the different set of personal protective gear worn by farmers during pesticide applications. Very few farmers have full protection.

Figure 7 shows that 12.62 % of farmers wear both masks and boots, while only 0.93% wears gloves, boots, overall, mask and glasses at the same time. Masks with filter cartridges are worn in combination with gloves, boots, coveralls and goggles in only 0.31% of cases. The scarce use of personal protective equipment and the tendency to have only partial protection inevitably leads to high exposure risks among pesticide applicators.

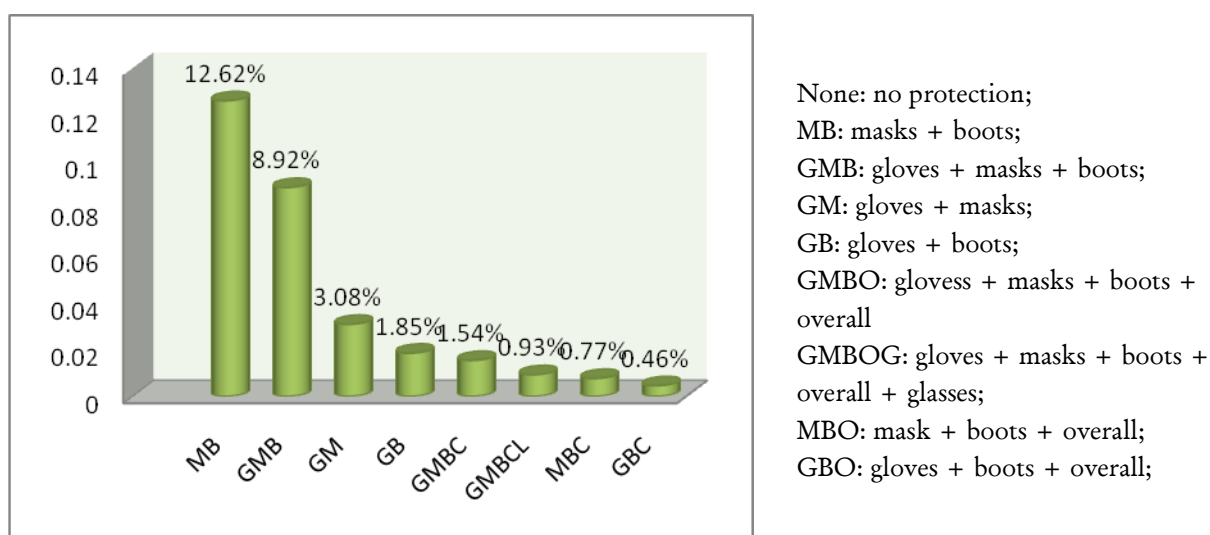


Figure 7: Combination of protective gears worn by surveyed persons involved in the application of pesticides

Surveyed persons were asked to explain why they did not use PPE and their comments were the following:

- Have no financial means to buy PPE;

- PPE are too expensive and not affordable on a farmers' budget;
- Do not know about their existence;
- Are expecting PPE to be provided for free;
- Unavailability of such equipments in the market place;
- PPE are not adapted to local weather conditions. For instance, some farmers said they feel discomfort and that they could not breathe properly while wearing PPE during spraying activity;
- Do not think of pesticide hazards

Intoxication risks to which applicators are exposed depends partly on the conditions in which pesticides are used and especially on the use made of personal protective equipment. If it is accepted that to ensure proper applicator protection should be joint use of suitable gloves, boots, coveralls, masks with cartridge filters and goggles, it appears that only 0.31% of farmers are entitled to this recommended protection. The majority of those who considered themselves to be protected during applications, that is to say 12.62% of the surveyed persons use only masks and boots.

Another sad fact which adds to the already low level of protection among farmers is that they usually wear inadequate and poor protective equipment. Alternatives to the use of conventional protective equipment are found to be very basic and consisting in using latex gloves or simple plastic bags instead of rubber gloves, old and torn clothes instead of overalls, socks instead of boots. Those substitutes cannot ensure the safe handling of pesticides and contribute to higher risks of exposure among applicators.



13)



14)

Photos 13 and 14: Farmers' protection during pesticide application

IV-3-2-5. Perception of health risks among farmers

Most of the farmers with whom we talked reported to be aware of the adverse effects of pesticides on their health and that of others. When asked what types of risks they were exposed to when using pesticides, the following responses were given:

- ✚ Pesticides can cause human poisoning;
- ✚ Can cause headaches, stomach pain;
- ✚ Can cause skin diseases;
- ✚ Can cause pain in the eyes;
- ✚ Can cause a cold;
- ✚ Can kill animals;
- ✚ Can make people sick;
- ✚ Can kill;
- ✚ etc.

IV-3-2-6. Perception and factors of environmental risks among farmers

Contamination risks of watering places according to their distance from agricultural fields

The majority of farmers (67.5%) have reported having a watering place in their fields or in the vicinity. As shown in Figure 9, 12.41% of watering places are found in the fields and a large number of them are situated at less than a hundred metres from the fields.

The vicinity of watering sources to fields increases the risks of water contamination by pesticides released through different mediums.

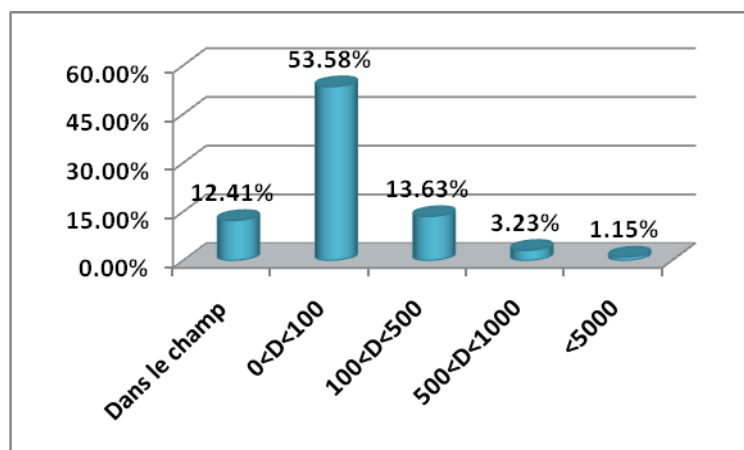


Figure 8: Distance between watering places and fields

(Text in the Table)

In the field

Risks associated with the use of water from watering sources

Uses made of water from watering sources are shown in Figure 9. It has been observed that in 50% of the watering places, water was used for consumption, in 29.26% of them it was used to mix or dilute pesticides and 26.96% of these structures were used to provide water for animals.

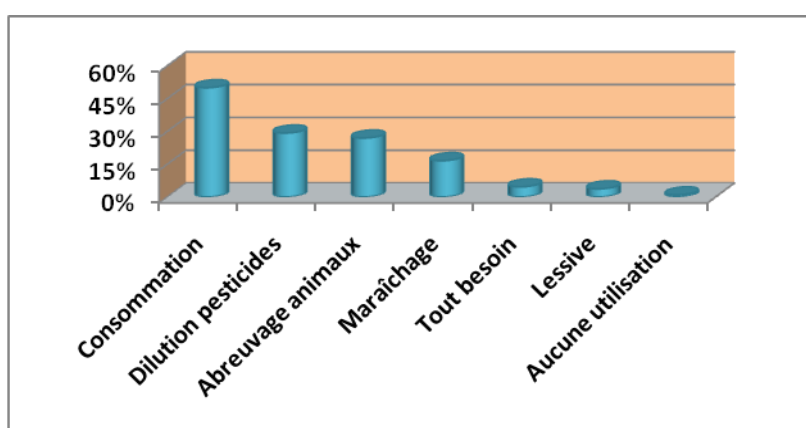


Figure 9: Uses of watering places

(Text in the table)

Consumption/Dilution of pesticides/Watering sources for animals/Horticulture/Any use/Washing/No use

Facts on the Loss of biodiversity

Surveyed farmers have observed that there is a correlation between pesticide treatments and the decline in numbers of various species: farmyard animals, birds, aquatic animals, land vertebrates and invertebrates etc.

IV-3-3. Toxicity of pesticides used by farmers

IV-3-3-1. Identification of pesticides used by farmers

The table of Annex 7 lists all of the pesticides together with their active ingredient(s) that surveyed farmers have reported having resorted to in the agricultural sector. A total of 78 products have been reported to be used. Information such as the WHO toxicity classification of chemicals as well as the regulatory status of the products under the Sahelian Pesticide Committee (CSP) is also included. Out of these products, 33 pesticide formulations (42.31 %) have been authorized for sale by the CSP.

IV-3-3-2. Pesticide Toxicity

Health damages caused by xenobiotics in general and pesticides in particular are linked to their toxic potential. Pesticides used by farmers are divided into different hazard classes under the WHO classification:

The WHO Classification of Pesticides by Hazard

	LD50 acute (mg/kg body weight) Rat	
Class and correspondence	ORAL	DERMAL
	Solid Liquid	Solid Liquid
Ia - Extremely hazardous Very toxic	< 5 200	< 10 420
Ib - Highly hazardous Toxic	5-50 200	10-100 40-400
II - Moderately hazardous Harmful	50-500 200-2000	100-1000 400-4000
III - Slightly hazardous Handle with care	> 500 2000	> 100 4000
IV - Unlikely to present acute		

hazard in normal use		
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Restricted Use Pesticide Classification

	Can be used by
Ia - Extremely hazardous Very toxic	Only licensed applicators
Ib - Highly hazardous Toxic	Certified and experienced applicators under close supervision
II - Moderately hazardous	Experienced applicators under close supervision who strictly follow precautionary measures
III - Slightly hazardous	Experienced applicators complying with routine safety requirements

Two of the pesticides used fall under Class Ib of the WHO Classification. Pesticides falling into that category are highly hazardous and can be used only by certified and trained applicators and under close supervision. The use of such products should be strictly forbidden to farmers who have no training, who do not have appropriate personal protective equipment and who tend to underestimate pesticide-related hazards.

Seventeen pesticides fall under Class II. They are considered as moderately hazardous and their use is restricted to trained applicators under close supervision who strictly comply with recommended precautionary measures. The population studied during our survey with its limited level of education, lack of training and the general tendency not to comply with safety requirements in terms of protective equipment should in no way use this category of pesticides.

It has been noted that most of the pesticides used fall under class III (26 out of 78). They are rated as slightly hazardous and can be used by trained applicators who comply with recommended precautionary measures. Well-trained farmers who would comply with recommended patterns of use and safety requirements should be able to handle these products with no major risk of intoxication.

Seven of the pesticides used by farm-workers belong to class U and are unlikely to present acute hazards under normal use. Complying both with restrictions of use and precautionary measures is a way for pesticide applicators to ensure their safety.

IV-3-3-3. Major sources of supply

Local markets have been reported to be the first source of supply for pesticides to farmers. Moreover, SOFITEX, which is a state-owned company supporting cotton producers, provides its customers with agricultural inputs including pesticides. Cotton producers are generally organized into cooperatives under the National Union of Cotton Producers in Burkina Faso (UNBCP) which ensures the supply of inputs to its members. As a matter of fact, the UNPCB delivers pesticides to its farmers. Other sources of supply have been mentioned as well and include SAPHYTO, Chinese bilateral aid and FAO. Some farmers located in the vicinity of neighbouring countries (Area of Tansili) have reported getting their supplies from Mali or Ivory Coast, which is evidence of the illegal and uncontrolled trade in the region.

IV-4. Health effects associated with the use and management of pesticides

III-4-1. Types of ailments affecting farmers during and after the use of pesticides

Figure 10 shows the distribution of the different types of ailments affecting farmers and their rate of prevalence

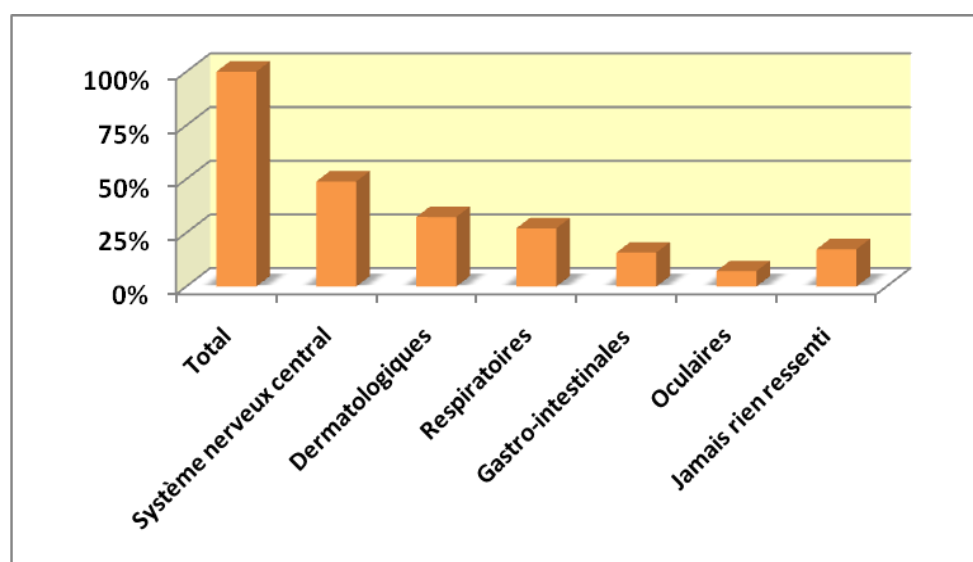


Figure 10: Distribution of farmers according to the type of ailments

Text in the Table

Total/Central nervous system CNS/Dermal affections/respiratory affections/Gastrointestinal affections/Ocular affections/no symptoms

Figure 10 indicate that the majority of surveyed farmers (82.66%) report having experienced, at least on one occasion, a feeling of ill-health during or just after pesticide applications while 17.34% of them have never felt anything. Major types of ailments reported during interviews with farmers are, by decreasing order of importance, those affecting the central nervous system (experienced by 48.92% of farmers), dermal affections (32.35%), respiratory affections (27.09%), gastrointestinal affections (15.79%) and ocular affections (7.12%). It has been noted that the disturbance to the central nervous system is prevalent. As a matter of fact, exposure to insecticides is known to have severe adverse effects on the nervous system.

Table IV lists the main symptoms associated with the different types of ailments

Table IV: Distribution of symptoms associated with the different types of ailments

Ailments	CNS	Dermal	Respiratory	Gastrointestinal	Ocular	Other sign
Signs	Vertigo	Itching	Cold	Abdominal pain	Blurred vision	Palpitations
	Cephalaea	Smarting	Cough	Diarrhea	Smarting	Sweating
	Fever	Skin irritation	Respiratory problems	Vomiting	Tearing	Heart rhythm problems
	Drowsiness/ Insomnia	Skin burn	Chest constriction	-	-	Tremor

IV-4-2. Intoxication cases reported by surveyed farmers

A total of 296 intoxication cases were reported among the surveyed farmers. In general, poisonings were accompanied by dermal affections (itching, smarting, skin burns, skin troubles, scars, full lesion of the contaminated area), respiratory ailments (smarting, burning and itching of the respiratory tract, respiratory problems and cough), ocular affections (burning sensation in the conjunctiva, blurred vision, smarting, burning sensation in the eyes, sight loss), gastrointestinal affections (abdominal pain, nausea, vomiting), cephalaea and vertigo. In some cases, the intoxicated person lost consciousness. Table V provides the distribution of reported intoxication cases among pesticide applicators together with the main symptoms experienced.

Table V: Summary of intoxication incidents recorded among farmers 1/6

Chemicals	Pesticide Category	WHO Classification	CSP Registration	Type of incident	Number of cases	Intoxication Symptoms	Total number of Incidents
GRAMOXONE (paraquat 200 g/l)	Herbicide	II	No	Dermal	38	Itching, irritation, skin burns, skin rash, scars, complete lesion of the contaminated area, fever, sweating, dizziness, headaches, bone pain, faintings	54
				Inhalation	08	Irritation, itching, burns, respiratory problems, cough, headaches, vomiting, fever, blurred vision, eye pain, buzzing ears	
				Ocular	05	Conjunctiva burns, blurred vision, irritation and eye burns, headaches, scars	
				Ingestion	03	Abdominal pains, nausea, vomiting, jaw paralysis	
ROCKY 386 EC (cypermethrine 36 g/l + endosulfan 350 g/l)	Insecticide	II	No	Dermal	16	Itching, irritation, burns, abdominal pains, dizziness, headaches, vomiting, cold, fever, shivering, dizziness, fainting, tiredness, skin rash	35
				Inhalation	10	Headache, vomiting, fainting, respiratory problems, burns, cold, abdominal pain, diarrhea, eye pain	
				Ocular	06	Burns, itching, smarting eye, tearing, ocular irritation, eye pain, headaches	
				Ingestion	03	Abdominal pains, vomiting, restlessness, aggressivity, confusional state	
CONQUEST 176 EC (cypermethrine 144 g/l + acetamipride 32 g/l)	Insecticide	II	Yes	Dermal	09	Burns, irritation, itching, shivering, restlessness, cold, persistent dizziness	22
				Inhalation	06	Shivering, vomiting, tiredness, dizziness, fainting, cold	
				Eye	04	Tearing, eye pain, smarting eye, eyeball acute pain	
				Ingestion	03	Abdominal pain, diarrhea, vomiting, delirium	
CAPT FORTE 184 WG (lambdacyhalothrine 120 g/l + acetamipride 64 g/l)	Insecticide	II	Yes	Dermal	09	Itching, skin burns, headache	21
				Inhalation	09	Headache, buzzing, dizziness, fever, abdominal pain, vomiting, itching, fainting, diarrhea	
				Ocular	01	Blurred vision, redness	
				Ingestion	02	Headache, cough, cardiac problem	

Table V: Summary of intoxication incidents recorded among producers 2/6

Chemicals	Pesticide Category	WHO Classification	CSP Registration	Type of incident	Number of cases	Intoxication Symptoms	Total number of Incidents
ROUNDUP 360 SL (glyphosate 360 g/l)	Herbicide	III	Yes	Skin	09	Itching, burns, skin rash, headache, respiratory problems, vomiting, eye burns	19
				Inhalation	04	Cold, headache, dizziness, skin rash, fever	
				Eye	03	Irritation, eye burns	
				Ingestion	03	Abdominal pains, nausea, abdominal swelling	
DECIS 25 EC (deltamethrine 25 g/l)	Insecticide	II	Yes	Skin	03	Itching, burns, scars, chronic pain	15
				Inhalation	06	Respiratory problems, dizziness, shivering, cold, headache, fainting, eye burns	
				Oculaire	04	Eye burns, fainting	
				Ingestion	02	Headache, vomiting, dizziness, diarrhea	
DELTAPHOS 210 EC (deltamethrine + triazophos)	Insecticide	Ib	No	Skin	04	Itching, burns, fever, abdominal pain, scar, fainting	14
				Inhalation	08	Respiratory problems, headaches, dizziness, abdominal pain, vomiting	
				Eye	01	Eye burns	
				Ingestion	01	Sweating, vomiting, diarrhea	
CONQUEST 88 EC (cypermethrine 80 g/l + acetamipride 16 g/l)	Insecticide	II	Yes	Skin	06	Itching, fever, headaches, burns, fainting	11
				Inhalation	05	Fever, blurred vision, abdominal pain, cold, cough, headaches, dizziness, fainting	
LAMDEX 430 EC (lamda-cyhalotrine (30 g/l + chlorpyrifos-éthyl 400 g/l)	Insecticide	II	Yes	Skin	05	Itching, burns, nausea, headaches, fever, pimples	10
				Inhalation	03	Dizziness, tiredness, burns, headaches, fever	
				Eye	02	Irritation, blurred vision, pimples	
CAIMAN SUPER (alpha-cypermethrine 18 g/l + endosulfan 350 g/l)	Insecticide	-	No	Skin	02	Burns, smarting eyes, itching, abdominal pain	08
				Inhalation	03	Dizziness, headaches, fever, cold, fainting	
				Eye	01	Eye burns	

				Ingestion	02	Restlessness, aggressivity, confusional state	
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TableV: Summary of intoxication incidents recorded among producers 3/6

Chemicals	Pesticide Category	WHO Classification	CSP Registration	Type of incident	Number of incidents	Intoxication Symptoms	Total number of incidents
CYPERCAL 230 EC (cypermethrine 30 + profenofos 200 g/l)	Insecticide	II	Yes	Skin	03	Itching, irritation, burns	08
				Inhalation	03	Cold, cough, tiredness, dizziness, sweating, insomnia	
				Eye	01	Eye burns	
				Ingestion	01	Vomiting, fainting	
BLAST 46 EC (lambdacyhalothrine 30 g/l + acetamipride 16 g/l)	Insecticide		No	Skin	05	Itching, skin burns, swelling, abdominal pain	07
				Inhalation	01	Burns, dizziness	
				Eye	01	Eye burns, swelling, cold	
CALFOS 500 EC (profenofos 500 g/l)	Insecticide	II	Yes	Skin	01	Itching, facila inflammation	06
				Inhalation	05	Fever, tiredness, dizziness, cold, nausea, respiratory problems	
CAPT 88 EC (acetamipride 16 g/l + cypermethrine 82 g/l)	Insecticide	II	Yes	Skin	03	Irritation, skin burns, headaches, respiratory problems, abdominal pain, fever.	06
				Inhalation	03	Headaches, abdominal pain, respiratory problems, cold, itching, eye pain, dizziness, headaches, skin rash.	
KALACH 360 SL (glyphosate 360 g/l)	Herbicide	III	Yes	Skin	03	Burns, itching, skin rash, eye burns	06
				Inhalation	02	Acute headaches, shivering, abdominal swelling	
				Eye	01	Eye burns	
LAMBACAL P 636 (lambda-cyhalothrine 36 g/l + profenofos 600 g/l)	Insecticide	II	Yes	Skin	03	Itching, skin burns	06
				Inhalation	02	Headaches, abdominal pain, fainting	
				Eye	01	Tearing, blurred vision.	
COTODON PLUS GOLD 450	Herbicide	III	Yes	Skin	02	Burns, itching, complete destruction of the zone, headaches,	

EC (S-metolachlore 245 g/l + terbutryne 196 g/l)						dizziness, abdominal pain	05
				Inhalation	02	Dizziness, fever, headaches, fainting	
				Eye	01	Eye burns, dizziness, fainting	

Table V: Summary of intoxication incidents recorded among producers 4/6

Chemicals	Pesticide Category	WHO Classification	CSP Registration CSP	Type of incident	Number of incidents	Intoxication Symptoms	Total number of incidents
FURY P 212 EC (zeta-cypermethrine 12 g/l + profenfos 200 g/l)	Insecticide	II	Yes	Skin	03	Itching, burns, skin rash, headaches, vomiting	04
				Ingestion	01	Dizziness, vomiting, tiredness	
TOUCHDOWN (glyphosate 500 g/l)	Herbicide	III	Yes	Skin	02	Burns, complete lesion of the skin	03
				Inhalation	01	Itching, skin burn	
TOPSTAR (Oxadiargyl 400 g/l)	Herbicide	III	Yes	Skin	02	Burns	02
ADWUMA WURA(glyphosate 360 g/l)	Herbicide	III	No	Skin	02	Itching, burns, tiredness	02
CAIMAN ROUGE (endosulfan 250 g/l + thirame 205 g/l)	Insecticide	II	No	Skin	02	Burns, itching, irritation, fever, restlessness	02
CALLOXONE SUPER (paraquat 200 g/l)	Herbicide	II	No	Inhalation	01	Itching	02
				Eye	01	Eye pain	
GRAMOQUAT SUPER (paraquat chloride 200 g/l)	Herbicide	II	No	Eye	02	Scars in the eyes, sight loss	02
STOMP 330 EC (pendimethaline 330 g/l)	Herbicide	II	No	Inhalation	02	Dizziness, headaches, abdominal pain, vomiting	02
ACTION 80 DF(diuron 800 g/l)	Herbicide		No	Skin	01	Itching, burns	01
ATRAZ 80 WP(atrazine 800)	Herbicide		No	Eye	01	Blurred vision	01
AVAUNT 150 EC(indoxacarb 150g/l)	Insecticide	II	Yes	Inhalation	01	Respiratory problems, cough	01

AVENTURA	-	-	-	Skin	01	Smarting eye, blurred vision	01
BENAXONE (paraquat chloride 200 g/l)	Herbicide	II	No	Inhalation	01	Cold, headaches, dizziness, buzzing	01
CALLIFOR G (prometryne 250 g/l + fluometuron 250 g/l + glyphosate 60 g/l)	Herbicide	III	Yes	Inhalation	01	Cold	01

TableV: Summary of intoxication incidents recorded among producers 5/6

Chemicals	Pesticide Category	WHO Classification	CSP Registration	Type OF incidents	Number of incidents	Intoxication Symptoms	Total number of incidents
CAPORAL 500 EC (profenofos 500 g/l)	Insecticide	II	Yes	Skin	01	Itching, skin burns	01
COTONET (metolachlore 333 g/l + terbutine 167 g/l)	Herbicide	III	No	Skin	01	Skin burns	01
CURACRON 500 EC (profenofos 500 g/l)	Insecticide	III	Yes	Ingestion	01	Itching, vomiting	01
ENDOCOTON 500 EC (endosulfan 500 g/l)	Insecticide	Ib	No	Skin	01	Skin burns	01
FANGA 500 EC (profénofos 500g/l)	Insecticide	II	No	Inhalation	01	Respiratory problems	01
FLUORALM 500 SC (fluométuron 250 g/l + prométryne 250 g/l)	Herbicide	IV	No	Skin	01	Burns, itching, eye burns	01
FURADAN (carbofuran 5%)	Insecticide	Ib	No	Eye	01	Tiredness, fainting	01
GALLANT SUPER (Haloxypop-R-methyl 104 g/l)	Herbicide	III	Yes	Eye	01	State of unconsciousness for three days	01
GARIL (trichlopyr 72g/l + propanyl 360 g/l)	Insecticide	II	No	Eye	01	Eye redness, swollen face	01
GLYPHADER 75 (glyphosate 750 g/l)	Herbicide	III	Yes	Skin	01	Itching, cold	01
HERBEXTRA (2,4, D de sel d'amine 720 g/l)	Herbicide	II	Yes	Skin	01	Itching, skin burn	01
KITAZINE	-	-	-	Inhalation	01	Diarrhea	01
LASSO (atrazine 250 g/l + alachlore 350 g/l)	Herbicide	III	No	Eye	01	Total sight loss	01

Table V: Summary of intoxication incidents recorded among producers 6/6

Chemicals	Pesticide Category	WHO Classification	CSP Registration	Type of incident	Number of incidents	Intoxication Symptoms	Total number of incidents
LUMAX 537,5 SE (S-metolachlore 375 g/l + mesotrione 375 g/l)	Herbicide	III	No	Skin	01	Burns, complete lesion of the skin	01
NICOMAS 40 SC (nicosulfuron 400 g/l)	Herbicide	III	Yes	Skin	01	Fever, sweating, abdominal pain, burns	01
RONSTAR (oxadiazon 200 g/l + propanyl 400 g/l)	Herbicide		No	Skin	01	Skin burns	01
TAMARIS	-	-	-	Skin	01	Itching, burns	01
TOPSTAR (Oxadiargyl 400 g/l)	Herbicide	III	Yes	Skin	01	Burns	01

With regard to incident frequency rate, GRAMOXONE alone (paraquat 200 g/l) has been implicated in 54 intoxication cases and is the product which has caused the most health problems among agricultural producers. Three other pesticide formulations containing paraquat, i.e. CALLOXONE SUPER (paraquat 200 g/l), GRAMOQUAT SUPER (paraquat chloride 200 g/l) and BENAXONE (paraquat chloride 200 g/l) have been reported to be implicated in 5 intoxication cases, bringing to 59 the total number of paraquat-related incidents. Caustic lesions which characterized the initial phase of paraquat intoxication were found to be symptoms affecting some of the patients. (Mégarbane, 2003).

The ROCKY 386 EC pesticide formulation (cypermethrine 36 g/l + endosulfan 350 g/l) comes second with 35 intoxication cases. Despite the fact that Endosulfan is banned in CILSS countries, it is still found in some pesticide formulations such as CAIMAN SUPER (alpha-cypermethrine 18 g/l + endosulfan 350 g/l) CAIMAN ROUGE (endosulfan 250 g/l + thirame 205 g/l) and ENDOCOTON 500 EC (endosulfan 500 g/l) which altogether have been incriminated in 11 intoxication cases, bringing to 46 the total number of endosulfan-related intoxication cases.

CONQUEST 176 EC (cyperméthrine 144 g/l + acétamipride 32 g/l) comes third with regard to incident frequency.

Exposure route distribution among the 296 poisoning cases

Figure 11 gives the exposure route distribution among poisoning cases

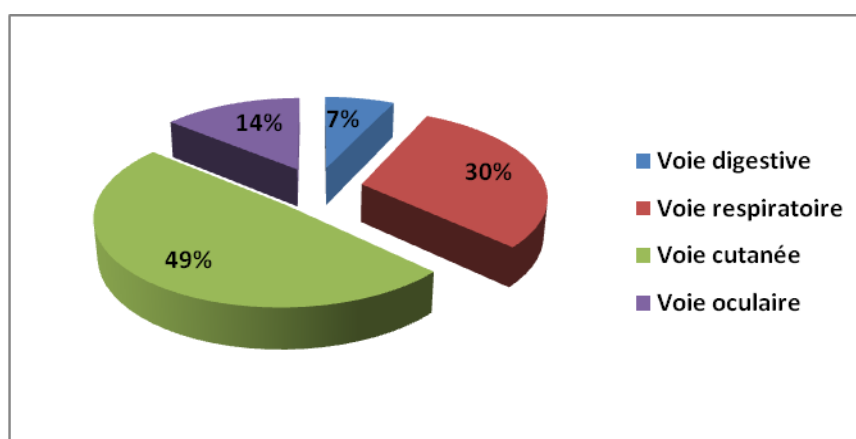


Figure 11: Exposure route distribution among poisoning cases
Ingestion, Inhalation, Dermal, Ocular,

The exposure route distribution is as follows: 145 contamination cases occur through dermal contact, 89 through the respiratory tract (inhalation), 40 through ocular contact and 22 cases through the digestive tract (ingestion). Dermal contact is the primary route of chemical exposure and accounts for 49% of the reported cases which is evidence of the correlation between the prevalence of intoxication through dermal contact and the scarce use of overalls as protective clothing. In fact, as seen earlier, only 4.5% of agricultural producers wear overalls during pesticide application operations whereas 96% of them are using backpack sprayers.

IV-4-3. Management of poisoning incidents by farmers

Table VI summarizes farmers' behaviour following intoxication incidents and their rate of occurrence

Table VI: Farmers' behaviour after contact with plant protection products

Practices	Number	Percentage
Drink milk	54	8,32
Drink tamarind	15	2,31
Drink lemon juice	13	2,00
Drink sour juice	1	0,15
Drink sorrel juice	2	0,31
Drink Nescafé	2	0,31
Take paracetamol	1	0,15
Ingest charcoal and vomit	1	0,15
Go to healthcare center (CSPS)	25	3,85
Get rid of	7	1,08
Rub herself/himself with lemon leaves	20	3,08
Rub herself/himself with sorrel leaves	1	0,15
Rub herself/himself with vines	1	0,15
Apply ointment	1	0,15
Apply shea-butter	43	6,62
Wash with soap	540	83,20
Wash with potash soap	8	1,23
Wash with warm water	1	0,15
Wash with salted water	1	0,15
Suck sugar	1	0,15
No answer	8	1,23

As seen above a large proportion of farmers have recourse to traditional medicine. This is not surprising when it is known that 80% of the population in developing countries

use medicinal plants to cure themselves (OMS, 2002). Only 3.08% of farmers go to healthcare service centres.

IV-4.4. Medical care and pesticide-related incidents

Medical care for pesticide-related incidents is not provided to agricultural producers. The cost of healthcare and medical exams has to be borne by farmers themselves. The study highlights the fact that there is no effective system to monitor farmers' health. It would be appropriate to take initiatives through existing health cooperatives or mutual healthcare scheme or through the establishment of such structures to develop a medical surveillance programme and a healthcare scheme to deal specifically with health incidents related to the use of pesticides.

IV-5. Results of the survey carried out in health service centres

This section indicates the number of pesticide intoxication cases reported to health service centres. In total, 42 health centres of which 40 Health and Social Advancement Centres (CSPS) and two (2) Health centres with surgical facilities (CMA) have been covered by the present study. Intoxication incidents were divided into the three (3) following categories on the basis of the level of details that were provided:

IV-5-1. Pesticide intoxication cases reported without detailed information

922 cases falling into this category were found to have been reported to the 42 health centers since 2002. Table VII gives the intoxication case distribution according to the victims' region and province of origin. The Boucle du Mouhoun comes first with 46.10% of reported cases, followed by the Hauts Bassins region with 38.28% of cases, and the Cascades with 15.62% of intoxication cases.

Table VII: Distribution of the 922 intoxication cases reported with no detailed information according to the victims' place of origin

Region	Province	Number	Percentage per region	Total per region
Boucle du Mouhoun	Banwa	273	64.24%	425 (46.10%)
	Mouhoun	152	35.76%	

Cascades	Léraba	144	100%	144 (15.62%)
Hauts-Bassins	Houet	35	9.92%	353 (38.28%)
	Kénédougou	182	51.56%	
	Tuy	136	38.53%	
Total		922		(100%)

The present results support earlier findings from Toé *et al*, (2000 and 2002) confirming the prevalence of intoxication cases in the Mouhoun area. Due to data storage problems and staff mobility, some health centres were not able to consistently record intoxication cases that have occurred since 2002. As a result, the effective number of incidents cases should be higher than the one given here.

IV-5-2. Pesticide intoxication cases reported with brief information

They include intoxication cases for which basic information is available. The information provided is related to the identity of the injured person (sex and age), the incident circumstance and its outcome. A total of 81 recorded intoxication cases fall into this category. As seen below most of the incidents were recorded in the Boucle de Mouhoun region (49.3%), followed by the Hauts-Bassins area with 34.6% of cases and the Cascades region with 16% of cases. Table VIII gives the intoxication case distribution according to the relevant regions and provinces.

Table VIII: Distribution of the 81 intoxication cases reported with basic information according to the place of origin

Region	Province	Number	Percentage per region	Total per region
Boucle du Mouhoun	Banwa	1	2.5%	40 (49.3%)
	Mouhoun	39	97.5%	
Cascades	Léraba	13	100%	13 (16%)
Hauts-Bassins	Balé	1	3.57%	28 (34.6%)
	Houet	11	39.29%	
	Kénédougou	16	57.14%	
Total		81		81 (100%)

Distribution of the 81 intoxication cases according to sex and age

The majority of victims were women accounting for 70.37% of reported cases against 29.63% for men.

The largest proportion of victims were adults (54.33%) whereas 19.75% of them were minors and 17.28% adolescents. In 8.84% of the cases, age could not be identified. (See Figure 12).

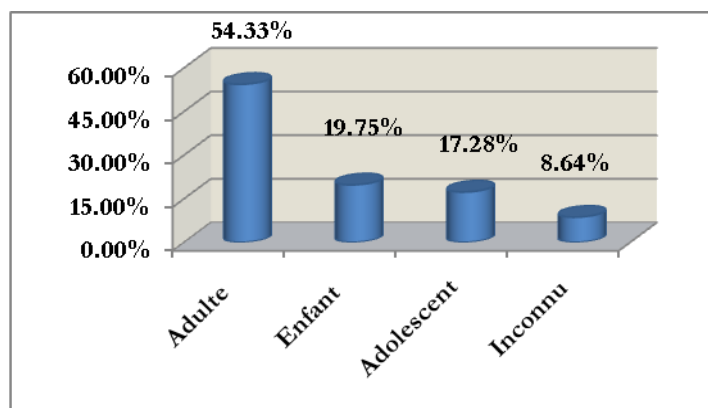
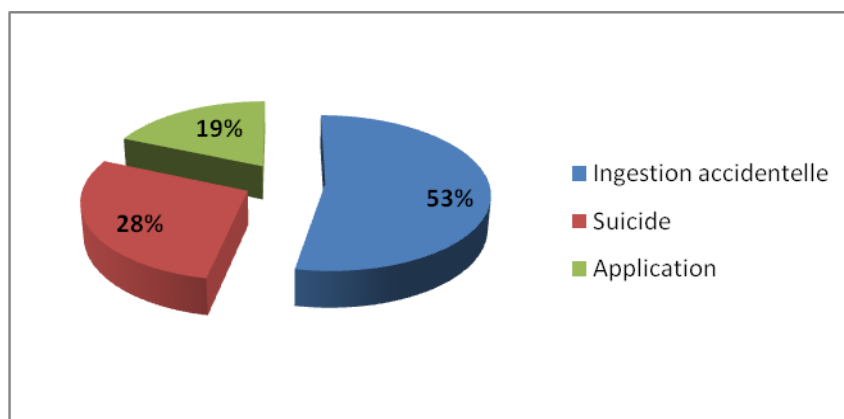


Figure 12: Age distribution among the 81 intoxication cases

Text in the Table (Adult/Child/Adolescent/Unknow)

Distribution of the 81 intoxication cases according to incident circumstances

The majority of intoxication cases (53%) were due to unintentional ingestion of pesticides by the victims (Figure 13). It has been observed that 19% of cases occurred during agricultural work involving the use of pesticides. This percentage corresponds to 15 individuals. The perusal of survey factsheets has revealed that only one person was wearing protective equipment at the time of the pesticide handling operation that led to the incident. As mentioned earlier, pesticide application operations without the use of personal protective equipment inevitably exposes applicators to high intoxication risks.



Unintentional ingestion/suicide/pesticide application

Figure 13: Distribution of the 81 poisoning cases according to incident circumstances

Application: intoxication incidents occurred during pesticide treatments in the field or while handling treated seeds.

Ingestion: in our context intoxication cases include:

Food intoxications: intoxications occurring after having ingested cereals which had been preserved with chemicals and used to cook meals. This raises the problem of the identification of appropriate pesticides for the preservation of stored food and of the compliance with recommended doses.

Cases resulting from a mistake: intoxications resulting from the ingestion of liquid or solid pesticide formulations which have been mistaken for water, drinks, food or medical substances. They indicate, on the one hand, how carelessly left-over pesticides or chemical stocks are managed and on the other hand, they highlight the lack of knowledge about the risks associated with pesticides.

Intoxications resulting from the use of empty containers: intoxications resulting from the consumption of water or food stored in empty pesticide containers which have not been previously decontaminated or properly cleaned.

Suicide: Some individuals facing personal problems try to commit suicide by ingesting pesticides.

Distribution of the 81 intoxication cases according to the year of occurrence of the incident

Figure 14 lists the number of intoxication incidents according to the year of occurrence.

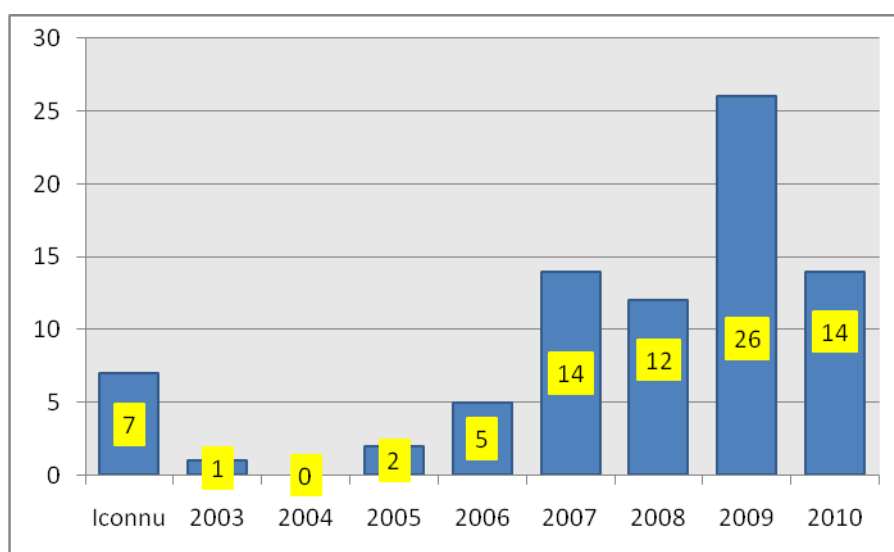


Figure 14: Distribution of the number of intoxication cases according to the year of occurrence.

As seen in Figure 14, the number of intoxication cases increases annually. With regard to 2010, the number of cases refers to the ones registered between January and the first two weeks of June, which implies that only the beginning of the winter season is taken into account.

Distribution of the 81 intoxication cases according to the outcome of the incident

The majority of victims, i.e. 80.25% have recovered whereas in 10% of cases, intoxication incidents were fatal. In 7.4% of cases, the outcome was unknown.

IV-5-3. Intoxication cases reported together with some detailed information

All recorded intoxication cases for which the implicated pesticide(s) was/were identified fall into this category. Overall, out of the 22 cases recorded, five (5) occurred during agricultural work involving the use of pesticides during application operations or the use of treated seeds. Six (6) of them result from the use of empty pesticide containers. Seven (7) cases are related to suicide and the four (4) remaining cases result from the ingestion of a chemical product which had been mistaken for a drink or a food substance. Table IX presents the intoxication symptoms related to the incriminated pesticides together with their active ingredients and corresponding concentrations.

Table IX: Intoxication cases (recorded within CSPS) where the incriminated pesticides and the poisoning circumstances of the incidents were clearly identified 1/3

Intoxication circumstance	Name of chemicals	Active ingredients and concentration	WHO Classification	Number of cases	Symptoms	Outcome
Application of agricultural pesticides or handling of pesticide-treated seeds	CAPT 88 EC	Acetamipride (16 g/l)	II	1	Dizziness, headache, blurred vision, vomiting	Recovery
		Cypermethrine (82 g/l)				
	CONQUEST 88	Cypermethrine (82 g/l)	II	1	Dizziness, excessive sweating, convulsion, staggering, excessive salivation, nausea and vomiting, restlessness, diarrhea	Recovery
		Profenofos (600 g/l)				
	GRAMOXONE	Paraquat (200 g/l)	II	2	Dizziness, headache, excessive sweating, blurred vision, hand tremor, convulsion, narrow pupils/miosis, staggering, excessive salivation excessive, nausea and vomiting	Recovery
	PROCOT 40 WS	Carbosulfan (250 g/kg)	II	1	Abdominal pain	Recovery
		Carbendazim (100 g/kg)				
		Metalaxyl-M (50 g/kg)				

Table IX: Intoxication cases (recorded within CSPS) where the incriminated pesticides and the poisoning circumstances of the incidents were clearly identified 2/3

Intoxication circumstance	Name of chemicals	Active ingredients and concentration	WHO Classification	Number of incidents	Symptoms	Outcome
Handling of packagings or consumption of food which had been placed in empty pesticide containers	CALTHIO C	Chlorpyrifos-ethyl (250g/l)	-	1	Excessive sweating, convulsion, excessive salivation	Death
		Thirame (250 g/l)				
	GRAMOXONE	Paraquat (200 g/l)	II	1	Dizziness, convulsion, staggering, excessive salivation, nausea and vomiting	Recovery
	DECIS 25 EC	Deltamethrine (25 g/l)	II	3	Excessive sweating, blurred vision, hand tremor, convulsion, staggering, excessive salivation excessive, nausea and vomiting	Transfer
	ADWUMA WURA	Glyphosate (480)	III	1	Headache, excessive sweating, blurred vision, hand tremor, excessive salivation, nausea and vomiting	Recovery
	FURADAN	Carbofuran (5%)	-	1	Headache, excessive sweating, blurred vision, hand tremor, excessive salivation, nausea and vomiting	Recovery
	LAMDEX 480	Lambdacyhalothrine (30 g/l)	II	1	Dizziness, headache, excessive sweating,	Recovery

	EC	Chlorpyrifos-ethyl (400 g/l)			convulsion, excessive salivation, nausea and vomiting	
	CAIMAN ROUGE	Endosulfan (250 g/l)	II	1	Dizziness, headaches, convulsion, nausea and vomiting, restlessness	Recovery

Table IX: Intoxication cases (recorded within CSPS) where the incriminated pesticides and the incident circumstances were clearly identified
3/3

Intoxication circumstance	Name of chemicals	Active ingredients and concentration	WHO Classification	Number of incidents	Symptoms	Outcome
Suicide	ROCKY C 386 C	Endosulfan (350 g/l)	III	3	Headaches, profuse sweating, convulsion, excessive salivation, nausea and vomiting	Transfer and recovery
		Cypermethrine (36 g/l)				
	ROCKY 350 EC	Endosulfan (350 g/l)	II	1	Dizziness, profuse sweating, narrow pupils/miosis, excessive salivation, nausea and vomiting, dyspnea	Death
	DECIS	Deltamethrine (25 g/l)	II	1	Profuse sweating, excessive salivation, nausea and vomiting, convulsion	Transfer
	CALTHIO DS	Endosulfan (25%)	-	1	Restlessness, delirium	Death
		Cypermethrine (25%)				
	CAPT 80 DS	Acetamipride (16 g/l)	II	1	Sweating, blurred vision, narrow pupils/miosis, unconsciousness	Recovery
		Cypermethrine (72 g/l)				

Confusion over the pesticide (liquid formulation) and a drink (including water) or a food or medical powder	ROCKY 350 EC	Endosulfan (350 g/l)	II	1	No description	Death
	FURADAN	Carbofuran (5%)	-	1	No description	Death
	LAMDEX 480 EC	Lamdacyhalothrine (30 g/l)	II	1	Dizziness, headaches, profuse sweating, convulsion, excessive salivation, nausea and vomiting	Death
		Chlorpyrifos-ethyl (400 g/l)				
	CAIMAN ROUGE	Endosulfan (250 g/l)	II	1	Dizziness, headaches, convulsion, nausea and vomiting, restlessness	Recovery
		Thirame (250 g/l)				

Out of the seventeen injured individuals, fifteen (15) were men (i.e. 77.3%) and five (5) were women (27.7%). The incidents occurred between 2003 and 2010 and have increased from 1 to 5 over the years (Figure 16).

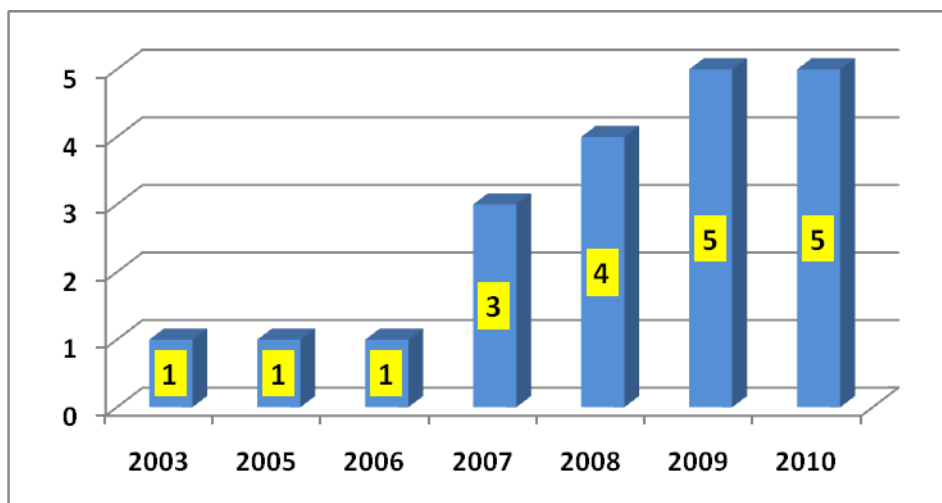


Figure 16: Distribution of the 22 intoxication cases according to the year of occurrence

IV-5-4. Capacity to deal with intoxication incidents

Overall, it has been found that health personnel have little information about pesticides. Out of the 42 surveyed health officers, 20 (47.62%) declared not having much knowledge about pesticides whereas twenty-two (22), i.e. 52.37% knew some facts about pesticides; each of them were able to quote some of the pesticide formulations' names. On the basis of the frequency with which chemicals were quoted, it has been found that GRAMOXONE and ROUNDUP were the best known ones (respectively quoted by 17 and 15 agents). Some pesticides were quoted at the most by three (3) agents only. They are: ALLIGATOR, ATRALM, ATRAZINE, CALTHIO, CONQUEST, COTODON, DECIS, ENDOSULFAN, GLYPHADER, HERBEXTRA, KALACH, RAMBO, ROCKY and TOUCHDOWN.

The lack of knowledge about pesticides presents a serious handicap in that it inhibits dealing effectively with intoxication incidents. In fact, only a correct and complete etiology of pesticide-related ailments can help to provide the appropriate treatment. However, it has been observed, through data collection on intoxication cases at health centres' level, that, in most situations, diagnostics carried out did not identify the incriminated pesticides, in which case, the administered cure can only be inadequate or

even have adverse effects on patients' health. In most intoxication cases, and independently of the route of exposure and of the pesticide formulation implicated, active charcoal and atropine were the only forms of treatment provided. Medical care related to intoxication cases is definitely insufficient.

The study also reveals that there is a tendency among people, who are usually characterized by a low level of education, not to talk much about pesticide poisoning issues. As a consequence, incident cases, if they are ever reported to health centres tend to be reported late. Poisoning victims only go to health care centres once they realize that their life is endangered. According to health agents, most of the intoxication victims coming to the centres do not immediately admit that their ailments are related to pesticide intoxication. A long and complex investigation is required before patients finally reveal the cause of their problems.

V- CONSTRAINTS AND LIMITS OF THE STUDY

V-1 Constraints of the study

At the farmers level, the major difficulties we encountered were related to:

- their unavailability as the survey took place at the peak of the winter season when they were busy with preparatory field work and sowing;
- their reluctance to speak about issues related to experienced and observed intoxication cases;
- Their illiteracy and thus their ignorance of the brand names of products they used, which makes it difficult to identify incriminated chemicals;
- Their lack of knowledge on pesticide-related symptoms;

At the health personnel's level, the major difficulties we came across were related to:

- The unavailability of activity reports or registers in some of the health centres visited due partly to staff mobility;
- The refusal of some patients to talk about their accident;

- The tendency for the injured to be cured at home with traditional practices, in which case, incidents were not reported to health centres;
- The lack of information on the identity of pesticides and on the poisoning incident circumstances in patients' personal records.

At the pesticide distributors and retailers level, their distrust towards interviewers and their unwillingness to answer questions.

V-2 Limits of the study

One of the limits of the study is related to the data collection method. Data on pesticide intoxication incidents was collected by means of prospective surveys and interviewers found themselves confronted by the unavailability of information regarding the identification of pesticide formulations implicated in poisoning incidents, the incident circumstances, the protection measures taken for pesticide handling and use and precautionary measures.

The fact that it was not possible to verify if precautionary measures intended for farmers were effectively taken during pesticide treatments constitutes another limit of the survey. A farmer could well report wearing personal protective equipment for pesticide applications while not doing so in reality.

VI- RECOMMENDATIONS

- ☞ Given the economic importance of pesticide trade for distributors and retailers, and
 - In view of the low level of education and training among most pesticide distributors and retailers,
 - In view of the role that distributors and retailers play in pesticide management processes through the advice they can provide to farmers,
 - Noting the government's commitment to play a central role in controlling agro-chemicals through the National Commission on the Control of Pesticides,
- We would then recommend:

- ✓ Supporting the strengthening of capacities to control the distribution of pesticides in the study zone in particular and in the whole country,

✓ organizing training sessions with a view to disseminating knowledge on the hazards associated with pesticides, the relevant techniques of use and tools on the management of left-over pesticides and empty containers.

☞ Given the high incidence of health problems resulting from the use of pesticides on farmers, and

- In view of the low level of education among the population,
- In view of their lack of knowledge about pesticides and the hazards associated with them,
- In view of the inexistence of training among them,
- In view of the lack of a health surveillance plan of action,
- In view of the limited knowledge of pesticides amongst health personnel,
- In view of the difficulties in providing medical care to intoxicated individuals,

We would then recommend:

- ✓ organizing training sessions aimed at farmers using pesticides,
- ✓ implementing a health surveillance plan to monitor farmers,
- ✓ organizing training sessions aimed at health agents.

Given the objective of the PIC Procedure under the Rotterdam Convention, and

- In view of the lack of human and material resources of the Directorate of Plant Protection (DPV),
- In view of the difficulties encountered by health research units and healthcare centres,

We would then recommend that FAO/PIC supports and helps strengthen the Crop Protection Directorate (DPV), health research units and healthcare centres capacities.

CONCLUSION

The overall objective of the present study is to contribute to achieving improvements in human health and to protect the environment. The work which has been conducted has enabled us to list the range of pesticides marketed in the study zone, to identify and describe health problems associated with the use of pesticides affecting farmers as well as associated risk factors.

A total of 153 pesticide formulations were recorded in the 97 establishments involved in pesticide distribution and trade. But despite the large number of agro-chemicals on the market, little efforts have been made to help minimize health and environmental risks associated with their use.

By recognizing the possible adverse effects of pesticides on human-beings, different categories of animals, plants, water and soil, the majority of farmers have shown to be aware of health and environmental risks resulting from the use of agro-chemical products. However, such knowledge has not necessarily led them to adopt responsible attitudes and to manage pesticides in a safer manner. In fact, personal protective equipment is only worn by a very limited number of workers, either out of carelessness or because farmers cannot afford them (only 0.31% of farmers use the personal protective equipment recommended. This sad fact highlights the non-compliance with Good Agricultural Practices. Similarly, irresponsible behaviour causing health and environmental damage such as, storing pesticides in sleeping rooms and exposing family members without informing them, using inappropriate products for domestic purposes, dumping empty containers into the environment or burying them in the soil, remain very common.

Data collected to assess the adverse effects of pesticides on farmers highlights the recurrence of health problems related to the use of agro-chemicals. Out of 42 surveyed health centres, 922 pesticide-related poisoning cases have been recorded since 2002. In 22 of those cases, the incriminated pesticide formulations and the incident circumstances were identified. Five of the 22 cases occurred during pesticide applications in the fields. 296 intoxication cases which occurred during pesticide treatments were reported among agricultural producers. Paraquat, which has been implicated in 59 poisoning incidents has been identified as the most hazardous active ingredient found in pesticide formulations. Formulations containing the combination of endosulfan/cypermethrine come second and have been found to be responsible for 35 poisoning cases. Present or delayed manifestations of pesticide exposure which affect 82.66% of farmers highlights the constant threat that pesticides pose to human health and their possible toxic chronic effects.

In view of their severe adverse effects on farmers, and in order to protect human health and the environment, special attention should be brought to active ingredients such as paraquat or endosulfan to effectively ban them and propose them for inclusion in Annex III of the Rotterdam Convention. To this purpose, advanced investigations together with

more in-depth studies should be carried out over a longer period of time to complement the present pilot study. Further studies should be undertaken through the joint collaboration of health centres and agricultural services in order to have a better understanding of the different types of intoxication cases.

It is then highly recommended to strengthen the Directorate for Plant Protection capacities (DPV), as well as that of health research units and healthcare centres.

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ANNEXES

Annex 1: Questionnaire aimed at pesticide distributors/retailers

QUESTIONNAIRE <i>“Study on Agro-chemical Poisoning in Agriculture (Burkina Faso Pilot Study)”</i>		
Form aimed at pesticide distributors/retailers		
Date: /__/_/- /__/_/- 2010	Sheet n° /__/_/_/	Location code: /__/_/_/
	Investigator code /__/_/_/	Department:
1. RESPONDENT IDENTITY		
Occupation:	Structure name:	
2. PRODUCT IDENTITY		
See Form in Annex		
3. PESTICIDE MANAGEMENT		
3.1. Do you have unused pesticides that have been returned by farmers in your building? Yes /__/_/ no /__/_/		
3.1.1. If yes, what do you do with them?.....		
3.2. Do you know of any other sources of pesticide supply for farmers? Yes /__/_/ no /__/_/		
3.2.1. If yes, which ones?		
3.3. Do you have a pesticide warehouse? Yes /__/_/ No /__/_/		
If yes: 3.3.1. Is the storage facility appropriate? Yes /__/_/ No /__/_/		
3.3.2. What type of storage is it? Segregated /__/_/ Unsegregated /__/_/		
3.3.3. Do you have a trained warehouse person?: Yes /__/_/ No /__/_/		
3.3.4. Is there a storage data sheet? Yes /__/_/ No /__/_/		
3.4. Is there a safety data sheet: Yes /__/_/ No /__/_/		
3.5. How are pesticide stocks managed? packaging /__/_/ repackaging /__/_/		
3.6. Is there a First-Aid-Kit? Yes /__/_/ no /__/_/		
3.6.1. If yes, what does it contain?		
3.7. What do you do with empty pesticide packagings?		
4. PREVENTION AND PROTECTION MEASURES		
4.1. Do you know about any potential risks related to the use of pesticides (or the exposure to pesticides? Yes /__/_/ no /__/_/		
4.1.1. If yes, which ones?.....		
4.2. Do you provide your customers with information on:		
4.2.1. The risks associated with the use of pesticides? Yes /__/_/ no /__/_/		
4.2.2. Proper pesticide handling techniques? Yes /__/_/ no /__/_/		
4.3. Are there any training sessions on the use of pesticides aimed at farmers? Yes /__/_/ no /__/_/		
4.3.1. If yes, with which frequency (number of times per year)?		

4.3.2. Are the training sessions free? Yes /__/ no /__/

4.4. Is there any personal protective equipment made available to customers? Yes /__/ no /__/

4.4.1. If yes, which ones? Gloves /__/ boots /__/ aprons /__/ overalls /__/ glasses /__/
 Cartridge masks /__/ dust masks /__/ other /__/

4.5. Do you think that these products have adverse effects on health? Yes /__/ No /__/

4.5.1. If yes, why?

4.5.2. If not, why?

4.6. Do you think that these products pose a threat to the environment? Yes /__/ No /__/

4.6.1. If yes, why?

4.6.2. If not, why?

5. SUGGESTIONS AND RECOMMENDATIONS

5.1. Please provide your suggestions/recommendations regarding the use of pesticides in general

Thank you for your attention!!!

Questionnaire aimed at pesticide distributors/retailers (Separate part)

Sheet n° /__/ __/ __/

Formulation	Type of formulation*	Name and concentration of active ingredients	Suppliers	Country of origin	Date of expiry	Amount sold	
						2009/2010	2008/2009
1.	
						2007/2008	2006/2007
2.	
						2007/2008	2006/2007
3.	
						2007/2008	2006/2007
4.	
						2007/2008	2006/2007

						-----	-----
5.		----- ----- -----				2009/2010 -----	2008/2009 -----
						2007/2008 -----	2006/2007 -----

*EC, WP, DP, SP, ULV, TA, GR ...

Annex 2: Questionnaire aimed at farmers

QUESTIONNAIRE		
<i>“Study on Agro-chemical Poisoning in Agriculture (Burkina Faso Pilot Study)”</i>		
Questionnaire aimed at farmers		
Date: / __ / __ - / __ / __ - 2010	Sheet n° / __ / __ / __ / Investigator code / __ / __ /	Location Depart
1. RESPONDENT IDENTITY		
1.1. Age / __ / __ /	1.2. Sex M / __ / F / __ /	1.3. Occupation:
1.4. Level of education: None / __ / Primary / __ / Secondary / __ / Tertiary / __ /		
1.5. Literacy language: French / __ / Local language / __ /		
2. KNOWLEDGE ABOUT THE PESTICIDES		
2.1. Which pesticides do you use? (Please specify names and their physical aspect: solid, liquid or gas substance)		
2.1.1. If the farmer does not know product names, ask her/him why?		
2.2. Do you know the following products, GRAMOXONE, CALLOXONE, atrazine, endosulfan? Yes / __ / No / __ /		
2.2.1. If yes, which of these products do you use?		
2.3. How do you acquire products you are using? At the local market / __ / at a licensed retailer / __ / at SOFITEX / __ / Other		
2.4. Do you think you incur risks when you are exposed to those chemicals? Yes / __ / No / __ /		
2.4.1. If yes, which risks?		
2.5. Have you already had an incident related to the use of those products? Yes / __ / No / __ /		
If yes:		
2.5.1. Specify the type of incident: skin / __ / inhalation / __ / ingestion / __ / eye / __ /		
2.5.2. Specify the product name:		
2.5.3. Describe experienced symptoms:.....		
2.6. What was your reaction in this situation?		
2.7. Have you already seen a person injured while using these products? Yes / __ / No / __ /		
2.7.1 If yes: Which year? Indicate : Her/his name; Her/his age / __ / __ / yrs; Her/His sex M / __ / F / __ / Specify the type of incident: skin / __ / inhalation / __ / ingestion / __ / eye / __ /		

<p>Specify the product name:</p> <p>Describe observed symptoms.....</p> <p>.....</p> <p>2.8. What do you think of those products/what is your opinion on those products?</p> <p>.....</p> <p>2.9. What do you do with empty pesticide containers?</p> <p>2.10. If there are unused products left, what do you do with them?</p>	<p>3. CONDITIONS IN WHICH THE PRODUCT WAS USED</p> <p>3.1. Since when have you been using pesticides?</p> <p>3.2. Do you wear any protective equipment during pesticide applications? Yes /__ / No /__ /</p> <p>3.2.1. If yes, which ones? gloves /__ / boots /__ / aprons /__ / overalls /__ / glasses /__ /</p> <p style="padding-left: 40px;">cartridge mask /__ / dust mask /__ / other /__ /</p> <p>3.2.2. If not, why?.....</p> <p>3.3. Are you satisfied with this equipment? Yes /__ / No /__ /</p> <p>3.3.1. If not, why?</p> <p>3.4. What type of equipment do you use to apply those pesticides?</p> <p>Backpack sprayer /__ / hand sprayers (ULV, UBV) /__ / Other (specify name) /__ /</p> <p>3.5. What is the tank volume of this equipment? litres</p> <p>3.6. What quantity of pesticide is applied per hectare? litres/ha</p> <p>3.7. Are the pesticides ready for use? /__ / or to be diluted /__ /.</p> <p>3.7.1. If diluted, give the quantity of pesticide used per litre of water:/..... litre of water</p> <p>3.8. How big is the area you treat during an agricultural season? hectares</p> <p>3.9. How many treatments do you apply during an agricultural season?</p> <p>3.10. In which month of the year do you apply: The first treatment? The last treatment?</p> <p>3.11. Which amount of product do you handle? per day /__ / per week /__ / per month /__ /</p> <p>3.12. Have you had any training related to the use of pesticides? Yes /__ / No /__ /</p> <p>3.12.1. If yes: - date of the training received: - through which structure?</p> <p style="padding-left: 40px;">- what do you remember of the training?</p> <p>.....</p> <p>3.15. After having treated a field, how long does it take before you come back to the same field?</p> <p>3.16. After exposure, what do you usually do?</p>
4. HEALTH EFFECTS	
<p>4.1. What do you feel during the use and/or handling of those products?</p> <p>.....</p> <p>4.2. What do you feel after your work?</p> <p>4.2.1. In the following hours:</p> <p>.....</p> <p>4.2.2. In the following days:</p> <p>.....</p> <p>4.3. Do you have any medical follow-up related to the use of those products? Yes /__ / No /__ /</p> <p>4.4. Do you see a general practitioner? Yes /__ / No /__ /</p> <p>4.4.1. If yes: once a/year /__ / twice a /year /__ / other /__ /</p>	

4.5. Do you have any medical care protection in case of disease?:

Individual / __/ Mutual or cooperative/ __/ Other / __/

5. PERCEPTION OF ENVIRONMENTAL RISK

5.1. Is there any water source (well, stream, river, forage,) in the vicinity or in your fields?

Yes / __/ No / __/

5.1.1. If yes, specify

5.1.2. What is the distance between the water source and the area you are treating?

5.1.3. What is the water source used for?

5.2. Have you noticed the death or disappearance of some insects or animals since you have been using the chemicals?

Yes / __/ No / __/

5.2.1. If yes, which ones?

5.3. Do you think that those products pose a risk to the environment? Yes / __/ No / __/

5.3.1. If yes, why?

5.3.2. If not, why?

6. SUGGESTIONS AND RECOMMENDATIONS

6.1. Please provide your suggestions/recommendations concerning the use of pesticides in general.

.....

Annex 3: Questionnaire aimed at health officers 1/2

<i>“Study on Agro-chemical Poisoning in Agriculture (Burkina Faso Pilot Study)”</i>	
Date: /__ / __ / - / __ / __ / - 2010	Sheet N° /__ / __ / __ / Investigator Code /__ / __ /
1.1. Sex M /__ / F /__ /	1.2. Occupation: _____
2.1 Do you know which pesticides are commonly used by farmers in your area of work? Yes /__ / No /__ /	
2.1.1. If yes, quote some of them.....	
2.2. Have you received any training related to the treatment of pesticide intoxications? Yes /__ / No /__ /	
2.2.1. If yes, where? Training school /__ / Seminar /__ / Workshop /__ / Other.....	
2.3. How many intoxication cases have been treated in your health center since 2002? /__ / __ / __ / __ /	
2.4. Have you ever heard about paraquat, atrazine or endosulfan? Yes /__ / No /__ /	
2.4.1. If yes, how many intoxication cases associated with those pesticides have you recorded? /__ / __ / __ /	
2.5. Have you heard about any other intoxication cases related to those pesticides and which have not been reported to your health centre? Yes /__ / No /__ /	
2.5.1. If yes, please provide comments on those incidents	
7.1. Please provide your suggestions/recommendations regarding the use of pesticides in general	

Annex 3: Questionnaire aimed at health officers 2/2

Date: / / - / - / 2010
<p>3.1. Formulation name:</p> <p>3.2. Type of formulation</p> <p style="padding-left: 40px;">Emulsifiable Concentre (EC) / / Wettable Powder (WP) / / Dustable Powder (DP) / /</p> <p>Water soluble Powder (SP) / / Ultra Low Volume (ULV) / / Tablet (TA) / / Granule (GR) / /</p> <p style="padding-left: 40px;">other (please specify) / /</p> <p>3.3. Manufacturer Name /Distributor Name (if available):</p> <p>3.4. Name and concentration of the active ingredient(s):</p> <p style="padding-left: 400px;">.....</p> <p style="padding-left: 400px;">.....</p> <p>3.5. Was the chemical label available? Yes / / No / /</p>
<p>4.1. Sex: Male / / Female / /</p> <p>4.2. Age / / / If age unknown, specify: child (<14 yrs) / / adolescent (14-19 yrs) / / adult (>19 yrs) / /</p> <p>4.3. Activity carried out at the time of incident</p> <p style="padding-left: 40px;">Mixing/loading / / Application / / Re-entry / / Other</p> <p>4.4. Was the injured person wearing any personal protection equipment (PPE) during the activity?</p> <p style="padding-left: 40px;">Yes / / No / / No answer / /</p> <p>4.4.1. If yes, which ones: gloves / / boots / / aprons / / overalls / / glasses / /</p> <p style="padding-left: 100px;">cartridge masks / / dust masks / / other / /</p>
<p>5.1. Date of accident: / / - / - /</p> <p>5.2. Location of accident: Village: _____ Department: _____ Province: _____</p> <p>5.3. Intoxication circumstance?</p> <p style="padding-left: 40px;">Unintentional / / Intentional (suicide) / / Criminal (poisoning) / / Unknown / /</p> <p>5.3. Description of the accident</p> <p>.....</p> <p>5.4. Main experienced intoxication symptoms (check one or more of the following):</p> <p style="padding-left: 40px;">Dizziness / / Headaches / / Profuse sweating / / Blurred vision / /</p> <p style="padding-left: 40px;">Hand tremor / / Convulsion / / Narrow pupils/miosis / / Staggering / /</p> <p style="padding-left: 40px;">Excessive salivation / / nausea/vomiting / / others (please specify) / / :</p> <p>.....</p> <p>5.5. Outcome of the intoxication incident: Recovery / / Death / / Transfer / / Transfer and death / / Unknown / /</p>

5.6. Were other individuals affected in the same accident? Yes /__ / No /__ /

5.6.1. If yes, how many? /__ / __ /

5.6.2. What happened to them?

6.1. Treatment given

.....

6.2. Hospitalization? Yes /__ / No /__ / If yes, duration of the hospitalization?

Annex 4: List of recorded active ingredients and their characteristics

(Source: Footprint PPDB, 2010 and PAN UK, 2009)

N°	Active ingredient	WHO Classification	Chemical family	Pesticide categorie	Inclusion to Annex 1
1.	2,4 D	II	Alkylchlorophenoxy	Herbicide	Yes
2.	Acetamipride	NL	Neonicotinoid	Insecticide	Yes
3.	Acetochlore	III	Chloroacetamide	Herbicide	No*
4.	Aclonifene	U	Diphenyl ether	Herbicide	Yes
5.	Alachlore	III	Chloroacetamide	Herbicide	No
6.	Alphacypermethrine	II	Pyrethroid	Insecticide	Yes
7.	Atrazine	U	Triazine	Herbicide	No
8.	Bensulfuron-methyl	U	Sulfonylurea	Herbicide	Yes
9.	Bifenthrine	II	Pyrethroid	Insecticide	No**
10.	Carbofuran	Ib	Carbamate	Insecticide	No
11.	Carboxine	U	Oxathiin	Fungicide	No*
12.	Cartap	II	Nereistoxin analogue insecticides	Insecticide	No
13.	Chlorpyrifos-éthyl	II	Organophosphorus	Insecticide	Yes
14.	Clethodim	III	Cyclohexanedione	Herbicide	No*
15.	Clomazone	II	Isoxazolidinone	Herbicide	Yes
16.	Cycloxydime	U	Cyclohexanedione	Herbicide	No*
17.	Cypermethrine	II	Pyrethroid	Insecticide	Yes
18.	Deltamethrine	II	Pyrethroid	Insecticide	Yes
19.	Difenoconazole	III	Triazole	Fungicide	Yes
20.	Diuron	U	Phenylurea	Herbicide	Yes
21.	Endosulfan	II	Organochlorine	Insecticide	No
22.	Fenvalerate	II	Pyrethroid	Insecticide	No
23.	Fluazifop-p-butyl	III	Aryloxyphenoxypropionate	Herbicide	No*
24.	Flubendiamide	NL	Benzene-dicarboxamide	Insecticide	No**
25.	Fluometuron	U	Phenylurea	Herbicide	No*
26.	Furathiocarbe	Ib	Carbamate	Insecticide	No
27.	Glyphosate	U	Phosphonoglycine	Herbicide	Yes
28.	Haloxifop-R-methyl	II	Aryloxyphenoxypropionate	Herbicide	No*

29.	Imidaclopride	II	Neonicotinoid	Insecticide	Yes
30.	Indoxacarb	NL	Oxadiazine	Insecticide	Yes
31.	Isoxaflutol	NL	Isoxazole	Herbicide	Yes
32.	Lambdacyhalothrine	II	Pyrethroid	Insecticide	Yes
33.	Lindane	II	Organochlorine	Insecticide	No
34.	Manebe	U	Dithiocarbamate	Fungicide	Yes
35.	Metalaxyl-M	II	Phenylamide	Fungicide	Yes
36.	Metolachlore	III	Chloroacetamide	Herbicide	No
37.	Nicosulfuron	U	Sulfonylurea	Herbicide	Yes
38.	Oxadiargyl	NL	Oxidiazole	Herbicide	Yes
39.	Oxadiazon	U	Oxidiazole	Herbicide	Yes
40.	Paraquat	II	Bipyridylum	Herbicide	No
41.	Pendimethaline	III	Dinitroaniline	Herbicide	Yes
42.	Permethrine	II	Pyrethroid	Insecticide	No
43.	Phosphure d'alumine	FM	Inorganic compound	Insecticide	Yes
44.	Profenofos	II	Organophosphorus	Insecticide	No
45.	Prometryne	U	Triazine	Herbicide	No
46.	Propanil	III	Anilide	Herbicide	No*
47.	Pyrimiphos-methyl	III	Organophosphorus	Insecticide	Yes
48.	Pyriproxylene	U	Juvenile hormone mimic	Insecticide	Yes
49.	Quizalofop-p-ethyl	NL	Aryloxyphenoxypropionate	Herbicide	Yes
50.	S-Metalochlore	III	Chloroacetamide	Herbicide	Yes
51.	Spirotetramate	NL	Tetramic acid	Insecticide	No**
52.	Terbutryne	U	Triazine	Herbicide	No
53.	Thiamethoxam	III	Neonicotinoid	Insecticide	Yes
54.	Thirame	III	Dithiocarbamate	Fungicide	Yes
55.	Triazophos	Ib	Organophosphorus	Insecticide	No
56.	Trichlopyr	III	Pyridine compound	Herbicide	Yes

* Re-submitted ** Pending

Annex 5: List of recorded active ingredients and their inclusion to international conventions and to the PAN Dirty Dozen List

N°	Active Ingredients	Conventions	Cancer			EDC			Pesticides toxic to bees	
			USEP A	E U	IAR C	E U	OS F	WW F	USEP A	UK PS D
1.	2,4 D					2		X		
2.	Acetamipride									
3.	Acetochlore		SECP			1	X	X		
4.	Aclonifene									
5.	Alachlore		L2	3		1	X	X		
6.	Alpha cypermethrine								X	X
7.	Atrazine				3	1	X	X		
8.	Bensulfuron-methyl									
9.	Bifenthrine		C			1	X	X	X	X
10.	Carbofuran					2		X	X	
11.	Carboxine									
12.	Cartap									
13.	Chlorpyrifos-éthyl									
14.	Clethodim									
15.	Clomazone									
16.	Cycloxydime									
17.	Cypermethrine		C							X
18.	Deltamethrine				3	1		X	X	X
19.	Difenoconazole		C							
20.	Diuron		KNO W	3		2				
21.	Endosulfan					2	X	X		
22.	Fenvalerate				3	2		X		
23.	Fluazifop-p-butyl									
24.	Flubendiamide									
25.	Fluometuron		C		3					X
26.	Furathiocarbe									
27.	Glyphosate									

28.	Haloxypop-R-methyl		B2							
29.	Imidaclopride								X	X
30.	Indoxacarb								X	X
31.	Isoxaflutole		L1							
32.	Lambdacyhalothrine					1		X	X	X
33.	Lindane	PIC/LRTA P/Dirty Dozen	3		2B	1	X	X		
34.	Manebe		B2		3	1	X	X		
35.	Metalaxyl-M									
36.	Metolachlore		C							
37.	Nicosulfuron									
38.	Oxadiargyl									
39.	Oxadiazon		C							
40.	Paraquat	Dirty Dozen								
41.	Pendimethaline		C							
42.	Permethrine		2		3	2	X	X		
43.	Phosphure alumine									
44.	Profenofos									
45.	Prometryne					2				
46.	Propanil		3			2				
47.	Pyrimiphos-methyl									
48.	Pyriproxyfene									
49.	Quizalofop-p-ethyl									
50.	S-Metalochlore		C							
51.	Spirotetramate									
52.	Terbutryne		C			1		X		
53.	Thiamethoxam									
54.	Thirame				3	1	X			
55.	Triazophos									
56.	Trichlopyr									

Annex 6: Pesticide formulations which were identified during the survey among dealers/vendeurs

N°	Formulation	Type of formulation	Active ingredients	Concentrations	Pesticide category	WHO Classification	Chemicals' sources	Dealers' source of supply	Registration CSP*
1.	ACEPRONET 400	EC	Acetochlore	250	Herbicide	III	China	Mali	No
			Prometryne	150					
2.	ACTELIC SUPER	WG	Pyrimiphos-methyl	16	Insecticide		France	Burkina	No
			Permethrine	32					
3.	ACTELIC 50	EC	Pyrimiphos-methyl	500	Insecticide	III	Switzerland	Burkina	Yes
4.	ACTELIC SUPER		Pyrimiphos-methyl	16	Insecticide		SAPHYTO	Burkina	No
			Permethrine	3					
5.	ACTION 80 DF	DF	Diuron	800	Herbicide		SCAB	Cameroon	No
6.	ADWUMA WURA	SL	Glyphosate	480	Herbicide		China	Ghana	No
7.	ADWUMA WURA 75.7%	GR	Glyphosate	757	Herbicide		China	Ghana	No
8.	ADWUMAMU HENE		Glyphosate	410	Herbicide			Ghana	No
9.	AGRAZINE 500	SC	Atrazine	500	Herbicide		China	Burkina/Ghana	No
10.	AGRAZINE 80 WP	WP	Atrazine	800	Herbicide		France/China	Ghana/Burkina	No
11.	AGRAZINE 90	DF	Atrazine	900	Herbicide		China/France	China	No
12.	AGRAZINE DF	WG	Atrazine	900	Herbicide		France		No
13.	AKIZON 40 SC	SC	Nicosulfuron	40	Herbicide	III	France	Burkina	Yes
14.	ALLIGATOR 400 EC	EC	Pendimethaline	400	Herbicide	III	France	Burkina, Mali	Yes
15.	APRON PLUS 50 DS	DS	Metalaxyl-M	100	Insecticide			Ivory Coast	
			Carboxine	60					

			Furathiocarbe	340					
16.	APRON STAR 42 WS	WS	Thiamethoxam	20%	Insecticide		Switzerland		
			Metalaxyl-M	20%					
			Difenoconazole	2%					
17.	ATRAHERB	SC	Atrazine	50%	Herbicide		China	Ghana	No
18.	ATRALM 500	EC/SC	Atrazine	500	Herbicide		SENEFURA/SCAB	Burkina	No
19.	ATRALM 90	WG	Atrazine	900	Herbicide		SENEFURA	Burkina	No
20.	ATRAVIC 500 SC	SC	Atrazine	500	Herbicide		SAPHYTO	France	No
21.	ATRAZ 50	FW	Atrazine	500	Herbicide		Cantonments Accra	China	No
22.	ATRAZ 80 WP	WP	Atrazine	800	Herbicide		SARO AGROCHEM	Nigeria	No
23.	ATRAZILA 500	SC	Atrazine	500	Herbicide		Kumark Trading Ent.	China	No
24.	ATRAZILA 80 WP	WP	Atrazine	800	Herbicide		Shenzhen Baocheng Chemical industry co. Ltd	China, Ghana	No
25.	ATRAZINE		Atrazine		Herbicide		Japan	Ghana	No
26.	ATRAZINE WEEDICIDE		Atrazine		Herbicide		Japan	Ghana	No
27.	AVAUNT 150 EC	EC	Indoxacarb	150	Insecticide	II	SOFITEX/SAPHYTO	Burkina	Yes
28.	BACCARA 335 EC	EC	Propanil	260	Herbicide		SAPHYTO	Burkina	No
			2,4 D	75					
29.	BENAXONE SUPER		Paraquat	270	Herbicide		Bentronic Productions	Ghana	No
30.	BEXTRA		2,4 D	720	Herbicide		CalliGhana/Ghana Bentronic Production	Ghana	No
31.	BISTAR 10 WP	WP	Bifenthrine	10%	Insecticide	II		Burkina	Yes
32.	BLAST 46 EC	EC	Lambdacyhalothrine	30	Insecticide		SAPHYTO	Chine	No
			Acetamipride	16					
33.	CAIMAN ROUGE	DP	Endosulfan	25%	Insecticide	II	SOFITEX/SSI	Senegal	No

			Thirame	25%	e				
34.	CAIMAN SUPER	EC	Alphacypermethrine	18	Insecticide		SSI	China	No
			Endosulfan	350					
35.	CALFOS 500 EC	EC	Profenofos	500	Insecticide	II	SAPHYTO	Burkina	Yes
36.	CALLIFOR	WG	Prometryne	440	Herbicide		SAPHYTO		No
			Fluometuron	440					
37.	CALLIFOR 500	SC	Prometryne	250	Herbicide	III	SAPHYTO	France	Yes
			Fluometuron	250					
38.	CALLIFOR G	WG	Prometryne	250	Herbicide	III	SAPHYTO	France	Yes
			Fluometuron	250					
			Glyphosate	60					
39.	CALLIHERB	EC/SL	2,4 D of amine salt	720	Herbicide		SAPHYTO	France	No
40.	CALLIMAN 80 WP	WP	Manebe	80	Fongicide		Callivoire	Ivory Coast	No
41.	CALLITRAZ 90 WG	WG	Atrazine	900	Herbicide		SAPHYTO		No
42.	CALLOXONE SUPER	SL	Paraquat	200	Insecticide		SAPHYTO	Burkina	No
43.	CALRIZ	EC	Propanil	360	Herbicide		SAPHYTO	France	No
			Trichlopyr	72					
44.	CALTHIO C	WG/WS	Chlorpyrifos-ethyl	25%	Insecticide		SAPHYTO/FASOCOTON	France	No
			Thirame	25%					
45.	CALTHIO DS	DS	Lindane	25%	Insecticide		SAPHYTO	Burkina	No
			Thirame	25%					
46.	CALTHIO E	DP	Endosulfan	25%	Insecticide		SCAB	Burkina	No
			Thirame	25%					
47.	CAPT 80 EC	EC	Acetamipride	16	Insecticide		SAPHYTO	Ivory Coast, BF	No

			Cypermethrine	72	e				
48.	CAPT 88 EC	EC	Acetamipride	16	Insecticide	II	Ivory Coast /ALM	Ivory Coast/China	Yes
			Cypermethrine	72	e				
49.	CARBODAN 3% G		Carbofuran	30	Insecticide		Makhteshim Agan France	Ghana	No
50.	CELTACAL 12,5 EC	EC	Deltamethrine	12,5	Insecticide		SAPHYTO	France	No
51.	CIGOGNE	EC	Profenofos	150	Insecticide		STEP C Abidjan	France	No
			Cypermethrine	36					
52.	CODAL gold 412,5 DC	EC	S-Metolachlore	162,5	Herbicide	III	SAPHYTO/SYNGENTA	Ivory Coast/Switzerland	Yes
			Prometryne	250					
53.	CONQUEST C 88 EC	EC	Cypermethrine	72	Insecticide	II	SAPHYTO	Burkina	Yes
			Acetamipride	16					
54.	CONQUEST C 176 EC	EC	Acetamipride	32	Insecticide	II	SAPHYTO	Burkina	Yes
			Cypermethrine	144					
55.	COTODON PLUS 500 EC	EC	Metolachlore	250	Herbicide	III	NOVARTIS	France	No
			Atrazine	250					
56.	COTONET 500 EC	EC	Metolachlore	333	Herbicide		DTE SA Chine	China	No
			Terbutryne	167					
57.	CURACRON 500 EC	EC	Profenofos	500	Insecticide	III	SOFITEX	Ivory Coast	Yes
58.	CYPERCAL 25 EC	EC	Cypermethrine	25	Insecticide		SAPHYTO	France	
59.	CYPERCAL 50 EC	EC	Cypermethrine	50	Insecticide	III	SAPHYTO		No
60.	CYPERCAL P 690 EC	EC	Profenofos	600	Insecticide	II	SAPHYTO	Burkina	Yes
			Cypermethrine	90					
61.	CYPERPHOS	EC	Cypermethrine	36	Insecticide		Bayer crop science	Germany	No
			Triazophos	150			Bayer crop science	Germany	

62.	CYRENS 480 EC	EC	Chlorpyrifos-ethyl	480	Insecticide		SAVANA	France	No
63.	DECIS	EC	Deltamethrine	25	Insecticide		STEPC/Bayer crop science	Ivory Coast	Yes
64.	DECTACOL 12,5	EC	Deltamethrine	12,5	Insecticide		SAPHYTO	Burkina	No
65.	DIAFURAN	WG	Carbofuran	5%	Insecticide		SAPHYTO	France	No
66.	DIGA FAGALAN 360 SL	SL	Glyphosate	360	Herbicide	III	PROPHYMA/SAVANA	France/Cameroon	Yes
67.	DIURALM 80 WG	WG	Diuron	800	Herbicide	III	SENEFURA/ALM	ALM/China	Yes
68.	DOMINEX 100	GL	Alpha cypermethrine	100	Insecticide			USA	No
69.	DUREXA	WG	Chlorpyrifos-ethyl	3,50%	Insecticide		SAPHYTO	France	No
70.	ENDOCOTON 500 EC	EC	Endosulfan	500	Insecticide	Ib	SAPHYTO	Israel	No
71.	FANGA 500 EC	EC	Profenofos	500	Insecticide	II	SENEFURA	ALM	No
72.	FOCUS GLYPHOSATE 360 SL	SL	Glyphosate	360	Herbicide		SOFITEX	France	No
73.	FOCUS Ultra 100 EC	EC	Cycloxydime	100	Herbicide	III	BASF/Tech Agro International	EU	Yes
74.	FURADAN 5G	GR	Carbofuran	5%	Insecticide		SCAB/FMC	Belgium	No
75.	FUSILADE	EC	Fluazifop-p-butyl	125	Herbicide	III	SCAB	Ivory Coast	No
76.	GALAXY 450 EC	EC	Clomazone	150	Herbicide		SENEFURA/SAPHYTO	Burkina	No
			Pendimethaline	300					
77.	GALLANT SUPER	EC	Haloxifop-R-methyl	104	Herbicide	III	Callivoire	France	Yes
78.	GARIL 432 EC	EC	Trichlopyr	72	Herbicide	II	SAPHYTO	Burkina	No

			Propanil	360					
79.	GLYCEL 410 SL	SL	Glyphosate	41%	Herbicide	II	Top phyt/ Topex Agro Elevage Developpement SARL CONAKRY	Ghana/India/Guinea	Yes
80.	GLYPHADER	SL	Glyphosate	310	Herbicide		SCAB		No
81.	GLYPHADER 480	SL	Glyphosate	480	Herbicide		Golden stork	GAGSIN PTE LTD Singapore	No
82.	GLYPHADER 75	SG	Glyphosate	680	Herbicide	III	SCAB	France/China	Yes
83.	GLYPHALM 500 WG	WG	Glyphosate	500	Herbicide	III	SENEFURA/ALM	France	Yes
84.	GLYPHALM 360 SL	SL	Glyphosate	360	Herbicide	III	SENEFURA/ALM	France	Yes
85.	GLYPHALM 720	WG	Glyphosate	720	Herbicide		SENEFURA	France	No
86.	GLYPHONET 360 SL	SL	Glyphosate	360	Herbicide	III	DTE SA Chine	China	Yes
87.	GLYSATE		Glyphosate	410	Herbicide		Yaw wussma Ventures	Ghana	No
88.	GRAMOQUAT SUPER	EC	Paraquat chloride	200	Insecticid e		Kumark Trading Ent.	China/Ghana	No
89.	GRAMOXONE SUPER		Paraquat	28	Insecticid e	II	SCAB		No
90.	HALONET SUPER 104 EC	EC	Haloxyp-R- methyl	104	Herbicide	III	DTE SA Chine	China	No
91.	HERBALM	SL	2,4 D of amine salt	720	Herbicide		SENEFURA/ALM International	France	No
92.	HERBEXTRA 720 SL	SL	2,4 D of amine salt	720	Herbicide	II	SCAB, Kumark Trading Ent., SSI	Burkina, China	Yes
93.	HERBEXTRA 750 SL	SL	2,4 D of amine salt	750	Herbicide		SCAB	France	No
94.	HERBISUPER		Acetochlore	300	Herbicide	II	SCAB		No
			Atrazine	200					

95.	HERBIMAS	DF	Atrazine	750	Herbicide		SCAB	SCPA SIVEX International	No
			Nicosulfuron	40					
96.	IBIS A	EC	Alphacypermethrine	36	Insecticide		SCAB/SSI	China	No
			Acetamipride	16					
97.	IBIS P	EC	Alphacypermethrine	15	Insecticide		SSI	China	No
			Profenofos	200					
98.	IKOKADIGNE	EC	Haloxyp-R-methyl	104	Herbicide	II	SCAB	China/France	Yes
99.	KALACH 360 SL	SL	Glyphosate	360	Herbicide	III	SAPHYTO/CalliGhana	France	Yes
100.	KALACH EXTRA 70 SG	SG	Glyphosate	700	Herbicide	III	SAPHYTO	France	Yes
101.	KAMAXONE		Paraquat	200	Insecticide		Kumasi/Ghana	China	No
102.	KART 500 SP	SP	Cartap	500	Insecticide	II	STEPC	France	Yes
103.	KOMBAT	EC	Lambdacyhalothrine	25	Insecticide		SARO	Nigeria	No
104.	KUAPA WARA	EC	Glyphosate	480	Herbicide			Ghana	No
105.	KUM NWURA	ULV	Glyphosate	41%	Herbicide			Ghana	No
106.	LAGON 380 SC	SC	Isoxaflutol	50	Herbicide	III	STEPC/Bayer crop science	Germany/Spain	Yes
			Aclonifene	333					
107.	LAMBDA SUPER	EC	Lambdacyhalothrine	25	Insecticide		SCAB, Kumark Trading Ent.	China	No
108.	LAMBACAL P 212 EC	EC	Profenofos	200	Insecticide	II	SAPHYTO	Burkina	No
			Lambdacyhalothrine	12					
109.	LAMBACAL P 636 EC	EC	Profenofos	600	Insecticide	II	SOFITEX	Burkina	Yes
			Lambdacyhalothrine	36					

110.	LAMDEX 430 EC	EC	Lambdacyhalot hrine	30	Insecticid e	II	Makhteshim Chemical Works	Israel	Yes
			Chlorpyrifos- ethyl	400					
111.	LASSO	GD	Atrazine	180	Herbicide	III	SCAB/Candel	Belgium	No
			Alachlore	300					
112.	MALIK 108 EC	EC	Haloxypop-R- methyl	108	Herbicide	III	SAVANA	France	Yes
113.	MALO BINFAGA	SL	2,4 D	720	Herbicide	II	SAVANA	France	Yes
114.	MILSATE	SL	Glyphosate	41%	Herbicide		Topaz Multi industrie Ghana	India	No
115.	MITOX	EC	Fenvalerate	200	Insecticid e		Bentronic Productions	Ghana	No
116.	MOMTAZ 45 WS	WS	Imidaclopride	250	Insecticid e	III	PROPHYMA/SAVANA	France	Yes
			Thirame	200					
117.	NICOMAIS 40	SC	Nicosulfuron	40	Herbicide	III	PROPHYMA/SAVANA	France/Cameroon	Yes
118.	NWURA WURA	SL	Glyphosate	480	Herbicide			Ghana/China	
119.	OXARIZ 250 EC	EC	Oxadiazon	250	Herbicide	III	SAVANA	France	Yes
120.	PACHA 25 EC	EC	Lambdacyhalot hrine	15	Insecticid e	II	SAVANA	France	No
			Acetamipride	10					
121.	PHOSTOXIN		Phosphure d'alumine		Insecticid e		Kumark Trading Ent.	Ghana	No
122.	POWER	SL	Glyphosate	480	Herbicide			China	No
123.	POWER GLYPHOSATE 480I. P.A	SL	Glyphosate	41%	Herbicide			Ghana	No
124.	PRIMAGRAM 360	SC	Atrazine	370	Herbicide		SYNGENTA	Ivory Coast	No
			S-Metalochlore	290					
125.	PROTECTOR	EC	Lambdacyhalot hrine	30	Insecticid e		SENEFURA, SOFITEX/AF- Chem SOFACO-CI	AF Chem SA Abidjan, Ivory Coast	No
			Pyriproxylene	30					

126.	RISTAR	EC	Oxadiazon	250	Herbicide		SCAB	Burkina	No
127.	RIZTOP 250 EC	EC	Oxadiazon	250	Herbicide		SAPHYTO	France	No
128.	ROCKY 386 EC	EC	Endosulfan	350	Insecticide	III	SAPHYTO	Burkina	No
			Cypermethrine	36					
129.	RONSTAR PL	EC	Oxadiazon	80	Herbicide		SAPHYTO/Bayer crop science	Burkina/ Ivory Coast	No
			Propanil	400					
130.	ROUNDUP 360 SL	SL	Glyphosate	360	Herbicide	III	SCAB	Burkina/Canada/ Switzerland/Belgium/ Ghana	Yes
131.	ROUNDUP 680	SP	Glyphosate	680	Herbicide		SCAB	Burkina	No
132.	ROUNDUP 680 BIOSEC	EC	Glyphosate	680	Herbicide		SCAB	Canada/Burkina/Belgium	No
133.	ROUNDUP TURBO		Glyphosate	450	Herbicide	III	SCAB		Yes
134.	SAMORY	WP	Bensulfuron- methyl	100	Herbicide	III	SCAB	France/Mali	Yes
135.	SELECT 120 EC	EC	Clethodim	120	Herbicide	III	SAPHYTO	France	Yes
136.	SHARP	SL	Glyphosate	480	Herbicide		Kumark Trading Ent.	China	No
137.	SHARP 80 g/L	SL	Glyphosate	380	Herbicide			Ghana	No
138.	SHYE NWURA	EC	Glyphosate	480%	Herbicide			Ghana/China	No
139.	SINOSATE	SL	Glyphosate	41%	Herbicide		Natosh Enterprise AGRO- DIVISION Ghana	China	No
140.	STOMP	CS	Pendimethaline	455	Herbicide		SENEFURA/BASF	France	No
141.	STOMP 500 EC	EC	Pendimethaline	500	Herbicide		SOFITEX	Italy	No
142.	SUPRAXONE	EC	Paraquat	200	Insecticide		Golden stork	Ghana	No
143.	TARGA SUPER 50	EC	Quizalofop-p- ethyl	50	Herbicide		SAPHYTO/SOFITEX	Burkina/Japan	No
144.	TEMPRA	WG	Diuron	900	Herbicide		SAPHYTO		No
145.	TERMICAL 480 EC	EC	Chlorpyrifos- ethyl	480	Insecticide		SAPHYTO	France	No

146.	TIHAN 175 O-TEQ		Spirotetramate	75	Insecticide	III	SCAB/Bayer crop science	Germany	Yes
147.			Flubendiamide	100					
148.	TITAN 25 EC	EC	Acetamipride	25	Insecticide		SAPHYTO	France	No
149.	TOPSTAR	SC	Oxadiargyl	400	Herbicide	III	SCAB, SAPHYTO	Burkina	Yes
150.	TOUCHDOWN	SC	Glyphosate	500	Herbicide		SYNGENTA	Ivory Coast	No
151.	TOUCHDOWN HI TECH	SL	Glyphosate	500	Herbicide			Ghana	No
152.	TRAZINE	SC	Atrazine	500	Herbicide		Bentronic Productions	Ghana	No
153.	WEED FAST	SL	Glyphosate	480	Herbicide		WEYOUNG CW Kumassi	WE YOUNG industrie	No

* Global list of January 2010

Annex 7: Chemicals used by agricultural producers

Formulation	Active ingredients	Pesticide category	WHO classification	CSP Registration
ACEPRONET 400 EC	Acetochlore 250 Prometryne 150	Herbicide	III	No
ACTION 80 DF	Diuron 800	Herbicide		No
ADWUMA WURA	Glyphosate 480	Herbicide		No
ADWUMAMU HENE	Glyphosate 410	Herbicide		No
AGRAZINE 90	Atrazine 900	Herbicide		No
AKIZON 40 SC	Nicosulfuron (40g/l)	Herbicide	III	Yes
APRON PLUS	Metalaxyl-M 100 Carboxine 60 Furathiocarbe 340	Fongicide		No
ATRALM 500 EC	Atrazine 500	Herbicide	U	No
ATRALM 500 SC	Atrazine 500	Herbicide	U	No
ATRALM 90 WG	Atrazine 900	Herbicide	U	No
ATRAVIC	Atrazine 500	Herbicide	U	No
ATRAZ 80 WP	Atrazine 800	Herbicide	U	No
ATRAZILA 500 SC	Atrazine 500	Herbicide	U	No
ATRAZINE	Atrazine	Herbicide	U	No
ATRAZILA 80 WP	Atrazine 800	Herbicide		No
AVAUNT 150 EC	Indoxacarb150	Insecticide	II	Yes
BENAXONE SUPER	Paraquat chloride 200	Herbicide		No
BLAST 46 EC	Lambda-cyhalothrine 30 Acetamipride 16	Insecticide		No
CAIMAN ROUGE	Endosulfan25% Thirame25%	Insecticide	II	No
CALFOS 500 EC	Profenofos (500g/l)	Insecticide	II	Yes
CALLIFOR	Prometryne (440g/l) Fluometuron (440g/l)	Herbicide	III	No
CALLIFOR 500 SC	Prometryne (250g/l) Fluometuron (250g/l)	Herbicide	III	Yes
CALLOXONE SUPER	Paraquat 200	Herbicide		No
CALRIZ	Propanil 360 Trichlopyr 72	Herbicide		No

CALTHIO	Endosulfan Thirame	Insecticide		No
CAPORAL 500 EC	Profenofos (500g/l)	Insecticide	II	Yes
CAPT 88 EC	Acetamipride (16g/l) Cypermethrine (72g/l)	Insecticide	II	Yes
CERETRAZ 500 SC				No
CODAL GOLD 412-5 DC	S-Metolachlore (162g/l) Prometryne (250g/l)	Herbicide	III	Yes
CONQUEST88 EC	Cypermethrine (72g/l) Acetamipride (16g/l)	Insecticide	II	Yes
CONQUEST 176 EC	Acetamipride (32g/l) Cypermethrine (144g/l)	Insecticide	II	Yes
COTODON PLUS GOLD 450 EC	s-métolachlore (245g/l) Terbutryne (196g/l)	Herbicide	III	No
COTODON PLUS 500 EC	Metolachlore (250g/l) Atrazine (250g/l)	Herbicide		No
CURACON 500 EC	Profenofos (500g/l)	Insecticide	III	Yes
CYPERCAL P 230 EC	Cypermethrine (30g/l) Profenofos (200g/l)	Insecticide	II	Yes
DIGA FAGALAN 360 SL	Glyphosate (360g/l)	Herbicide	III	Yes
DIURALM 80 WG	Diuron (800g/kg)	Herbicide	III	Yes
ENDOCOTON500 EC	Endosulfan (500g/l)	Insecticide	Ib	No
FANGA500 EC	Profenofos (500g/l)	Insecticide	II	No
FOCUS ULTRA100EC	Cycloxidime (100g/l)	Herbicide	III	Yes
FURY P 212 EC	Zeta-cyperméthrine (12g/l) Profenophos (200g/l)	Insecticide	II	Yes
FURY P 636 EC				No
GALLANT SUPER	Haloxypop-R-methyl (104g/l)	Herbicide	III	Yes
GALAXY450 EC	Clomazone 150 Pendimethaline 300	Herbicide		No
GARIL432 EC	Trichlopyr (72g/l) Propanil (360g/l)	Herbicide	II	No
GLYCEL	Glyphosate 41%	Herbicide	II	Yes
GLYPHADER 480 SL	Glyphosate480	Herbicide	III	No
GLYPHONET360 SL	Glyphosate (360g/l)	Herbicide	III	Yes

GRAMOQUAT SUPER	Paraquat chloride 200 (276)	Herbicide		No
GRAMOXONE SUPER	Paraquat (200g/l)	Herbicide	II	No
HERBALM	2,4 D (750g/l)	Herbicide		No
HERBEXTRA 720 SL	2,4 D (720g/l)	Herbicide	III	Yes
HERBICOTON DF	Fluometuron (440g/l) Prometryne (440g/l)	Herbicide	III	Yes
HERBICOTON 500SC	Fluometuron (250g/l) Prometryne (250g/l)	Herbicide	III	Yes
IKOKADIGNE	Haloxyp-R-methyl (104g/l)	Herbicide	II	Yes
KALACH 360 SL	Glyphosate (360g/l)	Herbicide	III	Yes
KALACH EXTRA 70SG	Glyphosate (700g/l)	Herbicide	III	Yes
KARATE MAX2,5 WG	Lambda-cyhalothrine (25g/l)	Insecticide	III	Yes
LAMBDACAL P 212 EC	Profenofos 600 Lambdacyhalothrine 36	Insecticide	II	Yes
LAMBDACAL P 636 EC	Profenofos (600g/l) Lambda-cyhalothrine (36g/l)	Insecticide	II	Yes
LASSO GD	Atrazine 180 Alachlore 300	Herbicide	III	No
MALO BINFAGA 720 SL	2,4 D (720 g/l)	Herbicide	II	Yes
NICOMAIS 40 SC	Nicosulfuron (400g/l)	Herbicide	III	Yes
NIVACRON				No
PRIMAGRAM 360	Atrazine	Herbicide		No
	S-Metalochlore			
RICAL 345 EC	Propanil (230g/l) Thiobencarbe (115 g/l)	Herbicide	III	Yes
RISTAR	Oxadiazon 250	Herbicide		No
ROCKY386 EC	Endosulfan (350g/l) Cypermethrine (36g/l)	Insecticide	III	No
ROCKY 500 EC	Endosulfan (500 g/l)	Insecticide	Ib	No
RONSTAR PL	Oxadiazon 80 Propanil 400	Herbicide		No
ROUNDUP 360 SL	Glyphosate (360g/l)	Herbicide	III	Yes

RONSTAR EC	Oxadiazon 80	Herbicide		No
	Propanil 400	Herbicide		
SAMORY	Bensulfuron-methyl (100g/kg)	Herbicide	III	Yes
SHYENWURA	Glyphosate 480%	Herbicide		No
STOMP	Pendimethaline 455	Herbicide		No
TARGA SUPER50 GL	Quizalofop-p-éthyl 50	Herbicide		No
TOP STAR400 SC	Oxadiargyl (400g/l)	Herbicide		No
TOUCHDOWN 500 SC	Glyphosate (500g/l)	Herbicide	III	Yes



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Date: March 8, 2006

MEMORANDUM

SUBJECT: ACETOCHLOR/ALACHLOR: Cumulative Risk Assessment for the Chloroacetanilides. PC Codes:121601 & 090501, DP Barcode: D292317

Regulatory Action: Tolerance Reassessment
Risk Assessment Type: Cumulative Risk assessment /Aggregate

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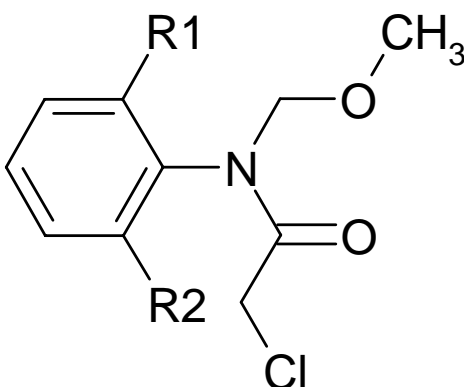
TO: Felicia Fort, Chemical Review Manager
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ACTION: Complete the Chloroacetanilide Cumulative Risk Assessment.

