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ANALYSIS

As defined earlier, the **Analysis** phase of the risk assessment framework (EPA 1992) includes the technical evaluation of data on both the effects of the stressor (characterization of ecological effects) and potential exposure to the stressor (characterization of exposure). The characterization of ecological effects involves identifying and quantifying the effects elicited by a stressor and, to the extent possible, evaluating cause-and-effect relationships, while characterization of exposure involves predicting or measuring the spatial and temporal distribution of a stressor and its co-occurrence or contact with the ecological components of concern.

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Characterization of Ecological Effects/Hazard Assessment

MRID numbers are given for studies cited in the EPA reviews. The detailed summaries of the new ecological effects studies, not summarized in the latest EPA reviews, used in this assessment are provided in Appendix 3.

Measures of Effect -- Laboratory Avian Toxicity Studies

There has been a battery of laboratory toxicity tests performed for chlorfenapyr. The results are summarized below. These results would apply to both Southern and Western Cotton.

Acute Oral Toxicity of Chlorfenapyr to Birds

Species	Toxicity Measure	Value Observed (mg/kg)
Northern Bobwhite (MRID No. 42770227)	LD_{50} (95%CI)	34 (24 - 49)
	No Observable Effect Level	8
	Lowest Lethal Level	16
Mallard Duck (MRID No. 42770228)	LD_{50} (95%CI)	10.3 (7.0 - 15.1)
	No Observable Effect Level	2
	Lowest Lethal Level	4
Red-winged Blackbird (MRID No. 43887004)	LD_{50} (95%CI)	2.2 (1.5 - 4.0)
	No Observable Effect Level	0.6
	Lowest Lethal Level	1.5

Acute Oral Toxicity of Chlorfenapyr Degradates to Birds

Compound	Species	Toxicity Measure	Value Observed (mg/kg)
CL 303268 (minor soil degradate)	Northern Bobwhite (MRID 43492809)	LD_{50}	25 (17 - 35)
	Mallard Duck (MRID 43492810)	LD_{50}	77 (57 - 104)
CL 312094 (major soil and fish metabolite)	Northern Bobwhite (MRID 43887006)	LD_{50}	>1,600
	Mallard Duck (MRID 43887005)	LD_{50}	>2,400
CL 303267 (soil degradate)	Northern Bobwhite (MRID 44452611)	LD_{50}	>2,250
	Mallard Duck (MRID 44452612)	LD_{50}	>2,250
CL 325195 (soil degradate)	Northern Bobwhite (MRID 44452611)	LD_{50}	741 (549 - 3017)
	Mallard Duck (MRID 44452612)	LD_{50}	>2,250

Acute Dietary Toxicity of Chlorfenapyr to Birds

Species	Toxicity Measure	Value Observed (ppm)
Northern Bobwhite (MRID 42770230)	LC_{50} (95%CI)	132 (88 - 170)
	No Observable Effect Level	80
	Lowest Lethal Level	160
Mallard Duck (MRID 42770229)	LC_{50} (95%CI)	8.6 (7.4 - 10.1)
	No Observable Effect Level	6
	Lowest Lethal Level	9
Red-winged Blackbird (MRID 44452613)	LC_{50} (95%CI)	11.3 (9.4 - 13.1)
	No Observable Effect Level	7
	Lowest Lethal Level	10.0

Subchronic (28-Day) Dietary Toxicity of Chlorfenapyr to Birds

Species	Toxicity Measure	Value Observed (ppm)
Northern Bobwhite (MRID 43492810)	LC_{50} (95%CI)	148 (105 -192)
	No Observable Effect Level	<10
	Lowest Lethal Level	10
Mallard Duck (MRID 43492812)	LC_{50} (95%CI)	8.1 (6.1 - 10.1)
	No Observable Effect Level	<5
	Lowest Lethal Level	5

Avian Reproduction Study Results for Chlorfenapyr

Species	Toxicity Measure	Value Observed