CONCLUSIONS:

1. A risk assessment of a Cumulative Assessment Group (CAG) consisting of the Chloroacetanilide pesticides acetochlor and alachlor has been conducted. MOE calculations have been made based on the endpoint of nasal olfactory epithelium tumors in rats, and using slightly refined values for food and drinking water,
2. Compared to a MOE of 100, defined as level of concern (LOC) for this risk assessment, the cumulated MOE values, greater than 13,000 for the subject CAG for all populations, are outside the Agency's level of concern.
3. Because these cumulative MOE values were obtained using high-end exposures, they are considered to be conservative. Additional MOE calculations in Appendixes 1 and 2 of the Cumulative Risk Assessment document, using more conservative approaches to estimation of drinking-water exposure, support the conclusions of this analysis by producing MOE values that exceed the LOC of 100 by nearly an order of magnitude or more.

CUMULATIVE RISK FROM CHLOROACETANILIDE PESTICIDES



**U.S. Environmental Protection Agency
Office of Pesticide Programs
Health Effects Division
March 8, 2006**

CUMULATIVE RISK FROM CHLOROACETANILIDE PESTICIDES

Executive Summary

As part of the tolerance reassessment process under the Food Quality Protection Act (FQPA) of 1996, EPA must consider available information concerning the cumulative effects on human health resulting from exposure to multiple chemicals that have a common mechanism of toxicity.

This document contains the results of a cumulative risk assessment conducted for a group of chloroacetanilide pesticides that have a common mode of action for the production of **tumors of the nasal olfactory epithelium** in rats.

Previously, a common mechanism group (CMG) of chloroacetanilide pesticides consisting of acetochlor, alachlor and butachlor was defined by the Agency for nasal tumors, and evaluated by the FIFRA Science Advisory Panel (SAP, 1997). After consideration of the SAP comments, OPP's own reviews and the data underlying these reviews, as well as additional information received by the Agency from registrants or presented in the open literature since the 1997 SAP meeting, OPP published a paper in 2001 titled "The Grouping of a Series of Chloroacetanilide Pesticides Based on a Common Mechanism of Toxicity"

(http://www.epa.gov/oppfod01/cb/csb_page/updates/commechs.htm) (USEPA 2001). It was concluded in that document that Acetochlor, Alachlor, and Butachlor should be considered as a Common Mechanism Group due to their ability to cause nasal turbinate tumors via the generation of a common tissue reactive metabolite that leads to cytotoxicity and regenerative proliferation in the nasal epithelium. Sustained cytotoxicity and proliferation is needed to lead to neoplasia. Thus, the common mechanism effect is a systemic chronic endpoint.

For purposes of a cumulative risk assessment Acetochlor, Alachlor, and Butachlor, will be considered as a Common Mechanism Group. Butachlor, however, has no registered uses in the US and has been excluded from the risk assessment. Thus, the Common Assessment Group (CAG: a subset of the CMG), on which the risk assessment was conducted consists of Acetochlor and Alachlor only.

Development of nasal olfactory epithelium tumors in rats has been attributed to a non-linear, non-mutagenic mode of action (USEPA, 2004). Thus, as per the 2005 EPA Cancer Guidelines (USEPA 2005b) a Margin-of-Exposure (MOE) calculation has been

used for the cumulative risk assessment, as one would do for a threshold noncancer toxicity risk assessment. Because of the threshold approach that is being used for risk assessment, the uncertainty factors (UFs) of 10 (interspecies) and 10 (intraspecies) are used. In the absence of sensitivity issues the FQPA factor is 1. Thus, MOEs above 100 are considered to be outside of the Agency's level of concern (LOC).

Calculations for this document have involved:

- For each CAG member, determination of the Point-of-Departure (POD) for the nasal tumors and its respective dietary exposure (food and drinking water).
- Computations of the MOE value for the cumulative exposure using alachlor as the index chemical and using a relative potency factor (RPF) to express the contribution of acetochlor in equivalents of the index chemical.

For this cumulative assessment, POD values were determined as the No-Observed-Adverse-Effect-Level (NOAELs) for tumor formation. NOAELs for nasal tumor formation were found to be 10 mg/kg bw per day for acetochlor and 0.5 mg/kg bw per day for alachlor. These values were used in the MOE calculations. The POD value for alachlor, the index chemical, was 0.5 mg/kg bw per day. Based on comparison of tumor NOAELs, the relative potency of acetochlor was estimated as 1/20th that of alachlor, yielding an RPF value of 0.05. This RPF value was used in subsequent calculations to express acetochlor in alachlor-equivalent units.

There are no residential uses for alachlor or acetochlor, thus this risk assessment involved only two pathways of exposure (food and drinking water) and the oral route of exposure. Exposure was evaluated, as follows, using a limited degree of refinement:

- **Alachlor** values in food were the anticipated residues, as estimated in the alachlor RED document of 1998 (USEPA, 1998), adjusted with current (year 2004, Attachment 2) values for percent crop treated.
- **Acetochlor**, values in food were tolerance values corrected for processing factor and percent crop treated from the Acetochlor TRED (USEPA 2005c). These acetochlor values were converted into alachlor equivalents by multiplying them by 0.05 (the RPF for acetochlor). The alachlor equivalents from acetochlor were then added to their counterparts for alachlor.
- The **water** component was obtained from a data set generated by the Acetochlor Registration Partnership (ARP; the registrant for acetochlor) which **monitored both acetochlor and alachlor** occurrence in drinking water supplies relying on surface water sources over a seven year period (1995 – 2001). The single-year water Time-Weighted-Annualized-Mean (TWAM) concentrations of

acetochlor, co-occurrent with alachlor, were converted into alachlor equivalents using RPFs and added to the co-occurrent alachlor TWAM concentration values. The single-year monitoring data for each site, now in alachlor equivalents, were averaged over the years of data availability (up to 7 years) to obtain a multi-year average. The **multi-year** average water concentrations were ranked from smallest to largest and the largest value was used for risk assessment. It is noted that most of the available data from the ARP represent finished drinking water; thus, exposure in the future could be higher if drinking water systems revert to treatment methods which less effectively reduce acetochlor or alachlor in drinking water.

Groundwater levels of alachlor and acetochlor were significantly lower than surface water sources, thus were not used in risk assessment.

Because the nasal olfactory epithelium tumors are a systemic chronic endpoint, a chronic dietary analysis was conducted. Multi-year averages for drinking water concentrations were used, as this is the standard practice at HED.

Acetochlor chronic dietary exposure assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID™, Version 2.03). Results of the DEEM-FCID™ analysis produced cumulated MOEs, greater than 13,000 for all populations. Selected cumulated MOEs were:

- U.S. Population (Total): 40,119
- Non-Nursing infants: 13,175 (lowest MOE)
- All Infants (<1 year): 16,464
- Females (13-19) not pregnant or nursing: 53,237 (highest MOE).

Compared to the MOE of 100 as the LOC, the cumulated MOE values reported in this document (in excess of 13,000) for the subject CAG are outside of the Agency's level of concern.

Because these cumulative MOE values were obtained using high-end exposures, they may be considered to be sufficiently protective and conservative. This conclusion is supported by subsequent analyses (detailed in Appendixes 1 and 2) using more conservative assumptions for chloroacetanilide concentrations in drinking water that give MOEs outside of the Agency's LOC:

- When **monitored single-year** TWAM concentrations of chloroacetanilides in water were used for DEEM-FCID™ analysis MOEs greater than 7,700 were obtained for all populations (Appendix 1).

- When **PRZM-EXAMS modeled estimates** of environmental concentrations of alachlor and acetochlor in drinking water (without correction for percent crop treated , PCT) were used for DEEM-FCID™ analysis MOEs greater than 640 were obtained for all populations (Appendix 2). These values will increase to several thousand if correction for current values of percent crop treated (PCT) were to be incorporated in the analysis.

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Cumulative Risk Assessment of the Chloroacetanilides

I. Introduction

The passage of the Food Quality Protection Act (FQPA) in August 1996 led the Office of Pesticide Programs (OPP) to develop methodology to evaluate the risk from exposure to more than one pesticide acting through a common mechanism of toxicity. As defined in FQPA, those pesticides that induce adverse effects by a common mechanism of toxicity must be considered jointly. In other words, the exposures of concern are to include all relevant routes and sources based upon the use patterns of the pesticides in question. This multi-chemical, multi-pathway risk is referred to as cumulative risk.

The Agency's first step in developing a cumulative risk assessment was to develop methodologies and guidance on determining whether two or more chemicals share a common mechanism of toxicity. The reader is referred to the document, **Guidance for Identifying Pesticide Chemicals and Other Substances that Have a Common Mechanism of Toxicity** (1/29/99) for additional information on this topic (see <http://www.epa.gov/fedrgstr/EPA-PEST/1999/February/Day-05/6055.pdf>).

Further guidance on conducting cumulative risk assessment was provided by EPA in 1999 and 2002. The **Guidance on Cumulative Risk Assessment of Pesticide Chemicals That Have a Common Mechanism of Toxicity** [1/14/02, see http://www.epa.gov/pesticides/trac/science/cumulative_guidance.pdf, (USEPA 2002a)] and its precursor document **General Principles for Performing Aggregate Exposure and Risk Assessments** (10/29/99), see (<http://www.epa.gov/pesticides/trac/science/aggregate.pdf>) describe aspects of the exposure assessment that must be accounted for in developing an integrated cumulative risk assessment. Specifically, these guidance documents state that the cumulative assessment must account for temporal aspects of exposure such as those related to the time of year during which applications resulting in exposures are likely to occur, the frequency of application and period of re-application. In addition, these documents state that the assessment must appropriately consider demographic factors and patterns.

Based in part on the principles and suggested practices contained in the above guidance documents, the first cumulative risk assessment conducted by the Agency was for the **organophosphorus (OP) class of pesticides**. EPA published a revised cumulative risk assessment for these pesticides in June 2002 (USEPA 2002b). In this assessment, OPP developed and demonstrated in detail the methods, parameters, and issues that should be considered in estimating cumulative risk associated with common mechanism pesticides by multiple pathways of exposure. Various aspects of the hazard

and dose-response assessment and the exposure analyses were presented to both the SAP and the public for comment numerous times over the course of several years. Both the SAP and the public provided helpful and insightful comments and ideas which were incorporated into the revised documents.

Following publication of the Cumulative Risk Assessment for the OP pesticides and in accordance with the requirements of FQPA, OPP conducted a preliminary cumulative risk assessment for the **N-methyl carbamate (NMC) class of pesticides**. The results of this effort appear in the document *Estimation of Cumulative Risk from N-Methyl Carbamates: Preliminary Assessment* (USEPA, 2005a).

The present document is regarded as a **screening-level cumulative risk assessment** of the chloroacetanilide pesticides. Namely, this risk assessment has been done using high-end exposure estimates and NOAELs have been used for hazard assessment.

As presented below, the selected endpoint for risk assessment (development of nasal tumors in rats) has been attributed to a non-linear, non mutagenic mode of action involving sustained cytotoxicity and regenerative cell proliferation. Thus, as per the 2005 EPA Cancer Guidelines (USEPA 2005b) a Margin-of-Exposure (MOE) calculation has been used for the cumulative risk assessment, as one would do for a threshold noncancer toxicity risk assessment. Because of the threshold approach that is being used for risk assessment, the uncertainty factors (UFs) of 10 (interspecies) and 10 (intraspecies) are used. In the absence of sensitivity issues the FQPA factor is 1. Thus, MOEs above 100 are considered to be outside of the Agency's level of concern (LOC).

The high MOE values obtained in this risk assessment are, thus, outside the Agency's LOC and are considered to be adequate to satisfy any safety concerns. Additional refinement of the data could be required if more common mechanism compounds are identified or higher exposures are observed.

II. The Cumulative Risk Assessment Process

As elaborated in OPP's cumulative guidance document (USEPA 2002a), the cumulative risk assessment process unfolds in several steps. In brief, these include:

- A. Identification of the Common Mechanism Group (CMG).
- B. Determination of the Candidate Cumulative Assessment Group (CAG)
- C. Determination of Points of Departure (dose response analysis)
- D. Exposure analysis (exposure scenarios for all routes and durations, establish exposure input parameters).

- E. Conduct final cumulative risk assessment.
- F. Characterize the cumulative risk assessment.

The following sections will develop the process as applied to the chloroacetanilide pesticides.

III. Performing the Cumulative Risk Assessment

A. Identification of the Common Mechanism Group (CMG)

i. Introduction

A cumulative risk assessment begins with the identification of a group of chemicals, called a common mechanism group (CMG), that induce a common toxic effect by a common mechanism of toxicity. Pesticides are determined to have a "common mechanism of toxicity" if they act the same way in the body--that is, the same toxic effect occurs in the same organ or tissue by essentially the same sequence of major biochemical events.

The chloroacetanilide pesticides, have been previously evaluated by the Agency to determine if some of them comprise a common mechanism group. Details of the analysis appear in the document *The Grouping of a Series of Chloroacetanilide Pesticides Based on a Common Mechanism of Toxicity* (USEPA 2001). In brief,

- **Acetochlor, Alachlor and Butachlor** may be grouped together based on a common end-point (nasal turbinate tumors in rats) and a known mechanism of toxicity for this endpoint. All three compounds produce tumors of the nasal olfactory epithelium in rats by way of a non-linear, non-genotoxic mode of action that includes cytotoxicity of the olfactory epithelium, followed by regenerative cell proliferation of the nasal epithelium that can then lead to neoplasia if cytotoxicity and proliferation are sustained (see more details below).
- **Acetochlor, Alachlor and Butachlor** may also be grouped together based on an common end-point and a known mechanism of toxicity (UDPGT induction). All three compounds produce tumors of the thyroid follicular cells in rats by way of a non-genotoxic mode of action that includes UDPGT induction, increased TSH, alterations in T3/T4 hormone production and thyroid hyperplasia.

The grouping of **Acetochlor, Alachlor, and Butachlor** based on a common mechanism of action was presented to the FIFRA Scientific Advisory Panel (SAP) as a draft on March 19, 1997. The SAP agreed with the Agency's conclusion that there is sufficient evidence to support the proposed grouping for the nasal turbinate tumors and for the thyroid follicular tumors (USEPA, 1997).

The FIFRA SAP noted in their report (USEPA, 1997), additionally, that even though the evidence illustrated that a common mechanism could be used to group certain chemicals for the development of thyroid tumors, it was recommended that this endpoint **not be used** in combining margins of exposure because the toxic effects were noted at doses above the Maximum Tolerated Dose (MTD). While the full range of doses employed can be used to determine common mechanisms, endpoints occurring solely at doses above the MTD should not be used in risk assessments. Furthermore, humans are more refractory to the induction of thyroid follicular cells tumors due to prolonged stimulation of thyroid stimulating hormone compared to rats.

Thus, for the purposes of this document, the induction of nasal olfactory epithelium tumors in rats was regarded as the most sensitive and relevant common mechanism endpoint to base the cumulative risk assessment of the chloroacetanilides.

ii. Determination of the CMG

As summarized below, and illustrated for acetochlor, there is ample evidence (USEPA, 2004) that the development of nasal olfactory epithelium tumors in rats dosed with chloroacetanilides involves the following sequence of steps,:

- Acetochlor conjugates with glutathione (GSH) and is excreted in the bile.
- The conjugate is biotransformed to a series of sulfur-containing products. Enterohepatic circulation of these products creates a pool of metabolites that are delivered to the nose.
- Biotransformation to tissue-reactive and toxic metabolites. Metabolism by nasal enzymes, results in formation of a benzoquinoneimine, an electrophile and redox-active molecule.
- Binding of toxic metabolite to cellular proteins plus possible generation of oxidative stress .
- Cytotoxicity
- Regenerative cell proliferation.
- Sustained cytotoxicity and cell proliferation that results in neoplasia.

The following three events are considered key events for formation of nasal olfactory epithelium tumors by the proposed non-linear, non genotoxic mode of action (MOA):

QUINONE IMINE- FORMATION (PROTEIN BINDING) → CYTOTOXICITY → CELL PROLIFERATION

Based on the FIFRA SAP's recommendations (USEPA 1997), on OPP's 2001 paper on the MOA of chloroacetanilides (USEPA 2001) and in a more recent evaluation of the MOA of acetochlor/alachlor (USEPA 2004), the Common Mechanism Group (CMG) for the present document consists of acetochlor, alachlor and butachlor with formation of nasal olfactory epithelium tumors in rats as the common endpoint.

Other chloroacetanilides were considered (USEPA, 1997), but the evidence was found to support only the three compounds selected. Although the chloroacetanilide metolachlor distributes to the nasal turbinates, and might produce a quinoneimine, it is not apparent from currently available data that it shares the same target site in the nasal tissue as acetochlor, alachlor and butachlor. Although another chloroacetanilide, propachlor, produces a precursor of a quinoneimine, the available data do not support its tumorigenicity to the nasal turbinates.

B. Identification of the Candidate Cumulative Assessment Group (CAG).

Once the CMG is defined, a subset of this group, the Common Assessment Group (CAG) is selected, for which the cumulative risk assessment will be performed. This final selection incorporates into the CAG those pesticides from the Common Mechanism Group whose uses, routes, and pathways of exposure will present sufficient exposure and hazard potential to warrant inclusion in the quantitative estimates of risk.

The CMG subject of this document consists of acetochlor, alachlor and butachlor. At present only alachlor and acetochlor are Registered pesticides in the US. There are no registered uses or import tolerances for butachlor. Therefore no exposure, and hence, no risk is expected for butachlor. **Thus, a cumulative risk assessment will**

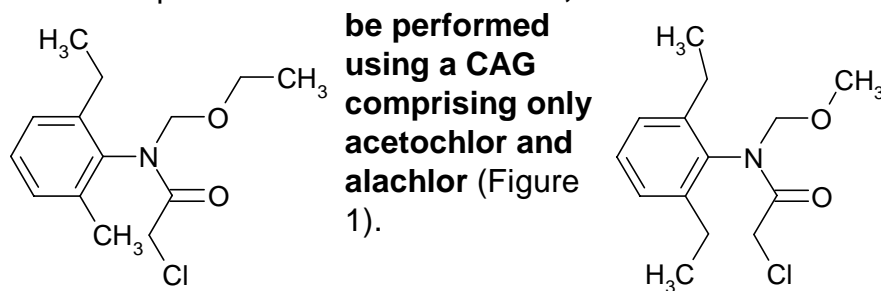


Figure 1. Structures of Acetochlor (left) and Alachlor (right)

C. Dose Response Analysis: Determination of Relative Potency Factors and Points of Departure.

The Agency's revised Guidelines for Carcinogen Risk Assessment (USEPA, 2005b) divide dose response assessment into two parts. The first is assessment of the dose response near the lower end of the observed range (the point of departure or POD). The second part is extrapolation of the dose-response curve from the POD into the low-dose range.

Once the POD is determined, it is used as the starting point for subsequent extrapolations and analyses. If data are available, biologically based dose-response (BBDR) modeling may be done to extrapolate to lower doses below the POD. In the absence of BBDR models, for linear extrapolation (i.e. genotoxic carcinogens), the POD may be used to calculate a *slope factor*, and for non-linear extrapolation (the present case for acetochlor and alachlor) the POD may be used in the calculation of a Margin of Exposure (MOE)

The revised Guidelines for Carcinogen Risk Assessment (USEPA, 2005b), discuss the relative advantages of several approaches to obtaining the POD for cancer risk assessment:

- *When tumor data are used*, a POD is obtained from the modeled tumor incidences. Conventional cancer bioassays, with approximately 50 animals per group, generally can support modeling down to an increased incidence of 1–10%. A *no-observed-adverse-effect level* (NOAEL) generally is not used for assessing the potential for carcinogenic response when one or more models can be fitted to the data.

- *When good quality precursor data are available and are clearly tied to the mode of action of the compound of interest*, models that include both tumors and their precursors may be advantageous for deriving a POD. Such models can provide insight into quantitative relationships between tumors and precursors, possibly suggesting the precursor response level that is associated with a particular tumor response level.

On the other hand, the Guidelines note, that if the precursor data are drawn from small samples or if the quantitative relationship between tumors and precursors is not well defined, then the tumor data will provide a more reliable POD.

In this document, tumor incidences will be used for POD determination because they constitute a robust set of data and use of observed tumor NOAELs will be used as a conservative screening approach. Since experimental NOAELs are determined by the doses selected by the investigator, the “true NOAEL” may actually be a higher value.

i. Determination of the POD using nasal tumor incidences.

Table 1 summarizes the incidences of nasal tumors in rats treated chronically with acetochlor or alachlor.

Table 1. Incidence of nasal tumors in rat chronic studies.

#	Study (MRID)	Dose Level (mg/kg/day)							
		Males				Females			
Acetochlor Tumors (Sprague-Dawley rats)									
#1	PR-80-006 (00131088, 40484801)	0	22	69	250	0	30	93	343
	papillary adenoma	0/69	1/70	6/69*	18/69**	0/69	0/68	2/70	1/69
	pap. adenocarcinom.	0/69	0/70	0/69	2/69	0/69	0/69	0/70	0/69
	Combined	ND	ND	ND	ND	ND	ND	ND	ND
#2	ML-83-200 (40077601)	0	2	10	50	0	2	10	50
	papillary adenoma ^a	1/58**	0/54	0/58	12/59**	0/69**	0/69	0/67	19/68**
#3	88/SUC017/0348 (41592004)	0	0.67	6.37	66.9	0	0.88	8.53	92.1
	papillary adenoma	0/69**	0/59	0/59	35/70**	0/69**	0/57	0/58	36/63**
	carcinom.	0/69	0/59	0/59	2/70	0/69	0/57	0/58	1/63
	Combined	0/69**	0/59	0/59	37/70**	0/69**	0/57	0/58	37/63**
Alachlor Tumors (Long-Evans rats)									
#1	BD-77-421 (00091050)	0	14	42	126	0	14	42	126
	Adenoma	0/46**	0/47	10/41	23/40**	0/47**	0/41	4/41	10/41**
	Carcinoma	0/27	0/20	1/21	0/19	0/34	0/28	1/34	0/22
	Combined	0/46**	0/47	11/41	23/40**	0/47**	0/41	5/41	10/41**
# 2	EHL 800218 (00075709)	0	0.5	2.5	15	0	0.5	2.5	15
	Adenoma	0/45**	0/47	0/45	11/45**	0/38**	0/38	1/43	9/34**

* = $p \leq 0.05$; ** = $p \leq 0.01$. ; ^a Only adenomas reported.

For **Acetochlor**, examination of the data in Table 1 indicates that the incidence of nasal tumors in Sprague-Dawley rats increases significantly with dose in all three studies.

- Study **PR-80-006** (MRIDs 00131088 and 40484801), does not define a NOAEL at 22 mg/kg/day for nasal olfactory epithelium tumors. Even though the incidence of papillary adenomas is only 1/70 and is not statistically significant vs controls, it is considered to be treatment-related due to the rarity of the tumor. It is likely that it is the beginning of the dose response, which reaches statistical significance for the two other higher doses in males.
- In study **ML-83-200** (MRID 40077601), likewise, the incidence of adenomas of the olfactory epithelium at the highest dose tested is statistically significantly higher than in controls. No carcinomas were reported. This study defines a NOAEL for adenomas of 10 mg/kg/day.
- In study **88/SUC017/0348** (MRID 41592004), the incidence of adenomas and combined adenomas/carcinomas of the olfactory epithelium at the highest dose tested is statistically significantly higher than in controls. No nasal tumors occurred at lower doses. Thus, the NOAEL for combined adenomas/carcinomas in female rats is 8.53 mg/kg bw/day. A similar pattern is evident for male rats: yielding a NOAEL for combined adenomas/carcinomas of 6.37 mg/kg bw/day.

Thus, the available data define a POD for acetochlor of 10 mg/kg/day for nasal tumors in S-D rats.

For **Alachlor**, examination of the data in Table 1, indicates that the incidences of nasal tumors in Long-Evans rats increases significantly with dose in both studies.

- Study **BD-77-421** (MRID 00091050), in Long-Evans rats, was conducted at dose levels of approximately 0, 14, 42 or 126 mg/kg bw/day using technical alachlor stabilized with 0.5% epichlorohydrin for the first eleven months of the study before a switch was made to stabilization with epoxidized soybean oil for the rest of the study. Epichlorohydrin is carcinogenic for male Wistar and Sprague-Dawley rats: when given in drinking water epichlorohydrin has been found to cause forestomach tumors (squamous cell papillomas and carcinomas) in Wistar rats (Konishi, et al., 1980). By the inhalation route, epichlorohydrin has caused squamous cell carcinomas of the nasal cavity (Laskin, et al., 1980). Although nasal tumors were observed in this study, these results are confounded by the nasal tumorigenic properties of epichlorohydrin. Results from the above study involving the administration of alachlor in the presence of epichlorohydrin will not be used for determining the POD for alachlor due to the confounding effect of the epichlorohydrin.
- In study **EHL 800218** (MRID 00075709), the incidences of adenomas of the nasal olfactory epithelium were statistically significantly increased in high-dose Long-Evans rats of both sexes (Table1). No carcinomas were reported.

Although the incidence of tumors in female rats at the mid-dose (2%) is not statistically significant, it may be considered toxicologically significant in view of the rarity of the tumors and the significantly increasing trend in the incidence of nasal tumors. Thus, for female rats the NOAEL for nasal tumors is 0.5 mg/kg bw/day.

Thus, the available data define a POD for alachlor of 0.5 mg/kg/day for nasal tumors in Long-Evans rats.

Determination of a Relative Potency Factor for Acetochlor.

The POD values (based on NOAELs) used in the risk assessment in this document are summarized in Table 2. The POD for acetochlor is 10 mg/kg/day and the POD for alachlor is 0.5 mg/kg/day. Relative Potency Factors (USEPA 2002a) were calculated using the ratio of POD values (based on NOAELs) for alachlor as (index chemical) and acetochlor. As shown in Table 2, the RPFs for alachlor and acetochlor are 1 and 0.05, respectively.

Table 2. Summary of POD values for Nasal Tumors in Rats Treated Chronically in the Diet with Acetochlor or Alachlor (Values from Table 1).

Compound	POD (Mg/kg bw/day)	RPF¹	Rat Strain/S ex	Comments
Alachlor (Index Chemical)	0.5	1	Long- Evans / Female	A conservative value, the incidence of 1/43 at 2.5 may well be the beginning of the dose response of a rare tumor, and thus toxicologically significant.
Acetochlor	10	0.05	Sprague- Dawley / Male & Female	The incidence is 1/70 at 22 mg/kg/day in study PR-80-006. This effect is likely toxicologically significant.

¹ With Alachlor as index chemical; RPF = POD of alachlor divided by the POD of acetochlor. Acetochlor (in alachlor equivalents) = Concentration of acetochlor x RPF.

D. Exposure Analysis

This assessment is designed to determine if the two chemicals in the chloroacetanilide CAG (Acetochlor and Alachlor) pose a cumulative dietary risk. There are no residential uses for these two chemicals. Thus, this risk assessment involves :

- Only two pathways (food and drinking water) and the oral route of exposure.
- Because the endpoint of interest is a cancer endpoint that arises via a mode of action that requires prolonged exposure, only a chronic analysis was performed.

i. Inputs for Determination of Exposure from Foods and Water

i.a. Inputs From Foods.

Acetochlor. The qualitative nature of acetochlor residues in plants is understood based on the adequate metabolism studies. Tolerances have been established (see 40 CFR 180.470) for residues of alachlor in/on a variety of food and feed commodities:

- Field corn (forage, grain and stover)
- Sorghum (forage, grain and stover)
- Soybeans (forage, grain and hay)
- Wheat (forage, grain and straw)

Considering the data from the available animal metabolism and feeding studies and the calculated maximum theoretical dietary burdens (MTDBs) of 3.0-3.8 ppm for cattle and 0.04 ppm for poultry and swine, the Agency concluded that there is no reasonable expectation of quantifiable residues of acetochlor or its metabolites occurring in livestock commodities, thus no tolerances have been established for those commodities.

Alachlor. The qualitative nature of alachlor residues in plants is understood based on adequate metabolism studies. Tolerances have been established (see 40 CFR 180.249) for residues of alachlor in/on a variety of food and feed commodities:

- beans, which includes dry beans, lima beans, forage and fodder;
- corn, fresh sweet, and forage, fodder, and grain;
- eggs;
- milk;
- peanuts, forage, hay, and hulls;
- sorghum, fodder, forage, and grain;
- soybeans, forage, and hay;
- meat and meat byproducts of cattle, goats, hogs, poultry and horses.

i. b. Inputs from Water

Introduction.

The primary source data for the water component of this exposure assessment is a data set generated by the Acetochlor Registration Partnership (ARP; the registrant for acetochlor) which **directly evaluated both acetochlor and alachlor occurrence in drinking water supplies relying on surface water sources over a 7-year period (1995 – 2001).**

This assessment does not use ground water exposure levels because ground-water monitoring data show that both parent acetochlor and parent alachlor are less prevalent and usually at lower chronic levels in ground water than in surface water (USEPA, 2006).

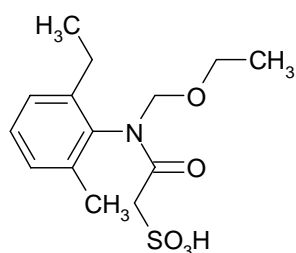
Additionally, the ARP monitored water levels of the **sulfonic and oxanilic environmental degradates of acetochlor and alachlor** shown in Figure 2. These compounds, however, are not included in this cumulative risk assessment because extensive data are available (USEPA 2004b) to show that these compounds show a different toxicological profile than the respective parents and do not contribute to the development of nasal olfactory epithelium tumors in rats.

The ARP selected a total of 175 Community Water Supplies (CWSs) in nine mid-western and three Mid-Atlantic States for the acetochlor and alachlor surface water monitoring program. The selection process was designed to include a wide array of CWSs with watersheds in areas of corn production, with an emphasis on including worst-case watersheds i.e., smaller watersheds (not on the Great Lakes and Continental Rivers) in areas of high corn production. These watersheds are expected to have higher concentrations of acetochlor and alachlor after runoff events than larger watersheds which drain areas of both high and low corn production, because dilution would be greater for CWSs taking water from the Great Lakes and Continental Rivers. Data were collected to characterize each community water system included in the program. Since there were some CWSs replaced during the course of the 7-year study, a total of 189 systems were included in the study. Raw (pre-treatment) water was only collected and analyzed for selected systems; therefore, only 44 of the CWSs have monitoring data for residues in both treated and untreated water. Further details on the design of the Surface Drinking Water Supply (SDWS) study by the ARP can be found in “Drinking Water Exposure Assessment for Acetochlor” (M. Barrett, OPP/EFED Memorandum, 1/3/2005) and USEPA (2006).

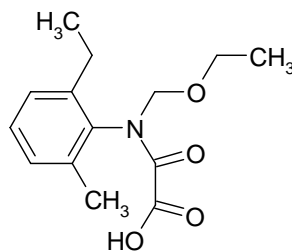
The surface drinking water supply (SDWS) and state ground water (SGW) monitoring programs were designed to focus on areas of high acetochlor/alachlor use. The monitoring does not cover the entire geographic distribution of acetochlor use.

Geographic analysis of the SDWS site locations and acetochlor/alachlor use patterns seems to indicate that a number of high acetochlor/alachlor use areas were not monitored. This is especially true for the SDWS where the lack of sampling of raw (pre-facility treatment) water at most locations makes it difficult to isolate the effects of site-specific usage and vulnerability factors and water treatment processes on the observed residue levels. Additionally, important caveats for the monitoring data are

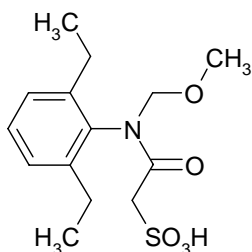
described in more detail in the EFED Memorandum cited above.



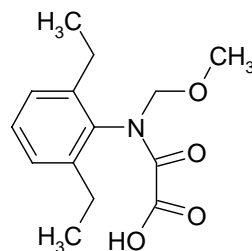
Acetochlor ethane sulfonic acid (Acetochlor ESA)



Acetochlor oxanilic acid (Acetochlor OXA)



Alachlor ethane sulfonic acid (Alachlor ESA)



Alachlor oxanilic acid (Alachlor OXA)

Figure 2. Environmental degradates of acetochlor and alachlor

Monitored Water Concentrations.

A chronic toxicity endpoint (nasal olfactory epithelium tumors) is used in this document for cumulative risk assessment of chloroacetanilides. Thus, multi-year monitored annual means for drinking water appear most appropriate for evaluation of risk relating to the selected chronic endpoint and are used for the calculations reported in this assessment. However, to further bracket the maximum potential risk associated with uncertainties in the cumulative exposure to acetochlor and alachlor in drinking water, two additional risk assessments using more conservative assumptions (one of them using PRZM/EXAMS modeling) are detailed in the Appendices.

Prior to calculating the multi-year monitored annual means for drinking water, the single-year values were examined. The single-year co-occurring Time-Weighted Annualized Mean (TWAM) concentrations of acetochlor and corresponding alachlor in the ARP SDWS study were ranked separately in decreasing order of acetochlor and alachlor. The top six values for acetochlor appear in Table 3 and the top six values for alachlor appear in Table 4.

There were significant differences in the community water supply systems with the highest residues (TWAMs) of acetochlor and alachlor (Tables 3 and 4, respectively). All of the systems with the highest residues of alachlor had finished water sampled and were not among the sites for which raw water samples were collected and analyzed. Although the highest alachlor exposure levels were lower than for acetochlor, the difference was not great. The alachlor TWAM for the 518-US-OH site in 1997 was 0.590 ppb, slightly lower than the second highest TWAM observed for acetochlor (compare Tables 3 and 4). Four of the six highest alachlor TWAMs (Table 4) occurred in three different community water supply systems in the state of Kansas; this is a state which has relatively little corn production acreage compared to Illinois and several other Corn Belt states. This may reflect significant alachlor usage on sorghum, which is a more important crop in Kansas. Five of the highest acetochlor TWAMs (Table 3) occurred in the state of Illinois.

As shown in Tables 3 and 4, the highest co-occurring TWAM for Acetochlor in surface waters was the value from site 214-GI-IL (1.428 ppb, Table 3) and for Alachlor the highest value was found in site 518-US-OH (0.590 ppb, Table 4).

Table 3. Top six **co-occurring** single-year Time-Weighed Annual Mean concentrations (TWAM) of acetochlor and corresponding alachlor TWAMs in the ARP SDWS study.¹

Site ID	Year	Water Type	Acetochlor TWAM (ppb)	Alachlor TWAM (ppb)
214-GI-IL	1996	Finished	1.428	0.009
168-PA-IL	1998	Raw	0.591	0.015
455-MO-OH	1997	Finished	0.584	0.121
166-NE-IL	1996	Finished	0.533	0.048
214-GI-IL	1998	Finished	0.489	0.009
168-PA-IL	1998	Finished	0.475	0.011

¹ Co-occurring acetochlor/alachlor concentrations were ranked in decreasing values for **acetochlor** for each year. The highest value for acetochlor (1.428 ppb) is in bold.

Table 4. Top six **co-occurring** single-year Time-Weighed Annual Mean concentrations (TWAM) of alachlor and corresponding acetochlor TWAMs in the ARP SDWS study ¹ (No raw water samples were in the top six).

Site ID	Year	Water Type	Acetochlor TWAM (ppb)	Alachlor TWAM (ppb)
518-US-OH	1997	Finished	0.202	0.590
23-WE-KS	2001	Finished	0.004	0.406
340-NV-IN	1996	Finished	0.372	0.357
114-RI-KS	1997	Finished	0.002	0.345
125-TO-KS	1996	Finished	0.089	0.269
125-TO-KS	1999	Finished	0.115	0.234

¹ Co-occurring acetochlor/alachlor concentrations were ranked in decreasing values for **alachlor** for each year. The highest value for alachlor (0.590 ppb) is in bold.

Combined Co-occurring Acetochlor and Alachlor Concentrations

To conduct the risk assessment, the single-year, co-occurring, acetochlor and alachlor TWAM water concentrations in surface waters in the ARP SDWS study, were combined using Relative Potency Factors (RPF). The concentrations were combined using the RPF factor of 0.05 (in Table 2) for acetochlor with alachlor as the index chemical. The concentrations, expressed as “alachlor equivalents”, were averaged for each site over the years (up to 7 years) for which data were available and the averages were ranked in decreasing order (Table 5). **The maximum value for this ranking (0.286 ppm) was used for MOE calculations with DEEM-FCID™.**

Table 5. Top ten **co-occurring** Multi-Year Time-Weighed Mean concentrations (TWAM) of alachlor and acetochlor in the ARP SDWS study **expressed as Alachlor equivalents**, ¹ (No raw water samples were in the top ten).

Site ID	No. Of Years ² with data	Water Type	Acetochlor TWAM (ppb)	Alachlor TWAM (ppb)	TWAM in Alachlor Equivalents (ppb)
340-NV-IN	2	Finished	0.205	0.276	0.286
125-TO-KS	7	Finished	0.069	0.158	0.155
23-WE-KS	4	Finished	0.004	0.147	0.147
114-RI-KS	3	Finished	0.001	0.144	0.144
408-DE-OH	6	Finished	0.129	0.110	0.104
518-US-OH	7	Finished	0.135	0.103	0.096
451-ML-OH	7	Finished	0.157	0.093	0.085
330-LO-IN	3	Finished	0.232	0.090	0.078
172-FA-IL	7	Finished	0.118	0.083	0.077
355-SC-IN	7	Finished	0.065	0.082	0.079

¹ Co-occurring acetochlor/alachlor concentrations (TWAMs) were converted to alachlor equivalents using an RPF (0.05) and ranked in decreasing values for **alachlor** for each year. The highest value for alachlor equivalents (0.286 ppb) is in bold and was used in risk assessment.

² Number of years for which water monitoring data were available during 1995-2001.

Table 6 summarizes the surface water multi-year TWAM concentrations (ppb) from the ARP SDWS study and their percentiles and median. The **combined concentrations**

Acetochlor plus Alachlor (in Alachlor equivalents) were used for the Margin-of-Exposure (MOE) calculations with **DEEM-FCID™** analysis.

Table 6. Summary of Surface Water Exposure Values for Acetochlor + Alachlor (in Alachlor equivalents) used for Risk Assessment^{1,2}.

Chemical	Maximum Multi year TWAM (ppb)	Percentiles (ppb)			Median (ppb)
		99.5 th	99 th	95 th	
Acetochlor	0.282	0.235	0.208	0.125	0.015
Alachlor	0.276	0.162	0.148	0.074	0.008
Acetochlor + Alachlor (in Alachlor equivalents) ³	0.286	0.166	0.149	0.078	0.009

¹ Multi year Time-Weighed Annualized Means (TWAM) in surface water from the ARP monitoring program for Chloroacetanilides (SDWS study). Values are maximum TWAM values (in ppb), 99.5th, 99th and 95th percentiles (in ppb) and median (in ppb) observed for all sites (**189 sites**). Represents predominantly TWAMs calculated from a series of finished water samples, although for a minority of sampled systems the ARP also regularly monitored raw (pre-treatment) water.

² Data from EFED's Cumulative Drinking Water Exposure Assessment for Chloroacetanilides, USEPA (2006).

³ Acetochlor concentration (in alachlor equivalents) = Acetochlor concentration x **RPF**.

Where $RPF = \text{NOAEL}_{\text{Alachlor}} / \text{NOAEL}_{\text{Acetochlor}} = (0.5 \text{ mg/kg/day}) / (10 \text{ mg/kg/day}) = 0.05$. NOAEL (i.e. POD) values were obtained from Table 2. Each acetochlor concentration was converted to alachlor equivalents and then added to its respective co-occurring alachlor concentration. Then, the sums were averaged for each site over the years of available data, ranked in descending order and the maximum TWAM was selected for risk assessment.

ii. DEEM-FCID™ Analysis of Exposure From Foods and Water.

Acetochlor chronic dietary exposure assessments were conducted using the Dietary Exposure Evaluation Model software with the Food Commodity Intake Database (DEEM-FCID™, Version 2.03), which incorporates consumption data from USDA's Continuing Surveys of Food Intakes by Individuals (CSFII), 1994-1996 and 1998. The 1994-96 and 98 data are based on the reported consumption of more than 20,000 individuals over two non-consecutive survey days. Foods "as consumed" (e.g., apple pie) are linked to EPA-defined food commodities (e.g. apples, peeled fruit - cooked; fresh or N/S; baked; or wheat flour - cooked; fresh or N/S, baked) using publicly available recipe translation files developed jointly by USDA/ARS and EPA. For chronic

exposure assessment, consumption data are averaged for the entire U.S. population and within population subgroups, but for acute exposure assessment are retained as individual consumption events.

Based on analysis of the 1994-96 and 98 CSFII consumption data, which took into account dietary patterns and survey respondents, HED concluded that it is most appropriate to report risk for the following population subgroups: the general U.S. population, all infants (less than 1 year old), children 1-2, children 3-5, children 6-12, youth 13-19, adults 20-49, females 13-49, and adults 50+ years old.

DEEM-FCID™ Analysis of the Data.

As summarized below, two types of **DEEM-FCID™** runs were done: **(1) DEEM-FCID™** runs to obtain the cumulative Margin-of-Exposure (MOE) and **(2) DEEM-FCID™** runs with each separate chemical to obtain MOE values for each chemical separately, to identify the risk-driving chemical.

1. Cumulative Margin-of-Exposure (MOE) values were obtained using the following commodity and water inputs:

- **Alachlor** commodity values were the anticipated residues, as estimated for the alachlor RED document of 1998, corrected for percent crop treated. The anticipated residue values are summarized in Attachment 1, obtained from USEPA (1998). The percent crop treated values that were used are current values (year 2004) determined by USEPA/OPP/BEAD and summarized in Attachment 2. It is noted that the anticipated residues used in this assessment are from field trial data. The anticipated residue values are summarized in Attachment 1, obtained from USEPA (1998). Thus the fact that they were obtained 8-9 years ago does not make them obsolete as would be the case if monitoring data had been used.
- **Acetochlor** commodity values were tolerance values refined through the use of experimentally determined processing factors and average percent crop treated data. These values were obtained from the acetochlor TRED (USEPA 2005c). These acetochlor values were converted into alachlor equivalents by multiplying them by 0.05 (the RPF for acetochlor). The alachlor equivalents from acetochlor were then added to their counterparts for alachlor (the index chemical).

Detailed guidance for these calculations appears in Section 9.5 (Expression of Cumulative Risk - Combining Multiple-Pathway Risk) of the Guidance on Cumulative Risk Assessment of Pesticide Chemicals (USEPA 2002b).

- For **Drinking Water** inputs multi-year averages were used. The Single-Year Water TWAM concentrations of acetochlor co-occurrent with alachlor from the ARP-SDWS study were converted into alachlor equivalents using RPFs and added to the co-occurrent alachlor TWAM concentration values. The monitoring data for each site were averaged over the years of data availability (up to 7 years) to obtain a multi-year average. The multi-year averages were ranked from smallest to largest and the highest value was used for risk assessment. The results of such calculations are shown in Table 5. The value used for risk assessment, in alachlor equivalents is **0.286 ppb** from site 340-NV-IN. Additionally, various percentiles and the median were calculated for the distribution of multi-year averages. These values are shown in Table 6.

2. MOE values were obtained for each chemical alone using the following commodity and water inputs:

- **Alachlor** commodity values were the same as above for (1).
- **Acetochlor** commodity values were the same as above for (1), except that they were not converted to alachlor equivalents.
- **Water** values were multi-year average values for concentration for each chemical in the ARP SDWS study. For acetochlor the value was 0.282 ppb, (See Table 6). For alachlor the value was 0.276 ppb (See Table 6).

E. The Cumulative Risk assessment

This section contains the results of the DEEM-FCID™ runs performed as discussed in Section D.

The following Tables report MOEs for some populations, including the U.S. Population (Total) and the results for the population groups that have the **highest** and the **lowest** MOE values. The MOE values for additional populations appear in Attachments 4, 6, and 8.

i. Cumulative DEEM Analysis using the RPF Method (Attachments 3 and 4): Acetochlor expressed as Alachlor equivalents.

Commodity levels and water concentrations for acetochlor were converted into alachlor equivalents using the RPF factor of 0.05 (see Tables 2, 5 and 6) and added to those of alachlor. The combined surface water TWAM concentration used was 0.286 ppm, instead of the separate concentrations used for each chemical in case 2 below (0.282 ppb for acetochlor and 0.276 ppb for alachlor).

As shown in Table 7, the lowest MOE (non nursing infants) is 13,175 and the MOE for the U.S. Population (Total) is 40,119. Results for other populations not listed in the Table, appear in Attachment 4.

Table 7. **Cumulative MOE for Alachlor and Acetochlor using the RPF method. (Acetochlor is expressed as Alachlor equivalents):** Highest and Lowest chronic MOE values obtained using DEEM-FCID for various population subgroups exposed to Acetochlor or Alachlor.

Population subgroup	Exposure (mg/kg/day)	Cumulated MOE (MOE _T)
U.S. Population (Total)	0.000012	40,119
All infants (less than 1 year old)	0.000030	16,464
Non-nursing infants	0.000038	13,175 (lowest)
Females (13-19) not preg. or nursing	0.000009	53,237
Children 1-2	0.000037	13,595
Children 3-5	0.000028	17,815
Children 6-12	0.000018	27,875
Youth 13-19	0.000010	47,799
Adults 20-49	0.000010	52,303
Females 13-49	0.000010	52,171
Adults 50+ years old	0.000009	54,027

¹ **Acetochlor** and **Alachlor** were refined as described in the text.

² Acetochlor was converted to alachlor equivalents using the RPF method. Acetochlor concentration (in alachlor equivalents) = Acetochlor concentration x **RPF**. Where **RPF** = $\text{NOAEL}_{\text{Alachlor}} / \text{NOAEL}_{\text{Acetochlor}}$ = (0.5 mg/kg/day) / (10 mg/kg/day), NOAEL (i.e. POD) values from Table 2. *For water*, each acetochlor concentration was converted to alachlor equivalents and then added to its respective co-occurring alachlor concentration. Then, the sums were averaged for each site over the years of data availability (up to 7 years), ranked in descending order and the maximum multi year average was selected for risk assessment. *For agricultural commodities*, each value was multiplied by the RPF of 0.05 (as described above and added to the respective value for alachlor).

³ Parameters used for the chronic DEEM-FCID runs for **alachlor as the Index Chemical** were:

(a) Water concentration: Max.Multiyear TWAM, from Table 6 for (alachlor + acetochlor) in alachlor equivalents = 0.286 ppb.

(b) POD (i.e NOAEL) for Alachlor = 0.5 mg/kg/day (From Table 2).

(c) Anticipated residues for alachlor as summarized in USEPA (1998) and also in Attachment 1 and correction for percent crop treated from Attachment 2.

ii. DEEM analysis for Acetochlor (Attachments 5 and 6) and Alachlor (Attachments 7 and 8) as separate chemicals.

In order to identify the risk-driving compound in the cumulative analysis, MOE values were also obtained each compound separately. As summarized above, anticipated residues corrected for percent crop treated were used for alachlor and tolerance levels corrected for processing factors and percent crop treated were used for acetochlor.

Water concentrations for each chemical were the maximum multiple-year average concentration for all sites (0.282 ppb for acetochlor and 0.286 ppb for alachlor) in the ARP SDWS study.

As shown in Table 8, under the exposure conditions used, the MOE values for acetochlor are much higher than those for alachlor (nearly 10-fold). The lowest MOE for alachlor is 13,636 (Children 1-2 years) and the U.S. Population (Total) has an MOE of 40,813. All MOEs for acetochlor exceed 160,000 and the U.S. Population Total has an MOE of 392,207. From this information one may conclude **that alachlor, under the exposure levels covered, is the risk driving component of the cumulative assessment group (CAG).**

Table 8. **DEEM Analysis for Acetochlor alone and Alachlor alone:** Highest and Lowest chronic MOE values obtained using DEEM-FCID for various population subgroups exposed to Acetochlor or Alachlor.

Chemical	Population subgroup	Exposure (mg/kg/day)	MOE
Acetochlor ¹	U.S. Population (Total)	0.000025	392,207
	Non-nursing infants	0.000062	160,914 (lowest)
	Females (13-19) not preg. or nurs.	0.000026	377,562
	Seniors 55+	0.000015	676,613 (highest)
Alachlor ²	U.S. Population (Total)	0.000012	40,813
	Non-nursing infants	0.000035	14,109
	Females (13-19) not preg. or nurs.	0.000009	56,016 (highest)
	Children 1-2 years	0.000037	13,636 (lowest)

¹ **Acetochlor** was refined as follows: Tolerance levels for RACs corrected for percent crop treated and for production factors, as shown in Table 11. **Alachlor** was refined as follows: Anticipated Residues [as summarized in Alachlor RED, Tables 18 and 19, December 1998, USEPA (1998)] corrected for percent crop treated, as shown in Table 12.

² Parameters used for the chronic DEEM-FCID runs for acetochlor were:

- (a) Water concentration: Max. Multi year average concentration for Acetochlor (alone) = 0.282 ppb.
- (b) POD (i.e. NOAEL) for Acetochlor = 10 mg/kg/day (From Table 2)
- (c) Tolerances for acetochlor from 40CFR(§180.470) July 2004 Edition.

³ Parameters used for the chronic DEEM-FCID runs for alachlor were:

- (a) Water concentration: Max. Multi year average concentration for alachlor = 0.276 ppb.
- (b) POD (i.e. NOAEL) for Alachlor = 0.5 mg/kg/day (From Table 2).
- (c) Anticipated residues for alachlor as summarized in Attachment 1 (From USEPA 1998) and correction for percent crop treated (See Attachment 2).

F. Characterization of the Risk Assessment

A cumulative risk assessment of a Cumulative Assessment Group (CAG) of Chloroacetanilide pesticides has been conducted. The CAG for this document consists of two chemicals: alachlor and acetochlor. An original member of the Common Mechanism Group, butachlor, has been excluded from the present risk assessment because at present there are no registered tolerances for this chemical.

The selected endpoint for risk assessment (development of nasal tumors in rats) has been attributed to a non-linear, non mutagenic mode of action involving sustained cytotoxicity and regenerative cell proliferation. Thus, as per the 2005 EPA Cancer

Guidelines (USEPA 2005b) a Margin-of-Exposure (MOE) calculation has been used for the cumulative risk assessment, as one would do for a threshold noncancer toxicity risk assessment. Because of the threshold approach that is being used for risk assessment, the uncertainty factors (UFs) of 10 (interspecies) and 10 (intraspecies) are used. In the absence of sensitivity issues the FQPA factor is 1. Thus, MOEs above 100 are considered to be outside of the Agency's level of concern (LOC).

i. Toxicological Considerations

The CAG members in this document were evaluated on their common mode of action for the production of tumors of the nasal olfactory epithelium in rats. Although this endpoint is observed in at least two strains of rats, it has not been observed in mice. Experiments conducted *in vitro* with primate tissues and other evidence, did not rule out that these tumors could also occur in humans (USEPA, 2004). No epidemiological cancer data are available.

The existing evidence is clearly supportive of the non-linear, non-genotoxic mode of action in the causation of tumors of the nasal olfactory epithelium in rats (USEPA 2004). Thus, in accordance with The Agency's revised Guidelines for Carcinogen Risk Assessment (USEPA, 2005b), an approach akin to the oral *reference dose* approach, MOE calculations, has been followed in this document to assess risk.

Under FQPA, the potential for increased sensitivity to adverse effects from a pesticide to children during gestation and postnatal development must be considered. As discussed in the following lines, no evidence has been found that the developing fetus or young animal has increased sensitivity, compared to the adult, to chloroacetanilide - induced nasal olfactory epithelial tumors.

A rat multigeneration reproductive toxicity study on acetochlor (MRID 45357503), in which nasal tissues were examined microscopically in F0 and F1 parental animals, provides an opportunity to compare nasal olfactory epithelial tumor incidence from exposure during development to incidence in adult rats exposed in carcinogenicity studies on acetochlor, as shown below in Table 9.

The Table shows that a similar dose threshold for nasal epithelial hyperplasia and neoplasia was observed in all of the studies. No nasal tumors were observed in the reproductive study at 19-22 mg/kg/day. A single nasal tumor was seen in a male at 38 mg/kg/day in a carcinogenicity study. At ≥ 57 mg/kg/day, a positive dose-response for nasal tumor incidence was observed. A single finding of papillary hyperplasia was also seen in a carcinogenicity study at 20 mg/kg/day in males, but not in the reproductive study. The higher tumor incidence in F1 animals compared to F0 at mid and high dose probably reflected both higher F1 test material intake between postnatal Day 29 and Week 6 (during which food consumption was not recorded) and additional exposure

time during gestation and lactation. However, the tumor incidence in the reproductive study was comparable to the carcinogenicity studies at similar dose levels. Tumor latency also was not affected by early exposure. In the reproductive study, tumors were observed in parental F0 and F1 rats at 130-154 days.

Table 9. : Comparison of nasal epithelial tumor incidence in the reproductive toxicity and carcinogenicity studies in the rat¹.

	MALES		FEMALES	
Study Type/MRID Dose in ppm	Dietary Intake (mg/kg/day)	Incidence of Nasal Tumors (%)	Dietary Intake (mg/kg/day)	Incidence of Nasal Tumors (%)
Reproductive toxicity ²				
F0 200 ppm	21	0	22	0
F1 200 ppm	19	0	22	0
F0 600 ppm	57	0	65	0
F1 600 ppm	66	12	71	4
F0 1750 ppm	166	15	198	23
F1 1750 ppm	196	31	216	65
Chronic toxicity/carcinogenicity ³				
500 ppm	38	1	45	0
1000 ppm	64	17	76	27
1750 ppm	131	53	150	57

¹ Table adapted from Table 5 of MRID 46081801. Intake values represent the average daily intake of acetochlor during the first ten weeks of the chronic toxicity/carcinogenicity studies and during the initial ten-week pre-mating periods from the reproductive toxicity study.

² MRID 45357503

³ Dose levels are taken from three different studies: MRIDs 00131088/40484801, 40077601 and 41592004.

The carcinogenicity studies on acetochlor show tumors in the interim (12-month) sacrifice animals, but no data are available at earlier times. However, a nasal epithelial cell proliferation study on acetochlor showed proliferation by 160 days (MRID 44496207). In published studies on alachlor in rats, nasal tumors were reported by 5-6 months of exposure, with increased cellular proliferation at 3-4 months (Gentner *et al.*, 2002). From these data, it is concluded that the POD of 10 mg/kg/day is adequately protective during development.

ii. Exposure Considerations

Evaluation of dietary exposure has been done with limited refinement and thus it considered to an overestimation of exposure overall. The calculated cumulative MOEs were greater than 13,000 for all population sub-groups and 40,119 for the Total U.S. Population.

To assess the significance of these MOEs, it is noted that compared to the MOE of 100, defined as the level of concern (LOC) for this cumulative risk assessment, the cumulated MOE values (greater than 13,000) reported in this document for the subject CAG, are well outside the Agency's LOC.

Table 10 shows how the MOE increases as smaller percentiles of the distribution of alachlor equivalents in water (See Table 8, alachlor + acetochlor) are utilized in cumulative MOE calculations. At the 99.5 percentile, all MOE values exceed 15,000.

Table 10. Cumulative MOEs for Various Populations at various percentiles of alachlor equivalents in water¹.

Population Group	MOE at Maximum Multi-year TWAM (ppb)	MOE at the following percentiles		
		99.5	99	95
U.S. Population	40,119	50,334	52,218	61,891
All Infants (less than1 year old)	16,464	22,649	23,921	31,259
Children (1-2)	13,595	15,142	15,390	16,519
Children (3-5)	17,815	20,336	20,788	22,757
Children (6-12)	27, 875	32,234	32,964	36,408
Youth (13-19)	47,799	57,923	59,714	68,573
Adults (20-49)	52,303	69,463	72,849	91,470
Females (13-49)	52,171	69,136	72,474	90,785
Adults (50+ years)	54,027	73,854	77,904	101,049

¹ The DEEM-FCID™ runs used the same food values used in Table 7. The maximum Multi-year TWAM concentrations in alachlor equivalents (0.286 ppb) and the percentiles shown in Table 6 (99.5, 99, and 95 percentiles) corresponding to multi-year TWAM concentrations of 0.166, 0.149 and 0.078 ppb, respectively, were used in the DEEM-FCID™ runs,

IV. Conclusions

A risk assessment of a Cumulative Assessment Group (CAG) consisting of the Chloroacetanilide pesticides acetochlor and alachlor has been conducted. MOE calculations have been made based on the endpoint of nasal olfactory epithelium tumors in rats, and using slightly refined values for food and drinking water,

Compared to a MOE of 100, defined as level of concern (LOC) for this risk assessment, the cumulated MOE values, greater than 13,000 for the subject CAG for all populations, are outside the Agency's level of concern.

Because these cumulative MOE values were obtained using high-end exposures, they are considered to be conservative. Additional MOE calculations in Appendixes 1 and 2, using more conservative approaches to estimation of drinking-water exposure, support the conclusions of this analysis by producing MOE values that exceed the LOC of 100 by nearly an order of magnitude or more.

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VII. Appendices

To bracket the maximum potential risk associated with uncertainties in the cumulative exposure to acetochlor and alachlor in drinking water, two additional risk assessments have been performed using more conservative assumptions for the determination of exposure to chloroacetanilides in water.

The cumulative risk assessment done in the main text used **Monitored Multi-Year** TWAM concentrations of chloroacetanilides in drinking water. In contrast, the cumulative risk assessments in Appendices 1 and 2 used the following more conservative approaches for determination of exposure to chloroacetanilides in drinking water:

- The risk assessment in Appendix 1, uses **Monitored Single-Year** TWAM concentrations of chloroacetanilides in drinking water. Single-year TWAMs will contain still the higher values of water concentrations that get averaged out in obtaining the multi-year TWAMs.
- The risk assessment in Appendix 2 uses **PRZM-EXAMS modeled estimates** of environmental concentrations of alachlor and acetochlor in drinking water to address potential limitations in the monitored data.

Outside of inputs for drinking water, all other inputs to **DEEM-FCID™** are the same as those for the cumulative risk assessment in the main body of the this document: Both risks assessments in the Appendices use:

- The same POD values for nasal tumors in rats summarized in Table 2 of the main body of this document: Alachlor is the index chemical with a POD of 0.5 mg/kg bw/day and acetochlor has a POD of 10 mg/kg bw/day. The RPF to convert acetochlor exposure to alachlor equivalents is thus 0.05.
- The same **DEEM-FCID™** inputs for exposure to foods, described in Section D.i.a. (Input from Foods) of the main body of this document for alachlor and acetochlor.

A. Appendix 1.

Cumulative Risk Assessment: Use of Monitored Single-Year TWAM Concentrations of Alachlor and Acetochlor in Water.

i. Introduction.

The multi year monitored annual means for drinking water used in the main part of this document are generally most appropriate for evaluation of risk relating to chronic endpoints such as the nasal olfactory epithelium tumors identified as the common mode of action for chloroacetanilides. However, to allow for the potential of higher exposure at unmonitored sites or with change use patterns or weather conditions, we use in this Appendix the single-year annual means from modeling to estimate high-end lifetime exposure levels.

In general, the highest single-year exposure levels for acetochlor plus alachlor (in alachlor equivalents (0.6 ppb Tables A1-1 and A1-2 of this Appendix) were a little more than double the respective highest multi-year exposure levels (0.286 ppb, Tables 5 and 6 of the main document). Noteworthy is that most of the highest annual mean concentrations were observed from sets of finished water samples and all of the top ten exposure sites expressed as alachlor toxic equivalents were from finished water. Data on treatment effects on alachlor or acetochlor concentrations were available from some sites showing that treatment at these sites typically removed from 30 to 90% of the alachlor equivalent residues.

ii. Combined Co-occurring Acetochlor and Alachlor Concentrations

The risk assessment conducted in this Appendix uses the same POD values and **DEEM-FCID™** inputs for food as the risk assessment in the main body of the document. Thus, this section focuses only on the specification of the **DEEM-FCID™** inputs for drinking water concentrations of the chloroacetanilides.

To conduct the risk assessment for this Appendix, the single-year, co-occurring, acetochlor and alachlor TWAM water concentrations in surface waters in the ARP SDWS study, were combined using Relative Potency Factors (RPF). The concentrations were combined using the RPF factor of 0.05 (in Table 2, of the main document) for acetochlor with alachlor as the index chemical. The concentrations, expressed as “alachlor equivalents”, were then ranked in decreasing order (Table A1-1, below), and the maximum value (**0.600 ppb**) corresponding to the site 518-US-OH for 1997 was used for the risk assessment in this Appendix.

Table A1-1. Top six **co-occurring** single-year Time-Weighed Annual Mean concentrations (TWAM) of alachlor and acetochlor in the ARP SDWS study **expressed as Alachlor equivalents**, ¹ (No raw water samples were in the top six).

Site ID	Year	Water Type	Acetochlor TWAM (ppb)	Alachlor TWAM (ppb)	TWAM in Alachlor Equivalents (ppb)
518-US-OH	1997	Finished	0.202	0.590	0.600
23-WE-KS	2001	Finished	0.004	0.406	0.406
340-NV-IN	1996	Finished	0.372	0.357	0.376
114-RI-KS	1997	Finished	0.002	0.345	0.345
125-TO-KS	1996	Finished	0.089	0.269	0.273
125-TO-KS	1999	Finished	0.115	0.234	0.247

¹ Co-occurring acetochlor/alachlor concentrations (TWAMs) were converted to alachlor equivalents using an RPF (0.05) and ranked in decreasing values for **alachlor** for each year. The highest value for alachlor (0.600 ppb) is in bold and was used in risk assessment.

Table A1-2 summarizes the surface water single-year TWAM concentrations (ppb) from the ARP SDWS study. The table shows the maxima for alachlor and acetochlor alone and for combined concentrations of alachlor plus acetochlor (in alachlor equivalents) plus their percentiles. It is apparent that the concentrations of combined alachlor plus acetochlor decline very rapidly, so that the 99.5th percentile (0.240 ppb) is quite comparable to the maximum value for the multi-year TWAM concentration (0.286 ppb) used for the risk assessment in the main body of this document.

Table A1-2. Summary of Surface Water Exposure Values used for Risk Assessment¹.

Chemical	Maximum single-year TWAM (ppb)	Percentiles ³ (ppb)			Median (ppb)
		99.5 th	99 th	95 th	
Acetochlor (alone)	1.428 ²	0.458	0.363	0.143	0.008
Alachlor (alone)	0.590	0.232	0.187	0.055	0.007
Acetochlor + Alachlor (in Alachlor equivalents) ⁴	0.600	0.240	0.191	0.061	0.08

¹ Single-year Time-Weighed-Annualized-Means (TWAM) in surface water from the ARP monitoring program for Chloroacetanilides (SDWS study). Values are maximum TWAM values (in ppb), 95th percentiles (in ppb) and medians (in ppb) observed for all sites. Represents predominantly TWAMs calculated from a series of finished water samples, although for a minority of sampled systems the ARP also regularly monitored raw (pre-treatment) water.

² Data from EFED's Drinking Water Exposure Assessment for Acetochlor (USEPA, 2006).

³ Water data furnished by M. Barrett (EFED) on July 21, 2005.

⁴ Acetochlor concentration (in alachlor equivalents) = Acetochlor concentration x **RPF**.
Where $RPF = NOAEL_{Alachlor} / NOAEL_{Acetochlor} = (0.5 \text{ mg/kg/day}) / (10 \text{ mg/kg/day}) = 0.05$. NOAEL (i.e. POD) values were obtained from Table 2. Each acetochlor concentration was converted to alachlor equivalents and then added to its respective co-occurring alachlor concentration. Then, the sums were ranked in descending order and the maximum TWAM was selected for risk assessment.

iii. DEEM-FCID™ Analysis of the Data.

As shown in Table A1-3 the lowest MOE (non nursing infants) is 7,713 and the MOE for the U.S. Population (Total) is 26, 204. Results for additional populations appear in Attachment 10.

TableA1-3 **Cumulative MOE for Alachlor plus Acetochlor using the RPF method with monitored single-year TWAM water concentrations:** Highest and Lowest chronic MOE values obtained using DEEM-FCID for various population subgroups exposed to Acetochlor or Alachlor^{1, 2, 3}.

Population subgroup	Exposure (mg/kg/day)	Cumulated MOE (MOE _T)
U.S. Population (Total)	0.000019	26,204
All Infants (Less than 1 year old)	0.000052	9,603
Non-nursing infants	0.000065	7,713 (lowest)
Females (13-19) not preg. or nursing	0.000014	35,590 (highest)
Children 1-2 years	0.000047	10,728
Children 3-5 years	0.000037	13,417
Children 6-12 years	0.000024	20,590
Youth 13-19 years old	0.000015	32,799
Adults 20-49	0.000016	31,768
Adults 50+ years old	0.000016	31,734

¹ **Acetochlor** and **Alachlor** were refined as described in the text.

² Acetochlor was converted to alachlor equivalents using the RPF method. Acetochlor concentration (in alachlor equivalents) = Acetochlor concentration x **RPF**. Where **RPF** = $\text{NOAEL}_{\text{Alachlor}} / \text{NOAEL}_{\text{Acetochlor}}$ = $(0.5 \text{ mg/kg/day}) / (10 \text{ mg/kg/day})$, NOAEL (i.e. POD) values from Table 2, in the main body of this document). *For water*, each acetochlor concentration was converted to alachlor equivalents and then added to its respective co-occurring alachlor concentration. Then, the sums were ranked in descending order and the maximum single-year TWAM was selected for risk assessment. *For agricultural commodities*, each value was multiplied by the RPF of 0.05 (as described above and added to the respective value for alachlor).

³ Parameters used for the chronic DEEM-FCID runs for **alachlor as the Index Chemical** were:

- (a) Water concentration: Max. TWAM, from Table A1-1 for alachlor = 0.600 ppb.
- (b) POD (i.e NOAEL) for Alachlor = 0.5 mg/kg/day (From Table 2, in the main body of this document).
- (c) Anticipated residues for alachlor as summarized in USEPA (1998) and also in Attachment 1 and correction for percent crop treated from Attachment 2.

iv. Conclusions.

A cumulative risk assessment has been done using **Monitored Single-Year TWAM Concentrations** of Alachlor and Acetochlor in drinking water. All other inputs to **DEEM-FCID™** analysis of the data are the same as those used cumulative risk assessment in the main body of this document.

Compared to an MOE of 100, defined as the level of concern (LOC) for this cumulative risk assessment, the cumulated MOE values, greater than 7,700 for the subject CAG for all populations, are outside the Agency's level of concern.

B. Appendix 2.

Cumulative Risk Assessment: Use of Modeled (PRZM/EXAMS) Concentrations of Alachlor and Acetochlor in Drinking Water.

i. Introduction.

The main body of this document covers a cumulative risk assessment of chloroacetanilides using the maximum monitored multi year TWAM concentration of alachlor and acetochlor in drinking water (0.286 ppb in alachlor equivalents). Appendix 1 of this document adds conservatism to that assessment by using the maximum single-year TWAM concentration of alachlor and acetochlor in drinking water (0.600 ppb in alachlor equivalents). The present appendix adds further conservatism to the previous cumulative risk assessments by utilizing PRZM/EXAMS-modeled concentrations for the chloroacetanilides in drinking water to address potential limitations in the monitoring data. The PRZM/EXAMS modeling assumes high-use levels and conservative modeling inputs in vulnerable watersheds.

ii. Modeling Based Exposure Estimation.

Crop scenarios only for corn, sorghum, soybeans, sweet corn and dry beans are considered in this assessment since these uses accounted for approximately 99% of all national alachlor usage for the years 2001-2003 according to OPP's BEAD (sweet corn and dry bean use are reflected in the monitoring-based exposure only to the extent that their relatively modest usages intersect with the areas monitored). For acetochlor, only the corn use is registered currently, although applications for registrations on sorghum for grain and sweet corn have been submitted to and are currently being reviewed by EPA. PRZM scenarios were chosen to represent each of these uses by considering state-level use intensity (lbs ai/ A treated) averaged over the three years reported by BEAD in relation to the existing standard PRZM scenarios. Final cumulative modeling exposure was based on alachlor use on corn, sorghum and soybeans and acetochlor use on corn.

Before determining a combined exposure to alachlor and acetochlor (as alachlor equivalents) exposure numbers were obtained for each herbicide from separate modeling runs. PRZM/EXAMS modeling used current maximum label rate, maximum number of applications per year and the minimum application interval. Additional model inputs are detailed in USEPA(2006).

Modeled cumulative exposure estimates are expressed as alachlor equivalents, the sum of alachlor use on corn, sorghum and soybeans and acetochlor use on corn adjusted by the relative potency factor (0.05). Separate estimates for expected environmental concentrations (EEC) of chloroacetanilide (in alachlor equivalents) were calculated for

differing ratios of alachlor to acetochlor usage on corn. All cumulative estimates include correction for Percent Crop Area (PCA) and assume 100% of the crop area was treated with the assessed chemical (i.e. there was no correction for percent crop treated, PCT).

iii. PRZM/EXAMS Modeling Results

Cumulative multi year mean estimated environmental concentrations (EEC) of the subject chemicals (as alachlor equivalents) appear in Table A2-1. The three columns of EECs represent the assumptions of 1:0, 1:1, and 0:1 alachlor to acetochlor ratios of use on corn, respectively; assuming exclusivity of use (i.e. either alachlor or acetochlor, but not both, may be used on a given corn field).

The EEC value of 8.94 ppb (alachlor equivalents) for the 50%/50% alachlor to acetochlor scenario was used as drinking water input for **DEEM-FCID™** analysis for risk assessment. The value of 12.81 (for 100% alachlor) was not used as it pertained only to alachlor. As noted in USEPA(2006), the trend has been for the overall alachlor to acetochlor ratio of usage to continue to decline. Thus, the value of 8.94 ppb alachlor equivalents is likely to be more conservative than a value closer to the 5.07 ppb estimated for the 100% acetochlor use.

iv. DEEM-FCID™ Analysis of the Data.

As summarized above, the risk assessment in this appendix employs the same POD values and **DEEM-FCID™** inputs for food as the risk assessment in the main body of the text. The cumulative MOE for alachlor plus acetochlor, using the modeled EEC of 8.94 ppb alachlor equivalents as **DEEM-FCID™** inputs for water concentrations of the chloroacetanilides, is shown in Table A2-3.

The MOE value (not corrected for PCT) for the U.S. population is 2,556; the lowest MOE is 642 for non-nursing infants and the highest is 3,513 for youths 13-19 years old.

Because all EEC estimates assume 100% of the crop area for the three crops was treated with the assessed chemicals, exposure will be overestimated to the extent the actual PCT is less than 100%. For example, screening levels of PCT for alachlor for 2004 (Attachment 3) and for acetochlor for 2003 (USEPA 2005c) were;

- Alachlor: Corn 5%, Sorghum 15%, soybeans <2.5%.
- Acetochlor: Corn 25%

Thus, the actual MOEs are likely to be much larger than those depicted in Table A2-3.

Table A2-1. Cumulative multi year mean estimated environmental concentrations (EEC) of the subject chemicals (as alachlor equivalents).

Watershed Type	Pesticide	EEC (100% alachlor on corn) ^{1,2} ppb	EEC (50% alachlor, 50% acetochlor on corn) ppb	EEC (100% acetochlor on corn) ppb
High Corn ³	Both	12.81	8.94	5.07
	Alachlor	12.81	8.89	4.97
	Acetochlor	0.00	0.05	0.10
High Sorghum	Both	5.67	5.31	4.95
	Alachlor	5.67	5.30	4.94
	Acetochlor	0.00	0.00	0.01

¹ All EEC values are presented as ppb in water. Data from USEPA (2006).

² The three EEC columns represent assumptions of 1:0, 1:1, and 0:1 alachlor: acetochlor ratios of use on corn, respectively; assuming exclusivity of use (i.e., either alachlor or acetochlor but not both may be used on a given corn field.)

³ EEC sources used :

IL Corn scenario PRZM-EXAMS multi-year mean (High Corn EEC).

MS Corn scenario PRZM-EXAMS multi-year mean (High Sorghum EEC).

MS Soybean scenario PRZM-EXAMS multi-year mean (both EEC calculation sets).

KS Sorghum scenario PRZM-EXAMS multi-year mean (both EEC calculation sets).

v. Discussion of Monitoring-Based and Modeling Based Cumulative Exposure Estimates

The PRZM/EXAMS modeling in this cumulative assessment is based on estimating exposure concentrations in watersheds in two counties which have the potential to be among the highest exposure sites in the United States. Major reasons for higher (up to 20x) estimates being derived from the modeling are likely due to be the use of assumptions in the modeling input which may lead to overestimation, e.g.; assuming higher pesticide persistence and/or mobility than may actually occur or assuming pesticide usage levels (100% crop land treated with maximum allowable rates) that may not actually occur (and therefore are not reflected in the monitoring data).

The monitoring data automatically reflects actual rates and amounts of use of the pesticide. To the extent that usage of chloroacetanilide herbicides remains level or declines, the highest one-year exposure level observed should rarely if ever be exceeded for a lifetime exposure endpoint (as is being considered in this cumulative risk assessment). Should usage rates increase in the future, the monitoring estimates may

no longer being reliable, but the modeling estimates should remain conservative. Future changes in weather or crop production regions resulting in scenarios which produce greater runoff of the pesticide are an unknown that could adversely affect the reliability of both monitoring-based and modeling-based exposure estimates.

vi. Summary of Exposure Considerations: Monitoring vs PRZM/EXAMS modeling

The highest alachlor equivalent single-year mean concentration observed in the ARP SDWS monitoring program is 0.6 ppb. The highest multi-year mean concentration is 0.286 ppb alachlor equivalents, occurring (at a site with only two years of data, Table ; the highest 7-year mean concentration was 0.16 ppb) (Table 5). Evaluation of the USGS NAWQA monitoring dataset indicates concentrations that are roughly equivalent for about the same monitoring period. Maximum cumulative exposure values (assuming maximum possible usage levels) estimated by computer simulation are 5 to 12 ppb alachlor equivalents. The latter value corresponds to an alachlor:acetochlor usage ratio of 1:0; the intermediate value of 8.94 was used for risk assessment, corresponding to an alachlor:acetochlor usage ratio of 1:1.

The modeled values exceed those developed from monitoring data by a factor of 10 to 20, and are likely to represent upper bound exposures to combined residues of alachlor and acetochlor. Given the number of maximum and high-end exposure assumptions discussed in the modeling exposure assessment sections, it is very likely that exposures in CWS across the country will not exceed predicted modeling levels. In addition, given the decline in alachlor use across the US and the lower toxicity of acetochlor, it is likely that the current annual cumulative alachlor equivalents exposure levels in the most vulnerable CWS watersheds may fall below the 0.6 to 12 ppb range estimated from monitoring data and computer simulation models. In the event there would be changes in the future to a higher level of usage of alachlor or, to a lesser extent, of acetochlor (e.g., from increased market share on currently registered crops or additions of new uses), exposure levels could increase, but would not be expected to exceed the levels estimated by modeling. Should a higher level of refinement be needed for this exposure assessment, more spatially explicit modeling or evaluation of monitoring data can be performed.

Table A2-3 Cumulative MOE for Alachlor and Acetochlor using the RPF method with modeled PRZM-EXAMS TWAM water concentrations: Highest and Lowest chronic MOE values obtained using DEEM-FCID for various population subgroups exposed to Acetochlor or Alachlor ^{1, 2, 3}. **Data corrected for PCA but not PCT.**

Population subgroup	Exposure (mg/kg/day)	Cumulated MOE (MOE _T)
U.S. Population (Total)	0.000195	2,566
All Infants (Less than 1 year old)	0.000628	796
Non-nursing infants	0.000779	642 (lowest)
Children 1-2 years	0.000138	1,625
Children 3-5 years	0.000282	1,775
Children 6-12 years	0.000193	2,593
Youth 13-19 years	0.000142	3,513 (highest)
Adults 20-49	0.000179	2,790
Adults 50+ years old	0.000188	2,653

¹ **Acetochlor** and **Alachlor** were refined as described in the text.

² Acetochlor was converted to alachlor equivalents using the RPF method. Acetochlor concentration (in alachlor equivalents) = Acetochlor concentration x **RPF**. Where **RPF** = $\text{NOAEL}_{\text{Alachlor}} / \text{NOAEL}_{\text{Acetochlor}}$ = $(0.5 \text{ mg/kg/day}) / (10 \text{ mg/kg/day})$, NOAEL (i.e. POD) values from Table 2, in the main body of this document). PRISM-EXAMS modeled values were used for water concentrations. 50/50 proportions of acetochlor/alachlor use were assumed. There was correction for PCA but not for PCT. *For agricultural commodities*, each value was multiplied by the RPF of 0.05 (as described above and added to the respective value for alachlor.

³ Parameters used for the chronic DEEM-FCID runs for **alachlor as the Index Chemical** were:
(a) Water concentration: Max. TWAM, from Table A1-1 for alachlor = 0.600 ppb.
(b) POD (i.e NOAEL) for Alachlor = 0.5 mg/kg/day (From Table 2, in the main body of this document).
(c) Anticipated residues for alachlor as summarized in USEPA (1998) and also in Attachment 2 and correction for percent crop treated from Attachment 3.

vii. Conclusion

A cumulative risk assessment has been done using **PRZM/EXAMS**-modeled EECs of Alachlor and Acetochlor in drinking water. All other inputs to **DEEM-FCID™** analysis of the data are the same as those used cumulative risk assessment in the main body of this document.

The cumulated MOE values observed using the PRZM/EXAMS-modeled EECs are greater than 640 for the subject CAG for all populations. Compared to an MOE of 100, defined as the level of concern (LOC) for this cumulative risk assessment in the main part of this document, these values are outside the Agency's level of concern. Because PCT was not incorporated in the modeling, the reported MOEs are expected to be underestimates of the actual MOEs.

VII. Attachments

Attachment 1. Anticipated Residues in Plant and Livestock Commodities for Alachlor.

Attachment 2. Screening Level Usage analysis (SLUA) for Alachlor.

Attachment 3. DEEM **CRA** (Multi-year) Food and Water Residue Input File.

Attachment 4. DEEM **CRA** (Multi year) Food and Water Results File.

Attachment 5. DEEM **Acetochlor** Alone (Multi year) Food and Water Residue Input File

Attachment 6. DEEM **Acetochlor** Alone (Multi year) Food and Water Results File.

Attachment 7. DEEM **Alachlor** Alone (Multi-year) Food and Water Residue Input File

Attachment 8. DEEM **Alachlor** Alone (Multi year) Food and Water Results File.

Attachment 9. DEEM **CRA** (Single-Year) Food and Water Residue Input File.

Attachment 10. DEEM **CRA** (Single-Year) Food and Water Results File.

Attachment 11. DEEM **CRA** (PRZM-EXAMS) Food and Water Residue Input File.

Attachment 12. DEEM **CRA** (PRZM-EXAMS) Food and Water Results File.

Attachment 1 (page 1 of 3): Anticipated Residues in Plant and Livestock Commodities for Alachlor. From: Reregistration ELEGIBILITY Decision (RED) for Alachlor. U.S. EPA. Office of Prevention, Pesticides and Toxic Substances. EPA 738-R-020. December 1998, pages 81-83.

Table 18: Anticipated Residues, Plant Commodities: Calculations and Summary			
Average Residues from Alachlor Uses			
	Avg. Residue	Proc. Factor	Avg. Residue
Corn- 90% of use was preemergence at 4 lb ai/A, 10% of use was postemergence at 4 lb ai/A or sequential applications (4+2 lb ai/A)			
Corn grain	0.011		0.011
Corn meal		0.91 ^a	0.010
Corn oil (refined)		0.12 ^a	0.0014
Corn starch		0.19 ^a	0.0022
Corn forage ⁷	0.21		0.21
Corn silage ⁷	0.22		0.22
Corn stover ⁷	0.12		0.12
Sweet Corn K+CWHR			
preemergence 4 lb ai/A	0.007		0.007
Peanuts-35% of use was preemergence, 75% of use was cracking			
Peanut hulls ⁷	0.38		0.38
Peanut nutmeat	0.15		0.15
Peanut meal ⁷		1.37 ^a	0.21
Peanut oil (refined)		0.06 ^a	0.009
Peanut butter		0.70 ^a	0.11
Peanuts, dry roasted		0.73 ^a	0.11
Peanuts, oil roasted		0.83 ^a	0.12
Sorghum preemergence 4 lb ai/A			
Sorghum grain	0.02		0.02
Sorghum forage ⁷	0.29		0.29
Sorghum fodder ⁷	0.29		0.29
Sorghum stover ⁷	0.2		0.20
Soybeans preemergence 4 lb ai/A			
Soybean grain and soybean full fat and low fat flour	0.105		0.11
Soybean grain dust ⁷		6.00 ^a	0.63
Soybean hulls ⁷		1.22 ^a	0.13
Soybean toasted meal (feed) ⁷		0.88 ^a	0.092
Soybean defatted meal (food)		1.30 ^a	0.137
Soybean oil (refined)		0.17 ^a	0.018
Soybean protein concentrate		0.32 ^a	0.034

Attachment 1 (continued, page 2 of 3):

Table 18: Anticipated Residues, Plant Commodities: Calculations and Summary			
Average Residues from Alachlor Uses			
	Avg. Residue	Proc. Factor	Avg. Residue
Soybean protein isolate		0.21 ^a	0.022
Soybean defatted flour			0.090 ^b
Soybean forage ^c	1.36		1.36
Soybean hay ^c	2.61		2.61
Dry Beans preplant incorporated 3 lb ai/A			
Dry beans	0.048	0.20 ^d	0.010
Dry lima beans	0.040	0.20 ^d	0.008
Bean forage ^c	0.340		0.34
Bean vines ^c	0.396		0.40
Bean hay ^c	0.866		0.87

^a MRID 00162939

^b MRID 40788201

^c MRID 40820601

^d MRID 00154239, 00154240, 40947101, 41862901 41916301

^e 4/7 defatted meal + 3/7 protein concentrates and isolates

^f MRID 40820701

^g Livestock feed only

In estimating anticipated residues for milk, poultry and eggs, anticipated residues as calculated in Table 18 were used in estimating the dietary burden. (See Table 7 for example of calculation.) Estimated dietary burdens based on these anticipated residues in livestock feeds for cattle, poultry, and swine were determined to be 0.49, 0.20, and 0.27 ppm, respectively. The anticipated residues in livestock commodities were then corrected for the expected recovery in each livestock tissue. Anticipated residue estimates for livestock commodities are listed in Table 19.

Table 19: Anticipated Residues in Livestock Commodities						
Alachlor Feeding Study Results			Estimated Residues			
	Feeding Level (ppm)	Residue (ppb)	Dietary Burden (ppm)	Residue Measured by Method (ppb)	% Residue of Concern Measured by Method	Total Residue of Concern (ppb)
BEEF						
muscle	4.20	1.20	0.53	0.15	38%	0.40
fat	4.20	1.90	0.53	0.24	70%	0.34

Table 19: Anticipated Residues in Livestock Commodities						
Alachlor Feeding Study Results			Estimated Residues			
	Feeding Level (ppm)	Residue (ppb)	Dietary Burden (ppm)	Residue Measured by Method (ppb)	% Residue of Concern Measured by Method	Total Residue of Concern (ppb)
liver	4.20	7.80	0.53	0.98	58%	1.70
kidney	4.20	8.70	0.53	1.10	68%	1.61
milk	4.20	1.50	0.69	0.23	40%	0.62
POULTRY						
muscle	12.00	1.00	0.09	0.01	34%	0.02
fat	12.00	1.30	0.09	0.01	73%	0.01
liver	4.00	2.10	0.09	0.05	51%	0.09
eggs	4.00	6.90	0.09	0.16	60%	0.26
SWINE						
muscle	4.00	1.30	0.19	0.06	38%	0.16
fat	4.00	2.60	0.19	0.12	70%	0.18
liver	4.00	4.10	0.19	0.19	58%	0.34
kidney	12.00	7.40	0.19	0.12	68%	0.17

Since the dietary exposure assessment is based on field trial data, the anticipated residues are likely to overestimate the dietary exposure because the application rates and timing assumed in the dietary exposure analysis were at the highest rate on the label, which is not necessarily the typical rate used by the applicator. Additionally, residues are likely to degrade from the time that samples are obtained at the farm gate during transportation, processing and storage, prior to consumption. For the livestock commodities, the following assumptions were used: (1) all alachlor metabolite residues found in the livestock animal metabolism studies are residues of concern and (2) the percentage recovery of the analytical method in livestock commodities is based on the percentage of metabolites recovered in metabolism studies. Alachlor metabolites not identified specifically in the metabolism studies may also respond to the analytical method, so the analytical recovery may be higher than estimated.

Percent Crop Treated Data

Percent crop treated (CT) information are from a three year period 1993 - 1995. The FQPA amendments to Section 408(b)(2)(F) of the FFDCA require that if a tolerance relies on percent crop-treated data, that the Agency make a determination as to the reliability of the data. The percent crop treated estimates used by EPA are derived from Federal and private market survey data. Typically, the Agency considers the range of percent crop treated data from a period of several years, and uses

**Attachment 2 (Page 1 of 3). Usage Report in Support of Reregistration for Acetochlor.
Screening Level Usage Analysis (SLUA) for (Alachlor)/(01/31/05)**

What is a Screening Level Usage Analysis (SLUA)?

It is a summary report of the available usage information for a particular pesticide active ingredient being used on agricultural crops at a national level for the United States.

What does it contain?

- Estimates of pesticide usage for a single active ingredient only.
- Estimates of pesticide usage for agricultural use sites(crops) only.
- Estimates of national level pesticide usage for the United States.
- Estimates of usage for use sites with reported pesticide usage only.
- Estimates of the average & maximum annual percent of crop treated with the pesticide for each agricultural use site.
- Estimates of the average annual pounds of the pesticide applied for each agricultural use site.

What assumptions can I make about the data reported?

- Average pounds of active ingredient applied - Values are calculated by merging pesticide usage data sources together; averaging by year, averaging across all years, & then rounding. (If the estimated value is less than 500, then that value is labeled <500. Estimated values between 500 & <1,000,000 are rounded to 1 significant digit. Estimated values of 1,000,000 or greater are rounded to 2 significant digits.)
- Average percent of crop treated - Values are calculated by merging data sources together; averaging by year, averaging across all years, & rounding to the nearest multiple of 5. (If the estimated value is less than 1, then the value is labeled <1.)
- Maximum percent of crop treated - Value is the single maximum value reported across all data sources, across all years, & rounded up. (If the estimated value is less than 2.5, then the value is labeled <2.5.)

What are the data sources used?

- United States Department of Agriculture's National Agricultural Statistics Service (USDA-NASS) - pesticide usage data from 1998 to 2003.
- National Center on Food and Agriculture Policy (NCFAP) - pesticide usage data from 1997 & is **only** used if data is not available from the other sources.
- Private pesticide market research - pesticide usage data from 1998 to 2003.

What are the limitations to the data?

- There may be instances where registered/labeled uses exist but are not surveyed by the available data sources.
- Lack of reported usage data for the pesticide on a crop does not imply zero usage.
- Cases may occur where usage on a particular use site is noted in the pesticide usage data, but not quantified. In these instances, no usage would be reported in the SLUA for that use site.

Attachment 3 (Page 2 of 3)

- The SLUA does not report estimates of pesticide usage for non-agricultural use sites (e.g., turf, post-harvest, mosquito control, etc.). A separate request must be made to receive estimates of pesticide usage for non-agricultural use sites.

Who do I contact for further information and/or questions on this SLUA?

- (Jihad Alsadek, Economist, EAB)
- (Jihad Alsadek û 703-308-8140 & alsadek.jihad@epa.gov)

SAS Monday, January 31, 2005 10:45 1

Screening Level Estimates of Agricultural Uses of alachlor Sorted Alphabetically

OBS	Crop	Lbs. A.I.	Percent Crop Treated	
			Avg.	Max.
1	Apples	<500	<1	<2.5
2	Beans, Dry (NCFAP '97)	300,000		10
3	Beans, Green	6,000	5	15
4	Cabbage	<500	<1	<2.5
5	Corn	4,200,000	5	5
6	Cotton	20,000	<1	<2.5
7	Dry Beans/Peas	200,000	5	5
8	Grapefruit	7,000	5	5
9	Peanuts	30,000	<1	<2.5
10	Peas, Dry (NCFAP '97)	4,000	20	
11	Peas, Green	<500	<1	<2.5
12	Potatoes	2,000	<1	<2.5
13	Pumpkin	<500	<1	<2.5
14	Sorghum	1,500,000	10	15
15	Soybeans	1,300,000	<1	<2.5
16	Spinach	1,000	<1	<2.5
17	Sunflowers	30,000	<1	<2.5
18	Sweet Corn	200,000	15	20
19	Watermelons	2,000	<1	<2.5

Attachment 3 (Page 3 of 3)

All numbers rounded.

'<500' indicates less than 500 pounds of active ingredient.

'<2.5' indicates less than 2.5 percent of crop is treated.

Use of alachlor on this crop may also have occurred in other states.

(slua003k.sas a005a8n.sas alachlor)

Attachment 3. DEEM CRA (Multi-year) Food and Water Residue Input File.

U.S. Environmental Protection Agency

Ver. 2.00

DEEM-FCID Chronic analysis for CUMULATIVE ALA + ACETO (ALA EQUIVS)

1994-98 data

Residue file:

C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\CRA_Multiyear_Res_File.R98

Adjust. #2 used

Analysis Date 02-24-2006

Residue file dated: 02-24-2006/18:15:30/8

Reference dose (NOEL) = 0.5 mg/kg bw/day

Comment:Cumulative (Aceto) + Ala (Avg. res+ SLUA Pct) + Water in ala equiv

Food Crop			Residue	Adj.Factors		Comment
EPA Code	Grp	Food Name	(ppm)	#1	#2	
06030300	6C	Bean, black, seed	0.010000	0.050	1.000	
06030320	6C	Bean, broad, seed	0.010000	0.050	1.000	
06030340	6C	Bean, cowpea, seed	0.010000	0.050	1.000	
06030350	6C	Bean, great northern, seed	0.010000	0.050	1.000	
06030360	6C	Bean, kidney, seed	0.010000	0.050	1.000	
06030380	6C	Bean, lima, seed	0.008000	0.050	1.000	
06030390	6C	Bean, mung, seed	0.010000	0.050	1.000	
06030400	6C	Bean, navy, seed	0.010000	0.050	1.000	
06030410	6C	Bean, pink, seed	0.010000	0.050	1.000	
06030420	6C	Bean, pinto, seed	0.010000	0.050	1.000	
21000440	M	Beef, meat	0.000400	1.000	1.000	
21000441	M	Beef, meat-babyfood	0.000400	1.000	1.000	
21000450	M	Beef, meat, dried	0.000400	1.000	1.000	
21000460	M	Beef, meat byproducts	0.000400	1.000	1.000	
21000461	M	Beef, meat byproducts-babyfood	0.000400	1.000	1.000	
21000470	M	Beef, fat	0.000340	1.000	1.000	
21000471	M	Beef, fat-babyfood	0.000340	1.000	1.000	
21000480	M	Beef, kidney	0.001610	1.000	1.000	
21000490	M	Beef, liver	0.001700	1.000	1.000	
21000491	M	Beef, liver-babyfood	0.001700	1.000	1.000	
40000930	P	Chicken, meat	0.000020	1.000	1.000	
40000931	P	Chicken, meat-babyfood	0.000020	1.000	1.000	
40000940	P	Chicken, liver	0.000090	1.000	1.000	
40000950	P	Chicken, meat byproducts	0.000020	1.000	1.000	
40000951	P	Chicken, meat byproducts-babyfoo	0.000020	1.000	1.000	
40000960	P	Chicken, fat	0.000010	1.000	1.000	
40000961	P	Chicken, fat-babyfood	0.000010	1.000	1.000	
40000970	P	Chicken, skin	0.000020	1.000	1.000	
40000971	P	Chicken, skin-babyfood	0.000020	1.000	1.000	
06030980	6C	Chickpea, seed	0.010000	1.000	1.000	
06030981	6C	Chickpea, seed-babyfood	0.010000	1.000	1.000	
06030990	6C	Chickpea, flour	0.010000	1.000	1.000	
15001200	15	Corn, field, flour	0.000925	1.000	1.000	s
15001201	15	Corn, field, flour-babyfood	0.000925	1.000	1.000	s
15001210	15	Corn, field, meal	0.000875	1.000	1.000	s
15001211	15	Corn, field, meal-babyfood	0.000875	1.000	1.000	s
15001220	15	Corn, field, bran	0.001125	1.000	1.000	s
15001230	15	Corn, field, starch	0.000485	1.000	1.000	s
15001231	15	Corn, field, starch-babyfood	0.000485	1.000	1.000	s
15001240	15	Corn, field, syrup	0.000735	1.000	1.000	s
15001241	15	Corn, field, syrup-babyfood	0.000735	1.000	1.000	s
15001250	15	Corn, field, oil	0.000445	1.000	1.000	s
15001251	15	Corn, field, oil-babyfood	0.000445	1.000	1.000	s
15001270	15	Corn, sweet	0.007000	0.150	1.000	
15001271	15	Corn, sweet-babyfood	0.007000	0.150	1.000	
70001450	P	Egg, whole	0.000260	1.000	1.000	
70001451	P	Egg, whole-babyfood	0.000260	1.000	1.000	
70001460	P	Egg, white	0.000260	1.000	1.000	
70001461	P	Egg, white (solids)-babyfood	0.000260	1.000	1.000	
70001470	P	Egg, yolk	0.000260	1.000	1.000	

70001471	P	Egg, yolk-babyfood	0.000260	1.000	1.000	
23001690	M	Goat, meat	0.000400	1.000	1.000	
23001700	M	Goat, meat byproducts	0.000400	1.000	1.000	
23001710	M	Goat, fat	0.000340	1.000	1.000	
23001720	M	Goat, kidney	0.001610	1.000	1.000	
23001730	M	Goat, liver	0.001700	1.000	1.000	
06031820	6C	Guar, seed	0.010000	1.000	1.000	
06031821	6C	Guar, seed-babyfood	0.010000	1.000	1.000	
24001890	M	Horse, meat	0.000400	1.000	1.000	
06032030	6C	Lentil, seed	0.010000	1.000	1.000	
27002220	D	Milk, fat	0.000620	1.000	1.000	
27002221	D	Milk, fat - baby food/infant for	0.000620	1.000	1.000	
27012230	D	Milk, nonfat solids	0.000620	1.000	1.000	
27012231	D	Milk, nonfat solids-baby food/in	0.000620	1.000	1.000	
27022240	D	Milk, water	0.000620	1.000	1.000	
27022241	D	Milk, water-babyfood/infant form	0.000620	1.000	1.000	
27032251	D	Milk, sugar (lactose)-baby food/	0.000620	1.000	1.000	
06032580	6C	Pea, pigeon, seed	0.010000	1.000	1.000	
95002630	O	Peanut	0.150000	0.010	1.000	
95002640	O	Peanut, butter	0.110000	0.010	1.000	
95002650	O	Peanut, oil	0.009000	0.010	1.000	
25002900	M	Pork, meat	0.000160	1.000	1.000	
25002901	M	Pork, meat-babyfood	0.000160	1.000	1.000	
25002910	M	Pork, skin	0.000160	1.000	1.000	
25002920	M	Pork, meat byproducts	0.000160	1.000	1.000	
25002921	M	Pork, meat byproducts-babyfood	0.000160	1.000	1.000	
25002930	M	Pork, fat	0.000180	1.000	1.000	
25002931	M	Pork, fat-babyfood	0.000180	1.000	1.000	
25002940	M	Pork, kidney	0.000170	1.000	1.000	
25002950	M	Pork, liver	0.000340	1.000	1.000	
60003010	P	Poultry, other, meat	0.000020	1.000	1.000	
60003020	P	Poultry, other, liver	0.000090	1.000	1.000	
60003030	P	Poultry, other, meat byproducts	0.000020	1.000	1.000	
60003040	P	Poultry, other, fat	0.000010	1.000	1.000	
60003050	P	Poultry, other, skin	0.000020	1.000	1.000	
26003390	M	Sheep, meat	0.000400	1.000	1.000	
26003391	M	Sheep, meat-babyfood	0.000400	1.000	1.000	
26003400	M	Sheep, meat byproducts	0.000400	1.000	1.000	
26003410	M	Sheep, fat	0.000340	1.000	1.000	
26003411	M	Sheep, fat-babyfood	0.000340	1.000	1.000	
26003420	M	Sheep, kidney	0.001610	1.000	1.000	
26003430	M	Sheep, liver	0.001700	1.000	1.000	
15003440	15	Sorghum, grain	0.002070	1.000	1.000	s
15003450	15	Sorghum, syrup	0.000070	1.000	1.000	aceto
06003470	6	Soybean, seed	0.001950	1.000	1.000	s
06003480	6	Soybean, flour	0.001738	1.000	1.000	s
06003481	6	Soybean, flour-babyfood	0.001738	1.000	1.000	s
06003490	6	Soybean, soy milk	0.001950	1.000	1.000	s
06003491	6	Soybean, soy milk-babyfood or in	0.001950	1.000	1.000	s
06003500	6	Soybean, oil	0.000350	1.000	1.000	s
06003501	6	Soybean, oil-babyfood	0.000350	1.000	1.000	s
50003820	P	Turkey, meat	0.000020	1.000	1.000	
50003821	P	Turkey, meat-babyfood	0.000020	1.000	1.000	
50003830	P	Turkey, liver	0.000090	1.000	1.000	
50003831	P	Turkey, liver-babyfood	0.000090	1.000	1.000	
50003840	P	Turkey, meat byproducts	0.000020	1.000	1.000	
50003841	P	Turkey, meat byproducts-babyfood	0.000020	1.000	1.000	
50003850	P	Turkey, fat	0.000010	1.000	1.000	
50003851	P	Turkey, fat-babyfood	0.000010	1.000	1.000	
50003860	P	Turkey, skin	0.000020	1.000	1.000	
50003861	P	Turkey, skin-babyfood	0.000020	1.000	1.000	
86010000	O	Water, direct, all sources	0.000286	1.000	1.000	s
86020000	O	Water, indirect, all sources	0.000286	1.000	1.000	s
15004010	15	Wheat, grain	0.000060	1.000	1.000	aceto
15004011	15	Wheat, grain-babyfood	0.000060	1.000	1.000	aceto
15004020	15	Wheat, flour	0.000060	1.000	1.000	aceto

15004021	15	Wheat, flour-babyfood	0.000060	1.000	1.000	aceto
15004030	15	Wheat, germ	0.000060	1.000	1.000	aceto
15004040	15	Wheat, bran	0.000060	1.000	1.000	aceto

Attachment 4. DEEM CRA (Multi year) Food and Water Results File.

U.S. Environmental Protection Agency Ver. 2.00
 DEEM-FCID Chronic analysis for CUMULATIVE ALA + ACETO (ALA EQUIVS)
 (1994-98 data)

Residue file name:

C:\Aprotzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\CRA_Multiyear_Res_File.R
 98

Adjustment factor #2 used.

Analysis Date 02-24-2006/18:41:35 Residue file dated: 02-24-2006/18:15:30/8

NOEL (Chronic) = .5 mg/kg bw/day

COMMENT 1: Cumulative (Aceto) + Ala (Avg. res+ SLUA Pct) + Water in ala equiv

=====

Total exposure by population subgroup

Population Subgroup	Total Exposure		
	mg/kg body wt/day	Percent of NOEL	Margin of Exposr 1/
U.S. Population (total)	0.000012	0.00%	40,119
U.S. Population (spring season)	0.000012	0.00%	40,540
U.S. Population (summer season)	0.000013	0.00%	39,041
U.S. Population (autumn season)	0.000012	0.00%	40,206
U.S. Population (winter season)	0.000012	0.00%	40,792
Northeast region	0.000012	0.00%	42,504
Midwest region	0.000013	0.00%	38,934
Southern region	0.000012	0.00%	42,855
Western region	0.000014	0.00%	35,850
Hispanics	0.000015	0.00%	34,027
Non-hispanic whites	0.000012	0.00%	41,259
Non-hispanic blacks	0.000012	0.00%	42,740
Non-hisp/non-white/non-black	0.000015	0.00%	33,389
All infants (< 1 year)	0.000030	0.01%	16,464
Nursing infants	0.000010	0.00%	48,127
Non-nursing infants	0.000038	0.01%	13,175
Children 1-6 yrs	0.000030	0.01%	16,508
Children 7-12 yrs	0.000017	0.00%	29,674
Females 13-19 (not preg or nursing)	0.000009	0.00%	53,237
Females 20+ (not preg or nursing)	0.000009	0.00%	52,829
Females 13-50 yrs	0.000010	0.00%	47,736
Females 13+ (preg/not nursing)	0.000012	0.00%	41,915
Females 13+ (nursing)	0.000014	0.00%	35,668
Males 13-19 yrs	0.000011	0.00%	43,704
Males 20+ yrs	0.000009	0.00%	53,580
Seniors 55+	0.000009	0.00%	54,056
Children 1-2 yrs	0.000037	0.01%	13,595
Children 3-5 yrs	0.000028	0.01%	17,815
Children 6-12 yrs	0.000018	0.00%	27,875
Youth 13-19 yrs	0.000010	0.00%	47,799
Adults 20-49 yrs	0.000010	0.00%	52,303

Adults 50+ yrs	0.000009	0.00%	54,027
Females 13-49 yrs	0.000010	0.00%	52,171

Attachment 5. DEEM Acetochlor Alone (Multi year) Food and Water Residue Input File

U.S. Environmental Protection Agency
 DEEM-FCID Chronic analysis for ACETOCHLOR
 Residue file:
 C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\acetochlor_tolerance_plus_water_
 PF_PCT.R98

Ver. 2.00
 1994-98 data

Analysis Date 02-24-2006 Residue file dated: 02-10-2006/18:53:10/8
 Reference dose (NOEL) = 10 mg/kg bw/day
 Comment: DEEM analysis with foods & water (max TWAM)

Food Crop			Residue (ppm)	Adj. Factors		Comment
EPA Code	Grp	Food Name		#1	#2	
15001200	15	Corn, field, flour	0.050000	0.600	0.250	PF & %
Full comment: PF & %CT, resp.						
15001201	15	Corn, field, flour-babyfood	0.050000	0.600	0.250	
15001210	15	Corn, field, meal	0.050000	0.600	0.250	
15001211	15	Corn, field, meal-babyfood	0.050000	0.600	0.250	
15001220	15	Corn, field, bran	0.050000	1.000	0.250	
15001230	15	Corn, field, starch	0.050000	0.600	0.250	
15001231	15	Corn, field, starch-babyfood	0.050000	0.600	0.250	
15001240	15	Corn, field, syrup	0.050000	1.000	0.250	
15001241	15	Corn, field, syrup-babyfood	0.050000	1.000	0.250	
15001250	15	Corn, field, oil	0.050000	0.600	0.250	
15001251	15	Corn, field, oil-babyfood	0.050000	0.600	0.250	
15003440	15	Sorghum, grain	0.020000	1.000	0.070	
15003450	15	Sorghum, syrup	0.020000	1.000	0.070	
06003470	6	Soybean, seed	0.100000	1.000	0.170	
06003480	6	Soybean, flour	0.100000	0.750	0.170	
06003481	6	Soybean, flour-babyfood	0.100000	0.750	0.170	
06003490	6	Soybean, soy milk	0.100000	1.000	0.170	
06003491	6	Soybean, soy milk-babyfood or in	0.100000	1.000	0.170	
06003500	6	Soybean, oil	0.100000	0.200	0.170	
06003501	6	Soybean, oil-babyfood	0.100000	0.200	0.170	
86010000	0	Water, direct, all sources	0.000282	1.000	1.000	Modele
Full comment: Modeled data						
86020000	0	Water, indirect, all sources	0.000282	1.000	1.000	modele
Full comment: modeled data						
15004010	15	Wheat, grain	0.020000	1.000	0.060	
15004011	15	Wheat, grain-babyfood	0.020000	1.000	0.060	
15004020	15	Wheat, flour	0.020000	1.000	0.060	
15004021	15	Wheat, flour-babyfood	0.020000	1.000	0.060	
15004030	15	Wheat, germ	0.020000	1.000	0.060	
15004040	15	Wheat, bran	0.020000	1.000	0.060	

Attachment 6. DEEM Acetochlor Alone (Multi year) Food and Water Results File.

U.S. Environmental Protection Agency
DEEM-FCID Chronic analysis for ACETOCHLOR
Residue file name:

Ver. 2.00
(1994-98 data)

C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\acetochlor_tolerance_plus_water_
PF_PCT.R98

Adjustment factor #2 used.

Analysis Date 02-24-2006/19:01:10 Residue file dated: 02-10-2006/18:53:10/8

NOEL (Chronic) = 10 mg/kg bw/day

COMMENT 1: DEEM analysis with foods & water (max TWAM)

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Total exposure by population subgroup

Population Subgroup	Total Exposure		
	mg/kg body wt/day	Percent of NOEL	Margin of Exposr 1/
U.S. Population (total)	0.000025	0.00%	392,207
U.S. Population (spring season)	0.000026	0.00%	389,031
U.S. Population (summer season)	0.000027	0.00%	373,685
U.S. Population (autumn season)	0.000025	0.00%	402,977
U.S. Population (winter season)	0.000025	0.00%	405,066
Northeast region	0.000023	0.00%	441,111
Midwest region	0.000027	0.00%	371,253
Southern region	0.000025	0.00%	396,985
Western region	0.000027	0.00%	370,738
Hispanics	0.000029	0.00%	349,586
Non-hispanic whites	0.000025	0.00%	404,820
Non-hispanic blacks	0.000027	0.00%	370,887
Non-hisp/non-white/non-black	0.000027	0.00%	371,089
All infants (< 1 year)	0.000049	0.00%	202,383
Nursing infants	0.000016	0.00%	630,390
Non-nursing infants	0.000062	0.00%	160,914
Children 1-6 yrs	0.000051	0.00%	195,033
Children 7-12 yrs	0.000038	0.00%	259,840
Females 13-19 (not preg or nursing)	0.000026	0.00%	377,562
Females 20+ (not preg or nursing)	0.000018	0.00%	553,328
Females 13-50 yrs	0.000023	0.00%	442,705
Females 13+ (preg/not nursing)	0.000022	0.00%	459,752
Females 13+ (nursing)	0.000024	0.00%	419,157
Males 13-19 yrs	0.000034	0.00%	295,184
Males 20+ yrs	0.000020	0.00%	489,163
Seniors 55+	0.000015	0.00%	676,613
Children 1-2 yrs	0.000050	0.00%	200,888
Children 3-5 yrs	0.000054	0.00%	186,331
Children 6-12 yrs	0.000040	0.00%	251,336
Youth 13-19 yrs	0.000030	0.00%	331,081
Adults 20-49 yrs	0.000022	0.00%	462,509
Adults 50+ yrs	0.000015	0.00%	660,144
Females 13-49 yrs	0.000021	0.00%	468,331

Attachment 7. DEEM Alachlor Alone (Multi-year) Food and Water Residue Input File

U.S. Environmental Protection Agency
DEEM-FCID Chronic analysis for ALACHLOR
Residue file:

Ver. 2.00
1994-98 data

C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\alachlor_Avg_Res_SLUA_PCT_Water.
R98

Analysis Date 02-24-2006 Residue file dated: 02-10-2006/19:05:02/8
Reference dose (NOEL) = 0.5 mg/kg bw/day
Comment: Risk Assessment using Average residues

Food Crop			Residue (ppm)	Adj. Factors		Comment
EPA Code	Grp	Food Name		#1	#2	
06030300	6C	Bean, black, seed	0.010000	0.050	1.000	
06030320	6C	Bean, broad, seed	0.010000	0.050	1.000	
06030340	6C	Bean, cowpea, seed	0.010000	0.050	1.000	
06030350	6C	Bean, great northern, seed	0.010000	0.050	1.000	
06030360	6C	Bean, kidney, seed	0.010000	0.050	1.000	
06030380	6C	Bean, lima, seed	0.008000	0.050	1.000	
06030390	6C	Bean, mung, seed	0.010000	0.050	1.000	
06030400	6C	Bean, navy, seed	0.010000	0.050	1.000	
06030410	6C	Bean, pink, seed	0.010000	0.050	1.000	
06030420	6C	Bean, pinto, seed	0.010000	0.050	1.000	
21000440	M	Beef, meat	0.000400	1.000	1.000	
21000441	M	Beef, meat-babyfood	0.000400	1.000	1.000	
21000450	M	Beef, meat, dried	0.000400	1.000	1.000	
21000460	M	Beef, meat byproducts	0.000400	1.000	1.000	
21000461	M	Beef, meat byproducts-babyfood	0.000400	1.000	1.000	
21000470	M	Beef, fat	0.000340	1.000	1.000	
21000471	M	Beef, fat-babyfood	0.000340	1.000	1.000	
21000480	M	Beef, kidney	0.001610	1.000	1.000	
21000490	M	Beef, liver	0.001700	1.000	1.000	
21000491	M	Beef, liver-babyfood	0.001700	1.000	1.000	
40000930	P	Chicken, meat	0.000020	1.000	1.000	
40000931	P	Chicken, meat-babyfood	0.000020	1.000	1.000	
40000940	P	Chicken, liver	0.000090	1.000	1.000	
40000950	P	Chicken, meat byproducts	0.000020	1.000	1.000	
40000951	P	Chicken, meat byproducts-babyfoo	0.000020	1.000	1.000	
40000960	P	Chicken, fat	0.000010	1.000	1.000	
40000961	P	Chicken, fat-babyfood	0.000010	1.000	1.000	
40000970	P	Chicken, skin	0.000020	1.000	1.000	
40000971	P	Chicken, skin-babyfood	0.000020	1.000	1.000	
06030980	6C	Chickpea, seed	0.010000	1.000	1.000	
06030981	6C	Chickpea, seed-babyfood	0.010000	1.000	1.000	
06030990	6C	Chickpea, flour	0.010000	1.000	1.000	
15001200	15	Corn, field, flour	0.011000	1.000	1.000	
15001201	15	Corn, field, flour-babyfood	0.011000	0.050	1.000	
15001210	15	Corn, field, meal	0.010000	0.050	1.000	
15001211	15	Corn, field, meal-babyfood	0.010000	0.050	1.000	
15001220	15	Corn, field, bran	0.010000	0.050	1.000	
15001230	15	Corn, field, starch	0.002200	0.050	1.000	
15001231	15	Corn, field, starch-babyfood	0.002200	0.050	1.000	
15001240	15	Corn, field, syrup	0.002200	0.050	1.000	
15001241	15	Corn, field, syrup-babyfood	0.002200	0.050	1.000	
15001250	15	Corn, field, oil	0.001400	0.050	1.000	
15001251	15	Corn, field, oil-babyfood	0.001400	0.050	1.000	
15001270	15	Corn, sweet	0.007000	0.150	1.000	
15001271	15	Corn, sweet-babyfood	0.007000	0.150	1.000	
70001450	P	Egg, whole	0.000260	1.000	1.000	
70001451	P	Egg, whole-babyfood	0.000260	1.000	1.000	
70001460	P	Egg, white	0.000260	1.000	1.000	
70001461	P	Egg, white (solids)-babyfood	0.000260	1.000	1.000	

70001470	P	Egg, yolk	0.000260	1.000	1.000	
70001471	P	Egg, yolk-babyfood	0.000260	1.000	1.000	
23001690	M	Goat, meat	0.000400	1.000	1.000	
23001700	M	Goat, meat byproducts	0.000400	1.000	1.000	
23001710	M	Goat, fat	0.000340	1.000	1.000	
23001720	M	Goat, kidney	0.001610	1.000	1.000	
23001730	M	Goat, liver	0.001700	1.000	1.000	
06031820	6C	Guar, seed	0.010000	1.000	1.000	
06031821	6C	Guar, seed-babyfood	0.010000	1.000	1.000	
24001890	M	Horse, meat	0.000400	1.000	1.000	
06032030	6C	Lentil, seed	0.010000	1.000	1.000	
27002220	D	Milk, fat	0.000620	1.000	1.000	
27002221	D	Milk, fat - baby food/infant for	0.000620	1.000	1.000	
27012230	D	Milk, nonfat solids	0.000620	1.000	1.000	
27012231	D	Milk, nonfat solids-baby food/in	0.000620	1.000	1.000	
27022240	D	Milk, water	0.000620	1.000	1.000	
27022241	D	Milk, water-babyfood/infant form	0.000620	1.000	1.000	
27032251	D	Milk, sugar (lactose)-baby food/	0.000620	1.000	1.000	
06032580	6C	Pea, pigeon, seed	0.010000	1.000	1.000	
95002630	O	Peanut	0.150000	0.010	1.000	
95002640	O	Peanut, butter	0.110000	0.010	1.000	
95002650	O	Peanut, oil	0.009000	0.010	1.000	
25002900	M	Pork, meat	0.000160	1.000	1.000	
25002901	M	Pork, meat-babyfood	0.000160	1.000	1.000	
25002910	M	Pork, skin	0.000160	1.000	1.000	
25002920	M	Pork, meat byproducts	0.000160	1.000	1.000	
25002921	M	Pork, meat byproducts-babyfood	0.000160	1.000	1.000	
25002930	M	Pork, fat	0.000180	1.000	1.000	
25002931	M	Pork, fat-babyfood	0.000180	1.000	1.000	
25002940	M	Pork, kidney	0.000170	1.000	1.000	
25002950	M	Pork, liver	0.000340	1.000	1.000	
60003010	P	Poultry, other, meat	0.000020	1.000	1.000	
60003020	P	Poultry, other, liver	0.000090	1.000	1.000	
60003030	P	Poultry, other, meat byproducts	0.000020	1.000	1.000	
60003040	P	Poultry, other, fat	0.000010	1.000	1.000	
60003050	P	Poultry, other, skin	0.000020	1.000	1.000	
26003390	M	Sheep, meat	0.000400	1.000	1.000	
26003391	M	Sheep, meat-babyfood	0.000400	1.000	1.000	
26003400	M	Sheep, meat byproducts	0.000400	1.000	1.000	
26003410	M	Sheep, fat	0.000340	1.000	1.000	
26003411	M	Sheep, fat-babyfood	0.000340	1.000	1.000	
26003420	M	Sheep, kidney	0.001610	1.000	1.000	
26003430	M	Sheep, liver	0.001700	1.000	1.000	
15003440	15	Sorghum, grain	0.020000	0.100	1.000	
06003470	6	Soybean, seed	0.110000	0.010	1.000	
06003480	6	Soybean, flour	0.110000	0.010	1.000	
06003481	6	Soybean, flour-babyfood	0.110000	0.010	1.000	
06003490	6	Soybean, soy milk	0.110000	0.010	1.000	
06003491	6	Soybean, soy milk-babyfood or in	0.110000	0.010	1.000	
06003500	6	Soybean, oil	0.018000	0.010	1.000	
06003501	6	Soybean, oil-babyfood	0.018000	0.010	1.000	
50003820	P	Turkey, meat	0.000020	1.000	1.000	
50003821	P	Turkey, meat-babyfood	0.000020	1.000	1.000	
50003830	P	Turkey, liver	0.000090	1.000	1.000	
50003831	P	Turkey, liver-babyfood	0.000090	1.000	1.000	
50003840	P	Turkey, meat byproducts	0.000020	1.000	1.000	
50003841	P	Turkey, meat byproducts-babyfood	0.000020	1.000	1.000	
50003850	P	Turkey, fat	0.000010	1.000	1.000	
50003851	P	Turkey, fat-babyfood	0.000010	1.000	1.000	
50003860	P	Turkey, skin	0.000020	1.000	1.000	
50003861	P	Turkey, skin-babyfood	0.000020	1.000	1.000	
86010000	O	Water, direct, all sources	0.000276	1.000	1.000	Multiy
Full comment: Multi year Ave TWAM						
86020000	O	Water, indirect, all sources	0.000276	1.000	1.000	Multiy
Full comment: Multi year Ave TWAM						

Attachment 8. DEEM Alachlor Alone (Multi year) Food and Water Results File.

U.S. Environmental Protection Agency
DEEM-FCID Chronic analysis for ALACHLOR
Residue file name:

Ver. 2.00
(1994-98 data)

C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\alachlor_Avg_Res_SLUA_PCT_Water.
R98

Adjustment factor #2 used.

Analysis Date 02-24-2006/18:57:00 Residue file dated: 02-10-2006/19:05:02/8

NOEL (Chronic) = .5 mg/kg bw/day

COMMENT 1: Risk Assessment using Average residues

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Total exposure by population subgroup

Population Subgroup	Total Exposure		
	mg/kg body wt/day	Percent of NOEL	Margin of Exposr 1/
U.S. Population (total)	0.000012	0.00%	40,813
U.S. Population (spring season)	0.000012	0.00%	41,596
U.S. Population (summer season)	0.000013	0.00%	39,792
U.S. Population (autumn season)	0.000012	0.00%	40,708
U.S. Population (winter season)	0.000012	0.00%	41,265
Northeast region	0.000012	0.00%	43,434
Midwest region	0.000012	0.00%	40,349
Southern region	0.000011	0.00%	44,113
Western region	0.000014	0.00%	35,173
Hispanics	0.000016	0.00%	30,682
Non-hispanic whites	0.000012	0.00%	42,911
Non-hispanic blacks	0.000011	0.00%	43,585
Non-hisp/non-white/non-black	0.000015	0.00%	34,155
All infants (< 1 year)	0.000028	0.01%	17,621
Nursing infants	0.000010	0.00%	51,227
Non-nursing infants	0.000035	0.01%	14,109
Children 1-6 yrs	0.000031	0.01%	16,357
Children 7-12 yrs	0.000017	0.00%	29,199
Females 13-19 (not preg or nursing)	0.000009	0.00%	56,016
Females 20+ (not preg or nursing)	0.000009	0.00%	54,593
Females 13-50 yrs	0.000011	0.00%	47,417
Females 13+ (preg/not nursing)	0.000012	0.00%	41,713
Females 13+ (nursing)	0.000015	0.00%	33,824
Males 13-19 yrs	0.000011	0.00%	45,092
Males 20+ yrs	0.000009	0.00%	55,118
Seniors 55+	0.000009	0.00%	55,311
Children 1-2 yrs	0.000037	0.01%	13,636
Children 3-5 yrs	0.000029	0.01%	17,467
Children 6-12 yrs	0.000018	0.00%	27,470
Youth 13-19 yrs	0.000010	0.00%	49,690
Adults 20-49 yrs	0.000009	0.00%	53,970
Adults 50+ yrs	0.000009	0.00%	55,460
Females 13-49 yrs	0.000009	0.00%	54,053

Attachment 9. CRA (Single-Year TWAM)-DEEM Food and Water Residue Input File (Page 1 of 3).

U.S. Environmental Protection Agency Ver. 2.00
DEEM-FCID Chronic analysis for CUMULATIVE ALA + ACETO (ALA EQUIVS)
1994-98 data

Residue file:
C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\Cum_acet_ala_Avg_Res_SLU
A_PCT_Water(equiv).R98

Adjust. #2 used
Analysis Date 09-16-2005 Residue file dated: 09-16-2005/16:31:17/8
Reference dose (NOEL) = 0.5 mg/kg bw/day
Comment: Cumulative (Aceto) + Ala (Avg. res+ SLUA Pct) + Water in ala equiv

Food Crop			Residue	Adj. Factors	
Comment					
EPA Code	Grp	Food Name	(ppm)	#1	#2

-					
06030300	6C	Bean, black, seed	0.010000	0.050	1.000
06030320	6C	Bean, broad, seed	0.010000	0.050	1.000
06030340	6C	Bean, cowpea, seed	0.010000	0.050	1.000
06030350	6C	Bean, great northern, seed	0.010000	0.050	1.000
06030360	6C	Bean, kidney, seed	0.010000	0.050	1.000
06030380	6C	Bean, lima, seed	0.008000	0.050	1.000
06030390	6C	Bean, mung, seed	0.010000	0.050	1.000
06030400	6C	Bean, navy, seed	0.010000	0.050	1.000
06030410	6C	Bean, pink, seed	0.010000	0.050	1.000
06030420	6C	Bean, pinto, seed	0.010000	0.050	1.000
21000440	M	Beef, meat	0.000400	1.000	1.000
21000441	M	Beef, meat-babyfood	0.000400	1.000	1.000
21000450	M	Beef, meat, dried	0.000400	1.000	1.000
21000460	M	Beef, meat byproducts	0.000400	1.000	1.000
21000461	M	Beef, meat byproducts-babyfood	0.000400	1.000	1.000
21000470	M	Beef, fat	0.000340	1.000	1.000
21000471	M	Beef, fat-babyfood	0.000340	1.000	1.000
21000480	M	Beef, kidney	0.001610	1.000	1.000
21000490	M	Beef, liver	0.001700	1.000	1.000
21000491	M	Beef, liver-babyfood	0.001700	1.000	1.000
40000930	P	Chicken, meat	0.000020	1.000	1.000
40000931	P	Chicken, meat-babyfood	0.000020	1.000	1.000
40000940	P	Chicken, liver	0.000090	1.000	1.000
40000950	P	Chicken, meat byproducts	0.000020	1.000	1.000
40000951	P	Chicken, meat byproducts-babyfoo	0.000020	1.000	1.000
40000960	P	Chicken, fat	0.000010	1.000	1.000
40000961	P	Chicken, fat-babyfood	0.000010	1.000	1.000
40000970	P	Chicken, skin	0.000020	1.000	1.000
40000971	P	Chicken, skin-babyfood	0.000020	1.000	1.000
06030980	6C	Chickpea, seed	0.010000	1.000	1.000
06030981	6C	Chickpea, seed-babyfood	0.010000	1.000	1.000
06030990	6C	Chickpea, flour	0.010000	1.000	1.000
15001200	15	Corn, field, flour	0.000925	1.000	1.000
15001201	15	Corn, field, flour-babyfood	0.000925	1.000	1.000
15001210	15	Corn, field, meal	0.000875	1.000	1.000
15001211	15	Corn, field, meal-babyfood	0.000875	1.000	1.000
15001220	15	Corn, field, bran	0.001125	1.000	1.000
15001230	15	Corn, field, starch	0.000485	1.000	1.000
15001231	15	Corn, field, starch-babyfood	0.000485	1.000	1.000
15001240	15	Corn, field, syrup	0.000735	1.000	1.000
15001241	15	Corn, field, syrup-babyfood	0.000735	1.000	1.000
15001250	15	Corn, field, oil	0.000445	1.000	1.000
15001251	15	Corn, field, oil-babyfood	0.000445	1.000	1.000

15001270	15	Corn, sweet	0.007000	0.150	1.000	
15001271	15	Corn, sweet-babyfood	0.007000	0.150	1.000	
70001450	P	Egg, whole	0.000260	1.000	1.000	
70001451	P	Egg, whole-babyfood	0.000260	1.000	1.000	
70001460	P	Egg, white	0.000260	1.000	1.000	
70001461	P	Egg, white (solids)-babyfood	0.000260	1.000	1.000	
70001470	P	Egg, yolk	0.000260	1.000	1.000	
70001471	P	Egg, yolk-babyfood	0.000260	1.000	1.000	
23001690	M	Goat, meat	0.000400	1.000	1.000	
23001700	M	Goat, meat byproducts	0.000400	1.000	1.000	
23001710	M	Goat, fat	0.000340	1.000	1.000	
23001720	M	Goat, kidney	0.001610	1.000	1.000	
23001730	M	Goat, liver	0.001700	1.000	1.000	
06031820	6C	Guar, seed	0.010000	1.000	1.000	
06031821	6C	Guar, seed-babyfood	0.010000	1.000	1.000	
24001890	M	Horse, meat	0.000400	1.000	1.000	
06032030	6C	Lentil, seed	0.010000	1.000	1.000	
27002220	D	Milk, fat	0.000620	1.000	1.000	
27002221	D	Milk, fat - baby food/infant for	0.000620	1.000	1.000	
27012230	D	Milk, nonfat solids	0.000620	1.000	1.000	
27012231	D	Milk, nonfat solids-baby food/in	0.000620	1.000	1.000	
27022240	D	Milk, water	0.000620	1.000	1.000	
27022241	D	Milk, water-babyfood/infant form	0.000620	1.000	1.000	
27032251	D	Milk, sugar (lactose)-baby food/	0.000620	1.000	1.000	
06032580	6C	Pea, pigeon, seed	0.010000	1.000	1.000	
95002630	O	Peanut	0.150000	0.010	1.000	
95002640	O	Peanut, butter	0.110000	0.010	1.000	
95002650	O	Peanut, oil	0.009000	0.010	1.000	
25002900	M	Pork, meat	0.000160	1.000	1.000	
25002901	M	Pork, meat-babyfood	0.000160	1.000	1.000	
25002910	M	Pork, skin	0.000160	1.000	1.000	
25002920	M	Pork, meat byproducts	0.000160	1.000	1.000	
25002921	M	Pork, meat byproducts-babyfood	0.000160	1.000	1.000	
25002930	M	Pork, fat	0.000180	1.000	1.000	
25002931	M	Pork, fat-babyfood	0.000180	1.000	1.000	
25002940	M	Pork, kidney	0.000170	1.000	1.000	
25002950	M	Pork, liver	0.000340	1.000	1.000	
60003010	P	Poultry, other, meat	0.000020	1.000	1.000	
60003020	P	Poultry, other, liver	0.000090	1.000	1.000	
60003030	P	Poultry, other, meat byproducts	0.000020	1.000	1.000	
60003040	P	Poultry, other, fat	0.000010	1.000	1.000	
60003050	P	Poultry, other, skin	0.000020	1.000	1.000	
26003390	M	Sheep, meat	0.000400	1.000	1.000	
26003391	M	Sheep, meat-babyfood	0.000400	1.000	1.000	
26003400	M	Sheep, meat byproducts	0.000400	1.000	1.000	
26003410	M	Sheep, fat	0.000340	1.000	1.000	
26003411	M	Sheep, fat-babyfood	0.000340	1.000	1.000	
26003420	M	Sheep, kidney	0.001610	1.000	1.000	
26003430	M	Sheep, liver	0.001700	1.000	1.000	
15003440	15	Sorghum, grain	0.002070	1.000	1.000	s
15003450	15	Sorghum, syrup	0.000070	1.000	1.000	aceto
06003470	6	Soybean, seed	0.001950	1.000	1.000	s
06003480	6	Soybean, flour	0.001738	1.000	1.000	s
06003481	6	Soybean, flour-babyfood	0.001738	1.000	1.000	s
06003490	6	Soybean, soy milk	0.001950	1.000	1.000	s
06003491	6	Soybean, soy milk-babyfood or in	0.001950	1.000	1.000	s
06003500	6	Soybean, oil	0.000350	1.000	1.000	s
06003501	6	Soybean, oil-babyfood	0.000350	1.000	1.000	s
50003820	P	Turkey, meat	0.000020	1.000	1.000	
50003821	P	Turkey, meat-babyfood	0.000020	1.000	1.000	
50003830	P	Turkey, liver	0.000090	1.000	1.000	
50003831	P	Turkey, liver-babyfood	0.000090	1.000	1.000	
50003840	P	Turkey, meat byproducts	0.000020	1.000	1.000	
50003841	P	Turkey, meat byproducts-babyfood	0.000020	1.000	1.000	

50003850	P	Turkey, fat	0.000010	1.000	1.000	
50003851	P	Turkey, fat-babyfood	0.000010	1.000	1.000	
50003860	P	Turkey, skin	0.000020	1.000	1.000	
50003861	P	Turkey, skin-babyfood	0.000020	1.000	1.000	
86010000	O	Water, direct, all sources	0.000600	1.000	1.000	s
86020000	O	Water, indirect, all sources	0.000600	1.000	1.000	s
15004010	15	Wheat, grain	0.000060	1.000	1.000	aceto
15004011	15	Wheat, grain-babyfood	0.000060	1.000	1.000	aceto
15004020	15	Wheat, flour	0.000060	1.000	1.000	aceto
15004021	15	Wheat, flour-babyfood	0.000060	1.000	1.000	aceto
15004030	15	Wheat, germ	0.000060	1.000	1.000	aceto
15004040	15	Wheat, bran	0.000060	1.000	1.000	aceto

Attachment 10. CRA (Single-Year TWAM) - DEEM Food and Water Results File (Page 1 of 2)

U.S. Environmental Protection Agency Ver. 2.00
DEEM-FCID Chronic analysis for CUMULATIVE ALA + ACETO (ALA EQUIVS)
(1994-98 data)

Residue file name:
C:\Aprotzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\Cum_acet_ala_Avg_Res_SLUA
A_PCT_Water(equiv).R98

Adjustment factor #2 used.

Analysis Date 09-16-2005/16:38:22 Residue file dated: 09-16-2005/16:31:17/8

NOEL (Chronic) = .5 mg/kg bw/day

COMMENT 1: Cumulative (Aceto) + Ala (Avg. res+ SLUA Pct) + Water in ala equiv

=====

Total exposure by population subgroup

Population Subgroup	Total Exposure		
	mg/kg body wt/day	Percent of NOEL	Margin of Exposr 1/
U.S. Population (total)	0.000019	0.00%	26,204
U.S. Population (spring season)	0.000019	0.00%	26,464
U.S. Population (summer season)	0.000020	0.00%	25,105
U.S. Population (autumn season)	0.000019	0.00%	26,549
U.S. Population (winter season)	0.000019	0.00%	26,801
Northeast region	0.000018	0.00%	28,088
Midwest region	0.000020	0.00%	25,597
Southern region	0.000018	0.00%	27,843
Western region	0.000022	0.00%	23,224
Hispanics	0.000022	0.00%	22,516
Non-hispanic whites	0.000019	0.00%	26,917
Non-hispanic blacks	0.000018	0.00%	27,807
Non-hisp/non-white/non-black	0.000023	0.00%	21,656
All infants (< 1 year)	0.000052	0.01%	9,603
Nursing infants	0.000018	0.00%	27,120
Non-nursing infants	0.000065	0.01%	7,713
Children 1-6 yrs	0.000040	0.01%	12,647
Children 7-12 yrs	0.000023	0.00%	21,871
Females 13-19 (not preg or nursing)	0.000014	0.00%	35,590
Females 20+ (not preg or nursing)	0.000016	0.00%	31,112
Females 13-50 yrs	0.000017	0.00%	29,626
Females 13+ (preg/not nursing)	0.000018	0.00%	27,226
Females 13+ (nursing)	0.000023	0.00%	21,564
Males 13-19 yrs	0.000016	0.00%	30,655
Males 20+ yrs	0.000015	0.00%	32,761
Seniors 55+	0.000016	0.00%	31,752
Children 1-2 yrs	0.000047	0.01%	10,728
Children 3-5 yrs	0.000037	0.01%	13,417
Children 6-12 yrs	0.000024	0.00%	20,590
Youth 13-19 yrs	0.000015	0.00%	32,799
Adults 20-49 yrs	0.000016	0.00%	31,768
Adults 50+ yrs	0.000016	0.00%	31,734
Females 13-49 yrs	0.000016	0.00%	31,771

Attachment 11. DEEM CRA (PRZM-EXAMS) Food and Water Residue Input File.

U.S. Environmental Protection Agency

Ver. 2.00

DEEM-FCID Chronic analysis for CUMULATIVE ALA + ACETO (ALA EQUIVS)

1994-98 data

Residue file:

C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\Cum_acet_ala_999_Avg_Res_SLUA_PC
T_Water(equiv).R98

Adjust. #2 used

Analysis Date 02-24-2006

Residue file dated: 02-24-2006/19:11:27/8

Reference dose (NOEL) = 0.5 mg/kg bw/day

Comment: Cumulative (Aceto) + Ala (Avg. res+ SLUA Pct) + Water in ala equiv

Food Crop			Residue (ppm)	Adj. Factors		Comment
EPA Code	Grp	Food Name		#1	#2	
06030300	6C	Bean, black, seed	0.010000	0.050	1.000	
06030320	6C	Bean, broad, seed	0.010000	0.050	1.000	
06030340	6C	Bean, cowpea, seed	0.010000	0.050	1.000	
06030350	6C	Bean, great northern, seed	0.010000	0.050	1.000	
06030360	6C	Bean, kidney, seed	0.010000	0.050	1.000	
06030380	6C	Bean, lima, seed	0.008000	0.050	1.000	
06030390	6C	Bean, mung, seed	0.010000	0.050	1.000	
06030400	6C	Bean, navy, seed	0.010000	0.050	1.000	
06030410	6C	Bean, pink, seed	0.010000	0.050	1.000	
06030420	6C	Bean, pinto, seed	0.010000	0.050	1.000	
21000440	M	Beef, meat	0.000400	1.000	1.000	
21000441	M	Beef, meat-babyfood	0.000400	1.000	1.000	
21000450	M	Beef, meat, dried	0.000400	1.000	1.000	
21000460	M	Beef, meat byproducts	0.000400	1.000	1.000	
21000461	M	Beef, meat byproducts-babyfood	0.000400	1.000	1.000	
21000470	M	Beef, fat	0.000340	1.000	1.000	
21000471	M	Beef, fat-babyfood	0.000340	1.000	1.000	
21000480	M	Beef, kidney	0.001610	1.000	1.000	
21000490	M	Beef, liver	0.001700	1.000	1.000	
21000491	M	Beef, liver-babyfood	0.001700	1.000	1.000	
40000930	P	Chicken, meat	0.000020	1.000	1.000	
40000931	P	Chicken, meat-babyfood	0.000020	1.000	1.000	
40000940	P	Chicken, liver	0.000090	1.000	1.000	
40000950	P	Chicken, meat byproducts	0.000020	1.000	1.000	
40000951	P	Chicken, meat byproducts-babyfoo	0.000020	1.000	1.000	
40000960	P	Chicken, fat	0.000010	1.000	1.000	
40000961	P	Chicken, fat-babyfood	0.000010	1.000	1.000	
40000970	P	Chicken, skin	0.000020	1.000	1.000	
40000971	P	Chicken, skin-babyfood	0.000020	1.000	1.000	
06030980	6C	Chickpea, seed	0.010000	1.000	1.000	
06030981	6C	Chickpea, seed-babyfood	0.010000	1.000	1.000	
06030990	6C	Chickpea, flour	0.010000	1.000	1.000	
15001200	15	Corn, field, flour	0.000925	1.000	1.000	s
15001201	15	Corn, field, flour-babyfood	0.000925	1.000	1.000	s
15001210	15	Corn, field, meal	0.000875	1.000	1.000	s
15001211	15	Corn, field, meal-babyfood	0.000875	1.000	1.000	s
15001220	15	Corn, field, bran	0.001125	1.000	1.000	s
15001230	15	Corn, field, starch	0.000485	1.000	1.000	s
15001231	15	Corn, field, starch-babyfood	0.000485	1.000	1.000	s
15001240	15	Corn, field, syrup	0.000735	1.000	1.000	s
15001241	15	Corn, field, syrup-babyfood	0.000735	1.000	1.000	s
15001250	15	Corn, field, oil	0.000445	1.000	1.000	s
15001251	15	Corn, field, oil-babyfood	0.000445	1.000	1.000	s
15001270	15	Corn, sweet	0.007000	0.150	1.000	
15001271	15	Corn, sweet-babyfood	0.007000	0.150	1.000	
70001450	P	Egg, whole	0.000260	1.000	1.000	
70001451	P	Egg, whole-babyfood	0.000260	1.000	1.000	
70001460	P	Egg, white	0.000260	1.000	1.000	
70001461	P	Egg, white (solids)-babyfood	0.000260	1.000	1.000	

70001470	P	Egg, yolk	0.000260	1.000	1.000	
70001471	P	Egg, yolk-babyfood	0.000260	1.000	1.000	
23001690	M	Goat, meat	0.000400	1.000	1.000	
23001700	M	Goat, meat byproducts	0.000400	1.000	1.000	
23001710	M	Goat, fat	0.000340	1.000	1.000	
23001720	M	Goat, kidney	0.001610	1.000	1.000	
23001730	M	Goat, liver	0.001700	1.000	1.000	
06031820	6C	Guar, seed	0.010000	1.000	1.000	
06031821	6C	Guar, seed-babyfood	0.010000	1.000	1.000	
24001890	M	Horse, meat	0.000400	1.000	1.000	
06032030	6C	Lentil, seed	0.010000	1.000	1.000	
27002220	D	Milk, fat	0.000620	1.000	1.000	
27002221	D	Milk, fat - baby food/infant for	0.000620	1.000	1.000	
27012230	D	Milk, nonfat solids	0.000620	1.000	1.000	
27012231	D	Milk, nonfat solids-baby food/in	0.000620	1.000	1.000	
27022240	D	Milk, water	0.000620	1.000	1.000	
27022241	D	Milk, water-babyfood/infant form	0.000620	1.000	1.000	
27032251	D	Milk, sugar (lactose)-baby food/	0.000620	1.000	1.000	
06032580	6C	Pea, pigeon, seed	0.010000	1.000	1.000	
95002630	O	Peanut	0.150000	0.010	1.000	
95002640	O	Peanut, butter	0.110000	0.010	1.000	
95002650	O	Peanut, oil	0.009000	0.010	1.000	
25002900	M	Pork, meat	0.000160	1.000	1.000	
25002901	M	Pork, meat-babyfood	0.000160	1.000	1.000	
25002910	M	Pork, skin	0.000160	1.000	1.000	
25002920	M	Pork, meat byproducts	0.000160	1.000	1.000	
25002921	M	Pork, meat byproducts-babyfood	0.000160	1.000	1.000	
25002930	M	Pork, fat	0.000180	1.000	1.000	
25002931	M	Pork, fat-babyfood	0.000180	1.000	1.000	
25002940	M	Pork, kidney	0.000170	1.000	1.000	
25002950	M	Pork, liver	0.000340	1.000	1.000	
60003010	P	Poultry, other, meat	0.000020	1.000	1.000	
60003020	P	Poultry, other, liver	0.000090	1.000	1.000	
60003030	P	Poultry, other, meat byproducts	0.000020	1.000	1.000	
60003040	P	Poultry, other, fat	0.000010	1.000	1.000	
60003050	P	Poultry, other, skin	0.000020	1.000	1.000	
26003390	M	Sheep, meat	0.000400	1.000	1.000	
26003391	M	Sheep, meat-babyfood	0.000400	1.000	1.000	
26003400	M	Sheep, meat byproducts	0.000400	1.000	1.000	
26003410	M	Sheep, fat	0.000340	1.000	1.000	
26003411	M	Sheep, fat-babyfood	0.000340	1.000	1.000	
26003420	M	Sheep, kidney	0.001610	1.000	1.000	
26003430	M	Sheep, liver	0.001700	1.000	1.000	
15003440	15	Sorghum, grain	0.002070	1.000	1.000	s
15003450	15	Sorghum, syrup	0.000070	1.000	1.000	aceto
06003470	6	Soybean, seed	0.001950	1.000	1.000	s
06003480	6	Soybean, flour	0.001738	1.000	1.000	s
06003481	6	Soybean, flour-babyfood	0.001738	1.000	1.000	s
06003490	6	Soybean, soy milk	0.001950	1.000	1.000	s
06003491	6	Soybean, soy milk-babyfood or in	0.001950	1.000	1.000	s
06003500	6	Soybean, oil	0.000350	1.000	1.000	s
06003501	6	Soybean, oil-babyfood	0.000350	1.000	1.000	s
50003820	P	Turkey, meat	0.000020	1.000	1.000	
50003821	P	Turkey, meat-babyfood	0.000020	1.000	1.000	
50003830	P	Turkey, liver	0.000090	1.000	1.000	
50003831	P	Turkey, liver-babyfood	0.000090	1.000	1.000	
50003840	P	Turkey, meat byproducts	0.000020	1.000	1.000	
50003841	P	Turkey, meat byproducts-babyfood	0.000020	1.000	1.000	
50003850	P	Turkey, fat	0.000010	1.000	1.000	
50003851	P	Turkey, fat-babyfood	0.000010	1.000	1.000	
50003860	P	Turkey, skin	0.000020	1.000	1.000	
50003861	P	Turkey, skin-babyfood	0.000020	1.000	1.000	
86010000	O	Water, direct, all sources	0.008940	1.000	1.000	s
86020000	O	Water, indirect, all sources	0.008940	1.000	1.000	s
15004010	15	Wheat, grain	0.000060	1.000	1.000	aceto
15004011	15	Wheat, grain-babyfood	0.000060	1.000	1.000	aceto

15004020	15	Wheat, flour	0.000060	1.000	1.000	aceto
15004021	15	Wheat, flour-babyfood	0.000060	1.000	1.000	aceto
15004030	15	Wheat, germ	0.000060	1.000	1.000	aceto
15004040	15	Wheat, bran	0.000060	1.000	1.000	aceto

Attachment 12. DEEM CRA (PRZM-EXAMS) Food and Water Results File

U.S. Environmental Protection Agency Ver. 2.00
 DEEM-FCID Chronic analysis for CUMULATIVE ALA + ACETO (ALA EQUIVS)
 (1994-98 data)

Residue file name:

C:\AProtzel\ALBERTO\Cumulative\Chloroacetanilides\DEEM_Files\Cum_acet_ala_999_Avg_Res_SLUA_PC
 T_Water(equiv).R98

Adjustment factor #2 used.

Analysis Date 02-24-2006/19:13:40 Residue file dated: 02-24-2006/19:11:27/8

NOEL (Chronic) = .5 mg/kg bw/day

COMMENT 1: Cumulative (Aceto) + Ala (Avg. res+ SLUA Pct) + Water in ala equiv

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Total exposure by population subgroup

Population Subgroup	Total Exposure		
	mg/kg body wt/day	Percent of NOEL	Margin of Exposr 1/
U.S. Population (total)	0.000195	0.04%	2,566
U.S. Population (spring season)	0.000193	0.04%	2,589
U.S. Population (summer season)	0.000209	0.04%	2,395
U.S. Population (autumn season)	0.000189	0.04%	2,649
U.S. Population (winter season)	0.000189	0.04%	2,651
Northeast region	0.000178	0.04%	2,806
Midwest region	0.000197	0.04%	2,535
Southern region	0.000185	0.04%	2,702
Western region	0.000223	0.04%	2,243
Hispanics	0.000222	0.04%	2,255
Non-hispanic whites	0.000190	0.04%	2,630
Non-hispanic blacks	0.000185	0.04%	2,705
Non-hisp/non-white/non-black	0.000239	0.05%	2,096
All infants (< 1 year)	0.000628	0.13%	796
Nursing infants	0.000232	0.05%	2,153
Non-nursing infants	0.000779	0.16%	642
Children 1-6 yrs	0.000285	0.06%	1,754
Children 7-12 yrs	0.000183	0.04%	2,739
Females 13-19 (not preg or nursing)	0.000138	0.03%	3,630
Females 20+ (not preg or nursing)	0.000192	0.04%	2,610
Females 13-50 yrs	0.000187	0.04%	2,675
Females 13+ (preg/not nursing)	0.000189	0.04%	2,641
Females 13+ (nursing)	0.000267	0.05%	1,875
Males 13-19 yrs	0.000146	0.03%	3,433
Males 20+ yrs	0.000173	0.03%	2,894
Seniors 55+	0.000188	0.04%	2,655
Children 1-2 yrs	0.000308	0.06%	1,625
Children 3-5 yrs	0.000282	0.06%	1,775
Children 6-12 yrs	0.000193	0.04%	2,593
Youth 13-19 yrs	0.000142	0.03%	3,513
Adults 20-49 yrs	0.000180	0.04%	2,780
Adults 50+ yrs	0.000188	0.04%	2,653

Females 13-49 yrs	0.000179	0.04%	2,790



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF PREVENTION, PESTICIDE
AND TOXIC SUBSTANCES

MEMORANDUM

July 1, 2009

SUBJECT: **Acetochlor** Human Health Risk Assessment for Proposed New Use of Acetochlor on Cotton and Soybeans

PC Code: 121601

Decision No.: 400597, 400596

Petition No.: PP#8F7443, PP#8E7448

Risk Assessment Type: Single Chemical Aggregate

TXR No.: NA

MRID No.: NA

DP Barcode: 360864, 360869

Registration No.: 524-483 and 524-LOR

Regulatory Action: Section 3 Registration

Case No.: NA

CAS No.: 34256-82-1

40 CFR: 180.470

FROM: Becky Daiss, Biologist
James Scott Miller, Environmental Scientist
Susan Hummel, Chemist
Risk Assessment Branch 4
Health Effects Division (7509P)

THROUGH: Susan V. Hummel, Branch Senior Scientist
Risk Assessment Branch 4, HED (7509P)

TO: James Tompkins, Risk Manager
Herbicide Branch
Registration Division (7505P)

This document provides Health Effects Division's (HED's) risk assessment of proposed new uses of acetochlor on cotton and soybean. Supporting documents are listed below.

Occupational Exposure Assessment – J.S. Miller, D, 6/24/2009

Residue Chemistry Assessment – S. Hummel, D, 6/17/09

Dietary and Drinking Water Exposure Assessment – B. Daiss, D 7/1/2009

Drinking Water Exposure Assessment – M. Barret, D 6/24/09

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1.0 EXECUTIVE SUMMARY

This assessment provides information to support an amended Section 3 registration for the use of acetochlor on soybeans and cotton. This document addresses the exposures and risks associated with currently registered uses and the proposed new uses of acetochlor. It provides a reassessment of tolerances (pesticide residue limits in food) to ensure that they meet the safety standard established by the Food Quality Protection Act (FQPA) of 1996.

Use Profile

Acetochlor is a chloroacetanilide herbicide used for control of weeds in corn and sorghum. Tolerances for acetochlor are currently established under 40 CFR §180.470(a) and (d). Tolerances for acetochlor are expressed in terms of acetochlor and its metabolites containing the EMA (2-ethyl-6-methylaniline) and HEMA (2-(1-hydroxyethyl)-6-methylaniline) moieties. Tolerances for field corn, pop corn, sweet corn, and sorghum commodities range from 0.05 ppm to 3.0 ppm. Tolerances for rotational crops, nongrass animal feeds, sugar beet root and tops, cereal grain commodities, peas and beans, potato, soybean commodities, sunflower seed, and wheat commodities range from 0.1 ppm to 1.0 ppm. No tolerances have been established for livestock commodities. Acetochlor works as a seedling shoot and root inhibitor. The mechanism of action is not well defined but appears to be similar to herbicides that affect various biochemical processes in the plant and interfere with normal cell development. Applications of acetochlor through irrigation systems and using aerial equipment are prohibited; only applications using ground equipment are allowed. There are no acetochlor products registered for homeowner use and there are no products registered for application to residential areas.

Proposed New Uses

Monsanto is requesting a Section 3 registration for a new 3 lb/gal microencapsulated (Mcap) formulation of acetochlor, MON 63410 Herbicide (33% ai) to be used on cotton and soybean products. Monsanto is also proposing to add new uses of acetochlor on cotton and soybeans to an existing emulsifiable concentrate (EC) product, MON 8435 (EPA Reg No. 524-483, 81% ai). Monsanto is proposing to establish new tolerances for residues of acetochlor in/on cotton undelinted seed and cotton gin byproducts. The company is also proposing to establish a new direct tolerance for soybean seed and to remove the established indirect tolerance for soybean seed. Preemergence and/or postemergence applications to cotton and soybean are proposed for application with ground equipment. The maximum proposed single application rate for the EC formulation is 1.5 lb ai/A/application with a maximum seasonal rate of 3 lb ai/A. The maximum single application rate for the Mcap formulation is 0.6 lb ai/A with a maximum seasonal rate of 1.2 lb ai/A. Postemergence application may be made no later than 15 days after first white flower for cotton or the R1-R2 growth stages of soybean; preharvest intervals (PHIs) are based on the growth stage of the crop. A restriction against the grazing/feeding of treated forage is specified.

Hazard Identification

The toxicology database for acetochlor is adequate for evaluating and characterizing toxicity and selecting endpoints for purposes of this risk assessment.

Acetochlor has low acute toxicity by the oral, dermal and inhalation routes and it is mildly irritating to the eyes. Acetochlor has shown mild skin irritation in one study, however in another study it was a strong skin irritant. Acetochlor is a strong dermal sensitizer.

Evidence of neurotoxicity has been observed in acute and subchronic neurotoxicity screening studies in rats, developmental studies in rats and subchronic and chronic studies in dogs. In addition to the nervous system, the major target organs affected in subchronic and chronic studies in rats, dogs and mice exposed to acetochlor are the liver, thyroid (secondary to liver), kidney, testes, and erythrocytes. Species specific target organs include the nasal olfactory epithelium in rats and the lungs in mice.

There is no evidence that acetochlor is teratogenic or that offspring are more susceptible than adults. Acetochlor causes developmental toxicity in rats (but not in rabbits) at maternally toxic doses. Available developmental toxicity studies in two species and three two-generation reproductive toxicity studies in the rat do not show evidence of increased susceptibility of the offspring. Based on neurotoxicity findings in two species a developmental neurotoxicity toxicity (DNT) is required and the FQPA factor is retained as a 10x data base uncertainty factor (UF_{DB}) for the absence of the DNT study.

Acetochlor is classified as “Suggestive Evidence of Carcinogenic Potential” based on weak evidence for benign lung tumors in male and female mice and histiocytic sarcomas in female mice.

An immunotoxicity study is required as part of new 40 CFR Part 158 the data requirements for registration of a pesticide. A DNT is required due to neurotoxicity findings in two species. In addition, submission of the positive control (validation) studies for the rat acute and subchronic neurobehavioral screening studies (MRIDs 45357501, 45357502), as cited in the neurobehavioral study reports, are requested as confirmatory data to upgrade these studies to acceptable/guideline.

Dose Response Assessment

Toxicological points of departure (PODs) were selected for dietary/drinking water and occupational exposure scenarios. Acute and chronic reference doses (RfDs) were selected for assessment of food and drinking water exposures. An acute RfD for all populations was selected from an acute oral neurotoxicity study in rats. A chronic RfD for all populations was selected from a chronic feeding study in dogs. Short and intermediate-term occupational exposures via the dermal and inhalation routes may occur based on the use pattern and label directions. A POD

for short-term inhalation was selected from a developmental study in rats. The POD for short-term dermal exposure was chosen from a 21 day dermal toxicity study in rabbits. PODs for intermediate-term inhalation and dermal exposure were selected from a two generation reproductive toxicity study. A dermal absorption factor of 20% is based on data from a dermal absorption study in rats. An uncertainty factor of 1000x was applied to the acute RfD (10x for interspecies extrapolation, 10x for intraspecies variation and 10x for data base uncertainty due to lack of a developmental neurotoxicity study. An uncertainty factor of 100x was applied to endpoints selected for all other exposure routes (10x for interspecies extrapolation, 10x for intraspecies variation).

Exposure/Risk Assessment and Risk Characterization

Risk assessments were conducted for dietary (food and water) and occupational exposure pathways based on registered uses and requests for new uses of acetochlor on cotton and soybean commodities. Screening level acute and semi-refined chronic dietary and drinking water risk assessments for acetochlor conclude that dietary and drinking water exposure estimates are below HED's level of concern for the general population and all population subgroups. Worker exposures were assessed for handler and post-application activities. Occupational exposure and risk estimates indicate that worker handler and post-application exposures are not of concern at the maximum allowable application rates for the proposed new uses if label-required personal protective equipment is used.

Use of Human Studies

This risk assessment relies in part on data from studies in which adult human subjects were intentionally exposed to a pesticide or other chemical. These studies, listed in Appendix 2.0, have been determined to require a review of their ethical conduct. Some of these studies are also subject to review by the Human Studies Review Board. All of the studies used have received the appropriate review.

Environmental Justice

Potential areas of environmental justice concerns, to the extent possible, were considered in this human health risk assessment, in accordance with U.S. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," <http://www.eh.doe.gov/oepa/guidance/justice/eo12898.pdf>.

As a part of every pesticide risk assessment, OPP considers a large variety of consumer subgroups according to well-established procedures. In line with OPP policy, HED estimates risks to population subgroups from pesticide exposures that are based on patterns of that subgroup's food and water consumption, and activities in and around the home that involve pesticide use in a residential setting. Whenever appropriate, non-dietary exposures based on home use of pesticide products and associated risks for adult applicators and for toddlers, youths,

and adults entering or playing on treated areas postapplication are evaluated. Further considerations are currently in development, as OPP has committed resources and expertise to the development of specialized software and models that consider exposure to bystanders and farm workers as well as lifestyle and traditional dietary patterns among specific subgroups.

Tolerance Recommendation

Pending submission of a revised Section B (see requirements under Directions for Use) and a revised Section F (see requirements under Proposed Tolerances), there are no residue chemistry issues that would preclude granting conditional registration for the requested uses of acetochlor or establishment of the following tolerances for residues of acetochlor:

Cotton, undelinted seed.....	0.6 ppm
Cotton, gin byproducts.....	4.0 ppm
Soybean, seed.....	1.0 ppm
Soybean, meal	1.2 ppm

Concurrent with the establishment of the proposed tolerance for soybean seed under 180.470(a), the tolerance for soybean seed listed under 180.470(d) should be removed.

2.0 INGREDIENT PROFILE

2.1 Registered Products

There are currently 44 active acetochlor registrations in the OPPIN data base.

Table 1. Summary Report of Supported Registered Acetochlor Products			
Reg#	Name	%AI	Company Name
100-1083	Doubleplay Selective Herbicide	16.9	Syngenta Crop Protection, Inc.
100-1142	Mesotrione/Acetochlor 3.5 Cs	35	
352-722	Dupont Breakfree Herbicide	70.87	E. I. Du Pont De Nemours And Co., Inc.
352-723	Dupont Breakfree Atz Lite	43.4	
352-724	Dupont Dpx-Qdn33 Herbicide	32.6	
524-473	Mon 8407 Herbicide	74.8	Monsanto Company
524-480	Harness Xtra Herbicide	46.3	
524-483	Tophand Grass Herbicide	81.15	
524-485	Harness Xtra 5.6l Herbicide Premix	33.4	
524-487	Harness 20g Granular Herbicide	20	
524-496	Mon 58430 Herbicide	42	
524-497	Mon 58442 Herbicide	21.6	
524-511	Mon 58494 Herbicide	29	
524-515	Mon 69400 Manufacturing Use Product	74.8	
10163-285	Gowan Ec Herbicide	16.9	Gowan Co
19713-513	Drexel Acetochlor Plus Atrazine	24.8	Drexel Chemical Company
19713-568	Drexel Power Play Herbicide	16.9	
33270-12	Tremor	70.87	United Supplies Inc.

Table 1. Summary Report of Supported Registered Acetochlor Products			
Reg#	Name	%AI	Company Name
33270-13	Tremor At	32.6	
33270-14	Tremor At Lite	43.4	
34704-926	Cadence Herbicide	70.87	Loveland Products, Inc.
34704-950	Cadence Atz Herbicide	32.6	
34704-952	Cadence Lite Atz Herbicide	43.4	
42750-101	Acetochlor 7.0 Ec	74.8	Albaugh Inc
42750-106	Acetochlor 4.3 + Atz 1.7	46.3	
42750-108	Acetochlor 3.1 + Atz 2.5	33.4	
42750-112	Acetochlor Tgai	97	
55467-6	Volley Atz Lite Tenkoz Herbicide	43.4	Tenkoz Inc
55467-7	Volley Atz Tenkoz Herbicide	32.6	
55467-8	Volley Tenkoz Herbicide	70.87	
62719-367	Surpass Ec Herbicide	70.87	Dow Agrosiences LLC
62719-368	Keystone Herbicide	32.6	
62719-369	Topnotch Herbicide	33.68	
62719-370	Surpass 20-G Granular Herbicide	20	
62719-371	Fultime Selective Herbicide	24.8	
62719-372	Surpass 7e Herbicide	75.4	
62719-479	Keystone La Herbicide	43.4	
62719-570	Surestart Herbicide	41.67	
62719-601	Acetochlor Technical	95.4	
66478-1	Acetochlor Technical	95.4	Monsanto Company
66478-2	Acetochlor Ec Herbicide	81.15	

2.2 Registered and Proposed New Uses

Acetochlor is a chloroacetanilide herbicide used to control weeds in corn and sorghum. Currently registered products include emulsifiable concentrate (EC) formulations (17-81 % ai), a 20% ai granular formulation, and a 33% ai microencapsulated formulation. Monsanto is requesting new uses on cotton and soybean for a new encapsulated formulation, MON 63410 Herbicide containing 33% acetochlor and an existing registered product MON 8453, an 81% ai EC formulation. Preemergence and/or postemergence applications to cotton and soybean are proposed. The maximum proposed application rates for the EC formulation are 1.5 lb ai/application and 3 lb ai/season. The maximum proposed rates for the Mcap formulation are 0.6 lb ai/application and 1.2 lb ai/season. Postemergence application may be made no later than 15 days after first white flower for cotton or the R1-R2 growth stages of soybean; PHIs are based on crop growth stage. A restriction against the grazing/feeding of treated forage is specified. Maximum application rates for existing and proposed new uses are provided in Table 2.

Table 2. Maximum Application Rates for Acetochlor Existing and Proposed New Uses			
Application Site	Max % AI	Max Single AR	Reg No.
Corn	81	3 lb/ai A	66487-2
Sorghum	29	2.5 lb/ai A	524-511
Cotton, Soybean	81	1.5 lb/ai A	524-483

2.3 Structure, Nomenclature, and Physical/Chemical Properties

The nomenclature and physicochemical properties of acetochlor are provided in Tables 3 and 4.

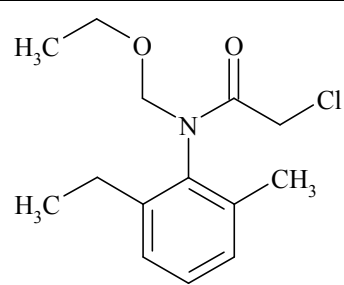
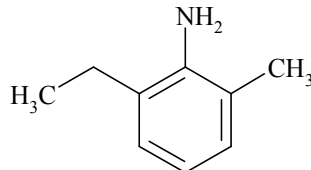
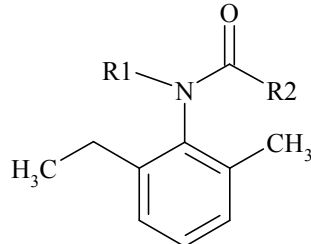
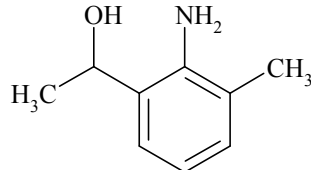
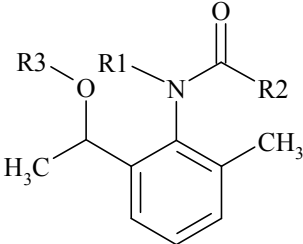
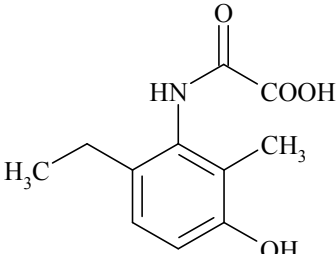
Table 3. Acetochlor Nomenclature.	
Chemical structure	
Common name	Acetochlor
Company experimental name	None
IUPAC name	2-chloro-N-ethoxymethyl-6'-ethylacet-o-toluidide
CAS name	2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)acetamide
CAS registry number	34256-82-1
End-use product (EP)	3 lb/gal Mcap formulation (MON 63410 Herbicide, EPA File Symbol No. 524-LOR) 3 lb/gal EC formulation (MON 8453, EPA Reg No 524-483)
Chemical structure of EMA moiety	 CAS Name: 2-ethyl-6-methylaniline
EMA-type metabolites ¹	
Chemical structure of HEMA moiety	 CAS Name: 2-(1-hydroxyethyl)-6-methylaniline

Table 3. Acetochlor Nomenclature.	
HEMA-type metabolites ¹	
Metabolite 57	 <p>N-(6-ethyl-3-hydroxy-2-methylphenyl) oxamic acid</p>

¹ For the EMA- and HEMA-type metabolites, the R1 functional group can consist of -H or -CH₂OCH₂CH₃ and the R2 functional group may consist of many different moieties. The R3 functional group for HEMA-type metabolites can consist of -H or a variety of components such as sugars.

Table 4. Physicochemical Properties of Acetochlor.		
Parameter	Value	Reference
Melting point/range	163 °C at 10 mm Hg; decomposition occurs before the boiling point at atmospheric pressure (calculated by extrapolation of vapor pressure at lower temperature)	Residue Chemistry Chapter of the Acetochlor TRED (DP# 297062, 5/31/05, S. Ary)
pH	4.41, 1% solution in acetone:water (1:1, v:v)	
Density	1.123 g/mL at 20 °C	
Water solubility	223 mg/L at 25 °C	
Solvent solubility	Infinitely soluble in acetone, benzene, carbon tetrachloride, ethanol, chloroform, and toluene at 25 °C	
Vapor pressure	0.045 µm Hg (4.5 x 10 ⁻⁵ mm Hg) at 25 °C	
Dissociation constant, pKa	Not applicable because acetochlor is neither an acid nor a base.	
Octanol/water partition coefficient, Log(KOW)	970 (Dow study) or 1082 (Monsanto study); differences are likely due to experimental error	
UV/visible absorption spectrum	Not available	

3.0 HAZARD CHARACTERIZATION/ASSESSMENT

3.1 Hazard Characterization

The toxicology database for acetochlor is adequate for evaluating and characterizing acetochlor toxicity and selecting endpoints for purposes of this risk assessment.

Acetochlor is classified as Toxicity Category III for acute exposure via the oral, dermal and inhalation routes and in ocular irritation studies. Although one primary dermal irritation study reported low levels of dermal irritation, severe irritation was observed in a second study, including microscopic changes (hair follicle hyperplasia, and in some animals, acanthosis and inflammatory cell infiltration). Acetochlor has been shown to be a potent dermal sensitizer in two studies.

Evidence of neurotoxicity from exposure to acetochlor was observed in several studies. Salivation and other clinical signs (anogenital staining, diarrhea) were reported in studies in both the rat (two developmental toxicity studies) and the dog (subchronic and chronic oral). A marginal decrease in brain cholinesterase was observed at the high dose in one subchronic rat study. The dog appears to be more sensitive than the rat or mouse to effects on the nervous system, in that salivation occurred at lower dose levels and frank neuropathology of the brain was observed in one study. In a one-year oral (capsule) toxicity study in the dog, pronounced neurological signs (ataxia, abnormal head movements, tremor, depressed righting, hopping and flexor reflexes, exaggerated tonic neck reflex and stiffness and rigidity of the hindlimbs) were observed at the high dose and were associated with degenerative lesions of the cerebellum. Acute and subchronic oral neurotoxicity screening studies in the rat were submitted for acetochlor. In the acute study at the time of peak effect, decreased total motor activity at mid and high dose was observed in females, but not males; at the highest dose, both males and females showed clinical signs of toxicity in the functional observational battery (perioral staining, piloerection, hunched posture). Single animals showed signs such as chromodacryorrhea, upward curvature of the spine and hypothermia. In the subchronic study, decreased body weight/weight gain in both sexes at the high dose was observed. A decrease in hindlimb grip strength in males at 2 weeks, but not at later times, was observed and considered a possible effect of treatment. The neurotoxicity studies did not evaluate cholinesterase levels.

In addition to the nervous system, the major target organs affected in subchronic and chronic studies in rats, dogs and mice exposed to acetochlor are the liver, thyroid (secondary to liver), kidney, testes, and erythrocytes. Species specific target organs include the nasal olfactory epithelium in rats and the lungs in mice. Effects observed in a 21-day dermal toxicity study the rabbit include high mortality and agonal clinical signs of toxicity at the highest dose tested (HDT) of 1200 mg/kg/day. Local dermal irritation was observed at all dose levels. A 21 day dermal toxicity showed excessive dermal irritation at 100 mg/kg/day.

The available developmental toxicity studies in two species do not show evidence of increased susceptibility of the offspring and no evidence of increased susceptibility was observed

in three two-generation reproductive toxicity studies in the rat. Toxicity to offspring was observed at or above maternally toxic dose levels. As noted, maternal neurotoxic effects were observed in two developmental toxicity studies in rats. One developmental toxicity study in the rat also showed increased early resorptions, postimplantation loss and decreased fetal weight at a maternally toxic dose of 600 mg/kg/day (HDT). Maternal effects at the HDT, in addition to neurotoxicity, included mortality and body weight decrease. In the second developmental study, decreased fetal weight was observed at maternally toxic (neurotoxicity, decreased body weight) HDT of 400 mg/kg/day. There was no evidence of reproductive toxicity observed at any dose tested in two of three available reproductive toxicity studies in rats. A third reproductive study in rats showed decreased number of implantations at the HDT of 1750 ppm. Parental effects at mid- and/or high doses included reduced body weight/weight gain and nasal epithelium effects. Offspring effects included reduced pup body weights, decreased F2 litter size at birth and decreased absolute and relative spleen weights in F2 weanlings at the mid and/or high doses.

Acetochlor is classified as “Suggestive Evidence of Carcinogenic Potential” based on weak evidence for benign lung tumors in male and female mice and histiocytic sarcomas in female mice. Based on the cancer classification, linear quantification of carcinogenic potential is not required for the mouse tumors. Nasal olfactory epithelial tumors and thyroid follicular cell tumors were observed in rats. There are acceptable mode of action data for the rat tumors which are adequate to support a non-linear, MOE approach for assessment of cancer risk for these tumor types. However, separate quantification of cancer risk is not required for the rat tumors since the chronic RfD of 0.02 mg/kg/day will be protective of these effects.

An immunotoxicity study is required as part of new 40 CFR Part 158 data requirements for registration of a pesticide. A developmental neurotoxicity (DNT) study in the rat is required due to observations in several oral studies indicating effects on the nervous system and uncertainties regarding the sensitivity of fetal and neonatal animals to neurotoxic effects. Studies required under the revised 40 CFR Part 158 Toxicology Data Requirements for a Neurotoxicity Battery (870.6200) have been submitted. However the submitted neurotoxicity studies are classified as Unacceptable/Guideline (upgradable) pending submission of information on positive control studies conducted at the performing laboratory and do not satisfy the guideline requirements for neurotoxicity studies in rats (870.6200; OECD 424). If such data have already been submitted to the agency, the registrant or performing laboratory should provide reference to the data including when the studies were conducted. In addition, information on the methods and equipment used for the quantitative measures during the FOB should also be provided

The complete toxicity profile for acetochlor is provided in Appendix 1.2, Tables 2 and 3.

3.2 FQPA Hazard Considerations

The toxicity database for acetochlor is sufficient for a full hazard evaluation and is considered adequate to evaluate risks to infants and children. Acceptable developmental toxicity studies in the rat and rabbit and acceptable multi- and single generation reproduction studies in

the rat have been submitted. Upgradable acute and subchronic neurotoxicity studies in the rat are also available. A DNT in the rat is required based on evidence of neurotoxicity in several studies. The FQPA factor of 10x is retained as a database uncertainty factor (UF_{DB}) pending submission and acceptance of the DNT study.

3.2.1 Developmental Toxicity

3.2.1.1 Rat Developmental Study

Study 1

In a developmental toxicity study (MRID 00050929), 25 mated female Crl:CD (SD)BR VAF/Plus rats were administered acetochlor (91.4% a.i.) by gavage in corn oil vehicle as single daily doses of 0 (corn oil only), 50, 200 or 400 mg/kg/day from Gestation Days 6 through 19, inclusive, with sacrifice and cesarean evaluations on Day 20. At 400 mg/kg/day, excessive salivation (post-dosing in 3 females on one occasion) and increased frequency of urogenital staining were observed. Mean body weight gain during treatment (Days 6- 20) was decreased by 30% and gestational weight gain (Days 0-20) was approximately 50% less than controls. There were no treatment-related effects on survival or cesarean parameters. Food consumption was not evaluated in this study. The maternal toxicity LOAEL is 400 mg/kg/day, based on clinical signs of toxicity and reduced body weight gain during treatment. The NOAEL is 200 mg/kg/day. A slight but not statistically significant reduction in mean fetal weight was observed At 400 mg/kg/day. No other cesarean parameters were affected and there were no treatment-related increases in fetal variations or malformations. The developmental toxicity LOAEL is 400 mg/kg/day, based on slightly (not statistically significant) reduced mean fetal weight. The developmental toxicity NOAEL is 200 mg/kg/day.

Study 2

In a developmental toxicity study (MRIDs 41592005, 42054902 and 42054903), 25 mated female Crl:CD (SD)BR VAF/Plus rats were administered acetochlor (90.5% a.i.) by gavage in corn oil vehicle as single daily doses of 0, 40, 150 or 600 mg/kg/day from Gestation Days 6 through 15, inclusive. At 600 mg/kg/day, two females died (on GD 13 and 15), apparently due to treatment. Clinical signs of increased salivation post-dosing and urogenital staining were reported. Mean body weight gain was reduced during the dosing period by 47% (mean corrected body weight gain from Days 6 to 20 was -38% below controls). A significant reduction in food consumption on Days 6-7 and 8-9 (20% and 16% respectively) was observed only between Days 6-9 of dosing; thereafter, consumption was comparable among all groups. The maternal toxicity LOAEL is 600 mg/kg/day, based on mortality, clinical signs of toxicity and reduced body weight gain during treatment. The NOAEL is 150 mg/kg/day. At 600 mg/kg/day, the following effects showed statistically significant differences from controls and were considered treatment-related: increased early resorptions/dam and total resorptions/dam; increased postimplantation loss and reduced mean fetal weight. There were no treatment-related increases in fetal variations or malformations. The developmental toxicity LOAEL is 600

mg/kg/day, based on increased fetal early resorptions and postimplantation loss and reduced mean fetal weight. The developmental toxicity NOAEL is 150 mg/kg/day.

3.2.1.2 Rabbit Developmental Study

Study 1

In a developmental toxicity study (MRID 40134101), acetochlor (94.2% a.i.) was administered to 20 artificially inseminated female New Zealand White rabbits/dose by gavage in corn oil at dose levels of 0, 15, 50 or 190 mg/kg bw/day from days 7 through 19 of gestation, inclusive. Loss of weight during treatment was reported in high dose females. A rebound in body weight gain was observed postdosing. There were no treatment-related effects on survival, clinical signs of toxicity or cesarean parameters. The maternal toxicity LOAEL is 190 mg/kg bw/day, based on weight loss during treatment. The maternal toxicity NOAEL is 50 mg/kg bw/day. There were no treatment-related effects on litter cesarean parameters, or on the incidence of fetal variations or malformations. The developmental toxicity NOAEL is 190 mg/kg bw/day. A developmental toxicity LOAEL was not established in this study (>190 mg/kg bw/day).

Study 2

In a developmental toxicity study (MRIDs 41592006, 42054901 and 42077101), acetochlor (90.5% a.i.) was administered to 16 female New Zealand White rabbits/dose by gavage in corn oil at dose levels of 0, 30, 100 or 300 mg/kg bw/day from days 6 through 18 of gestation. There were no effects of treatment observed on maternal survival, clinical signs of toxicity, body weight or weight gain, food consumption or cesarean parameters. Although no toxicity was observed in this study, the results of the range-finding study (MRID 42077101) indicated that toxicity (body weight decrement) was observed between 200-400 mg/kg bw/day and therefore that a LOAEL was approached in the main study; dose selection was therefore determined to be appropriate. The maternal toxicity NOAEL is 300 mg/kg bw/day (highest dose tested). A maternal LOAEL was not established in this study but was likely approached, based on the results of the range-finding study. There were no effects of treatment observed on cesarean parameters and no effect on the incidence of fetal variations or malformations. The developmental NOAEL is 300 mg/kg bw/day (highest dose tested). A developmental LOAEL was not established in this study. Although a maternal toxicity LOAEL was not achieved, dosing is considered adequate based on the results of the range-finding study. In addition, a second acceptable developmental toxicity study in the rabbit showed weight loss during treatment at 190 mg/kg bw/day.

3.2.2 Reproductive Toxicity

Study 1

In a two-generation reproduction study (MRID 00131391), MON 097 (94.2%) was

continuously administered to 24 female and 12 male Charles River albino rats/dose in the diet at dose levels of 0, 500, 1500 or 5000 ppm (equivalent to average daily intakes during premating in F0 animals of 0, 30.8, 60.4 or 316 mg/kg bw/day, males and 0, 46.2, 130.4 or 442 mg/kg bw/day, females and in F1 animals of 0, 29.9, 87.8 or 333 mg/kg/day, males and 43.6, 129.8 or 441 mg/kg/day, females). Mating was initiated after at least 100 days of treatment for the F0 parental animals and at least 120 days of treatment for the F1 parental animals. Matings were performed twice for each generation. Five F1b and F2b pups/sex/dose and ten F1 parents/sex/dose were also selected for evaluation of testes, ovary, pituitary, thyroid, spleen and liver weights and histopathology.

Mean parental premating body weights were slightly reduced compared to controls at 1500 ppm. At 5000 ppm, mean parental body weights were reduced compared to controls for all groups. Slight reductions in food consumption were also reported. Some increases in absolute/relative organ weights were observed in F1 parents (e.g., thyroid, liver, kidney). The incidence of chronic nephritis was increased in F1 females. F0 animals were not evaluated for organ weights except testes in males, which showed no effects. There were no treatment-related effects on survival or clinical signs of toxicity. The parental systemic LOAEL is 1500 ppm, based on reduced body weight/weight gain during premating in both generations. The parental systemic NOAEL is 500 ppm.

At 1500 ppm, mean pup body weights on Lactation Day 21 showed a slight decrease in the F2a and F2b offspring. At 5000 ppm, mean pup body weights on Lactation Day 21 in all F1 and F2 pup groups were reduced and mean litter size tended to be smaller (statistical significance only achieved for the F1b generation). Although statistically significantly increased absolute/relative thyroid weights were reported at low and mid dose, they were not considered to be a clear treatment-related finding based on lack of a dose-response and lack of a corresponding increase in liver weights. No effects on pup survival, birth weight, gross abnormalities or other cesarean offspring parameter were observed. The offspring LOAEL is 1500 ppm, based on slightly reduced pup body weight during lactation in F2 offspring. The offspring NOAEL is 500 ppm. There was no evidence of reproductive toxicity observed at any dose tested in this study. The reproductive NOAEL is 5000 ppm. A reproductive toxicity LOAEL was not determined in this study.

Study 2

In a two-generation reproduction study (MRID 41565120), acetochlor (90.8% a.i.) was administered to 25 Sprague-Dawley CD rats/sex/dose in the diet at dose levels of 0, 18, 175 or 1750 ppm (equivalent to average daily premating intakes for the F0 generation of 0, 1.27, 12.6 or 123.8 mg/kg/day, F0 males and 0, 1.63, 15.5 or 157.4 mg/kg/day, F0 females; 0, 0, 1.53, 15.2 or 152.1 mg/kg bw/day, F1 males and 1.83, 18.3 or 192.4 mg/kg bw/day, F1 females). Matings were performed twice for each generation.

At 1750 ppm, mean body weights were significantly lower by the end of premating in all

parental animals. Premating mean body weight gain of parental animals was also lower than controls, and slight reductions in food consumption were reported. Some increases in absolute/relative organ weights were observed (e.g., liver, kidney) but were not accompanied by microscopic findings. There were no treatment-related effects on survival, clinical signs of toxicity or gross/microscopic pathology (microscopic examination included evaluation of nasal turbinates). The parental systemic LOAEL is 1750 ppm, based on reduced body weight/weight gain during premating in both generations. The parental systemic NOAEL is 175 ppm.

Mean pup body weights were reduced at 1750 ppm, on lactation Day 21. No effects on pup survival, birth weight, gross abnormalities or other offspring parameters were observed. The offspring LOAEL is 1750 ppm, based on reduced pup body weight during lactation. The offspring NOAEL is 175 ppm. There was no evidence of reproductive toxicity observed at any dose tested in this study. The reproductive NOAEL is 1750 ppm. A reproductive toxicity LOAEL was not determined in this study.

Study 3

In a 2-generation reproduction toxicity study, acetochlor was administered continuously in the diet to CD (SD) IGS BR (Sprague-Dawley) rats (26/sex/dose) at nominal dose levels of 0, 200, 600, or 1750 ppm (equivalent to 0, 21.2, 65.6, and 196.4 mg/kg/day in F1 males and 0, 22.4, 70.9, and 215.9 mg/kg/day in F1 females). F0 animals were given test article diet formulations for 10 weeks prior to mating to produce the F1 litters. On postnatal day (PND) 29, F1 animals (26/sex/dose) were selected to become the F1 parents of the F2 generation and were given the same concentration test formulation as their dams. F1 animals were given test formulations for 10 weeks prior to mating to produce the F2 litters. No parental treatment-related clinical observations were observed in this study. Survival of parental animals was unaffected by treatment at any dose level. The parental LOAEL is 600 ppm, based on focal hyperplasia and polypoid adenomata in the nasal epithelium of adult F1 offspring at study termination. The parental NOAEL is 200 ppm.

A significant treatment-related decrease in the number of implantations was observed at 1750 ppm in both the F0 and F1 generations. In addition, the mean number of live pups on postnatal day 1 decreased in a dose related manner in both the F1 and F2 litters. Mean live F1 pups per litter was significantly decreased at 1750 ppm, and the mean number of live-plus-dead pups per litter was statistically significantly lower in F1 and F2 litters at 1750 ppm and also in F2 litters at 600 ppm. These findings are considered possible evidence of fetal loss. Postnatal survival was not affected by treatment. Initial mean body weights of F1 pups of both sexes were significantly decreased in both the 600 and 1750 ppm groups. At the 1750 ppm level, significantly decreased mean F1 pup body weights were also observed in late lactation and overall body weight gain was significantly reduced as compared to controls. In F2 litters, male and female pup body weights were reduced in both 1750 and 600 ppm dose levels and overall F2 pup weight gain was reduced. A decrease in anogenital distance in F2 males on PND 1, and a 3-day treatment-related delay in the day of vaginal opening in F1 females at the high dose level

appeared to be associated with delayed growth. Decreases in absolute mean brain weights of F1 males and F2 males and females were noted at 1750 ppm. Relative brain weight ratios were statistically increased in F2 pups at the 600 ppm dose. Mean absolute spleen weights were decreased in F1 males and both sexes of F2 pups at mid and high doses. Mean relative spleen weights were reduced in 600 ppm F2 females. Mean absolute thymus weights were decreased in F2 pups at the high dose level. No macroscopic changes were reported. The offspring LOAEL is 600 ppm, based on decreased F2 litter size at birth, decreased F1 and F2 pup body weights during lactation, and decreased absolute and relative spleen weights in F2 weanlings; and on the presence of focal hyperplasia and polypoid adenomata in the nasal epithelium of adult F1 offspring at study termination. The offspring NOAEL is 200 ppm.

The number of implantations decreased in a dose related manner in both the F0 and F1 generations, the differences reaching statistical significance at the high dose level in both generations. In addition, the mean number of live pups on postnatal day 1 decreased in a dose related manner in both the F0 and F1 litters. Due to the lack of corpora lutea count data, the origin of the decreased implantation counts could not be determined; therefore, this was conservatively interpreted as a possible effect on reproduction. The LOAEL for reproductive toxicity is 1750 ppm, based on decreased number of implantations. The reproductive toxicity NOAEL is 600 ppm.

3.2.3 Pre-and/or Postnatal Toxicity

The database is considered adequate for selection of study endpoints and determination of a dose/response to characterize the potential prenatal or postnatal toxicity of acetochlor to infants and children. No increase in susceptibility was seen in developmental toxicity studies in rat and rabbit or in three multigeneration reproductive toxicity studies in the rat. Toxicity to offspring was observed at dose levels the same or greater than those causing maternal or parental toxicity. Based on the results of developmental and reproductive toxicity studies, there is not a concern for increased qualitative and/or quantitative susceptibility following in utero exposure to acetochlor.

A developmental neurotoxicity study is required because evidence of neurotoxicity, was observed in studies in the dog and the rat including frank neuropathology in a chronic study in the dog. Results of the DNT study could impact the current selected regulatory dose for acute oral exposure, since the NOAEL used for that risk assessment endpoint (150 mg/kg/day) is greater than the NOAELs in the reproductive toxicity study (21 mg/kg/day) on acetochlor. A DNT study will likely be conducted at dose levels similar to those of the two-generation reproductive toxicity study. The uncertainty associated with the lack of this data is accounted for by use of a database uncertainty factor (UF_{DB}) of 10, where appropriate.

3.2.4 Neurotoxicity

Acute Study

In an acute neurotoxicity study, groups of fasted, 42 day old Alpk:AP_fSD (Wistar-derived) rats (10/sex/dose) were given a single oral dose of acetochlor (94.7% a.i.) at doses of 0, 150, 500 or 1500 mg/kg bw and observed for 14 days. Neurobehavioral assessment (FOB and motor activity testing) was performed at pre-test and study Days 1 (time of peak effect), 8 and 15. Cholinesterase activity was not determined. At study termination, 5 animals/sex/group were euthanized and perfused *in situ* for neuropathological examination. Of the perfused animals, 5 rats/sex from the control and high dose groups were subjected to histopathological evaluation of brain and peripheral nervous system tissues.

At 1500 mg/kg bw, body weights adjusted for initial weight were significantly lower than the control group on Day 8 for males and on Days 1 (peak effect), 8 and 15 for females. Body weight gains were significantly lower for the Day -7 to 8 time period for males (77% of controls) and during throughout the study for females (65-76% of controls). Food consumption by the high-dose males and females was significantly reduced during the first week of the study compared with the controls. During the FOB, findings were limited to the time of peak effect at the high-dose level. These consisted of hunched posture observed in 5-6 animals/sex, piloerection on 7-10/sex, and staining around the mouth seen in 3-4/sex. The severity was considered slight in the males and from slight to moderate in females. Other findings at 1500 mg/kg bw were decreased activity in one female, chromodacryorrhea in one female, hypothermia in one female, labored breathing in one male, sides pinched in one male, and upward curvature of the spine in one female. No effects of treatment were noted on landing foot splay measurement, time to tail-flick, or grip strengths. No effects of treatment were noted for motor activity in males. Total activity counts for high-dose females on Day 1 were significantly decreased compared to controls at 500 and 1500 mg/kg (401.7 and 251.7, respectively, vs. 571.4 for controls; equivalent to reductions of 30% and 56%) and also were decreased by 43.8% of the pre-test value. A statistically significant increase in motor activity of 28% was also observed in high dose females on Day 8. There were no treatment-related effects on brain weights or gross and histologic pathology or neuropathology. The LOAEL in females was 500 mg/kg bw, based on dose-related decreases in motor activity on Day 1 and the NOAEL was 150 mg/kg bw. In males, the LOAEL was 1500 mg/kg bw, based on decreased body weights and body weight gain (males and females), reduced food consumption (males and females), increased incidence of clinical signs during the FOB (males and females) at the time of peak effect, with a NOAEL of 500 mg/kg bw.

Subchronic Study

In an oral subchronic neurotoxicity study (MRID 45357502) acetochlor (94.7% ai) was administered to the diet to 12 Alpk:AP_fSD rats/sex/group at dose levels of 0, 200, 600 or 1750 ppm (equivalent to 0, 15.4, 47.6 or 139.9 mg/kg/ bw/day, males and 0, 18.3, 55.9 or 166.5 mg/kg

bw/day, females) for 93 days. A neurobehavioral assessment (functional observational battery and motor activity testing) was performed in all animals/sex/group at -1 week pretest and at weeks 2, 5, 9 and 14. At study termination, 5 animals/sex/group were euthanized and perfused *in situ* for neuropathological examination (brain, spinal cord and peripheral nervous system of the control and high dose animals were examined microscopically; brain weights were also measured).

At 1750 ppm, slight but statistically significant decreases in mean body weight and weight gain were reduced in both sexes in the early weeks of the study. During the FOB evaluations at week 2, a statistically significant decrease in hindlimb grip strength in males was observed, which was of unclear significance but considered a possible treatment-related effect based on neuromuscular effects to hindlimbs observed in dog studies. There were no treatment-related increases in clinical signs of toxicity or effects on other neurobehavioral parameters in the FOB, motor activity, brain weight or gross/microscopic neuropathology. The LOAEL is 1750 ppm based on marginal decreases in mean body weight/weight gain in both sexes and a possible transient decrease in hindlimb grip strength in males at week 2. The NOAEL is 600 ppm.

3.2.5 Immunotoxicity

There are no indications in the available studies that organs associated with immune function, such as the thymus and spleen, are affected by acetochlor. An immunotoxicity study is required. This is a new data requirement under 40 CFR Part 158 as a part of the data requirements for registration of a pesticide (food and non-food uses).

3.2.6 FQPA Factor

A 10X UF_{DB} is applied to the acute RfD to account for the lack of a DNT.

3.3 Toxicity Endpoint Selection

3.3.1 Acute Reference Dose (aRfD) – All Populations

Selected Study: Acute oral neurotoxicity screening in the rat MRID No. 45357501
See Section 3.2.5

Dose and Endpoint for Establishing an aRfD: 150 mg/kg/day based on decreased motor activity in females at 500 mg/kg on the day of dosing.

Uncertainty Factor (UF): 1000x (10x for interspecies variation, 10x for intraspecies variation and 10x UF_{DB} for lack of developmental neurotoxicity study)

Comments about Study/Endpoint: The effect observed at the selected endpoint (decreased motor activity in females on the day of dosing) occurred following a single dose. This

endpoint is considered protective of females age 13-49 because there are no lower relevant endpoints that may potentially result from a single exposure.

[Note: This neurotoxicity study is classified as Unacceptable/Guideline (upgradable) pending submission of information on positive control studies conducted at the performing laboratory and does not satisfy the guideline requirement for an acute neurotoxicity study in rats (870.6200; OECD 424). If such data have already been submitted to the agency, the registrant or performing laboratory should provide reference to the data and when the studies were conducted. In addition, methods and equipment used for the quantitative measures during the FOB were not described. This information should also be provided.]

$\text{Acute RfD (Females 13-49)} = \frac{150 \text{ mg/kg (NOAEL)}}{1000 \text{ (UF)}} = 0.15 \text{ mg/kg}$

3.3.2 Chronic Reference Dose (cRfD) - All Populations

Selected Study: Chronic (1-year) oral toxicity in the dog MRID 41565118

I In a chronic toxicity study, acetochlor (90.5% a.i.) was administered to 5 beagle dogs/sex/dose in gelatin capsules at dose levels of 0 (empty capsules only), 2, 10 or 50 mg/kg bw/day) for 52 weeks. In addition to the standard parameters evaluated in a chronic oral toxicity study in the dog, plasma and erythrocyte cholinesterase activities (at 12, 24 and 50 weeks) and brain cholinesterase activity (termination) were evaluated. A neurological evaluation (tests examining cranial nerve function, segmental reflexes, postural reactions and general observations) was also performed at Week 47 to assess treatment-related signs of toxicity.

At 10 mg/kg/day, male dogs showed an increased incidence of salivation following dosing throughout the study. Males also showed increased incidence of renal interstitial nephritis and renal chronic vasculitis, tubular degeneration of the testes, hypospermia of the epididymides and reduced glycogen in the liver. At 50 mg/kg/day, the incidence of salivation was markedly increased in both sexes and neurologic symptoms including head shaking/nodding and ataxia (also hunched posture, abnormal gait, tremor) were reported in both sexes towards the later weeks of the study. Mean body weight gain was reduced significantly during weeks 13-26. Water consumption was increased. Changes in clinical chemistry values included increased ALT, GGT, OCT, cholesterol and triglycerides, along with increased urea, creatinine and decreased glucose. In females, statistically significant increases in plasma AChE at week 24 and BChE at week 24 and 50 were observed. At weeks 23 and 49, significantly increased urinary volume in males and reduced specific gravity in both sexes were observed. Organ weight changes included increased relative brain weight in females, decreased testicular weights in males (abs and rel) and possibly increased absolute adrenal weights in females, increased relative liver weights in both sexes and thyroid weights in males. Kidneys showed grossly visible abnormal shape, pale areas, cortical fibrosis and/or scarred areas, collecting duct hyperplasia,

dilatation of Bowman's space, cortical atrophy, transitional cell hyperplasia and lipofuchsin pigment in cortical tubules were reported in the microscopic evaluation. Brain histopathology (degeneration of the granular layer, depletion of Purkinje cells, demyelination and degeneration of granule cell axons) was observed, along with maturation arrest within the testes, pigment in hepatocytes. There were no treatment-related effects observed on brain cholinesterase activity or on ophthalmologic or hematological parameters. The LOAEL is 10 mg/kg/day, based on testicular, hepatic and renal histopathology and increased salivation in males. The NOAEL is 2 mg/kg/day.

Dose and Endpoint for Establishing a cRfD: 2.0 mg/kg/day, based on excessive salivation and histopathology of the testes, kidney and liver at 10 mg/kg/day.

Uncertainty Factor (UF): 100x (10x for interspecies variation and 10x for intraspecies variation)

Comments about Study/Endpoint/Uncertainty Factor: A 10x UF_{DB} was not used in calculation of the UF for this endpoint because the results of the developmental neurotoxicity study are not expected to affect the point of departure to assess chronic risk.

$\text{Chronic RfD} = \frac{2.0 \text{ mg/kg (NOAEL)}}{100 \text{ (UF)}} = 0.02 \text{ mg/kg}$
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3.3.3 Incidental Oral Exposure (Short and Intermediate Term)

Acetochlor has not been approved for residential uses; therefore, selection of a toxicity endpoint is not necessary for this exposure scenario at this time.

3.3.4 Dermal Absorption

A dermal absorption factor of 20% was estimated from an *in vivo* rat dermal absorption study (MRID 41778303), based on absorption observed following a 10-hr dermal exposure to acetochlor (see HIARC Document, TXR #00135858).

3.3.5 Dermal Exposure

3.3.5.1 Dermal Exposure (Short-Term)

Selected Study: 21-day dermal toxicity in the rabbit; MRID No. 00116637

In a 21 day dermal toxicity study, acetochlor as MON -097 (94.5%;) was applied to the abraded and intact shaved skin of groups of 10 New Zealand white rabbits/sex/dose at dose levels of 0,100, 400 or 1200 mg/kg bw/day, 6 hours/day for 5 days/week during a 21-day period. At 1200 mg/kg/day, excessive mortality (8/10 males and 7/10 females) was observed (first death

occurred on Day 7, last on Day 19). Clinical signs of toxicity were first observed on Day 5 and included nasal and ocular discharge, nasal congestion; this group also exhibited possible treatment-related signs of anorexia, respiratory congestion, labored breathing, ataxia, hypoactivity, rigid body, tonic convulsions, decreased limb tone, impaired righting reflex, emaciation and hypothermia. No deaths were seen at lower levels and there were no adverse effects on body weight, hematology, clinical chemistry or organ weight but it is noted that there were insufficient surviving high dose animals to evaluate effects at termination. Histopathology revealed skin lesions at the application sites in all treatment groups. Irritation consisted of erythema and edema; desquamation was observed both macroscopically and microscopically in all dosed groups. At day 21, the intensity of dermal irritation was higher in the mid-dose group than in the low dose group. The LOAEL (for systemic effects) is 1200 mg/kg/day, based on mortality and clinical signs of toxicity. The NOAEL is 400 mg/kg/day. The LOAEL for local dermal effects is 100 mg/kg/day, based on skin lesions. The NOAEL for local effects is not established.

Dose and Endpoint for Risk Assessment: 400 mg/kg/day, based on mortality and clinical signs at 1200 mg/kg/day.

Uncertainty Factor (UF): 100 – 10x for interspecies extrapolation and 10x for intraspecies variation.

Comments about Study/Endpoint: The route and duration of exposure is appropriate for this exposure scenario. Although mortality is an endpoint, it was seen at a dose level which is higher than the limit dose. While developmental and neurotoxicity effects are not measured in a dermal toxicity study, the endpoint selected from the dermal toxicity is considered protective of these effects. The NOAEL of 150 mg/kg/day for both developmental and neurotoxicity when coupled with the dermal absorption factor of 20%, results in a dermal NOAEL estimate of 750 mg/kg/day. This level of exposure exceeds the dermal toxicity study NOAEL of 400 mg/kg/day. Therefore use of the dermal toxicity NOAEL as an endpoint for risk assessment is protective.

3.3.5.2 Dermal Exposure (Intermediate-Term)

Selected Study: Co-critical subchronic oral toxicity studies in the dog – MRID Nos. 00050928 and 41565116

In a 119-day oral toxicity study acetochlor (91.3% a.i.) was administered to 6 beagle dogs/sex/dose in gelatin capsules at dose levels of 0 (capsule only), 25, 75 or 200 mg/kg bw/day. There were no treatment-related effects observed at 25 mg/kg/day. At 75 mg/kg/day, one male died at week 11, with diarrhea and inactivity occurring in the last weeks prior to death. Mean body weights were lower for much of the study and at termination; weight gain at termination was reduced. Increased liver enzyme SGPT was observed in males and females at some time points. Relative liver weights were increased. Atrophy of the liver in one male and infiltration of the kidney in one male were observed. At 200 mg/kg/day, 5 males and 6 females died or were

sacrificed *in extremis*, beginning at week 5, with no females surviving by Week 12 and only one male surviving from week 8 through 17. There was severity of clinical signs (bloody diarrhea, vomiting) increased and increased relative liver weight. Food consumption was significantly reduced. Mean body weights showed statistically significant reductions in surviving males and surviving females showed statistically significantly reduced mean body weights. Some dogs showed proteinuria and hematuria, primarily at Month 2 (evaluations not performed later due to mortality). Microscopic findings included hypercellularity of the bone marrow, atrophy of the liver, infiltration of the kidneys and thymic atrophy. The LOAEL is 75 mg/kg/day, based on decreased body weight/weight gain, mortality and slight effects on the liver and kidney. The NOAEL is 25 mg/kg/day.

In a 90-day oral toxicity study acetochlor (91% a.i.) was administered to 4 beagle dogs/sex/dose in gelatin capsules at dose levels of 0, 2.0, 10 or 60 mg/kg bw/day. Erythrocyte and brain cholinesterase were evaluated in addition to guideline parameters. At 60 mg/kg/day, increased incidence of mucous diarrhea was reported for both sexes, beginning during week 1. Females had an increased incidence of salivation during the last 5 weeks of the study. Occasional emesis and vocalization during defecation was reported from weeks 8 through 10. A statistically significantly decrease in mean body weight gain was observed in both sexes. In females food consumption was reduced at weeks 12 and 13. Other effects included mild anemia in females, increased alanine aminotransferase and slightly reduced blood glucose in both sexes and slightly increased relative liver weight in both sexes. There were no treatment-related effects observed at 10 mg/kg/day. No mortality, abnormalities of the urinalysis or ophthalmologic parameters, nor alterations in the gross or microscopic pathological evaluation were observed at any dose level. Plasma, erythrocyte and brain cholinesterase were not affected by treatment. The LOAEL is 60 mg/kg/day, based on clinical signs of toxicity, decreased body weight gain, mild anemia, slightly increased relative liver weight and increased serum alanine aminotransferase. The NOAEL is 10 mg/kg/day.

Dose and Endpoint: 25 mg/kg/day, based on clinical signs of toxicity, decreased body weight gain, mild anemia, slightly increased relative liver weight and increased serum alanine aminotransferase at 60 mg/kg/day.

Uncertainty Factor (UF): 100 – 10x for interspecies extrapolation and 10x for intraspecies variation.

Comments about Study/Endpoint: Oral studies were selected because a dermal study of the appropriate duration was not available. The two subchronic dog studies were considered together to provide the highest NOAEL and the lowest LOAEL. The selection of this endpoint is further supported by the NOAELs and LOAELs for multigeneration reproductive toxicity studies in rats. Since an oral NOAEL was selected, the 20% dermal absorption factor should be used in risk assessment.

3.3.6 Inhalation Exposure

3.3.6.1 Inhalation Exposure (Short-Term)

Selected Study: Developmental toxicity in the rat (oral) (MRIDs 41592005, 42054903)
See Section 3.2.1

Dose and Endpoint: Developmental NOAEL = 150 mg/kg/day, based on increased fetal early resorptions and postimplantation loss, reduced mean fetal weight at 600 mg/kg/day.

Uncertainty Factor (UF): 100 – 10x for interspecies extrapolation and 10x for intraspecies variation.

Comments about Study/Endpoint: Since an oral NOAEL was selected for inhalation risk assessment, an inhalation absorption factor of 100% is assumed.

3.3.6.2 Inhalation Exposure (Intermediate-Term)

Selected Study: Co-critical subchronic oral toxicity studies in the dog – MRID Nos. 00050928 and 41565116 See Section 3.3.5.2

Dose and Endpoint: 25 mg/kg/day, based on clinical signs of toxicity, decreased body weight gain, mild anemia, slightly increased relative liver weight and increased serum alanine aminotransferase at 60 mg/kg/day

Uncertainty Factor (UF): 100 – 10x for interspecies extrapolation and 10x for intraspecies variation.

Comments about Study/Endpoint: Since an oral NOAEL was selected for inhalation risk assessment, an inhalation absorption factor of 100% is assumed.

3.3.7 Classification of Carcinogenic Potential

In accordance with the EPA's Final Guideline for Carcinogen Risk Assessment (March 2005), the HED Cancer Assessment Review Committee (CARC) classified Acetochlor as "Suggestive Evidence of Carcinogenic Potential" based on weak evidence for benign lung tumors in male and female mice and histiocytic sarcomas in female mice (TXR No. 0054494). Consequently, linear quantification of carcinogenic potential is not required for the mouse tumors. There are acceptable mode of action data for the rat tumors (nasal olfactory epithelial tumors and thyroid follicular cell tumors) which are adequate to support a non-linear MOE approach for assessment of cancer risk. The rat nasal tumors, with a POD of 10 mg/kg/day are the most sensitive effect for cancer risk. Quantification of cancer risk is not required since the

chronic RfD of 0.02 mg/kg/day (based on chronic oral toxicity in the dog) will be protective of both non-cancer and cancer effects, including rat nasal tumors, thyroid tumors, and mouse tumors.

3.4 Margins of Exposure

A summary of target Levels of Concern for risk assessment is provided in Table 5.

Table 5. Target Levels of Concern/Margin of Exposure for Acetochlor			
Route/Duration	Short-Term (1-30 Days)	Intermediate-Term (1 - 6 Months)	Long-Term (> 6 Months)
Occupational (Worker) Exposure			
Dermal	100	100	NA
Inhalation	100	100	NA
Residential (Non-Dietary) Exposure			
Oral	N/A	N/A	N/A
Dermal	NA	N/A	N/A
Inhalation	N/A	N/A	N/A

3.5 Recommendation for Aggregate Exposure Risk Assessments

When there are potential residential exposures to the pesticide, aggregate risk assessment must consider exposures from three major sources: oral, dermal and inhalation exposures. Since there are no residential incidental oral exposures to acetochlor, aggregate exposure from food and non-food oral exposures is not required. Short-term dermal and inhalation exposures to workers should not be aggregated because endpoints are not based on common target organ toxicity effects. Intermediate-term dermal and inhalation exposures to workers should be aggregated for acetochlor, however, because the same oral toxicity endpoint was selected for both exposure routes.

3.6 Summary of Endpoints Selected for Risk Assessment

Toxicological doses/endpoints selected for the acetochlor risk assessment are provided in Tables 6 and 7.

Table 6. Summary of Toxicological Doses and Endpoints for Acetochlor for Use in Dietary Human Health Risk Assessments				
Exposure/Scenario	Point of Departure	Uncertainty/FQPA Safety Factors	RfD, PAD, LOC for Risk Assessment	Study and Toxicological Effects
Acute Dietary (All Populations)	NOAEL = 150 mg/kg/day	UF _A = 10x UF _H = 10x FQPA SF = 10x (UF _{DB})	Acute RfD = 0.15 mg/kg/day aPAD = 0.15 mg/kg/day	Acute oral neurotoxicity in rats LOAEL = 500 mg/kg/day, based on decreased motor activity in females.

Table 6. Summary of Toxicological Doses and Endpoints for Acetochlor for Use in Dietary Human Health Risk Assessments				
Exposure/Scenario	Point of Departure	Uncertainty/FQPA Safety Factors	RfD, PAD, LOC for Risk Assessment	Study and Toxicological Effects
Chronic Dietary (All Populations)	NOAEL = 2.0 mg/kg/day	UF _A = 10x UF _H = 10x FQPA SF = 1x	Chronic RfD = 0.02 mg/kg/day cPAD = 0.02 mg/kg/day	Chronic oral toxicity in beagle dogs LOAEL = 10 mg/kg/day, based on increased salivation and histopathology in the testes, kidney and liver.
Incidental Oral Dermal Inhalation	There are no residential uses for or exposures to acetochlor. Therefore exposure endpoints are not required and not selected for residential exposure assessment.			
Cancer (all routes)	Classification: "Suggestive Evidence of Carcinogenic Potential". Quantification of cancer risk is not required since the cRfD of 0.02 mg/kg/day will be protective of both non-cancer and cancer effects			

Point of Departure (POD) = A data point or an estimated point that is derived from observed dose-response data and used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. NOAEL = no observed adverse effect level. LOAEL = lowest observed adverse effect level. UF = uncertainty factor. UF_A = extrapolation from animal to human (interspecies). UF_H = potential variation in sensitivity among members of the human population (intraspecies). UF_L = use of a LOAEL to extrapolate a NOAEL. UF_S = use of a short-term study for long-term risk assessment. UF_{DB} = to account for the absence of key data (i.e., lack of a critical study). FQPA SF = FQPA Safety Factor. PAD = population adjusted dose (a = acute, c = chronic). RfD = reference dose. MOE = margin of exposure. LOC = level of concern. N/A = not applicable.

Table 7. Summary of Toxicological Doses and Endpoints for Acetochlor for Use in Occupational Human Health Risk Assessments				
Exposure/Scenario	Point of Departure	Uncertainty Factors	Level of Concern for Risk Assessment	Study and Toxicological Effects
Dermal Short (1-30 days)	NOAEL = 400 mg/kg/day	UF _A = 10x UF _H = 10x	Occupational LOC for MOE = 100	21-day dermal toxicity study in rabbits LOAEL = 1200 mg/kg/day, based on mortality and clinical signs of toxicity.
Dermal Intermediate (1-6 mo) DAF = 20%	NOAEL = 25 mg/kg/day	UF _A = 10x UF _H = 10x	Occupational LOC for MOE = 100	Subchronic oral toxicity in dogs LOAEL = 60 mg/kg/day, based on decreased body weight/weight gain, slight anemia, slight liver effects.
Inhalation Short-Term (1-30 days) Term	NOAEL = 150 mg/kg/day	UF _A = 10x UF _H = 10x	Occupational LOC for MOE = 100	Developmental toxicity study in rats Developmental LOAEL = 600 mg/kg/day, based on decreased fetal weight; increased resorptions and postimplantation loss.
Inhalation Intermediate-Term (1-6 mo)	NOAEL = 25 mg/kg/day	UF _A = 10x UF _H = 10x	Occupational LOC for MOE = 100	Subchronic oral toxicity in dogs LOAEL = 60 mg/kg/day, based on decreased body weight/weight gain, slight anemia, slight liver effects.
Cancer (all routes)	Classification: "Suggestive Evidence of Carcinogenic Potential". Quantification of cancer risk is not required since the cRfD of 0.02 mg/kg/day will be protective of both non-cancer and cancer effects			

DAF = Dermal Absorption Factor

3.7 Endocrine Disruption

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a

naturally occurring estrogen, or other such endocrine effects as the Administrator may designate.” Following recommendations of its Endocrine Disruptor and Testing Advisory Committee (EDSTAC), EPA determined that there was a scientific basis for including, as part of the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC’s recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When additional appropriate screening and/or testing protocols being considered under the Agency’s EDSP have been developed, acetochlor may be subjected to further screening and/or testing to better characterize effects related to endocrine disruption.

4.0 PUBLIC HEALTH DATA

In addition to the Scientific Literature, the following data bases have been consulted for the poisoning incident data on the active ingredient Acetochlor: 1) OPP Incident Data System (IDS) 2) Poison Control Centers 3) California Department of Pesticide Regulation 4) National Pesticide Information Center (NPIC) 5) National Institute of Occupational Safety and Health’s Sentinel Event Notification System for Occupational Risks (NIOSH SENSOR). The few reports of acetochlor exposure mostly involve minor effects to the eyes and skin. No recommendations are made based on the limited information available. (J. Blondell, D318498, 7/5/05)

5.0 DIETARY AND DRINKING WATER EXPOSURE ASSESSMENT

5.1 Residue Chemistry Profile

5.1.1 Metabolism in Primary Crops

The qualitative nature of acetochlor residues in corn and sorghum is understood based on adequate corn metabolism studies. HED previously concluded that the regulated residues of concern in corn for both risk assessment and tolerance enforcement include parent and any metabolites containing the EMA or the HEMA moiety, expressed in acetochlor equivalents (M. Flood, MARC Memorandum, 9/30/93). The submitted cotton metabolism study is acceptable and demonstrates that metabolism of acetochlor in cotton is similar to that in corn. The available cotton and corn metabolism data are adequate to support the proposed uses on cotton and soybean. HED has determined that, for purposes of the subject petitions, the residues of concern for risk assessment and tolerance enforcement in cotton and soybean are the parent and any metabolites containing the EMA or the HEMA moiety, expressed in acetochlor equivalents. For purposes of the dietary risk assessment, residues in/on rotational crops should also include metabolites containing the HMEA moiety, expressed in acetochlor equivalents. The HED MARC

also determined that parent only in drinking water should be considered in the dietary risk. The need for additional plant metabolism studies to support future uses will be decided on a case-by-case basis. Table 8 is a summary of the HED MARC decisions concerning the residues of concern in plants, rotational crops, and drinking water.

Table 8: Summary of MARC Decisions for Acetochlor		
Matrix	Residues of Concern	
	For Risk Assessment	For Tolerance Expression
Plants	Parent and metabolites containing the EMA or HEMA or HMEA moiety	Parent and metabolites containing the EMA or HEMA moiety
Rotational Crops	Parent and metabolites containing the EMA or HEMA or HMEA moiety	Parent and metabolites containing the EMA or HEMA moiety
Drinking Water	Parent Only	NA

5.1.2 Metabolism in Livestock

HED previously concluded that the qualitative nature of acetochlor residues in animals is adequately understood based on adequate studies examining the metabolism of various plant metabolites (EMA type metabolites, HEMA type metabolites, and Metabolite 57) in both ruminants and poultry. The residues of concern in ruminants and poultry include acetochlor, its EMA- and HEMA-type metabolites, and Metabolite 57 (a ring hydroxylated metabolite)). HED further concluded that tolerances were not required for livestock commodities to support use on corn and sorghum based on the low levels of residues expected in livestock commodities.

Two additional studies examining the direct metabolism of radiolabeled acetochlor in goats were found to be inadequate due to insufficient characterization of ¹⁴C-residues in liver and kidney. In determining the residues of concern in livestock, the Agency noted the absence of fully acceptable metabolism studies in ruminants or poultry in which acetochlor *per se* was dosed, and concluded that additional metabolism data would be required for any new use in which detectable residues in animal commodities were likely. However, the dietary burden for ruminants has not increased significantly.

The proposed uses on cotton and soybean are not expected to increase the dietary burdens of acetochlor for cattle; however, with the establishment of a tolerance at 1.20 ppm for soybean meal, the dietary burdens to poultry and swine will increase ~7x and ~4x over the previously calculated values. On re-examination of the available feeding study data for livestock and the maximum reasonable dietary burdens (MRDBs) for ruminants and swine, it appears that there is potential for accumulation of residues of acetochlor in the tissues of ruminant and swine. Although a feeding study for acetochlor, *per se*, in ruminants was not fully adequate, a new ruminant feeding study will not be required at this time. Acceptable ruminant metabolism data are available reflecting the metabolism of the EMA and HEMA metabolites and Metabolite 57. No additional poultry metabolism data are needed at this time.

5.1.3 Residue Analytical Methods

5.1.3.1 Enforcement Methods

An adequate high performance liquid chromatography (HPLC) method with oxidative coulometric electrochemical detection (OCED) is available for tolerance enforcement for plant commodities. For this method, extracted residues are base hydrolyzed to yield EMA and HEMA, HEMA is methylated, and residues of EMA and methylated HEMA are separated and determined using HPLC/OCED. Residues of EMA and HEMA are expressed in acetochlor equivalents, and the validated method limit of quantitation (LOQ) is 0.02 ppm for each analyte. The LC/MS/MS method was adequate for data collection based on acceptable concurrent method recoveries in the cotton and soybean field trial and processing studies.

5.1.3.2 Multiresidue Methods

The FDA PESTDATA database dated 06/05 (PAM Volume I, Appendix I) indicates that acetochlor *per se* is completely recovered using Multiresidue Methods Section 302 (Luke Method; Protocol D) and 303 (Mills Method; Protocol E), but is only partially recovered by Method 304 (Protocol F). Data have also been submitted reflecting testing of six acetochlor metabolites (three EMA metabolites, two HEMA metabolites, and an ethyl hydroxymethyl aniline (EHMA) metabolite) under the Multiresidue Method Testing protocols. None of these metabolites was recovered under the FDA multiresidue protocols.

5.1.4 Residues in Crops

Field trial data for acetochlor on conventional and glyphosate-tolerant cotton have been submitted. Thirteen trials were conducted in the United States during the 2007 growing season. Glyphosate-tolerant cotton varieties were used in four of the field trials. The submitted cotton field trial data are adequate to fulfill data requirements in support of the proposed use on cotton. The number and locations of the trials are in accordance with OPPTS Guideline 860.1500 for cotton, and ample data were submitted for cotton gin byproducts reflecting harvest by stripper equipment. Samples were analyzed for residues of acetochlor and its EMA- and HEMA-type metabolites using an acceptable method, and the study is supported by adequate storage stability data. Following postemergence application of the Mcap formulation to cotton 7-15 days after the first white flower at 2.95-3.07 lb ai/A, maximum total residues of acetochlor were 0.408 ppm in/on undelinted seed and 2.501 ppm in/on gin byproducts harvested 64-133 day after treatment (DAT). Following postemergence application of the Mcap formulation to cotton at the 7- to 8-leaf growth stage at 2.96-3.12 lb ai/A, maximum total residues of acetochlor were 0.106 ppm in/on undelinted seed and 0.392 ppm in/on gin byproducts harvested 100-154 DAT. Following split applications of the Mcap formulation (preplant application made 26-32 days prior to planting and a subsequent postemergence application to cotton at the 7- to 8-leaf growth stage) for a total rate of 2.97-3.04 lb ai/A, maximum total residues of acetochlor were 0.070 ppm in/on undelinted seed and 0.290 ppm in/on gin byproducts harvested 100-154 days after the last

application. The highest residues were observed in samples from plants treated at a later growth stage with a single postemergence application made ~15 days after the first white flower at 3.0 lb ai/A. The results of the decline trial indicate that total acetochlor residues generally declined from the early sampling interval to target harvest; at subsequent sampling intervals, residues in/on seed did not increase, but residues in gin byproducts increased slightly.

The registrant also submitted field trial data for acetochlor on soybean. Twenty-one trials were conducted in the United States in during the 2007 growing season. The submitted soybean field trial data are adequate to fulfill data requirements in support of the proposed use on soybean. The number and locations of the trials are in accordance with OPPTS Guideline 860.1500 for soybean. Samples were analyzed for residues of acetochlor and its EMA- and HEMA-type metabolites using an acceptable method, and the study is supported by adequate storage stability data. Following a single postemergence application of the 3.8 lb/gal Mcap formulation to soybean plants at the R1-R2 growth stage at 2.97-3.12 lb ai/A, maximum residues of acetochlor were 96.59 ppm in/on forage, 130.9 ppm in/on hay, and 1.058 ppm in/on seed. Following split applications of the 3.8 lb/gal Mcap formulation (preplant application made 43-46 days prior to planting and two subsequent postemergence applications to soybeans at the V3 and the R1-R2 growth stages) for a total rate of 2.94-3.08 lb ai/A, maximum residues of acetochlor were 36.26 ppm in/on forage, 42.33 ppm in/on hay, and 0.465 ppm in/on seed. The highest residues were observed in samples from plants treated with a single postemergence application at the R1-R2 stage. The results of the two decline trials (Treatment plot #2) indicate that total acetochlor residues generally declined in forage and hay at later sampling intervals; residues in/on seed remained the same or declined slightly over the sampling period.

5.1.5 Residues in Livestock

Acceptable feeding studies were previously submitted for cattle reflecting feeding of EMA- and HEMA-producing metabolites and Metabolite 57, and for poultry and swine, reflecting feeding of EMA-producing metabolites only. HED previously concluded that tolerances were not required for livestock commodities to support use on corn and sorghum based on the low levels of residues expected in livestock commodities.

5.1.6 Residues in Processed Commodities

The submitted cotton and soybean processing studies reflecting application at ~3x the maximum proposed application rate are adequate. Residues do not appear to concentrate in the processed commodities of cotton and soybean with the exception of soybean meal (1.2x processing factor). A tolerance for soybean meal must be proposed at 1.2 ppm.

For the processing study for acetochlor on cotton seed a single trial was conducted in TX. Split applications were made reflecting a preplant application of a 7.0 lb/gal EC formulation to the soil 29 days prior to planting at 1.48 lb ai/A, and a postemergence application of a 3.8 lb ai/gal Mcap formulation to cotton plants 15 days after the first white flower at 7.93 lb ai/A for a

total application rate of 9.41 lb ai/A (~3x the maximum proposed seasonal application rate for cotton). The RTI was 122 days. Applications were made using ground equipment in 15-17 gal/A spray volumes; an adjuvant was not used. Bulk samples of cotton undelinted seed were harvested using picker equipment 84 days after the last treatment. Cotton seed was processed into hulls, meal, and refined oil using simulated industrial practices. Following a preplant application of the 7 lb/gal EC formulation and a subsequent postemergence application of the 3.8 lb/gal Mcap formulation for a total rate of 9.41 lb ai/A, average total acetochlor residues (determined as the sum of EMA- and HEMA-producing metabolites) were 0.0476 ppm in/on cotton undelinted seed (RAC). Following processing, total acetochlor residues were 0.0137 ppm in hulls, 0.0213 ppm in meal, and 0.0035 ppm in refined oil. Based on the results of the processing study, residues of acetochlor do not appear to concentrate in hulls (0.3x processing factor), meal (0.4x), and refined oil (0.1x). Adequate storage stability data are available to support the study.

A single trial in IL was conducted for the soybean processing study. A postemergence foliar broadcast application of a 3.8 lb ai/gal Mcap formulation of acetochlor was made to soybean plants at the R1-R2 growth stage (beginning flower to full flower) at 8.0 lb ai/A (2.7x the maximum proposed seasonal application rate for soybean). Application was made using ground equipment in a 14 gal/A spray volume; an adjuvant was not used. The soybean plants used in the trial were a commercially available glyphosate-tolerant variety. Bulk samples of soybean seed were harvested 91 days after application. Soybean seed was processed into hulls, meal, and refined oil using simulated commercial practices. Samples of soybean seed and its processed commodities were analyzed for residues of acetochlor and its EMA- and HEMA-producing metabolites, determined as the EMA and HEMA moieties, using an adequate LC/MS/MS Method, method ES-ME-1215-01. The combined LOQ for total acetochlor in soybean seed was 0.012 ppm; the LOQ for seed was used by the petitioner for the processed matrices. Based on the results of the processing study, residues of acetochlor do not appear to concentrate in hulls (0.7x processing factor) and refined oil (0.1x), but may concentrate slightly in meal (1.2x). Adequate storage stability data are available to support the study. No tolerances are required for cotton hulls, meal, and refined oil, or for soybean hulls and refined oil; however, a tolerance for soybean meal must be proposed at 1.2 ppm.

5.1.7 Rotational Crops

The nature of the residue in rotational crops is adequately understood based on the results of confined rotational crop studies in lettuce, radishes, and wheat. HED concluded that rotational tolerances should be expressed as acetochlor and its EMA- and HEMA-producing metabolites, and residues of hydroxymethyl ethyl aniline (HMEA) type metabolites would not be included in the tolerance expression, but should be included in the risk assessment.

Adequate field rotational crop data reflecting a maximum seasonal application rate of 3.0 lb ai/A are available to support the established tolerances for rotated crops and the label restrictions specified on the proposed label. Because the proposed uses on cotton and soybean

will not affect the maximum seasonal rate for acetochlor, the available data will support the proposed plantback intervals (PBIs) and established rotational crop tolerances.

5.2 Drinking Water Profile

Acetochlor is a mobile and persistent compound that can impact drinking water resources from its registered uses. Estimated Drinking Water Concentrations (EDWCs) were incorporated directly into the acute and chronic dietary analyses (“water, direct, all sources” and “water, indirect, all sources”) and were provided by the Environmental Fate and Effects Division (EFED; D359995, M. Barrett, 6/24/2009). The drinking water assessment provides modeling-based Tier 2 drinking water exposure estimates for the proposed uses of acetochlor on soybeans and cotton along with the existing uses on corn (including sweet corn, popcorn, field corn, and corn for silage) and sorghum. The Tier 2 aquatic model used for this assessment employs PRZM (Pesticide Root Zone Model; version 3.12 Beta compiled May 24, 2001) and EXAMS (Exposure Analysis Modeling System; version 2.98.04, compiled November 12, 2002). Surface water EDWCs from use of acetochlor on sorghum, which produces the highest estimated water concentrations, were used for the dietary analysis (Table 9). Using Tier 2 estimation methods, parent acetochlor concentrations in drinking water are estimated to be up to 74.9 ug/L (ppb) for instantaneous exposure, 72.2 ppb for 96-hour exposure, and 4.84 ppb for annual exposure

Table 9. Modeled EDWCs for Use of Acetochlor on Sorghum (ug/L) Underlined values Recommended by EFED for Dietary Exposure Assessment.				
Exposure Scenario	Peak Day	Peak 96 Hr Avg	365 Day Avg	Lifetime (30 yr Avg)
KS Sorghum (2.5 lb ai/ A)	49.9 to <u>74.9</u>	47.4 to <u>72.2</u>	4.14 to <u>4.84</u>	0.29 to <u>1.12</u>

5.3 Dietary and Drinking Water Exposure and Risk

Screening-level acute and semi-refined chronic dietary and drinking water exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model with the Food Commodity Intake Database (DEEM-FCID™). Dietary risk assessment incorporates both exposure and toxicity of a given pesticide. For acute and chronic dietary assessments, the risk is expressed as a percentage of a maximum acceptable dose (i.e., the dose which HED has concluded will result in no unreasonable adverse health effects). This dose is referred to as the population adjusted dose (PAD). The PAD is equivalent to the reference dose (RfD) divided by the additional Safety Factor, if applied. For acute and non-cancer chronic exposures, HED is concerned when estimated dietary risk exceeds 100% of the PAD.

5.3.1 Acute Dietary and Drinking Water Analysis

A screening level acute dietary and drinking water exposure analysis was performed for the general population and all population subgroups. The acute analysis assumed tolerance level residues, DEEM default processing factors, and 100% crop treated. The resulting 95th percentile acute exposure estimate for infants < 1 year old (the most highly exposed subgroup) is not of

concern to HED (11% acute population adjusted dose (aPAD)). The aPAD for the general U.S. population was 3%.

Table 10: Summary of Acute Dietary and Drinking Water Exposure and Risk for Acetochlor			
Population Subgroup	aPAD (mg/kg/day)	Acute (95th Percentile)	
		Exposure (mg/kg/day)	% aPAD
General U.S. Population	0.15	0.0045	3
All Infants (< 1 year old)		0.0159	11
Children 1-2 years old		0.0075	5
Children 3-5 years old		0.0066	4
Children 6-12 years old		0.0046	3
Youth 13-19 years old		0.0036	2
Adults 20-49 years old		0.0040	3
Adults 50+ years old		0.0035	2
Females 13-49 years old		0.0040	3

5.3.2 Chronic Dietary and Drinking Water Analysis

A semi-refined chronic dietary and drinking water exposure analysis was performed for the general U.S. population and various population subgroups. Tolerance level residues were used for cotton and soy bean crops. Average field trial residues and 100 crop treated assumptions were used for all other commodities. DEEM default and empirical processing factors were used to modify the tolerance values. Chronic dietary and drinking water risk estimates are not of concern for general population or other population subgroups. The subgroup with the highest risk estimate was infants < 1 year old with a cPAD of 6%. The cPAD for the general U.S. population was 2%.

Table 11: Summary of Chronic Dietary and Drinking Water Exposure and Risk for Acetochlor			
Population Subgroup	cPAD (mg/kg/day)	Chronic	
		Exposure (mg/kg/day)	% cPAD
General U.S. Population	0.02	0.0004	2
All Infants (< 1 year old)		0.0012	6
Children 1-2 years old		0.0009	4
Children 3-5 years old		0.0008	4
Children 6-12 years old		0.0005	3
Youth 13-19 years old		0.0004	2
Adults 20-49 years old		0.0004	2
Adults 50+ years old		0.0004	2
Females 13-49 years old		0.0004	2

6.0 AGGREGATE EXPOSURE AND RISK ASSESSMENT

In accordance with the FQPA, when there are potential residential exposures to a pesticide, aggregate risk assessment must consider exposures from three major routes: oral, dermal, and inhalation. There are three sources for these types of exposures: food, drinking water, and residential uses. In an aggregate assessment, exposures from relevant sources are added together and compared to quantitative estimates of hazard (e.g., a NOAEL or PAD), or the risks themselves can be aggregated. When aggregating exposures and risks from various sources,

HED considers both the route and duration of exposure. The proposed/registered acetochlor uses are not expected to result in residential exposure. Therefore, the acute and chronic exposure estimates provided in the Dietary Exposure Section represent aggregate exposure. Intermediate-term dermal and inhalation exposures to workers should be aggregated for acetochlor because the same oral toxicity endpoint was used to assess risk from both exposure routes.

7.0 OCCUPATIONAL EXPOSURE AND RISK

7.1 Exposure Scenarios

Occupational handler and post-application exposure scenarios were assessed for the risk assessment of the proposed new uses on cotton and soybean. There is a potential for short- and intermediate-term occupational exposure to acetochlor during mixing, loading, application, and post-application activities. Chronic exposure is not expected for the proposed use patterns. The proposed 33% a.i. microencapsulated formulation is designed for the slow release of acetochlor due to the encapsulation of the a.i. in beads or capsules. This formulation is mixed with water for dispersal but is designed for to remain in an encapsulated state on initial dispersion. Micro-encapsulation serves as an engineering control for mixing, loading and applying activities but also may extend post-application exposure because this formulation is designed to dissipate at a slower rate.

7.1.1 Handler Exposure Scenarios

The term “handler” applies to individuals who mix, load, and apply the pesticide product. The following handler exposure scenarios were assessed for proposed new acetochlor - uses. Formulation-specific unit exposure data for micro-encapsulated products is not available. In the absence of formulation-specific data, exposure data for dry-flowable formulations were used as a surrogate for mixer/loader scenarios. Exposure data for both liquid and granular formulations were used as surrogates for micro-encapsulate application scenarios as a means of bounding potential exposures for this use.

- 1) Mixing/Loading Emulsifiable Concentrate for Groundboom Application to Cotton and Soybeans.
- 2) Mixing/loading Micro-encapsulate for Groundboom Application to Cotton and Soybeans. [Note: unit exposures for dry flowable formulations were used as surrogate exposure assumptions for micro-encapsulated formulations in the absence of specific data on micro-encapsulated formulations]
- 3) Applying Emulsifiable Concentrate by Groundboom to Cotton and Soybeans.
- 4) Applying Micro-encapsulated Product by Groundboom to Cotton and Soybeans [Note: unit exposures for liquid formulations were assumed for groundboom application].

- 5) Applying Micro-encapsulated Product by Broadcast Spreader to Cotton and Soybeans [Note: unit exposures for granular formulations were assumed for broadcast application].

7.1.2 Post-Application Exposure Scenarios

This registration action for acetochlor involves application to agricultural crops exclusively (cotton, and soybeans). Post-application inhalation exposure is expected to be negligible; however, dermal exposure is possible for workers entering treated areas to tend or harvest crops. There are no compound specific data with which to estimate post-application exposures to agricultural workers. Estimates of post-application re-entry exposure to agricultural workers are based upon the EXPOSAC Standard Operating Procedures (SOPs) (3.1, Reference 4). This SOP lists a number of possible post-application agricultural activities for the proposed crop uses that might result in post-application.

7.2 Occupational Exposure Data and Assumptions

7.2.1 Exposure Data

7.2.1.1 Application Parameters

Maximum application rates for all of the exposure scenarios assessed are based on information provided in the acetochlor labels for the proposed new uses. The maximum application rate for microencapsulated formulations is 0.6 lbs ai per acre. The maximum application rate for emulsifiable concentrates is 1.5 lb ai per acre.

7.2.1.2 Occupational Exposure Data

Data from the Pesticide Handlers Exposure Database (PHED) was used to assess handler and post-application exposures in the absence of chemical-specific data. The transfer coefficients used in the post-application exposure assessment are from an interim transfer coefficient guidance document developed by HED's Science Advisory Council for Exposure using proprietary data from the Agricultural Re-entry Task Force (ARTF) data base (SOP #3.1)

7.2.2 Exposure Assumptions

The following standard exposure assumptions were used in estimating risks to workers from exposure to acetochlor for the proposed new uses on onion and cucurbits.

7.2.2.1 Handler Exposures

- Average body weight of an adult handler is 60 kg.
- Exposure duration is short-term and intermediate-term for all workers assessed.

- Maximum application rates as determined by label review were used for all types and methods of application.
- SOP daily volumes handled and/or area treated used for the scenarios assessed are:
 - 200 acres treated per day for groundboom mixing, loading and applying

7.2.2.2 Post Application Exposures

- Average body weight is 60 kg.
- Transferrable residue is application rate times the fraction initially available (20%).
- Maximum transfer coefficient for post-application activities is 1500 cm²/hour (weeding mature plants).
- Exposure duration is 8 hours day.
- Exposure is assumed to occur on the day of application (day 0).

7.3 Occupational Exposure and Risk Estimates

7.3.1 Handler Exposure and Risk Estimates

A target LOC or MOE of 100 is considered adequate for inhalation and dermal exposure. All worker exposures are assessed as short-and intermediate-term based on label prescribed uses and expected exposure durations. Short-term dermal and inhalation exposures are not aggregated because the selected endpoints are not based on common toxicological effects. Intermediate-term dermal and inhalation exposures to workers should be aggregated for acetochlor because the same oral toxicity endpoint was selected for these exposure routes. Exposure and risk estimates indicate MOEs are not of concern (MOEs > 100) at the maximum use rate for occupational handler activities for the proposed new uses. A summary of occupational handler exposure and risk calculations, assumptions, and results is provided in Tables 12 and 13.

Table 12. Estimated Acetochlor Exposure & MOEs for Short-Term Occupational Handler Exposure - Dermal LOC/MOE = 100; Inhalation LOC/MOE = 100;								
Exposure Scenario¹	Inhalation Unit Exposure (ug/lb ai)²	Dermal Unit Exp (mg/lb ai)²	App Rate (lbai/A)³	Area Treated (A/day)⁴	Inhalation Dose (m/k/d)⁵	Inhalation MOE⁶	Dermal Dose (m/k/d)⁷	Dermal MOE⁸
Mixing/Loading Emulsifiable Concentrate – Cotton & Soybean								
Groundboom	1.2	2.9	1.5	200	0.0060	25000	14.5	30
Groundboom Dermal PPE	1.2	0.023	1.5	200	0.0060	25000	0.115	3500
Mixing/Loading Micro-Encapsulated – Cotton & Soybean								
Groundboom	0.77	0.066	0.6	200	0.0015	970000	0.1320	3000
Applying Sprays Emulsifiable Concentrate - Cotton & Soybean								
Ground boom (Open Cab)	0.74	0.014	1.5	200	0.0037	40500	0.0700	5700
Applying Micro-Encapsulated - Cotton & Soybean								
Ground boom (Open Cab)	0.74	0.014	0.6	200	0.0015	101000	0.028	14000
Broadcast Granular	1.2	0.0099	0.6	200	0.0024	62500	0.0198	20000

¹ Use patterns are from the proposed labels.

² Baseline unit exposures are assumed unless otherwise noted. Baseline and PPE unit exposure values are reported in the PHED Surrogate Exposure Guide dated August 1998 or are from data submitted by the Outdoor Residential Exposure Task Force dated May 2000.

³ Application rates are based on maximum values based on proposed label. Most application rates upon which the analysis is based are presented as lb ai/A. In some cases, the application rate is based on applying a solution at concentrations specified by the label (i.e., presented as lb ai/gallon).

⁴ Amount treated is based on the area or gallons that can be reasonably applied in a single day for each exposure scenario of concern based on the application method and formulation/packaging type. (Standard EPA/OPP/HED values).

⁵ Inhalation dose (mg/kg/day) = [unit exposure (ug/lb ai) * 0.001 mg/ug unit conversion * Inhalation absorption (100%) * Application rate (lb ai/acre or lb ai/gallon) * Daily area treated/amount handled (acres or gallons)] / Body weight (60 kg).

⁶ Inhalation MOE = short-term endpoint for inhalation (NOAEL 150 mkd)/ Daily Inhalation Dose.

⁷ Dermal Dose (mg/kg/day) = [unit exposure (mg/lb ai) * Application rate (lb ai/acre or lb ai/gallon) * Daily area treated/amount handled (acres or gallons) * Dermal Absorption Factor (100%)] / Body weight (60 kg).

⁸ Dermal MOE = short-term and intermediate-term endpoint for dermal (NOAEL 400 mkd)/Daily Dermal Dose.

⁹ Aggregate MOE = NOAEL (8.2 mkd)/Daily Inhalation Dose + Daily Dermal Dose

Table 13. Estimated Acetochlor Exposure & MOEs for Intermediate-Term Occupational Handler Exposure - Dermal LOC/MOE = 100; Inhalation LOC/MOE = 100;									
Exposure Scenario¹	Inhalation Unit Exposure (ug/lb ai)²	Dermal Unit Exp (mg/lb ai)²	App Rate (lb ai/A)³	Area Treated (A/day)⁴	Inhalation Dose (m/kg/d)⁵	Inhalation MOE⁶	Dermal Dose (m/kg/d)⁷	Dermal MOE⁸	Aggreg MOE⁹
Mixing/Loading Emulsifiable Concentrate – Cotton & Soybean									
Groundboom	1.2	2.9	1.5	200	0.0060	4000	2.9	9	9
Groundboom PPE	1.2	0.023	1.5	200	0.0060	4000	0.023	1000	860
Mixing/Loading Micro-Encapsulated – Cotton & Soybean									
Groundboom	0.77	0.066	0.6	200	0.0015	97000	0.0264	950	850
Applying Sprays Emulsifiable Concentrate - Cotton & Soybean									
Ground boom (Open Cab)	0.74	0.014	1.5	200	0.0037	6800	0.0140	1800	1400
Applying Micro-Encapsulated - Cotton & Soybean									
Ground boom (Open Cab)	0.74	0.014	0.6	200	0.0015	17000	0.0056	4500	3500
Broadcast Granular	1.2	0.0099	0.6	200	0.0024	10500	0.0040	6300	3900

¹ Use patterns are from the proposed labels.

² Baseline unit exposures are assumed unless otherwise noted. Baseline and PPE unit exposure values are reported in the PHED Surrogate Exposure Guide dated August 1998 or are from data submitted by the Outdoor Residential Exposure Task Force dated May 2000.

³ Application rates are based on maximum values based on proposed label. Most application rates upon which the analysis is based are presented as lb ai/A. In some cases, the application rate is based on applying a solution at concentrations specified by the label (i.e., presented as lb ai/gallon).

⁴ Amount treated is based on the area or gallons that can be reasonably applied in a single day for each exposure scenario of concern based on the application method and formulation/packaging type. (Standard EPA/OPP/HED values).

⁵ Inhalation dose (mg/kg/day) = [unit exposure (ug/lb ai) * 0.001 mg/ug unit conversion * Inhalation absorption (100%) * Application rate (lb ai/acre or lb ai/gallon) * Daily area treated/amount handled (acres or gallons)] / Body weight (60 kg).

⁶ Inhalation MOE = intermediate-term endpoint for inhalation (NOAEL 25 mkd)/ Daily Inhalation Dose.

⁷ Dermal Dose (mg/kg/day) = [unit exposure (mg/lb ai) * Application rate (lb ai/acre or lb ai/gallon) * Daily area treated/amount handled (acres or gallons) * Dermal Absorption Factor (20%)] / Body weight (60 kg).

⁸ Dermal MOE = intermediate-term and intermediate-term endpoint for dermal (NOAEL 25 mkd)/Daily Dermal Dose.

⁹ Aggregate MOE = NOAEL (25 mkd)/Daily Inhalation Dose + Daily Dermal Dose

7.3.2 Post-Application Exposure and Risk Estimates

A target LOC or MOE of 100 is considered adequate for dermal exposure. Exposure and risk estimates indicate MOEs are not of concern (MOEs > 100) at the maximum use rate for occupational post-application exposure activities for the proposed new uses. A summary of post-application exposure and risk calculations, assumptions, and results is provided in Table 14.

Table 14. Estimated Acetochlor Exposure & MOEs for Occupational Post-application Exposure - Dermal LOC/MOE = 100					
Exposure Scenario	AR (lb ai/A) ¹	TTR/DFR (mg/cm²) ²	TC (cm²/hr) ³	ST Dermal MOE ⁴	IT Dermal MOE ⁵
Cotton/Soybeans (⁶ EC) scouting immature plants	1.5	3.36	100	22000	2800
Cotton/Soybeans (⁶ EC) scouting mature plants			1500	1500	200
Cotton/Soybeans (⁷ ME) scouting immature plants	0.6	1.35	100	56000	7000
Cotton/Soybeans (⁷ ME) scouting mature plants			1500	3700	460

¹ Application rates are based on maximum values based on proposed label.

² DFR (mg/cm²) = Dislodgeable Foliar Residues corresponding to day 0. Application Rate (lb ai/A) x CF (4.54E+5 mg/lb) x CF (2.47E-8 A/ cm²) x 20% (initial fraction of ai retained on foliage)

³ TC cm²/hr = Transfer coefficients and associated activities (ExpoSAC Policy Memo #003.1)

⁴ ST Dermal MOE = short-term endpoint for dermal (NOAEL 400 mkd)/Dermal Dose

⁵ IT Dermal MOE = short-term endpoint for dermal (NOAEL 25 mkd)/Dermal Dose

⁶ EC = Emulsifiable Concentrate formulation

⁷ ME = Micro-Encapsulated formulation

8.0 CUMULATIVE RISK

As part of the provisions of the Food Quality Protection Act (FQPA, 1996), EPA must consider the cumulative effects on human health that may result from exposure to different chemicals that cause toxic effects by the same mode of action. The chloroacetanilides have been evaluated by the Agency and the FIFRA Scientific Advisory Panel (SAP) as a related group of chemicals for this purpose. Acetochlor is included in a Cumulative Assessment Group (CAG) of Chloroacetanilide pesticides. Structurally related chloroacetanilides include acetochlor, alachlor, butachlor, propachlor and metolachlor. For purposes of a cumulative risk assessment, it was determined that the common mechanism of toxicity group consists of alachlor, acetochlor and butachlor. Butachlor is excluded from the group for risk assessment purposes at present there are no registered uses or tolerances for this chemical in the US. The group was selected based on common endpoints of (1) nasal turbinate tumors in rats, and a known mechanism of toxicity for development of these tumors and (2) induction of hepatic UDP-Glucuronosyl Transferase (UDPGT), which results in increased incidence of thyroid follicular cell tumors secondary to disruption of pituitary-thyroid homeostasis. Thyroid effects were not included in the final cumulative assessment of the chloroacetanilide herbicides because they were determined to occur at excessively toxic dose levels, and therefore were not considered relevant to human risk assessment. Nasal tumors represent the most sensitive endpoint for both compounds.

An updated cumulative risk assessment of the Chloroacetanilide (CAG) pesticides acetochlor and alachlor conducted in April, 2007 provides an assessment of existing and new uses of those chemicals to date (Y. Donovan, D336214, 4/30/07). Based on the most recent chloroacetanilide CAG cumulative risk assessment, cumulative risk is not of concern. A revised quantitative cumulative assessment was not conducted for the current assessment of proposed

new uses for acetochlor because acetochlor is a very minor contributor to the cumulative when compared to alachlor and the proposed new use would not affect the cumulative risk results.

9.0 DATA NEEDS

9.1 Toxicology Data Requirements

- Immunotoxicity (GLN 870.7800)
- Developmental Neurotoxicity (GLN 870.6300)
- The revised 40 CFR Part 158 Toxicology Data Requirements for a Neurotoxicity Battery (870.6200) are satisfied. However the submitted neurotoxicity studies are classified as Unacceptable/Guideline (upgradable) pending submission of information on positive control studies conducted at the performing laboratory and does not satisfy the guideline requirement for an acute neurotoxicity study in rats (870.6200; OECD 424). If such data have already been submitted to the agency, the registrant or performing laboratory should provide reference to the data and when the studies were conducted. In addition, methods and equipment used for the quantitative measures during the FOB were not described. This information should also be provided.

APPENDICES

1.0 TOXICOLOGY DATA SUMMARY

1.1 Guideline Data Requirements

Table 1. Guideline Data Requirements			
Test		Technical	
		Required	Satisfied
870.1100	Acute Oral Toxicity	yes	yes
870.1200	Acute Dermal Toxicity	yes	yes
870.1300	Acute Inhalation Toxicity	yes	yes
870.2400	Primary Eye Irritation	yes	yes
870.2500	Primary Dermal Irritation	yes	yes
870.2600	Dermal Sensitization	yes	yes
870.3100	Oral Subchronic (rodent)	yes	yes
870.3150	Oral Subchronic (nonrodent)	yes	yes
870.3200	21-Day Dermal	yes	yes
870.3250	90-Day Dermal	no	no
870.3465	90-Day Inhalation	no	no
870.3700a	Developmental Toxicity (rodent)	yes	yes
870.3700b	Developmental Toxicity (nonrodent)	yes	yes
870.3800	Reproduction	yes	yes
870.4100a	Chronic Toxicity (rodent)	yes ^a	yes
870.4100b	Chronic Toxicity (nonrodent)	yes	yes
870.4200a	Oncogenicity (rat)	yes ^a	yes
870.4200b	Oncogenicity (mouse)	yes	yes
870.4300	Chronic/Oncogenicity	yes	yes
870.5100	Mutagenicity—Gene Mutation - bacterial	yes	yes
870.5300	Mutagenicity—Gene Mutation - mammalian	yes	yes
870.5375	Mutagenicity—Structural Chromosomal Aberrations ...	yes	yes
870.5900	Mutagenicity—Other Genotoxic Effects	yes	yes
870.6100a	Acute Delayed Neurotox. (hen)	no	-
870.6100b	90-Day Neurotoxicity (hen)	no	-
870.6200a	Acute Neurotox. Screening Battery (rat)	yes	no ^b
870.6200b	90-Day Neuro. Screening Battery (rat)	yes	no ^b
870.6300	Develop. Neuro	yes	no
870.7485	General Metabolism	yes	yes
870.7600	Dermal Penetration	-	-
870.7800	Immunotoxicity	Yes	no

^a Guideline 870.4300 satisfies guideline 870.4100a and 870.4200a.

^b Submitted study is upgradable to acceptable/guideline upon submission of positive control/validation studies.

1.2 Toxicity Profiles

Table 1. Acute Toxicity Profile - Test Substance				
Guideline No.	Study Type	MRID(s)	Results	Toxicity Category
870.1100	Acute oral, rat	(1) 41565104 (1986) Acceptable/guideline (2) 00118944 (1982) Acceptable/guideline	(1) LD ₅₀ = 4238 mg/kg (males); 4025 mg/kg (females); 4124 mg/kg (combined) (2) LD ₅₀ = 2389 mg/kg (males); 1929 mg/kg (females); 2148 mg/kg (combined)	III (both studies)
870.1200	Acute dermal, rabbit	(1) 41565105 (1986) Acceptable/guideline (2) 00118945 (1982) Unacceptable/guideline (upgradable with submission of dosing procedure (surface area treated))	(1) LD ₅₀ > 2000 mg/kg (combined males and females) (2) LD ₅₀ = 4166 (combined males and females). Estimated between 3536-5000 mg/kg for males and females.	III (both studies)
870.1300	Acute inhalation, rat	(1) 41565106 (1989) Acceptable/guideline (2) 40994401(1988) Acceptable/guideline	(1)LC ₅₀ >4.46 mg/L (males) LC ₅₀ = 3.99 mg/L (females) (2) LC ₅₀ >3.0 mg/L (both males and females)	III (both studies)
870.2400	Acute eye irritation, rabbit	(1) 41592003 (1989) Acceptable/guideline (2) 00118947 (1982) Acceptable/guideline	slightly irritating (both studies)	III (both studies)
870.2500	Acute dermal irritation, rabbit	(1) 41565107 (1989) Acceptable/guideline (2) 00118946 (1982) Acceptable/guideline	(1) severe (including microscopic changes) (2) mild irritation at 72 hrs	(1) II (2) IV
870.2600	Skin sensitization, guinea pig	(1) 00131396 (1983) Acceptable/guideline (2) 41565108 (1989) Acceptable/guideline	Both studies-very strong dermal sensitizer	N/A

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.3100 90-Day oral toxicity (rat)	00050933 (1980) Acceptable/guideline 0, 800, 2000, 6000 ppm (diet) 0, 40, 100, 300 mg/kg/day	NOAEL = 40 mg/kg/day LOAEL = 100 mg/kg/day based on decreased mean body weight/weight gain in males and females.
870.3100 90-Day oral toxicity (rat)	41565115 (1986) Acceptable/guideline 0, 20, 200, 2000 ppm (diet) males 0, 1.6, 16.1, 161.1 mg/kg/day; females 0, 1.9, 18.7, 191.9 mg/kg/day	NOAEL = 16.1 mg/kg/day males (18.7 mg/kg/day females) LOAEL = 161.1 mg/kg/day males (18.7 mg/kg/day females) based on decreased body weight/weight gain in males and females.
870.3150 119-Day oral toxicity (dog)	00050928 (1980) Acceptable/guideline 0, 25, 75, 200 (capsule)	NOAEL = 25 mg/kg/day LOAEL = 75 mg/kg/day based on death of 1 male (diarrhea, emaciation also in this animal) and in both sexes, decr. body weights and decr. food consumption, liver effects. (It is noted that in this study, mid and high dose animals were acclimated by increasing dose weekly: mid dose started at 25 mg/kg/day week 1, 50 mg/kg/day week 2, then 75 mg/kg/day. High dose started at 50 mg/kg/day, incr. weekly by 50 mg/kg/day then 200 mg/kg/day)
870.3150 90-Day oral toxicity (dog)	41565116 (1986) Acceptable/guideline 0, 2, 10, 60 mg/kg/day (capsule)	NOAEL = 10 mg/kg/day LOAEL = 60 mg/kg/day based on mucous diarrhea, decr. body wt, slight anemia, incr. alanine aminotransferase, incr. relative liver weight, decr. blood glucose.
870.3200 21-Day dermal toxicity (rabbit)	00116637 (1981) Acceptable/guideline 0, 100, 400, 1200 mg/kg/day (applied 5 days/week for 3 weeks)	systemic NOAEL = 400 mg/kg/day systemic LOAEL = 1200 mg/kg/day based on high mortality and agonal clinical signs of toxicity. Local dermal irritation was observed at all dose levels.
870.3200 21-Day dermal toxicity (rat)	41565117 (1989) Acceptable/guideline 0, 0.1 1.0, 10, 100 mg/kg/day (applied 5 days/week for 3 weeks)	systemic NOAEL = 100 mg/kg/day (HDT) systemic LOAEL = >100 mg/kg/day (not tested at higher dose levels due to reported excessive dermal irritation in preliminary testing). Local dermal irritation reported in this study in all groups including controls but epithelial hyperplasia was observed at 100 mg/kg/day.
870.3465 90-Day inhalation toxicity	none submitted (not required)	N/A

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.3700a Prenatal developmental in rats	00050929 (1980) Acceptable/guideline 0, 50, 200, 400 mg/kg/day (gavage)	Maternal NOAEL = 200 mg/kg/day LOAEL = 400 mg/kg/day based on clinical signs of toxicity and decreased maternal body weight/weight gain. Developmental NOAEL = 200 mg/kg/day LOAEL = 400 mg/kg/day based on slightly decreased mean fetal weight.
870.3700b Prenatal developmental in rats	41592005 (1989), 42054903 Acceptable/guideline 0, 40, 150, 600 mg/kg/day (gavage)	Maternal NOAEL = 150 mg/kg/day LOAEL = 600 mg/kg/day based on mortality, clinical signs of toxicity and decreased maternal body weight gain. Developmental NOAEL = 150 mg/kg/day LOAEL = 600 mg/kg/day based on increased early resorptions, postimplantation loss and decreased fetal weight.
870.3700b Prenatal developmental in rabbits	40134101(1986) Acceptable/guideline 0, 30, 100, 300 mg/kg/day (gavage)	Maternal NOAEL = 300 mg/kg/day LOAEL >300 mg/kg/day (HDT; study acceptable based on results of a range-finding study). Developmental NOAEL = 300 mg/kg/day LOAEL >300 mg/kg/day .
870.3700b Prenatal developmental in rabbits	41592006 (1989) Acceptable/guideline 0, 15, 50, 190 mg/kg/day (gavage)	Maternal NOAEL = 50 mg/kg/day LOAEL = 190 mg/kg/day based on body weight loss. Developmental NOAEL = 190 mg/kg/day LOAEL >190 mg/kg/day (HDT).
870.3800 Reproduction and fertility effects rats	00131391(1982) Acceptable/guideline 0, 500, 1500, 5000 ppm (diet) F0 premating 0, 30.8, 60.4 or 316 mg/kg/day, males; 0, 46.2, 130.4 or 442 mg/kg/day, females; F1 premating 0, 29.9, 87.8 or 333 mg/kg/day, males; 0, 43.6, 129.8 or 441 mg/kg/day, females.	Parental/Systemic NOAEL = 30.8/46.2 mg/kg/day males/females LOAEL = 60.4/130.4 mg/kg/day males/females, based on decreased maternal gestation body weight gain and slightly reduced male and female premating body weight gain. Offspring NOAEL = 30.8/46.2 mg/kg/day males/females LOAEL = 60.4/130.4 mg/kg/day males/females, based on slightly decreased mean pup weights in F2b pups at lactation day 21. Reproductive NOAEL = 316/442 mg/kg/day males/females. LOAEL = mg/kg/day (HDT).

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.3800 Reproduction and fertility effects rats	41565120 (1989) Acceptable/guideline 0, 18, 175, 1750 ppm (diet) Premating F0 males 0, 1.27, 12.6 or 123.8 mg/kg/day; F0 females 0, 1.63, 15.5 or 157.4 mg/kg/day Premating F1 males 0, 1.53, 15.2 or 152.1 mg/kg/day; F1 females 0, 1.83, 18.3 or 192.4 mg/kg/day	Parental/Systemic NOAEL = 12.6 mg/kg/day males/15.2 mg/kg/day females LOAEL = 123.8 mg/kg/day males/157.4 mg/kg/day females, based on decreased body weight gain during premating. Offspring NOAEL = 12.6 mg/kg/day males/15.2 mg/kg/day females. LOAEL = 123.8/157.4 mg/kg/day males/females, based on reduced pup weight during lactation. Reproductive NOAEL = 123.8/157.4 mg/kg/day (HDT). LOAEL > 123.8/157.4 mg/kg/day males/females.
870.3800 Reproduction and fertility effects rats	45357503 (2001) Acceptable/guideline 0, 200, 600, 1750 ppm (diet) Premating F1 males 0, 21.2, 65.6, 196.4 mg/kg/day; Premating F1 females 0, 22.4, 70.9, 215.9 mg/kg/day	Parental/Systemic NOAEL = males 21.2 mg/kg/day; females 22.4 mg/kg/day LOAEL = males 65.6 mg/kg/day; females 70.9 mg/kg/day, based on focal hyperplasia and polypoid adenomata in nasal epithelium of adult F1 offspring at study termination. Offspring NOAEL = males 65.6 mg/kg/day; females 70.9 mg/kg/day LOAEL = males 196.4 mg/kg/day; females 215.9 mg/kg/day based on decreased pup weights during lactation (F1 and F2), decreased F2 litter size at birth, focal hyperplasia and polypoid adenomata in nasal epithelium of adult F1 offspring at study termination. Reproductive NOAEL = males 65.6 mg/kg/day; females 70.9 mg/kg/day LOAEL = males 196.4 mg/kg/day; females 215.9 mg/kg/day based on decreased implantations.
870.4100a Chronic toxicity (rat)	See 870.4200, below	
870.4100b Chronic toxicity (dog)	00116631, 00164944 (1981) Acceptable/guideline 0, 4, 12, 40 mg/kg/day (capsule)	NOAEL = 12 mg/kg/day LOAEL = 40 mg/kg/day based on decr. body wt. (females) and decr. wt. gain (males), incr. adrenal wt. (females), incr. liver weight (males and females), decr. testes wt., testicular atrophy.

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.4100b Chronic toxicity (dog)	41565118 (1988), Acceptable/guideline 0, 2, 10, 50 mg/kg/day (capsule) 46100901 (2003) Unacceptable/nonguideline (reexamination of testicular / epididymal tissue)	NOAEL = 2 mg/kg/day LOAEL = 10 mg/kg/day based on incr. salivation, incr. ornithine carbamyltransferase and triglycerides, decr. blood glucose; incr. incidence of interstitial nephritis, testicular degeneration/hypospermia and liver glycogen depletion. [Neurotoxic effects seen at 50 mg/kg/d - salivation, ataxia, histopathological changes in the brain] Reexamination of testicular/epididymal tissue (MRID 46100901) was not performed according to Agency pathology working group/peer review policy and the findings do not change the original dog study (MRID 41565118) conclusions.
870.4200 Carcinogenicity (rat)	00131088, 40484801 (1983) 0, 500, 1500 or 5000 ppm in diet males: 0, 22, 69 or 250 mg/kg/day, 115 weeks females: 0, 30, 93 or 343 mg/kg/day for 103 weeks (females; discontinued earlier due to high mortality).	NOAEL <22 mg/kg/day LOAEL = 22 mg/kg/day based on decreased body weight/weight gain (males) and increased abs/rel thyroid weight in females. HDT (250 males, 343 females) considered excessive based on high mortality and markedly reduced body weight/weight gain, both sexes. evidence of carcinogenicity)-at 69/93 mg/kg/day and higher-increased incidence of nasal epithelial adenomas (males). At 250/343 mg/kg/day (excessively toxic dose based on high mortality and markedly decreased body weight/weight gain (both sexes)-increased incidence of nasal epithelial carcinomas and thyroid follicular cell adenomas (males) and hepatocellular tumors (both sexes).
870.4200 Carcinogenicity (rat)	40077601 (1986) Acceptable/guideline 0, 40, 200 or 1000 ppm in diet 0, 2, 10 or 50 mg/kg/day in diet (estimated for both sexes using standard conversion factor of 0.05)	NOAEL = 10 mg/kg/day LOAEL = 50 mg/kg/day based on decreased body weight/weight gain (both sexes, slight in females), increased bilirubin in females and in males, increased GGT, cholesterol, thyroid c-cell hyperplasia, papillary hyperplasia of the nasal epithelium, hepatocellular alterations and necrosis. evidence of carcinogenicity-at 50 mg/kg/day, increased incidence of nasal epithelial papillary adenoma in males and females and thyroid follicular cell adenoma/cystadenoma in females. PWG reevaluation of liver did not show increase with treatment.

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.4200 Carcinogenicity (rat)	41592004 (1988) Acceptable/guideline 0, 18, 175 or 1750 ppm in diet males 0, 0.67, 6.37 or 66.9 mg/kg/day; females 0, 0.88, 8.53 or 92.1 mg/kg/day	NOAEL = 6.37 mg/kg/day LOAEL = 66.9 mg/kg/day based on decreased body weight/weight gain, increased GGT and cholesterol (both sexes; marginal in females), nasal epithelial hyperplasia, degeneration of retinal outer layer, renal pelvic epithelial hyperplasia, stromal fatty infiltration of the pancreas. evidence of carcinogenicity-increased incidence of nasal epithelial adenoma/carcinoma and thyroid follicular cell adenomas in males and females. Benign chondroma of femur and basal cell tumor of the stomach were reevaluated and reclassified by the PWG and are not considered treatment-related tumors.
870.4300 Carcinogenicity (mouse)	00131089 (1983) Acceptable/guideline 0, 500, 1500 or 5000 ppm in diet 0, 75, 225, 750 mg/kg/day (estimated for both sexes using standard conversion factor of 0.15)	NOAEL = 75 mg/kg/day LOAEL = 225 mg/kg/day based on reduced survival (females), slightly decreased body weight during part of study (males), anemia (females), increased abs/re/thyroid weight (females) and renal interstitial nephritis (males). evidence of carcinogenicity-incidence of lung tumors showed a dose-related increase. A PWG reevaluation of liver showed increases only at the HDT (excessive dose); ovarian and kidney tumors were not considered treatment-related.
870.4300 Carcinogenicity (mouse)	41565119 (1989) Acceptable/guideline 0, 10, 100 or 1000 ppm in diet Males 0, 1.1, 11, 116 mg/kg/day; females 0, 1.4, 13, 135 mg/kg/day	NOAEL = 1.1 mg/kg/day males; 135 mg/kg/day females LOAEL = 11 mg/kg/day in males, based on increased incidence of brochiolar hyperplasia and possibly renal tubular hyperplasia; > 135 mg/kg/day in females. evidence of carcinogenicity-increased incidence of lung adenomas (females) and adenoma/carcinoma (males) at 116/135 mg/kg/day.
Gene Mutation 870.5100 Bacterial reverse mutation <i>Salmonella typhimurium</i>	00050930 (1978) Acceptable/guideline 0.001-1 μ l/plate - /+ S9	Negative up to the highest dose tested (1 μ l/plate - /+ S9); higher concentrations (≥ 10 μ l/plate - /+ S9) were cytotoxic
Gene Mutation 870.5100 Bacterial reverse mutation <i>Salmonella typhimurium</i>	41565121 (1989) Acceptable/guideline 1.6-5000 μ g/plate - /+ S9	Equivocal positive in TA 1538 at 2500 and 1000 μ g/plate + S9; reproducible at 1000 μ g/plate but <2-fold, not dose-related and not seen in TA98
Gene Mutation 870.5100 Bacterial reverse mutation <i>Salmonella typhimurium</i> (strain T1538 only)	44863202 (1989) Acceptable/nonguideline 100-5000 μ g/plate - /+ S9 (Arochlor 1254 or Pheno-barbital / β -naphthoflavone induced rat livers)	Negative in TA1538 using 3 different batches of acetochlor (89.8-99.6%) in two separate tests

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
Gene Mutation 870.5300 Mammalian cell gene mutation Chinese hamster ovary (CHO) cells	00131395 (1983) Acceptable/guideline 25-150 $\mu\text{g/mL}$ - S9 25-125 $\mu\text{g/mL}$ + 10% S9	Positive ≥ 2 -fold in mutation frequency (MF) at 125 or 150 $\mu\text{g/mL}$ - S9 & 125 $\mu\text{g/mL}$ + S9 accompanied by cytotoxicity (61% or 93% decrease in cell survival -/+S9)
Gene Mutation 870.5300 Mammalian cell gene mutation CHO cells	42713106 (1989) Acceptable/guideline 50-200 $\mu\text{g/mL}$ -S9 50-300 $\mu\text{g/mL}$ + 1, 2, 5 or 10% S9	Negative up to cytotoxic levels (≥ 200 $\mu\text{g/mL}$ -/+ 10% S9)
Cytogenetics 870.5300 Mammalian cell gene mutation Mouse lymphoma L5178Y cells	00131394 (1982) Acceptable/guideline 20-400 $\mu\text{L/mL}$ -S9 5-250 $\mu\text{L/mL}$ +S9	Positive 30-50 $\mu\text{L/mL}$ +S9 2.2-5.2 fold increase accompanied by cytotoxicity (<10% survival at ≥ 50 $\mu\text{L/mL}$ +S9)
870.5375 Cytogenetics <i>In vitro</i> mammalian cell chromosomal aberration assay human lymphocytes (whole blood vs separated blood)	44863204 (1998) Acceptable/guideline (1) 0, 10, 75 150 $\mu\text{g/mL}$ - /+ S9 (2) 0, 100 $\mu\text{g/mL}$ - S9 (whole blood) 0, 75 $\mu\text{g/mL}$ - S9 (separated blood)	Positive at 50 and 100 $\mu\text{g/mL}$ +S9 accompanied by marked reduction in mitotic indices at 100 $\mu\text{g/mL}$ ($\geq 59\%$ decrease). Types of aberrations: breaks, fragment and minutes.
870.5375 Cytogenetics <i>In vitro</i> mammalian cell chromosomal aberration assay human lymphocytes	41565122 (1989) Acceptable/guideline 0, 10, 50, 100 $\mu\text{g/mL}$ +/- S9	Negative up to overt toxicity (significant decrease in body weight gain)
870.5385 Mammalian Bone Marrow Chromosomal Aberration Test Rat	00131392 (1983) Acceptable/guideline 0, 40, 150, 500 mg/kg IP injection	Negative up to overt toxicity (mortality) & cytotoxicity (significant decrease in PCE:NCE ratio at 2000 mg/kg, both sexes combined)
870.5395 Mammalian Erythrocyte Micronucleus Test CD-1 Mice	00164941 (1986) Acceptable/guideline 0, 200, 660, 2000 mg/kg oral gavage	

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.5395 Mammalian Erythrocyte Micronucleus Test CD-1 Mice	41565123 (1989) Acceptable/guideline 0, 898 or 1436 mg/kg ♂ 0, 1075 or 1719 mg/kg ♀	Negative up to a cytotoxic dose (significant decrease in PCE:NCE ratio) seen at both doses in ♂♀
870.5450 Cytogenetics Dominant Lethal Rat	44069502 (1996) Unacceptable/guideline 0, 200, 1000, 1500 ppm for 10 weeks	Negative for dominant lethal mutations but dosage was insufficient
870.5450 Cytogenetics Dominant Lethal Rat	41963309/44093703 (1991/1996) Acceptable/guideline 0, 200, 1000, 2000 mg/kg oral gavage	Negative; earlier report of positive results now considered to be due to reproductive (infertility) toxicity
870.5450 Cytogenetics Dominant Lethal Mouse	44093701(1996) Unacceptable/guideline 0, 200, 1000, 3500 ppm for 8 weeks	Negative for dominant lethal mutations but dosage was insufficient
870.5900 Other Genotoxicity <i>In vitro</i> sister chromatid exchange assay Human Lymphocytes	Hill et al. (1997) Acceptable/guideline 10 μ M (2.7 μ g/mL)	Weak evidence of positive response (1.5-fold increase) in one of two donor cells
870.5550 Other Genotoxicity <i>In vitro</i> UDS in Primary Rat Hepatocytes	00131393 (1983) Acceptable/guideline 0.032-320 μ g/well	Negative up to cytotoxic concentrations (≥ 10.6 μ g/well)
870.5550 Other Genotoxicity <i>In vitro</i> UDS in Primary Rat Hepatocytes	41565124 (1989) Acceptable/guideline 0, 500, 1000, 2000 mg/kg oral gavage	Weak positive response accompanied by major hepatic pathology (necrosis, 70% decreased GSH, 60-fold increase in aspartate transaminase)
870.6200 Other Genotoxicity <i>In vivo</i> Comet Assay in Rat Olfactory and respiratory cells	44863208 (1999) Acceptable/nonguideline 1750 ppm (175 mg/kg/day) 7 days	Negative at a tumorigenic dose <i>in vivo</i>

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.6200a Acute neurotoxicity screening battery	MRID 45357501 (2001) Unacceptable (guideline)-upgradable 0, 150, 500, 1500 mg/kg	NOAEL = 150 mg/kg (females); 500 mg/kg (males) LOAEL = 500 mg/kg based on decreased motor activity in females (1500 mg/kg in males based on clinical signs in the FOB and decreased body weight/weight gain). Positive control (validation) studies cited in study required to confirm endpoints.
870.6200b Subchronic neurotoxicity screening battery	MRID 45357502 (2001) Unacceptable (guideline)-upgradable. 0, 200, 600, 1750 ppm (♂ 0, 15.4, 47.6, 139.0 mg/kg/day; ♀ 0, 18.3, 55.9, 166.5 mg/kg/day)	NOAEL = 47.6 mg/kg/day LOAEL = 139.0 mg/kg/day based on decreased body weight/weight gain in males and females, possible transiently decreased hindlimb grip strength in males at week 2. Positive control (validation) studies cited in study required to confirm endpoints.
870.6300 Developmental neurotoxicity	Not available	N/A
870.7485 Metabolism and pharmacokinetics (rat)	00130839 (1983) Acceptable/guideline Oral 10 mg/kg, 400 mg/kg (¹⁴ C-acetochlor)	Rapidly eliminated (>70% of administered dose by day 2), elimination biphasic (rapid phase ½-life 5.4-10.4 hrs, slow phase 128.6-286.4 hrs for 10 mg/kg dose). Tissues did not retain high levels of radioactivity except for RBC, which retained about 2.5% of dose at study termination. Acetochlor was completely metabolized, via N-dealkylation and glucuronide conjugation, primarily to mercapturic acid derivatives, with other sulfur-containing derivatives identified.
870.7485 Metabolism and pharmacokinetics (rat)	41565125, -26, -27, 41592007, -08 (1987, 1989, 1990) Acceptable/guideline Oral 10 mg/kg, 200 mg/kg and 10 mg/kg/day x 14 days (¹⁴ C-acetochlor)	Well-absorbed and rapidly eliminated (92-96% of dose by day 5, ½ life of elimination 20-30 hrs), primarily excreted in urine (about 60% by 24 hrs) but significant fecal excretion observed, especially males and at high dose, with biliary excretion observed. Elimination biphasic. Retention in tissue/carass negligible, primarily in blood (binding to RBC) and well-perfused organs (heart, spleen, kidney, lungs, liver). Acetochlor was completely metabolized (15 compounds separated in urine, 4 in bile, 5 in feces), with glutathione, mercapturic acid or glucuronide conjugation of n-dealkylated acetochlor a major route of metabolism; sulfoxymethyl and cysteine conjugates also identified in feces. In urine, major metabolite was mercapturic acid conjugate of N-deethylated acetochlor; in bile, major metabolite was the glucuronide conjugate. Major fecal metabolite not characterized.

Table 2. Subchronic, Chronic and Other Toxicity Profile		
Guideline No./ Study Type	MRID No. (year)/ Classification /Doses	Results
870.7600 Dermal <i>in vivo</i> penetration (rat)	41778303 (1990) Acceptable/guideline	Acetochlor was dermally absorbed in rats in a dose and time-related manner. Maximum % of dose absorbed during a 10 hr exposure duration (used for unintentional occupational exposure) was 19-23% using an application of 1/70 or 1/1000 dilution of formula concentrate (equivalent to 11.772 or 0.763 mg/g, respectively).

Table 3. Special (Nonguideline) Mechanistic Study Toxicity Profile		
Study Type	MRID No. (year)/ Classification /Doses	Results
Studies on Nasal Tumorigenesis		
Comparative metabolism (rat/mouse)	44496203 (1998) Acceptable/nonguideline (1) 200 mg/kg single gavage dose or (2) 1750 ppm in diet for 6 months, then 200 mg/kg single dose or (3) 0, 10, 200, 1000 or 2000 mg/kg single gavage dose (¹⁴ C-acetochlor)	Differences in metabolism between rats and mice were seen. Initial reactions both species were oxidative O-deethylation of the N-ethoxymethyl sidechain and glucuronidation of the methylol group. In rats-glucuronide conjugate excreted in the bile, followed by hepatic removal of methylol group and glutathione conjugation, yielding mercapturic acid derivative of the glutathione conjugate (major urinary metabolite in rats). Sulfoxides and sulfone derivatives also identified. In mice-major urinary metabolite was a chloramide-enterohepatic circulation not observed and glutathione conjugation not a major route of metabolism.
Nasal cell proliferation (rat)	44496207 (1996) Acceptable/nonguideline 0, 200, 1750 or 5000 ppm in diet for 160 days	Cell proliferation in nasal turbinate olfactory respiratory epithelium, but not respiratory epithelium, was significantly increased at 1750 and 5000 ppm as measured by tritiated thymidine incorporation into DNA at each dose level at 60 days (5000 ppm only), 90 or 160 days of treatment. Bromodeoxyuridine incorporation also showed significant increases after 160 days at 1750 and 5000 ppm, but not at 200 ppm. No increase was seen in respiratory epithelium. Cell proliferation increased 1.5-2.0-fold at 5000 ppm and 1.3-1.5-fold at 1750 ppm.
Nasal cell proliferation (mouse)	44496209 (1996) Acceptable/nonguideline 0, 1000 or 5000 ppm in diet for 60 and 90 days.	Acetochlor did not cause increased nasal olfactory or respiratory epithelial cell proliferation in mice as evaluated by bromodeoxyuridine nuclear incorporation.

Table 3. Special (Nonguideline) Mechanistic Study Toxicity Profile

Study Type	MRID No. (year)/ Classification /Doses	Results
Quinoneimine-protein binding, autoradiography (rat)	44496210 (1998) Unacceptable/nonguideline (upgradable) 1710 or 5170 ppm acetochlor in diet containing ¹⁴ C-acetochlor for 14 days.	In rat nasal turbinate tissue, a dose-dependent formation of 3-ethyl, 5-methyl-benzoquinoneimine-cysteine (EMIQ-cysteine) adducts was observed (119 and 206 pmole/mg protein at 1710 and 5170 ppm, respectively) (determined by acid hydrolysis and HPLC). Whole body autoradiography showed localization of radioactivity in gut, stomach contents, urinary bladder, highly perfused organs and in the nasal turbinates, adrenal and preputial glands. Microautoradiography of decalcified noses showed localization in Bowman's glands at 1720 and 5170 ppm and RBC at 5170 ppm, with equivocal localization in the neuron layer of the olfactory surface epithelium.
Quinoneimine-protein binding autoradiography (mouse)	44496211 (1998) Unacceptable/nonguideline (upgradable) 1800 or 4750 ppm acetochlor in diet containing ¹⁴ C-acetochlor for 14 days.	EMIQ-cysteine adduct formation not observed in mice as assessed by acid hydrolysis and HPLC.
Quinoneimine-protein binding autoradiography acetochlor secondary sulfide (rat)	44496212 (1998) Unacceptable/nonguideline (upgradable) 7 mg/kg/day ¹⁴ C-acetochlor for either 5 consecutive days or single dose, sacrificed either one or 5 days after final dose.	EMIQ-cysteine adducts were observed in nasal turbinate tissue as assessed by acid hydrolysis and HPLC. Autoradiography showed localization in nasal turbinates and microautoradiography of decalcified noses showed binding in the Bowman's glands.
Quinoneimine-protein binding autoradiography (Rhesus monkey)	44496213 (1998) Acceptable/nonguideline 126 mg/kg ¹⁴ C-acetochlor for 14 days	EMIQ-cysteine adducts were not detected in nasal turbinate tissues as assessed by acid hydrolysis and HPLC.
Nasal tumor mapping (rat)	44496214 (1997) Acceptable/nonguideline nasal passages examined from rats in chronic/carcinogenicity dietary studies on acetochlor (1750 ppm) and butachlor (3000 ppm) and a one-year gastric initiation-promotion study on alachlor (126 mg/kg).	Hyperplastic and preneoplastic/neoplastic lesions for all compounds were located primarily in the ethmoid turbinates, regions normally lined by olfactory mucosa, with many near the olfactory-respiratory junctions. Olfactory to respiratory metaplasia was a significant feature of neoplastic progression. Females given acetochlor also showed basal cell hyperplasia in the region underlying Bowman's glands in dorsal and medial airways.

Table 3. Special (Nonguideline) Mechanistic Study Toxicity Profile

Study Type	MRID No. (year)/ Classification /Doses	Results
<i>In vitro</i> metabolism (rat/mouse/one human sample)	44530001 (1998) Acceptable/nonguideline ¹⁴ C-acetochlor sulfoxide (0.025 mM, 15.5 kBq) incubated w/microsomes from rat liver, nasal olfactory and nasal respiratory epithelia; mouse nasal olfactory and liver cells; and human nasal epithelia (mixed olfactory/respiratory)	Acetochlor sulfoxide was rapidly hydroxylated in rat and mouse olfactory microsomal fractions, but not respiratory or liver fractions. Major metabolites were (1) side chain oxidation product of acetochlor sulphone and (2) para-hydroxy metabolite of acetochlor sulfoxide. Hydroxylation of acetochlor sulfoxide was not detected in the sample of human nasal tissue.
<i>In vitro</i> metabolism (rat/mouse/squirrel monkey)	44530002 (1998) 46081803 (2003) Unacceptable/nonguideline (upgradable) ¹⁴ C-acetochlor (30 mM, 0.05 mBq)	Study evaluated rates of steps in metabolism of acetochlor to p-hydroxy-2-ethyl-6-methylaniline (pOH-EMA), a precursor to quinoneimine formation, in cellular fractions from rat and mouse liver, nasal olfactory epithelia and nasal respiratory epithelia; and from monkey combined nasal olfactory/respiratory epithelia. In mice and rat tissues, the rate of acetochlor-GSH conjugation of acetochlor was comparable, but slightly higher in rat olfactory tissue than mouse olfactory tissue. Rate of secondary sulfide hydrolysis to EMA was significantly lower in olfactory and respiratory tissues of mice vs. rats; p-hydroxylation of EMA was comparable in nasal tissues of rats and mice but lower in rat liver than mouse liver. Overall conversion of acetochlor to pOH-EMA was slower in mice than rats, lowering potential to form reactive intermediates. Rates of all reactions were much lower in monkey nasal tissue than rat nasal or liver tissue, suggesting lower potential to form reactive intermediates.
Protein adduct formation (rat)	46009402 (2001) <i>in vivo</i> protein binding, 10 mg/kg ¹⁴ C-acetochlor sulfoxide; <i>in vitro</i> binding, 0.4 mM ¹⁴ C-acetochlor sulfoxide, 407-458 Kbpq to cellular fractions of nasal and liver tissue Unacceptable/nonguideline (upgradable)	(1) HPLC analysis comparing radioactivity of acid hydrolysates from olfactory vs respiratory mucosa showed significantly higher levels of radioactivity in the olfactory mucosa; (2) SDS-PAGE of bound proteins from incubation of olfactory epithelial microsomal fractions showed similar patterns for carbonyl and phenyl-labeled acetochlor sulfoxide, indicating that the sulfoxide moiety was retained in much of the bound radioactivity; (3) Histoautoradiography of the olfactory and respiratory regions of the rat nasal cavity at 8 and 24 hrs postdosing showed the highest levels of bound radioactivity over Bowman's glands in the olfactory mucosa, with none in the respiratory region. The areas of binding coincide with the cellular location of xenobiotic metabolizing enzymes in the nasal passages.

Table 3. Special (Nonguideline) Mechanistic Study Toxicity Profile

Study Type	MRID No. (year)/ Classification /Doses	Results
<i>In vitro</i> metabolism (rat/mouse/squirrel monkey/human)	46009401 (2000) 46081802 (2003) Unacceptable/nonguideline (upgradable)	Rate of hydroxylation of acetochlor sulfoxide to p-OH-acetochlor sulfoxide evaluated. Highest levels of activity observed in the rat and mouse nasal olfactory tissues, no detectable activity seen in monkey or human samples. Enzyme characterization studies indicated that the reaction is catalyzed by a cytochrome similar to the CYP2A family, but not coumarin hydroxylase itself.
Studies on thyroid tumorigenesis		
Characterization of thyroid toxicity and liver effects-time course (rats)	44496208 (1996) Acceptable/nonguideline 0, 1750 or 5000 ppm (0, 100.6 or 280.9 mg/kg/day) in diet for 14, 28 or 56 days; 0, 200, 1750 or 5000 ppm (0, 10.4, 91.9 or 270.3 mg/kg/day) in diet for 160 days.	Effects on liver and thyroid weights, thyroid hormones and liver UDPGT activity were observed at 1750 and 5000 ppm, consistent w/perturbation of thyroid-pituitary homeostasis via UDPGT-mediated clearance of T4. Increased hepatic UDPGT activity (by day 14), increased TSH (by day 14 at 5000 ppm and day 56 at 1750 ppm) and T4 (day 14 only) and decreased T3 (day 14 only) were observed. Liver and thyroid weights were increased (days 14-90; liver also at day 160).
Studies on acute liver toxicity (supplemental data for UDS studies) and liver cell proliferation		
Acute liver toxicity (rats)	(1993) Unacceptable/nonguideline (upgradable with test material purity information) (1) 2000 mg/kg via gavage in corn oil (evaluation of UDS); (2) 0, 500, 1000 or 2000 mg/kg via gavage in corn oil (evaluation of liver tissue non-protein sulphhydryl groups)	Dose-dependent depletion of hepatocellular glutathione leading to mild to marked necrosis at ≥ 500 mg/kg was observed, with slight stimulation of UDS at 2000 mg/kg. Increased serum AST and ALT were observed at 2000 mg/kg. UDS therefore observed at conditions of excessive hepatocellular toxicity and reduced hepatocellular glutathione levels.
Acute liver toxicity (rats)	44863207 (1994) Unacceptable/nonguideline (upgradable with submission of test material purity) 0, 500, 1000 or 2000 mg/kg via gavage in corn oil	Dose-dependent depletion of hepatocellular glutathione observed at ≥ 500 mg/kg, peaking 6-12 hrs post-dosing (17 to 63% of control levels between 3-12 hrs). Necrosis and serum liver enzymes returned to normal levels thereafter and normal levels of glutathione were observed by 48 hr.
Hepatocellular proliferation (mice)	44863601 (1999) Acceptable/nonguideline 0, 1000 or 5000 ppm in diet for 90 days (males only). Equivalent to 0, 166.6 or 887.9 mg/kg/day).	Incorporation of BrdU in mice treated with acetochlor was approximately doubled (0.15, 0.35, 0.38 at 0, 1000 and 5000 ppm, respectively).

2.0 Studies Reviewed for Ethical Conduct

The PHED Task Force, 1995. The Pesticide Handlers Exposure Database, Version 1.1. Task Force members Health Canada, U.S. Environmental Protection Agency, and the National Agricultural Chemicals Association, released February, 1995.

Agricultural Re-entry Task Force (ARTF) data base (SOP #3.1)

4.0 TOXICOLOGY STUDY REFERENCES

81-8 Acute neurotoxicity screen study in rats

MRID	Citation Reference
45357501	Kilgour, J. (2001) Acetochlor: Acute Neurotoxicity Study in Rats: Lab Project Number: CTL/AR6884: 852-542. Unpublished study prepared by Central Toxicology Laboratory (Zeneca). 557 p. {OPPTS 870.6200}

82-1 Subchronic Oral Toxicity: 90-Day Study

MRID	Citation Reference
50928	Ahmed, F.E.; Tegeris, A.S.; Underwood, P.C.; et al. (1980) CP 55097: 119-Day Study in the Dog: Report No. 7920; Report No. 79- 114. (Unpublished study received Dec 12, 1980 under 524-EX-56; prepared by Pharmacopathics Research Laboratories, Inc., submitted by Monsanto Co., Washington, D.C.; CDL:099810-B; 099811)
50933	Ahmed, F.E.; Tegeris, A.S.; Underwood, P.C.; et al. (1980) CP 55097: 91-Day Feeding Study in the Rat: Report No. 7914; Report No. PR-79-051. Includes undated method entitled: CP 55097: 91- day feeding study in the mouse/rat; feed mixing efficiency and compound-in-feed stability studies. (Unpublished study including protocol # 378, received Dec 12, 1980 under 524-EX-56; submitted by Monsanto Co., Washington, D.C.; CDL:099807-F; 099808; 099809)
76701	Ahmed, F.E.; Seely, J.C.; Tegeris, A.S.; et al. (1981) MON 097: One Year Study in the Dog: Report No. 8006; Report No. PR-80-008. Six month interim rept. (Unpublished study received Jun 9, 1981 under 524-EX-56; prepared by Pharmacopathics Research Laboratories, Inc., submitted by Monsanto Co., Washington, D.C.; CDL: 070134-A)
41565115	Broadmeadow, A. (1986) SC-5676: Toxicity Study by Dietary Administration to CD Rats for 13 Weeks: Final Report: Lab Project No: 86/0051: 86/SUC011/00511: SUC/II/5676. Unpublished study prepared by Life Science Research Ltd. 222 p.
41565116	Broadmeadow, A. (1986) SC-5676: Toxicity Study by Oral (Capsule) Administration to Beagle Dogs for 13 Weeks: Final Report: Lab Project Number: 86/SUC010/0059: SUC/010/5676: 86/0059. Unpublished study prepared by Life Sciences Research Ltd. 201 p.
45300503	Lees, D. (2000) R290131: 28 Day Dietary Toxicity Study in Rats (Dose Range Finder for a 90 Day Study): Lab Project Number: CTL/KR1350/RE/REPT: KR1350: 852-503. Unpublished study prepared by Central Toxicity Laboratory (Zeneca). 81 p.
45300506	Williams, J. (2000) R290130: 28 Day Dietary Toxicity Study in Rats (Dose Range Finder for a 90 Day Study): Lab Project Number: CO9031: 22082: Y09620/002. Unpublished study prepared by Central Toxicology Laboratory (Zeneca). 79 p.
45313801	Lees, D. (2000) R290131: 90 Day Dietary Toxicity Study in Rats: Lab Project Number: C09034: WINO 23039: Y09621/002. Unpublished study prepared by Central Toxicology Laboratory (Zeneca). 998 p.
45313805	Williams, J. (2000) R290130: 90 Day Dietary Toxicity Study in Rats: Lab Project Number: CTL/PR1148/REGULATORY/REPORT: PR1148: CTL/PR1148/REG/REPT. Unpublished study prepared by Central Toxicology Laboratory. 985 p. {OPPTS 870.3100}

82-2 21-day dermal-rabbit/rat

MRID	Citation Reference
116637	Johnson, D.; Myer, J.; Marroquin, F.; et al. (1981) 21-day Dermal Toxicity Study in Rabbits: (MON-097): 401-157; IR-80-356. (Unpublished study received Oct 21, 1982 under 524-EX-56; prepared by International Research and Development Corp., submitted by Monsanto Co., Washington, DC; CDL:248620-C)
41565117	Leah, A. (1989) Acetochlor: 21-Day Dermal Toxicity to the Rat: Lab Project Number: CTL/P/2613: LR0531. Unpublished study prepared by ICI Central Toxicology Laboratory. 364 p.

82-3 90-day dermal-rodent

MRID	Citation Reference
118943	Branch, D.; Kronenberg, J. (1982) Summaries of Toxicology Studies: ?MON 097]. (Unpublished study received Nov 18, 1982 under 524- EX-56; submitted by Monsanto Co., Washington, DC; CDL:071244-A)

82-7 Subchronic Neurotoxicity

MRID	Citation Reference
45357502	Kilgour, J. (2001) Acetochlor: Subchronic Neurotoxicity Study in Rats: Lab Project Number: CO9232: 24836: CTL/PR1176. Unpublished study prepared by Central Toxicology Laboratory (Zeneca). 742 p. {OPPTS 870.6200}

83-1 Chronic Toxicity

MRID	Citation Reference
116631	Ahmed, F.; Tegeris, A.; Seely, J.; et al. (1981) MON 097: 12 Month Chronic Toxicity Study in the Dog: Report No. 8006; Sponsor's Report No. PR-80-008. (Unpublished study received Oct 21, 1982 under 524-EX-56; prepared by Pharmacopathics Research Laboratories, Inc., submitted by Monsanto Co., Washington, DC; CDL: 248618-A; 248619)
164944	Pharmacopathics Research Laboratories (1986?) One-year Feeding Study in Dogs with Acetochlor: Historical Control Data Provided by the Animal Supplier, Hazleton Research Animals: Historical Control Data Provided by the Testing Laboratory, Pharmacopathics Research Laboratories. Unpublished study. 39 p.
40077601	Naylor, M.; Ribelin, W. (1986) Chronic Feeding Study of MON 097 in Albino Rats: Project ID: EHL-83107: Study No. 83107. Unpublished study prepared by Monsanto Environmental Health Laboratory. 2201 p.
40484801	Ribelin, W. (1987) Histopathological Findings in Noses of Rats Administered Mon 097 in a Lifetime Feeding Study: Study No. ML-86-44/EHL 86027. Unpublished study prepared by Tegeris Laboratories in cooperation with Monsanto Environmental Health Laboratory. 77 p.
41565118	Broadmeadow, A. (1988) SC-5676: Toxicity Study by Oral (Capsule) Administration to Beagle Dogs for 52 Weeks: Final Report: Lab Project Number: 88/SUC018/0136: SUC/018/5676: 88/0136. Unpublished study prepared by Life Science Research Ltd. 377 p.
44496205	Hardisty, J. (1997) Pathology Working Group Peer Review of Hepatocellular Neoplasms in the Liver of Rats and Mice from Five Long-Term Studies with Acetochlor: Lab Project Number: CTL/C/3197: PR-80-006: PR-80-007. Unpublished study prepared by Experimental Pathology

Laboratories, Inc. 310 p.

44496206 Hardisty, J. (1997) Pathology Working Group Peer Review of Neoplastic Lesions in the Lung of Male and Female Mice from Two Long-Term Studies with Acetochlor: Lab Project Number: CTL/C/3198: PR-80-007: 87/SUC012/0702. Unpublished study prepared by Experimental Pathology Laboratories, Inc. 356 p.

45367404 Hardisty, J. (2001) Pathology Working Group Peer Review of Neoplastic Lesions in the Femur and Non-Glandular Stomach of Male and Female Rats from a Combined Oncogenicity and Toxicity Study in Dietary Administration to CD Rats for Weeks with Acetochlor: Final Report: Lab Project Number: 550-003. Unpublished study prepared by Experimental Pathology Labs., Inc. 112 p.

83-2 Oncogenicity

MRID	Citation Reference
131088	Ahmed, F.; Seely, J.; Underwood, P.; et al. (1983) MON 097: Chronic Toxicity and Oncogenicity Study in the Rat: Report No. 8004; Re- port No. PR-80-006. (Unpublished study received Sep 22, 1983 under 524-348; prepared by Pharmacopathics Research Laboratories, Inc., submitted by Monsanto Co., Washington, DC; CDL: 071962-D; 071963; 071964; 071965)
131089	Ahmed, F.; Seely, J.; Tegeris, A.; et al. (1983) MON-097: 24-Month Oncogenicity Study in the Mouse: Report No. 8002; Report No. PR- 80-007. (Unpublished study received Sep 22, 1983 under 524-348; prepared by Pharmacopathics Research Laboratories, Inc., submitted by Monsanto Co., Washington, DC; CDL:071966-A; 071967; 071968)
40077601	Naylor, M.; Ribelin, W. (1986) Chronic Feeding Study of MON 097 in Albino Rats: Project ID: EHL-83107: Study No. 83107. Unpub- lished study prepared by Monsanto Environmental Health Labora- tory. 2201 p.
40484801	Ribelin, W. (1987) Histopathological Findings in Noses of Rats Administered Mon 097 in a Lifetime Feeding Study: Study No. ML-86-44/EHL 86027. Unpublished study prepared by Tegeris Laboratories in cooperation with Monsanto Environmental Health Laboratory. 77 p.
41565119	Amyes, S. (1989) SC-5676: 78 Week Feeding Study in CD-1 Mice: Final Report: Lab Project No: SUC/012/5676: 87/SUC012/0702. Unpub- lished study prepared by Life Science Research Ltd. 156 p.
41592004	Broadmeadow, A. (1988) SC-5676: Combined Oncogenicity and Toxicity Study in Dietary Administration to CD Rats for 104 Weeks: Final Report: Lab Number: 88/SU017/0348. Unpublished study prepared by Life Science Research Ltd. 2490 p.
44496204	Hardisty, J. (1997) Pathology Working Group Peer Review of Histiocytic Sarcoma in Female Mice from Two Long-Term Studies with Acetochlor: Lab Project Number: CTL/C/3196: 3002: PR-80-007. Unpublished study prepared by Experimental Pathology Laboratories, Inc. 473 p.
44496205	Hardisty, J. (1997) Pathology Working Group Peer Review of Hepatocellular Neoplasms in the Liver of Rats and Mice from Five Long-Term Studies with Acetochlor: Lab Project Number: CTL/C/3197: PR-80-006: PR-80-007. Unpublished study prepared by Experimental Pathology Laboratories, Inc. 310 p.
44496206	Hardisty, J. (1997) Pathology Working Group Peer Review of Neoplastic Lesions in the Lung of Male and Female Mice from Two Long-Term Studies with Acetochlor: Lab Project Number: CTL/C/3198: PR-80-007: 87/SUC012/0702. Unpublished study prepared by Experimental Pathology Laboratories, Inc. 356 p.

- 45367403 Hardisty, J. (2001) Pathology Working Group Peer Review of Proliferative Lesions in the Kidney of Female Mice from a 24-Month Oncogenicity Study in the Mouse with Acetochlor: Final Report: Lab Project Number: 550-001: EP-2000-227. Unpublished study prepared by Experimental Pathology Labs., Inc. 110 p.
- 45367404 Hardisty, J. (2001) Pathology Working Group Peer Review of Neoplastic Lesions in the Femur and Non-Glandular Stomach of Male and Female Rats from a Combined Oncogenicity and Toxicity Study in Dietary Administration to CD Rats for Weeks with Acetochlor: Final Report: Lab Project Number: 550-003. Unpublished study prepared by Experimental Pathology Labs., Inc. 112 p.

83-3 Teratogenicity -- 2 Species

MRID	Citation Reference
50929	Rodwell, D.E.; McMeekin, S.O. (1980) Teratology Study in Rats IR- 79-009: IRDC No. 401-066. (Unpublished study received Dec 12, 1980 under 524-EX-56; prepared by International Research and Development Corp., submitted by Monsanto Co., Washington, D.C.; CDL:099811-B)
116635	Schardein, J.; Sherman, D.; McFadden, D.; et al. (1981) Teratology Study in Rabbits (IR-79-293): ?MON-097]: 401-104. (Unpublished study received Oct 21, 1982 under 524-EX-56; prepared by International Research and Development Corp., submitted by Monsanto Co., Washington, DC; CDL:248620-A)
116636	Schardein, J.; Aldridge, D.; Allen, S.; et al. (1981) Pilot Teratology Study in Rabbits (IR-79-292): ?MON-097]: 401-103a/b. (Unpublished study received Oct 21, 1982 under 524-EX-56; prepared by International Research and Development Corp., submitted by Monsanto Co., Washington, DC; CDL:248620-B)
40134101	Adam, G. (1986) A Teratology Study in Rabbits with MON 097 (Acetochlor): WIL-50009. Unpublished study prepared by WIL Research Laboratories, Inc. 173 p.
41089201	Adam, G. (1989) Teratology Study of MON 4660 in Rats: Monsanto Project No. SB-88-260: SLS Study No. 3044.10. Unpublished study prepared by Springborn Life Sciences, Inc. 273 p.
41592005	Brooker, A.; Stubbs, A.; John, D. (1989) Acetochlor: Teratogenicity Study in the Rat: Lab Project Number: RR0431: ISN 204/89369. Unpublished study prepared by Huntingdon Research Centre Ltd. 121 p.
41592006	Brooker, A.; Stubbs, A.; John, D. (1989) Acetochlor: Teratogenicity Study in the Rabbit: Lab Project Number: RB0432: ISN 205/89432. Unpublished study prepared by Huntingdon Research Centre Ltd. 102 p.
42054901	Brooker, A.; Stubbs, A.; John, D. (1991) Acetochlor: Teratogenicity Study in the Rabbit: Report Supplement 1: Lab Project Number: ISN 205/89432: RB0432. Unpublished study prepared by Huntingdon Research Centre, Ltd. 12 p.
42054902	Brooker, A.; Stubbs, A. (1989) Acetochlor: A Preliminary Study of the Effect on Pregnancy of the Rat: Lab Project Number: CTL/C/ 2185: ISN 198/89180: RR 0429. Unpublished study prepared by Huntingdon Research Centre, Ltd. 60 p.
45313806	Holson, J. (2000) A Dose Range-Finding Prenatal Developmental Toxicity Study of MON 52755 in Rats: Final Report: Lab Project Number: WIL/50258: WI-99-111: 852-512. Unpublished study prepared by WIL Research Laboratories. 246 p.
45313807	Holson, J. (2000) A Prenatal Developmental Toxicity Study of MON 52755 in Rats: Final Report: Lab Project Number: 852-513: WIL-50259: WI-99-121. Unpublished study prepared by

83-4 2-generation repro.-rat

MRID	Citation Reference
131391	Schardein, J.; Marroquin, F.; Thorstenson, J. (1982) Two Generation Reproduction Study in Rats: ?Mon 097]; IR-80-053: 401-138. Fi- nal rept. (Unpublished study received Sep 22, 1983 under 524- 348; prepared by International Research and Development Corp., submitted by Monsanto Co., Washington, DC; CDL:071969-A)
40389301	Naylor, M. (1987) Dominant Lethal/Fertility Study of MON-097 in Sprague-Dawley Rats: Laboratory Project No. EHL-86008. Unpub- lished study prepared by Monsanto Environmental Health Labora- tory. 261 p.
41565120	Willoughby, C. (1989) SC-5676: Effects Upon Reproductive Performance of Rats Treated Continuously throughout Two Succesive Generations: Final Report: Lab Project No: 89/SUC020/ 0414: 89/0414. Unpublished study prepared by Life Science Research Ltd. 908 p.
42077101	Brooker, A.; Stubbs, A. (1989) Acetochlor: A Preliminary Study of the Effect on Pregnancy of the Rabbit: Lab Project Number: ISN 199: RR 0430: ISN 199/89176/B. Unpublished study prepared by Huntingdon Research Centre Ltd. 61 p.
44863209	Hodge, M. (1991) Acetochlor: Male Reproductive Tract Pathology Study in the Rat: Lab Project Number: PR0839: CTL/T/2759. Unpublished study prepared by Central Toxicology Labs. 49 p.
45357503	Milburn, G. (2001) Acetochlor: Multigenerational Reproduction Toxicity Study in Rats: Lab Project Number: RR0818: CTL/RR0818: 852-544. Unpublished study prepared by Central Toxicology Laboratory (Zeneca). 2529 p. {OPPTS 870.3800}

84-2 Intreraction with Gonadal DNA

MRID	Citation Reference
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OFFICE OF
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MEMORANDUM

Subject: Revised Drinking Water Exposure Assessment for Acetochlor

To: Felecia Fort, Chemical Review Manager
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Steven P. Bradbury, Ph.D. Director
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Attached is the revised drinking water exposure assessment for acetochlor. It has been updated to include the EFED response to comments from the Acetochlor Registration Partnership (ARP).

Emphasis in this assessment is placed on acetochlor parent because of its important in the dietary risk assessment; however, data on exposure to acetochlor degradates are also reviewed in this assessment. Note that this assessment covers only the one major field use site (corn for grain or forage) that is currently registered; registration applications for other major field uses of acetochlor are pending; additional field uses for acetochlor will require significant additions and revisions to the exposure assessment.

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3. ABBREVIATIONS

AC	Acetochlor
Ac_ESA	Acetochlor ethanesulfonic acid
Ac_OXA	Acetochlor oxanilic acid
ARP	Acetochlor Registration Partnership
BEAD/OPP	Biological and Economic Analysis Division of OPP
CDF	Cumulative frequency distribution
CWS	Community water system
ESA	Acetochlor ethanesulfonic acid
EFED/OPP	Environmental Fate and Effects Division of OPP
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act of 1996
GAC	Granular activated carbon treatment
GWM	Ground Water Monitoring (ARP Reference)
NAWQA	National Water Quality Assessment Program of USGS
NCFAP	National Center for Food and Agricultural Policy (pesticide usage monitoring program)
OPP	Office of Pesticide Programs of USEPA
OXA	Acetochlor oxanilic acid
PAC	Powdered activated carbon treatment
PGW	Prospective ground water study (monitoring program)
SDWS	Surface drinking water supply (monitoring program)
SGW	State ground water (monitoring program)
SWM	Surface water monitoring (ARP Reference)
TWAM	Time-weighted annualized mean
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WARP	Watershed Regression for Pesticides – USGS Pesticide Concentration Model

4. EXECUTIVE SUMMARY

4.1. Purpose

In March of 1994, USEPA and ARP entered into a conditional registration agreement (USEPA, 1994) for the chemical acetochlor (2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)-acetamide), the active ingredient in a number of herbicides used on corn (*Zea mays*) crops to control annual grasses and certain broadleaf weeds (Hackett et al., 2004). Under the agreement, USEPA required ARP to conduct several acetochlor monitoring programs and specified a number of cancellation or mitigation endpoints aimed at protecting the environment and limiting potential risks to human health (USEPA, 1994). The purpose of this assessment is, therefore, to estimate exposure to acetochlor (in support of a human health dietary risk assessment) and to summarize the status of mitigation / cancellation endpoints encapsulated in the acetochlor conditional registration agreement.

The primary source data for both this exposure assessment and evaluation of the registration agreement compliance are the three major acetochlor data sets generated by the Acetochlor Registration Partnership (ARP). Two data sets are ground water source based and include the “State” Ground Water (SGW) monitoring program and the Prospective Ground Water studies (PGW) and one is surface water source based referred to as Surface Drinking Water Supplies (SDWS) monitoring program. The ARP provided a fourth acetochlor data set that consists of incident investigation of ground water primarily around pesticide dealer and storage facilities. The incident data are only indirectly related to impacts from registered uses of acetochlor therefore these data have not been explicitly included in the direct exposure assessment. When relevant to the exposure assessment, additional publicly available water monitoring data for acetochlor are discussed in this document.

4.2. Acetochlor Usage, Monitoring Locations, and the Exposure Assessment

Acetochlor is now registered in 42 states as well as the District of Columbia (Hackett et al., 2004). It is also used in corn growing areas of several countries including China, Europe, and Argentina. Presently, roughly 80% of the total use of acetochlor in the United States occurs in the Midwest. Detailed county-level sales maps for acetochlor from 1994 to 2003 are provided in Appendix section 12.3 **Acetochlor Usage – Detailed Summary**. These sales data have been provided separately by members of the acetochlor registration partnership (ARP) as confidential information and cannot be shared with unauthorized individuals.

The sales data are presented as a surrogate for the location of acetochlor usage. Pesticide sales data may not be a consistent estimator of usage in any particular watershed because usage may not occur near the location of purchase. The maps of acetochlor sales data and surface water monitoring locations show that the set of monitoring sites selected does not coincide well with all of the areas where high sales have been reported. A lower rate of utilization of surface water sources by drinking water facilities and lower overall numbers of CWS’ utilizing surface water in some high acetochlor use regions appears to be a factor in the paucity of sites in these regions that were eventually selected for monitoring in the SDWS. For these reasons of facility location and sampling design, it is possible therefore that the drinking water intake locations that were monitored do not fully represent the sites where highest concentrations in then current or potential surface source drinking water occurred.

The lack of monitoring in some of the high acetochlor use areas is especially problematic for broader interpretation of the SDWS monitoring results where the lack of sampling of raw (pre-facility treatment)

water at most locations makes it difficult to isolate the effects of site-specific usage, vulnerability factors, and water treatment processes on the observed residue levels.

4.3. Time Weighted Annualized Means and 95th Percentile Calculations

Time-weighted annualized means (TWAMs) were calculated for each site in the three major monitoring programs (SDWS, SGW, and PGW). Two separate weighting methods were implemented using a custom-built TWAM computer program to verify the TWAMs computed by the ARP. The weighting method used by the ARP (described later in this report) was cross-checked with a slightly different method implemented in the WARP beta model developed by the USGS (USGS 2004). Both weighting methods assign a weight to each discrete sample observation based upon the fraction of the time during a year that each sample represents. Weighted concentrations were then summed to provide an annualized mean.

4.4. Mitigation/Cancellation Endpoints

In addition to providing a drinking water exposure assessment for application to a dietary risk assessment for acetochlor, this document also addresses the endpoints or triggers for regulatory action incorporated into the acetochlor registration agreement are provided in Appendix 1 (see USEPA, 1994; for a full copy of the agreement). These endpoints are directly tied to each of the major monitoring programs required of the ARP in the Acetochlor Registration Agreement; the reader may need to refer to the Appendix for a complete understanding of the reasons for the way in which these endpoints are discussed in this document. The triggers varied between monitoring programs, the following is a comparison of the results to the triggers for each program. Discussion of both parent and degradate occurrence and their relation to the triggers is separately provided in this document, however, only parent residues are clearly classified as residues of concern for which the triggers for mitigation measures in the Registration Agreement apply. At the time acetochlor was registered monitoring data for the major degradation products of acetochlor was virtually non-existent and specific toxicity studies had not yet been conducted. Consequently, no informed determination could have been made at the time of the registration agreement about whether any significant risk could potentially arise from exposure to acetochlor ESA or OXA in water.

4.4.1. ARP Surface Water Monitoring Endpoints

Acetochlor was detected above 8.0 ppb trigger for individual detections in 2 samples in the surface drinking water supply (SDWS) monitoring program. Two finished (treated water) samples were detected above 8.0 ppb, however the twelve month time-weighted annualized mean did not exceed the 2.0 ppb regulatory action trigger for these or any of the other water supply systems included in the SDWS. No raw (untreated) concentrations were detected above 8.0 ppb. For both raw and finished surface drinking water, roughly 99% of the time-weighted

annualized means were below 0.5 ppb. Maximum acetochlor instantaneous concentrations, 95th percentiles, and time-weighted annualized means were observed in Illinois.

4.4.2. ARP Ground Water Monitoring Endpoints – PGW Study

For the PGW, the triggers for regulatory action were tied to both soil pore-water (lysimeter) and ground water detections. Acetochlor was detected above 0.1 ppb at only one site in nine foot lysimeters in the prospective ground water (PGW) studies. The maximum concentration of acetochlor in soil pore water was 3.2 ppb observed in the nine foot lysimeters in Iowa. The maximum residue detected in ground water wells was 0.06 ppb observed in Iowa. The acetochlor degradates ethanesulfonic acid (Ac_ESA) and oxanilic acid (Ac_OXA) were generally detected more frequently than parent acetochlor. In the PGW studies for example, ESA demonstrated a pattern of movement as defined by concentrations greater than or equal to 1.0 ppb at three, six, and nine foot lysimeter depths. In 293 instances ESA was detected above 1.0 ppb at all three lysimeter depths. These exceedences occurred in seven out of the eight states.

4.4.3. ARP Ground Water Monitoring Endpoints – SGW Study

For the SGW, the trigger for regulatory action was a pattern of detections in 20 or more wells at or above 0.10 ppb “followed by two subsequent detections of at least 0.10 ppb in monthly sampling of each of those wells, conducted over a period of six months” (this language did not anticipate the impact of a large number of missing samples as in the reduced sample collection regime resulting in a maximum of four samples per well per year being collected during the last two years of the monitoring program). See Appendix 12.2 for details. Parent acetochlor exhibited a pattern of detection in the required number of samples in seven wells, or thirteen wells short of the trigger for regulatory action based on SGW results. Residues of acetochlor degradates were much more widespread in the SGW wells, but these compounds have not been deemed residues of concern.

Aproximately 10% of the site maximum instantaneous concentrations in the SGW wells were above 0.5 ppb and 15% of all time-weighted annualized means were greater than or equal to 0.03 ppb (i.e., the minimum detection limit). If the degradates are included in an exposure calculation, then the number of wells with a pattern of detections increases to approximately 36 (requires a modification of the “pattern of movement” definition to 2 of 3 consecutive detections greater than 0.1 ppb (0.2 ppb for ESA since the detection limit was 0.2 ppb) since sampling of degradates never occurred more frequently than a quarterly basis.

4.5. Exposure Summary

Acetochlor parent residue exposure is generally higher and more widespread through surface water sources than ground water (Table 1). Available data indicate that water treatment involving the use of activated carbon may reduce exposure by close to 50% on average; however limitations on the data preclude generalizing this as a predictable effect of water treatment. In particular, no data are available that match the same water in raw and finished water, the ARP SDWS dataset did not measure samples in intake water from those systems using other types of water treatment, and most of the highest concentrations observed in the SDWS study occurred in

finished (not raw) samples. EFED is aware that while specific matching of raw and finished water is not available for the ARP study, other studies of treatment effects are available such as that by Gustafson et al. (2003).

Table 1. Summary presentation of chronic exposure to parent acetochlor: Time-weighted annualized mean concentrations (ppb) in surface and ground water from the ARP monitoring program (based on maximum TWAM values observed at each site by calendar year) along with WARP model predictions for streams and rivers.

Study	N	Maximum	95 th Percentile	Median
Surface Water - SDWS raw	44	0.591	0.355	0.042
Surface Water - SDWS finished	189	1.428	0.347	0.032
<i>Surface Water - WARP model (raw)^a</i>	<i>470</i>	<i>0.812</i>	<i>0.435</i>	<i>0.042</i>
Ground Water (shallow) - PGW site averages	8	<0.03	<0.03	<0.03
Ground Water (shallow) - PGW cluster maximums	8	<0.03	<0.03	<0.03
Ground Water - SGW	182	0.520	0.039	<0.03

^a Includes TWAMs calculated by the WARP model. The WARP results are provided for comparison to the ARP monitoring results and include WARP results only for states where ARP also had surface water monitoring stations.
N = total number of sites included in the statistics.

Should a toxicological concern arise from exposure anywhere near these levels (up to 3x the levels reported in **Table 1**), a refined exposure assessment can be done adjusting the ARP exposure values for any disparity between usage intensity at the ARP monitoring sites and other watersheds with surface water serving as drinking water sources with higher use intensities. A requirement for this would be acquisition from the ARP or independent calculation by EPA of acetochlor usage by watershed based on the overlap of county and watershed boundaries (the best available data representing acetochlor spatially have all been reported at the county level).

Finally, the results of this monitoring analysis only apply to acetochlor use on field corn (significant new field uses are currently under review by EPA).

5. INTRODUCTION

Pesticide substances in the United States are regulated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), later amended by the Food Quality Protection Act of 1996 (FQPA). Under FIFRA, any pesticide, be it a single active ingredient or a mixture, must be registered for use as a pesticide before a person may distribute or sell the product. Pesticides are also regulated at the state level (usually by U.S. Department of Agriculture); however, state regulations must be at least as stringent as federal regulations. In order to register a pesticide in

the US, the USEPA must ensure that the pesticide, when used according to the product label, will not pose an unreasonable risk to human health or the environment. Under FQPA, regulators must also consider threats to human health through food residues and via pesticides in drinking water. The latter requirement has created a need to monitor and estimate pesticides in drinking water supplies, including both surface water and ground water sources.

In March of 1994, USEPA and ARP entered into a conditional registration agreement (USEPA, 1994) for the chemical acetochlor (2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)-acetamide), the active ingredient in a number of herbicides used on corn (*Zea mays*) crops to control annual grasses and certain broadleaf weeds (Hackett et al., 2004). Under the agreement, USEPA required ARP to conduct several acetochlor monitoring programs and specified a number of cancellation or mitigation endpoints aimed at limiting potential risks to human health and endangered species

5.1. Overview of ARP Monitoring Programs

As part of the conditional registration agreement, the USEPA mandated ARP to develop an “early warning” detection system that would alert health officials if acetochlor is found migrating toward surface or ground water resources or may have the potential to migrate to receiving waters. This early warning system consists of rigorous surface and ground water monitoring programs, specifically: (1) Surface Drinking Water Supplies (SDWS) as measured at water supply intakes for roughly 175 sites, (2) Prospective Ground Water (PGW) studies at eight sites in eight states that are geographically diverse and generally representative of U.S. corn production regions, and (3) State Ground Water (SGW) studies that included monitoring approximately 175 ground water wells located near treated cornfields. Appendices 0, 12.5, and 12.6 provide further details on the monitoring locations, site selection procedures and site descriptions, and the analytical methods used in the ARP programs.

5.1.1. Surface Water Monitoring (SDWS)

5.1.1.1. Scope of the SDWS

The surface drinking water supply (SDWS) program is intended to detect the presence of acetochlor or any of its degradates of toxicological concern in surface water bodies that may be used for community drinking water supplies. The program is funded by ARP and is focused on states that were anticipated to be major use areas (Figure 1). Specific details regarding the program are provided in Hackett et al. (2004). States involved in the surface water monitoring program are shown in Figure 1. In general, “finished” (or treated) water samples were collected from approximately 175 sampling stations each year at biweekly to monthly intervals (roughly 14 samples per year), although some sites were dropped and replaced by others in some years resulting in a total of 189 individual stations sampled over the seven year period (Table 2). “Raw” or untreated samples were also collected for a total of 44 stations and ranged from 26 to 38 individual stations per year (Table 2). Similar to finished water samples, some stations were dropped and others added throughout the seven year monitoring period. Specific details can be found in ARP annual reports as well as Hackett et al. (2005). Under the conditional registration agreement (USEPA 1994), the need for monitoring is reassessed every five years. Concentrations of acetochlor (and, potentially, acetochlor degradates, which were monitored for

only from 1999 to 2001) from drinking water intakes are then compared to target levels to determine if mitigation or cancellation actions are required.

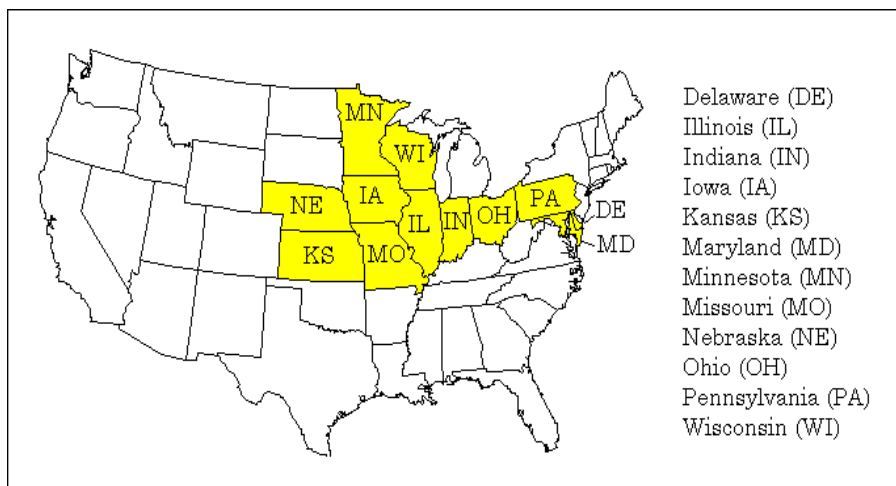


Figure 1. States involved in the Surface Water Monitoring Program for Acetochlor.

Table 2. Number of community drinking water supply sites sampled for the parent acetochlor in each year.

YEAR	# Raw Water Sites	# Finished Water Sites
1995	26	175
1996	32	175
1997	35	175
1998	37	175
1999	38	175
2000	33	156
2001	37	152
TOTAL	44 ^a	189 ^b

^a Total number of individual sites sampled. Raw water (untreated surface water) samples were collected from all community water systems (CWSs) that use granular activated carbon (GAC), and from several systems that use powdered activated carbon (PAC) (Hacket et al. 2005).

^b Total number of individual sites sampled. Some sites were added in subsequent years while others were dropped. "The total number of CWSs was kept at 175 for the first five years with fewer than three sites requiring replacement in any year. Sites were always replaced by CWSs from the same or a higher vulnerability stratum. Several CWSs chose not to continue when the monitoring was extended for a final two years, dropping the number of sites to 156 in 2000, and to 152 in 2001" (Hacket et al, 2005).

Figure 1 shows the locations of ARP surface water monitoring locations overlaid on the maximum concentration observed by county based on NAWQA data. The blue circles represent locations of community water supply intakes where ARP sampled finished (treated) water and in some locations raw water samples were additionally sampled.

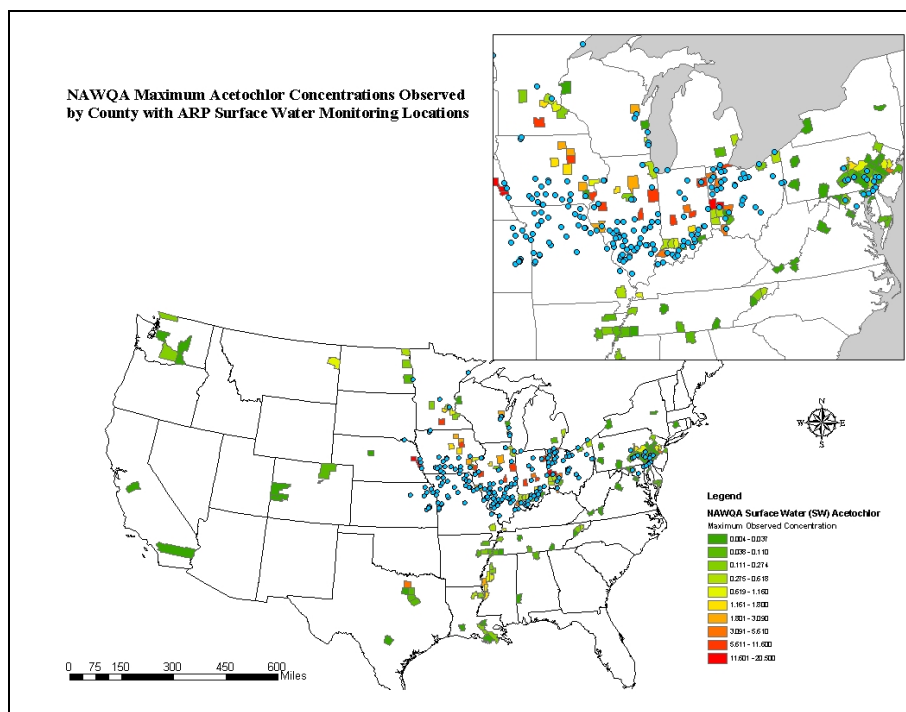


Figure 2. Locations of ARP surface water monitoring sites (blue circles) in relation to maximum observed concentrations of acetochlor in surface water (SW) by county based on available NAWQA data.

Figure 2 shows the locations of ARP surface water monitoring locations overlaid on the maximum concentration observed by county based on NAWQA data. The blue circles represent locations of community water supply intakes where ARP sampled finished (treated) water and in some locations raw water samples were additionally sampled.

5.1.1.2. Site Selection for Surface Drinking Water Sites

A particularly important issue in the assessment of exposure to parent acetochlor is how well the ARP SDWS study assesses the most vulnerable watersheds to acetochlor exposure (parent exposure levels in ground water sources were generally significantly lower). Included here is a summary of the SDWS site selection procedures, and, additionally, an excerpt from the ARP report describing the SDWS site selection process in more detail is provided in Appendix 12.5.

A site selection process was conducted to identify 175 CWSs in 12 states. Data regarding population and CWS source(s) were collected, and watershed areas and corn intensities were determined. Each of the 175 systems was visited, inspected, and data confirmed. Watersheds for the 175 systems were mapped. The selected CWSs represent a broad spectrum based on geographic diversity, general size and corn intensity of the watersheds. The data for the selected

systems demonstrate the extensive diversity of the ARP surface water monitoring program. The watersheds are representative of the key acetochlor-use states, with a few extending into numerous states not included in the program. The CWSs are supplied by surface water from a variety of sources including small rivers and lakes, larger rivers and lakes, and reservoirs, and employ a wide variety of treatment methods. The selected watersheds span a large range of watershed area, and serve a large range of populations.

A total of 175 CWSs in nine mid-western and three mid-Atlantic states were selected for the program. The selection process was designed to include a wide array of CWSs with watersheds in areas of corn production, with an emphasis on including worst-case watersheds i.e., smaller watersheds (not on the Great Lakes and Continental Rivers) in areas of high corn production. These watersheds are expected to have higher concentrations of acetochlor after runoff events than larger watersheds which drain areas of both high and low corn production, because dilution would be greater for CWSs taking water from the Great Lakes and Continental Rivers. Data were collected to characterize each community water system included in the program.

The steps for the CWS selection and characterization process are summarized below:

1) Identification of all public CWSs that use surface water in the following 12 states: Illinois, Indiana, Iowa, Minnesota, Nebraska, Kansas, Wisconsin, Ohio, Missouri, Pennsylvania, Maryland, and Delaware.

2) Identification of all CWSs that belong to the target population.

Target Population - All CWSs in the 12 states that:

- use only surface water, or can discretely sample surface water,
- are willing to cooperate and
- have a corn intensity (for smaller watersheds that do not have an intake on a Great Lake or Continental River) greater than or equal to 5%, where corn intensity is the ratio of acreage of harvested corn to total acreage in the upstream watershed.

3) Separation of the target population of CWSs into disjoint (non-overlapping) strata based on the size of the watershed, the corn intensity (for smaller watersheds), and State that the system is in:

- State
- size of watershed (three major subdivisions)
 - Great Lakes
 - Continental Rivers (Missouri, Mississippi, Ohio Rivers)
 - Smaller Rivers and Lakes
- corn intensity (% corn planted in total area of watershed) (three major subdivisions)
 - 5-10% CI
 - 11-20% CI
 - >20% CI

- 4) Determination of the number of CWSs to be selected from each stratum. The focus was on strata containing CWS watersheds which are expected to have higher levels of acetochlor after runoff events, based on the size of the watershed and its corn intensity. A higher percentage of CWSs from these strata were chosen.
- 5) Random selection (using random number generation) of the appropriate number of CWSs from each stratum. All CWSs meeting the target population criteria were selected from the identified strata (for example, the >20% corn intensity, smaller watershed strata). A total of 175 CWSs were required for the study.
- 6) Collection of information for each selected CWS regarding intake location, sources of water, treatment, customer information, point of finished water sampling, soil types, and corn intensity of the watershed(s) for that system.
- 7) Removal of systems that did not meet target population criteria based on additional data collected. Systems were replaced in the same stratum and state, if possible, by additional random selection from the stratum. If there were no systems available in the same stratum, then a system was randomly selected from another stratum with available CWSs.
- 8) Generation of maps of watersheds for each CWS. Data entry into a Geographical Information System (GIS).

The highest percentage of CWSs, 100% of the available CWSs, was selected from the >20% corn intensity strata, 66% were selected from the 11-20% corn intensity strata, 49% from the 5-10% corn intensity strata, 43% from the Continental River strata, and 14% from the Great Lakes strata. Almost 50% of the sites were selected from smaller watersheds with >20% corn intensity, the watersheds expected to have the highest concentrations of acetochlor after runoff events. The focus on more vulnerable watersheds with higher corn intensity combined with the diversity of watersheds selected for this study will allow us to obtain both a worst-case and representative evaluation of the impact of acetochlor and other corn herbicide usage on surface drinking water in significant corn-growing areas of the United States.

5.1.2. Prospective Ground Water (PGW) Studies

ARP was also required to conduct eight Prospective Ground Water (PGW) studies according to the protocol approved for other herbicides in order to determine the potential for pesticide transport, or a “pattern of movement”. Specific details regarding the program are provided by Newcombe et al. (2005). In general, sites were geographically located based on representative product label uses, or “in accordance with widespread and commonly recognized practice, including vulnerable and typical use situations,” as outlined in the registration agreement. Sites were required to be located on a wide variety of soil textures as per the product label, and an effort was made to include a broad geographical representation. Test sites were located in the following states: Wisconsin, Ohio, Minnesota, Nebraska, Iowa, Indiana, Pennsylvania, and Delaware (Figure 3). Specifics of the study design are provided in Table 4. Newcombe et al., 2005 cites that these areas corresponded to areas of significant acetochlor use. Further details

regarding the geographic distribution of acetochlor can be found in the “Acetochlor Usage” section of this report.

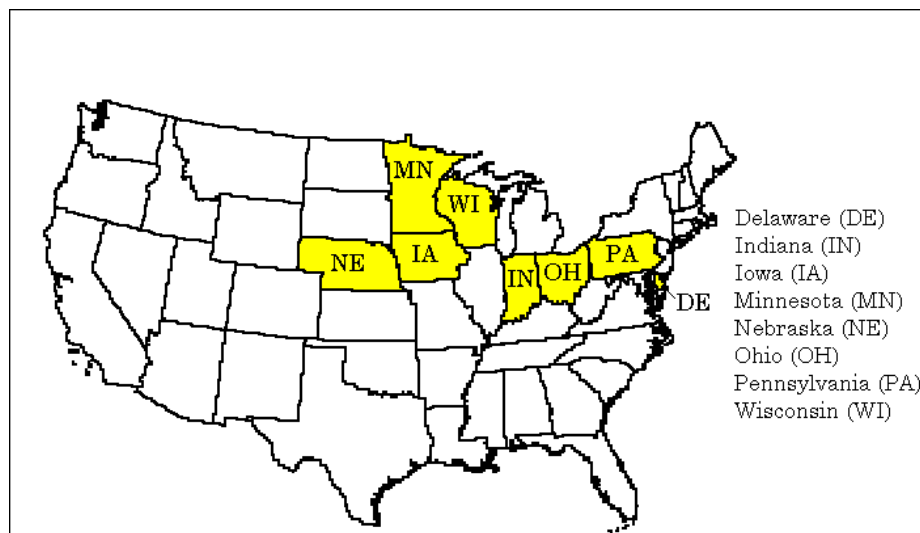


Figure 3. States with prospective ground water (PGW) studies for acetochlor.

Table 3. PGW sites: Selected soil and aquifer characteristics.

PGW Study Location	NRCS Soil Series; On-site surface soil % O.M. & pH	Subsoil Textures ¹	Avg. Hydraulic Conductivity ² (mm/hr)		Aquifer soil textures determined ¹	Depth to ground water ³ (m)	Pore-water velocity (m/day) ⁴
Wisconsin	Richford loamy sand OM = 1.6% pH = 6.4	Loamy	0-1.2 m	177	Loamy	7.6-10	1.9×10^{-3}
		Sand	1.2-2.4 m	358	sand		
		Sand	2.4-3.6 m	810	Sandy loam		
		Sandy loam	3.6-4.8 m	1482	Sand		
			>4.8 m	776			
Ohio	Genessee silt loam Fox silt loam OM = 2.9% pH = 7.7	Clay	0-1.2 m	293	Sandy loam	0.6-5.2	0.8×10^{-1}
		loam	1.2-2.4 m	153	Loamy sand		
		Loam	2.4-3.6 m	NA			
		Sandy loam	3.6-4.8 m	NA			
Minnesota	Estherville sandy loam OM = 3.5% pH = 6.3	Sandy loam	0-1.2 m	180	Sand	4.8-6.4	0.4×10^{-1}
			1.2-2.4 m	331	Loamy sand		
		Loamy sand	2.4-3.6 m	NA			
		Sand	3.6-4.8 m	NA	Sandy loam		
Nebraska	Kenesaw silt loam Coly-Kenesaw silt loam OM = 1.8% pH = 5.7	Loam	0-1.2 m	75	Silt loam	7.0-9.7	0.4×10^{-2}
		Silt loam	1.2-2.4 m	45	Loam		
			2.4-3.6 m	28	Sandy loam		
			3.6-4.8 m	18			
			>4.8 m	84			
Iowa	Marshall silty	Silty	0-1.2 m	207	Sand	1.2-8.5	0.9×10^{-1}

Table 3. PGW sites: Selected soil and aquifer characteristics.

PGW Study Location	NRCS Soil Series; On-site surface soil % O.M. & pH	Subsoil Textures ¹	Avg. Hydraulic Conductivity ² (mm/hr)		Aquifer soil textures determined ¹	Depth to ground water ³ (m)	Pore-water velocity (m/day) ⁴
	clay loam	clay	1.2-2.4 m	84	Silt loam		
	Minden silty	loam	2.4-3.6 m	172	Loam		
	clay loam	Silt loam	3.6-4.8 m	87			
	OM = 3.9% pH = 5.6		>4.8 m	1.0			
Indiana	Door loam	Sandy clay	0-1.2 m	64	Sand	7-9.1	0.6 x 10 ⁻¹
	Lydick loam	loam	1.2-2.4 m	190			
	OM = 3.0% pH = 6.7	Sandy	2.4-3.6 m	244			
		loam	3.6-4.8 m	742			
Pennsylvania		Sand	>4.8 m	978			
	Clarksburg silt	Loam	0-1.2 m	382	Sandy loam	1.8–	0.4 x 10 ⁻¹
	loam	Sandy	1.2-2.4 m	138	Loam	7.3	
	Duffield silt	loam	2.4-3.6 m	95			
Delaware	loam		3.6-4.8 m	19			
	OM = 2.7% pH = 6.3		>4.8 m	NA			
	Sassafras sandy	Sandy	0-1.2 m	30	Sand	3.3-6.1	0.6 x 10 ⁻²
	loam	loam	1.2-2.4 m	86	Sandy loam		
	OM = 2.9% pH = 5.8	Loamy	2.4-3.6 m	30	Loamy		
		sand	3.6-4.8 m	129	sand		
		Sand	>4.8 m	NA			

¹ Soil texture determined by 3-fraction analysis (% sand, silt, and clay)

² Vertical saturated hydraulic conductivity determined by constant head permeability method

³ Depth to ground water listed is below ground surface, and the minimum and maximum values are of all measurements made in the test plot piezometers during the course of the study

⁴ Average value determined during the course of the study

This table is modified from a more extended version by the ARP found in Newcombe et al. (2005).

5.1.3. “State Ground Water” (SGW) Monitoring Program

In addition to PGW studies, the ARP, as part of the “State Ground Water” Monitoring program, was required to monitor 25 ground water wells in each of the expected seven high use states (WI, IL, IA, MN, IN, NE, KS) in Figure 4 all located adjacent to fields with contractually guaranteed use of acetochlor and located in areas representing a variety of use conditions based on soil characteristics, local hydrogeology, and climatic conditions. The monitoring data serve as an early indication that pesticide residues may be reaching ground water. Risk managers can then use this information to assess the potential threat to humans. Specific details regarding the program are provided in de Guzman et al., (2004), but a brief description of the program design follows here.

The SGW study was set up through the establishment of a network of 175 monitoring sites in regions of high corn production in each of the seven states chosen for this study. A site selection scheme for the SGW wells was set up using corn production data, soils database information, and consultations with state regulatory officials to obtain a set of wells representing a range of soil textures typical of corn agriculture in those regions. Soil classification was not a direct component of the site selection procedure. Soil survey data were collected for each site and are available in the documents submitted to the EPA by the ARP. The soil classification data are not available in a readily summarized form and are not presented here, but details can be found in the ARP Site Selection submission (MRID 43899601).

In general, ground water monitoring wells were to be located down gradient of acetochlor use areas at a distance agreed upon by the states. States participating in the SGW are shown in **Figure 4**. Where technically feasible, ARP is required to provide assistance to water system operators in monitoring for acetochlor residues at drinking water wells.

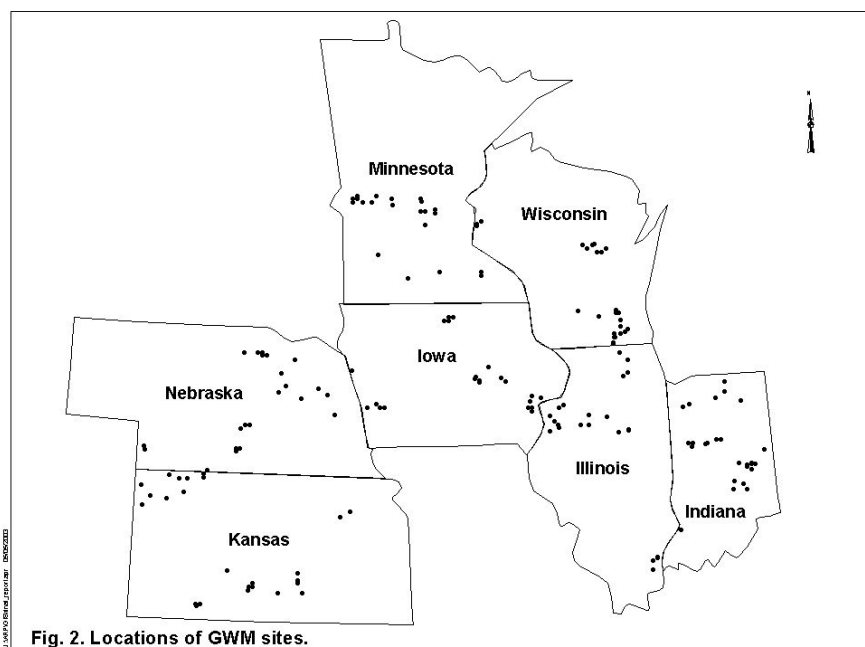


Figure 4. States involved in the “SGW” ground-water monitoring program for acetochlor and locations of wells. Source: De Guzman et al. (2005).

Table 4. Well characteristic summary for the SGW program. Values expressed in meters below ground surface (bgs).

State	Buffer distance ²	Screen length	Depth to water	Screening Depth Interval ³		
-----meters-----						
				Minimums	Maximums	Mean DTW – DTS
Illinois	9.1 - 45.7	4.6	3 - 22.8	2.7-4.6	7.3-9.1	2.5
Indiana	15.2 - 45.7	3	<7.6 - 22.8	5.8-23.5	8.8-26.5	3.1
Iowa	9.1 - 45.7	4.6	1.5 - 15.2	1.5-7.0	6.1-11.6	6.5
Kansas	9.1 - 30.5	3	4.6 - 22.8	4.0-22.9	7.0-25.9	1.2
Minnesota	15.2 - 45.7	3	7.6 - 22.8	4.9-21.3	7.9-24.4	3.4
Nebraska	15.2 - 45.7	4.6	3 - 22.8	4.6-20.4	9.1-25.0	1.8
Wisconsin	9.1	3	<7.6 - 15.2	1.2-14.9	4.3-18.0	1.4

¹ Table is adapted from Newcombe et al. (2005); state average difference between average screening interval (DTS) and average depth to ground water (DTW) has been added.

² Distance between wellhead and nearest point of the acetochlor treatment area.

³ Screening depth interval data were extracted from master ground water database submitted by ARP. The screening interval represents the positions of the top and bottom of the screen measured during installation. The first pair is the minimum top of screen and the maximum top of screen, the second pair is the minimum bottom of screen and the maximum bottom of screen.

5.2. Design and Scope of Exposure Assessment

The purpose of this assessment is to evaluate exposure to acetochlor by reviewing results from the three major acetochlor data sets generated by the ARP as described above (two ground water source based and one surface water source based) in the context of other available monitoring data. The assessment focuses on the status of acetochlor in ground and surface water with respect to specific endpoints triggering mandatory requirements for implementation of mitigation measures or cancellation of acetochlor uses (detailed in the conditional registration agreement, USEPA 1994) and evaluation of the impact of acetochlor on drinking water sources in support of human health risk assessments. ARP provided a fourth acetochlor data set that consists of incident investigation of ground water primarily around pesticide dealer and storage facilities. The incident data are only indirectly related to impacts from registered uses of acetochlor therefore these data have not been included in the direct exposure assessment.

Primary focus of this exposure assessment is on the parent acetochlor, with secondary emphasis on acetochlor degradates in water – widespread occurrence. This section deals with exposure to acetochlor parent residues in water and serves as the basis of the current Drinking Water

Assessment. Conclusions made about exposure to the parent acetochlor apply to the parent chemical only. Although this assessment is focused on the parent acetochlor, exposure levels to degradates can be quite significant and has been characterized with secondary emphasis. Some of the ARP monitoring studies also contain data on the occurrence of other chloroacetanilide herbicides (alachlor and metolachlor and / or other corn herbicides (atrazine) – a limited discussion on these data and their utility for other exposure assessments will also follow this section. A portion of these data were reviewed for a previous drinking water assessment for another pesticide - atrazine (Environmental Fate and Effects Division, OPP, EPA, 2001).

5.3. Documents and Data

This assessment is based primarily on extensive surface water and ground water monitoring programs submitted in support of acetochlor registration and intended to provide a reasonably comprehensive portrait of exposure levels possible in ground and surface water. Discussion of the most relevant outside monitoring programs for acetochlor, most notably the NAWQA monitoring program by the USGS, is also provided. Since there were many hundreds of interim documents and reports submitted, only selected references (but including all final reports) are included in the bibliography.

5.4. Data Gaps

The ARP monitoring program was designed to assess exposure or exposure potential to acetochlor in the context of an evaluation of the compliance of the ongoing usage of acetochlor with exposure limits, and other regulatory requirements contained in the Acetochlor Registration Agreement (USEPA, 1994).

5.5. Uncertainties in the Drinking Water Assessment

A number of uncertainties must be recognized when interpreting this exposure assessment. These include the following:

- The surface drinking water supply (SDWS) and state ground water (SGW) monitoring programs were designed to focus on areas of high acetochlor use. The monitoring does not cover the entire geographic distribution of acetochlor use. Geographic analysis of the SDWS site locations and acetochlor use patterns seems to indicate that even a number of high acetochlor use areas were not monitored. Conclusions drawn in this report apply only to those areas monitored by the ARP and it may not be possible to generalize to all acetochlor usage areas. This is especially true for the SDWS where the lack of sampling of raw (pre-facility treatment) water at most locations makes it difficult to isolate the effects of site-specific usage and vulnerability factors and water treatment processes on the observed residue levels.
- County level sales data submitted separately by members of the ARP from 1994 -2003 is arguably some of the most extensive data available as a close approximation of acetochlor usage across the US. As such, it has been incorporated in this exposure assessment as a surrogate for acetochlor use in the mapping and statistical analyses. It is assumed that acetochlor sold in an individual county is, in general, also applied in the

same county and in the same watershed. However, the exposure characterization recognizes that inter-county as well as inter-watershed transfer of acetochlor does occur in some cases.

- Acute exposure in this risk assessment is defined as the overall maximum observed concentration at a site. The actual peak concentration, however, may have occurred between sampling times. Thus, the maximum observed concentrations reported in this study may underestimate the true maximum acute exposure.

5.6. Environmental Fate

5.6.1. Degradation Pathways

Acetochlor persistence in a confined soil system appears to increase with coarser soil texture and increased application rate. The half-lives in aerobic soils for the 3, 4.5, 10.5, 41, and 50 ppm application rates were 8-12, 14, 110-245, 55, and 300 days, respectively. However, the most representative aerobic soil half-life is 8-14 days determined in the Monsanto study conducted in Ray silt loam (1.2 % OM), Drummer silty clay loam (3.4 % OM), and Spinks sandy loam (2.4 % OM) soils treated with 3 ppm (—2X label rate) of acetochlor. The 8-14 day half-life represents the labeled application rate and the soils to be treated with acetochlor. The longer half-lives were found only at exaggerated application rates (7.5-36X) labeled rates to coarse, low organic matter soils. The aerobic soil metabolism degrades oxanilic acid (oxamic acid), sulfonic acid, and thioacetic acid sulfoxide degrades of acetochlor. These degradates are rearrangement products of one amino moiety of the acetochlor molecule.

Relevant to this discussion are label restrictions to which the ARP has previously implemented on all product labels to prohibit acetochlor use in certain areas with ground water that is highly vulnerable to contamination by pesticides such as acetochlor. Acetochlor product use is restricted on coarse-textured, low-organic-matter soils where groundwater is within 30 feet of the surface.

The following language is included with all acetochlor product labels:

Acetochlor products may not be applied to the following soils, if depth to groundwater is 30 feet or less:

- Sands with less than 3% organic matter.
- Loamy sands with less than 2% organic matter.
- Sandy loams with less than 1% organic matter.

Acetochlor herbicides may be applied to the above soils if depth to groundwater is more than 30 feet.

5.6.2. Soil Mobility

Parent acetochlor has a reported water solubility of 223 mg/l and K_d values of 0.4-2.7 ml/g in various soils texturally classified as sandy loam, loamy sand, silt loam and silty clay soils. Acetochlor also leached through soil columns.

The degradates are expected to have even higher mobility based on structural features. K_d values for the degradates were 0.15 to 0.97 for ESA, 0.13 to 0.86 for OXA, and 0.10 to 0.90 for a third degradate (acetochlor thioacetic acid sulphoxide) not included in this exposure assessment because of the low levels detected in environmental samples in previous studies. K_{oc} values were 21 to 68 in 9 of 10 soils tested and 430 in the other soil (median = 57) for ESA and 17 – 124 (median = 45) for OXA.

The results of studies submitted to support Subdivision N requirements for registration appear to be inconsistent with the laboratory data with respect to mobility. In at least one study, leaching of oxamic acid (oxanilic acid) and sulfonic acid and thioacetic acid sulfoxide was observed to a depth of 18 inches in a silt loam soil in Illinois containing 1.7% organic matter. No leaching was detected in another silt loam soil in Mississippi containing only 0.5% organic matter.

5.6.3. Dissipation Pathways

The major routes of dissipation for acetochlor appear to be microbially-mediated degradation, runoff, and leaching. Although acetochlor generally degrades rapidly when applied to soil, in some field situations it can be relatively persistent (e.g., field dissipation half-lives were up to 36 days) and it has been found in ground water at numerous locations. There is variable evidence as to the persistence of acetochlor in subsoil horizons (often persistence is increased substantially for organic pesticides that are subject to microbial degradation) with a published study by the registrant reporting only a modest increase in persistence from surface soils at two sites using *in situ* methods (Mills et al., 2001). Lavy et al. (1996) have reported a much more substantial increase in persistence at two sites (also *in situ* studies) for alachlor, a herbicide that is chemically related to acetochlor and tends to have a very similar environmental fate profile. Laboratory degradation data indicate that acetochlor does not degrade by abiotic processes (hydrolysis and photolysis); this may be to the higher application rates than used in the Mills et al. study. While acetochlor has relatively short half lives in fine-textured aerobic soil, it may be moderately persistent in coarser soils (this may be related to the lower rate of microbial activity in sandy, low organic matter soils).

5.7. **Acetochlor Usage**

5.7.1. Summary of Registered / Proposed Uses

Acetochlor is restricted for direct use only on field corn and corn grown only for silage or seed. Labels allowing direct application to pop corn should be amended to prevent such application until the registrant formally petitions for the use. Although several of the labels also allow for a

fall application to soybean stubble after crop harvest, replanting the following spring is restricted to field corn. Generally, acetochlor can be applied as either a single broadcast or banded application, preplant, preemergence, or early post-emergence. Preplant applications can be made as either a single or split application that is either surface applied or incorporated. The early post-emergence application is allowed only on corn up to eleven inches in height. For application, acetochlor may be either diluted with water or liquid fertilizers or impregnated onto dry bulk fertilizers. Only applications using ground equipment are allowed; applications through irrigation systems and using aerial equipment are prohibited.

Application rates for acetochlor are dependent on the soil type and the type of weeds to be controlled. However, the maximum single use rate for any soil type is 3.0 lb ai/A, which is also the maximum seasonal use rate. Formulations containing only acetochlor do not specify pregrazing (PGI) or preharvest intervals (PHI); however, the multiple active ingredient formulations contain PGI and PHI restrictions that are based on the other active ingredients included in the formulation. Following application with acetochlor, the labels only allow for rotation to soybeans, corn (all types), grain sorghum (milo), wheat, or tobacco.

Due to concerns about ground water contamination, at the time of the original registration on corn the ARP volunteered to prohibit use in certain areas with ground water that is highly vulnerable to contamination by pesticides such as acetochlor. Acetochlor product use was and is restricted on coarse-textured, low-organic-matter soils where groundwater is within 30 feet of the surface. The following language is included with all acetochlor product labels:

Acetochlor products may not be applied to the following soils, if depth to groundwater is 30 feet or less:

- Sands with less than 3% organic matter.
- Loamy sands with less than 2% organic matter.
- Sandy loams with less than 1% organic matter.
- Acetochlor herbicides may be applied to the above soils if depth to groundwater is more than 30 feet.

Acetochlor is now registered in 42 states as well as the District of Columbia (Hackett et al., 2004). It is also used in corn growing areas of several countries including China, Europe, and Argentina. In the United States, the ARP has submitted petitions for other direct field uses of acetochlor including application to sweet corn and sorghum for grain or silage / forage.

5.7.2. Usage Targets in the Original Acetochlor Conditional Registration

Acetochlor is effective on a broad spectrum of weeds in corn fields and it therefore was expected that reductions in overall corn herbicides would occur. As such, the conditional registration agreement mandated a 33 percent reduction in the aggregate use of the selected corn herbicides (alachlor, metolachlor, atrazine, EPTC, butylate, and 2,4-D) over a five year period. Cancellation of the conditional registration agreement would be triggered if any one of the following usage target levels were not met:

1. At the end of 18 months from the date of registration, a net cumulative reduction of the six corn herbicides by 4 million pounds (4 M lbs) from 1992 levels, adjusted for planted acreage differences; or
2. At the end of three years from the date of registration, a net cumulative reduction of the six corn herbicides of 22.6 M lbs from 1992 levels, adjusted for planted acreage differences; or
3. At the end of five years from the date of registration, a net cumulative reduction of the six corn herbicides of 66.3 M lbs from 1992 levels, adjusted for planted acreage differences.

Based on OPPs Biological and Economic Analysis Division's analysis, it appears that increased use of acetochlor did result in a decrease in the combined use of the six selected herbicides. OPP/BEAD's review of the usage data submitted by ARP concluded that the 18 month, three year, and five year target reductions were achieved. The cumulative net reduction for the three year target (22.6 M lbs) was exceeded by 1996, and the five year target (66.3 M lbs) was exceeded by 4 M lbs in 1998. Overall, the proportion of acetochlor used relative to other pesticides steadily increased based on USDA and Doane Marketing Research surveys. These research surveys indicate that the percent of field corn treated specifically with acetochlor increased from 7 percent in 1994 to 24 percent in 1997. This increase amounted to an increase in total acetochlor use (based on surveys of 39 states) from 7.4 M lbs in 1994 to 31.8 M lbs by 1998.

At the time of its registration, the increase in acetochlor use was of particular concern since it was listed as a probable human carcinogen (a classification which it still maintains), and therefore exposure to acetochlor in drinking water contamination may pose a human health risk. In anticipation of its widespread use, several use restrictions were implemented as preventative measures. Specifically, acetochlor may only be applied by certified applicators. It may not be applied to coarse soils (e.g., sands with less than 3% organic matter) where depth to ground water is less than 30 feet. Acetochlor cannot be applied through any irrigation system (including flood irrigation), nor via aerial application. Acetochlor may not be applied directly to water or areas where surface water is present. In addition, acetochlor must not be mixed or loaded within 50 feet of surface water or wells, unless proper containment and disposal measures are in place. Each of these measures is intended to prevent acetochlor from migrating to ground water and/or surface water resources.

5.7.3. Geographic Patterns of Acetochlor Use

This summary only presents selected data on acetochlor usage from non-confidential sources. Presently, roughly 80% of the total use of acetochlor in the United States occurs in the Midwest. The usage areas generally mirror the production areas for field corn (Figure 5 and Figure 6).

Detailed annual county-level sales maps for 1994 to 2003 are provided in Appendix section 12.3 Acetochlor Usage – Detailed Summary. These sales data have been provided separately by members of the acetochlor registration partnership (ARP) as confidential information and cannot be shared with unauthorized individuals. These sales data are presented as a surrogate for the location of acetochlor usage. It should be noted that pesticide sales data may not be a consistent

estimator of usage in any particular watershed because usage does not necessarily occur near the location of purchase and watershed boundaries do not coincide with county boundaries (all sales data were reported by county units).

The following language is included with all acetochlor product labels:

Acetochlor products may not be applied to the following soils, if depth to groundwater is 30 feet or less:

- Sands with less than 3% organic matter.
- Loamy sands with less than 2% organic matter.
- Sandy loams with less than 1% organic matter.

Acetochlor herbicides may be applied to the above soils if depth to groundwater is more than 30 feet.

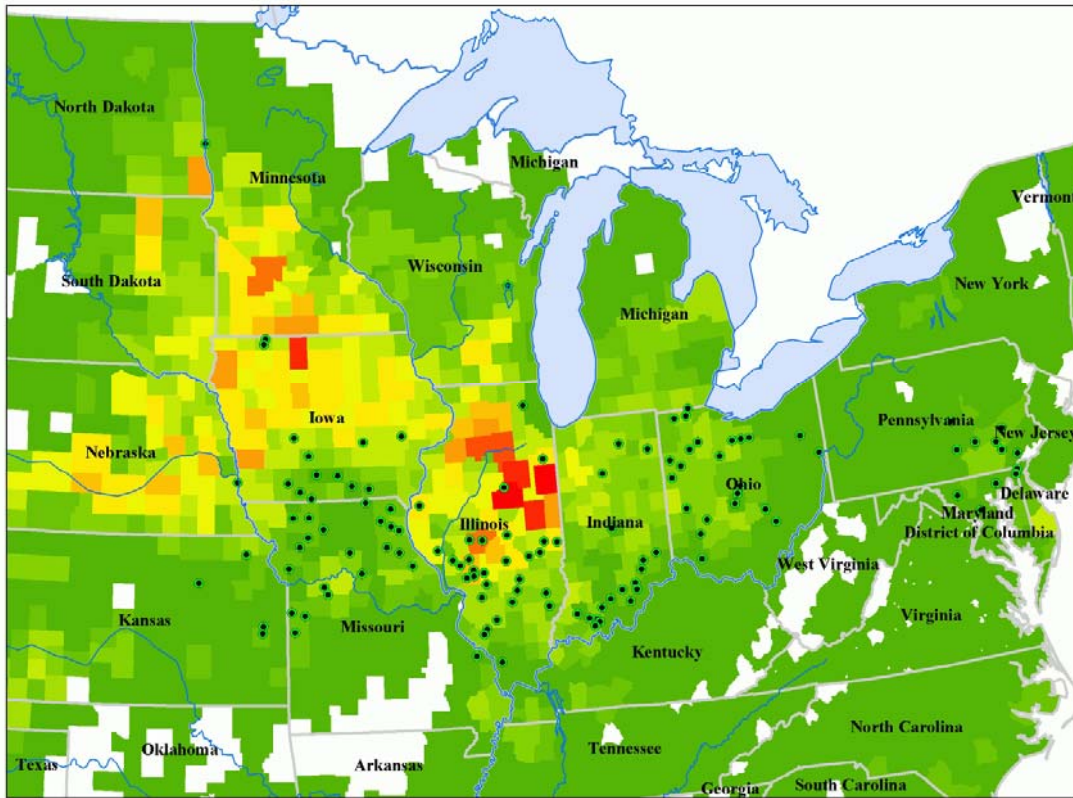


Figure 5. Corn production intensity (2002 Census of Agriculture data) and general locations of drinking water intakes sampled in the ARP's SDWS monitoring program (white = no reported corn acreage, green = lowest intensity category, red = highest corn intensity category).

Figure 5 shows corn production intensity and the generalized locations of the ARP SWDS monitoring locations (2002 Census of Agriculture data, see Appendix B for maps based on 1992 and 1997 Census of Agriculture data). Figure 6 provides the USGS estimate of acetochlor usage

in the United States for 1997. Note that this map is a coarse estimate and should not be used for decision making at the county level. The USGS provides the following caveat with the data: “The pesticide use map shows regional-scale patterns of use intensity within the United States and [is] not intended for making local-scale estimates of pesticide use, such as for individual counties. The USGS maps are based on state-level estimates of pesticide use rates for individual crops, which have been compiled by the National Center for Food and Agricultural Policy (NCFAP) for 1995-1998, and on 1997 Census of Agriculture county crop acreage. Key limitations include: (1) state use-coefficients represent an average for the entire state and consequently do not reflect the local variability of pesticide management practices found within many states and counties, and (2) the county-level acreage are based on the 1997 Census of Agriculture and may not represent all crop acreage due to Census non-disclosure rules.

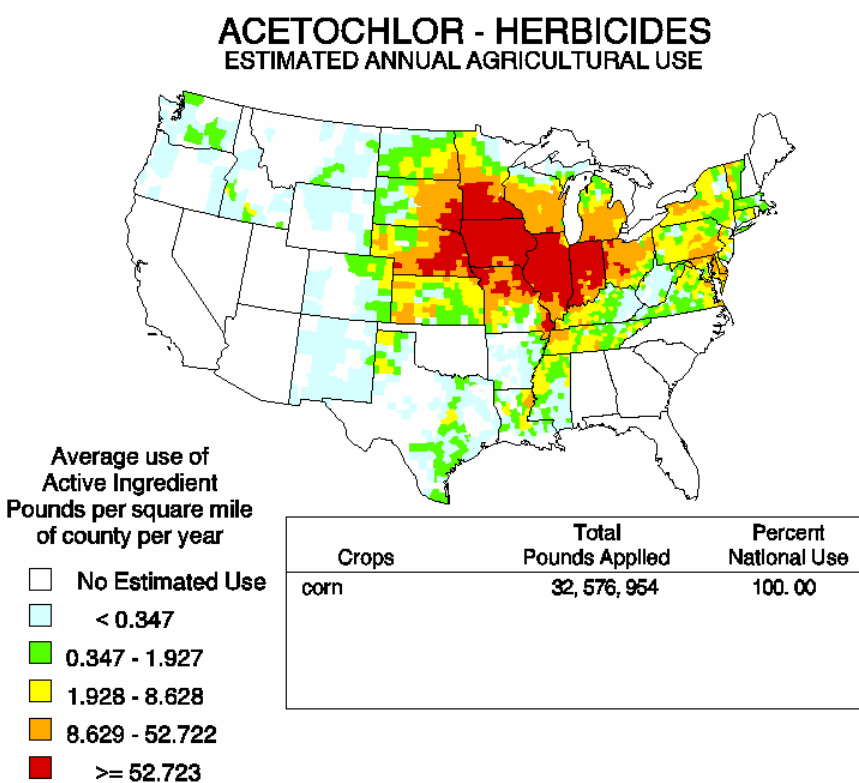


Figure 6. USGS estimated acetochlor use for 1997.

5.8. Overview of Exposure Assessment

This exposure assessment is based primarily on an extensive monitoring program submitted by the ARP as a requirement for registration of acetochlor. Other monitoring data and modeling results are also discussed in order to provide a more complete picture of exposure to acetochlor. Section 6 deals with parent acetochlor exposure, Section 7 evaluates exposure to degradates of acetochlor, and Section 8 provides an overview of the extensive body of monitoring data for other herbicides and herbicide degradates (including parent atrazine, and parent + degradates of

alachlor and metolachlor) that the ARP compiled in the course of conducting some major surface water and ground water studies to support the acetochlor registration.

Uniquely relevant to OPP's exposure assessment for acetochlor is an evaluation of the detection rates and amounts in the ARP monitoring studies relevant to endpoints identified in the original Acetochlor Registration Agreement which could trigger requirements for mitigation or cancellation of uses should the endpoints be exceeded. There are unique endpoints identified for each of the three major ARP monitoring programs (SDWS, PGW, and SGW) as well as for outside monitoring; these are discussed separately for each of these monitoring programs. At this time, only acetochlor parent residues have been identified as relevant to the regulatory triggers.

Precedence in the review of the monitoring data is given to acetochlor parent based upon a presumption that the current risk assessment will focus on exposure to acetochlor parent. The Health Effects Division (HED) of the Office of Pesticide Programs has evaluated currently available toxicity and carcinogenicity data and determined that the dietary drinking water risk assessment should be based upon parent acetochlor alone (HED, 2004).

Although not anticipated to be included in the current drinking water risk assessment the degrade data are also included in this exposure assessment in a separate section of this document. The primary reason for this is to document the data submitted by the ARP which show exposure levels to acetochlor degradates that are frequently higher than acetochlor and many other pesticide residues and are widespread (Table 27 and Table 1); see below for a complete characterization). Some of the ARP monitoring studies also contain data on the occurrence of other chloroacetanilide herbicides (alachlor and metolachlor) and / or other corn herbicides (atrazine) – a limited discussion on these data and their utility for other exposure assessments also follows this section (See "Other Chemicals" section of this document). A portion of these data were reviewed for a previous drinking water assessment for atrazine (Environmental Fate and Effects Division, OPP, EPA, 2001).

6. RESIDUES - ACETOCHLOR PARENT

The focus of the current risk assessment is on the parent acetochlor, with secondary emphasis on acetochlor degradates in water and their widespread occurrence. The assessment focuses on the status of acetochlor in ground and surface water with respect to specific endpoints triggering mandatory requirements for implementation of mitigation measures or cancellation of acetochlor uses (detailed in the conditional registration agreement, USEPA 1994) and to evaluate the impact of acetochlor on drinking water sources in support of human health risk assessments. The following sections present time-weighted annualized means and 95th percentile values, as well as the methodology implemented to compute these values. Assessments of acute and chronic exposure are also provided for each of the three surfaces and ground water monitoring programs.

6.1. Data Files Used

Table 5 lists the data files used for computing annualized means and summary statistics for each data set.

Table 5. Key data files submitted by the ARP used in this assessment

Data set	File Name	Modified
SDWS	Data: Surface water monitoring concentrations	2/10/2003
	File Name: swm_conc.xls	2/10/2003
	Datswm_anc.xls	9/17/04
	cws-population-served.xls	
SGW	master SGM reporting dbase.mdb; Table "tblGWM_all"	6/25/2002
PGW	http://www.arpinfo.com/download/pgw/PGW_NUM_FINAL.TXT	4/22/04
	(All observed concentrations in the PGW studies)	
	http://www.arpinfo.com/download/pgw/pgw_uncensored.xls	10/2/04
	(Uncensored data provided ARP for computation of TWAMs and Percentiles)	

6.2. Time Weighted Annualized Means and 95th Percentile Calculations

Time-weighted annualized means (TWAMs) were calculated for each site in the three major monitoring programs (SDWS, SGW, and PGW). Two separate weighting methods were implemented using a custom-built TWAM computer program to verify the TWAMs computed by the ARP. The weighting method used by the ARP (described below) was cross-checked with a slightly different method implemented in the WARP beta model developed by the USGS (USGS 2004). Both weighting methods assign a weight to each discrete sample observation based upon the fraction of the time during a year that each sample represents. Weighted concentrations are then summed to provide an annualized mean.

6.2.1. ARP Weighting Methodology

The weighting method implemented by the ARP (equation 1) calculates annual means based on the calendar year. January 1 - December 31). Separate time-weighted annualized means are computed for each combination of analyte, site id, sample type, and year. Weighted concentrations are computed based on a two-step process. First, an average concentration is calculated as the sum of a value and the previous value divided by two. A weighting factor is then calculated as the time interval between a value and the previous value, divided by the time in 1 year. The final weighted concentration is the product of the average concentration and the corresponding weight factor.

Equation 1 :

$$TWAM = (c_1 + c_0) (t_1 - t_0) / 2 + (c_2 + c_1) (t_2 - t_1) / 2 + \dots + (c_n + c_{n-1}) (t_n - t_{n-1}) / 2 + (c_n) (t_f - t_n) \text{ Days}_{yr}$$

Where “c” is the observed concentration, “t” is the sample date, “Days_{yr}” is the total number of days in the given year (accounts for leap years), and “n” is the total number of observations in the given year. The subscripts represent the observation number where “0” is Jan 1st at 0 hours, and “f” is December 31st at 2400 hrs, note that this is slightly different than ARP’s code, which does not include the time from 0 hrs to 2400 hrs on December 31st. Each annualized mean begins January 1st. Therefore, for each new year, a January 1st concentration must be calculated. This is done based on linear interpolation between the last record of the previous year and the first record of next consecutive year. For the first record in the set, there is no previous year for the first sample of a new site. The first concentration is used as the mean concentration from January 1st to the first observation at that site. Similarly, for the last year in record in a data set (“C_n” and “t_f”), the last concentration is used as the mean concentration through the end of the year.

6.2.2. USGS WARP Beta Model Weighting Methodology

The USGS beta model weighting method (equation 2) also calculates time weighted annualized means based on the calendar year (January 1 - December 31). This method is different from the ARP method, as individual weights are computed as “the amount of time extending from one-half the time interval between a value and the preceding value and one-half the time interval extending from the value to the subsequent value, divided by the total time in 1 year....The annual mean concentration is simply the sum of the sample weight times the sample concentrations” (USGS 2004).

Equation 2:

$$TWAM = (c_1) [(t_1 - t_0) + (t_2 - t_1) / 2] + (c_2) [(t_3 - t_2) + (t_4 - t_3) / 2] + \dots + (c_n) [(t_n - t_{n-1}) / 2 + (t_f - t_n)] \text{ Days}_{yr}$$

Where “c” is the observed concentration, “t” is the sample date, “Days_{yr}” is the total number of days in the given year (accounts for leap years), and “n” is the total number of observations in the given year. The subscripts represent the observation number where “0” is Jan 1st at 0 hours, and “f” is December 31st at 2400 hrs. Each annualized mean begins January 1.

This method requires special conditions to handle leap years as well as the first and last records of a subset (e.g., unique combination of site, type, and year). The Visual Basic for Applications (VBA) workbook developed for the TWAM calculations automatically accounts for leap years using a custom-built visual basic procedure. In cases of leap years, the weighting factors are divided by 366 rather than 365. Additionally, for the first record of a year, the weighting factor is calculated as the time interval between a value and January 1st of the corresponding year, and one-half the time interval extending from the value to the subsequent value, divided by the total time in 1 year. For the last record of a year in a subset the weighting factor is calculated as one-

half the time interval between a value and the preceding value plus the time interval extending from the value to December 31st of the corresponding year, divided by the total time in 1 year.

6.2.3. 95th Percentile Calculations

The 95th percentile concentration was also computed for each calendar year of observations at a site. In this analysis, a given percentile represents the fraction of the year that the concentration was at or below the given percentile of the distribution of concentration values. This method is based on the method implemented in the USGS WARP beta model (USGS 2004). In general, the 95th percentile indicates that 95% of the time the value was at or below the given concentration. Percentiles were calculated in several steps. First, the observed concentrations within a year for a given site and sample type are ranked from low to high. The corresponding weighting factors (calculated as the fraction of the year the individual concentration represents based on one of the weighting methods described above) are then summed to obtain a cumulative distribution function (CDF), the sum of which equals 1. The concentration for each percentile is then obtained by matching the percentile values to the CDF. If a percentile falls between two values in the CDF, the corresponding weight and concentration is then linearly interpolated. In some cases, the weight corresponding to the lowest observed concentration is greater than a desired percentile; in these cases, exact percentiles could not be calculated. Specific details for each weighting method are described in the following sections.

6.3. **Surface Water**

6.3.1. ARP Data

Time weighted annualized means were calculated using the method described in the prior section (implemented by TWAM Tool version 2.0). The weighting method used was the same method as that used by the ARP in the data submission to USEPA, with the exception of one modification in the code to account for the last day of the year in each site subset. As described earlier, Table 3 lists the files used in computing TWAMs. For the surface drinking water supplies (SDWS), separate TWAMs were computed for “finished”, “raw” sample types. Finished (or treated) water samples were sampled post-treatment and the water treatment system outflow. Raw (or untreated) samples were collected prior to treatment at the treatment system intake. A total of 189 individual drinking water supplies were monitored (Table 2).

6.3.1.1. Regulatory Action Endpoints

The conditional registration agreement includes a number of regulatory action endpoints that, if exceeded by acetochlor or its related degradates of toxicological concern, would trigger mitigation measures or the cancellation of acetochlor registration (USEPA 1994). These endpoints are discussed in detail in the “Regulatory History” report provided in an earlier

deliverable. A brief list of the cancellation triggers and the results of the ARP monitoring program are provided below.

In addition to mitigation/cancellation endpoints, acute and chronic exposure to acetochlor and its degradates in surface drinking water was also of concern. For the purposes of this analysis, acute exposure was defined as the overall maximum instantaneous concentration observed at a site. This approach may underestimate actual acute exposure since typically only 14 samples were collected each year (generally bi-weekly samples collected during late winter to late fall) and it is unlikely that the sampling times coincided with peak annual acetochlor concentrations. *Chronic exposure was defined using both the maximum time-weighted average and mean time-weighted annual average for a site.*

6.3.1.1.1.Endpoint 1: 2.0 ppb TWAM

The conditional registration agreement states that “If one (1) community water supply system, that derives its water primarily from surface water, detects an annual time-weighted mean concentration of 2.0 ppb, then the use of acetochlor in the related watershed will be prohibited..... or; the ARP will absorb 100% of the costs required to restore the community water supply system to compliance.” Cancellation would automatically occur if two large community water supply systems or ten community water supply systems of any size observed time-weighted mean concentrations of 2.0 ppb or were out of compliance.

No time-weighted annualized means for acetochlor exceeded 2.0 ppb (Table 6). For both raw and finished surface drinking water, roughly 99% of the time-weighted annualized means were below 0.5 ppb.

Table 6. Frequency of time-weighted annualized mean concentrations (ppb) for the parent acetochlor herbicide in raw and finished water drinking water.

<i>Bin</i>	Raw		Finished	
	<i>Frequency</i>	<i>Cumulative %</i>	<i>Frequency</i>	<i>Cumulative %</i>
0	0	0.00%	12	1.01%
0 – 0.003	33	13.87%	395	34.40%
0.003 – 0.005	48	34.03%	115	44.13%
0.005 – 0.01	34	48.32%	138	55.79%
0.0 – 0.05	63	74.79%	333	83.94%
0.05 – 0.1	25	85.29%	93	91.80%
0.1 – 0.5	34	99.58%	94	99.75%
0.5 – 1.0	1	100.00%	2	99.92%
1.0 - 2.0	0	100.00%	1	100.00%
>2	0	100.00%	0	100.00%
Total	238		1183	

6.3.1.1.2. Endpoint 2: 8.0 ppb Instantaneous Concentration

The conditional registration agreement (USEPA 2004) also states that “If any community water supply system that derives its water primarily from surface water detects a single peak acetochlor concentration of 8.0 ppb, the ARP will make biweekly sampling of that system throughout the following 12 months to determine whether the 2.0 ppb annual time-weighted mean concentration has been exceeded.” Acetochlor was detected above 8.0 ppb in 2 cases for the finished water samples (**Table 7**), however, the twelve month annualized mean did not exceed 2.0 ppb (**Table 6**) since none of the sites exceeded an acetochlor TWAM of 2.0 ppb. Acetochlor concentrations in SDWS were the highest of all three studies, followed by raw surface water samples, state ground water samples, and PGW studies as indicated by the cumulative frequency distribution (CDF) for all sample observations (**Figure 7**). The lines on the CDF represent the percent of samples (frequency) that were detected at or below the corresponding concentration. For example, roughly 80% of all raw (untreated) water samples in the SDWS drinking water program were less than or equal to 0.05 ppb.

Table 7. Frequency of occurrence for all instantaneous parent acetochlor concentrations (ppb) in raw and finished water drinking water.

<i>Bin</i>	Finished Water		RAW Water	
	<i>Frequency</i>	<i>Cumulative %</i>	<i>Frequency</i>	<i>Cumulative %</i>
0	4297	26.00%	530	15.94%
0.0 – 0.003	3107	44.80%	538	32.12%
0.003 - 0.005	1502	53.88%	325	41.89%
0.005 - 0.01	2084	66.49%	536	58.02%
0.01 - 0.05	3279	86.33%	808	0
0.05 - 0.1	832	91.37%	188	87.97%
0.1 - 0.5	1096	98.00%	279	96.36%
0.5 - 1	183	99.10%	71	98.50%
1 - 4	136	99.93%	47	99.91%
4 - 8	10	99.99%	3	100.00%
>8	2	100.00%	0	100.00%
Total	16528		3325	

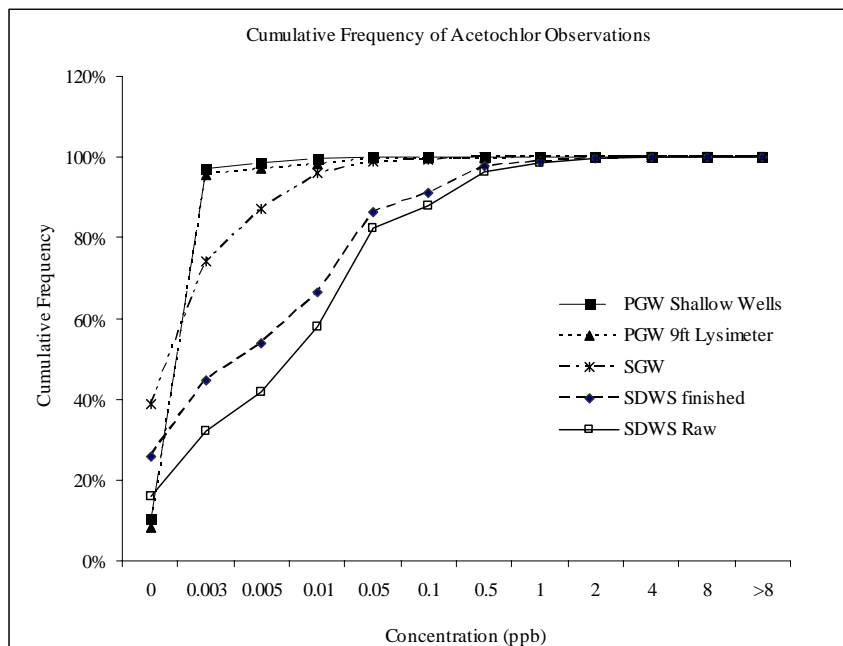


Figure 7. Cumulative frequency distribution for all acetochlor observations for each study. PGW data represented include separate distributions for the 9-foot depth lysimeter data and the shallow groundwater wells for each study.

6.3.1.2. Acute Exposure

Maximum exposures for acetochlor parent were generally higher at the SDWS sites than the PGW and SGW sites (Figure 8). Roughly 85% of the SDWS maximum overall peak finished observations for each site were below 2.0 ppb and 80% of maximum overall peak raw water observations for each site were below 2.0 ppb. Approximately 99% of the PGW and SGW peak observations were below 2.0 ppb. Median values were 0.3 for SDWS raw water, 0.25 for SDWS finished water, 0.02 for SGW ground water, and 0.004 for PGW ground water studies. The majority of overall maximum peak acetochlor concentrations for each site in the state ground water (SGW) program were less than 0.05 ppb.

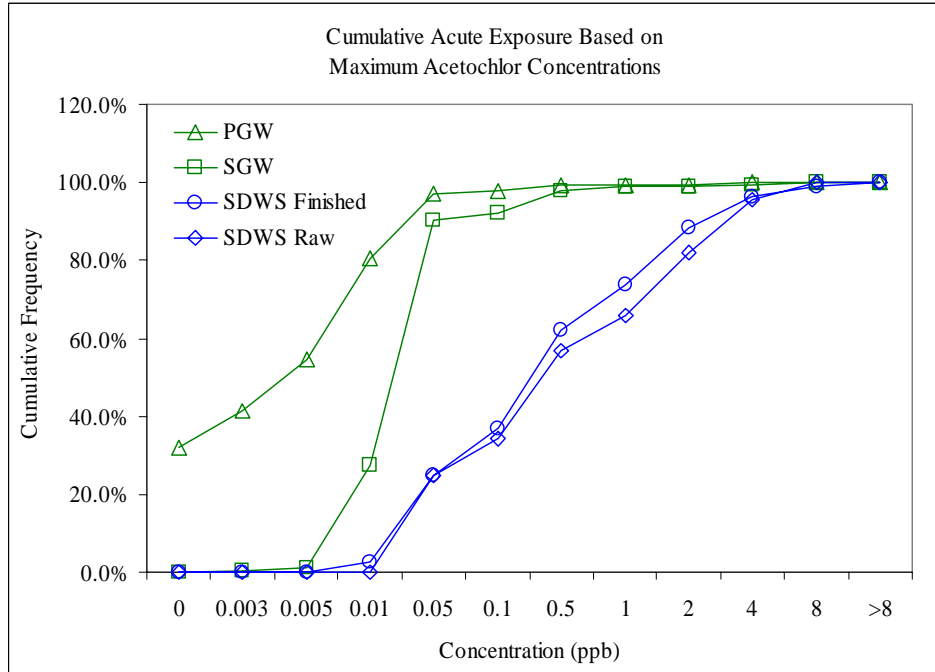


Figure 8. Cumulative frequency distribution for acetochlor acute exposure in all ARP studies, based on the maximum observed concentration at each site. PGW data maximum exposures are provided for each lysimeter and each depth.

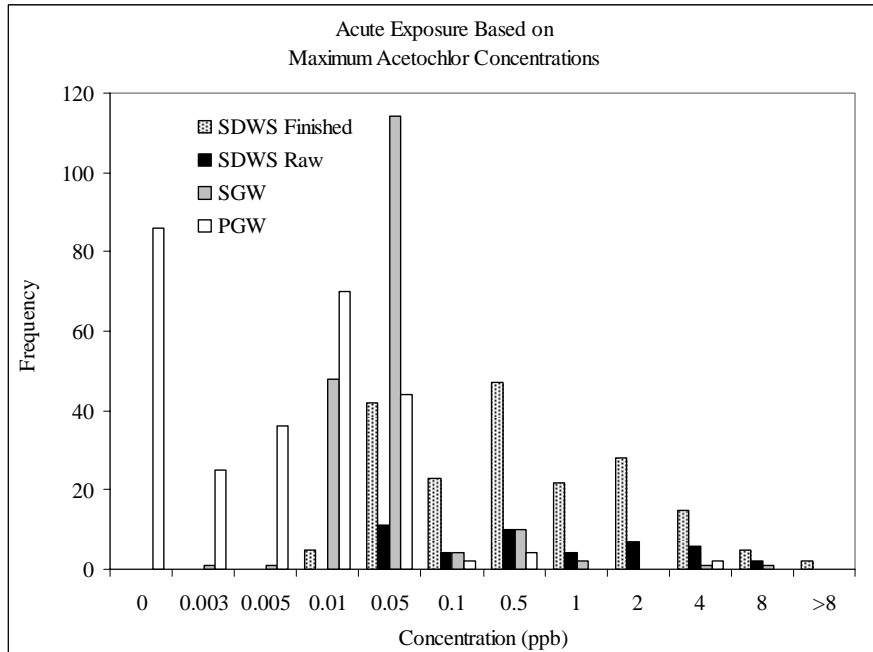


Figure 9. Distribution of acute exposure, based on the maximum observed concentration at each site. PGW data maximum exposures are provided for each lysimeter and each depth.

6.3.1.3. Acute and Chronic Exposure Distribution by Population.

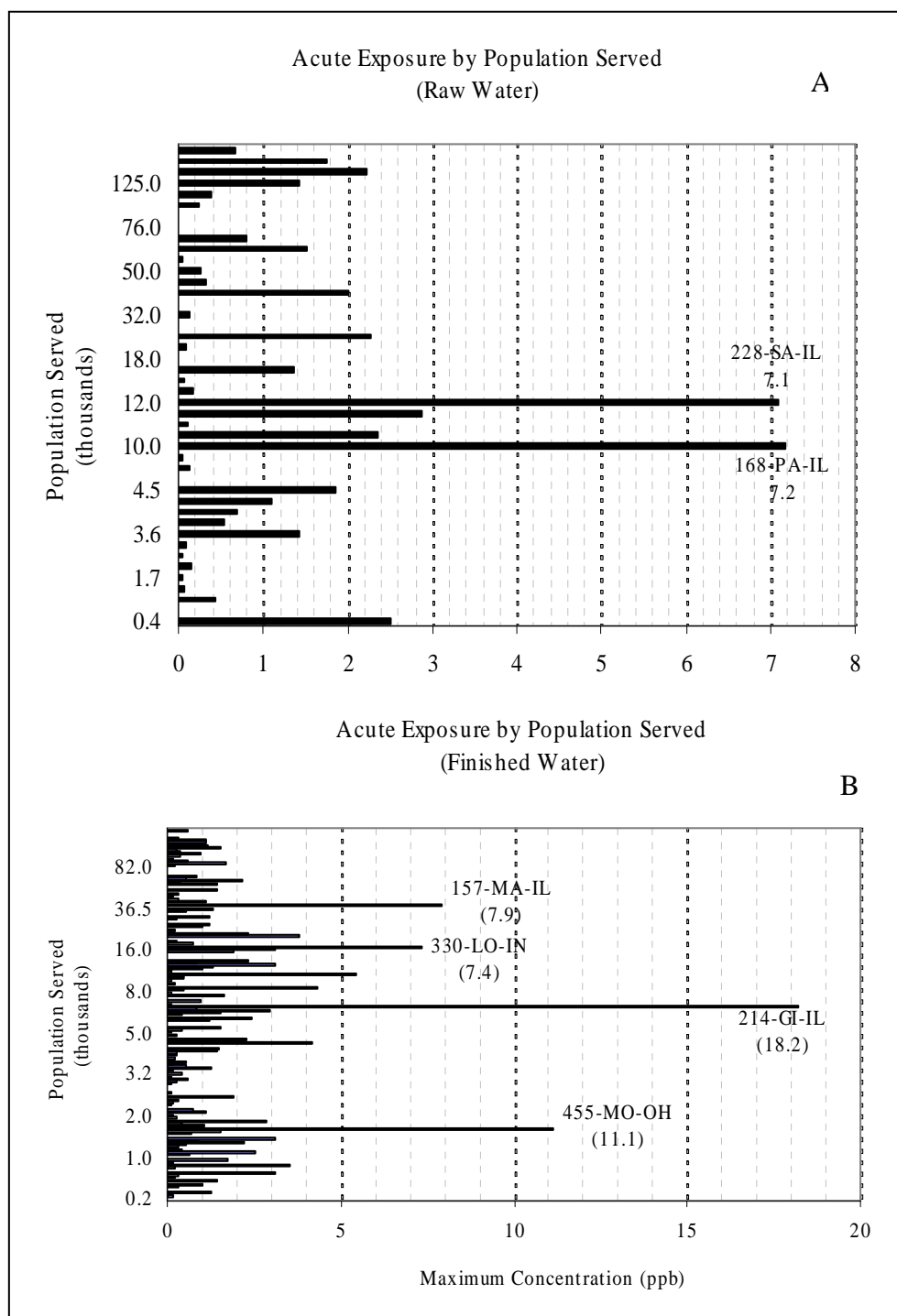


Figure 10. Acute acetochlor exposure distribution by population served for raw (A) and finished (B) water samples.

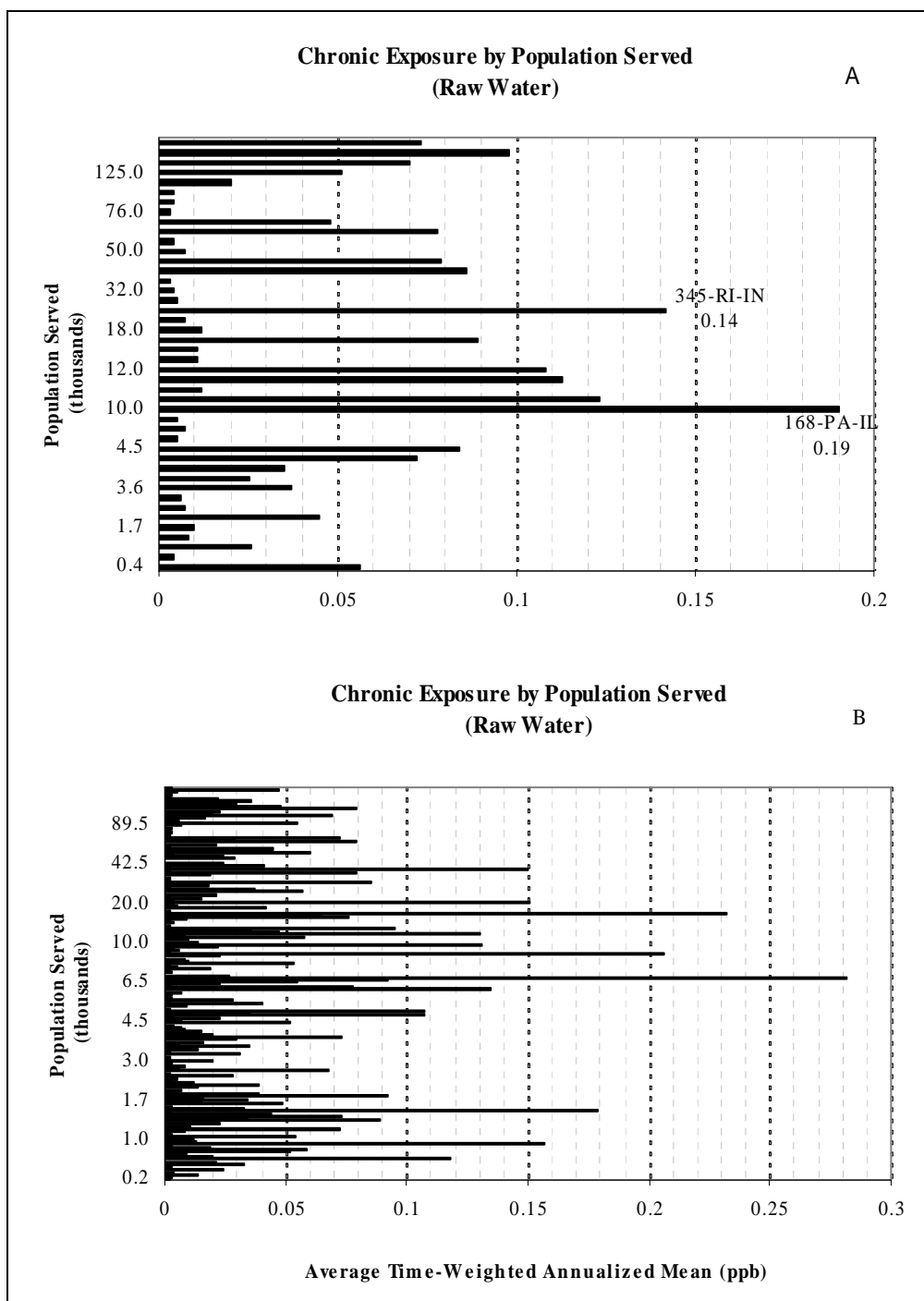


Figure 11. Chronic exposure to parent acetochlor in raw surface drinking water (SDWS) using the average time-weighted mean at each site.

6.3.1.4. Chronic Exposure Distribution by System

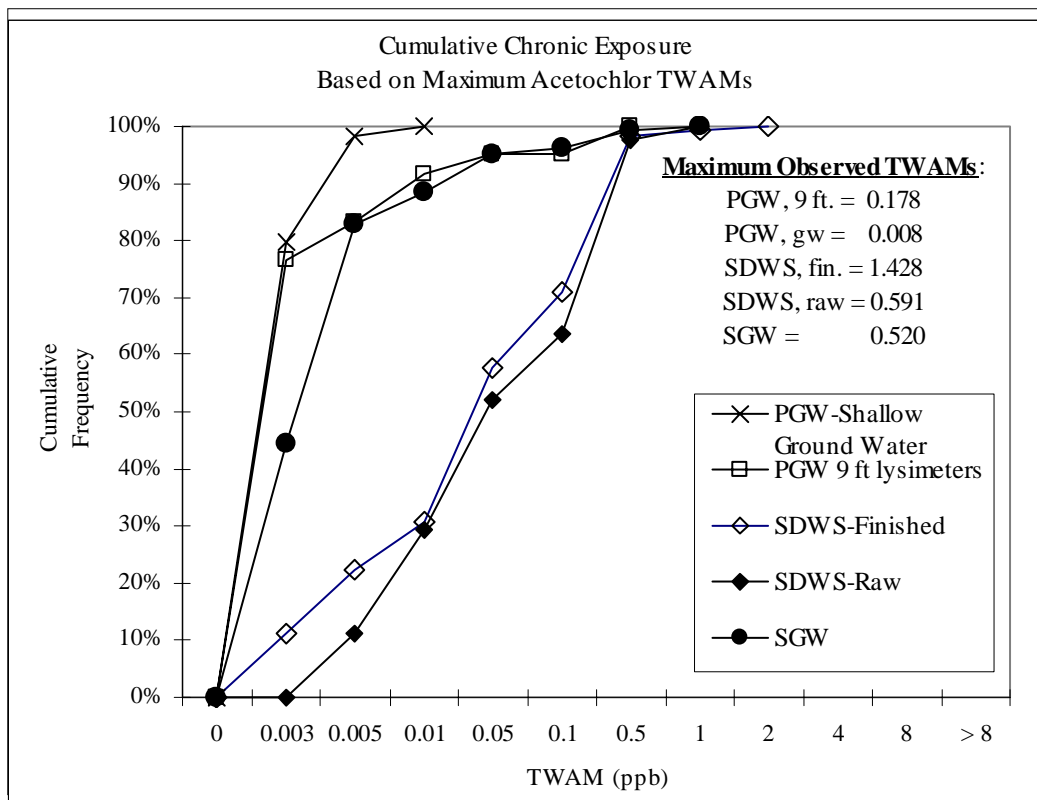


Figure 12. Cumulative frequency distribution for parent acetochlor chronic exposure, based on the highest time-weighted annual mean at each site. PGW chronic exposures are the maximum TWAM for each cluster at 9-foot depth for lysimeters and shallow monitoring wells for ground water.

6.3.2. Surface Water Factorial Analysis

For parent acetochlor, the most toxic of residues, surface water is the dominant medium of exposure. Consequently, the focus of statistical analysis was on factors related to occurrence in surface drinking water supplies. Statistical analyses examined environmental variables that could potentially explain the spatial variability among sites (e.g., watershed size, corn intensity, etc.). In addition, the relationship between raw and finished samples was examined to determine the effects of water treatment.

Appendix 12.7 presents correlation matrices for surface drinking water sites, individually for raw and finished water samples. A number of hypothesized explanatory variables were examined including watershed area, average watershed sales (1994-2003), the mean sales (1994) for the county with the overall highest sales in each watershed, watershed runoff, watershed corn intensity, 30-yr average precipitation, and 30-yr average spring precipitation (April – June). In general, the ancillary variables that were available were unable to explain a significant amount of the variability in maximum observed concentrations (acute exposure), average TWAMS, and maximum TWAMs (chronic exposure). It was originally expected that acetochlor acute and chronic exposure would be moderately to strongly correlated with the variability in acetochlor sales in the associated watersheds, however sales were only weakly correlated ($r < 0.5$).

Some associations were observed between ancillary variables as expected. For example, watershed corn intensity was moderately to strongly correlated with the watershed runoff curve number (RCN) with correlation coefficients (r) ranging from 0.78 for all sites where raw water samples were collected to 0.82 for only those sites where finished water samples were collected. The correlation between runoff curve number and watershed corn intensity is not surprising, since land cover is a factor in generating the curve number.

Statistical analysis of time-weighted means revealed no significant increase or decrease in annualized mean concentrations for acetochlor over time, nor did ARP's analysis detect a change in annualized means over the seven year monitoring period. Scatter plots for raw and finished time-weighted means can be found in Appendix section 12.7.

Raw water concentrations in the SDWS program were significantly ($p < 0.05$) greater than treated water concentrations. A paired two sample t-test for means was performed on those sites and sample dates that had both raw and finished water observations. Results of the t-test are provided in the Appendix section entitled **Statistical Analyses for the ARP monitoring Studies**. Statistical analysis indicates that water treatment plants that use granulated activated carbon (GAC) or powdered activated carbon (PAC) significantly reduce acetochlor concentrations in drinking water ($p < 0.001$)

In nearly half the cases (43%), finished water samples were moderately to strongly associated ($r \geq 0.75$) with observed raw water concentrations, suggesting that finished water samples are moderately predictive of raw water concentrations. Raw water concentrations explained at least 75% of the variability in finished water concentrations for 30% of the sites. Raw water concentrations explained at least 50 % ($r^2 \geq 0.5$) of the variability in finished water concentrations using a simple linear model. In general increasing the sample size (N) did not result in an increase in correlation between raw and finished water concentrations. Lack of

correspondence for some sites may be partially a result of differences in sampling times for raw and finished samples and the uncertainty in residence time for each of the water treatment facilities. Because there is a time lag from when water enters the intake (raw water) to when the treatment processes are completed (finished water) it is unlikely that raw and finished samples were taken from the same volume of water.

Percent reduction due to treatment was also calculated to assess the relative success of treatment. Percent reduction was computed for those observations that had non-zero raw values using the following formula:

$$\text{Percent Reduction} = ((\text{Raw}-\text{Finished})/\text{Raw}) * 100.$$

Figure 13 summarizes the percent reduction in acetochlor parent in surface drinking water supplies sampled. Values on the x-axis represent percent reduction; a value of 100% indicates that all of the acetochlor was eliminated. A negative value means that the concentration went up between pre and post-treatment. Based on the chart roughly 35% of the non-zero samples had complete elimination of Acetochlor, another 15% had about an 80% reduction, another 10% had about a 60% reduction and so forth. About 12.5% of surface water samples had concentrations that increased after treatment.

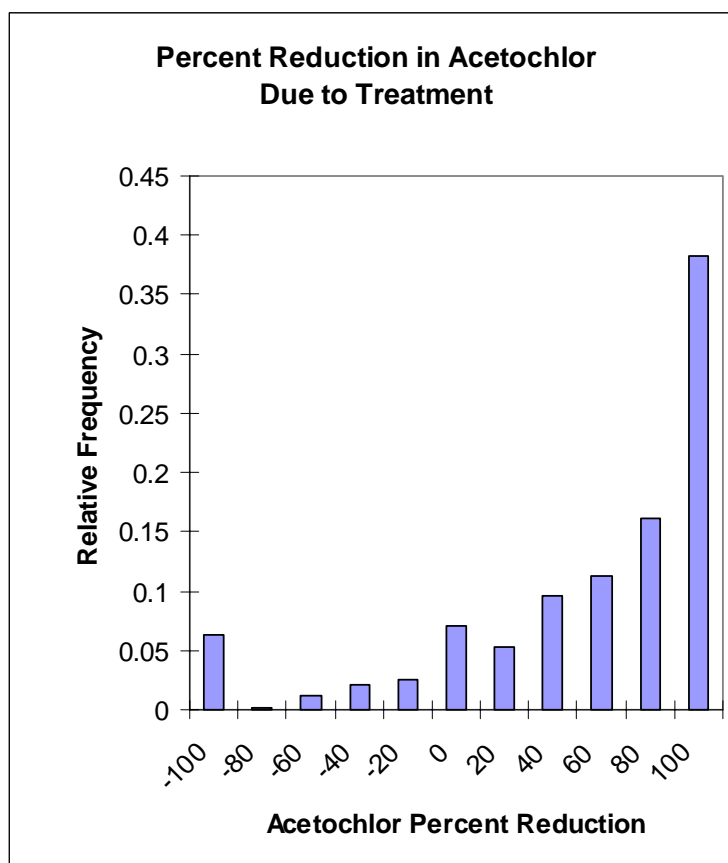


Figure 13. Percent reduction in acetochlor from pre-treatment (raw) to post treatment (finished) sample.

6.3.3. Characterization of Exposure to Surface Water

Exposure to acetochlor parent was significantly higher in the surface water monitoring sites than the ground water monitoring sites (see Figure 7, Figure 8, and Figure 12). Only the surface water monitoring samples represented water from existing drinking water intakes.

While most of the factors for selection for the ground water sites would tend to make these sites susceptible to higher levels of contamination than occurring in samples from actual drinking water wells, this is not an assumption which is directly verifiable. The preponderance of the evidence does indicate that it is proper to base the parent exposure assessment on the surface water monitoring results, nonetheless, there are still some unknowns with regard to the relative conservativeness (i.e., degree of tendency to overestimate exposure) of the ground water monitoring studies by the ARP. For example, a major limitation in a monitoring survey for a new pesticide is that the full impact of the use of the pesticide on ground water quality may not be observed for a number of years. The number of years required for residues to reach ground water at each SGW sampling site is not knowable. Data from the PGW studies show, that even with higher than average rainfall supplemented by irrigation it can take several years for some residues to reach shallow ground water, witness the Nebraska PGW site where residues of the acetochlor ethanesulfonic acid degradates were still moving through the soil pore-water at a 9-foot depth when the study was terminated more than seven years after the only acetochlor application.

The ten overall highest single acetochlor concentrations, time-weighted annualized means, and 95th percentiles for the community water systems were determined for both raw (**Table 8**) and finished (**Table 9**) water samples. These systems generally draw water from watersheds with high corn crop intensity (ca. 20 to 35%) and include both reservoir and river water sources (**Table 10**). Acetochlor concentrations were highest in Illinois. Eight of the ten highest raw water concentrations, time-weighted annualized means, and 95th percentiles were observed in Illinois, including the overall highest raw water concentration (7.19 ppb), TWAM (0.59 ppb), and 95th percentile (3.31 ppb) were observed at a single site (168-PA-IL) in Illinois. Similarly, six of the ten highest finished water concentrations were observed in Illinois, including the overall highest finished water concentration (18.21 ppb), TWAM (1.43 ppb), and 95th percentile (6.97 ppb) observed at 214-GI-IL. Most of the ten highest observations occurred between the years 1996-1998.

Statistical analysis of raw versus finished water concentrations indicates that treatment does indeed on average significantly decrease acetochlor concentrations, the top ten finished (treated) water concentrations exceed the top ten raw (untreated) concentrations suggesting that paired sampling of raw and finished water at all sites would have provided a much more reliable indication of the level of impact of acetochlor residues on surface waters and the degree of mitigation provided by treatment systems with and without carbon filtration (that is, in general, with the recognition that it is generally not possible to exactly match the water sampled prior to and post-treatment). Without these data, we have no possibility of determining, for example, whether the treatment systems that did not use carbon filtration reduced exposure and we have an inadequate ability to determine the impact on acetochlor residue levels of treatment systems that include GAC (because most of these CWS also did not sample pre-treatment water). In fact, the SDWS was set up with paired raw and finished water sampling at only about 25 (initially in

1995) to 44 (overall, for one or more years) of the up to 175 sites sampled each year during this seven-year study.

To further isolate treatment effects in the SDWS it would have been worthwhile to attempt to match, to the extent it can be determined and is feasible, the volumes of water that are sampled for the raw and finished water analyses at each sampling date. Future studies of this nature should detail results of the investigation of water handling practices and a determination on a site-by-site basis of the degree to which this is feasible. If attempts to more closely pair the raw and finished water are deemed to be futile, the reasons for this determination should at least be specifically documented.

Table 8. Ten highest raw (untreated) water concentrations of parent acetochlor at community water system (CWS) intake locations.

Maximum Single Concentration (ppb)			Maximum TWAM (ppb)			Maximum 95th %tile Concentration (ppb) ^a		
CWS Name	Value	Year	CWS Name	Value	Year	CWS Name	Value	Year
168-PA-IL	7.19	1998	168-PA-IL	0.59	1998	168-PA-IL	3.31	1998
228-SA-IL	7.09	1996	168-PA-IL	0.43	1996	222-HI-IL	2.10	1998
168-PA-IL	5.89	1996	228-SA-IL	0.40	1996	1070-WY-MO	1.81	1997
228-SA-IL	3.45	1998	222-HI-IL	0.36	1998	228-SA-IL	1.56	1996
606-KA-IL	2.88	1998	1070-WY-MO	0.32	1997	259-SP-IL	1.44	1998
1070-WY-MO	2.50	1997	345-RI-IN	0.30	1997	168-PA-IL	1.39	1996
222-HI-IL	2.36	1998	222-HI-IL	0.26	1996	225-CE-IL	1.38	1998
345-RI-IN	2.27	1997	259-SP-IL	0.25	1998	228-SA-IL	1.37	1998
259-SP-IL	2.22	1998	606-KA-IL	0.23	1996	603-BL-IL	1.28	1995
225-CE-IL	2.01	1999	603-BL-IL	0.23	1995	557-DM-IA	1.13	2001

^a Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

Table 9. Ten highest finished (treated) water concentrations of parent acetochlor at community water system (CWS) outflow locations.

Maximum Single Concentration (ppb)			Maximum TWAM (ppb)			Maximum 95th %tile Concentration (ppb) ^a		
CWS Name	Value	Year	CWS Name	Value	Year	CWS Name	Value	Year
214-GI-IL	18.21	1996	214-GI-IL	1.43	1996	214-GI-IL	6.97	1996
455-MO-OH	11.14	1997	455-MO-OH	0.58	1997	168-PA-IL	3.01	1998
157-MA-IL	7.93	1996	166-NE-IL	0.53	1996	340-NV-IN	2.87	1996
330-LO-IN	7.35	1997	214-GI-IL	0.49	1998	182-GE-IL	2.70	1998
168-PA-IL	5.43	1998	168-PA-IL	0.48	1998	166-NE-IL	2.67	1996
455-MO-OH	5.17	1996	157-MA-IL	0.46	1996	143-SO-IL	2.65	1998
340-NV-IN	4.31	1996	330-LO-IN	0.42	1997	214-GI-IL	2.21	1998
214-GI-IL	4.28	1998	182-GE-IL	0.39	1998	518-US-OH	2.03	1996
537-WM-OH	4.16	2000	518-US-OH	0.37	1996	330-LO-IN	1.94	1996
168-PA-IL	4.14	1996	340-NV-IN	0.37	1996	242-CO-IL	1.71	1996

^a Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

Table 10. Watershed characteristics for the ten highest finished (treated) water concentrations of parent acetochlor at community water system (CWS) outflow locations.						
CWS Name	Watershed Area, acres	Type	Reservoir Volume or Area²	Chronic Rank¹	Acute Rank¹	% Corn Intensity
214-GI-IL	2996	Reservoir	250 mg	1,4	1, 8	25.0
455-MO-OH	138245	River	NA	2	2, 6	18.7
157-MA-IL	11916	Reservoir	900 mg	6	3	34.5
330-LO-IN	524144	River	NA	7	4	28.3
340-NV-IN	68241	River	NA	10	7	21.0
537-WM-OH	427302	River	NA	NC	9	28.3
168-PA-IL	11733	Reservoir	900 mg	5	5, 10	38.7
166-NE-IL	34849	Reservoir	NA	3	NC	33.5
182-GE-IL	724	Reservoir	50 acres, 9 ft deep	8	NC	29.1
518-US-OH	894	Reservoir	90 mg	9	NC	23.8
¹ Ranking by TWAM (Chronic) or single highest concentration (acute) as presented in Table 9. NC = Not in top ten.						
² mg = million gallons, NA = not available or unknown.						

The highest overall maximum TWAM, single concentration, and 95th percentile was observed in Illinois, followed by Missouri at nearly half the maximum concentrations observed in Illinois (Table 11 and Table 12). The top ten raw (untreated) water TWAMs, peak concentrations, and peak 95th percentile concentrations ranged from 0.007 ppb in WI to 0.591 ppb in IL, 0.044 ppb in OH to 7.186 ppb in IL, 0.019 ppb in PA to 3.313 ppb in IL, respectively. Peak finished (treated) water concentrations were again sometimes higher than pre-treated water samples. The top ten treated water TWAMs, peak concentrations, and peak 95th percentile concentrations ranged from 0.004 in MD to 1.428 ppb in IL, 0.034 ppb in MD to 18.21 ppb in IL, 0.011 in DE to 6.973 in IL, respectively. The highest maximum TWAM for MD occurred three times at two different sites (Table 12).

Table 11. Highest raw (untreated) water concentrations of parent acetochlor at community water system (CWS) intake locations in each state (sorted by Max TWAM).

Max TWAM (ppb)				Maximum Single Concentration (ppb)				Max. 95th %tile Concentration (ppb) ^a			
State	Value	Year	CWS Name	State	Value	Year	CWS Name	State	Value	Year	CWS Name
IL	0.591	1998	168-PA-IL	IL	7.186	1998	168-PA-IL	IL	3.313	1998	168-PA-IL
MO	0.317	1997	1070-WY-MO	MO	2.504	1997	1070-WY-MO	MO	1.807	1997	1070-WY-MO
IN	0.304	1997	345-RI-IN	IN	2.265	1997	345-RI-IN	IN	1.118	1997	345-RI-IN
IA	0.217	1996	574-OS-IA	IA	1.762	2001	557-DM-IA	IA	1.129	2001	557-DM-IA
KS	0.085	1999	89-MI-KS	KS	0.426	1999	89-MI-KS	KS	0.272	1999	89-MI-KS
NE	0.045	2001	301-BL-NE	NE	0.161	2001	301-BL-NE	NE	0.131	2001	301-BL-NE
MN	0.019	1999	296-SC-MN	MN	0.251	1999	296-SC-MN	MN	0.066	1999	296-SC-MN
OH	0.010	2001	452-MC-OH	OH	0.044	2001	452-MC-OH	OH	0.033	2001	452-MC-OH
PA	0.010	1996	737-AW-PA	PA	0.241	1996	737-AW-PA	PA	0.019	1998	737-AW-PA
WI	0.007	1996	13-AP-WI	WI	0.046	1996	18-OK-WI	WI	0.024	1996	18-OK-WI

^a Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

Table 12. Highest finished (treated) water concentrations of parent acetochlor at community water system (CWS) outflow locations in each state.

Max TWAM (ppb)				Maximum Single Concentration (ppb)				Max. 95th %tile Concentration (ppb)			
State	Value	Year	CWS Name	State	Value	Year	CWS Name	State	Value	Year	CWS Name
IL	1.428	1996	214-GI-IL	IL	18.21	1996	214-GI-IL	IL	6.973	1996	214-GI-IL
OH	0.584	1997	455-MO-OH	OH	11.14	1997	455-MO-OH	OH	2.03	1996	518-US-OH
IN	0.416	1997	330-LO-IN	IN	7.353	1997	330-LO-IN	IN	2.872	1996	340-NV-IN
MO	0.258	1998	1098-GE-MO	MO	1.289	1997	1070-WY-MO	MO	1.114	1998	1098-GE-MO
IA	0.207	1996	570-MO-IA	IA	2.328	1998	572-MP-IA	IA	1.402	1998	572-MP-IA
KS	0.133	2001	125-TO-KS	KS	1.88	1999	25-AT-KS	KS	0.983	1999	71-KC-KS
PA	0.092	1995	729-PH-PA	PA	2.34	1995	729-PH-PA	PA	0.045	1995	769-RE-PA
NE	0.088	1999	301-BL-NE	NE	1.116	1995	303-OM-NE	NE	0.288	2001	303-OM-NE
WI	0.039	1997	17-ME-WI	WI	0.192	1997	17-ME-WI	WI	0.167	1997	17-ME-WI
DE	0.025	1998	652-WI-DE	DE	0.598	1998	652-WI-DE	DE	0.011	1998	651-NE-DE
MN	0.006	1999	296-SC-MN	MN	0.043	1997	277-MI-MN	MN	0.03	1999	296-SC-MN
MD**	0.004	2001	702-LA-MD	MD	0.034	1996	699-HG-MD	MD	0.012	1996	699-HG-MD

^a Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

** There are also two other Maryland sites with concentration values of 0.004 ppb

6.3.4. Comparison of ARP and WARP beta Model Results

Table 13 presents the highest acetochlor concentrations estimated by the WARP beta model (USGS 2004) for states where ARP also had surface water monitoring locations. For comparison, the top ten peak raw water concentrations measured by the ARP for community water supply systems are also provided. In both data sets, the majority of the top ten peak concentrations were located in Illinois. In general, the maximum time-weighted annualized means measured by the ARP are close to those modeled by WARP, as are the 95%tile values. Recall that the 95th percentile values represent the fraction of the year (e.g., 95 percent of the time) that the concentration was equal to or less than the listed value (USGS 2004).

The modeling results are based on use estimates provided by the National Center for Food and Agricultural Policy (<http://www.ncfap.org/database/default.php>) These data are different than the annual sales data provided by the ARP. The USGS modeling is based on nationally available hydrologic and soils data.

Table 13. Top ten highest raw water concentrations (ppb) of parent acetochlor modeled by WARP multi-compound regression model and measured by ARP at community water system (CWS) intakes.

WARP results (Beta version, results supplied by USGS) are only for states where ARP also had surface water monitoring locations. WARP data are ranked by maximum 95%tile and measured results by ARP are ranked separately by maximum time-weighted mean and 95%tile.

WARP			ARP				
Site	TWAM	95%tile Conc.	Max Single Conc.	Max TWAM		Max 95%tile Conc. ^a	
				Value	CWS Name	Value	CWS Name
KASKASKIA RIVER (E. FORK) FARINA, IL	0.81	3.77	7.19	0.59	168-PA-IL	3.31	168-PA-IL
LITTLE WABASH RIVER FLORA, IL	0.56	2.64	7.09	0.43	168-PA-IL	2.10	222-HI-IL
LITTLE WABASH RIVER CLAY CITY, IL	0.55	2.60	5.89	0.40	228-SA-IL	1.81	1070-WY-MO
LITTLE WABASH RIVER FAIRFIELD, IL	0.54	2.59	3.45	0.36	222-HI-IL	1.56	228-SA-IL
KASKASKIA RIVER (E. FORK) FARINA, IL	0.54	2.50	2.88	0.32	1070-WY-MO	1.44	259-SP-IL
WILDCAT CREEK KOKOMO, IN	0.52	2.31	2.50	0.30	345-RI-IN	1.39	168-PA-IL
WHITE RIVER NORTH INDIANAPOLIS, IN	0.50	2.28	2.36	0.26	222-HI-IL	1.38	225-CE-IL
KASKASKIA RIVER EVANSVILLE, IL	0.48	2.24	2.27	0.25	259-SP-IL	1.37	228-SA-IL
KASKASKIA RIVER FAYETTEVILLE TWP, IL	0.48	2.22	2.22	0.23	606-KA-IL	1.28	603-BL-IL
KASKASKIA RIVER NEW ATHENS TWP, IL	0.47	2.22	2.01	0.23	603-BL-IL	1.13	557-DM-IA

^a Max 95%tile indicates that 95% of the time the value was less than or equal to the specified value (USGS 2004).

6.3.5. Summary Results of National Water Quality Assessment (NAWQA) Results

NAWQA data (NAWQA a long-term multi-faceted monitoring program being conducted by the USGS) have included serial monitoring for a large schedule of pesticides, including acetochlor in

multiple study areas across the United States. NAWQA monitoring sites are not selected to represent the locations of drinking water intakes nor are they directly selected to represent sites at which specific pesticides are used. They do, however, represent ambient pesticide concentrations in the environment, include many watersheds where agriculture is the documented dominant land use, and may be an indication of vulnerability of sites to runoff of acetochlor (These data are used as an indication of the occurrence pattern and concentration of pesticides in surface source water). Table 14 summarizes acetochlor monitoring concentrations measured in NAWQA study unit locations. The two columns of data represent overall (non-time weighted) mean and maximum concentration data at all sites for which the maximum concentration value is above 1.00 ppb.

Table 14. Acetochlor monitoring concentrations at NAWQA study unit locations. (Notes: ‘Mean Conc’ values are not Time Weighted Annual Mean (TWAM) concentration values; ‘Max Conc’ values occurred, for the most part, at different times [dates and years] during the monitoring period which also varied from site to site.)

Site Name	Mean Conc (ppb)	Max Conc (ppb)
MAPLE CREEK NEAR NICKERSON, NE	1.359	61.00
SUGAR CREEK AT MILFORD, IL	0.993	35.90
ELKHORN RIVER AT WATERLOO, NE	1.304	31.00
PLATTE R AT LOUISVILLE NE	0.416	14.20
LA MOINE RIVER AT COLMAR, IL	0.532	11.60
LITTLE COBB RIVER NEAR BEAUFORD, MN	0.361	10.70
MAUMEE RIVER AT WATERVILLE OH	0.596	10.60
SKUNK RIVER AT AUGUSTA, IA	0.768	10.60
SANGAMON RIVER AT MONTICELLO, IL	0.510	9.71
MAUMEE RI AT NEWHAVEN IN	0.710	8.88
OLD MANS CREEK NEAR IOWA CITY, IA	0.636	8.16
WEST FORK CEDAR RIVER AT FINCHFORD, IA	0.366	7.62
SUGAR CREEK AT CO RD 400 S AT NEW PALESTINE, IN	0.238	7.17
CEDAR RIVER NEAR CONESVILLE, IA	0.376	7.10
ST JOSEPH RIVER NEAR NEWVILLE IN	0.373	5.61
AUGLAIZE RIVER NEAR FORT JENNINGS OH	0.515	5.13
LITTLE BUCK CREEK NEAR INDIANAPOLIS, IN	0.053	4.20
MAD RIVER AT ST PARIS PIKE AT EAGLE CITY OH	0.065	4.02
BLACK RIVER NR JEDDO MI	0.292	3.80
CLEAR CK NR SANGER, TX	0.115	3.59
WHITE RIVER AT HAZLETON, IN	0.194	3.56
IOWA RIVER NEAR ROWAN, IA	0.116	3.50
WAPSIPINICON RIVER NEAR TRIPOLI, IA	0.188	3.09
DUCK CREEK AT SEMINARY ROAD NEAR ONEIDA, WI	0.124	2.90
IOWA RIVER AT WAPELLO, IA	0.159	2.89
FLOOD CREEK NEAR POWERSVILLE, IA	0.164	2.56
WAPSIPINICON RIVER NEAR DE WITT, IA	0.360	2.30
BOGUE PHALIA NR LELAND, MS	0.068	2.28
ENGLISH RIVER AT RIVERSIDE, IA	0.117	2.23
ILLINOIS RIVER AT VALLEY CITY	0.240	2.01
ILLINOIS RIVER AT OTTAWA, IL	0.260	2.00
BIG SUNFLOWER RIVER NR ANGUILLA, MS	0.104	1.68
CEDAR RIVER AT GILBERTVILLE, IA	0.111	1.66
IOWA RIVER AT MARENGO, IA	0.184	1.50
MINNESOTA RIVER NEAR JORDAN, MN	0.143	1.50
YAZOO RIVER BL STEELE BAYOU NR LONG LAKE, MS	0.036	1.45
PLATTE RIVER NEAR GRAND ISLAND, NEBR.	0.133	1.40
SOUTH FORK IOWA RIVER NE OF NEW PROVIDENCE, IA	0.090	1.36
WOLF CREEK NEAR DYSART, IA	0.121	1.25

6.3.6. USGS / EPA Pilot Reservoir Monitoring Program

The highest levels of chronic exposure to acetochlor parent most often occur in reservoirs (compared to streams and rivers and to ground water, Table 10), and a significant source of

additional monitoring for a number of pesticides in settings of high vulnerability is provided in Bloomquist et al. (2001). Each sampling site included in the USGS reservoir monitoring study consisted of both a reservoir (raw water sample source) and a Community Water System (finished water source). The study focused on small drinking-water supply reservoirs in areas with high pesticide use (not necessarily high acetochlor use areas). The program was implemented with a NAWQA design structure and strong consideration in site selection was given to sites within existing NAWQA Study Units. One drinking water reservoir was chosen in each of 12 states: California, Indiana, Ohio, Oklahoma, Louisiana, Missouri, South Carolina, South Dakota, New York, North Carolina, North Carolina, Pennsylvania and Texas. No samples were taken in Illinois, a high acetochlor usage state.

Table 15. Maximum acetochlor concentration values in pilot reservoir monitoring study (Blomquist et al., 2001).

State	Reservoir	Maximum Conc (ppb)
SD	Mitchell	0.395
SD	Mitchell	0.395
SD	Mitchell	0.375
SD	Mitchell	0.354
SD	Mitchell	0.334
SD	Mitchell	0.324
SD	Mitchell	0.289
OH	Clermont	0.284
SD	Mitchell	0.265
SD	Mitchell	0.249
SD	Mitchell	0.229

The maximum concentration in the intake water at the Mitchell, South Dakota site was 0.334 ppb and the concentrations in both the outflow from the CWS treatment facility and the reservoir were 0.395 ppb. The highest 67 concentration values were all found at the South Dakota, Ohio and Indiana sites.

6.4. Ground Water

6.4.1. PGW Leaching Summary

Two separate data files were used in this analysis (Table 5). One file contained all the concentration values observed in the PGW studies provided by the ARP, while the second contained raw uncensored concentrations also provided by the ARP. Because of the overwhelming number of censored values (defined in this context as values that were not reported numerically – generally because of the precision and accuracy limitations of the analytical method for low residue levels), the PGW uncensored file was used to compute time-weighted annualized means and percentiles. The underlying assumption here is that the uncensored data represent the best available estimates of unmeasured values (any substitution method for nondetects would be arbitrary).

6.4.2. Comparison of PGW Results to the Acetochlor Regulatory Action Endpoints

The conditional registration agreement states that automatic cancellation of acetochlor will occur if “out of the eight sites, 4 sites in a variety of geographic, and climatic conditions under both vulnerable and general use conditions (as determined by EPA) in corn growing states indicate a pattern of movement of acetochlor toward ground water” (USEPA 1994). ”. In the PGW studies, one indication of a pattern of movement was defined as the detection of acetochlor greater than or equal to 1.0 ppb at nine foot lysimeter depth as well as corresponding three and 6 foot depths in that cluster. Table 16 indicates that only one site (Iowa) had detections greater than 1.0 ppb, and moreover it was the only site to have detected concentrations greater than 0.1 ppb in the nine foot lysimeters.

Peak concentrations of the parent acetochlor were determined for each state and are presented separately for three foot lysimeters (Table 17), nine foot lysimeters (Table 18), shallow ground water (Table 19), and deep ground water (Table 20). The maximum soil-pore water residue for parent acetochlor was measured as 3.2 ppb, which was observed in the 9 ft (2.7 m) lysimeters in Iowa (Table 18). According to the pgw_num_final.txt file provided by the registrant, the maximum residue observed in ground water was 0.06 ppb, observed in Iowa. Concentrations in the deep ground water monitoring wells (**Table 20**) were only slightly lower than concentrations in the shallow ground water wells.

Table 16. PGW Sites exceeding 0.1 ppb at 9 feet depth (exceedences only occurred at 1 of the 8 sites).

MAT	DATE ^a	STATE	DEVICE	DEPTH	CLUSTER	RAW CONCENTRATION
0.5	6/24/1996	IA	LY	9	1	2.6
1	7/9/1996	IA	LY	9	1	0.195
0.5	6/24/1996	IA	LY	9	3	3.2
1	7/9/1996	IA	LY	9	3	0.628
1.5	7/24/1996	IA	LY	9	3	0.208
2	8/8/1996	IA	LY	9	3	0.102
0.5	6/24/1996	IA	LY	9	4	0.132
0.5	6/24/1996	IA	LY	9	6	0.365

^a Date was not provided, but was approximated using the initial treatment date, months after treatment, and assuming average of 30 days per month.

Table 17. Concentrations of AC observed in 3-foot lysimeters from the eight prospective ground water studies.

STATE	Max TWAM		Max 95 %tile		Max Concentration		Max Moving Average
	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	
DE	0.004	0.009	0.008	0.019	0.009	0.024	0.012
IA	0.000	0.000	0.000	0.000	0.000	0.003	0.000
IN	0.006	0.045	0.028	0.195	0.047	0.330	0.228
MN	0.001	0.001	0.000	0.000	0.001	0.001	NA
NE	0.004	0.007	0.010	0.017	0.011	0.018	0.011
OH	NA	NA	NA	NA	NA	0.025	NA
PA	0.009	0.068	0.016	0.129	0.020	0.156	0.118
WI	NA	NA	NA	NA	NA	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all cluster for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed based on uncensored data file; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored concentrations to compute the value

Table 18. Concentrations of AC observed in 9-foot lysimeters from the eight prospective ground water studies.

STATE	Max TWAM		Max 95 %tile		Max Concentration		Max Moving Average
	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	
DE	0.004	0.006	0.006	0.013	0.006	0.014	0.009
IA	0.458	1.639	0.820	2.931	0.900	3.200	1.345
IN	0.000	0.000	0.000	0.000	0.000	0.003	0.000
MN	0.000	0.001	0.000	0.000	0.000	0.003	NA
NE	0.003	0.007	0.006	0.018	0.010	0.018	0.011
OH	NA	NA	NA	NA	0.003	0.003	NA
PA	0.003	0.013	0.010	0.061	0.015	0.072	0.062
WI	NA	NA	NA	NA	0.003	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all cluster for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; the ARP provided no uncensored data implying the data was all below detection ; NA = Insufficient uncensored concentrations to compute the value

Table 19. Concentrations of AC observed in Shallow ground water from the eight prospective ground water studies.

STATE	Max TWAM	Max 95 %tile	Max Concentration
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STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.002	0.003	0.005	0.008	0.005	0.008	0.004
IA	0.000	0.000	0.000	0.000	0.000	0.025	0.002
IN	0.001	0.000	0.000	0.000	0.003	0.005	0.002
MN	NA	NA	NA	NA	0.003	0.003	NA
NE	0.003	0.008	0.006	0.014	0.007	0.027	0.011
OH	NA	NA	NA	NA	NA	0.003	NA
PA	0.002	0.005	0.003	0.009	0.004	0.011	0.005
WI	NA	NA	NA	NA	NA	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across wells for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored concentrations to compute the value

Table 20. Concentrations of AC observed in Deep ground water from the eight prospective ground water studies.

	Max TWAM		Max 95 %tile		Max Concentration		
STATE	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.002	0.003	0.006	0.007	0.006	0.008	0.005
IA	0.001	0.003	NA	NA	0.002	0.06	NA
IN	0.002	0.004	NA	NA	0.003	0.006	NA
MN	0.005	0.010	NA	NA	0.007	0.014	NA
NE	0.002	0.003	0.007	0.010	0.007	0.012	0.008
OH	NA	NA	NA	NA	NA	0.003	NA
PA	0.001	0.002	0.003	0.008	0.005	0.013	0.005
WI	NA	NA	NA	NA	NA	0.003	NA

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across wells for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored concentrations to compute the value

6.4.3. SGW Summary

In addition to PGW studies, the ARP was required to monitor 25 wells in each of the expected seven high use states (WI, IL, IA, MN, IN, NE, KS) shown in Figure 4. Sites ranged from vulnerable to general use conditions, including diverse geographic, soil, and climatic conditions.

Numerous studies have demonstrated that the time to recharge of shallow superficial aquifer from the land surface can be several years or more (including the results at some of the ARP's PGW sites - for acetochlor degradates). Therefore, the 7 years of state ground water monitoring data may under-estimate the full potential leaching of acetochlor and its degradates to ground water if this chemical is used annually and with significant frequency for the next 10 or 20 years. Additional concerns relate to the lack of definitive confirmation by the ARP of a hydraulic connection between the ARP monitoring sites and

the sampled ground water (i.e., data were not collected specifically to confirm the direction of vadose zone flow and transport during the course of the SGW study). The ARP states the following about how they obtained adequate justification of the locations of their wells in relation to fields treated with acetochlor as part of the SGW program:

Monitoring wells were sited within or closely adjacent to, and down-gradient of the study plot. Various sources of published ground water data were used (for example, the Department of Natural Resources Hydrologic Assessment, the USGS Hydrologic Atlas and local university data) to assess ground water flow direction for most sites. At sites where published ground water data were not available, trained hydrogeologists evaluated topography in conjunction with surface water drainage features in order to assess ground water flow direction. (Source: De Guzman et al., in press).

The ARP did not attempt to determine the age of the ground water sampled at any location or confirm the travel times for water from the treated field to the sampled ground water via use of tracers. Some indication, at least, may be obtained of the intrinsic vulnerability of the ground water sampled to contamination from leachable pesticides by evaluation of the patterns of detection of other corn herbicides at the SGW sites (atrazine, alachlor, metolachlor, and metabolites of alachlor and metolachlor were routinely analyzed along with acetochlor residues for in all well water samples).

The monitoring data serve as an early indication that pesticide residues may be reaching ground water. ARP found that parent acetochlor demonstrated a confirmed pattern of movement to ground water above 0.1 ppb at only seven sites. However, Table 1 of Appendix 12.8 indicates that acetochlor was detected above 0.1 ppb in 14 individual wells located across five states.

6.4.3.1. Comparison of SGW Results to Regulatory Action Endpoints

In the SGW study parent acetochlor in seven of the approximately 175 wells (there were some wells replaced and lost during the course of the study) exceeded a literal interpretation of the SGW regulatory trigger involving a pattern of detections at 0.10 ppb or greater (20 wells with such a pattern of detection would have triggered regulatory action to mitigate ground water contamination). The rate of detection of both acetochlor degradates was much higher than for parent over the 1999 to 2001

6.4.3.2. SGW Acute Exposure

The distribution of maximum observed acetochlor concentrations for each site is given in **Figure 14**. Overall, the majority of values were reported as 0.05 ppb. No sites had detections of acetochlor greater than 8.0 ppb, and only one site had a maximum concentration between 4 and 8 ppb. Roughly 90% of the peak acetochlor values observed for each site were less than or equal to 0.5 ppb.

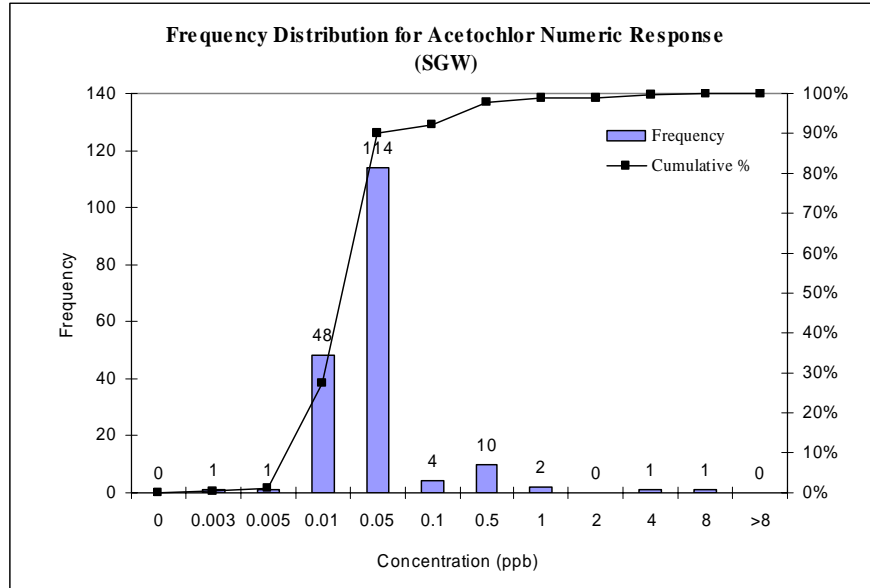


Figure 14. Distribution of maximum acetochlor concentrations observed at each site in the state ground water program.

6.4.3.3.SGW Annual Means

Time-weighted annualized means were computed for each site in the SGW data set based on numeric response data submitted by the ARP. Figure 15 shows the frequency of each time-weighted annualized mean as well as the cumulative frequency distribution. A total of 1,207 annualized means were calculated, with roughly 85% of the TWAMs less than or equal to 0.003.

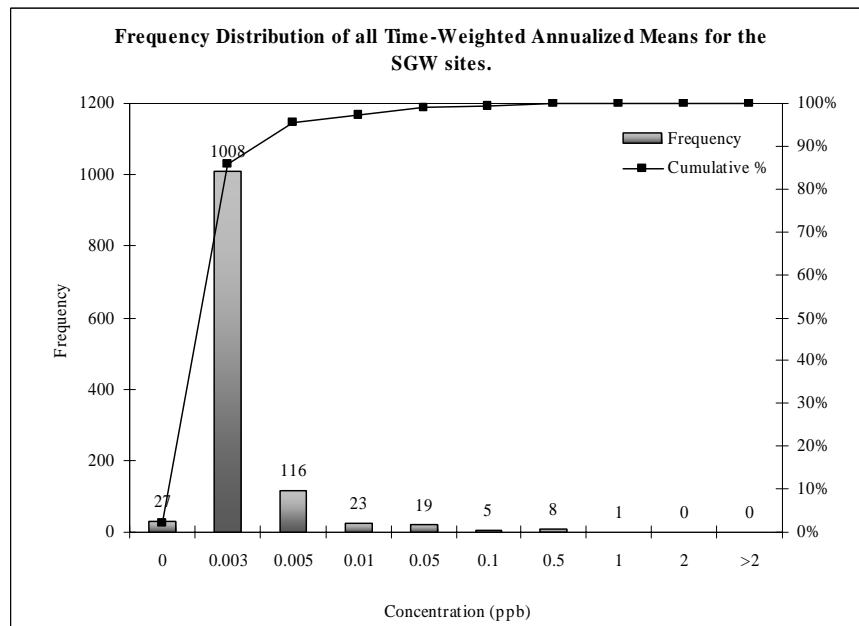


Figure 15. Distribution of all time-weighted annualized means for sites in the state ground water (SGW) monitoring program.

6.4.3.4. Ground Water Factor Analysis

Several environmental variables in the PGW studies were examined to assess their role in observed acetochlor concentrations. Given that at most sites acetochlor was only applied in the first year of the study, this analysis used acute concentrations as the dependent variable. Acute exposure was analyzed individually for three and six foot lysimeters, as well as shallow groundwater. Several hydrogeologic and meteorological factors were selected as independent variables. Factors included average pore water velocity at each site, average hydraulic conductivity, average hydraulic gradient, precipitation for the first three months after treatment, annual precipitation for the 1st year after treatment, 2nd year, 3rd year, and 4th year after treatment, as well as total precipitation during the monitoring period. Results of the analysis are provided in Appendix

Acute exposure in nine foot lysimeters was weakly correlated with annual precipitation 2 years after treatment. Acute exposure in shallow ground water was weakly correlated with total precipitation during the monitoring period, as well as acute exposure in nine foot lysimeters. None of the correlations were statistically significant at $p = 0.05$.

ARP's analysis of the state ground water monitoring program indicated that soil texture was originally hypothesized to be a factor in the geographic distribution of detections. Rather, the detection of acetochlor in shallow ground water was more influenced by site-specific factors related to site topography, irrigation practices, surface water drainages, and the vertical location of the well-screen. Based on the limited availability of data, and given that the scope of the current risk assessment does not attempt to predict concentrations in ground water, no further statistical analysis is warranted at this time.

7. RESIDUES - ACETOCHLOR DEGRADATES

Although the purpose of this assessment is primarily to focus on exposure to the parent acetochlor, some attention was given to the two acetochlor degradates, ethanesulfonic acid (ESA) and oxanilic acid (OXA), monitored in this study. The Health Effects Division of OPP has determined that the toxicological profiles of parent acetochlor, ESA, and OXA

Each of the two degradates were measured in all three monitoring programs. In addition to results for the individual degradates, total combined residues were computed for acetochlor. Each of the degradates were given the same weight as the parent acetochlor using equation three.

Equation 3:

$$C_{\text{Combined Residue}} = C_{\text{parent}} + C_{\text{ESA}} + C_{\text{OXA}}, \text{ where } C \text{ is the concentration in ppb.}$$

Note that if at some point a risk assessment for combined residues would be needed, these calculations would have to be converted to a molar basis before application of any relevant potency factors to such an assessment.

7.1. Surface Water

7.1.1. Acute Exposure Distributions by SDWS Sites

Acute exposure of acetochlor ethanesulfonic acid and oxanilic acid, as well as the combined residues and are presented as a cumulative distribution function in Figure 16. The lines indicate the frequency at

which the degradates or combined residues concentration were detected at or below a given concentration. In addition, as the CDF line shifts to the right it indicates a higher concentration at a given frequency. In general, maximum raw water concentrations were greater than finished water samples for both degradates and combined residues up to approximately 0.5 ppb. However, finished water concentrations exceeded maximum raw water once concentrations exceeded roughly 0.5 ppb. This shift in raw versus finished concentrations can be seen at the point where the dotted line intersects the solid line.

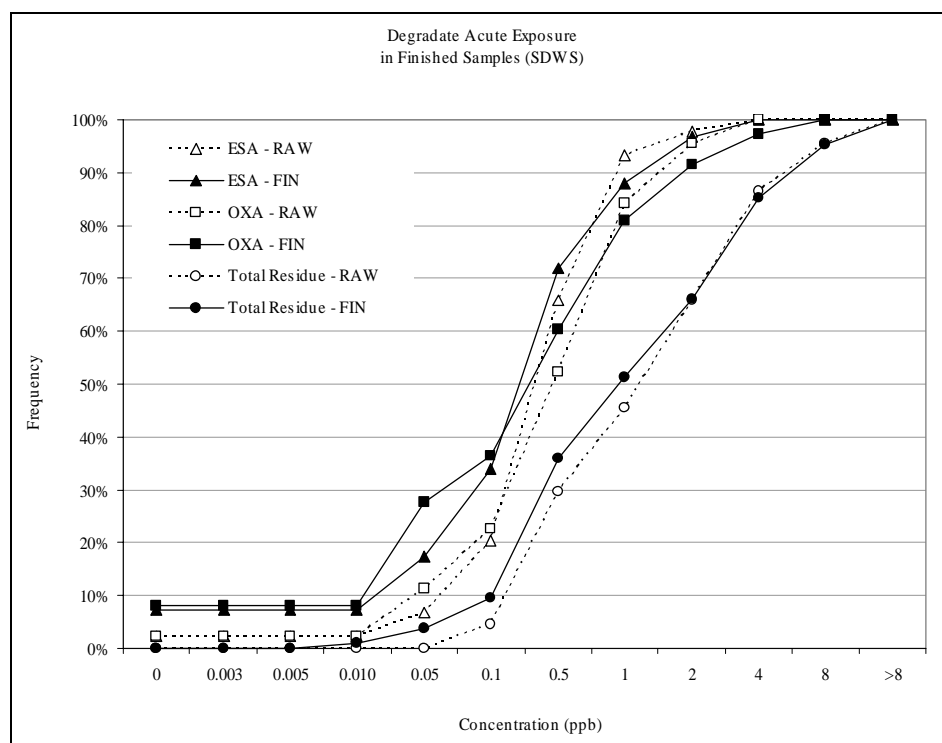


Figure 16. Maximum observed concentrations (acute) of the two acetochlor degradates and Total Combined residues (parent + ESA + OXA) in raw (dashed) and finished (solid) surface drinking water samples.

Percent reduction of ESA and OXA (Figure 17) was also computed for dates where both a raw and finished water sample pair was available. In general OXA had a higher percent reduction than ESA. As with the parent acetochlor, in some cases the finished water sample was higher than the raw water sample as indicated by a negative percent reduction on the chart.

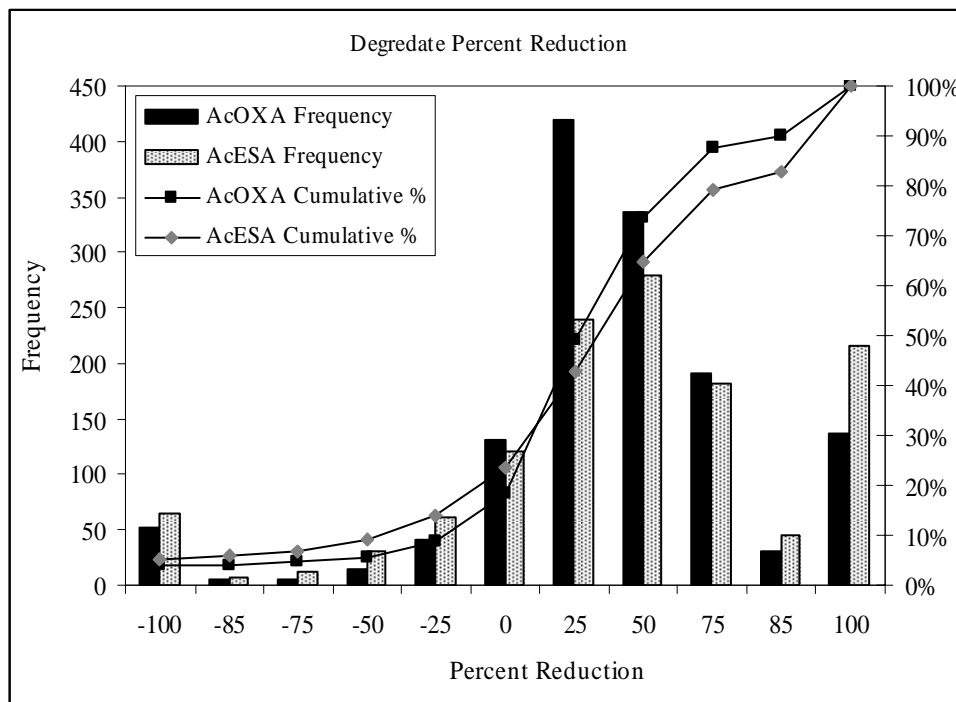


Figure 17. Percent reduction of acetochlor degradates in surface drinking water supplies.

7.1.2. Chronic Exposure Distributions

Chronic exposure for acetochlor degradates and combined residues were also determined for the surface drinking water supplies. Figure 18 presents the cumulative distribution of chronic exposure based on the maximum time-weighted annualized mean for each site. The total residue was computed by summing the concentrations for the parent and degradates. Therefore, the chart only reflects sample observations where a sample was analyzed for both the parent and degradates.

The chart demonstrates that overall, TWAMs for each of the degradates and total combined residues were higher in raw water samples (dotted lines) than in finished water samples (solid lines). This again emphasizes the importance of surface water treatment in reducing exposure to acetochlor degradates.

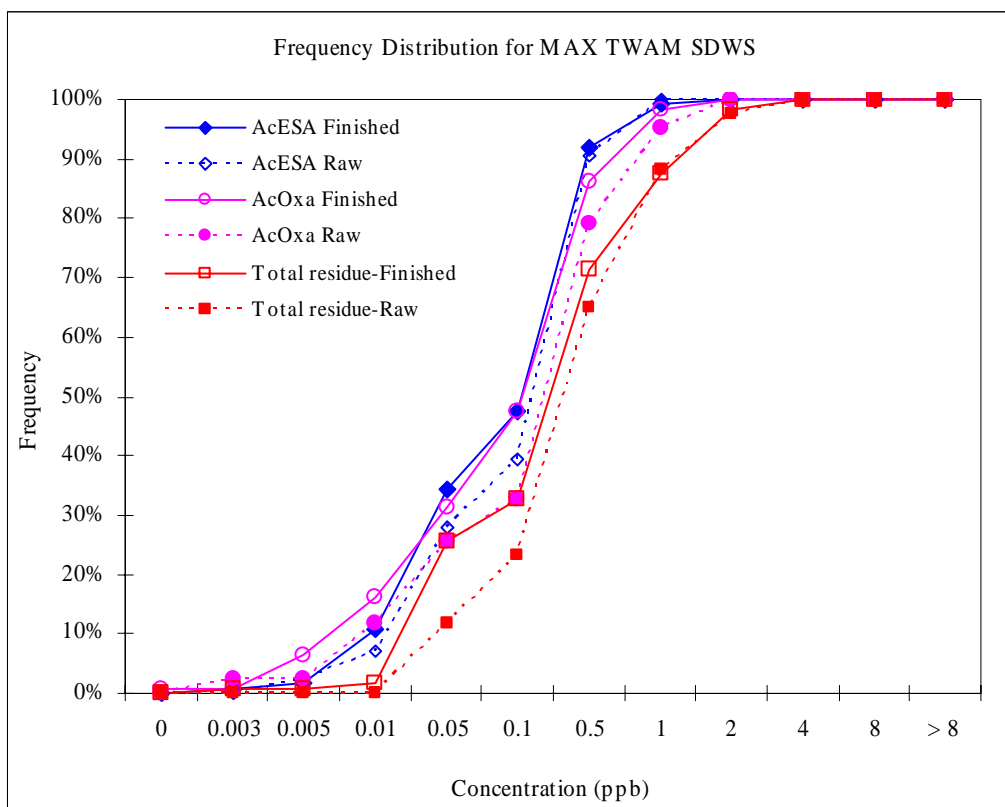


Figure 18. Chronic exposure distribution for acetochlor degradates (ESA and OXA) in surface drinking water supplies using the maximum time-weighted annualized mean for each site. Summary of USGS monitoring results for acetochlor degradates

7.2. Ground Water

Two separate data files were used in this analysis (Table 5). One file contained all the concentration values observed in the PGW studies provided by the ARP, while the second contained raw uncensored concentrations also provided by the ARP. Under the assumption that it represented the best available estimates of unmeasured values (any substitution method for nondetects would be arbitrary), the PGW uncensored file was used to compute time-weighted annualized means and percentiles.

7.2.1. Comparison of Ground Water Degradate Monitoring results to Cancellation / Mitigation Endpoints.

The degradate data are discussed here with regard to the mitigation endpoints included in the acetochlor registration agreement, however, it is not anticipated that the compounds will needed to be included in the residues of concern for the drinking water risk assessment. The conditional registration agreement only requires mitigation or cancellation of acetochlor “residues of concern” once the presence of a “pattern of movement” as specified in the agreement is established. In the PGW studies, one indication of a pattern of movement was defined as the detection of acetochlor or any of its degradates greater than or equal to 1.0 ppb at nine foot lysimeter depth as well as corresponding three and 6 foot depths in that cluster. The Appendix (Section 12.8 of this report) lists all the sites where acetochlor or either of its degradates equaled or exceeded 1.0 ppb at three, six, and nine foot depths. The acetochlor degradate OXA did not exceed 1.0 ppb at three, six, and nine foot depths in any cluster. However in 293 instances, ESA equaled

or exceeded 1.0 ppb at the nine foot lysimeter depth in clusters where ESA also exceeded 1.0 ppb at the three and six foot depths at some time over the course of investigation.

Seven out of the eight states in the PGW studies demonstrated a pattern of movement of ESA as defined by exceedence of 1.0 ppb in at least one cluster of lysimeters at three, six, and nine foot depths (see **“Data Tables for the ARP Monitoring Studies Related to Mitigation Endpoints”** in the Appendix). Although the cancellation triggers apply only to the parent acetochlor, the pattern of movement demonstrated by the acetochlor degradates would be important if one of the degradates becomes a toxicological concern.

A cancellation endpoint for the parent acetochlor was the detection of acetochlor at 0.10 ppb or above in 20 or more wells in the state ground water monitoring program followed by two subsequent detections in monthly follow up samples within six months. Again, this does not presently apply to acetochlor degradates, however degrade data was compared to the endpoint for parent. A number of sites in the state ground water monitoring program had acetochlor degrade detections of at least 0.10 ppb as well as in two monthly follow up samples (see Appendix, section 12.7).

7.2.2. PGW Acute Exposure by Site.

Distributions of peak concentrations by site using the maximum of any individual cluster are provided in Table 25. Data are summarized by the peak value across all clusters, as well as the average of all clusters for each depth. Because of the overwhelming number of censored values, maximum TWAMs as well as maximum 95th percentiles were computed based on the uncensored data file provided by the ARP (**Table 5**). In addition, the maximum three consecutive sample running average for each of the eight PGW sites is included. A three consecutive running average was used to reduce the likelihood that the assessment would be based upon statistical outliers. A three value running average was chosen over a three month running average due to the frequency of sampling. In some cases observations were spaced more than one month apart as a result of sampling limitations, such as inclement weather or inadequate sample volume in the well or lysimeter.

Table 21. Concentrations of ESA observed in 9-foot lysimeters from the eight prospective ground water studies.

STATE	Max TWAM		Max 95 %tile		Max Concentration		
	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	0.77	2.48	1.31	3.90	1.70	4.30	3.73
IA	0.94	3.17	1.58	5.09	1.68	5.40	3.13
IN	5.79	18.29	9.79	23.39	13.00	24.00	22.67
MN	6.58	13.42	8.84	23.39	9.70	24.00	19.33
NE	2.26	9.21	2.32	11.19	2.33	11.40	11.03
OH	0.36	2.11	1.88	5.81	2.96	6.50	5.87
PA	1.13	2.53	1.41	3.50	1.42	3.59	3.39
WI	9.69	14.44	16.71	29.60	17.00	36.00	22.67

All values are as ppb (ug/L). Values below 0.2 ppb are not verifiable because of the detection limit of the analytical method.

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed; Max TWAM = Maximum time-weighted average based on uncensored data file; Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file; NA = Insufficient uncensored data to compute the value

Table 22. Concentrations of ESA observed in shallow ground water from the eight prospective ground water studies.

STATE	Max TWAM		Max 95 %tile		Max Concentration		
	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	1.179	2.519	1.370	3.148	1.443	3.220	3.013
IA	0.123	0.240	0.287	0.728	0.312	0.766	0.644
IN	1.237	9.241	1.684	13.470	1.775	14.200	13.400
MN	1.523	3.015	2.592	6.423	2.698	7.700	6.067
NE	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
OH	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
PA	1.567	6.848	1.924	8.056	1.962	8.300	7.980
WI	3.533	8.054	4.590	10.679	4.736	11.000	8.133

All values are as ppb (ug/L). Values below 0.2 ppb are not verifiable because of the detection limit of the analytical method.

Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed; Max TWAM = Maximum time-weighted average based on uncensored data file; Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file; NA = Insufficient uncensored data to compute the value

Table 23. Comparison of Acetochlor ESA and bromide breakthrough in 9-foot lysimeters at the eight prospective ground-water monitoring sites: Normalized concentrations.¹

STATE	Application rates lb a.i. / acre		Acetochlor ESA Max Concentration		Bromide Max Concentration		Acetochlor ESA	Bromide
	Acetochlor	Bromide	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average	Max Moving Average
DE	2.05	89	0.829	2.098	40	80	1.820	52
IA	3.12	98	0.538	1.731	28	58	1.003	16
IN	2.5	98	5.200	9.600	31	61	9.068	23
MN	2.14	82	4.533	11.215	61	107	9.033	13
NE	3.12	98	0.747	3.654	80	133	3.535	125
OH	2.05	98	1.444	3.171	60	112	2.863	NA
PA	3.12	89	0.455	1.151	18	28	1.087	12
WI	1.78	125	9.551	20.225	95	136	12.736	NA

¹ Calculated concentration in ug/L divided by the application rate as pound active ingredient per acre. This gives a comparable concentration for the tracer and pesticide degradate if the observed concentration is proportional to the application rate; Single Cluster = Statistic applies to all observed values for the given depth; Cluster Average = Statistic applies to concentrations averaged across all cluster for a given date for the depth listed; Max TWAM = Maximum time-weighted average observed; Max 95%tile = Represents the amount of time during the calendar year the concentration was below the listed value; Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = Insufficient uncensored data to compute the value

Table 24. Comparison of Acetochlor ESA and bromide breakthrough (with months after treatment) in shallow ground water at the eight prospective ground-water monitoring sites: Normalized concentrations.¹

STATE	Application rates (as lb ai/A or lb Br/A)		ESA Max Concentration		Bromide Max Concentration		ESA	Bromide
	Acetochlor	Bromide	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average	Max Moving Average
DE	2.05	59.8	0.702 (33)	1.571 (33)	98.0 (39)	120.6 (29)	1.868 (13.5)	114.7 (31)
IA	3.12	65.8	0.112 (24)	0.160 (22)	31.3 (23)	62.6 (23)	1.003 (1.5)	65.5 (28)
IN	2.5	65.8	0.684 (6)	5.200 (6)	29.8 (34)	86.4 (34)	9.068 (15)	81.9 (15)
MN	2.14	55.1	1.280 (27)	3.598 (30)	38.7 (38)	73.0 (27&28)	9.033 (13)	146.0 (23)
NE	3.12	65.8	0.048 (34)	0.160 (34)	13.4 (54)	71.5 (54)	3.535 (83)	186.2 (87)
OH	2.05	65.8	0.049 (7)	0.049 (--)	16.4 (11)	20.9 (11)	2.863 (4)	105.7 (14)
PA	3.12	59.8	0.628 (55)	2.660 (51)	11.9 (41)	26.8 (53)	2.558 (54)	40.2 (28)
WI	1.78	83.9	2.584 (24)	6.180 (24)	70.0 (24)	131.1 (23)	12.736 (14)	186.2 (16)

¹ Calculated concentration in ug/L divided by the application rate as pound active ingredient per acre. This gives a comparable concentration for the tracer and pesticide degradate if the observed concentration is proportional to the application rate; single cluster = statistic applies to all observed values for the given depth; cluster average = statistic applies to concentrations averaged across all cluster for a given date for the depth listed; max TWAM = maximum time-weighted average observed; max 95%tile represents the amount of time during the calendar year the concentration was below the listed value; maximum moving average = the single highest average for 3 consecutive values (separately by cluster and depth) across all clusters; NA = insufficient data in the uncensored file to compute the value. Italicized values in parenthesis for each site are the months after treatment that the ESA or Br concentration was observed.

Table 25. Concentrations of acetochlor OXA observed in 9-foot lysimeters from the eight prospective ground water studies.

STATE	Max TWAM		Max 95 %tile		Max Concentration		
	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
IA	<0.1	0.23	0.12	0.37	0.13	0.40	0.13
IN	0.58	1.16	0.69	1.38	0.75	1.50	0.50
MN	0.16	0.18	0.19	<0.1	0.20	2.70	0.90
NE	<0.1	0.12	<0.1	0.13	<0.1	0.13	0.11
OH	<0.1	0.40	0.14	1.53	0.37	2.20	1.10
PA	<0.1	<0.1	0.10	0.26	0.15	0.30	0.17
WI	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

All values are as ppb (ug/L). Values below 0.1 ppb are not verifiable because of the detection limit of the analytical method.
Single Cluster = Statistic applies to all observed values for the given depth
Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed
Max TWAM = Maximum time-weighted average based on uncensored data file
Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file.
Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file.
NA = Insufficient data in the uncensored file to compute the value

Table 26. . Concentrations of acetochlor OXA observed in shallow ground water from the eight prospective ground water studies.

STATE	Max TWAM		Max 95 %tile		Max Concentration		
	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Cluster Average	Single Cluster	Max Moving Average
DE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
IA	<0.1	<0.1	<0.1	0.176	<0.1	0.200	<0.1
IN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MN	0.207	0.296	0.874	1.339	1.300	1.400	1.100
NE	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
OH	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
WI	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

All values are as ppb (ug/L). Values below 0.1 ppb are not verifiable because of the detection limit of the analytical method.
Single Cluster = Statistic applies to all observed values for the given depth
Cluster Average = Statistic applies to concentrations averaged across all clusters for a given date for the depth listed
Max TWAM = Maximum time-weighted average based on uncensored data file
Max 95%tile = The amount of time during the calendar year the concentration was below the listed value based on uncensored data file.
Maximum Moving Average = The single highest average for 3 consecutive values (separately by cluster and depth) across all clusters based on uncensored data file.
NA = Insufficient data in the uncensored file to compute the value

7.2.3. Chronic Exposure

Chronic exposure for acetochlor degradates and combined residues were also determined for the state ground water monitoring program. Figure 19 presents the cumulative distribution of chronic exposure based on the maximum time-weighted annualized mean for each site. The total residue was computed by summing the concentrations for the parent and degradates. As such, chart only reflects sample observations where a sample was analyzed for both the parent and degradates. Peak time-weighted annualized means concentrations for acetochlor ESA in ground water were higher than those for acetochlor OXA in the state monitoring program (Figure 19).

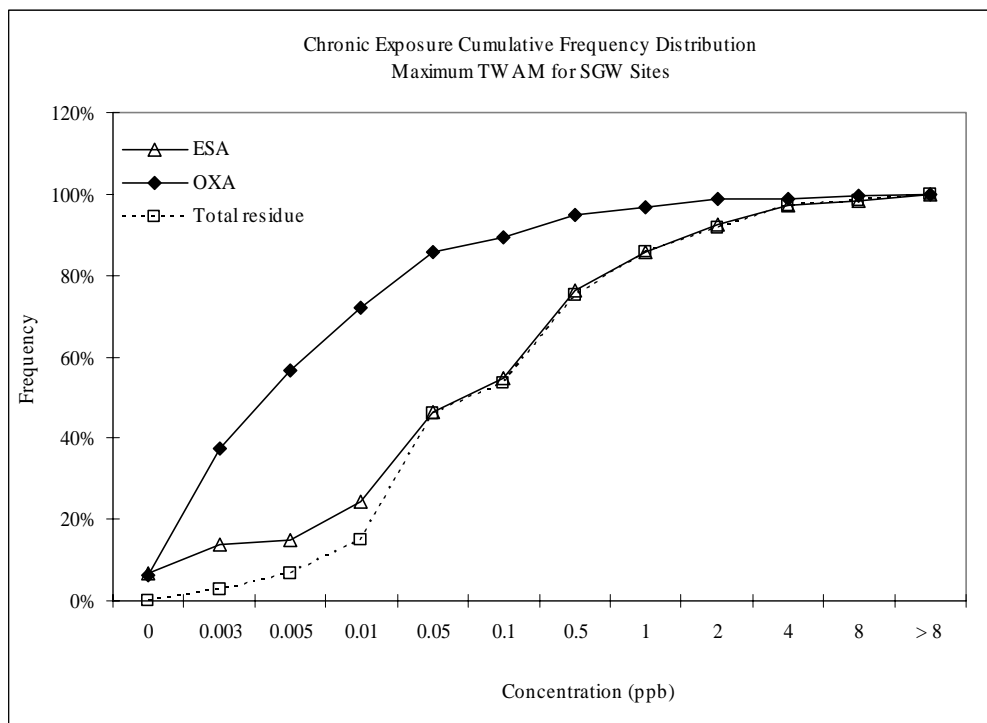


Figure 19. Chronic exposure distribution for acetochlor degradates (ESA and OXA) in the state ground water monitoring program using the maximum time-weighted annualized mean for each site.

7.3. Summary Assessment of Exposure to Acetochlor Degradates

Unlike exposure to acetochlor parent alone, the concentration profiles for the ARP studies show that exposure to combined residues can be higher in ground water than surface water (Table 27). The maximum annual mean concentrations in ground water were up to 8x greater than in surface water and the 95th percentile annual mean concentrations were up to about 5x greater than in surface water. The combined exposure levels however have not been used for the OPP human health risk assessment (ACETOCHLOR. Revised HED Chapter of the Tolerance Reassessment Eligibility Decision (TRED) Document. PC Code:121601, DP Barcode: D306535, D292338; dated 11/8/2005). In the HED chapter the following is stated:

“based on comparison of the available toxicity data for acetochlor and the ESA and OXA degradates. (summarized in Tables 3.2-3.4 of the ACETOCHLOR HED Chapter of the TRED) and structure-activity relationships, the MARC concluded that: the ESA and OXA degradates of acetochlor should not be included in the water risk assessment with the parent.”

HED has, however calculated the risk contribution from drinking water separately each for ESA and OXA for their respective, distinctively different acute and chronic toxicological endpoints. Again quoting from the HED Chapter of the TRED for acetochlor:

“Comparison of the toxicities of the ESA and OXA degradates with the toxicity of the parent acetochlor [See Tables 3.2 and 3.3 of the ACETOCHLOR HED Chapter of the TRED] indicated that the degradates had distinct, different, toxicological profiles from the parent. Thus, endpoints for the risk assessment of the ESA and OXA degradates were searched within their respective databases.”

EFED has therefore separately evaluated exposure to acetochlor ESA and acetochlor OXA by analysis of all of the ARP surface water and ground water monitoring studies (unlike with parent acetochlor, ground water and surface water exposure are both frequently at relatively significant levels (in terms of exposure frequency and amount, not in terms of risk level).

Key points to consider in the interpretation of these results are:

1. The surface water data, unlike the ground water data, represent actual drinking water intakes or finished water; however, many of the highest acetochlor use watersheds were not included in the monitoring program.
2. Since this monitoring program started immediately after the registration of acetochlor, the full extent of contamination of ground water possible from the use of acetochlor could not be assessed with confidence in the SGW program since it may take many years to observe the maximum extent of ground water contamination from the use of a pesticide. Even in the PGW program, there was one site (Nebraska) where the leaching of an acetochlor degradate (ESA) was still moving downward through the vadose zone when sampling was terminated seven years after the original (and only) acetochlor application.
3. In both the SGW and PGW ground water monitoring programs, the water sampled was more vulnerable than most (but not all) water used for drinking water.
4. The results of this monitoring analysis only apply to acetochlor use on field corn (significant new field uses are currently under review by EPA).

The highest monitored values for acetochlor ESA were:

Acute exposure (**Table 28**):

20.0 ppb ESA in a sample from one of the approximately 175 SGW study sites.

14.2 ppb ESA in a sample from one of the shallow wells from one of the eight PGW study sites.

4.8 ppb ESA in a sample from one of the approximately 175 SDWS study sites.

Chronic exposure (**Table 30**):

12.7 ppb ESA TWAM from one of the SGW study sites.

9.2 ppb ESA TWAM from one of the shallow wells from one of the PGW study sites.

1.0 ppb ESA TWAM from one of the SDWS study sites.

The highest monitored values for acetochlor OXA were:

Acute exposure (**Table 29**):

19.1 ppb OXA in a sample from a shallow well from one of the SGW study sites.

1.4 ppb OXA in a sample from one of the shallow wells from one of the PGW study sites.

6.3 ppb OXA in a sample from one of the SDWS study sites.

Chronic exposure (**Table 31**):

5.9 ppb OXA TWAM from a shallow well from one of the SGW study sites.

Not calculated (TWAM <1 ppb for all wells) OXA for the eight PGW study sites.

1.7 ppb TWAM OXA from one of the approximately 175 SDWS study sites.

In general acetochlor ESA was detected more frequently at higher concentrations in both of the ground water studies than in the SDWS. The highest acetochlor OXA acute and chronic exposure levels occurred in ground water, but there was less overall difference in the residue levels between ground and surface than there was for ESA and the median acute and chronic values were actually higher in the SDWS than in the PGW or SGW studies.

Table 27. Summary presentation of time-weighted annualized mean concentrations (ppb) for the combined residues of acetochlor (parent + ESA and OXA degradates) in surface and ground water (based on maximum TWAM values observed at each site by calendar year).

Study	N	Maximum	95th Percentile	Median
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Table 27. Summary presentation of time-weighted annualized mean concentrations (ppb) for the combined residues of acetochlor (parent + ESA and OXA degradates) in surface and ground water (based on maximum TWAM values observed at each site by calendar year).

Study	N	Maximum	95th Percentile	Median
Surface Water - SDWS raw	43	2.04	1.67	0.31
Surface Water - SDWS finished	175	2.91	1.39	0.25
Ground Water (shallow) – PGW site averages	8	3.51	2.83	1.12
Ground Water (shallow) – PGW cluster maximums	8	8.11	7.57	2.85
Ground Water – SGW	176	24.11	3.24	0.08

Table 28. Acute Exposure to ESA. Summary presentation of acute concentrations (ppb) for the residues of acetochlor ethanesulfonic acid in surface and ground water.

Sample / Study Type (# of sites)	N¹	Maximum	99th Percentile	95th Percentile	Median
Surface Water – SDWS raw ²	1496	2.310	1.000	0.633	<0.200
(ca. 43 sites)					
Surface Water – SDWS finished ²	6774	3.320	1.133	0.571	<0.200
(ca. 175 sites)					
Ground Water (shallow) – PGW site averages by date	670	4.736	2.471 ³	1.488 ³	<0.200 ³
(8 sites)					
Ground Water (shallow) – PGW single cluster basis	NC	14.200	6.100 ³	2.640 ³	<0.200 ³
(8 sites)					
Ground Water – SGW	1983	20.000	6.418	1.790	<0.200

(ca. 175 sites)

¹ Number of samples represented. NC = Not calculated.

² Comparisons between raw and finished water concentration distributions should be made with caution since most SDWS sites never had raw water sampled. Statistics based on monitoring for only the last three years of the study (1999 to 2001); this is also true for the SGW study.

³ Statistics here are less meaningful for the PGW studies because of the small number of study sites (8), the lag time between the start of sampling of ground water after application and breakthrough of any residues into ground water, and the lack of reproduction of long-term use patterns in PGW studies (i.e., generally only a one-time application of acetochlor was made during the first growing season of

Table 28. Acute Exposure to ESA. Summary presentation of acute concentrations (ppb) for the residues of acetochlor ethanesulfonic acid in surface and ground water.

Sample / Study Type (# of sites)	N ¹	Maximum	99 th Percentile	95 th Percentile	Median
the study).					

Table 29. Acute Exposure to OXA. Summary presentation of acute concentrations (ppb) for the residues of acetochlor oxanilic acid in surface and ground water.

Sample / Study Type (# of sites)	N ¹	Maximum	99 th Percentile	95 th Percentile	Median
Surface Water – SDWS raw ² (ca. 43 sites)	1496	3.320	1.634	0.898	0.118
Surface Water – SDWS finished ² (ca. 175 sites)	6774	6.340	1.593	0.761	<0.1
Ground Water (shallow) – PGW site averages by date (8 sites)	670	Low ⁴	Low	Low	Low
Ground Water (shallow) – PGW single cluster basis (8 sites)	NC	1.400	Low	Low	Low
Ground Water – SGW (ca. 175 sites)	1983	19.100	1.98	0.177	<0.1

¹ Number of samples represented. NC = Not calculated.

² Comparisons between raw and finished water concentration distributions should be made with caution since most SDWS sites never had raw water sampled. Statistics based on monitoring for only the last three years of the study (1999 to 2001); this is also true for the SGW study.

³ Statistics here are less meaningful for the PGW studies because of the small number of study sites (8), the lag time between the start of sampling of ground water after application and breakthrough of any residues into ground water, and the lack of reproduction of long-term use patterns in PGW studies (i.e., generally only a one-time application of acetochlor was made during the first growing season of the study).

⁴ Low = Two few detections to calculate accurately.

Table 30. Chronic Exposure to ESA. Summary presentation of time-weighted annualized mean concentrations (ppb) for the residues of acetochlor ethanesulfonic acid in surface and ground water (based on maximum TWAM values observed at each site by calendar year).

Sample / Study Type	N ¹ (# of sites)	Maximum	99th Percentile	95th Percentile	Median
Surface Water - SDWS raw ²	111 (43)	0.752	0.726	0.525	<0.200
Surface Water - SDWS finished ²	486 (175)	1.008	0.701	0.477	<0.200
Ground Water (shallow) - PGW site averages by date	8 (8)	3.53	NA ³	NA	1.21
Ground Water (shallow) – PGW single cluster maximums	58 (8)	9.24	NA	NA	NA
Ground Water – SGW	495 (176)	12.658	6.713	1.819	<0.200

¹ Number of TWAMs included in statistics; followed by number of study sites represented in parenthesis. Number of sites for SDWS and SGW does not include direct replacement sites.

² Comparisons between raw and finished water concentration distributions should be made with caution since most SDWS sites never had raw water sampled. Statistics based on monitoring for only the last three years of the study (1999 to 2001); this is also true for the SGW study.

³ NA = calculation not appropriate because of the small number of PGW study sites (8) and the lack of reproduction of long-term use patterns at the study sites. This is also why only the PGW maximum single TWAM at each site was calculated and is a more appropriate endpoint for chronic exposure than multi-year means.

Table 31. Chronic Exposure to OXA. Summary presentation of time-weighted annualized mean concentrations (ppb) for the residues of acetochlor oxanilic acid in surface and ground water (based on maximum TWAM values observed at each site by calendar year).

Sample / Study Type	N ¹ (# of sites)	Maximum	99 th Percentile	95th Percentile	Median
Surface Water - SDWS raw ²	111 (43)	1.289	1.220	0.766	0.140
Surface Water - SDWS finished ²	486 (175)	1.697	0.935	0.628	<0.100
Ground Water (shallow) - PGW site averages by date	8 (8)	Lower ³	NA ⁴	NA	NA
Ground Water (shallow) – PGW single cluster maximums	58 (8)	Lower	NA	NA	NA
Ground Water – SGW	495 (176)	5.860	1.852	0.224	<0.100

¹ Number of TWAMs included in statistics; followed by number of study sites represented in parenthesis. Number of sites for SDWS and SGW does not include direct replacement sites.

² Comparisons between raw and finished water concentration distributions should be made with caution since most SDWS sites never had raw water sampled. Statistics based on monitoring for only the last three years of the study (1999 to 2001); this is also true for the SGW study.

³ Lower = Chronic exposure was not calculated for the PGW because the exposure level was clearly lower than for the SDWS or SGW studies and the quantification detection frequency was too low for accurate calculation.

⁴ NA = calculation not appropriate because of the small number of PGW study sites (8) and the lack of reproduction of long-term use patterns at the study sites. This is also why only the PGW maximum single TWAM at each site was calculated and is a more appropriate endpoint for chronic exposure than

Table 31. Chronic Exposure to OXA. Summary presentation of time-weighted annualized mean concentrations (ppb) for the residues of acetochlor oxanilic acid in surface and ground water (based on maximum TWAM values observed at each site by calendar year).

Sample / Study Type	N ¹ (# of sites)	Maximum	99 th Percentile	95 th Percentile	Median
multi-year means.					

The ARP studies demonstrate that the degradates of acetochlor (and two other acetanilide herbicides, see the following section) can significantly impact ground and surface waters and that exposure to some mobile and persistent degradates can be significantly higher and more widespread in ground water than the respective parent compounds or than in surface waters. Similar results have been obtained by Kalkhoff et al. (1998), Kolpin et al. (1996, 1997, and 1998), and Rheineck and Postle (2000).

8. OTHER CHEMICALS

The ARP collected a wealth of monitoring data for three other pesticides in both the SDWS and SGW studies. Virtually every sample collected in these studies for acetochlor analysis was also analyzed for atrazine, alachlor, and metolachlor. The ethanesulfonic acid and oxanilic acid degradates of both alachlor and metolachlor were also included in the analytical plan.

Sample results for these other analytes are given in Tables 28 to 30 Figures 20 to 22 taken from de Guzman et al. (2005), MRID 45722701, and Hackett et al. (2005). In general, the detection frequency was atrazine > metolachlor > alachlor or acetochlor in both studies; changes in usage pattern over the course of the studies had a marked impact on the detection frequency of alachlor (declining use over the 7 years of monitoring in the SDWS) and acetochlor (increasing use over the 7-year monitoring period in the SDWS). Metolachlor degradates were generally detected with greater frequency than alachlor or acetochlor degradates. The sulfonic acid degradates were detected more frequently than the oxanilic acid degradates of the same parent herbicide in ground water; the detection frequency was generally similar for the two degradates in surface waters.

Table 32. Occurrence (%) of TWAMs in Finished Drinking Water at Various Concentrations by Sampling Stratum

AMC ($\mu\text{g L}^{-1}$) and Analyte	Percent Occurrence					
	Great Lakes	Continental Rivers	Smaller Watersheds			Overall
			5-10% CI ¹	11-20% CI	>20% CI	

>0.1 Acetochlor	0.0	5.0	2.4	8.5	12.8	8.1
>1.0 Acetochlor	0.0	0.0	0.0	0.0	0.2	0.1
>0.5 Ac_ESA	0.0	0.0	0.9	1.0	10.6	4.9
>0.5 Ac_OXA	0.0	0.0	5.2	5.2	15.0	8.5
>0.1 Alachlor	0.0	0.0	3.1	5.8	2.6	2.9
>1.0 Alachlor	0.0	0.0	0.0	0.0	0.0	0.0
>0.5 AIESA	0.0	0.0	0.9	3.1	1.5	1.4
>0.5 AIOXA	0.0	0.0	2.6	0.0	0.5	0.8
>0.1 Atrazine	7.6	70.3	58.7	85.7	86.2	74.4
>1.0 Atrazine	0.0	0.8	12.5	30.5	25.8	19.8
>0.1 Metolachlor	0.0	36.4	25.4	44.0	44.7	37.1
>1.0 Metolachlor	0.0	0.0	1.7	2.7	3.0	2.2
>0.5 MeESA	0.0	5.8	15.5	29.9	45.9	29.4
>0.5 MeOXA	0.0	0.0	6.0	20.6	16.4	12.4

¹ CI = Corn production intensity in the watershed.

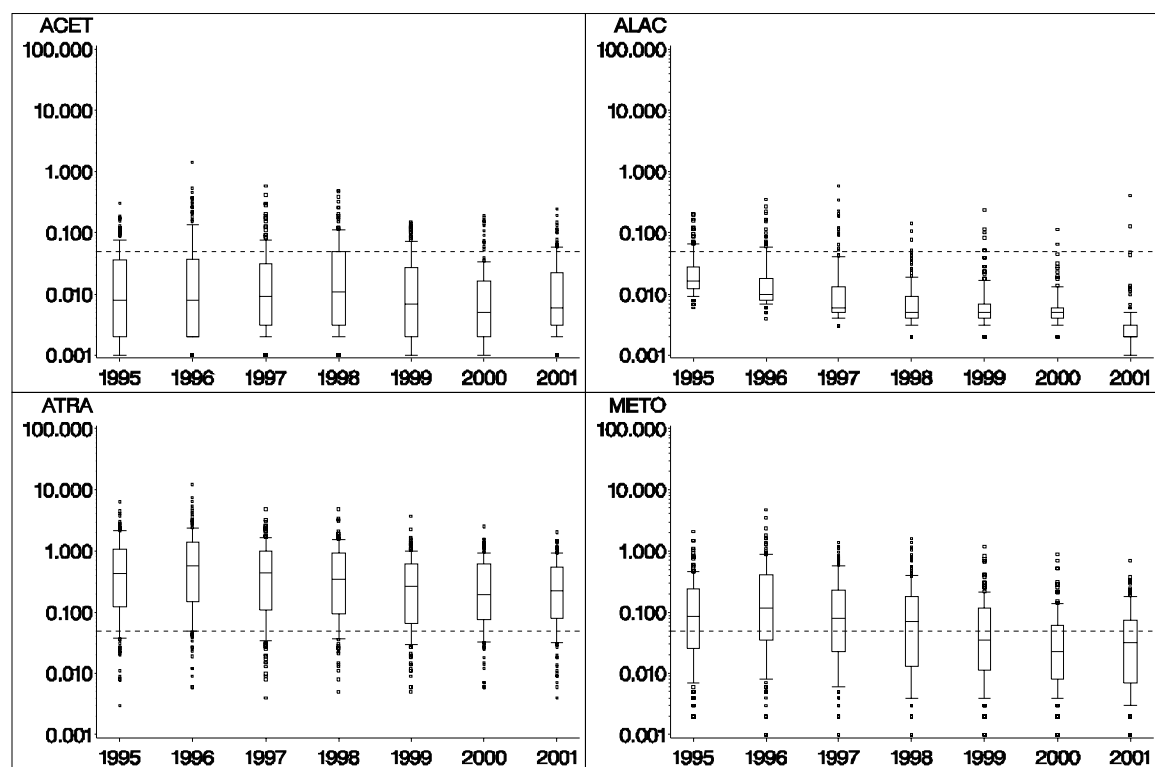


Figure 20. Box plot of annualized mean concentrations (AMCs) of parent herbicides in finished drinking water from the SDWS study (Hackett et al., 2005).

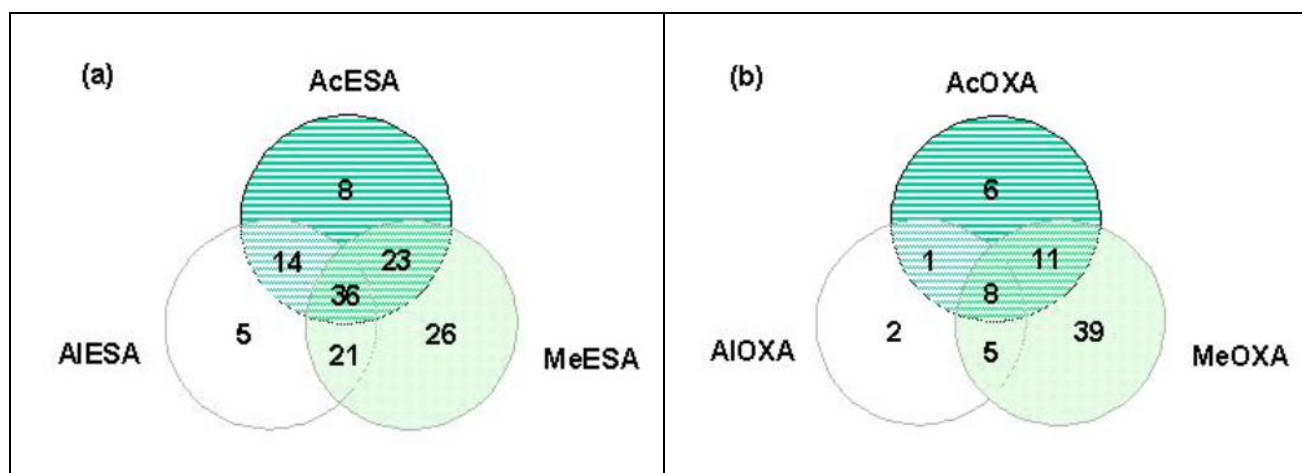


Figure 21. Co-occurrence of (a) sulfonic acid (ESA) degradate residues and (b) oxanilic acid (OXA) degradate residues for acetochlor, alachlor, and metolachlor in the SGW study. Values reflect the number of SGW wells with observed residues (Minimum detection limit was 0.2 ppb for the sulfonic acid degradates and 0.1 ppb for the oxanilic acid degradates). No ESA soil degradate residues were observed in 49 of the 182 wells and no OXA soil degradate residues were observed in 110 of the 182 wells. Source: de Guzman et al. (2005).

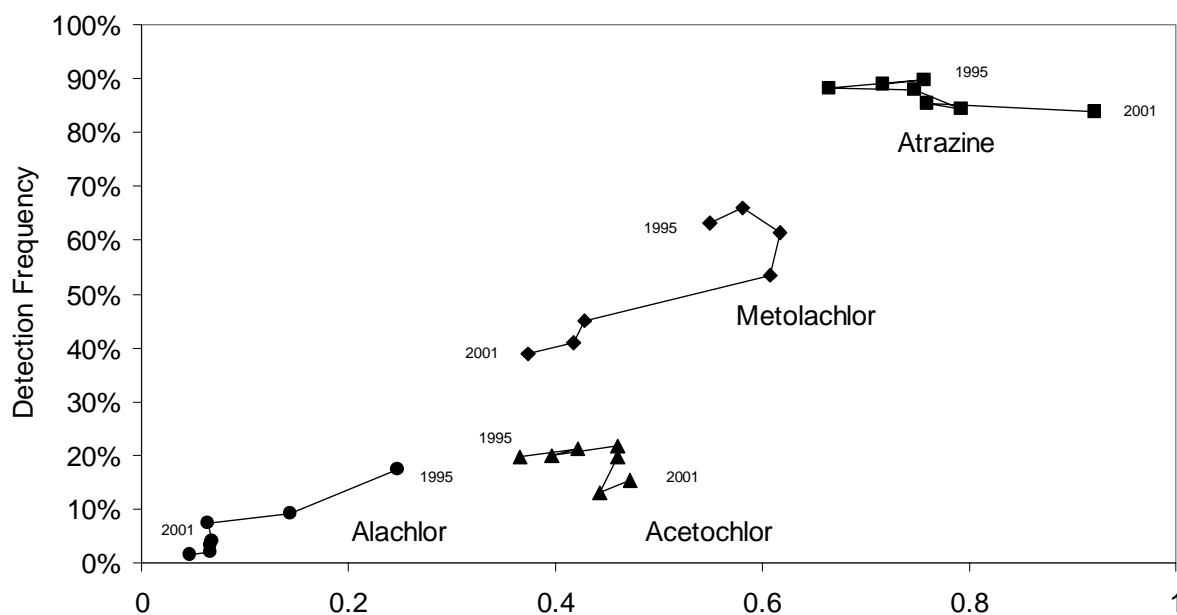


Figure 22. Frequency of drinking water detections by year for parent herbicides as a function of use (relative use on the x axis) – SDWS study.

Table 33. Summary of the Distribution of Degradate Residues for ARP SGW Analytes – 2001 Data only.

The values represent the numbers of samples with residues fitting the specified criteria.

Compound	Not Detected OR "NR"	LOD to 0.499	0.50 to 0.999 ppb	1.0 to 1.999 ppb	2.0 to 9.999 ppb	>=10.0 ppb	Total
Ac_ESA	475	56	31	32	28	2	624
AlESA	435	48	45	40	51	5	624
MeESA	311	74	59	55	114	11	624
Ac_OXA	578	27	6	7	5	1	624
AlOXA	599	18	0	3	4	0	624
MeOXA	506	80	16	10	12	0	624

Ac_ESA = Acetochlor sulfonic acid

Ac_OXA = Acetochlor oxanilic acid

AlESA = Alachlor sulfonic acid

AlOXA = Alachlor oxanilic acid

MeESA = Metolachlor sulfonic acid

MeOXA = Metolachlor oxanilic acid

OXA Limit of Detection (LOD) = 0.10 ppb

ESA Limit of Detection (LOD) = 0.20 ppb

Limit of Quantitation (LOQ) = 0.50 ppb.

Source: MRID 45722701.

Table 34. Summary of the Distribution of Parent Residues for ARP SGW Analytes – 2001 data only.

Compound	Not Detected (ND) OR "NR"	0.03 to 0.049 ppb	0.05 to 0.099 ppb	0.10 to 0.249 ppb	0.25 to 0.499 ppb	0.50 to 4.999 ppb	>= 5.0 ppb	Total
Acetochlor	611	3	2	2	3	3	0	624
Alachlor	623	ND	1	0	0	0	0	624
Atrazine	400	38	58	87	28	13	0	624
Metolachlor	611	1	9	3	0	0	0	624

The values represent the numbers of samples with residues fitting the specified criteria.

Limit of Detection (LOD) = 0.03 ppb for acetochlor, atrazine, and metolachlor.

Alachlor LOD = 0.05 ppb

Limit of Quantitation (LOQ) = 0.05 ppb.

Source: MRID 45722701.

9. **CONCLUSIONS**

This analysis characterized the overall detection of acetochlor and its degradates (ethanesulfonic acid, and oxanilic acid) with an emphasis on parent acetochlor, given its inclusion by the Office of Pesticide Programs in the residues of concern for human exposure.

9.1. Parent Acetochlor

Surface water sources are the driver for exposure to parent acetochlor (Table 1). There is a potential for underestimation of chronic exposure to acetochlor parent from the ARP study because of:

- The lack of raw water analyses at most of the sites makes it difficult to extrapolate the results to estimate exposure in additional (or new) use areas or to predict the impact of changes in the type of water treatment used on exposure levels.
- Some areas with fewer CWS that utilize surface waters present (or use a mixture of sources) were largely unrepresented in the SDWS

Available data indicate that water treatment involving the use of activated carbon may reduce exposure by close to 50% on average; limitations on the SDWS data preclude generalizing this as a predictable effect of water treatment. Others have found that GAC treatment may remove 60 to 90% of the acetochlor parent residues originally present in the raw water (Bloomquist et al., 2001; Coupe et al., 2004).

The ARP data that are available match raw and finished water samples at selected sites only in the sense that they were taken on the same day. Matching of the same volume of water is difficult, but the publications by Blomquist et al. and Coupe et al. provide a description of an attempt to match such samples as closely as possible. the ARP SDWS dataset did not measure samples in intake water from those systems using other types of water treatment, and most of the highest concentrations observed in the SDWS study occurred in finished (not raw) samples.

Maximum acetochlor instantaneous concentrations, 95th percentiles, and time-weighted annualized means in the SDWS were all observed from the Gillespie, Illinois reservoir (Table 9). The highest acetochlor parent concentrations observed in the ARP monitoring program were 1.428 for chronic exposure (Table 1) and the highest finished water acute exposure was 18.21 (Table 9); all these values were from the surface water monitoring program (SDWS study). Significantly higher concentrations were observed in the NAWQA monitoring program (Table 14), although these sites did not necessarily represent source water for drinking.

Geographic analysis of the SDWS monitoring locations, CWS intake locations, and acetochlor usage intensity indicates that the SDWS monitoring program may have missed some of the watersheds in the Midwestern US with the highest acetochlor usage intensities over the monitoring program. A lower rate of utilization and lower overall numbers of surface water

sources by drinking water facilities in these high acetochlor use regions appears to be a factor in the paucity of sites in these regions that were eventually selected for monitoring in the SDWS (probably a sample selection algorithm that placed greater emphasis on a preference for geographic diversity in the higher corn density strata could have prevented this). The lack of monitoring in some of the high acetochlor use areas is especially problematic for the SDWS where the lack of sampling of raw (pre-facility treatment) water at most locations makes it difficult to isolate the effects of site-specific usage and vulnerability factors and water treatment processes on the observed residue levels.

We conclude therefore, there is a potential that exposure could be somewhat higher in areas other than those monitored if treatment systems at the locality do not remove a significant portion of the acetochlor residues, utilization of surface water sources for drinking water increases in some high use areas, and/or the usage of acetochlor expands in some areas through changing patterns of corn production or registration and use of acetochlor on additional crop sites. Further analysis may be needed if the reported acetochlor concentrations are within a factor of 3 of levels of concern for drinking water.

Besides the above described difficulties in isolating the effects of water treatment on observed residues from the ARP SDWS study, a number of uncertainties must be recognized when interpreting this exposure assessment. These include the following:

- The surface drinking water supply (SDWS) and state ground water (SGW) monitoring programs were designed to focus on areas of high acetochlor use. The monitoring does not cover the entire geographic distribution of acetochlor use. Conclusions drawn in this report apply only to those areas monitored by the ARP and it may not be possible to generalize to all acetochlor usage areas. Additional data analysis and modeling would be needed to expand this exposure assessment to cover the unmonitored areas.
- County level sales data submitted separately by members of the ARP from 1994 -2003 is arguably some of the most extensive data available as a close approximation of acetochlor usage across the US. As such, it has been incorporated in this exposure assessment as a surrogate for acetochlor use in the mapping and statistical analyses. It is assumed that acetochlor sold in an individual county is, in general, also applied in the same county and in the same watershed. However, the exposure characterization recognizes that inter-county as well as inter-watershed transfer of acetochlor does occur in some cases.
- Acute exposure in this risk assessment is defined as the overall maximum observed concentration at a site. The actual peak concentration, however, may have occurred between sampling times. Thus, the maximum observed concentrations reported in this study may underestimate the true maximum acute exposure.

9.2. Acetochlor Degradates

The Health Effects Division of OPP has determined that the available toxicological data indicates that degradates do not have similar toxicological endpoints to parent acetochlor nor to

each other. Consequently, the emphasis on our analysis has been on separate examination of exposure levels for each of these compounds.

The highest monitored values for acetochlor ESA were:

Acute exposure: 20.0 ppb ESA in a sample from one of the approximately 175 SGW study sites.

Chronic exposure: 12.7 ppb ESA TWAM from one of the SGW study sites.

The highest monitored values for acetochlor OXA were:

Acute exposure: 19.1 ppb OXA in a sample from a shallow well from one of the SGW study sites.

Chronic exposure: 5.9 ppb OXA TWAM from a shallow well from one of the SGW study sites.

Acetochlor degradates ethanesulfonic acid (ESA) and oxanilic acid (OXA) were detected more frequently and at higher concentrations than the parent acetochlor in ground water; chronic levels of the degradates in surface water tended to be similar to that of parent (Compare **Table 1** with **Table 27**, **Table 30**, and **Table 31**). Peak levels of degradates in surface waters were generally lower or similar to peak levels of parent acetochlor (Compare **Table 11** and **Table 12** with **Table 28** and **Table 29**).

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(Grouped by study type.)

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MRID: 00064805

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MRID: 00131388

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MRID: 44402801

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Barcodes of actions completed with this review:

D245339	D260167	D266400	D272343	D280479
D249062	D260372	D268225	D272347	D284563
D257732	D260831	D269431	D275586	D284868
D257889	D260917	D269432	D275593	D284868
D257961	D262987	D269661	D275890	D284868
D257976:	D263614	D269664	D278534	D288177
D257982	D265250	D269888	D278837	D301788
D258421	D265265	D271012	D279225	D301823
D258783	D265617	D271883	D279306	D305544
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12. APPENDICES

APPENDIX

12.1. Chemical Names and Structures

Table A-1. Chemical names and structures of acetochlor and its degradates discussed in this exposure assessment.

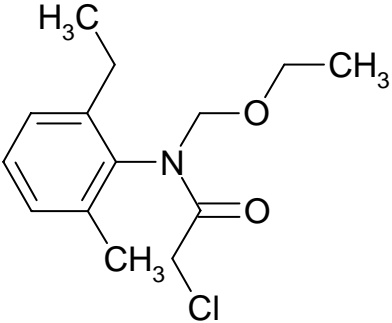
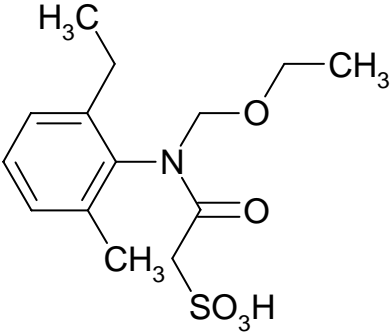
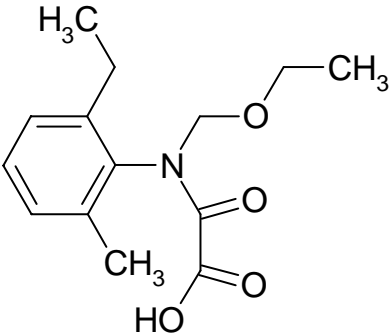
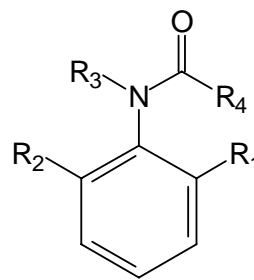
	<p>Acetochlor</p> <p>2'-Ethyl-6'-methyl-N-(ethoxymethyl)-2-chloroacetanilide</p>
	<p>Acetochlor ethanesulfonic acid</p> <p>2-[(2-ethyl-6-methylphenyl)(ethoxymethyl)amino]-2-oxoethanesulfonic acid</p>
	<p>Acetochlor oxanilic acid</p> <p>2-[(2-ethyl-6-methylphenyl)(ethoxymethyl)amino]-2-oxoacetic acid]</p>

Table A-2. Structures of the chloroacetanilide herbicides and their major degradates (Source: ARP pre-publication journal article). Both the SDWS and the SGW studies conducted by the ARP simultaneously monitored for each of these three parent compounds (plus the corn herbicide atrazine) during the full 7 years of monitoring and for each of the degradation products listed during the last 3 years of monitoring.



R ₁	R ₂	R ₃	R ₄	Common Name	Abbr.	Chemical Name (CAS)	LOD/LOQ (µg L ⁻¹)	CAS Number
CH ₃	CH ₃ CH ₂	CH ₂ OCH ₂ CH ₃	CH ₂ Cl	acetochlor	Acet	2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)-acetamide	0.03/0.05	34256-82-1
CH ₃ CH ₂	CH ₃ CH ₂	CH ₂ OCH ₃	CH ₂ Cl	alachlor	Alac	2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)acetamide	0.05/0.05	15972-60-8
CH ₃	CH ₃ CH ₂	CH(CH ₃)CH ₂ OCH ₃	CH ₂ Cl	metolachlor	Meto	2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)-acetamide	0.03/0.05	51218-45-2
CH ₃	CH ₃ CH ₂	CH ₂ OCH ₂ CH ₃	CH ₂ SO ₃ H	acetochlor sulfonic acid	Ac_ESA	2-[(ethoxymethyl)(2-ethyl-6-methylphenyl)amino]-2-oxoethanesulfonic acid	0.20/0.50	187022-11-3
CH ₃	CH ₃ CH ₂	CH ₂ OCH ₂ CH ₃	CO ₂ H	acetochlor oxanilic acid	Ac_OXA	2-[(ethoxymethyl)(2-ethyl-6-methylphenyl)amino]oxoacetic acid	0.10/0.50	194992-44-4
CH ₃ CH ₂	CH ₃ CH ₂	CH ₂ OCH ₃	CH ₂ SO ₃ H	alachlor sulfonic acid	AlESA	[2-(2,6-diethylphenyl)(methoxymethyl) amino]-2-oxoethanesulfonic acid	0.20/0.50	142363-53-9
CH ₃ CH ₂	CH ₃ CH ₂	CH ₂ OCH ₃	CO ₂ H	alachlor oxanilic acid	AlOXA	[2-(2,6-diethylphenyl)(methoxymethyl) amino]-2-oxoacetic acid	0.10/0.50	171262-17-2
CH ₃	CH ₃ CH ₂	CH(CH ₃)CH ₂ OCH ₃	CH ₂ SO ₃ H	metolachlor sulfonic acid	MeESA	2-[(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl)amino]-2-oxoethane sulfonic acid	0.20/0.50	171118-09-5
CH ₃	CH ₃ CH ₂	CH(CH ₃)CH ₂ OCH ₃	CO ₂ H	metolachlor oxanilic acid	MeOXA	[(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl)amino]oxoacetic acid	0.10/0.50	152019-73-3

Atrazine, which is not a chloroacetanilide herbicide, was also monitored in this study, and is denoted by the abbreviation: Atraz. Its chemical name is 6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine, and its CAS number is 1912-24-9. Its LOD and LOQ were 0.03 and 0.05 µg L⁻¹, respectively.

APPENDIX

12.2. Acetochlor Registration Agreement – Cancellation / Mitigation Endpoints

The following text is excerpted from the registration agreement (section numbering retained from the agreement):

Excerpt 1, Regarding Ground Water Detections:

5.1.3. Response to Ground Water Detections

5.1.3.1 Investigation of Cause of Detections

Any information pertaining to detection of acetochlor and any degradates of toxicological concern which become known to the ARP, Monsanto, Zeneca or their agents will be reported to EPA within 15 days of the date such information becomes known to the ARP, Monsanto, Zeneca, or their agents. The ARP may respond to any detections of acetochlor or its degradates of toxicological concern reported by investigators, using confirmed analytical methods, by sending a qualified third party representative to investigate the incident. The investigation shall be completed within 60 days of receipt of the report and the results reported to EPA within 30 days of completion of the investigation, unless the ARP and EPA agree to extend those deadlines. The investigation may include any additional sampling useful in determining if the detection is due to a point source or intentional contamination. The EPA shall consider the results of any such investigation in determining whether a reported and investigated detection will be considered a "detection" for the purpose of establishing a pattern of movement, or the need for additional mitigation, or for triggering suspension or cancellation under this Section 5.1.3.

5.1.3.2 Exposure Reduction

For detections verified by the ARP's GC/MS method (at ARP's expense), occurring at a level at or above 1.0 ppb in rural drinking water wells, the ARP will offer without conditions a Well Assistance Program to compensate rural well owners by paying for the cost of drilling the new well, or installing and maintaining filters, or connecting to public water supplies, and other appropriate measures. The ARP will unconditionally pay for all costs associated with this remediation up to \$5,000 per well (in 1994 dollars). All private rural drinking water wells and community drinking water supply wells in rural areas are eligible for the ARP well assistance program.

Public wells in rural areas which have verified detections (using the ARP's GC-MS method) at ARP's expense of acetochlor at a level at or above 1.0 ppb, that are not associated with product mishandling will be, at ARP's expense, remediated to provide drinking water below a detection limit of 0.10 ppb.

5.1.3.3. Detection Criteria

The data from either the PGW or other sampling/monitoring programs may indicate a pattern of movement of acetochlor or degradates of toxicological concern toward ground water, as a result of use according to label directions or in accordance with widespread and commonly recognized practice. At present, the ARP is not aware of any degradates of toxicological concern. If, in the future, EPA determines there are degradates of toxicological concern, the detection concentrations noted below will be reviewed and will be revised, if appropriate, based upon the toxicologic effect of the degradate. A pattern of movement is defined as being:

- detections of acetochlor or degradates of toxicological concern confirmed by the approved and validated GC-MS method, and
- IN THE PGW STUDIES. Detections of acetochlor or degradates of toxicological concern that are greater than or equal to 0.10 ppb in ground water which are consistent with recharge as measured with tracers and/or suction lysimeters; OR

Detections of acetochlor or degradates of toxicologic concern at a concentration greater than or equal to 1.0 ppb in soil water collected by suction lysimeters at a depth of 9 feet below the land surface. Such soil water detections must be consistent with the movement of soil water as determined by conservative tracers, and consistent with detections in the three and six foot lysimeters in that cluster. Lysimeter samples from the same depth will be composited to ensure adequate sample size (for the purpose of analysis) when necessary; or

- IN THE STATE MONITORING PROGRAMS. For reports of detections of acetochlor or degradates of toxicological concern in the state monitoring programs described in section 5.1.2, a detection greater than or equal to a concentration of 0.10 ppb in ground water subsequently detected at greater than or equal to 0.10 ppb in two follow-up samples collected monthly over a period of six months; or
- OTHER MONITORING STUDIES (outside of the PGW study or State Monitoring Programs (defined in section 5.1.2)). For reports of any other detections of acetochlor, a detection greater than or equal to a concentration of 0.20 ppb in ground water, subsequently detected at greater than or equal to 0.20 ppb in two or more follow-up samples collected monthly over a period of six months.

If the ARP does not take appropriate steps to secure follow-up sampling, the initial report of the detection shall be treated as sufficient to define a pattern of movement. The determination of what constitutes appropriate steps to be taken is a "reserved issue" subject to the provisions of Section 7A.

5.1.3.4. Additional Mitigation Measures

If EPA determines that a pattern of movement, as defined in 5.1.3.3. has occurred from use in accordance with label directions or in accordance with widespread and commonly recognized practice, then the ARP, in conjunction with EPA, will determine whether the movement is limited to a geographical area or soil type. In that case, the ARP will revise the acetochlor label to include geographic or additional soil type label restrictions.

5.1.3.5. Automatic Suspension

If EPA determines that a pattern of movement toward ground water as defined in 5.1.3.3., above has occurred arising from use in accordance with label directions or in accordance with widespread and commonly recognized practice, and if within 30 days EPA and the ARP cannot agree on an immediate mitigation option, the registration shall be automatically suspended on a geographic basis. This suspension will terminate if EPA determines that the ARP has taken adequate steps to implement appropriate mitigation measures. The determination of appropriate mitigation options shall be governed by the provisions of Section 7.

5.1.3.6. Cancellation

- **GW Scenario 1**

For the PGW studies, if EPA determines that out of the 8 sites, 4 sites in a variety of geographic, and climatic conditions under both vulnerable and general use conditions, (as determined by EPA) in corn growing areas indicate a pattern of movement of acetochlor toward ground water, as defined in 5.1.3.3. from use in accordance with label directions or in accordance with widespread and commonly recognized practice, registration shall be automatically canceled. The sites at which a pattern of movement occurs shall represent a range of vulnerable and general use soil textures consistent with labeled use.

- **GW Scenario 2**

For monitoring programs outside the PGW studies, the registration of acetochlor will be automatically canceled if EPA determines that either of the criteria specified below have been met. All detections shall be verified by the ARP's GC-MS method at the ARP's expense.

- Criterion 1:

- Detections occur in 20 or more wells included in the State Monitoring Program at or above 0.10 ppb followed by two subsequent detections of at least 0.10 ppb in monthly sampling of each of those wells, conducted over a period of six months.

- Criterion 2:

- Detections occur in 150 or more individual wells at or above 0.20 ppb, followed by two subsequent detections of at least 0.20 ppb in monthly sampling of each of those wells, conducted over a period of six months across a wide variety of geographic, soil, and climatic conditions in corn growing area.

- **GW Scenario 3**

For monitoring programs outside the PGW studies, the registration of acetochlor will be automatically canceled if EPA determines that detections occur in twenty (20) or more wells across a wide variety of geographic, soil, and climatic conditions in corn growing areas at a concentration of at least 1.0 ppb, followed by two subsequent detections of at least 1.0 ppb in monthly sampling of each of those wells, conducted over a period of six months. All detections shall be verified by the ARP's GC-MS method at the ARP's expense.

An initial detection shall be treated as sufficient to meet these cancellation criteria if the ARP has failed to take timely and appropriate steps to secure follow-up samples.

If EPA determines at any time that mitigation measures have been or will be undertaken which are likely to be effective, the Agency may treat, for a period of up to 18 months, some or all detections within the area subject to such mitigation measures (mitigation area) as insufficient to meet the cancellation criteria in section 5.1.3.6. No later than 18 months after such mitigation measures have been initiated, EPA shall make a final determination whether the mitigation measures have been or are likely to be effective. During this time, the ARP may investigate whether such mitigation measures have been, or are likely to be, effective. The EPA shall notify the ARP 60 days prior to making its determination, and shall consider the results of any such investigation, if timely received, in making that determination. If EPA's final determination is that the mitigation measures have not been or are not likely to be successful, all detections within the mitigation area shall be subject to the provisions of sections 5.1.3.3., 5.1.3.5., and 5.1.3.6. If EPA's final determination is that the mitigation measures have been or are likely to be successful,

some or all detections within the mitigation area may be designated by EPA as insufficient to meet the cancellation provisions of Section 5.1.3.6. Such final determination will be consistent, to the extent feasible, with relevant existing policies and procedures.

Point source contamination detections shall be treated as sufficient to meet these cancellation criteria unless EPA determines that such contamination: (i) does not result from use in accordance with label directions or widespread and commonly recognized practice, or (ii) results from use in accordance with label directions or in accordance with widespread and commonly recognized practice, but that the general cause of the contamination can be mitigated with product stewardship, label language or repair/replacement of damaged or inadequately installed wells.

5.2. State Management Plans

If at any time after the registration EPA decides to nominate acetochlor for inclusion in State Management Plans, the ARP will not file any objection to such inclusion, nor will it challenge such action in any court or administrative forum.

5.3. Continued Stewardship

Regardless of whether the data indicate any pattern of movement toward groundwater, the ARP will continue its product stewardship commitment and cooperate with the Agency to develop and implement additional product stewardship measures considered appropriate.

Excerpt 2, Regarding Surface Water Detections:

6.2 Response to Surface Water Detections

The ARP agrees in principle to provisions relating to surface water, which include a sampling program, investigation of the source of surface water detections, and mitigation measures. The elements of the response to surface water detections will parallel those described in Section 5 for ground water protection.

6.2.1 Investigation of Cause of Detections

The ARP may respond to any detections of acetochlor or degradates of toxicological concern, using confirmed analytical methods, by sending a qualified third party representative to investigate the incident. The investigation shall be completed within 60 days of the incident becoming known to the ARP and the results reported to EPA within 30 days of completion of the investigation, unless the ARP and EPA agree to extend those deadlines. The investigation may include any additional sampling useful in determining if the detection is due to a point source or intentional contamination. The EPA shall consider the results of any such investigation in determining whether a reported and investigated detection will be considered a "detection" for the purpose of establishing the need for mitigation or for triggering cancellation under Section 6.2.2.

6.2.2 Mitigation and Cancellation

At present, the ARP is not aware of any degradates of toxicological concern. If, in the future, EPA determines there are degradates of toxicological concern, the detection concentrations noted below will be reviewed and will be revised, if appropriate, based upon the toxicologic effect of the degradate.

- SW Scenario I:

If one (1) community water supply system, that derives its water primarily from surface water, detects an annual time-weighted mean concentration of 2.0 ppb, acetochlor, then either;

- The use of acetochlor in the related watershed will be prohibited. Such prohibition will be implemented by means of amendment of the acetochlor registration to prohibit sale, distribution, and use in the specified watershed. The timing, content, and implementation of such restriction shall be governed by the provisions of Section 7; or
 - The ARP will absorb 100% of costs required to restore the community water supply system to compliance. If EPA determines that the ARP has failed to meet this obligation, it may cancel the registration without opportunity for hearing.
- SW Scenario II:

If EPA determines that two (2) large (serving 100,000 people) community water supply systems, or ten (10) community water supply systems of any size across a wide variety of corn growing, soil, and climatic have an annual time-weighted mean concentration of 2.0 ppb or are otherwise determined to be out of compliance based on Office of Water criteria, the registration will be automatically canceled.

If any community water supply system that derives its water primarily from surface water detects a single peak concentration of 8.0 ppb of acetochlor, the ARP will make biweekly sampling of that water system throughout the following 12 months to determine whether the 2.0 ppb annual time-weighted mean concentration has been exceeded.

APPENDIX

12.3. Acetochlor Usage – Detailed Summary

CONFIDENTIAL BUSINESS INFORMATION, NOT INCLUDED HERE

APPENDIX

12.4. Locations of Monitoring Sites for the ARP SDWS Study

(Acetochlor Surface Drinking Water Supply Study)

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
Corning	IA	Lake Binder	Lake	2126	15.3	23.0	>20% CI	YES
Des Moines	IA	Raccoon River and Infiltration Galleries	River	2304810	31.1	39.4	>20% CI	YES
Iowa City	IA	Iowa River	River	2099081	30.6	40.3	>20% CI	YES
Milford	IA	West Lake Okoboji	Lake	14866	22.9	32.6	>20% CI	YES
Montezuma	IA	Diamond Lake	Reservoir	2724	31.8	33.3	>20% CI	YES
Mount Pleasant	IA	Skunk River	River	2599367	15.6	34.2	>20% CI	YES
Okoboji	IA	West Okoboji Lake	Lake	14866	22.9	32.6	>20% CI	NO
Ottumwa	IA	Des Moines River	River	8569564	31.7	35.5	>20% CI	YES
Panora	IA	Middle Raccoon River	River	265272	32.5	41.1	>20% CI	NO
Spirit Lake	IA	Spirit Lake	Lake	43135	25.0	36.2	>20% CI	NO
Winterset	IA	Cedar Lake	Reservoir	10443	35.5	21.7	>20% CI	YES
Altamont	IL	Altamont New Reservoir	Reservoir	521	26.7	28.5	>20% CI	YES
Blandinsville	IL	LaHarpe Creek	River	8779	33.7	35.5	>20% CI	NO
Breese	IL	Shoal Creek	River	480358	35.7	25.2	>20% CI	YES
Carlinville	IL	Carlinville Lake I	Reservoir	15706	28.8	25.0	>20% CI	YES
Carthage	IL	Carthage Lake	Reservoir	1756	33.6	28.4	>20% CI	YES
Charleston	IL	Lake Charleston	Reservoir	1198	28.7	34.4	>20% CI	YES
Clay City	IL	Little Wabash River	River	518175	36.3	26.9	>20% CI	YES
Decatur	IL	Lake Decatur	Reservoir	602057	30.1	41.5	>20% CI	YES
Elgin	IL	Fox River	River	953176	23.4	20.3	>20% CI	YES
Fairfield	IL	Little Wabash River	River	1169567	35.4	25.0	>20% CI	YES
Flora	IL	Little Wabash River	River	491311	36.5	27.3	>20% CI	YES
Georgetown	IL	Little Vermillion River	River	106395	35.7	39.5	>20% CI	YES

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATERSHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
Gillespie	IL	Old Gillespie Lake	Reservoir	2966	30.3	25.0	>20% CI	YES
Greenfield	IL	Greenfield Lake	Reservoir	724	28.1	29.1	>20% CI	YES
Hudson	IL	Lake Bloomington	Reservoir	41942	28.7	44.4	>20% CI	YES
Kankakee	IL	Kankakee River	River	2952111	27.1	37.4	>20% CI	YES
Litchfield	IL	Lake Lou Yeager	Reservoir	69219	23.3	30.1	>20% CI	YES
Mascoutah	IL	Kaskaskia River	River	2844480	29.7	26.3	>20% CI	YES
Mattoon	IL	Lake Paradise	Reservoir	11916	29.3	34.5	>20% CI	YES
Nashville	IL	City of Nashville Reservoir	Reservoir	1013	21.1	23.1	>20% CI	YES
Neoga	IL	Lake Mattoon	Reservoir	34849	32.7	33.5	>20% CI	YES
New Athens	IL	Kaskaskia River	River	3274132	30.6	25.4	>20% CI	YES
New Berlin	IL	Spring Creek	River	16852	34.1	35.2	>20% CI	YES
Oakland	IL	Lake Oakland	Reservoir	6909	26.5	39.7	>20% CI	YES
Olney	IL	East Fork Lake	Reservoir	6644	28.1	28.8	>20% CI	YES
Palmyra	IL	Palmyra-Modesto Lake	Reservoir	826	40.0	25.0	>20% CI	YES
Pana	IL	Lake Pana	Reservoir	4545	33.8	32.3	>20% CI	YES
Paris	IL	Twin Lakes	Reservoir	11733	30.3	38.7	>20% CI	YES
Pittsfield	IL	Lake Pittsfield	Reservoir	6971	40.6	22.6	>20% CI	NO
Shipman	IL	Shipman Reservoir	Reservoir	427	28.6	25.0	>20% CI	NO
Sparta	IL	South City Lake	Reservoir	480	32.0	15.2	>20% CI	YES
Springfield	IL	Lake Springfield	Lake	162178	29.7	34.9	>20% CI	YES
West Salem	IL	West Salem Reservoir & shale pit	Reservoir	614	27.2	26.1	>20% CI	NO
White Hall	IL	White Hall Reservoir	Reservoir	613	29.8	29.1	>20% CI	YES
Ferdinand	IN	Old Lake (No. 1)	Reservoir	105	29.7	26.2	>20% CI	NO
Holland	IN	New Holland Lake	Reservoir	348	27.4	26.2	>20% CI	YES
Kokomo	IN	Wildcat Creek	River	121637	37.4	38.0	>20% CI	YES
Logansport	IN	Eel River	River	524144	24.9	28.3	>20% CI	NO
Mitchell	IN	East Fork of the White River	River	2470938	39.5	26.9	>20% CI	YES
North Vernon	IN	Vernon Fork of Muscatatuck River	River	68241	26.3	21.0	>20% CI	YES

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
Oakland City	IN	Old Lake	Lake	83	31.9	33.8	>20% CI	YES
Richmond	IN	Middle Fork Reservoir	Lake	30825	25.3	27.2	>20% CI	YES
Santa Claus	IN	Christmas Lake	Reservoir	1583	37.4	21.8	>20% CI	NO
Seymour	IN	East Fork of the White River	River	1516709	33.2	33.8	>20% CI	YES
Speedway	IN	Big Eagle Creek	River	119080	29.2	26.8	>20% CI	YES
Warsaw	IN	Center Lake	Reservoir	444	20.3	30.3	>20% CI	NO
Westport	IN	Sand Creek	River	60170	30.2	43.1	>20% CI	YES
Concordia	MO	Edwin A. Pape Lake	Reservoir	5507	23.8	20.6	>20% CI	YES
Higginsville	MO	Higginsville City Lake	Reservoir	3547	23.5	20.6	>20% CI	YES
Plattsmouth	NE	Beaver Lake	Reservoir	7397	33.5	26.1	>20% CI	YES
Archbold	OH	Tiffin River	River	208202	29.8	23.9	>20% CI	YES
Attica	OH	Honey Creek	River	46710	28.9	24.2	>20% CI	YES
Bowling Green	OH	Maumee River	River	3977343	26.0	23.1	>20% CI	YES
Cedarville	OH	Massies Creek	River	31764	30.4	27.2	>20% CI	NO
Celina	OH	Grand Lake St Marys	Reservoir	72549	32.8	30.9	>20% CI	NO
Columbus	OH	Scioto River	River	665366	27.4	21.4	>20% CI	YES
Defiance	OH	Maumee River	River	1395515	26.8	21.5	>20% CI	YES
Delta	OH	Bad Creek	River	22000	22.0	33.6	>20% CI	YES
Lima	OH	Auglaize River	River	131174	25.2	24.3	>20% CI	NO
McClure	OH	Maumee River	River	3777748	26.0	23.0	>20% CI	YES
McComb	OH	Rader Creek	River	668	30.3	23.4	>20% CI	YES
Metamora	OH	Ten Mile Creek	River	3174	31.5	32.4	>20% CI	YES
Ottawa	OH	Blanchard River	River	394516	27.2	23.5	>20% CI	YES
Upper Sandusky	OH	Upper Sandusky Reservoir	Reservoir	894	29.7	23.8	>20% CI	YES
Van Wert	OH	Town Creek	River	16385	33.3	29.2	>20% CI	NO
West Milton	OH	Stillwater River	River	427302	28.9	28.3	>20% CI	NO
Wilmington	OH	Caesar's Creek Lake	Reservoir	147651	36.9	27.1	>20% CI	YES
Denver	PA	Cocalico Creek	River	12201	30.6	26.4	>20% CI	NO

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATERSHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
New Holland	PA	New Holland Reservoir	Reservoir	704	8.0	27.4	>20% CI	NO
Appleton	WI	Lake Winnebago	Lake	3776966	14.6	12.9	>20% CI	YES
Menasha	WI	Lake Winnebago	Lake	3776966	14.6	12.9	>20% CI	YES
Oshkosh	WI	Lake Winnebago	Lake	3776966	14.6	12.9	>20% CI	YES
Bloomfield	IA	Lake Fisher	Reservoir	1458	40.3	13.9	11-20% CI	NO
Centerville	IA	Lake Rathbun	Reservoir	353792	37.4	13.2	11-20% CI	YES
Chariton	IA	Lake Ellis and Lake Morris	Reservoir	6453	38.0	10.6	11-20% CI	YES
Lenox	IA	Lenox West Lake	Reservoir	100	28.4	19.8	11-20% CI	NO
Mount Ayr	IA	Loch Ayr Reservoir	Reservoir	2563	11.3	13.5	11-20% CI	YES
Osceola	IA	West Lake	Reservoir	6241	24.2	13.5	11-20% CI	YES
Centralia	IL	Raccoon Lake	Reservoir	30293	32.0	12.2	11-20% CI	YES
Coulterville	IL	Coulterville Lake	Reservoir	449	45.3	15.2	11-20% CI	YES
Farina	IL	East Fork of Kaskaskia River	River	2959	30.6	17.1	11-20% CI	YES
Highland	IL	Silver Lake	Reservoir	30593	31.0	17.5	11-20% CI	YES
Salem	IL	Salem Reservoir	Reservoir	2452	29.6	12.2	11-20% CI	YES
Sorento	IL	Sorento Lake	Reservoir	376	40.2	15.8	11-20% CI	NO
Austin	IN	Muscatatuck River	River	223967	28.1	11.8	11-20% CI	NO
Batesville	IN	Biscoff Reservoir	Reservoir	2916	23.1	19.5	11-20% CI	NO
Fort Wayne	IN	St. Joseph River	River	657980	27.0	18.6	11-20% CI	YES
Salem	IN	Lake John Hay	Reservoir	5797	27.6	11.9	11-20% CI	YES
Scottsburg	IN	Scottsburg Reservoir	Reservoir	1977	26.9	11.3	11-20% CI	NO
Horton	KS	Delaware River	River	91634	33.7	11.5	11-20% CI	NO
Ewing	MO	Lewis County Water District Lake	Reservoir	684	30.8	14.0	11-20% CI	YES
Trenton	MO	Thompson River	River	963925	26.8	10.8	11-20% CI	YES
Wyaconda	MO	Wyaconda City Lake	Reservoir	208	13.0	15.3	11-20% CI	YES
Galena	OH	Alum Creek Reservoir	Reservoir	82605	23.4	16.5	11-20% CI	NO
Monroeville	OH	West Branch Huron River	River	138245	29.9	18.7	11-20% CI	YES
New London	OH	Buck Creek	River	40614	29.1	17.3	11-20% CI	NO

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
Paulding	OH	Flatrock Creek	River	109270	36.5	21.4	11-20% CI	YES
Sunbury	OH	Big Walnut Creek	River	50886	27.8	16.5	11-20% CI	YES
Westerville	OH	Alum Creek	River	95314	32.1	16.4	11-20% CI	YES
Willard	OH	Huron River	River	46081	28.2	18.2	11-20% CI	NO
Williamsburg	OH	East Fork of the Little Miami River	River	149474	35.3	18.1	11-20% CI	NO
Carlisle	PA	Conodoguinet Creek	River	242629	24.8	12.6	11-20% CI	YES
Hummelston	PA	Swatara River	River	284337	31.0	12.1	11-20% CI	YES
Mechanicsburg	PA	Conodoguinet Creek	River	293855	25.4	12.5	11-20% CI	YES
Norristown	PA	Schuylkill River	River	1133118	28.7	9.2	11-20% CI	YES
Reading	PA	Lake Ontelaunee	Reservoir	120883	34.1	13.1	11-20% CI	YES
Newark	DE	White Clay Creek	River	43629	26.8	10.4	5-10% CI	YES
Wilmington	DE	Red & White Clay Creek	River	100409	27.9	10.6	5-10% CI	YES
Lamoni	IA	Home Lake (Pond)	Reservoir	321	31.8	8.7	5-10% CI	YES
Alto Pass	IL	Little Cedar Lake	Reservoir	19625	17.8	7.3	5-10% CI	YES
Borden	IN	Packwood Branch Reservoir	Reservoir	1275	28.9	10.8	5-10% CI	YES
Dubois	IN	Patoka Lake	Reservoir	108655	31.7	8.4	5-10% CI	YES
Paoli	IN	Lick Creek	River	13424	28.1	8.8	5-10% CI	YES
St. Meinrad	IN	Lake Benet	Reservoir	135	23.7	4.5	5-10% CI	NO
Garnett	KS	Crystal Lake	Reservoir	386	35.8	6.1	5-10% CI	YES
Milford	KS	Milford Lake	Reservoir	15963347	35.3	9.6	5-10% CI	YES
Richmond	KS	Richmond City Lake	Reservoir	557	29.1	5.1	5-10% CI	YES
Topeka	KS	Kansas River	River	36446269	28.2	8.8	5-10% CI	NO
Valley Falls	KS	Delaware River	River	570021	26.1	7.5	5-10% CI	NO
Westphalia	KS	Lake (No Name)	Reservoir	1652	42.9	4.8	5-10% CI	NO
Bel Air	MD	Winter's Run	River	23264	38.5	8.2	5-10% CI	YES
Elkton	MD	Big Elk Creek	River	39985	30.2	9.7	5-10% CI	YES
Frederick	MD	Monocacy River	River	456687	30.0	12.0	5-10% CI	YES
Frederick	MD	Monocacy River	River	456040	27.2	8.9	5-10% CI	YES

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATERSHED RUNOFF RATING	WATERSHED % CORN INTENSITY	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
Havre de Grace	MD	Susquehanna River	River	17629428	15.0	5.5	5-10% CI	YES
Silver Spring	MD	Howard Duckett Reservoir (Rocky Gorge Re	Reservoir	85109	31.9	5.6	5-10% CI	YES
Moorhead	MN	Red River	River	4309787	20.0	10.8	5-10% CI	YES
Armstrong	MO	Armstrong City Lake	Reservoir	342	28.6	10.4	5-10% CI	YES
Bethany	MO	Old City Lake	Reservoir	191	39.7	10.2	5-10% CI	NO
Butler	MO	Butler City Lake	Reservoir	1965	31.5	6.6	5-10% CI	YES
Cameron	MO	Reservoirs #1 #2 and #3	Reservoir	3274	26.7	8.2	5-10% CI	YES
Edina	MO	New Lake	Reservoir	781	38.5	8.6	5-10% CI	YES
Freeman	MO	South Grand River	River	63850	36.2	5.6	5-10% CI	NO
Gallatin	MO	Lake Viking	Reservoir	9049	32.3	7.1	5-10% CI	YES
Garden City	MO	Lake 1	Reservoir	455	35.2	5.8	5-10% CI	YES
Gentry	MO	Middle Fork Water Co. Lake	Reservoir	4233	29.7	9.5	5-10% CI	NO
Labelle	MO	LaBelle City Lake #1	Reservoir	140	34.2	14.0	5-10% CI	YES
Lancaster	MO	North Lake	Reservoir	728	29.5	6.1	5-10% CI	NO
Marceline	MO	New Marceline Reservoir	Reservoir	2455	24.3	12.6	5-10% CI	YES
Monroe City	MO	South Lake	Reservoir	668	25.5	6.2	5-10% CI	YES
Perryville	MO	Saline Creek	River	36335	26.3	8.6	5-10% CI	NO
Shelbina	MO	Shelbina Lake	Reservoir	1521	43.0	8.8	5-10% CI	YES
Smithville	MO	Smithville Lake	Reservoir	133182	23.5	8.8	5-10% CI	YES
Vandalia	MO	Vandalia Reservoir	Reservoir	3654	28.1	11.8	5-10% CI	YES
Alliance	OH	Deer Creek Lake	Reservoir	162028	21.9	8.5	5-10% CI	YES
Glouster	OH	Burr Oak Lake	Reservoir	20596	27.0	3.7	5-10% CI	YES
Somerset	OH	Somerset Reservoir	Reservoir	572	31.9	8.3	5-10% CI	YES
Wellsville	OH	Little Yellow Creek	River	10832	29.5	9.2	5-10% CI	YES
Beavertown	PA	PL 638	Reservoir	3339	8.4	10.4	5-10% CI	NO
Phoenixville	PA	Schuylkill River	River	771279	28.7	10.4	5-10% CI	NO
West Chester	PA	East Branch of Brandywine River	River	72185	28.3	10.3	5-10% CI	YES
Davenport	IA	Mississippi River	River	56626192	11.1	15.9	Cntl. River	YES

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHE D AREA (acres)	WATER- SHED RUNOFF RATING	WATERS HED % CORN INTENSIT Y	STATISTICA L STRATUM	ACTIVATE CARBON Treatment ?
Moline	IL	Mississippi River	River	56626192	11.1	15.9	Cntl. River	YES
Rock Island	IL	Mississippi River	River	56626192	11.1	15.9	Cntl. River	YES
Shipman	IL	Mississippi River	River	115258084	23.1	24.2	Cntl. River	YES
Evansville	IN	Ohio River	River	68358056	21.8	5.6	Cntl. River	YES
Mount Vernon	IN	Ohio River	River	68778138	21.8	5.7	Cntl. River	YES
Atchison	KS	Missouri River	River	266847707	10.1	5.1	Cntl. River	NO
Kansas City	KS	Missouri River	River	268749082	10.2	5.1	Cntl. River	YES
Leavenworth	KS	Missouri River	River	267061176	10.1	5.1	Cntl. River	YES
Minneapolis	MN	Mississippi River	River	12527540	14.6	7.5	Cntl. River	YES
St. Cloud	MN	Mississippi River	River	8774874	12.6	4.0	Cntl. River	YES
Jefferson City	MO	Missouri River	River	319081997	13.1	5.7	Cntl. River	YES
Louisiana	MO	Mississippi River	River	90230044	17.9	22.1	Cntl. River	YES
St. Louis	MO	Mississippi River	River	443533492	15.3	10.1	Cntl. River	YES
St. Louis	MO	Missouri River	River	332845687	29.2	5.6	Cntl. River	YES
Blair	NE	Missouri River	River	203739516	9.3	3.3	Cntl. River	YES
Hartington	NE	Lewis & Clark Lake (Missouri River)	Reservoir	177705449	7.4	0.8	Cntl. River	NO
Omaha	NE	Missouri River	River	204687766	9.4	3.5	Cntl. River	YES
East Liverpool	OH	Ohio River	River	14999469	17.7	2.5	Cntl. River	YES
Chicago	IL	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES
Michigan City	IN	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES
Beaver Bay	MN	Lake Superior	Lake	10719768	7.2	0.0	Great Lakes	NO
Cleveland	OH	Lake Erie	Lake	63168475	14.2	8.2	Great Lakes	YES
Willoughby	OH	Lake Erie	Lake	63168475	14.2	8.2	Great Lakes	YES
Cudahy	WI	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES

P1 (primary) Community Water Systems only								
CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSIT Y	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
Oak Creek	WI	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES
Port Washington	WI	Lake Michigan	Lake	28845270	14.4	8.9	Great Lakes	YES

P1 (primary) Community Water Systems only

Site ID (ARP)	CITY	STATE	SUPPLY SYSTEM NAME	TYPE	WATERSHED AREA (acres)	WATER-SHED RUNOFF RATING	WATERSHED % CORN INTENSIT Y	STATISTICAL STRATUM	ACTIVATE CARBON Treatment ?
651-NE-DE	Newark	DE	White Clay Creek	River	43629	NA	10.4	5-10% CI	
652-WI-DE	Wilmington	DE	Red & White Clay Creek	River	100409	NA	10.6	5-10% CI	
544-BL-IA	Bloomfield	IA	Lake Fisher	Reservoir	1458	390 mg	13.9	11-20% CI	
577-RA-IA	Centerville	IA	Lake Rathbun	Reservoir	353792	Unknown	13.2	11-20% CI	
548-CH-IA	Chariton	IA	Lake Ellis and Lake Morris	Reservoir	6453	598 mg	10.6	11-20% CI	
553-CO-IA	Corning	IA	Lake Binder	Lake	2126	85 acres	23	>20% CI	
556-DA-IA	Davenport	IA	Mississippi River	River	56626192	NA	15.9	Continental Rivers	
557-DM-IA	Des Moines	IA	Raccoon River and Infiltration Galleries	River	2304810	Unknown	39.4	>20% CI	
562-IC-IA	Iowa City	IA	Iowa River	River	2099081	NA	40.3	>20% CI	
565-LA-IA	Lamoni	IA	Home Lake (Pond)	Reservoir	321	65 mg	8.7	5-10% CI	
566-LE-IA	Lenox	IA	Lenox West Lake	Reservoir	100	13 acres	19.8	11-20% CI	

569-MI-IA	Milford	IA	West Lake Okoboji	Lake	14866	NA	32.6	>20% CI
570-MO-IA	Montezuma	IA	Diamond Lake	Reservoir	2724	125 acres 250 mg	33.3	>20% CI
571-MA-IA	Mount Ayr	IA	Loch Ayr Reservoir	Reservoir	2563	78 acres	13.5	11-20% CI
572-MP-IA	Mount Pleasant	IA	Skunk River	River	2599367	NA	34.2	>20% CI
547-CW-IA	Okoboji	IA	West Okoboji Lake	Lake	14866	NA	32.6	>20% CI
574-OS-IA	Osceola	IA	West Lake	Reservoir	6241	300 acres	13.5	11-20% CI
575-OT-IA	Ottumwa	IA	Des Moines River	River	8569564	NA	35.5	>20% CI
576-PA-IA	Panora	IA	Middle Racoon River	River	265272	NA	41.1	>20% CI
579-SL-IA	Spirit Lake	IA	Spirit Lake	Lake	43135	6000 acres	36.2	>20% CI
582-WI-IA	Winterset	IA	Cedar Lake	Reservoir	10443	886 acre-ft	21.7	>20% CI
170-AL-IL	Altamont	IL	Altamont New Reservoir	Reservoir	521	56 acres	28.5	>20% CI
261-AP-IL	Alto Pass	IL	Little Cedar Lake	Reservoir	19625	115 acres	7.3	5-10% CI
601-BL-IL	Blandinsville	IL	LaHarpe Creek	River	8779	7 acre-ft	35.5	>20% CI
152-BR-IL	Breese	IL	Shoal Creek	River	480358	15 mg	25.2	>20% CI
213-CA-IL	Carlinville	IL	Carlinville Lake I	Reservoir	15706	Unknown	25	>20% CI
184-CA-IL	Carthage	IL	Carthage Lake	Reservoir	1756	48 acres	28.4	>20% CI
225-CE-IL	Centralia	IL	Raccoon Lake	Reservoir	30293	Unknown	12.2	11-20% CI
155-CH-IL	Charleston	IL	Lake Charleston	Reservoir	1198	935 mg	34.4	>20% CI
159-CH-IL	Chicago	IL	Lake Michigan	Lake	28845270	NA	8.9	Great Lakes
149-CC-IL	Clay City	IL	Little Wabash River	River	518175	3.4 mg	26.9	>20% CI

242-CO-IL	Coulterville	IL	Coulterville Lake	Reservoir	449	61 mg	15.2	11-20% CI
212-DE-IL	Decatur	IL	Lake Decatur	Reservoir	602057	6500 mg	41.5	>20% CI
197-EL-IL	Elgin	IL	Fox River	River	953176	NA	20.3	>20% CI
269-FA-IL	Fairfield	IL	Little Wabash River	River	1169567	90 mg	25	>20% CI
172-FA-IL	Farina	IL	East Fork of Kaskaskia River	River	2959	30 mg	17.1	11-20% CI
150-FL-IL	Flora	IL	Little Wabash River	River	491311	Unknown	27.3	>20% CI
263-GO-IL	Georgetown	IL	Little Vermillion River	River	106395	NA	39.5	>20% CI
214-GI-IL	Gillespie	IL	Old Gillespie Lake	Reservoir	2966	250 mg	25	>20% CI
182-GE-IL	Greenfield	IL	Greenfield Lake	Reservoir	724	50 acres 9 ft deep	29.1	>20% CI
222-HI-IL	Highland	IL	Silver Lake	Reservoir	30593	550 acres	17.5	11-20% CI
603-BL-IL	Hudson	IL	Lake Bloomington	Reservoir	41942	7380 acre-ft	44.4	>20% CI
198-KA-IL	Kankakee	IL	Kankakee River	River	2952111	1.25 mg	37.4	>20% CI
233-LI-IL	Litchfield	IL	Lake Lou Yeager	Reservoir	69219	1500 acres	30.1	>20% CI
608-SU-IL	Mascoutah	IL	Kaskaskia River	River	2844480	Unknown	26.3	>20% CI
157-MA-IL	Mattoon	IL	Lake Paradise	Reservoir	11916	900 mg	34.5	>20% CI
248-MO-IL	Moline	IL	Mississippi River	River	56626192	NA	15.9	Continental Rivers
268-NA-IL	Nashville	IL	City of Nashville Reservoir	Reservoir	1013	77 mg	23.1	>20% CI
166-NE-IL	Neoga	IL	Lake Mattoon	Reservoir	34849	Unknown	33.5	>20% CI
606-KA-IL	New Athens	IL	Kaskaskia River	River	3274132	NA	25.4	>20% CI
258-NB-IL	New Berlin	IL	Spring Creek	River	16852	38 mg	35.2	>20% CI

158-OA-IL	Oakland	IL	Lake Oakland	Reservoir	6909	26 acres 28 mg	39.7	>20% CI
245-OL-IL	Olney	IL	East Fork Lake	Reservoir	6644	5500 mg	28.8	>20% CI
217-PA-IL	Palmyra	IL	Palmyra-Modesto Lake	Reservoir	826	35 acres	25	>20% CI
147-PA-IL	Pana	IL	Lake Pana	Reservoir	4545	890 mg	32.3	>20% CI
168-PA-IL	Paris	IL	Twin Lakes	Reservoir	11733	900 mg	38.7	>20% CI
239-PI-IL	Pittsfield	IL	Lake Pittsfield	Reservoir	6971	Unknown	22.6	>20% CI
249-RO-IL	Rock Island	IL	Mississippi River	River	56626192	Unknown	15.9	Continental Rivers
228-SA-IL	Salem	IL	Salem Reservoir	Reservoir	2452	75 acres	12.2	11-20% CI
219-SH-IL	Shipman	IL	Shipman Reservoir	Reservoir	427	13 acres (x 9 ft)	25	>20% CI
221-AL-IL	Shipman	IL	Mississippi River	River	11525808 4	NA	24.2	Continental Rivers
143-SO-IL	Sorento	IL	Sorento Lake	Reservoir	376	Unknown	15.8	11-20% CI
244-SP-IL	Sparta	IL	South City Lake	Reservoir	480	33 acres	15.2	>20% CI
259-SP-IL	Springfield	IL	Lake Springfield	Lake	162178	17 000 mg	34.9	>20% CI
169-WS-IL	West Salem	IL	West Salem Reservior & shale pit	Reservoir	614	22 acres/2 acres	26.1	>20% CI
183-WH-IL	White Hall	IL	White Hall Reservoir	Reservoir	613	200 mg 51 acres	29.1	>20% CI
355-SC-IN	Austin	IN	Muscatatuck River	River	223967	NA	11.8	11-20% CI
307-BA-IN	Batesville	IN	Biscoff Reservoir	Reservoir	2916	700 mg 200 acres	19.5	11-20% CI
310-BO-IN	Borden	IN	Packwood Branch Reservoir	Reservoir	1275	445 acre- ft	10.8	5-10% CI
344-DU-IN	Dubois	IN	Patoka Lake	Reservoir	108655	8800 acres	8.4	5-10% CI
314-	Evansville	IN	Ohio River	River	68358056	NA	5.6	Continental

Agency	City	County	Water Body	Type	Volume	Concentration	Flow	Notes
EV-IN 315-FE-IN	Ferdinand	IN	Old Lake (No. 1)	Reservoir	105	15 mg	26.2	Rivers >20% CI
362-FW-IN	Fort Wayne	IN	St. Joseph River	River	657980	Unknown	18.6	11-20% CI
320-HO-IN	Holland	IN	New Holland Lake	Reservoir	348	20 acres x 12 feet	26.2	>20% CI
328-KO-IN	Kokomo	IN	Wildcat Creek	River	121637	NA	38	>20% CI
330-LO-IN	Logansport	IN	Eel River	River	524144	NA	28.3	>20% CI
332-MC-IN	Michigan City	IN	Lake Michigan	Lake	28845270	NA	8.9	Great Lakes
334-MI-IN	Mitchell	IN	East Fork of the White River	River	2470938	NA	26.9	>20% CI
335-MV-IN	Mount Vernon	IN	Ohio River	River	68778138	NA	5.7	Continental Rivers
340-NV-IN	North Vernon	IN	Vernon Fork of Muscatatuck River	River	68241	NA	21	>20% CI
341-OC-IN	Oakland City	IN	Old Lake	Lake	83	Unknown	33.8	>20% CI
343-PA-IN	Paoli	IN	Lick Creek	River	13424	NA	8.8	5-10% CI
345-RI-IN	Richmond	IN	Middle Fork Reservoir	Lake	30825	1.01 bg	27.2	>20% CI
346-SA-IN	Salem	IN	Lake John Hay	Reservoir	5797	211 acres	11.9	11-20% CI
348-SC-IN	Santa Claus	IN	Christmas Lake	Reservoir	1583	210 acre-ft.	21.8	>20% CI
350-SC-IN	Scottsburg	IN	Scottsburg Reservoir	Reservoir	1977	100 acres	11.3	11-20% CI
351-SE-IN	Seymour	IN	East Fork of the White River	River	1516709	NA	33.8	>20% CI
352-SP-IN	Speedway	IN	Big Eagle Creek	River	119080	24 000 acre ft	26.8	>20% CI
354-SM-IN	St. Meinrad	IN	Lake Benet	Reservoir	135	Unknown	4.5	5-10% CI
321-WA-IN	Warsaw	IN	Center Lake	Reservoir	444	120 acres	30.3	>20% CI
359-	Westport	IN	Sand Creek	River	60170	Unknown	43.1	>20% CI

WE-IN 25-AT- KS	Atchison	KS	Missouri River	River	26684770 7	NA	5.1	Continental Rivers
58-GA- KS	Garnett	KS	Crystal Lake	Reservoir	386	80 acre-ft	6.1	5-10% CI
73-HO- KS	Horton	KS	Delaware River	River	91634	Unknown	11.5	11-20% CI
71-KC- KS	Kansas City	KS	Missouri River	River	26874908 2	NA	5.1	Continental Rivers
77-LE- KS	Leavenworth	KS	Missouri River	River	26706117 6	11 mg	5.1	Continental Rivers
89-MI- KS	Milford	KS	Milford Lake	Reservoir	15963347	16 000 acres	9.6	5-10% CI
114-RI- KS	Richmond	KS	Richmond City Lake	Reservoir	557	11 acres X 35 ft max	5.1	5-10% CI
125- TO-KS	Topeka	KS	Kansas River	River	36446269	NA	8.8	5-10% CI
129- VF-KS	Valley Falls	KS	Delaware River	River	570021	Unknown	7.5	5-10% CI
23-WE- KS	Westphalia	KS	Lake (No Name)	Reservoir	1652	Unknown	4.8	5-10% CI
696- BA-MD	Bel Air	MD	Winter's Run	River	23264	NA	8.2	5-10% CI
676- EL-MD	Elkton	MD	Big Elk Creek	River	39985	Unknown	9.7	5-10% CI
683- FR-MD	Frederick	MD	Monocacy River	River	456687	NA	12	5-10% CI
684- FR-MD	Frederick	MD	Monocacy River	River	456040	NA	8.9	5-10% CI
699- HG-MD	Havre de Grace	MD	Susquehanna River	River	17629428	NA	5.5	5-10% CI
702- LA-MD	Silver Spring	MD	Howard Duckett Reservoir (Rocky Gorge Re	Reservoir	85109	6500 mg	5.6	5-10% CI
279- BB-MN	Beaver Bay	MN	Lake Superior	Lake	10719768	Unknown	0	Great Lakes
277-MI- MN	Minneapolis	MN	Mississippi River	River	12527540	Unknown	7.5	Continental Rivers
275- MO-	Moorhead	MN	Red River	River	4309787	Unknown	10.8	5-10% CI

MN 296- SC-MN	St. Cloud	MN	Mississippi River	River	8774874	Unknown	4	Continental Rivers
1039- AR-MO	Armstrong	MO	Armstrong City Lake	Reservoir	342	5-7 acres	10.4	5-10% CI
1003- BE-MO	Bethany	MO	Old City Lake	Reservoir	191	17 acres	10.2	5-10% CI
1005- BU-MO	Butler	MO	Butler City Lake	Reservoir	1965	60 acres	6.6	5-10% CI
1006- CA-MO	Cameron	MO	Reservoirs #1 #2 and #3	Reservoir	3274	200 mg #3 : 115 acres	8.2	5-10% CI
1009- CO-MO	Concordia	MO	Edwin A. Pape Lake	Reservoir	5507	1120 mg	20.6	>20% CI
1046- ED-MO	Edina	MO	New Lake	Reservoir	781	60.6 acres	8.6	5-10% CI
1071- EW- MO	Ewing	MO	Lewis County Water District Lake	Reservoir	684	140 mg	14	11-20% CI
1035- FR-MO	Freeman	MO	South Grand River	River	63850	130.68 mg / 20 acres	5.6	5-10% CI
1038- GA-MO	Gallatin	MO	Lake Viking	Reservoir	9049	640 acres	7.1	5-10% CI
1013- GC-MO	Garden City	MO	Lake 1	Reservoir	455	65 mg	5.8	5-10% CI
1098- GE-MO	Gentry	MO	Middle Fork Water Co. Lake	Reservoir	4233	160 acres	9.5	5-10% CI
1016- HI-MO	Higginsville	MO	Higginsville City Lake	Reservoir	3547	550 mg	20.6	>20% CI
1076- JC-MO	Jefferson City	MO	Missouri River	River	31908199 7	N/A	5.7	Continental Rivers
1053- LA-MO	Labelle	MO	LaBelle City Lake #1	Reservoir	140	Unknown	14	5-10% CI
1054- LA-MO	Lancaster	MO	North Lake	Reservoir	728	30 acres	6.1	5-10% CI
1058- LO-MO	Louisiana	MO	Mississippi River	River	90230044	NA	22.1	Continental Rivers
1060- MA-MO	Marceline	MO	New Marceline Reservoir	Reservoir	2455	759 mg	12.6	5-10% CI
1065-	Monroe City	MO	South Lake	Reservoir	668	304.3	6.2	5-10% CI

MC-MO						acre-ft		
1082-PE-MO	Perryville	MO	Saline Creek	River	36335	NA	8.6	5-10% CI
1066-SH-MO	Shelbina	MO	Shelbina Lake	Reservoir	1521	209 mg	8.8	5-10% CI
1032-SM-MO	Smithville	MO	Smithville Lake	Reservoir	133182	1 145 acres	8.8	5-10% CI
1091-SL-MO	St. Louis	MO	Mississippi River	River	44353349	NA	10.1	Continental Rivers
1092-SL-MO	St. Louis	MO	Missouri River	River	33284568	NA	5.6	Continental Rivers
1067-TR-MO	Trenton	MO	Thompson River	River	963925	200 mg	10.8	11-20% CI
1069-VA-MO	Vandalia	MO	Vandalia Reservoir	Reservoir	3654	13 mg 43 acres	11.8	5-10% CI
1070-WY-MO	Wyaconda	MO	Wyaconda City Lake	Reservoir	208	74 acre-ft	15.3	11-20% CI
305-BL-NE	Blair	NE	Missouri River	River	20373951	NA	3.3	Continental Rivers
304-LC-NE	Hartington	NE	Lewis & Clark Lake (Missouri River)	Reservoir	17770544	31000 acre-ft	0.8	Continental Rivers
303-OM-NE	Omaha	NE	Missouri River	River	20468776	NA	3.5	Continental Rivers
301-BL-NE	Plattsmouth	NE	Beaver Lake	Reservoir	7397	325 acres	26.1	>20% CI
371-AL-OH	Alliance	OH	Deer Creek Lake	Reservoir	162028	1000 mg	8.5	5-10% CI
372-AR-OH	Archbold	OH	Tiffin River	River	208202	300 mg	23.9	>20% CI
374-AT-OH	Attica	OH	Honey Creek	River	46710	15 mg	24.2	>20% CI
386-BG-OH	Bowling Green	OH	Maumee River	River	3977343	170 mg	23.1	>20% CI
394-CE-OH	Cedarville	OH	Massies Creek	River	31764	16-18 mg	27.2	>20% CI
395-CE-OH	Celina	OH	Grand Lake St Marys	Reservoir	72549	17 500 acres 6-7 ft	30.9	>20% CI

400-CM-OH	Cleveland	OH	Lake Erie	Lake	63168475	NA	8.2	Great Lakes
403-CD-OH	Columbus	OH	Scioto River	River	665366	15000 mg and 4000 mg	21.4	>20% CI
408-DE-OH	Defiance	OH	Maumee River	River	1395515	NA	21.5	>20% CI
412-DE-OH	Delta	OH	Bad Creek	River	22000	400 mg and 108 mg	33.6	>20% CI
413-EL-OH	East Liverpool	OH	Ohio River	River	14999469	NA	2.5	Continental Rivers
410-DA-OH	Galena	OH	Alum Creek Reservoir	Reservoir	82605	6300 acres	16.5	11-20% CI
470-BO-OH	Glouster	OH	Burr Oak Lake	Reservoir	20596	5800 acre-ft	3.7	5-10% CI
443-LI-OH	Lima	OH	Auglaize River	River	131174	5000 mg	24.3	>20% CI
451-ML-OH	McClure	OH	Maumee River	River	3777748	NA	23	>20% CI
452-MC-OH	McComb	OH	Rader Creek	River	668	163 mg	23.4	>20% CI
454-ME-OH	Metamora	OH	Ten Mile Creek	River	3174	70 mg	32.4	>20% CI
455-MO-OH	Monroeville	OH	West Branch Huron River	River	138245	NA	18.7	11-20% CI
461-NL-OH	New London	OH	Buck Creek	River	40614	1500 mg	17.3	11-20% CI
485-OT-OH	Ottawa	OH	Blanchard River	River	394516	116 mg	23.5	>20% CI
487-PA-OH	Paulding	OH	Flatrock Creek	River	109270	NA	21.4	11-20% CI
506-SO-OH	Somerset	OH	Somerset Reservoir	Reservoir	572	22 mg	8.3	5-10% CI
511-SU-OH	Sunbury	OH	Big Walnut Creek	River	50886	62 mg	16.5	11-20% CI
518-US-OH	Upper Sandusky	OH	Upper Sandusky Reservoir	Reservoir	894	90 mg	23.8	>20% CI
519-VW-OH	Van Wert	OH	Town Creek	River	16385	780 mg	29.2	>20% CI

527-WE-OH	Wellsville	OH	Little Yellow Creek	River	10832	180 mg	9.2	5-10% CI
537-WM-OH	West Milton	OH	Stillwater River	River	427302	NA	28.3	>20% CI
530-WE-OH	Westerville	OH	Alum Creek	River	95314	NA	16.4	11-20% CI
531-WI-OH	Willard	OH	Huron River	River	46081	2200 mg	18.2	11-20% CI
532-WI-OH	Williamsburg	OH	East Fork of the Little Miami River	River	149474	13 mg	18.1	11-20% CI
437-LC-OH	Willoughby	OH	Lake Erie	Lake	63168475	NA	8.2	Great Lakes
534-WI-OH	Wilmington	OH	Caesar's Creek Lake	Reservoir	147651	40 000 mg	27.1	>20% CI
865-SP-PA	Beavertown	PA	PL 638	Reservoir	3339	81 mg	10.4	5-10% CI
636-CA-PA	Carlisle	PA	Conodoguinet Creek	River	242629	NA	12.6	11-20% CI
596-DE-PA	Denver	PA	Cocalico Creek	River	12201	Unknown	26.4	>20% CI
593-HE-PA	Hummelston	PA	Swatara River	River	284337	NA	12.1	11-20% CI
997-WE-PA	Mechanicsburg	PA	Conodoguinet Creek	River	293855	NA	12.5	11-20% CI
622-NH-PA	New Holland	PA	New Holland Reservoir	Reservoir	704	30 mg	27.4	>20% CI
737-AW-PA	Norristown	PA	Schuylkill River	River	1133118	NA	9.2	11-20% CI
729-PH-PA	Phoenixville	PA	Schuylkill River	River	771279	NA	10.4	5-10% CI
769-RE-PA	Reading	PA	Lake Ontellaunee	Reservoir	120883	3880 mg	13.1	11-20% CI
730-WC-PA	West Chester	PA	East Branch of Brandywine River	River	72185	Unknown	10.3	5-10% CI
13-AP-WI	Appleton	WI	Lake Winnebago	Lake	3776966	NA	12.9	>20% CI
4-SMI-WI	Cudahy	WI	Lake Michigan	Lake	28845270	2 mg	8.9	Great Lakes
17-ME-	Menasha	WI	Lake Winnebago	Lake	3776966	Unknown	12.9	>20% CI

WI 7-OC- WI	Oak Creek	WI	Lake Michigan	Lake	28845270	NA	8.9	Great Lakes
18-OK- WI	Oshkosh	WI	Lake Winnebago	Lake	3776966	NA	12.9	>20% CI
10-PW- WI	Port Washington	WI	Lake Michigan	Lake	28845270	NA	8.9	Great Lakes

APPENDIX

12.5. Site Selection for ARP Monitoring Studies

12.5.1. Surface Drinking Water Site Selection (SDWS Study)

Language and subject headings below are directly extracted from:

Hackett, A. (2000) Surface Drinking Water Monitoring Program for Acetochlor and Other Corn Herbicides: Site Selection and Data Collection. Lab Project Number: SWM1100. Unpublished study prepared by Monsanto Company.

1.0 INTRODUCTION AND SUMMARY

Acetochlor is a selective herbicide for control of annual grasses and broadleaf weeds in corn. Acetochlor was registered on March 11, 1994, by the Acetochlor Registration Partnership (ARP), consisting of Monsanto Co. and Zeneca, Inc., and is marketed under trade names such as Harness® (Monsanto) and Surpass® (Zeneca). Acetochlor is registered for use in 42 states and the District of Columbia, and about 80% of yearly production is in the mid-western United States.

EPA and the ARP defined conditions of registration for acetochlor. One requirement of these conditions was to conduct a monitoring program to evaluate the extent of contamination of surface-drinking water with acetochlor over a five-year period. EPA and the ARP agreed that if acetochlor was found above mutually agreed trigger levels at a site, mitigation would be required. If found at numerous sites, its registration could be canceled.

The objective of the monitoring program is to determine seasonal and annualized mean concentrations of acetochlor and other major corn herbicides in finished drinking water derived from surface water sources. The program consists of several phases including: community water system (CWS) selection and data collection; sampling mechanics; execution of sampling; residue analysis; and reporting of results. This report describes the CWS selection and data collection phase of the program. This portion of the study was conducted by Stone Environmental Inc. (SEI, Montpelier, VT) in conjunction with the ARP. Details of sampling mechanics, execution of sampling, and initial analytical results will be reported in the first annual interim report due to EPA by January 31, 1996.

A total of 175 CWSs in nine mid-western and three mid-Atlantic states were selected for the program. The selection process was designed to include a wide array of CWSs with watersheds in areas of corn production, with an emphasis on including worst-case watersheds i.e., smaller watersheds (not on the Great Lakes and Continental Rivers) in areas of high corn production. These watersheds are expected to have higher concentrations of acetochlor after runoff events than larger watersheds which drain areas of both high and low corn production, because dilution would be greater for CWSs taking water from the Great Lakes and Continental Rivers. Data were collected to characterize each community water system included in the program.

The steps for the CWS selection and characterization process are summarized below:

- 1) Identification of all public CWSs that use surface water in the following 12 states: Illinois, Indiana, Iowa, Minnesota, Nebraska, Kansas, Wisconsin, Ohio, Missouri, Pennsylvania, Maryland, and Delaware.
- 2) Identification of all CWSs that belong to the target population.

Target Population - All CWSs in the 12 states that:

- use only surface water, or can discretely sample surface water,
 - are willing to cooperate and
 - have a corn intensity (for smaller watersheds that do not have an intake on a Great Lake or Continental River) greater than or equal to 5%, where corn intensity is the ratio of acreage of harvested corn to total acreage in the upstream watershed.
- 3) Separation of the target population of CWSs into disjoint (nonoverlapping) strata based on the size of the watershed, the corn intensity (for smaller watersheds), and State that the system is in:
 - State
 - size of watershed (three major subdivisions)
 - Great Lakes
 - Continental Rivers (Missouri, Mississippi, Ohio Rivers)
 - Smaller Rivers and Lakes
 - corn intensity (% corn planted in total area of watershed) (three major subdivisions)
 - 5-10% CI
 - 11-20% CI
 - >20% CI
 - 4) Determination of the number of CWSs to be selected from each stratum. The focus was on strata containing CWS watersheds which are expected to have higher levels of acetochlor after runoff events, based on the size of the watershed and its corn intensity. A higher percentage of CWSs from these strata were chosen.
 - 5) Random selection (using random number generation) of the appropriate number of CWSs from each stratum. All CWSs meeting the target population criteria were selected from the identified strata (for example, the >20% corn intensity, smaller watershed strata). A total of 175 CWSs were required for the study.
 - 6) Collection of information for each selected CWS regarding intake location, sources of water, treatment, customer information, point of finished water sampling, soil types, and corn intensity of the watershed(s) for that system.
 - 7) Removal of systems that did not meet target population criteria based on additional data collected. Systems were replaced in the same stratum and state, if possible, by additional random selection from the stratum. If there were no systems available in the same stratum, then a system was randomly selected from another stratum with available CWSs.
 - 8) Generation of maps of watersheds for each CWS. Data entry into a Geographical Information System (GIS).

The final distribution of selected CWSs by state, size, and corn intensity is presented in Table 1. The top number in each stratum (delineated by a box) is the total number of CWSs meeting the target population criteria in that stratum. The middle number in each stratum is the number of CWSs selected from that stratum, and the bottom percentage is the percentage of CWSs selected from the total population in that stratum. The highest percentage of CWSs, 100% of the available CWSs, were selected from the >20% corn intensity strata, 66% were selected from the 11-20% corn intensity strata, 49% from the 5-10% corn intensity strata, 43% from the Continental River strata, and 14% from the Great Lakes strata. The bulk of the selected CWSs are located on watersheds with higher corn intensity, but the program also includes CWSs representative of other watersheds in corn growing areas.

Data regarding population and CWS source(s) were collected, watersheds for the 175 selected CWSs were mapped, and watershed areas and corn intensities were determined. Each of the 175 systems was visited and inspected to confirm data. Characteristics of the 175 selected CWSs including total population for all the CWSs, watershed areas and corn intensities for all watersheds, are summarized in Table 2. The 175 CWSs serve populations ranging from 167 to 5,100,000 people. The watersheds associated with the 175 CWSs cover areas ranging from 83 to 443,533,492 acres. All of the 175 CWSs in the program use some type of conventional treatment (coagulation, flocculation, sedimentation, and filtration) for their water. There are 21 CWSs using a granular activated carbon (GAC) treatment and 111 CWSs using a powdered activated carbon (PAC) treatment. Most of the GAC units are used by systems in the >20% and 11-20% corn intensity strata, strata that cover the higher corn-growing areas. A total of 124 CWSs have at least one reservoir. Maps showing corn intensity in the 12 states, watershed boundaries, and intake locations are displayed in Figures 1, 2, and 3, respectively. A table of CWSs and their characteristics is in Appendix A. State maps, individual site data sheets and maps for each system are in Appendix C, and are grouped by state. The state maps include a map of watershed boundaries, and a map of intake locations with site codes for each state. The site data sheets provide information on treatment method, surface water source (s), population served, training dates of CWS samplers, corn intensity, location of intake, soil texture and hydrologic group. Maps of all watersheds are included with each site data sheet. Based on the watershed maps and the data collected on CWS sources, watershed areas, corn intensities, population, and treatment methods, the 175 selected CWSs represent a diverse group of sampling sites.

2.0 MATERIALS AND METHODS

2.1 Site Selection

A total of 175 surface water CWSs in 12 states (IL, IN, IA, KS, MN, NE, WI, OH, MO, PA, MD, and DE) were selected for the surface water program. Procedures for the identification and selection of CWSs are described in sections 2.1.1 - 2.1.4 of this report.

2.1.1 Identification of Public CWSs

Lists of public Community Water Systems that use surface water in the 12 states were obtained from state agencies and the American Water Works Association (AWWA).¹

The total number of surface water CWSs originally identified in each of the 12 states is shown in Table 3.

2.1.2 Identification of CWSs in the Target Population

Two procedures were used to identify which of the CWSs in each state fell into the target population:

- 1) Information was obtained by telephone interviews with operators from each of the CWSs.
- 2) Subsequently, for smaller watersheds, corn intensity for each CWS watershed was determined. Corn intensity was used as a surrogate for acetochlor usage for two principal reasons. Firstly, acetochlor was only registered in 1994 and use of first-year sales data would not be an accurate predictor of 1995 and following years' use. To achieve the use-reduction targets specified in the agreement, acetochlor will eventually become a major corn herbicide, so corn use is an excellent surrogate. Secondly, because Monsanto and Zeneca are competing in the market place with separate products, sharing sales data on a local level could be viewed as anti-competitive and thereby prohibited by United States' law.

Operator Interview Process

Telephone interviews were conducted by SEI staff with CWS operators to provide a general overview of the program, determine if operators were willing to cooperate in a five-year monitoring study, confirm preliminary information obtained during the identification of CWSs that use surface water, and to collect additional information needed to determine if the system fitted the target population. A standard operating procedure (SOP) was developed for the interview procedure in order to obtain consistent information from all CWS personnel. The procedure for the operator interview process is described in the following paragraphs.

Initial contact with operators was conducted by telephone. The interviewer attempted to contact an individual in a managerial position for the water system to ensure that cooperation was obtained from an employee with authority. If a manager was difficult to reach, an operator was interviewed. An overview of the program, and the program requirements regarding sampling and shipping were described to the operator. Every effort was made to encourage participation in the program by emphasizing the benefits to the CWS to be derived from receiving additional data on water quality. If the system was willing to participate, the following information was obtained or confirmed:

- a) name of system, operator, telephone and fax numbers, and address;
- b) whether the CWS uses surface water year round, or if it is an emergency or back-up source;
- c) whether the system uses ground water in addition to surface water, and if so, whether it is possible to sample the surface water discretely;
- d) whether the source is indeed a surface water source, and not a pit or static water body fed in the

- e) number of sources supplying the CWS, name of each source and whether a particular source is a river, lake, reservoir, or some other type;
- f) general location of intake(s), the specific location was determined at a later date if the system was selected.

Communication was continued with sites initially meeting the target population criteria to provide detailed information about the monitoring program, confirm information listed above, and obtain additional information regarding treatment of water, flow measurement, and population served.

Calculation of Corn Intensity (CI)

During the CWS selection process, CI values for each CWS meeting the criteria were determined manually using the procedure outlined below. However, the CI values provided in the Table of CWSs and Characteristics in Appendix A reflect more accurate values computed using GIS. For the selection process, the approximate corn intensity of a watershed was determined for watersheds associated with CWSs that initially met the target population criteria based on the operator interview process, and also did not draw water from a Continental River or one of the Great Lakes (henceforth "smaller watersheds"). First, the watersheds were drawn for each CWS according to the process described below:

- 1) If possible, the intake of the CWS was located on a USGS Hydrologic Unit Map (HUM) based on information obtained from the CWS contact during the operator interview process. Landmarks, such as roads, railroad tracks, bridges, towns, and rivers, were identified to aid in location of intakes. Intakes on smaller water bodies could not be located on the 1:500,000 scale HUM, because the water bodies were not shown on these maps. Therefore, their locations were marked on a larger-scale map², and transferred to the HUM. For instance, if the intake was located on a reservoir which did not appear on the HUM, the reservoir would be located on a larger-scale map. Its distance from a town or another landmark was noted and using that information, its location was identified on the HUM based on the location of the landmark. If the site was in Illinois, Ohio, Minnesota, Wisconsin, Pennsylvania, Maryland, or Delaware, a state atlas at a scale of 1:150,000 was used. For the remaining states where such an atlas was unavailable, a road atlas, with a more detailed scale, was used.
- 2) The direction of water flow was determined by examining the hydrology and/or topography of the surrounding area.
- 3) The watershed was drawn to encompass all areas upstream or draining to the lake, reservoir, or point of intake on the river. Where possible the USGS Hydrologic Unit Code (HUC)

boundaries (regional, subregional, accounting unit, cataloging unit) were used to define the watershed.

Corn intensity (CI) values for each county were calculated by dividing the acreage of harvested corn for each county³ by the total acreage of the county⁴. Harvested acres of corn for grain and silage were added to give total acreage of harvested corn. Corn cropping data from 1992 were used in this study. Calculations of corn intensity for a few sample counties are shown in the table below:

<u>State Name</u>	<u>County Name</u>	<u>Total County Acres</u>	<u>1992 Harvested Acres of Corn Grain</u>	<u>1992 Harvested Acres of Corn Silage</u>	<u>Corn Intensity (%)</u>
	(a)	(b)	(c)	(d)	[(c+d)/b] x 100
Indiana	Allen	437852.5	84154	1987	19.67
Iowa	Adair	361858.5	102811	1577	28.85
Ohio	Adams	379027.9	15792	1154	4.47
Illinois	Alexander	158236.6	11253	50	7.14

Mylar overlay maps with county outlines were generated using ArcInfo software. Counties were shaded on the mylar according to their corn intensity value. A unique color was assigned to each of the following categories:

- a) 0-5% CI
- b) 5-10% CI
- c) 11-20% CI
- d) >20% CI

The Mylar overlays with county outlines were on the same scale as the Hydrologic Unit Code maps on which the watersheds were drawn. The appropriate Mylar overlay and map were superimposed in order to visually estimate the CI of each watershed. If a particular watershed was dominantly one color, the watershed was considered to be in that corn intensity category. If no predominant color was discernable, then the approximate area of each county within the watershed was estimated to the nearest 1×10^5 acres using a transparent grid graduated in inches and fractions of inches. Each 0.5 inch square (0.25 square inches) is equivalent to approximately 10,000 acres at the 1:500,000 scale of the HUC maps. The corn intensity of the watershed was then estimated using the following formula:

$(P_a \times CI_a) + (P_b \times CI_b) = \text{Average CI percentage for the watershed, where}$

P_a = percentage of watershed in county a

CI_a = corn intensity of county a

P_b = percentage of watershed in county b'

CI_b = corn intensity of county b

The formula was modified to include all counties that made up a significant portion of the area of the watershed. For CWSs with more than one watershed, only the primary water sources were included in the CI determination. If more than one watershed or source CI was determined and the

two sources did not have the same CI category, then a weighted average was used to determine the CI for the system.

After estimation of corn intensity, smaller watersheds were placed in the appropriate corn intensity category. All smaller watersheds with less than 5% CI were removed from the target population.

2.1.3 Separation of Target Population of CWSs into Disjoint Strata

The CWSs meeting the criteria of the target population were separated into disjoint strata based on their state, the size of their watershed, and for smaller watersheds, their corn intensity (CI). There are five strata for each of the twelve states:

1. Great Lakes (Erie, Superior, Michigan)
2. Three Continental Rivers (Missouri, Mississippi, and Ohio)

Smaller Watersheds with

3. 5-10% CI
4. 11-20% CI
5. >20% CI

There are a total of 60 strata for the 12 states. The disjoint strata structure is displayed in Table 1.

2.1.4 Random Selection of CWSs from each Stratum

Concentrations of acetochlor and other corn herbicides are likely to be higher in smaller watersheds with higher corn intensity. Acetochlor concentrations are expected to be lower in major rivers and lakes where herbicide levels will be diluted after runoff events. Therefore, CWSs on smaller watersheds with >20% CI are expected to potentially have the highest concentrations of acetochlor after runoff events, while CWSs on the Great Lakes are expected to potentially have the lowest concentrations of acetochlor after runoff events. A higher percentage of CWSs were selected from strata expected to have higher concentrations of acetochlor after runoff events. However, all strata are represented in this program.

Computer-generated random numbers were assigned to CWSs in each stratum. A certain number of CWSs from each stratum was selected by choosing the sites with the lowest random numbers. If a system subsequently needed to be removed due to unwillingness to participate, or some other reason which eliminated the system from the target population, then where possible, another system was randomly selected from the same stratum. If no systems were available in the same stratum for use as replacements, then a system was randomly selected from another stratum with available CWSs, where possible, from the next stratum in the same state. In general, the replacement CWSs were selected from strata with available CWSs, expected to have the highest concentrations of acetochlor after runoff events.

2.2 Data Collection for Selected CWSs

Specific data for each selected CWS was collected and verified using a standard operating procedure and data collection forms. Each CWS representative was contacted by telephone, and subsequently during a site visit, and asked to verify data previously obtained and to supply additional information about their system.

Detailed information was obtained on the location of each CWS intake, and the location was marked on a 7.5 minute USGS topographic map. Other data obtained are listed below:

- 1) name of system and owner
- 2) contact name
- 3) telephone and fax number
- 4) address and county
- 5) description and name(s) of primary source(s) of water
- 6) whether there is a reservoir, and if so, the approximate volume of the reservoir
- 7) description, name(s), and location(s) of alternative source(s) of water
- 8) frequency of backup supply use and date last used
- 9) treatment method and filtration type
- 10) whether system uses granular activated carbon treatment and is willing to collect raw water
- 11) whether system measures river flow and how
- 12) location of any nearby gaging stations
- 13) whether system measures stage height
- 14) peak and average volumes of surface water treated daily
- 15) whether system sells water to other CWSs, and the names of the customer CWSs
- 16) population served, population served by water sold to other CWSs
- 17) location of any pesticide storage/shipping facilities in watershed
- 18) whether system has a refrigerator/freezer to freeze ice packs
- 19) proximity of available shipping services
- 20) whether system is capable of collecting samples Mon.-Thurs, year round
- 21) number of staff available to collect samples, names(s) and title(s)
- 22) whether CVs/resumes are available for samplers
- 23) whether the intake was located and reference provided
- 24) comments for system participants

2.3 Drawing of Watersheds

Watersheds were drawn for each selected CWS following a standard procedure. Watershed boundaries provided: 1) a basis for the maps of all watersheds included in the program, and 2) the points and lines used to create Geographical Information System (GIS) coverages. The process for drawing watersheds is summarized below.

- The intake location was marked on a 7.5 minute USGS topographic map based on detailed information obtained during the telephone interview and confirmed during site visits.
- The intake location was transcribed from the 7.5 minute USGS topographic map onto the map of appropriate scale for drawing the watershed. The appropriate scale map was selected by choosing a USGS topographic or hydrologic unit map that provided the most detail possible and also was suitable for reduction to an 8.5 x 11 inch page.
- The watershed was drawn by connecting points of highest elevation upstream from the intake. This was done by following the drainage divide, a continuous line joining the points from which surface water will flow in different directions. These points can be determined from the contour lines of a topographic map by observing the slope of the land and thus, noting

which way the water will flow. The highest points surrounding land that slopes towards all tributaries of a water body are joined together to delineate the drainage divide. With few exceptions, the drainage divide cannot cross any bodies of water. The area within the drainage divide defines the watershed.

- The watershed was drawn initially in pencil and then traced onto Mylar. Geographic reference points (latitude and longitude) were also marked on the Mylar.

For systems with more than one intake, the individual intakes and their associated watersheds were designated as primary (P1, P2, etc), or as backup (B1, B2, etc). Watersheds were drawn for all primary intakes. Back-up source watersheds were drawn only if the back-up source was likely to provide more than 20% of the volume on sampling weekdays between March 15 and August 31, the time period when peak concentrations of herbicides due to field runoff are expected. All primary and significant backup watersheds were drawn in order to obtain realistic watershed data for the surface water used by the system.

For systems with watersheds on the Great Lakes or Continental Rivers, the watersheds were drawn on appropriate small scale maps (referenced on each map in the site data section in Appendix C) to provide the individual site map. The intake locations for Great Lake watersheds were traced onto Mylar along with geographic reference points (latitude and longitude) and existing ArcInfo polygon lines from EPA sources⁵ were used to delineate the watersheds for GIS. The watershed was drawn initially in pencil and then traced onto Mylar. Geographic reference points (latitude and longitude) were marked on the Mylar.

Watersheds for Continental Rivers are available on the USGS 1:500,000 Hydrologic Unit Maps (HUMs). The HUMs are available for each state, and the Continental Rivers commonly extend through several state maps. To use existing data, watershed boundaries were drawn using both the HUMs and the USGS State Series 1:500,000 Topographic Maps. Both maps are of the same scale. The procedure for drawing the Continental River watersheds is described below:

- Locate the intake on the Topographic Map
- Overlay the appropriate Hydrologic Unit Map with the Topographic Map, and draw the watershed boundaries on the Topographic Map until they connect with a hydrologic unit code boundary.
- Reverse the maps so the Hydrologic Unit Map is over the Topographic Map, and trace the intake location and watershed boundaries onto the Hydrologic Unit Map. The Hydrologic Unit Map was used as the base map for the Mylar trace.
- Trace the watershed onto Mylar. Geographic reference points (latitude and longitude) were also marked on the Mylar.

The boundaries of all watersheds traced on Mylar were scanned and converted to digitized polygons to serve as a basis for a Geographic Information System (GIS) database. This allows other data (e.g. soil texture and hydrologic group, and weather data) to be overlaid and compared to specific watersheds. Corn intensity (based on county data)^{3,4} and watershed area were calculated for each watershed using GIS. Corn intensity had been previously estimated using the method described in Section 2.1.2. in order to determine if watersheds belonged to the target population, and to assign watersheds to categories of corn intensity. GIS provided a more accurate determination of corn intensity. Most of the GIS-calculated corn intensities are within the range of the stratum of the associated CWS, but as can be seen in Table 2 and in more detail in the Table of CWSs and

Characteristics in Appendix A, some of the watersheds have GIS-calculated corn intensities that are higher or lower than their CWS stratum corn-intensity range. Both determinations of corn intensity are based on county corn data. An area index, that is a relative measure of the proportion of each county contained in a watershed, was calculated for each watershed. This provides information on the reliability of the corn intensity based on county data. Details regarding calculation of corn intensity, area index, and watershed area using GIS are provided below in Section 2.4. Details regarding GIS databases and mapping are provided in Appendix B.

2.4 GIS Calculation of Corn Intensity and Watershed Area

2.4.1 Corn Intensity

ArcInfo GIS software is used to assist in the calculation of watershed corn intensity (WCI) for each watershed. County corn intensities are used to calculate this number. An intersection is made of the county (polygon) ArcInfo GIS coverage (database) with the watershed ArcInfo GIS coverage using ArcInfo's "Union" command. This process results in the creation of county watershed (polygon) coverage. A new item in the PAT file (the polygon attribute table-the database file) is then created using the ArcInfo "Additem" command to accept the values for the percentage of watershed within each county. To calculate this percentage, the following formula is used in the ArcInfo program:

$$P = \frac{WSCTY}{TOTAL} * 100$$

where:

P = Percentage of watershed within the county

WSCTY = area of watershed in the county

TOTAL = total area of watershed polygon

Another item in the PAT file is created to accept values for the average CI of each watershed. The average CI for each watershed is calculated in ArcInfo using the following formula:

$$WCI \text{ Percentage} = (Pa \times CIa) + (Pb \times C Ib) + \dots + (Pnth \times CInth)$$

where:

WCI = Watershed Corn Intensity

Pa = percentage of watershed in county a

CIa = corn intensity of county a

Pb = percentage of watershed in county b

C Ib = corn intensity of county b

Pnth = percentage of watershed in nth county

CInth = corn intensity of the nth county

For each watershed an "area index" is calculated. The index is a relative measure of the proportion of each county contained in the watershed and thus, provides information regarding the reliability of the calculated WCI. For example, if a watershed has three counties and each county has greater than 50% of its area within the watershed, the calculated watershed corn intensity is likely more

accurate than for a watershed in which the counties have only 20% of their areas within the watershed. The formula for calculating the index is:

$$\text{AREA INDEX} = \frac{\sum_{i=a}^n \text{WSCTY}_i}{\sum_{i=a}^n \text{CTY}_i} * 100$$

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where:

WSCTY = acreage of watershed in county *i*

CTY = acreage of county *i*

2.4.2 Watershed Area

Geographic locations are stored as vector data in ArcInfo. The ArcInfo software is able to perform precise planimetric area calculations on polygons delineated by these vectors. The area is calculated through preprogrammed algorithms in the software.

The watershed areas for the Great Lakes do not include the area of the lake itself. This has an impact on the calculation of the CI. Because of the smaller areas, the GIS-calculated CI will be a higher number than if the calculation had included area of the lake. Also some of the Great Lakes' watersheds extend into Canada where county corn intensities are not available, and are not included in the calculation.

3.0 RESULTS AND DISCUSSION

3.1 CWS Distribution

The distribution of CWSs in the surface water program is displayed in Table 1.

3.1.1 States

A total of 175 CWSs were required for inclusion in the surface water program. Initially, all 175 sites were to be located in the seven core states (IL, IN, IA, KS, MN, NE, and WI) as defined by the March, 1994, registration agreement. The rationale was that these seven states accounted for over 80% of the corn production, and therefore, acetochlor would be used predominantly in these states. However, based on data collected in the Fall of 1994 by the ARP, it was clear that several of the core states, KS, MN, NE, and WI, had very few surface water CWSs in areas of greater than 5% corn intensity. The ARP and EPA discussed these data and the possibility of expanding the surface water program to include additional states, in order to avoid over-sampling in several of the originally identified states. The outcome of these discussions resulted in inclusion of five more states, OH, MO, PA, MD, and DE. By including these states, the ARP was able to identify hundreds of additional CWSs that used surface water. Many of these were smaller CWSs in areas of greater than

5% intensity. The expansion to additional states is likely to benefit interpretation of the data obtained from this study.

3.1.2 Watershed Size and Corn Intensity

Watersheds were separated into three size strata:

- 1) Great Lakes
- 2) Continental Rivers
- 3) Smaller Watersheds

An objective of the selection process was to represent all three sizes of watersheds, but focus on the watersheds expected to have the highest concentrations of acetochlor after runoff events. Therefore, the highest percentage of watersheds was selected from the Smaller Watershed strata and the lowest percentage from the Great Lakes strata. A total of 150 CWSs (71% of the available CWSs) were selected from the Smaller Watershed strata, a total of 17 were selected from the Continental River strata (43% of the available CWSs), and a total of 8 from the Great Lakes strata (14% of the available CWSs).

The Smaller Watershed strata were further separated by their corn intensity into three additional strata:

- 1) 5-10% Corn Intensity
- 2) 11-20% Corn Intensity
- 3) >20% Corn Intensity

A second objective of the selection process was to represent all three corn intensity ranges but focus on the watersheds expected to have the highest concentrations of acetochlor after runoff events. Therefore, the highest percentage of watersheds was selected from the >20% Corn Intensity strata and the lowest percentage from the 5-10% Corn Intensity strata. A total of 76 CWSs were selected from the >20% Corn Intensity strata (100% of the available CWSs), a total of 31 CWSs from the 11-20% Corn Intensity strata (66% of the available CWSs), and a total of 43 CWSs from the 5-10% strata (49% of the available CWSs).

Corn intensity is used as a surrogate for acetochlor usage, and the strata expected to have the highest levels of acetochlor are the Smaller Watershed, >20% Corn Intensity strata.

3.2 Characterization of CWSs

Corn intensity (for the 12 states included in the program), watershed boundaries, and CWS intake locations are displayed on maps in Figures 1-3.

The watersheds associated with the 175 selected CWSs are in the 12 states included in the program, and also extend into 12 other states and Canada. The watersheds extending into Canada and the 12 other states are listed below:

Great Lakes:	Canada, New York, Michigan
Mississippi River:	Canada, Colorado, Wyoming, Montana, North Dakota, South Dakota

Ohio River:	New York, West Virginia, Kentucky, Tennessee, North Carolina
Missouri River:	Canada, Colorado, Wyoming, Montana, North Dakota, South Dakota
Kansas and Republican Rivers:	Colorado
Red Rivers:	North Dakota, South Dakota

CWSs were generally characterized by their size and corn intensity, population served, watershed area, treatment type, and whether a reservoir is used. An overview of the characteristics of the 175 CWSs in the surface water program is provided in Table 2.

All of the 175 CWSs in the program use some type of conventional treatment (coagulation, flocculation, sedimentation, and filtration) for their water. There are 21 CWSs using a granular activated carbon (GAC) treatment and 111 CWSs using a powdered activated carbon (PAC) treatment. Most of the GAC units are used by systems in the >20% and 11-20% corn intensity strata, strata that cover the higher corn-growing areas. A total of 124 CWSs have at least one reservoir. The 175 CWSs serve populations ranging from 167 to 5,100,000 people. The watersheds associated with the 175 CWSs cover areas ranging from 83 to 443,533,492 acres. An overview of CWS distribution by population and strata is presented in Figure 4. The distribution of watershed area by strata is presented in Figure 5. This data includes watershed area for all watersheds (primary: P1, P2 and back-up: B1, B2) for a given CWS that are likely to provide more than 20% of the volume on sampling weekdays between March 15 and August 31. The number of CWSs with reservoirs and GAC treatment is compared to the total number of CWSs in each stratum in Figure 6.

A table of the 175 CWSs and 200 watersheds, sorted by state, strata and site code, with system name and address, total population served (including population served by sales to other systems), GIS-calculated corn intensity and watershed area(s) for all watersheds for a given CWS, whether system uses GAC and/or PAC, or has a reservoir, source code, is in Appendix A. Detailed information on each of the 175 selected CWSs is presented in site data sheets in Appendix C and organized by state and site code. A state map with watershed boundaries, and a state map with intake locations marked and identified by site code are included with the site data sheets for each state. Maps of all watersheds associated with a site are also included with each site data sheet. The site data sheets provide the following information:

- 1) system name, delivery address, mailing address, telephone, fax
- 2) treatment information including type of treatment, and peak and average volume treated/day
- 3) watershed stratum
- 4) population served and population sold
- 5) names of CWS samplers and dates of training
- 6) source information including source name, watershed area, source type, volume/area for reservoirs, backup frequency, and whether stage height is measured
- 7) corn intensity for each watershed calculated by GIS using county data, and area index providing information on the proportion of the counties within the watershed
- 8) location of intake, latitude and longitude, for each watershed
- 9) hydrologic group and soil texture information for all watersheds that are not Great Lake or Continental River watersheds

4.0 CONCLUSIONS

A site selection process was conducted to identify 175 CWSs in 12 states. Data regarding population and CWS source(s) were collected, and watershed areas and corn intensities were determined. Each of the 175 systems was visited, inspected, and data confirmed. Watersheds for the 175 systems were mapped. The selected CWSs represent a broad spectrum based on geographic diversity, general size and corn intensity of the watersheds. The data for the selected systems demonstrate the extensive diversity of the ARP surface water monitoring program. The watersheds are representative of the key acetochlor-use states, with a few extending into numerous states not included in the program. The CWSs are supplied by surface water from a variety of sources including small rivers and lakes, larger rivers and lakes, and reservoirs, and employ a wide variety of treatment methods. The selected watersheds span a large range of watershed area, and serve a large range of populations.

The highest percentage of CWSs, 100% of the available CWSs, was selected from the >20% corn intensity strata, 66% were selected from the 11-20% corn intensity strata, 49% from the 5-10% corn intensity strata, 43% from the Continental River strata, and 14% from the Great Lakes strata. Almost 50% of the sites were selected from smaller watersheds with >20% corn intensity, the watersheds expected to have the highest concentrations of acetochlor after runoff events. The focus on more vulnerable watersheds with higher corn intensity combined with the diversity of watersheds selected for this study will allow us to obtain both a worst-case and representative evaluation of the impact of acetochlor and other corn herbicide usage on surface drinking water in significant corn-growing areas of the United States.

12.5.2. Site Selection – SGW Study

The description below is taken from De Guzman et al (2005), a more comprehensive description is available in:

MRID: 43899601

Hendley, P. (1995) State Ground Water Monitoring Program for Acetochlor and Other Corn Herbicides--Part 1: Site Selection and Site Details: Lab Project Number: ACET-94-GW-01: RR 95-087B: GWMSIT05.DOC. Unpublished study prepared by Zeneca Ag Products and Levine-Fricke, Inc. 3217 p.

Site Selection Criteria

The goal of the first phase of the study was to establish a network of 175 monitoring sites in regions of high corn production in each of the seven states representing a range of soil textures typical of corn agriculture in those regions. Each site was expected to have shallow ground water, as defined by each state (Table 1), unprotected by restrictive subsurface layers. A new monitoring well was installed within or closely adjacent to and down-gradient of each site. Initially, the seven-state area was evaluated to determine the counties with significant corn production. The evaluation was based on the most recent (1987) United States Department of Agriculture (USDA) Agricultural Product Statistics available at that time. An area-weighted distribution of soil textures across the selected counties in each state was obtained from STATSGO, a USDA-National Resources Conservation Service (NRCS) spatial soils database (USDA, 2004). This distribution was used to develop initial targets for the numbers of sites to

be assigned to each soil texture in each state. Table 2 details the planned and actual distribution of SGM sites by soil texture.

Potential monitoring sites were also required to: 1) be representative of the irrigation and crop rotation practices performed on the particular soil type and region; 2) be able to accommodate a new monitoring well installed within or adjacent to, and down-gradient of a 4.0-hectare (minimum) treated study plot; 3) be free of any historical application of acetochlor; 4) not be prone to flooding, runoff or run-on; 5) be relatively flat ($< 8\%$ slope); 6) accommodate the installation of a monitoring well without drilling into bedrock; and 7) have a site landowner who agreed, via a formal agreement with the ARP, to follow a specific acetochlor use plan.

Site Characterization and Well Installation

Once a SGM site was confirmed to meet the above criteria, it was visited by ARP personnel to collect additional characterization data. A topographical survey, hydrogeological assessment, soil characterization and a cooperator interview were conducted. If available, published maps of the site and vicinity were obtained, including county roadmaps, plat maps, USGS 7.5-minute quadrangles, NRCS County Soils maps, and aerial photos. Furthermore, a detailed map of each site was produced in order to identify site-specific features, such as access lanes, study plot location, irrigation and other farming equipment, tile drains, ditches and other waterway features. Historical pesticide use, dating back to 1990 (when available), cropping and other agronomic practices were obtained by interviewing the cooperators. A minimum 4.0-hectare portion of the farm was designated as the study plot. Ten soil cores (0 – 0.15 m) were collected from representative locations in the study plot. These soil cores were composited and a subsample was analyzed (A&L Great Lakes Laboratories Inc., Fort Wayne, IN) for pH, organic carbon/organic matter, cation exchange capacity, USDA texture classification and bulk density. Monitoring wells were sited within or closely adjacent to, and down-gradient of the study plot. Various sources of published ground water data were used (for example, the Department of Natural Resources Hydrologic Assessment, the USGS Hydrologic Atlas and local university data) to assess ground water flow direction for most sites. At sites where published ground water data were not available, trained hydrogeologists evaluated topography in conjunction with surface water drainage features in order to assess ground water flow direction.

Monitoring wells were installed by licensed commercial drilling contractors under the direct supervision of a professional geologist/hydrogeologist and in compliance with state and local guidelines. Each boring was drilled using a hollow-stem auger advanced by a rotary drill rig. Continuous core soil samples were collected from each boring and lithologic descriptions were recorded using the Unified Soil Classification System (USCS). Each monitoring well was constructed with 0.05 m (inside diameter) polyvinyl chloride (PVC) casing with flush-threaded joints and 0.254-mm machine-slotted screen. A filter pack of coarse sand to fine gravel was placed in the annular space surrounding and up to approximately 0.6 m above the well screen. The length and position of the well screen was defined by each state (Table 1). A minimum 0.9 m bentonite seal was installed in the annular space above the filter pack. The remaining annular space from 0.6 to 0.9 m bgs was sealed using a Portland cement grout or a bentonite grout. The PVC casing extended up to approximately 0.9 m above the surface grade and was protected by a 0.1 m inside diameter steel protective casing and a locking cap. Wooden posts were installed in a square formation 0.2 m from the monitoring well for added protection against farm equipment. Figure 1 illustrates the typical well construction details of the SGM wells. After well installation, each monitoring well was thoroughly developed and equipped with a dedicated

bladder pump. Each of the 175 monitoring wells was locked and access was limited to ARP personnel.

Each monitoring well was surrounded by an 'acetochlor-free' buffer zone to minimize the chance of direct spray drift contamination of the monitoring wellhead and sampling area. Acceptable buffer zones were defined by each state and ranged from 9.1 - 45.7 m (Table 1). Each of the 175 wells was given a unique ID, which followed a standard SSnn format where "SS" reflected the state abbreviation and the "nn" represented a sequential number within the state (e.g. IL01 - IL25). Figure 2 shows the approximate location of the sites. Exact locations of the sites and wells were held confidential in order to minimize the risk of vandalism or sabotage and to protect the privacy of the cooperator.

Monitoring began in 1995 with every cooperator expected to plant corn and treat the study plot with an acetochlor product that spring. In later years, the cooperators were expected to follow their typical cropping plans (e.g. continuous corn or a crop rotation), provided that by the end of the 5-year monitoring program, each of the 175 sites would be cropped to corn three times, and therefore, would receive at least three acetochlor applications. In order to accommodate the 2-year extension, a new agreement was made between the ARP and the cooperators in 1999, which specified that another corn crop be planted and treated with an acetochlor formulation during at least one of the two additional growing seasons. Therefore, each cooperator was required to make at least four acetochlor treatments during the course of the 7-year study.

12.5.3. PGW Study Site Selection and Characterization

The following description is taken from Newcombe et al. (2005), more detailed descriptions are found in the Final Reports and Site Characterization reports for each of the eight studies (see Bibliography section).

PGW site selection criteria

Careful selection of PGW monitoring sites is critical to ensure that study results are useful in risk assessments and pesticide regulatory decisions. A combination of US EPA (US EPA 1995 and 1998) and ARP-specific site selection criteria were followed to locate candidate sites for the acetochlor PGW program. These criteria included;

- Uniform soil characteristics
- Unconfined aquifer
- Less than 9 m depth to the water table
- Less than or equal to 2% topographic slope
- Sufficient distance from drainage features to ensure stable hydraulic gradient conditions
- No impeding low-permeability layers between the surface and water table
- No prior acetochlor use
- Absence of seasonally high water tables
- Farmer and/or landowner cooperation
- Adherence to the acetochlor soil use restriction in the United States. This restriction prohibits the use of acetochlor on sands with less than 3% organic matter, loamy sands

with less than 2% organic matter, or sandy loams with less than 1% organic matter, when ground water is less than 9 m below land surface.

The US EPA required that studies be conducted on the following soil textures; loamy sand (1), sandy loam (2), loam (1) silt loam (3), and clay loam (1). This distribution includes most soils on which corn is grown in the United States, but is weighted towards coarser-textured soils.

Site identification

Preliminary site identification activities included a review of available soils, agronomy, and hydrogeologic data. Geographic Information System overlays of land use and soil type were created to identify sub-county areas for further investigation. During visits to candidate sites, preliminary surface-soil samples were collected for laboratory characterization, and hand auger borings collected to determine the nature of vadose zone material, and if possible, to determine depth to ground water at each site.

Site characterization

Site characterization activities included surface soil and subsoil characterization, aquifer characterization, and the conduct of a site survey. Surface soil (0-15 cm) was collected from each proposed PGW study location to assess variability of surface-soil texture, pH, organic matter, cation exchange capacity, and disturbed bulk density. Soil samples were collected using a stainless steel trowel or hand auger and shipped to a contract laboratory for characterization. Subsurface soil at each study location was characterized during piezometer or monitoring well installation activities. Boreholes for piezometer and monitoring well installation were advanced using 11-cm inner diameter, 150 cm-long hollow stem augers mounted on a drilling rig. Soil samples were collected during drilling operations using a 5-cm outer-diameter, 61-cm-long split-spoon sampling device. Split-spoon samples were placed on plastic sheeting for lithologic description and partitioned into discrete lithologic horizons, sub-sampled, then shipped to a contract laboratory for soil characterization.

Shelby tube sampling was conducted to obtain relatively undisturbed soil samples for the measurement of vertical saturated hydraulic conductivity and undisturbed bulk density. Soil samples were collected using 8-cm o.d., 76-cm-long steel Shelby tubes. A hollow-stem auger-drilling rig was used to advance the Shelby tube into the soil profile. Samples were scheduled to be collected in 61-cm increments from land surface to ground water; however the presence of coarse materials (cobbles and stones) in the vadose zone prevented the collection of continuous cores at two PGW study locations.

Aquifer properties were assessed by observations made during piezometer and monitoring-well drilling activities, and by measurements recorded after instrumentation. Aquifer characterization included the types of materials encountered below the water table, depths to ground water, ground water flow direction, hydraulic gradient, hydraulic conductivity, porosity, and pore-water velocity.

Table 1: Topography and Soil Characterization Summary

PGW Study Location	Slope (%)	NRCS Soil Series [†]	Surface Soil Organic Matter (%) [‡]	Surface Soil pH	Subsoil Textures [†]	Avg. Hydraulic Conductivity [§] (mm/hr)	
Wisconsin	<0.5	Richford loamy sand	1.6 [¶]	6.4	Loamy Sand	0-1.2 m	177
					Sand	1.2-2.4 m	358
					Sandy loam	2.4-3.6 m	810
						3.6-4.8 m	1482
						>4.8 m	776
Ohio	<0.5	Genessee silt loam	2.9	7.7	Clay loam	0-1.2 m	293
		Fox silt loam			Loam	1.2-2.4 m	153
					Sandy loam	2.4-3.6 m	NA
						3.6-4.8 m	NA
						>4.8 m	NA
Minnesota	<0.5	Estherville sandy loam	3.5	6.3	Sandy loam	0-1.2 m	180
					Loamy sand	1.2-2.4 m	331
					Sand	2.4-3.6 m	NA
						3.6-4.8 m	NA
						>4.8 m	NA
Nebraska	<0.5	Kenesaw	1.8	5.7	Loam	0-1.2 m	75
		silt loam			Silt loam	1.2-2.4 m	45
		Coly-Kenesaw				2.4-3.6 m	28
		silt loam				3.6-4.8 m	18
						>4.8 m	84
Iowa	<2	Marshall silty clay loam	3.9	5.6	Silty clay loam	0-1.2 m	207
		Minden silty clay loam			Silt loam	1.2-2.4 m	84
						2.4-3.6 m	172
						3.6-4.8 m	87
						>4.8 m	1.0
Indiana	<0.5	Door loam	3.0	6.7	Sandy clay loam	0-1.2 m	64
		Lydick loam			Sandy loam	1.2-2.4 m	190
					Sand	2.4-3.6 m	244
						3.6-4.8 m	742
						>4.8 m	978

Pennsylvania	<2	Clarksburg silt loam	2.7	6.3	Loam	0-1.2 m	382
					Sandy loam	1.2-2.4 m	138
		Duffield silt loam				2.4-3.6 m	95
					3.6-4.8 m	19	
					>4.8 m NA	NA	
Delaware	<1	Sassafras sandy loam	2.9	5.8	Sandy loam	0-1.2 m	30
					Loamy sand	1.2-2.4 m	86
					Sand	2.4-3.6 m	30
					3.6-4.8 m	129	
					>4.8 m	NA	

Depths to ground water were recorded to assess ground water flow direction and hydraulic gradients at each study location. Monitoring wells were instrumented with dedicated submersible pumps; consequently depths to ground water were only measured in the piezometers located at the corners of the test plot and on the periphery of the study location. Depths to ground water were measured manually from a fixed surveyed point on the top of the casing of each piezometer.

The depths to ground water and corresponding elevations were used to create ground water elevation contour maps for each ground water-sampling event at each study location. Ground water flow direction and hydraulic gradient were assessed from these contour maps.

Hydraulic gradients were estimated by calculating the difference in ground water elevation (m) between two points along a line-oriented perpendicular to the ground water elevation contour lines. The difference between ground water elevations was divided by the horizontal distance between the two points to obtain a resulting gradient (m/m).

Table 2: Aquifer Characterization Summary

PGW Study	Aquifer soil textures determined [†]	Depth to ground water [‡] (m)	Hydraulic Gradient (m/m) [§]	Hydraulic Conductivity (m/day)	Porosity (%)	Pore-water velocity (m/day) [¶]
Wisconsin	Loamy sand Sandy loam Sand	7.6-10	1.5×10^{-3}	0.16	40	1.9×10^{-3}
Ohio	Sandy loam Loamy sand	0.6-5.2	4.5×10^{-4}	17.9	35	0.8×10^{-1}
Minnesota	Sand Loamy sand Sandy loam	4.8-6.4	2.5×10^{-4}	14.5	32	0.4×10^{-1}
Nebraska	Silt loam Loam Sandy loam	7.0-9.7	5.4×10^{-4}	0.8	38	0.4×10^{-2}
Iowa	Sand Silt loam Loam	1.2-8.5	6.6×10^{-4}	13.1	32	0.9×10^{-1}
Indiana	Sand	7-9.1	1.0×10^{-3}	6.0	32	0.6×10^{-1}
Pennsylvania	Sandy loam Loam	1.8– 7.3	2.6×10^{-3}	1.7	40	0.4×10^{-1}
Delaware	Sand Sandy loam Loamy sand	3.3-6.1	4.2×10^{-4}	1.4	32	0.6×10^{-2}

[†] Soil texture determined by 3-fraction analysis (% sand, silt, and clay)

[‡] Depth to ground water listed is below ground surface, and minimum and maximum value determined in the test plot corner piezometers during the course of the study

[§] Hydraulic gradient listed is the average value determined during the course of the study

[¶] Pore-water velocity listed is the average value determined during the course of the study

Hydraulic conductivity of the aquifer was estimated by conducting rising or falling-head slug tests in randomly selected monitoring wells located in the test plot. The slug test data were used to calculate the hydraulic conductivity of the aquifer in the vicinity of the well, using standard formulae for monitoring wells screened in unconfined aquifers (Bouwer et al., 1976 and 1989).

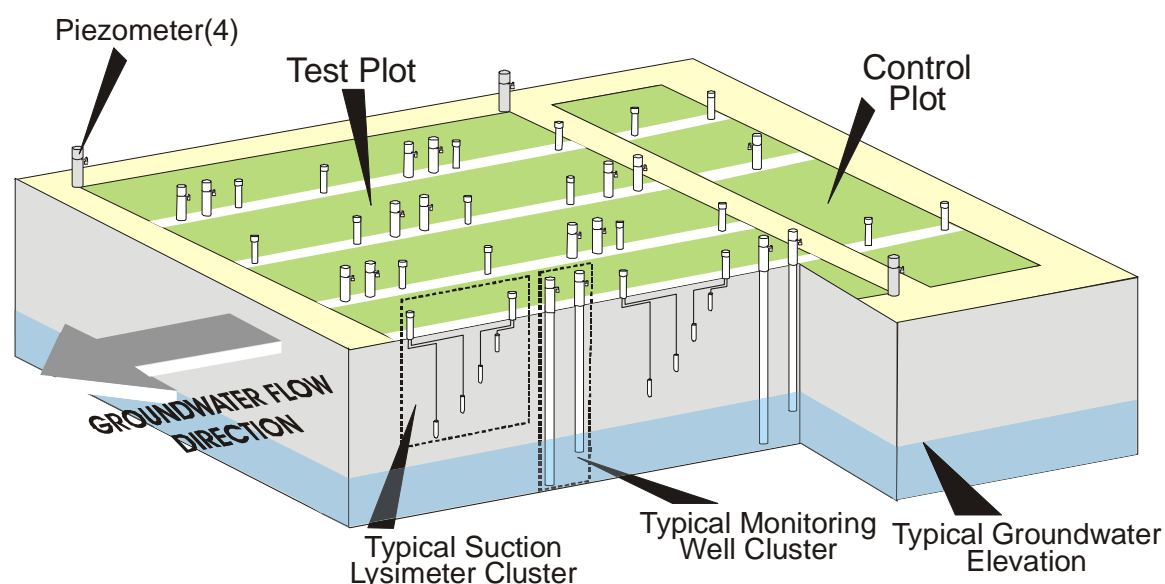
Porosity of the aquifer material was not measured directly, but was estimated empirically based on the types of sediments (Driscoll, 1986) encountered below the water table during monitoring well installation. Pore-water velocity values were calculated using hydraulic conductivity, hydraulic gradient, and porosity data.

Study design and instrumentation

Each PGW site was instrumented in accordance with the US EPA draft guidance document on the conduct of PGW studies (US EPA, 1995 and 1998) with the exception of the Wisconsin and Ohio PGW studies, which were initiated prior to the issue of US EPA's 1995 guidance document. The US EPA agreed to the instrumentation configuration for these studies prior to instrumentation.

Each PGW study consisted of an approximately 1.2-ha test plot adjacent to a 0.2-ha control plot. The control plot was located hydrogeologically upgradient from the test plot (Fig. 1). The test and control plots were instrumented with suction lysimeters (for sampling soil-pore water) installed at varying depths within the vadose zone, and ground water monitoring wells screened at varying depths within the aquifer (Fig. 1).

Figure 1: PGW Study Layout and Instrumentation



In summary, each PGW site was instrumented with seven piezometers to measure depths to ground water and to monitor variations in ground water flow direction and hydraulic gradient. A single piezometer was installed at each of the four-corners of the test plot (Fig. 1), and three piezometers were located around the periphery of the PGW study location.

Piezometers were constructed with flush-threaded, 5-cm-i.d., Schedule 40 polyvinyl chloride (PVC) casing and 0.25 mm slotted screen. Piezometers were completed above ground with a concrete pad, steel protective outer casing, and locking cap. Horizontal coordinates and top-of-casing elevations of each piezometer were professionally surveyed.

Monitoring wells were installed to collect ground water samples and were arranged in clusters within each test plot. For the Wisconsin and Ohio PGW studies, ten monitoring wells were installed at each PGW study location. One monitoring well was installed in each control plot, and three clusters of three monitoring wells were installed in each test plot. The clusters consisted of one shallow, one deep, and one extra deep monitoring well (Fig. 2).

For the six remaining PGW studies, 17 monitoring wells were installed at each PGW study location. One monitoring well was installed in each control plot, and eight clusters of two

monitoring wells were installed in each test plot. The clusters consisted of one shallow and one deep monitoring well (Fig. 3).

Approximate monitoring well screen lengths and positions were as follows:

- | | |
|-----------------------------|--|
| Control plot well: | 4.5 m screen positioned with approximately 1.5 m of screen above the water table at the time of well installation. |
| Test plot shallow wells: | 3 m screen positioned with approximately 1.5 m of screen above the water table at the time of well installation. |
| Test plot deep wells: | 1.5 m screen positioned approximately 1.5 m below the water table at the time of well installation. |
| Test plot extra-deep wells: | (Wisconsin and Ohio only): 1.5 m screen positioned approximately 3 m below the water table at the time of well installation. |

The positioning of each monitoring well screen at each PGW site was dictated by the depth to ground water encountered during monitoring well borehole advancement. Screens for the shallow monitoring wells were 3 m in length, to enable ground water samples to be collected in the event the depth to ground water increased after monitoring well installation. Monitoring well clusters were installed in a linear arrangement, with a 3-meter distance between each monitoring well within a cluster. Monitoring wells were constructed as described for the piezometers.

APPENDIX

12.6. Analytical Method Summary Descriptions for the ARP Monitoring Programs

SDWS Study (from Hackett et al., 2005)

Sample Analysis

We employed two analytical methods, one for parent compounds and the other for degradates. Both relied on mass spectrometry for detection. Samples were generally not filtered prior to analysis, although raw water samples occasionally required the use of a sea sand filtration step. Parent herbicides were analyzed using stable isotope dilution gas chromatography/mass spectrometry (GC/MS), preceded by solid phase extraction for cleanup and concentration (Fuhrman et al. 1996). The method involved addition of deuterated analogs of each analyte, as internal standards, to a 200 mL water sample prior to extraction, concentration, and analysis. We analyzed for the oxanilic and sulfonic acid degradates of acetochlor, alachlor, and metolachlor by direct aqueous injection reversed-phase liquid chromatography tandem mass spectrometry (LC/MS/MS). The samples were injected directly into an LC/MS/MS (HP1100/Sciex API-3000) without prior concentration, cleanup or filtration (Hackett et al. 2003). All surface water samples were refrigerated at 2-10 °C upon receipt at Monsanto, before extraction or preparation for analysis. Replicate samples were transferred to a freezer at -20 ± 5 °C. Sample extracts were either analyzed immediately or refrigerated at 2-10 °C until analysis. All reported analytes demonstrated acceptable storage stability under these conditions, which was confirmed both through separate storage stability studies and by analysis of field-fortified samples. The median times from collection to extraction and collection to analysis were 7 and 9 days, respectively.

SGW Study (from de Guzman et al., 2005)

Analytical Methodology

Ground water samples were analyzed for parent acetochlor, alachlor, atrazine and metolachlor during the first four years of the SGM. For the final three years, samples were also analyzed for the tertiary amide soil degradates of acetochlor, alachlor and metolachlor, specifically tertiary amide sulfonic acid (ESA) and tertiary amide oxanilic acid (OXA). A complete list of the target compounds, including common name, chemical name and CAS number, is as follows: acetochlor (2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)-acetamide), CAS No. 34256-82-1, alachlor (2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)-acetamide), CAS No. 15972-60-8, atrazine (6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine), CAS No. 1912-24-9, metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)-acetamide), CAS No. 51218-45-2, acetochlor oxanilic acid ([[(ethoxymethyl)(2-ethyl-6-methylphenyl)amino]-oxoacetic acid, sodium salt), CAS No. 194992-44-4 (free acid), acetochlor sulfonic acid (2-[(ethoxymethyl)(2-ethyl-6-methylphenyl)amino]-2-oxoethanesulfonic acid,

sodium salt), CAS No. 187022-11-3 (free acid), alachlor oxanilic acid ([2,6-diethylphenyl)(methoxymethyl)amino]-oxoacetic acid, sodium salt), CAS Nos. 140939-14-6 (free acid) and 171262-17-2 (free acid), alachlor sulfonic acid (2-[(2,6-diethylphenyl)(methoxymethyl)amino]-2-oxoethanesulfonic acid, sodium salt), CAS Nos. 140939-15-7 (sodium salt) and 142363-53-9 (free acid), metolachlor oxanilic acid [(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl)amino]oxoacetic acid, sodium salt), CAS No. 152019-73-3 (free acid), and metolachlor sulfonic acid (2-[(2-ethyl-6-methylphenyl)(2-methoxy-1-methylethyl)amino]-2-oxoethanesulfonic acid, sodium salt), CAS No. 171118-09-5 (free acid). GC/MS method for parent herbicides. Parent herbicides were analyzed using stable isotope dilution gas chromatography/mass spectrometry (GC/MS), which was preceded by solid phase extraction for cleanup and concentration. The method involved addition of deuterated analogs of each analyte, as surrogates, to the 200-mL sample prior to extraction, concentration, and analysis (Fuhrman et al., 1996). Based on actual prior fortification data, the Limit of Detection (LOD) and Limit of Quantification (LOQ) of this method was determined to be 0.03 µg L⁻¹ and 0.05 µg L⁻¹, respectively, for all non-polar analytes (Hackett et al., 2003), with the exception of alachlor, whose LOD was 0.05 µg L⁻¹ due to higher background levels of this compound. LC/MS/MS method for chloroacetanilide degradates. The ESA and OXA soil degradates of acetochlor, alachlor, and metolachlor were analyzed by direct aqueous injection reversed-phase liquid chromatography tandem mass spectrometry (LC/MS/MS). The samples were injected directly into the LC/MS/MS (HP1100/Sciex API-3000) without prior concentration, cleanup or filtration (Hackett et al., 2003). Based on actual prior fortification data, the LOQ of all six polar degradates was determined to be 0.50 µg L⁻¹. The LOD for the three OXA soil degradates was 0.10 µg L⁻¹, and for the three ESA soil degradates, the LOD was 0.20 µg L⁻¹. Storage stability. All ground water samples were stored in a refrigerator at 2 - 10 °C upon receipt at Monsanto, before extraction or preparation for analysis. Replicate samples were transferred to a freezer at -20 °C ± 5 °C. Sample extracts were either analyzed immediately or stored in a refrigerator at 2 - 10 °C before analysis. All reported analytes demonstrated acceptable storage stability under these conditions.

PGW Study (from Newcombe et al., 2005)

Analytical methodology

Three laboratory facilities were used to analyze acetochlor PGW program samples; (1) Zeneca Agrochemicals, Jealott's Hill Research Centre, Bracknell, United Kingdom, (2) Covance Laboratories, Harrogate, United Kingdom, (3) Monsanto Company St. Louis, MO, USA. Limits of detection (LOD) and LOQ varied slightly among the methods used at the various laboratories and are briefly summarized below. The common names, chemical names and structures, and CAS registry numbers of the analytes of interest are provided in Table 4.

Potassium bromide – soil-pore water and ground water

Bromide residues in water were determined using ion chromatography (IC) with conductivity detection. Water samples were analyzed directly by IC with no sample pre-treatment required. The LOQ of the analytical method was 100 µg L⁻¹ and the LOD approximately 30 µg L⁻¹. Acetochlor – soil

Acetochlor residues in soil were determined by gas-liquid chromatography (GC) using a Mass Selective Detector (MSD). The LOQ of the analytical method was 0.01 mg kg⁻¹ and the LOD was approximately 0.005 mg kg⁻¹. For the application rate verification analysis, where acetochlor residues were significantly higher, the LOD was calculated as 0.02 mg kg⁻¹.

APPENDIX

12.7. Statistical Analyses for the ARP monitoring Studies

12.7.1. SDWS

12.7.1.1. Pearson Product Moment Correlation Coefficients for Raw vs. Finished Water Samples

Correlation coefficients and coefficients of determination for raw versus finished water samples for each of the P-1 study sites in the surface drinking water data set were derived using the CORR procedure in SAS version 9.1 (SAS 2004). This analysis was aimed at determining whether finished water concentrations observed at facilities that utilize activated charcoal in water treatment (the only sites for which the raw water analytical results are available) could be predicted by raw water concentrations observed at that facility. Finished and raw water observations were paired by site and by the date the sample was collected.

A correlation coefficient (r) is an index of the degree linear association of two variables, X and Y generated using a simple linear regression model to predict variable Y from variable X . Correlation coefficients are directional in that variables exhibit positive and negative correlations. The coefficient of determination (r^2) provides an estimate of how well the relationship can be defined by a straight line and is neither positive nor negative.

Table 35 provides correlation coefficients for raw versus finished surface water samples for all P-1 sites in the SDWS data set. In nearly half the cases (43%), finished water samples were moderately to strongly associated ($r \geq 0.75$) with observed raw water concentrations. For 30% of the sites, raw water concentrations explained at least 75% of the variability in finished water concentrations, and in 50 % of the cases raw water concentrations explained at least half ($r^2 \geq 0.5$) of the variability in finished water concentrations using a simple linear model. In general increasing the sample size (N) did not result in an increase in correlation between raw and finished water concentrations. Lack of correspondence for some sites may be partially a result of differences in sampling times for raw and finished samples and the uncertainty in residence time for each of the water treatment facilities. Because there is a time lag from when water enters the intake (raw water) to when the treatment processes in completed (finished water) it is unlikely that raw and finished samples were taken from the same volume of water.

Table 35. Pearson product-moment correlation coefficients for raw versus finished water parent acetochlor concentrations observed at the P-1 sites in the SDWS monitoring data set.

Site ID	N	Correlation Coefficient (r)	Coefficient of Determination (r^2)
168-PA-IL	98	0.9932	0.9864
1009-CO-MO	83	0.9895	0.9792

Table 35. Pearson product-moment correlation coefficients for raw versus finished water parent acetochlor concentrations observed at the P-1 sites in the SDWS monitoring data set.

Site ID	N	Correlation Coefficient (<i>r</i>)	Coefficient of Determination (<i>r</i> ²)
346-SA-IN	28	0.9841	0.9684
89-MI-KS	71	0.9739	0.9484
301-BL-NE	14	0.9696	0.9401
1070-WY-MO	84	0.9692	0.9393
228-SA-IL	98	0.9552	0.9124
225-CE-IL	70	0.9409	0.8853
606-KA-IL	98	0.9276	0.8604
582-WI-IA	98	0.9039	0.8171
344-DU-IN	98	0.9016	0.8128
556-DA-IA	70	0.8858	0.7847
152-BR-IL	83	0.8745	0.7648
603-BL-IL	98	0.8545	0.7302
259-SP-IL	98	0.8478	0.7188
557-DM-IA	91	0.8390	0.7039
351-SE-IN	43	0.7851	0.6164
245-OL-IL	98	0.7773	0.6042
577-RA-IA	98	0.7551	0.5702
268-NA-IL	98	0.7346	0.5397
1092-SL-MO	27	0.7324	0.5365
574-OS-IA	98	0.7101	0.5042
197-EL-IL	98	0.6670	0.4449
1016-HI-MO	70	0.6544	0.4282
155-CH-IL	42	0.6101	0.3722
328-KO-IN	57	0.5966	0.3559
222-HI-IL	98	0.5764	0.3323
244-SP-IL	98	0.5636	0.3177
296-SC-MN	98	0.4836	0.2338
170-AL-IL	98	0.4469	0.1997
345-RI-IN	43	0.4403	0.1938
593-HE-PA	98	0.3897	0.1519
997-WE-PA	98	0.3806	0.1449
452-MC-OH	14	0.3340	0.1116
242-CO-IL	56	0.3283	0.1078
18-OK-WI	98	0.2517	0.0633
548-CH-IA	28	0.2080	0.0433
1069-VA-MO	84	0.2036	0.0414
569-MI-IA	83	0.1976	0.0390
1038-GA-MO	14	0.1393	0.0194

Table 35. Pearson product-moment correlation coefficients for raw versus finished water parent acetochlor concentrations observed at the P-1 sites in the SDWS monitoring data set.

Site ID	N	Correlation Coefficient (<i>r</i>)	Coefficient of Determination (<i>r</i> ²)
737-AW-PA	98	0.1008	0.0102
332-MC-IN	98	0.0935	0.0087
13-AP-WI	98	0.0517	0.0027
371-AL-OH	14	0.0146	0.0002

The effect of water treatment on acetochlor concentrations in the surface drinking water supplies was also examined. A paired two sample t-test for means was performed on those sites and sample dates that had both raw and finished water observations. Results of the t-test are provided in Table 36. Statistical analysis indicates that water treatment plants that use granulated activated carbon (GAC) or powdered activated carbon (PAC) significantly reduce acetochlor concentrations in drinking water ($p < 0.001$)

Table 36. Paired t-test for raw versus finished water samples.

	RAW	FINISHED
Mean	0.076	0.030
Variance	0.097	0.030
Observations	3325	3325
Pearson Correlation	0.858	
Hypothesized Mean Difference	0.000	
df	3324.000	
t Stat	14.296	
P(T<=t) one-tail	<0.001	
t Critical one-tail	1.645	
P(T<=t) two-tail	<0.001	
t Critical two-tail	1.961	

12.7.1.2. Analysis of Factors Related to Occurrence of Acetochlor

For parent acetochlor, the most toxic of residues, surface water is the dominant medium of exposure. Consequently, the focus of statistical analysis was on factors related to occurrence in surface drinking water supplies. Two levels of analysis were required. The first analysis examined environmental variables that could potentially explain the temporal variability in acetochlor concentrations *within a site* (e.g., rainfall amounts). The second level of analysis examined environmental variables that could potentially explain the spatial variability *among sites* (e.g., watershed size, corn intensity, etc.).

The tables in the following section present Pearson's correlation matrices for surface drinking water sites, individually for raw and finished water samples. Correlation coefficients greater than 0.5 are shown in shaded cells and bold font.

In general, the ancillary variables that were available were unable to explain a significant amount of the variability in maximum observed concentrations (acute exposure), average TWAMS, and maximum TWAMs (chronic exposure). It was originally expected that acetochlor acute and chronic exposure would be moderately to strongly correlated with the variability in acetochlor sales in the associated watersheds, however sales were only weakly correlated ($r < 0.5$).

Some associations were observed between ancillary variables as expected. For example, watershed corn intensity was moderately to strongly correlated with the watershed runoff curve number (RCN) with correlation coefficients (r^2) ranging from 0.78 for all sites where raw water samples were collected to 0.82 for only those sites where finished water samples were collected. The correlation between runoff curve number and watershed corn intensity is not surprising, since land cover is a factor in generating the curve number.

The lack of correlation between watershed corn intensity (% of watershed cropped as corn) and watershed sales was unexpected. Part of the explanation may be related to violations of the assumption that acetochlor sold in a county is actually applied in the same county. Additionally, the total area cropped in a watershed is likely to be more correlated to total sales in a watershed. Refining the sales estimate to be more reflective of actual usage in the county is also likely to improve the correlation. In the current analysis, maximum and average watershed sales were determined using GIS to compute an average and maximum sales value for all counties that were wholly or partially within the drainage area for a site. This is only a coarse estimate that could be refined by weighting the values in each county by the fraction of the county that is within the drainage area. One option would be to employ the methodology used by the USGS to generate pesticide usage. Additional analysis may be necessary to investigate the relationship between watershed sales and watershed corn intensity. This may

12.7.2.CORRELATION MATRICES (r^2) FOR FACTORS RELATED TO THE OCCURRENCE OF ACETOCHLOR IN SURFACE DRINKING WATER SUPPLIES.

TYPE=RAW ANALYTE=ACETOCHLOR

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN)
MAX CONC	1	0.90968	0.80287	-0.03763	0.0155	0.02844	-0.099	0.19272	-0.03778	0.09178	0.12141
p=		<.0001	<.0001	0.8201	0.9254	0.8414	0.5488	0.1711	0.7903	0.5441	0.4215
MAX TWAM		1	0.91683	0.10095	0.14664	0.04916	-0.07858	0.31534	0.03282	-0.03133	0.10452
p=			<.0001	0.5409	0.373	0.7293	0.6344	0.0228	0.8173	0.8363	0.4894
AVG TWAM			1	0.16822	0.2084	0.1089	-0.1052	0.39726	0.13515	-0.05047	0.0989
p=				0.306	0.203	0.4422	0.5239	0.0035	0.3394	0.739	0.5132
MAX_WS_SALES				1	0.91023	-0.06938	0.04003	0.69005	0.01621	-0.23407	-0.18546
p=					<.0001	0.6747	0.8088	<.0001	0.922	0.1515	0.2583
AVG_WS_SALES					1	-0.02849	-0.14627	0.76207	0.02463	-0.08057	-0.00725
p=						0.8633	0.3743	<.0001	0.8817	0.6258	0.9651
WS_CORN_INT						1	0.0049	0.18291	0.78228	0.09362	0.28261
p=							0.9764	0.1943	<.0001	0.536	0.057
WSHED_AREA_ACRES							1	-0.22928	-0.05634	-0.66987	-0.64615
p=								0.1603	0.7334	<.0001	<.0001
WS_RUNOFF_RATING								1	0.2287	-0.1193	0.02634
p=									0.1029	0.4297	0.862
WS_RCN									1	0.26665	0.25775
p=										0.0732	0.0837
AVE_PPT										1	0.70699
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

TYPE=RAW ANALYTE=AC_ESA

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN)
MAX CONC	1	0.93765	0.92534	0.35044	0.40398	-0.00239	-0.18141	0.50226	0.04886	0.08075	0.03614
p=		<.0001	<.0001	0.031	0.0119	0.9867	0.2757	0.0002	0.7335	0.598	0.8137
MAX TWAM		1	0.98928	0.38003	0.46886	0.0824	-0.22055	0.51583	0.13918	0.08355	0.05036
p=			<.0001	0.0186	0.003	0.5654	0.1833	0.0001	0.33	0.5853	0.7425
AVG TWAM			1	0.36782	0.44719	0.08639	-0.2176	0.53202	0.16759	0.07717	0.02955
p=				0.0231	0.0049	0.5466	0.1894	<.0001	0.2398	0.6144	0.8472
MAX_WS_SALES				1	0.90986	-0.07213	0.03606	0.6861	0.01931	-0.21605	-0.17224
p=					<.0001	0.6669	0.8298	<.0001	0.9084	0.1927	0.3011
AVG_WS_SALES					1	-0.03033	-0.14992	0.76113	0.02693	-0.06323	0.00493
p=						0.8566	0.369	<.0001	0.8725	0.7061	0.9766
WS_CORN_INT						1	0.00394	0.1833	0.78283	0.10375	0.29088
p=							0.9813	0.1979	<.0001	0.4976	0.0526
WSHED_AREA_ACRES							1	-0.23749	-0.0552	-0.68354	-0.6485
p=								0.1511	0.742	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23354	-0.09106	0.04801
p=									0.0991	0.5519	0.7541
WS_RCN									1	0.27109	0.25881
p=										0.0717	0.086
AVE_PPT										1	0.69863
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

MAX CONC = maximum observed concentration at each site; MAX TWAM = maximum time-weighted annualized mean for each site; AVG TWAM = average time-weighted annualized mean for each site; MAX_WS_SAL = average sales (94-03) for the county with the highest average sales in the watershed; AVG_WS_SAL = average sales (94-03) for all counties located in the intake drainage area; WS_CORN_INT = watershed corn intensity (defined as the percent of total watershed area planted in corn based on area-weighted county level USDA data for 1992 (USDA, 1994); WSHED_AREA = watershed area draining to surface water intake location; WS_RUNOFF = watershed runoff rating; WS_RCN = watershed runoff curve number; AVE_PPT = 30-yr average precipitation for the site; AVE_SPR = 30-yr average spring rainfall (April - June).

TYPE=RAW ANALYTE=AC_OXA

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN)
MAX CONC	1	0.93301	0.91866	0.13114	0.18678	-0.0324	-0.16615	0.25298	0.05454	0.13176	0.01277
p=		<.0001	<.0001	0.4326	0.2615	0.8214	0.3188	0.0733	0.7039	0.3883	0.9337
MAX TWAM		1	0.98943	0.18408	0.26059	0.08263	-0.19169	0.26467	0.13518	0.13598	0.06509
p=			<.0001	0.2686	0.1141	0.5643	0.2489	0.0605	0.3443	0.3731	0.671
AVG TWAM			1	0.20066	0.2704	0.09252	-0.18483	0.28301	0.16429	0.12939	0.0396
p=				0.2271	0.1006	0.5184	0.2666	0.0442	0.2493	0.3969	0.7962
MAX_WS_SALES				1	0.90986	-0.07213	0.03606	0.6861	0.01931	-0.21605	-0.17224
p=					<.0001	0.6669	0.8298	<.0001	0.9084	0.1927	0.3011
AVG_WS_SALES					1	-0.03033	-0.14992	0.76113	0.02693	-0.06323	0.00493
p=						0.8566	0.369	<.0001	0.8725	0.7061	0.9766
WS_CORN_INT						1	0.00394	0.1833	0.78283	0.10375	0.29088
p=							0.9813	0.1979	<.0001	0.4976	0.0526
WSHED_AREA_ACRES							1	-0.23749	-0.0552	-0.68354	-0.6485
p=								0.1511	0.742	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23354	-0.09106	0.04801
p=									0.0991	0.5519	0.7541
WS_RCN									1	0.27109	0.25881
p=										0.0717	0.086
AVE_PPT										1	0.69863
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1

TYPE=FINISHED ANALYTE=ACETOCHLOR

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN)
MAX CONC	1	0.9427	0.86867	0.14362	0.16023	0.09696	-0.04165	0.21547	0.12951	-0.01151	-0.05418
p=		<.0001	<.0001	0.0746	0.0464	0.1537	0.6069	0.0014	0.0562	0.8774	0.4676
MAX TWAM		1	0.89153	0.1383	0.16995	0.14409	-0.04334	0.24343	0.17299	-0.05567	-0.07242
p=			<.0001	0.0861	0.0345	0.0335	0.5923	0.0003	0.0105	0.4554	0.3313
AVG TWAM			1	0.22615	0.20047	0.09705	-0.03819	0.31138	0.18002	-0.07154	-0.1104
p=				0.0047	0.0124	0.1533	0.6371	<.0001	0.0077	0.3372	0.1379
MAX_WS_SALES				1	0.89329	-0.00252	0.0892	0.71138	0.01268	-0.28792	-0.26106
p=					<.0001	0.9752	0.2697	<.0001	0.8755	0.0003	0.001
AVG_WS_SALES					1	0.02687	-0.0681	0.74732	-0.01835	-0.2415	-0.18251
p=						0.74	0.3998	<.0001	0.8207	0.0025	0.023
WS_CORN_INT						1	-0.08315	0.2414	0.81822	0.07058	0.26884
p=							0.3037	0.0003	<.0001	0.3438	0.0002
WSHED_AREA_ACRES							1	-0.08321	-0.10273	-0.46226	-0.44379
p=								0.3033	0.2034	<.0001	<.0001
WS_RUNOFF_RATING								1	0.22106	-0.1422	-0.19303
p=									0.001	0.0555	0.009
WS_RCN									1	0.11193	0.15593
p=										0.1325	0.0356
AVE_PPT										1	0.60527
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

MAX CONC = maximum observed concentration at each site; MAX TWAM = maximum time-weighted annualized mean for each site; AVG TWAM = average time-weighted annualized mean for each site; MAX_WS_SAL = average sales (94-03) for the county with the highest average sales in the watershed; AVG_WS_SAL = average sales (94-03) for all counties located in the intake drainage area; WS_CORN_IN = watershed corn intensity (defined as the percent of total watershed area planted in corn based on area-weighted county level USDA data for 1992 (USDA, 1994); WSHED_AREA = watershed area draining to surface water intake location; WS_RUNOFF = watershed runoff rating; WS_RCN = watershed runoff curve number; AVE_PPT = 30-yr average precipitation for the site; AVE_SPR = 30-yr average spring rainfall (April - June).

TYPE=FINISHED ANALYTE=AC_ESA

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN E)
MAX CONC	1	0.83489	0.81411	0.28225	0.2827	0.15449	-0.08288	0.42043	0.22937	-0.07571	-0.13567
p=		<.0001	<.0001	0.0007	0.0007	0.0278	0.3303	<.0001	0.001	0.3308	0.0804
MAX TWAM		1	0.9757	0.32186	0.35346	0.20089	-0.10542	0.44736	0.27	-0.12625	-0.17281
p=			<.0001	0.0001	<.0001	0.0041	0.2151	<.0001	<.0001	0.104	0.0255
AVG TWAM			1	0.37042	0.40565	0.20608	-0.09916	0.50223	0.26727	-0.13097	-0.18918
p=				<.0001	<.0001	0.0032	0.2437	<.0001	0.0001	0.0916	0.0143
MAX_WS_SALES				1	0.89848	0.00297	0.09208	0.71218	0.01218	-0.30334	-0.26312
p=					<.0001	0.9722	0.2792	<.0001	0.8864	0.0003	0.0017
AVG_WS_SALES					1	0.02455	-0.07068	0.74803	-0.01119	-0.23449	-0.17726
p=						0.7734	0.4067	<.0001	0.8956	0.0053	0.0362
WS_CORN_INT						1	-0.0814	0.24167	0.82681	0.07485	0.27167
p=							0.339	0.0005	<.0001	0.3363	0.0004
WSHED_AREA_ACRES							1	-0.0874	-0.09998	-0.48056	-0.44911
p=								0.3045	0.2399	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23259	-0.1407	-0.18504
p=									0.0008	0.0697	0.0167
WS_RCN									1	0.11822	0.16063
p=										0.1281	0.0381
AVE_PPT										1	0.62157
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

FINISHED ANALYTE=AC_OXA

	MAX CONC	MAX TWAM	AVG TWAM	MAX_WS_SALES	AVG_WS_SALES	WS_CORN_INT	WSHED_AREA_ACRES	WS_RUNOFF_RATING	WS_RCN	AVE_PPT	AVE_SPR(APR_MAY_JUN E)
MAX CONC	1	0.73401	0.72528	0.20807	0.21914	0.15941	-0.07487	0.32559	0.22749	0.00018	-0.04199
p=		<.0001	<.0001	0.0136	0.0093	0.0231	0.3793	<.0001	0.0011	0.9982	0.59
MAX TWAM		1	0.96304	0.21535	0.27765	0.25049	-0.10435	0.31642	0.28598	-0.08452	-0.07366
p=			<.0001	0.0106	0.0009	0.0003	0.2198	<.0001	<.0001	0.2775	0.3441
AVG TWAM			1	0.2776	0.3396	0.24915	-0.09597	0.38097	0.27995	-0.08497	-0.09639
p=				0.0009	<.0001	0.0003	0.2593	<.0001	<.0001	0.275	0.2153
MAX_WS_SALES				1	0.89848	0.00297	0.09208	0.71218	0.01218	-0.30334	-0.26312
p=					<.0001	0.9722	0.2792	<.0001	0.8864	0.0003	0.0017
AVG_WS_SALES					1	0.02455	-0.07068	0.74803	-0.01119	-0.23449	-0.17726
p=						0.7734	0.4067	<.0001	0.8956	0.0053	0.0362
WS_CORN_INT						1	-0.0814	0.24167	0.82681	0.07485	0.27167
p=							0.339	0.0005	<.0001	0.3363	0.0004
WSHED_AREA_ACRES							1	-0.0874	-0.09998	-0.48056	-0.44911
p=								0.3045	0.2399	<.0001	<.0001
WS_RUNOFF_RATING								1	0.23259	-0.1407	-0.18504
p=									0.0008	0.0697	0.0167
WS_RCN									1	0.11822	0.16063
p=										0.1281	0.0381
AVE_PPT										1	0.62157
p=											<.0001
AVE_SPR(APR_MAY_JUNE)											1
p=											

MAX CONC = maximum observed concentration at each site; MAX TWAM = maximum time-weighted annualized mean for each site; AVG TWAM = average time-weighted annualized mean for each site; MAX_WS_SAL = average sales (94-03) for the county with the highest average sales in the watershed; AVG_WS_SAL = average sales (94-03) for all counties located in the intake drainage area; WS_CORN_INT = watershed corn intensity (defined as the percent of total watershed area planted in corn based on area-weighted county level USDA data for 1992 (USDA, 1994); WSHED_AREA = watershed area draining to surface water intake location; WS_RUNOFF = watershed runoff rating; WS_RCN = watershed runoff curve number; AVE_PPT = 30-yr average precipitation for the site; AVE_SPR = 30-yr average spring rainfall (April - June).

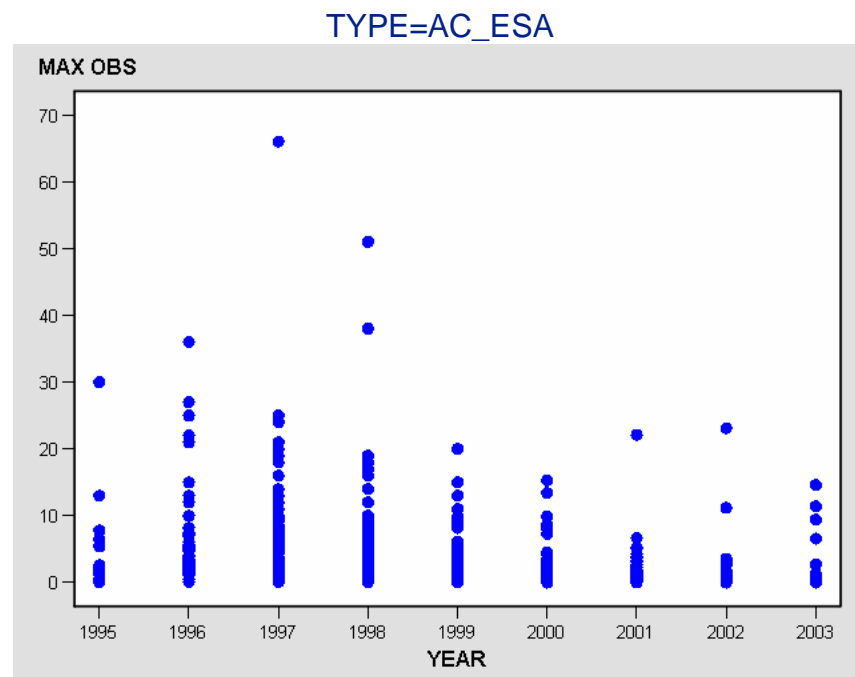
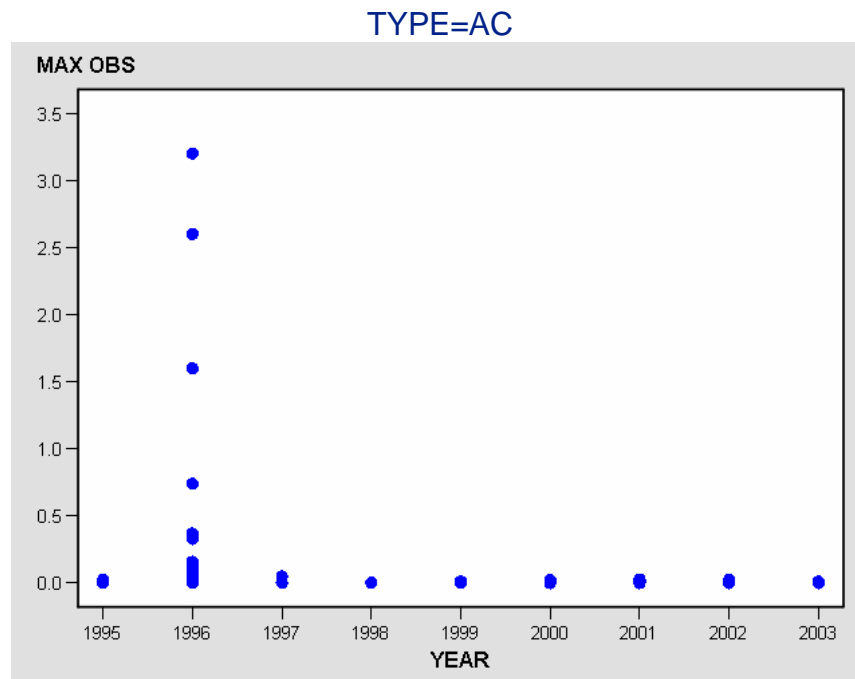
Time-weighted means over time

PGW maximum observations for each lysimeter as well as time-weighted means derived from the censored data file were examined for trends over time. Plots of time-weighted means versus year are provided in the subsequent section. In general, peak concentrations of acetochlor, ESA, and OXA were greatest in the early years of monitoring from 1996 to 1998. Bromide peak concentrations tended to be highest during 1998. Highest time weighted means for acetochlor, ESA, and OX were observed between 1996 and 1998.

12.7.3. MAXIMUM OBSERVED CONCENTRATIONS (PER YEAR) OVER TIME FOR THE PGW STUDIES.

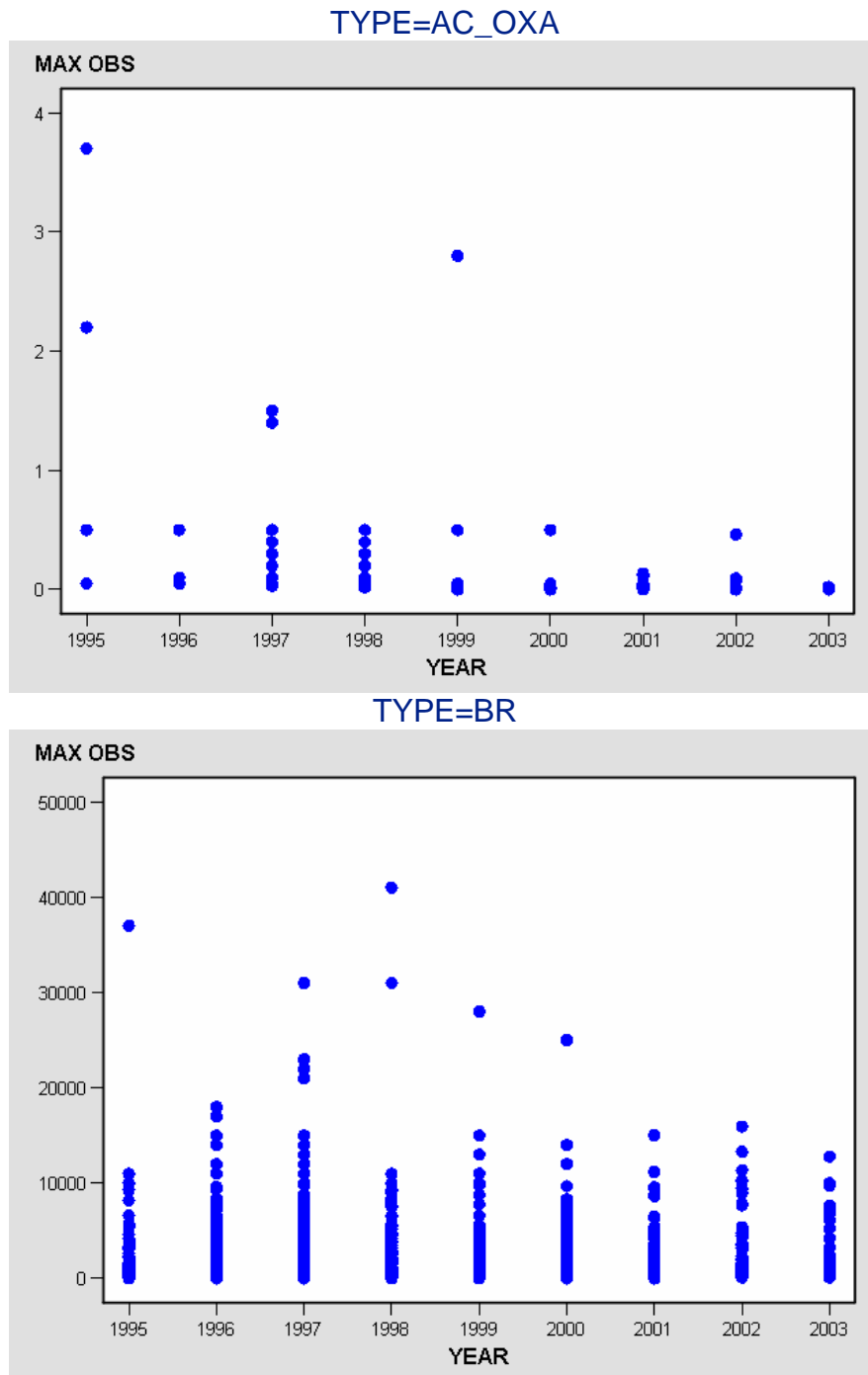
Correlations Plots

Scatter plot of 'MAX OBS' by YEAR



Correlations Plots

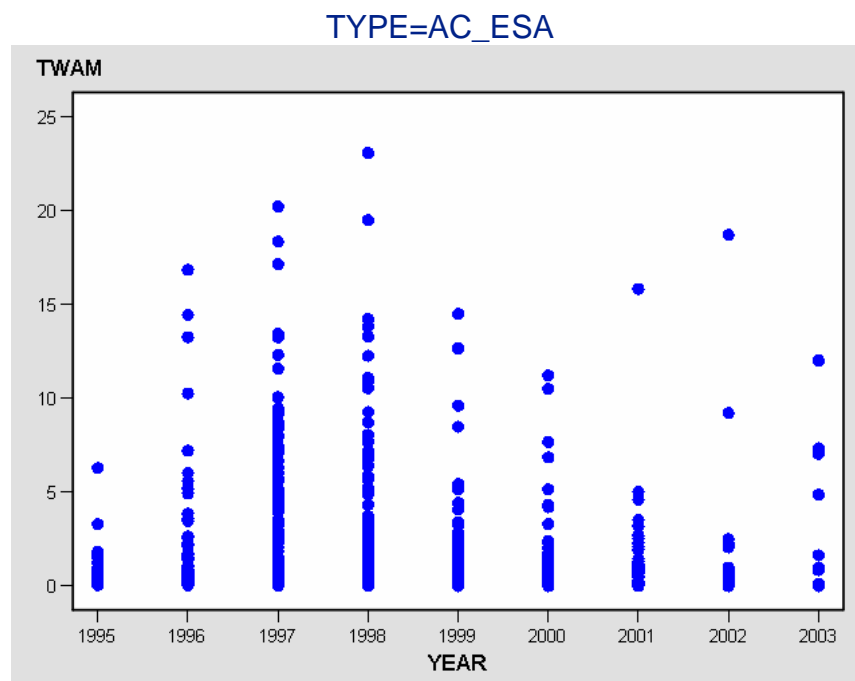
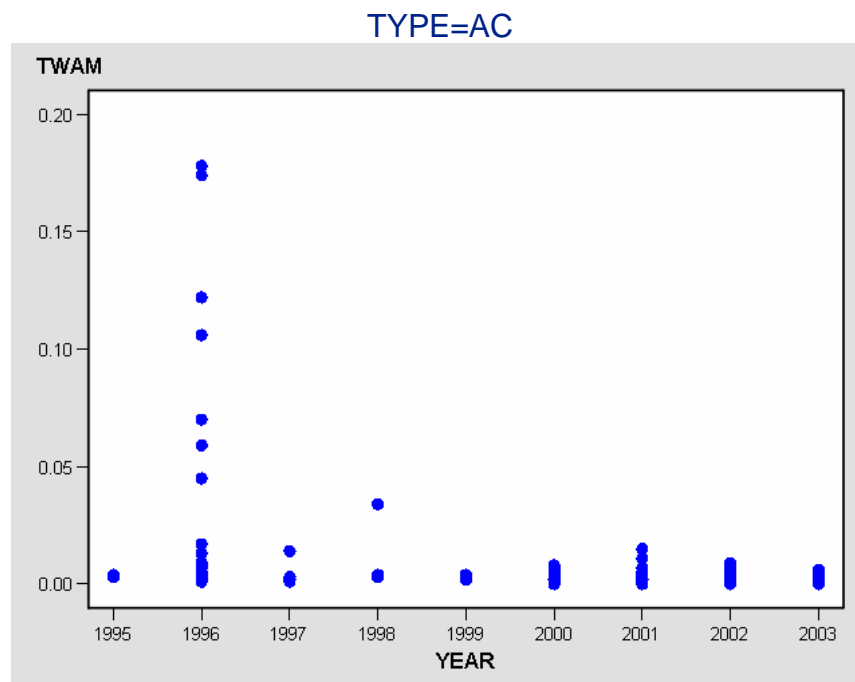
Scatter plot of 'MAX OBS' by YEAR



12.7.4. TIME-WEIGHTED ANNUALIZED MEANS OVER TIME FOR THE PGW STUDIES.

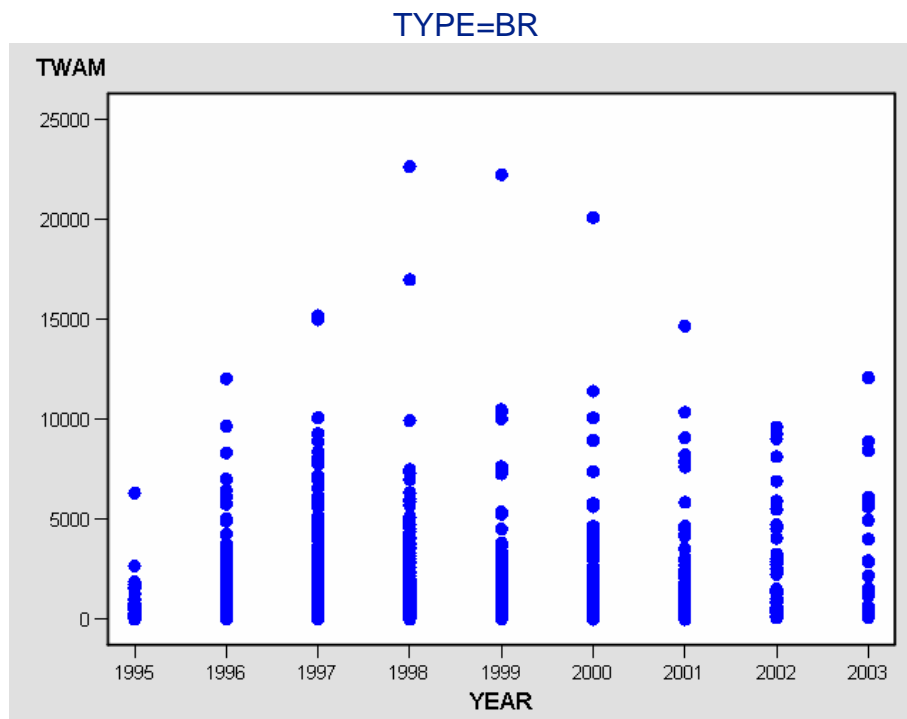
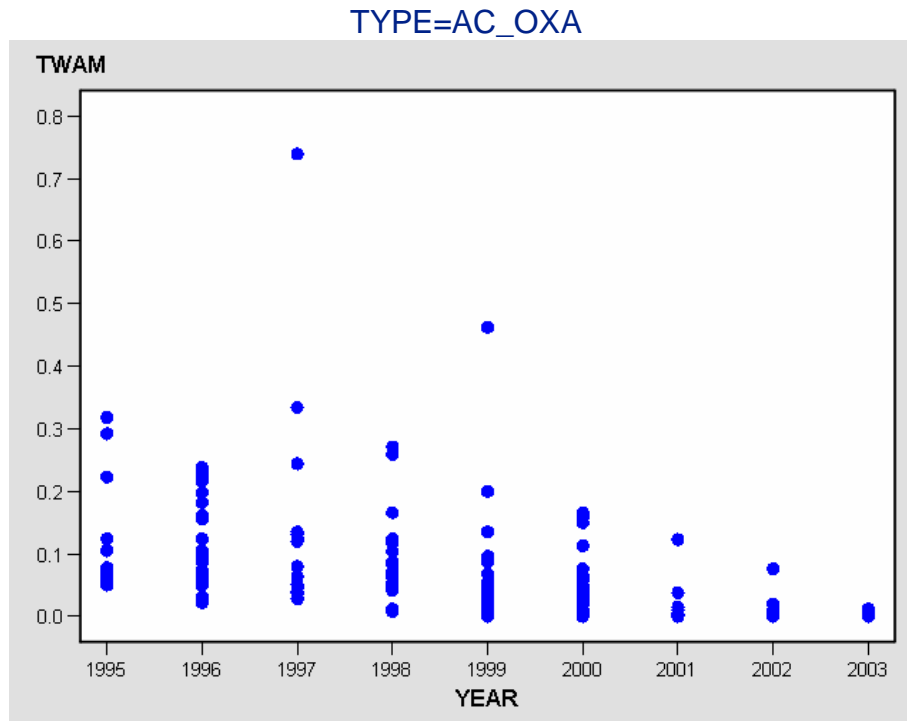
Correlations Plots

Scatter plot of TWAM by YEAR



Correlations Plots

Scatter plot of TWAM by YEAR



12.7.5. CORRELATION MATRICES (r^2) FOR FACTORS RELATED TO ACETOCHLOR
ACUTE EXPOSURE IN THE PROSPECTIVE GROUND WATER STUDIES.

Pearson Correlation Coefficients Prob > r under H0: Rho=0 Number of Observations												
	AE_3FT	AE_9FT	AE_SHGW	PPT3MOS	PPT1YR	PPT2YR	PPT3YR	PPT4YR	PPT_TOT	AVG_HC	AVG_PWV	AVG_HG
AE_3FT	1	-0.22757	-0.31336	-0.07682	0.40856	0.1471	0.05601	0.09501	0.05572	-0.18503	-0.12216	0.53558
p=		0.5878	0.4938	0.8565	0.3149	0.7281	0.8952	0.8229	0.8957	0.6609	0.7732	0.1713
AE_9FT		1	0.5803	-0.12632	0.04307	0.59107	0.30713	0.32253	0.076	0.33555	0.17678	-0.03546
p=			0.172	0.7657	0.9194	0.1228	0.4593	0.4359	0.858	0.4165	0.6754	0.9336
AE_SHGW			1	-0.09752	-0.41872	0.31223	-0.1394	0.062	0.54038	-0.04658	-0.39305	0.02066
p=				0.8352	0.3498	0.4954	0.7656	0.8949	0.2105	0.921	0.3831	0.9649
PPT3MOS				1	-0.35631	-0.2604	-0.66558	-0.63715	-0.4388	0.20764	0.41885	-0.53312
p=					0.3863	0.5334	0.0716	0.0893	0.2768	0.6217	0.3017	0.1737
PPT1YR					1	0.62496	0.77424	0.73588	0.43935	-0.03077	-0.1655	0.62
p=						0.0976	0.0241	0.0374	0.2761	0.9423	0.6953	0.1011
PPT2YR						1	0.72921	0.84462	0.60217	-0.05395	-0.20217	0.15564
p=							0.0401	0.0083	0.1142	0.899	0.6311	0.7129
PPT3YR							1	0.95157	0.45759	0.11494	-0.2965	0.31123
p=								0.0003	0.2543	0.7864	0.4758	0.453
PPT4YR								1	0.67654	-0.05389	-0.45033	0.30683
p=									0.0654	0.8992	0.2628	0.4598
PPT_TOT									1	-0.4631	-0.72074	0.41897
p=										0.2478	0.0437	0.3015
AVG_HC										1	0.03648	-0.25309
p=											0.9317	0.5453
AVG_PWV											1	-0.27042
p=												0.5171
AVG_HG												1
p=												

Generated by the SAS System (Local, XP PRO) on 16NOV2004 at 4:57 PM

AE_3FT = Acute exposure for 3 foot depth lysimeters

AE_9FT = Acute exposure for 9 foot depth lysimeters

AE_SHGW = Acute exposure for shallow ground water

PPT3MOS = precipitation for the first three months of study

PPT1YR = precipitation for the first year, second year, etc., of study

PPT_TOT = total precipitation for the study

AVG_HC = Average hydraulic conductivity

AVG_PWV = Average pore water velocity

AVG_HG = Average hydraulic gradient

APPENDIX

12.8. Data Tables for the ARP Monitoring Studies Related to Mitigation Endpoints

State Ground Water Monitoring Program.

Table 37. SGW acetochlor numeric response samples exceeding 0.1 ppb for detection of “pattern of movement”.

Site	Date	Conc (ppb)
IA07	6/1/1995	0.8
IA07	7/1/1995	0.391
IA07	8/1/1995	0.131
IA07	5/1/1997	4.354
IA07	6/1/1997	1.266
IA07	7/1/1997	0.283
IA07	8/1/1997	0.143
IA07	9/1/1997	0.106
IA07	6/1/1999	0.396
IA07	7/1/1999	0.132
IA07	6/1/2001	0.23
IA09	5/1/1997	0.14
IL08	5/1/1995	0.268
IL08	6/1/1995	0.105
IL24	5/1/1995	2.168
IL24	6/1/1995	1.036
IL24	7/1/1995	0.379
IL24	8/1/1995	0.246
IL24	9/1/1995	0.305
IL24	10/1/1995	0.313
IL24	11/1/1995	0.246
IL24	12/1/1995	0.144
KS06	8/1/1998	0.112
KS06	10/1/1998	0.139
KS06	11/1/1998	0.105
KS06	12/1/1998	0.24
KS09	3/1/2001	0.453
KS14	4/1/1996	0.12
KS14	5/1/1996	0.145
KS14	6/1/1996	0.122
KS14	7/1/1996	0.135
KS14	8/1/1996	0.291
KS14	9/1/1996	0.171
KS14	10/1/1996	0.26
KS14	11/1/1996	0.177

Table 37. SGW acetochlor numeric response samples exceeding 0.1 ppb for detection of “pattern of movement”.

Site	Date	Conc (ppb)
KS14	12/1/1996	0.158
KS14	1/1/1997	0.319
KS14	2/1/1997	0.206
KS14	3/1/1997	0.152
KS14	4/1/1997	0.133
KS14	5/1/1997	0.132
KS14	6/1/1997	0.137
KS14	7/1/1997	0.148
KS14	8/1/1997	0.218
KS14	9/1/1997	0.221
KS14	10/1/1997	0.214
KS14	11/1/1997	0.171
KS17	3/1/1998	0.159
KS17	4/1/1998	0.143
KS17	7/1/1998	0.108
KS17	8/1/1998	0.131
KS17	9/1/1998	0.163
KS17	10/1/1998	0.188
KS17	11/1/1998	0.106
KS17	12/1/1998	0.155
KS17	1/1/1999	0.109
KS17	3/1/1999	0.125
KS17	4/1/1999	0.181
KS17	5/1/1999	0.16
KS17	9/1/1999	0.135
KS19	10/1/1998	0.107
KS19	11/1/1998	0.109
KS19	12/1/1998	0.131
KS19	1/1/1999	0.149
KS19	2/1/1999	0.145
KS19	3/1/1999	0.178
KS19	4/1/1999	0.215
KS19	5/1/1999	0.2
KS19	6/1/1999	0.153
KS19	7/1/1999	0.11
KS19	10/1/1999	0.107
KS19	11/1/1999	0.106
KS25	7/1/1998	0.118
MN13	9/1/1995	0.101
MN24	5/1/1995	0.105
MN25	6/1/2001	0.741
MN25	7/1/2001	0.456
MN25	9/1/2001	0.611
MN25	10/1/2001	0.694
MN25	11/1/2001	0.499

Table 37. SGW acetochlor numeric response samples exceeding 0.1 ppb for detection of “pattern of movement”.

Site	Date	Conc (ppb)
MN25	12/1/2001	0.168
NE16	6/1/1999	0.186
NE16	8/1/1999	0.534

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA01	3/1/1999	0.367	IA01	3/1/2001	0.242
IA01	6/1/1999	0.547	IA01	6/1/2001	0.154
IA01	9/1/1999	0.528	IA07	6/1/1999	19.1
IA01	12/1/1999	0.471	IA07	9/1/1999	2.55
IA01	3/1/2000	0.178	IA07	12/1/1999	1.3
IA01	6/1/2000	0.819	IA07	3/1/2000	0.819
IA01	9/1/2000	0.438	IA07	9/1/2000	0.251
IA01	12/1/2000	0.645	IA07	12/1/2000	0.224
IA01	3/1/2001	1.33	IA07	3/1/2001	0.112
IA01	6/1/2001	5.38	IA07	6/1/2001	10.4
IA01	9/1/2001	1.6	IA07	9/1/2001	3.36
IA01	12/1/2001	1.56	IA07	12/1/2001	0.324
IA02	3/1/1999	0.176	IA09	6/1/1999	3.15
IA02	6/1/1999	0.36	IA09	6/1/2001	2.72
IA02	12/1/1999	0.913	IA23	9/1/1999	0.118
IA02	3/1/2000	0.445	IA23	12/1/1999	0.115
IA02	6/1/2000	0.22	IA23	3/1/2000	0.132
IA02	3/1/2001	0.147	IA23	9/1/2000	0.178
IA02	6/1/2001	0.104	IA23	12/1/2000	0.117
IA02	9/1/2001	0.188	IL04	3/1/1999	6.48
IA02	12/1/2001	0.147	IL04	6/1/1999	4.6
IA03	3/1/1999	0.134	IL04	9/1/1999	7.32
IA03	6/1/1999	0.421	IL04	12/1/1999	4.72
IA03	9/1/1999	0.214	IL04	3/1/2000	5.56
IA03	12/1/1999	0.205	IL04	6/1/2000	0.662
IA04	6/1/1999	0.274	IL04	9/1/2000	0.628
IA04	9/1/1999	0.474	IL04	12/1/2000	0.702
IA04	12/1/1999	0.187	IL04	3/1/2001	0.462
IA04	3/1/2000	0.167	IL04	6/1/2001	0.47
IA04	6/1/2000	0.204	IL04	9/1/2001	0.345
IA04	9/1/2000	0.105	IL04	12/1/2001	0.23
IA04	9/1/2001	0.128	IN16	3/1/1999	0.1
IA07	6/1/1999	20	IN16	12/1/2001	0.392
IA07	9/1/1999	4.84	KS10	3/1/1999	0.794
IA07	12/1/1999	3.27	KS10	6/1/1999	0.574

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA07	3/1/2000	2.03	KS10	9/1/1999	0.846
IA07	6/1/2000	0.262	KS10	12/1/1999	0.723
IA07	9/1/2000	0.891	KS10	3/1/2000	1.13
IA07	12/1/2000	0.688	KS10	6/1/2000	1.3
IA07	3/1/2001	0.119	KS10	9/1/2000	2.15
IA07	6/1/2001	10.8	KS10	12/1/2000	1.43
IA07	9/1/2001	7.92	KS10	3/1/2001	1.29
IA07	12/1/2001	1.68	KS10	6/1/2001	2.17
IA07-2	3/1/1999	3.85	KS10	9/1/2001	1.27
IA07-2	6/1/1999	2.11	KS10	12/1/2001	0.971
IA07-2	9/1/1999	0.464	KS14	3/1/1999	0.184
IA07-2	12/1/1999	0.163	KS14	6/1/1999	0.183
IA07-2	3/1/2000	0.302	MN05	12/1/2001	0.153
IA07-2	6/1/2000	0.237	MN06	9/1/2001	0.235
IA07-2	9/1/2000	0.131	MN13	12/1/1999	0.107
IA07-2	12/1/2000	0.14	MN13	6/1/2001	0.103
IA07-2	3/1/2001	0.168	MN17	6/1/2001	0.819
IA07-2	6/1/2001	0.13	MN17	9/1/2001	0.559
IA09	6/1/1999	2.68	MN17	12/1/2001	0.176
IA09	12/1/1999	0.213	MN25	6/1/1999	0.339
IA09	6/1/2001	1.6	MN25	12/1/1999	0.156
IA09	12/1/2001	0.128	MN25	3/1/2000	0.191
IA10	9/1/2001	0.844	MN25	6/1/2000	0.177
IA10	12/1/2001	0.144	MN25	9/1/2000	0.145
IA11	9/1/1999	0.277	MN25	12/1/2000	0.101
IA11	12/1/1999	0.326	MN25	6/1/2001	6.17
IA11	3/1/2000	0.23	MN25	7/1/2001	1
IA11	6/1/2000	0.224	MN25	9/1/2001	1.56
IA11	9/1/2000	0.524	MN25	10/1/2001	2.45
IA11	12/1/2000	0.4	MN25	11/1/2001	1.98
IA12	3/1/1999	0.113	MN25	12/1/2001	0.868
IA12	12/1/1999	0.124	NE07	9/1/2000	0.109
IA12	6/1/2000	0.104	NE07	12/1/2000	0.111
IA12	9/1/2000	0.157	NE07	6/1/2001	0.133
IA12	9/1/2001	0.114	NE07	9/1/2001	0.143
IA12	12/1/2001	0.1	NE07	12/1/2001	0.158
IA13	12/1/1999	0.12	NE13	9/1/1999	0.172
IA13	3/1/2000	0.269	NE16	3/1/1999	0.193
IA13	9/1/2000	0.147	NE16	6/1/1999	0.248
IA13	12/1/2000	0.271	NE16	9/1/1999	0.221
IA13	3/1/2001	0.201	NE25	3/1/2001	0.383
IA13	6/1/2001	0.128	NE25	6/1/2001	0.132
IA13	9/1/2001	0.144	WI03	3/1/2001	0.486
IA13	12/1/2001	0.206	WI03	6/1/2001	1.01

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA14	3/1/1999	0.249	WI03	9/1/2001	1.36
IA14	6/1/1999	0.245	WI03	12/1/2001	0.412
IA14	12/1/1999	0.102	WI04	3/1/1999	0.332
IA14	3/1/2000	0.778	WI04	6/1/1999	0.421
IA14	6/1/2000	0.216	WI04	9/1/1999	0.234
IA14	9/1/2000	0.694	WI05	3/1/1999	0.121
IA14	3/1/2001	0.738	WI05	6/1/1999	0.103
IA14	6/1/2001	0.554	WI11	3/1/1999	2.7
IA14	9/1/2001	0.585	WI11	6/1/1999	1.61
IA14	12/1/2001	0.831	WI11	9/1/1999	1.15
IA15	3/1/1999	1.88	WI11	12/1/1999	1.45
IA15	6/1/1999	2.12	WI11	1/1/2000	0.364
IA15	9/1/1999	1.39	WI11	2/1/2000	0.427
IA15	12/1/1999	1.79	WI11	3/1/2000	0.427
IA15	3/1/2000	1.82	WI11	6/1/2000	0.759
IA15	6/1/2000	1.25	WI11	9/1/2000	0.118
IA15	9/1/2000	1.33	WI11	12/1/2000	0.556
IA15	12/1/2000	1.64	WI11	3/1/2001	0.336
IA15	3/1/2001	1.61	WI11	6/1/2001	0.921
IA15	6/1/2001	1.63	WI11	9/1/2001	0.183
IA15	9/1/2001	1.31	WI12	9/1/1999	0.148
IA15	12/1/2001	1.49	WI12	12/1/1999	0.724
IA16	3/1/1999	0.135	WI12	1/1/2000	0.738
IA16	12/1/1999	0.162	WI12	2/1/2000	0.57
IA16	3/1/2000	0.136	WI12	3/1/2000	0.57
IA16	6/1/2000	0.216	WI12	6/1/2000	0.133
IA16	9/1/2000	0.21	WI12	12/1/2000	0.36
IA16	12/1/2000	0.129	WI23	3/1/1999	3.7
IA16	3/1/2001	0.149	WI23	6/1/1999	3.06
IA16	6/1/2001	0.139	WI25	6/1/2000	0.1
IA16	9/1/2001	0.168	WI25	9/1/2000	0.14
IA17	3/1/1999	0.304	WI25	12/1/2000	0.121
IA17	6/1/1999	0.952	WI27	3/1/1999	0.587
IA17	9/1/1999	0.567	WI27	6/1/1999	0.261
IA17	12/1/1999	0.577	WI27	9/1/1999	0.127
IA17	3/1/2000	0.166	WI27	12/1/1999	0.138
IA17	6/1/2000	0.16	WI27	9/1/2000	0.101
IA17	9/1/2000	0.223	WI27	9/1/2001	0.232
IA17	12/1/2000	0.397	WI27	12/1/2001	0.326
IA17	3/1/2001	0.126	WI28	3/1/1999	0.325
IA17	6/1/2001	0.375	WI28	6/1/1999	0.909
IA17	9/1/2001	0.468	WI28	9/1/1999	0.78
IA17	12/1/2001	0.354	WI28	12/1/1999	1.02
IA18	6/1/1999	0.876	WI28	2/1/2000	1.53

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IA18	9/1/1999	0.304	WI28	3/1/2000	1.53
IA18	12/1/1999	0.125	WI28	6/1/2000	0.466
IA19	6/1/1999	0.665	WI28	9/1/2000	0.535
IA19	6/1/2000	0.254	WI28	12/1/2000	0.554
IA20	3/1/1999	0.107	WI28	3/1/2001	0.526
IA20	6/1/1999	0.183	WI28	6/1/2001	0.258
IA20	9/1/1999	0.204	WI28	9/1/2001	0.202
IA20	12/1/1999	0.195	WI28	12/1/2001	0.237
IA20	3/1/2000	0.135			
IA21	6/1/1999	0.452			
IA21	9/1/1999	0.177			
IA21	12/1/1999	0.176			
IA22	3/1/1999	0.512			
IA22	6/1/1999	0.515			
IA22	9/1/1999	0.312			
IA22	12/1/1999	0.119			
IA22	6/1/2001	0.119			
IA22	9/1/2001	0.194			
IA23	9/1/1999	0.287			
IA23	12/1/1999	0.337			
IA23	3/1/2000	0.442			
IA23	6/1/2000	0.445			
IA23	9/1/2000	0.931			
IA23	12/1/2000	0.528			
IA23	3/1/2001	0.51			
IA23	6/1/2001	0.505			
IA23	9/1/2001	0.481			
IA23	12/1/2001	0.543			
IA24	6/1/1999	0.374			
IA24	9/1/1999	0.858			
IA24	12/1/1999	0.892			
IA24	3/1/2000	0.311			
IA25	6/1/2000	0.125			
IA25	3/1/2001	0.509			
IA25	6/1/2001	0.225			
IL01	3/1/1999	0.632			
IL01	6/1/1999	0.754			
IL01	9/1/1999	0.577			
IL01	12/1/1999	0.51			
IL01	3/1/2000	0.458			
IL01	6/1/2000	0.428			
IL01	9/1/2000	0.516			
IL01	12/1/2000	0.478			
IL01	3/1/2001	0.332			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IL01	6/1/2001	0.338			
IL01	9/1/2001	0.347			
IL01	12/1/2001	0.342			
IL02	3/1/1999	0.219			
IL02	6/1/1999	0.194			
IL02	6/1/2000	0.155			
IL04	3/1/1999	12.6			
IL04	6/1/1999	9.25			
IL04	9/1/1999	14.7			
IL04	12/1/1999	14.4			
IL04	3/1/2000	14.3			
IL04	6/1/2000	1.79			
IL04	9/1/2000	3.17			
IL04	12/1/2000	6.62			
IL04	3/1/2001	1.89			
IL04	6/1/2001	5.44			
IL04	9/1/2001	5.21			
IL04	12/1/2001	5.56			
IL05	6/1/1999	2.31			
IL05	12/1/1999	0.14			
IL05	3/1/2000	0.147			
IL08	6/1/1999	0.137			
IL08	3/1/2000	0.203			
IL08	6/1/2000	0.111			
IL08	9/1/2001	0.544			
IL08	12/1/2001	0.173			
IL10	3/1/1999	1.22			
IL10	6/1/1999	0.942			
IL10	9/1/1999	0.412			
IL10	12/1/1999	0.14			
IL10	6/1/2000	0.116			
IL10	6/1/2001	0.167			
IL10	9/1/2001	1.62			
IL10	12/1/2001	1.26			
IL14	3/1/1999	0.203			
IL14	6/1/1999	0.112			
IL15	3/1/1999	0.172			
IL15	6/1/1999	0.163			
IL15	9/1/1999	0.155			
IL15	12/1/1999	0.112			
IL17	9/1/1999	0.114			
IL18	3/1/1999	0.233			
IL18	6/1/1999	0.217			
IL18	9/1/1999	0.103			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
IL18	12/1/1999	0.11			
IL18	3/1/2000	0.207			
IL18	6/1/2000	0.256			
IL18	9/1/2000	0.111			
IL18	9/1/2001	0.126			
IL18	12/1/2001	0.142			
IL24	9/1/1999	0.156			
IL24	3/1/2000	0.146			
IN02	9/1/2000	0.102			
IN02	3/1/2001	0.101			
IN08	9/1/1999	0.109			
IN08	12/1/1999	0.133			
IN08	6/1/2000	0.124			
IN08	9/1/2000	0.143			
IN08	12/1/2000	0.153			
IN08	3/1/2001	0.289			
IN08	6/1/2001	0.199			
IN08	9/1/2001	0.225			
IN08	12/1/2001	0.299			
IN14	6/1/2000	0.158			
IN14	3/1/2001	0.112			
IN14	6/1/2001	0.23			
IN14	9/1/2001	0.163			
IN14	12/1/2001	0.139			
IN16	3/1/1999	0.848			
IN16	6/1/1999	0.721			
IN16	9/1/1999	0.594			
IN16	12/1/1999	0.466			
IN16	6/1/2000	0.262			
IN16	9/1/2000	0.233			
IN16	12/1/2000	0.175			
IN16	3/1/2001	0.226			
IN16	6/1/2001	0.18			
IN16	12/1/2001	0.2			
IN17	3/1/2000	0.285			
KS04	3/1/1999	0.312			
KS04	6/1/1999	1.5			
KS04	9/1/1999	1.94			
KS04	12/1/1999	1.31			
KS04	3/1/2000	0.869			
KS04	6/1/2000	0.985			
KS04	9/1/2000	0.816			
KS04	12/1/2000	0.828			
KS04	3/1/2001	0.494			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
KS04	6/1/2001	0.373			
KS04	9/1/2001	0.366			
KS04	12/1/2001	0.237			
KS08	12/1/1999	0.118			
KS09	3/1/2001	0.134			
KS09	6/1/2001	0.239			
KS10	3/1/1999	1.28			
KS10	6/1/1999	1.31			
KS10	9/1/1999	2.23			
KS10	12/1/1999	2.1			
KS10	3/1/2000	4.08			
KS10	6/1/2000	4.23			
KS10	9/1/2000	7.37			
KS10	12/1/2000	5.95			
KS10	3/1/2001	7.55			
KS10	6/1/2001	11.1			
KS10	9/1/2001	8.56			
KS10	12/1/2001	9.08			
KS11	6/1/2001	0.163			
KS12	9/1/2000	0.21			
KS12	12/1/2000	0.112			
KS13	3/1/1999	0.202			
KS13	6/1/1999	0.534			
KS13	9/1/1999	0.237			
KS13	12/1/1999	0.212			
KS13	3/1/2000	0.283			
KS13	9/1/2000	0.174			
KS13	12/1/2000	0.487			
KS13	6/1/2001	0.198			
KS13	9/1/2001	0.225			
KS14	3/1/1999	1.4			
KS14	6/1/1999	1.43			
KS14	9/1/1999	1.11			
KS14	12/1/1999	1.34			
KS14	3/1/2000	0.875			
KS17	9/1/1999	0.23			
KS17	12/1/1999	0.131			
KS17	3/1/2000	0.179			
KS17	6/1/2000	0.196			
KS17	9/1/2000	0.226			
KS17	12/1/2000	0.182			
KS17	3/1/2001	0.209			
KS17	6/1/2001	0.235			
KS17	9/1/2001	0.201			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
KS17	12/1/2001	0.171			
KS19	3/1/1999	0.263			
KS19	6/1/1999	0.206			
KS19	9/1/1999	0.242			
KS19	12/1/1999	0.121			
KS19	9/1/2000	0.125			
KS19	12/1/2001	0.107			
KS21	3/1/2000	0.35			
KS25	3/1/1999	0.546			
KS25	6/1/1999	0.614			
KS25	9/1/1999	0.522			
KS25	12/1/1999	0.485			
KS25	3/1/2000	0.672			
KS25	6/1/2000	0.492			
KS25	9/1/2000	0.392			
KS25	12/1/2000	0.371			
KS25	3/1/2001	0.271			
KS25	6/1/2001	0.167			
KS25	9/1/2001	0.153			
KS25	12/1/2001	0.185			
MN05	3/1/1999	0.226			
MN05	6/1/1999	0.149			
MN05	9/1/1999	0.255			
MN05	12/1/1999	0.3			
MN05	3/1/2000	0.26			
MN05	6/1/2000	0.266			
MN05	3/1/2001	0.399			
MN05	6/1/2001	0.549			
MN05	9/1/2001	0.307			
MN05	12/1/2001	1.32			
MN06	12/1/1999	0.264			
MN06	6/1/2001	0.112			
MN06	9/1/2001	0.901			
MN06	12/1/2001	1.29			
MN08	3/1/1999	0.858			
MN08	6/1/1999	0.844			
MN08	9/1/1999	0.253			
MN08	12/1/1999	0.541			
MN08	3/1/2000	1.28			
MN08	6/1/2000	1.03			
MN08	3/1/2001	0.508			
MN08	6/1/2001	0.318			
MN13	3/1/1999	0.152			
MN13	6/1/1999	0.229			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
MN13	9/1/1999	0.172			
MN13	12/1/1999	0.206			
MN13	3/1/2000	0.217			
MN13	6/1/2000	0.212			
MN13	9/1/2000	0.188			
MN13	6/1/2001	0.311			
MN13	9/1/2001	0.337			
MN13	12/1/2001	0.205			
MN14	9/1/1999	0.106			
MN17	3/1/1999	0.755			
MN17	6/1/1999	0.827			
MN17	9/1/1999	1.65			
MN17	12/1/1999	0.952			
MN17	3/1/2000	0.941			
MN17	6/1/2000	0.797			
MN17	9/1/2000	0.917			
MN17	12/1/2000	0.983			
MN17	3/1/2001	0.471			
MN17	6/1/2001	3.04			
MN17	9/1/2001	4.31			
MN17	12/1/2001	4.29			
MN18	3/1/1999	0.552			
MN18	6/1/1999	0.298			
MN18	9/1/1999	0.568			
MN18	12/1/1999	1			
MN18	3/1/2000	1.05			
MN18	6/1/2000	0.416			
MN18	6/1/2001	0.535			
MN25	3/1/1999	0.387			
MN25	6/1/1999	1.62			
MN25	9/1/1999	3.76			
MN25	12/1/1999	4.06			
MN25	3/1/2000	2.52			
MN25	6/1/2000	1.75			
MN25	9/1/2000	1.69			
MN25	12/1/2000	1.67			
MN25	3/1/2001	0.731			
MN25	7/1/2001	2.71			
MN25	9/1/2001	3.39			
MN25	10/1/2001	5.29			
MN25	11/1/2001	4.42			
MN25	12/1/2001	2.36			
NE01	9/1/2000	0.119			
NE01	3/1/2001	0.187			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
NE01	6/1/2001	0.197			
NE01	9/1/2001	0.248			
NE01	12/1/2001	0.365			
NE02	3/1/1999	6.85			
NE02	6/1/1999	6.4			
NE02	9/1/1999	6.65			
NE02	12/1/1999	7.72			
NE02	3/1/2000	6.5			
NE02	6/1/2000	5.7			
NE02	9/1/2000	2.78			
NE02	12/1/2000	4.06			
NE02	3/1/2001	3.61			
NE02	6/1/2001	3.14			
NE02	9/1/2001	3.11			
NE02	12/1/2001	3.06			
NE03	3/1/1999	0.911			
NE03	6/1/1999	0.802			
NE03	9/1/1999	0.941			
NE03	12/1/1999	1.53			
NE03	3/1/2000	0.491			
NE03	6/1/2000	0.281			
NE03	9/1/2000	0.479			
NE03	12/1/2000	0.339			
NE03	3/1/2001	0.228			
NE03	6/1/2001	0.381			
NE03	9/1/2001	0.605			
NE03	12/1/2001	1.45			
NE04	3/1/1999	0.25			
NE04	6/1/1999	0.691			
NE04	9/1/1999	0.319			
NE04	12/1/1999	0.514			
NE04	3/1/2000	0.384			
NE04	6/1/2000	1.41			
NE04	9/1/2000	0.773			
NE04	12/1/2000	0.926			
NE04	3/1/2001	1.37			
NE04	6/1/2001	1.01			
NE04	9/1/2001	0.711			
NE04	12/1/2001	0.888			
NE05	3/1/1999	3.38			
NE05	6/1/1999	2.74			
NE05	9/1/1999	2.53			
NE05	12/1/1999	3.56			
NE05	3/1/2000	4.27			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
NE05	6/1/2000	4.08			
NE05	9/1/2000	2.23			
NE05	12/1/2000	2.44			
NE05	3/1/2001	0.54			
NE05	6/1/2001	0.641			
NE05	9/1/2001	0.975			
NE05	12/1/2001	1.27			
NE06	6/1/1999	0.147			
NE06	9/1/1999	0.167			
NE06	12/1/1999	0.123			
NE06	6/1/2000	0.141			
NE06	9/1/2000	0.119			
NE06	12/1/2000	0.112			
NE06	3/1/2001	0.124			
NE06	12/1/2001	0.181			
NE07	9/1/1999	0.141			
NE07	12/1/1999	0.109			
NE07	6/1/2000	0.149			
NE07	9/1/2000	0.211			
NE07	12/1/2000	0.146			
NE07	3/1/2001	0.304			
NE07	6/1/2001	0.363			
NE07	9/1/2001	0.411			
NE07	12/1/2001	0.513			
NE10	9/1/2001	0.1			
NE10	12/1/2001	0.153			
NE12	12/1/2000	0.115			
NE12	9/1/2001	0.272			
NE12	12/1/2001	0.377			
NE13	3/1/1999	0.262			
NE13	6/1/1999	0.269			
NE13	9/1/1999	0.553			
NE13	12/1/1999	0.352			
NE13	3/1/2000	0.36			
NE16	3/1/1999	0.833			
NE16	6/1/1999	0.477			
NE16	9/1/1999	0.716			
NE17	3/1/1999	0.875			
NE17	6/1/1999	0.929			
NE17	9/1/1999	1.01			
NE17	12/1/1999	0.597			
NE17	3/1/2000	0.516			
NE17	6/1/2000	0.315			
NE17	9/1/2000	0.502			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
NE17	12/1/2000	0.534			
NE17	3/1/2001	0.497			
NE17	6/1/2001	0.8			
NE17	9/1/2001	0.604			
NE17	12/1/2001	0.609			
NE18	9/1/1999	0.301			
NE18	12/1/1999	0.138			
NE18	3/1/2001	0.154			
NE18	6/1/2001	0.184			
NE19	3/1/1999	0.752			
NE19	6/1/1999	0.843			
NE19	9/1/1999	2.44			
NE19	12/1/1999	1.64			
NE19	3/1/2000	2.09			
NE19	6/1/2000	2.15			
NE19	9/1/2000	1.33			
NE19	12/1/2000	0.928			
NE19	3/1/2001	1.66			
NE19	6/1/2001	1.64			
NE19	9/1/2001	1.56			
NE19	12/1/2001	1.08			
NE23	6/1/1999	0.164			
NE23	9/1/1999	0.103			
NE23	12/1/1999	0.126			
NE25	3/1/2001	0.959			
NE25	6/1/2001	0.325			
NE25	9/1/2001	0.183			
NE25	12/1/2001	0.22			
WI01	3/1/1999	1.02			
WI01	6/1/1999	0.5			
WI01	9/1/1999	0.206			
WI01	12/1/1999	0.864			
WI01	2/1/2000	0.565			
WI01	3/1/2000	0.565			
WI01	6/1/2000	0.112			
WI01	9/1/2000	0.116			
WI01	6/1/2001	0.409			
WI01	9/1/2001	0.766			
WI01	12/1/2001	1.89			
WI03	3/1/1999	1.38			
WI03	6/1/1999	1.5			
WI03	9/1/1999	0.817			
WI03	12/1/1999	1.17			
WI03	2/1/2000	1.13			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
WI03	3/1/2000	1.13			
WI03	6/1/2000	0.879			
WI03	9/1/2000	1.04			
WI03	12/1/2000	1.11			
WI03	3/1/2001	1.2			
WI03	6/1/2001	2.27			
WI03	9/1/2001	1.93			
WI03	12/1/2001	2.91			
WI04	3/1/1999	1.98			
WI04	6/1/1999	2.09			
WI04	9/1/1999	2.44			
WI04	12/1/1999	2.44			
WI04	2/1/2000	2.05			
WI04	3/1/2000	2.05			
WI04	6/1/2000	1.79			
WI04	9/1/2000	0.999			
WI04	12/1/2000	0.801			
WI04	3/1/2001	0.639			
WI04	6/1/2001	0.496			
WI04	9/1/2001	0.282			
WI04	12/1/2001	0.582			
WI05	3/1/1999	2.41			
WI05	6/1/1999	2.59			
WI05	9/1/1999	0.382			
WI05	12/1/1999	0.892			
WI05	2/1/2000	0.107			
WI05	3/1/2000	0.107			
WI05	6/1/2000	0.827			
WI05	9/1/2000	0.153			
WI05	12/1/2000	0.18			
WI05	3/1/2001	0.498			
WI05	6/1/2001	0.119			
WI05	12/1/2001	0.113			
WI06	3/1/1999	2.77			
WI06	6/1/1999	2.31			
WI06	9/1/1999	0.519			
WI06	12/1/1999	0.477			
WI08	3/1/1999	0.215			
WI08	9/1/1999	0.142			
WI08	2/1/2000	0.124			
WI08	3/1/2000	0.124			
WI09	6/1/1999	2.7			
WI09	9/1/1999	1.64			
WI09	12/1/1999	0.514			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
WI09	2/1/2000	0.372			
WI09	3/1/2000	0.372			
WI10	3/1/1999	0.1			
WI10	6/1/1999	0.125			
WI10	9/1/1999	0.13			
WI10	6/1/2001	0.248			
WI10	9/1/2001	0.24			
WI11	3/1/1999	3.2			
WI11	6/1/1999	2.84			
WI11	9/1/1999	1.62			
WI11	12/1/1999	3.12			
WI11	1/1/2000	0.848			
WI11	2/1/2000	0.798			
WI11	3/1/2000	0.798			
WI11	6/1/2000	1.86			
WI11	9/1/2000	0.434			
WI11	12/1/2000	0.89			
WI11	3/1/2001	1.1			
WI11	6/1/2001	1.67			
WI11	9/1/2001	5.26			
WI11	12/1/2001	1.67			
WI12	3/1/1999	0.15			
WI12	12/1/1999	0.168			
WI12	1/1/2000	0.122			
WI12	2/1/2000	0.118			
WI12	3/1/2000	0.118			
WI12	9/1/2000	0.105			
WI12	12/1/2001	0.341			
WI15	9/1/1999	0.133			
WI15	12/1/1999	0.101			
WI20	3/1/1999	0.343			
WI20	6/1/1999	0.456			
WI20	9/1/1999	0.275			
WI20	9/1/2000	0.121			
WI20	3/1/2001	0.136			
WI20	6/1/2001	0.11			
WI20	9/1/2001	0.167			
WI20	12/1/2001	0.171			
WI21	3/1/1999	0.221			
WI21	6/1/1999	0.28			
WI21	9/1/1999	0.273			
WI21	12/1/1999	0.128			
WI21	9/1/2000	0.456			
WI21	12/1/2000	0.235			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
WI21	3/1/2001	0.111			
WI21	6/1/2001	0.124			
WI21	9/1/2001	0.211			
WI22	3/1/1999	0.162			
WI22	2/1/2000	0.16			
WI22	3/1/2000	0.16			
WI22	6/1/2000	0.147			
WI22	9/1/2000	0.221			
WI22	12/1/2000	0.145			
WI22	3/1/2001	0.216			
WI22	12/1/2001	0.156			
WI23	3/1/1999	11.7			
WI23	6/1/1999	10.5			
WI25	9/1/1999	0.159			
WI25	12/1/1999	0.168			
WI25	2/1/2000	0.168			
WI25	3/1/2000	0.168			
WI25	6/1/2000	0.194			
WI25	9/1/2000	0.215			
WI25	12/1/2000	0.22			
WI25	3/1/2001	0.188			
WI25	6/1/2001	0.12			
WI25	9/1/2001	0.164			
WI25	12/1/2001	0.174			
WI26	3/1/1999	0.265			
WI26	6/1/1999	0.294			
WI26	9/1/1999	0.374			
WI26	12/1/1999	0.378			
WI26	2/1/2000	0.263			
WI26	3/1/2000	0.263			
WI26	6/1/2000	0.364			
WI26	9/1/2000	0.56			
WI26	12/1/2000	0.365			
WI26	3/1/2001	0.447			
WI26	6/1/2001	1.79			
WI26	9/1/2001	2.87			
WI26	12/1/2001	2.73			
WI27	3/1/1999	1.76			
WI27	6/1/1999	1.33			
WI27	9/1/1999	1.08			
WI27	12/1/1999	1.25			
WI27	2/1/2000	0.785			
WI27	3/1/2000	0.785			
WI27	6/1/2000	1			

Table 38. Acetochlor degradate samples exceeding 0.1 ppb in the state monitoring program.

Ac_ESA numeric response			AcOX numeric response		
Site	Date	Conc	Site	Date	Conc
WI27	9/1/2000	1.51			
WI27	3/1/2001	1.56			
WI27	6/1/2001	2.2			
WI27	9/1/2001	5.16			
WI27	12/1/2001	3.33			
WI28	3/1/1999	0.303			
WI28	6/1/1999	1.09			
WI28	9/1/1999	1.01			
WI28	12/1/1999	1.2			
WI28	2/1/2000	1.4			
WI28	3/1/2000	1.4			
WI28	6/1/2000	0.655			
WI28	9/1/2000	1.12			
WI28	12/1/2000	0.943			
WI28	3/1/2001	0.977			
WI28	6/1/2001	1.48			
WI28	9/1/2001	0.942			
WI28	12/1/2001	1.04			

PGW

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimeter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
1	ESA	DE	6	1	9	2.61	3
2	ESA	DE	6	2.4	10	2.61	3
3	ESA	DE	6	3.9	12.5	2.61	3
4	ESA	DE	6	3.9	13	2.61	3
5	ESA	DE	6	3.7	13.5	2.61	3
6	ESA	DE	6	3.6	14	2.61	3
7	ESA	DE	6	2.1	14.5	2.61	3
8	ESA	DE	6	4.3	15	2.61	3
9	ESA	DE	6	3.5	15.5	2.61	3
10	ESA	DE	6	3.1	16	2.61	3
11	ESA	DE	6	2.4	16.5	2.61	3
12	ESA	DE	6	2.6	17	2.61	3
13	ESA	DE	3	1.1	17.5	9.9	1.1
14	ESA	DE	6	2.7	17.5	2.61	3

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimeter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
15	ESA	DE	3	1.2	18	9.9	1.1
16	ESA	DE	6	2.5	18	2.61	3
17	ESA	DE	3	1.3	19	9.9	1.1
18	ESA	DE	6	2.9	19	2.61	3
19	ESA	DE	3	1.4	20	9.9	1.1
20	ESA	DE	3	1.3	21	9.9	1.1
21	ESA	DE	3	1.7	22	9.9	1.1
22	ESA	DE	6	1.4	22	2.61	3
23	ESA	DE	3	2.5	23	9.9	1.1
24	ESA	DE	6	4.3	23	2.61	3
25	ESA	DE	3	1.9	24	9.9	1.1
26	ESA	DE	6	2.8	24	2.61	3
27	ESA	DE	3	2	25	9.9	1.1
28	ESA	DE	6	2.6	25	2.61	3
29	ESA	DE	3	2.3	26	9.9	1.1
30	ESA	DE	6	2.5	26	2.61	3
31	ESA	DE	3	3.1	27	9.9	1.1
32	ESA	DE	6	1.7	27	2.61	3
33	ESA	DE	1	1.1	28	1.2	1.4
34	ESA	DE	3	3.2	28	9.9	1.1
35	ESA	DE	1	1.3	29	1.2	1.4
36	ESA	DE	3	3.5	29	9.9	1.1
37	ESA	DE	3	2.85	30	9.9	1.1
38	ESA	DE	3	2.94	31	9.9	1.1
39	ESA	DE	1	1.06	33	1.2	1.4
40	ESA	DE	1	1.13	34	1.2	1.4
41	ESA	DE	3	1.45	36	9.9	1.1
42	ESA	DE	1	1.15	36	1.2	1.4
43	ESA	DE	3	1.43	37	9.9	1.1
44	ESA	DE	1	1.05	37	1.2	1.4
45	ESA	DE	3	1.13	38	9.9	1.1
46	ESA	DE	3	1.05	39	9.9	1.1
47	ESA	DE	1	1.01	39	1.2	1.4
48	ESA	DE	6	1.7	11	2.61	3
49	ESA	DE	6	3.2	12	2.61	3
50	ESA	IN	6	3.6	2	12	2.2
51	ESA	IN	4	1.2	2.5	3.3	1.3
52	ESA	IN	6	8.1	2.5	12	2.2
53	ESA	IN	4	1.1	3.5	3.3	1.3
54	ESA	IN	6	13	3.5	12	2.2
55	ESA	IN	6	16	4	12	2.2

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimeter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
56	ESA	IN	6	16	4.5	12	2.2
57	ESA	IN	6	21	5	12	2.2
58	ESA	IN	6	22	5.5	12	2.2
59	ESA	IN	4	13	9	3.3	1.3
60	ESA	IN	6	10	9	12	2.2
61	ESA	IN	7	15	9	6.9	4.5
62	ESA	IN	2	1.7	10	18	17
63	ESA	IN	4	10	10	3.3	1.3
64	ESA	IN	6	7	10	12	2.2
65	ESA	IN	7	19	10	6.9	4.5
66	ESA	IN	2	2.3	11	18	17
67	ESA	IN	4	10	11	3.3	1.3
68	ESA	IN	6	6.8	11	12	2.2
69	ESA	IN	7	16	11	6.9	4.5
70	ESA	IN	2	3.1	12	18	17
71	ESA	IN	4	11	12	3.3	1.3
72	ESA	IN	6	6.7	12	12	2.2
73	ESA	IN	7	18	12	6.9	4.5
74	ESA	IN	8	3.3	12	4.6	7.3
75	ESA	IN	2	3.6	13	18	17
76	ESA	IN	4	10	13	3.3	1.3
77	ESA	IN	6	3.1	13	12	2.2
78	ESA	IN	7	21	13	6.9	4.5
79	ESA	IN	2	5.4	14	18	17
80	ESA	IN	4	10	14	3.3	1.3
81	ESA	IN	6	6.2	14	12	2.2
82	ESA	IN	7	24	14	6.9	4.5
83	ESA	IN	8	7.6	14	4.6	7.3
84	ESA	IN	2	5.4	15	18	17
85	ESA	IN	4	6.3	15	3.3	1.3
86	ESA	IN	6	5.2	15	12	2.2
87	ESA	IN	7	23	15	6.9	4.5
88	ESA	IN	8	5.8	15	4.6	7.3
89	ESA	IN	2	5.4	16	18	17
90	ESA	IN	4	3.8	16	3.3	1.3
91	ESA	IN	6	4.6	16	12	2.2
92	ESA	IN	7	20	16	6.9	4.5
93	ESA	IN	8	4.3	16	4.6	7.3
94	ESA	IN	2	6.9	18	18	17
95	ESA	IN	4	5.7	18	3.3	1.3
96	ESA	IN	6	4.3	18	12	2.2

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimeter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
97	ESA	IN	7	22	18	6.9	4.5
98	ESA	IN	8	2.8	18	4.6	7.3
99	ESA	IN	2	1.7	22	18	17
100	ESA	IN	3	3.5	22	7	6.1
101	ESA	IN	4	2.2	22	3.3	1.3
102	ESA	IN	6	6.6	22	12	2.2
103	ESA	IN	7	5.1	22	6.9	4.5
104	ESA	IN	2	19	23	18	17
105	ESA	IN	3	1.8	23	7	6.1
106	ESA	IN	4	1.1	23	3.3	1.3
107	ESA	IN	5	2.3	23	7.6	3.6
108	ESA	IN	6	1.4	23	12	2.2
109	ESA	IN	7	16	23	6.9	4.5
110	ESA	IN	8	8.2	23	4.6	7.3
111	ESA	IN	2	18	24	18	17
112	ESA	IN	3	2	24	7	6.1
113	ESA	IN	5	1.9	24	7.6	3.6
114	ESA	IN	7	14	24	6.9	4.5
115	ESA	IN	8	6.9	24	4.6	7.3
116	ESA	IN	2	17	27	18	17
117	ESA	IN	3	1.2	27	7	6.1
118	ESA	IN	5	1	27	7.6	3.6
119	ESA	IN	7	10	27	6.9	4.5
120	ESA	IN	8	4.3	27	4.6	7.3
121	ESA	IN	2	17	28	18	17
122	ESA	IN	7	8.6	28	6.9	4.5
123	ESA	IN	8	3.3	28	4.6	7.3
124	ESA	IN	2	12	29	18	17
125	ESA	IN	7	6.6	29	6.9	4.5
126	ESA	IN	8	2.4	29	4.6	7.3
127	ESA	IN	7	6.1	30	6.9	4.5
128	ESA	IN	2	13	33	18	17
129	ESA	IN	2	8.8	34	18	17
130	ESA	IN	7	1.7	34	6.9	4.5
131	ESA	IN	8	1.1	34	4.6	7.3
132	ESA	IN	2	10	35	18	17
133	ESA	IN	7	1.9	35	6.9	4.5
134	ESA	IN	8	1.3	35	4.6	7.3
135	ESA	IN	2	8.9	36	18	17
136	ESA	IN	7	1.4	36	6.9	4.5
137	ESA	IN	7	1.2	37	6.9	4.5

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimeter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet	6 Feet	3 Feet
				Obs Conc MAT	Max	Max
138	ESA	IN	2	8.1	45	18
139	ESA	IN	2	6.7	46	18
140	ESA	IN	2	2.8	50	18
141	ESA	IN	2	1.94	52	18
142	ESA	MN	4	3.8	4.5	13
143	ESA	MN	6	3.7	4.5	4.5
144	ESA	MN	3	2	5	7
145	ESA	MN	4	10	5	13
146	ESA	MN	5	1.1	5	3
147	ESA	MN	6	7.5	5	4.5
148	ESA	MN	7	3.3	5	11
149	ESA	MN	1	1.7	11	9.7
150	ESA	MN	2	5.6	11	9.4
151	ESA	MN	3	5.7	11	7
152	ESA	MN	4	12	11	13
153	ESA	MN	5	5.1	11	3
154	ESA	MN	6	9.2	11	4.5
155	ESA	MN	7	11	11	11
156	ESA	MN	8	2.1	11	14
157	ESA	MN	1	4	12	9.7
158	ESA	MN	2	6.4	12	9.4
159	ESA	MN	3	3.9	12	7
160	ESA	MN	5	7.5	12	3
161	ESA	MN	6	8	12	4.5
162	ESA	MN	7	24	12	11
163	ESA	MN	8	3.1	12	14
164	ESA	MN	1	5	13	9.7
165	ESA	MN	2	8	13	9.4
166	ESA	MN	4	2.8	13	13
167	ESA	MN	5	7.5	13	3
168	ESA	MN	6	8.1	13	4.5
169	ESA	MN	7	23	13	11
170	ESA	MN	8	2.6	13	14
171	ESA	MN	2	16	14	9.4
172	ESA	MN	7	11	14	11
173	ESA	MN	8	2.1	14	14
174	ESA	MN	1	5.7	15	9.7
175	ESA	MN	2	20	15	9.4
176	ESA	MN	3	4.8	15	7
177	ESA	MN	4	6.7	15	13
178	ESA	MN	5	9.4	15	3

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimeter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
179	ESA	MN	6	2.6	15	4.5	20
180	ESA	MN	7	11	15	11	19
181	ESA	MN	8	2.3	15	14	21
182	ESA	MN	1	4.6	16	9.7	13
183	ESA	MN	2	21	16	9.4	22
184	ESA	MN	3	4	16	7	10
185	ESA	MN	4	6	16	13	6.1
186	ESA	MN	5	6.6	16	3	21
187	ESA	MN	6	1.8	16	4.5	20
188	ESA	MN	7	14	16	11	19
189	ESA	MN	1	5.3	17	9.7	13
190	ESA	MN	3	4.4	17	7	10
191	ESA	MN	4	4.9	17	13	6.1
192	ESA	MN	5	7.6	17	3	21
193	ESA	MN	6	1.4	17	4.5	20
194	ESA	MN	7	16	17	11	19
195	ESA	MN	1	4	18	9.7	13
196	ESA	MN	1	1.8	22	9.7	13
197	ESA	MN	3	3.1	22	7	10
198	ESA	MN	4	3.1	22	13	6.1
199	ESA	MN	5	5.7	22	3	21
200	ESA	MN	7	12	22	11	19
201	ESA	MN	8	2.2	22	14	21
202	ESA	MN	1	2.2	23	9.7	13
203	ESA	MN	2	14	23	9.4	22
204	ESA	MN	3	2.2	23	7	10
205	ESA	MN	4	1.7	23	13	6.1
206	ESA	MN	5	3.5	23	3	21
207	ESA	MN	7	6.3	23	11	19
208	ESA	MN	8	1.5	23	14	21
209	ESA	MN	1	2.4	24	9.7	13
210	ESA	MN	2	12	24	9.4	22
211	ESA	MN	3	2	24	7	10
212	ESA	MN	4	1.6	24	13	6.1
213	ESA	MN	5	3.6	24	3	21
214	ESA	MN	7	7.5	24	11	19
215	ESA	MN	8	1.4	24	14	21
216	ESA	MN	1	1.6	27	9.7	13
217	ESA	MN	3	1.9	27	7	10
218	ESA	MN	4	1.6	27	13	6.1
219	ESA	MN	5	1.9	27	3	21

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimeter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet	6 Feet	3 Feet
				Obs Conc MAT	Max	Max
220	ESA	MN	7	5.4	27	11
221	ESA	MN	1	1.7	28	9.7
222	ESA	MN	3	2	28	7
223	ESA	MN	4	1.7	28	13
224	ESA	MN	5	2.1	28	3
225	ESA	MN	7	6.7	28	11
226	ESA	MN	8	1	28	14
227	ESA	MN	1	1.2	29	9.7
228	ESA	MN	3	1.5	29	7
229	ESA	MN	4	1.2	29	13
230	ESA	MN	5	1.4	29	3
231	ESA	MN	7	5.3	29	11
232	ESA	MN	2	2	34	9.4
233	ESA	MN	2	3.7	35	9.4
234	ESA	MN	7	1.1	35	11
235	ESA	MN	2	2.2	36	9.4
236	ESA	MN	2	1.8	37	9.4
237	ESA	NE	2	1.3	23	11
238	ESA	NE	7	1.7	32	4.25
239	ESA	NE	6	1.03	44	23.1
240	ESA	NE	6	1.07	47	23.1
241	ESA	NE	8	2.33	64	18
242	ESA	NE	8	2.81	65	18
243	ESA	NE	8	3.65	66	18
244	ESA	NE	8	6.92	71	18
245	ESA	NE	8	9.3	72	18
246	ESA	NE	6	1.29	72	23.1
247	ESA	NE	8	11.1	73	18
248	ESA	NE	6	1.43	73	23.1
249	ESA	NE	8	9.26	74	18
250	ESA	NE	6	1.6	74	23.1
251	ESA	NE	8	10.5	75	18
252	ESA	NE	6	1.84	75	23.1
253	ESA	NE	8	11.2	77	18
254	ESA	NE	6	3.28	77	23.1
255	ESA	NE	8	11.4	83	18
256	ESA	NE	6	4.19	83	23.1
257	ESA	NE	8	7.67	85	18
258	ESA	NE	6	7.74	85	23.1
259	ESA	NE	8	3.95	87	18
260	ESA	NE	7	2.72	87	4.25

Table 39. Acetochlor and degradate detections in PGW studies greater than 1.0 ppb at nine foot lysimter depth consistent with three and six foot lysimeters in that cluster as defined by “pattern of movement” criteria. MAT = months after treatment.

#	ANALYTE	STATE	CLUSTER	9 Feet		6 Feet	3 Feet
				Obs Conc	MAT	Max	Max
261	ESA	NE	6	9.42	87	23.1	22
262	ESA	NE	4	1.26	87	1.4	66
263	ESA	NE	2	1.08	87	11	5.9
264	ESA	OH	1	1.3	2.5	5.4	1.2
265	ESA	OH	1	6	3	5.4	1.2
266	ESA	OH	1	5.1	3.5	5.4	1.2
267	ESA	OH	1	6.5	4	5.4	1.2
268	ESA	OH	1	3.4	5	5.4	1.2
269	ESA	OH	1	1.3	11	5.4	1.2
270	ESA	OH	1	3.8	12	5.4	1.2
271	ESA	PA	4	1.2	7	2	1.2
272	ESA	PA	4	1.8	9	2	1.2
273	ESA	PA	3	1.3	10	1	3
274	ESA	PA	4	2.7	10	2	1.2
275	ESA	PA	8	2.7	10	2.8	2.4
276	ESA	PA	3	1.1	11	1	3
277	ESA	PA	4	1.7	11	2	1.2
278	ESA	PA	4	1.7	12	2	1.2
279	ESA	PA	4	1.4	13	2	1.2
280	ESA	PA	4	1.3	14	2	1.2
281	ESA	PA	4	1.4	15	2	1.2
282	ESA	PA	4	1.6	16	2	1.2
283	ESA	PA	4	1.7	18	2	1.2
284	ESA	PA	4	1.4	20	2	1.2
285	ESA	WI	2	1.7	4.5	13	1.8
286	ESA	WI	2	1.5	7	13	1.8
287	ESA	WI	2	4.1	11	13	1.8
288	ESA	WI	2	24	12	13	1.8
289	ESA	WI	2	25	13	13	1.8
290	ESA	WI	2	19	14	13	1.8
291	ESA	WI	2	11	15	13	1.8
292	ESA	WI	2	3	23	13	1.8
293	ESA	WI	2	3.6	24	13	1.8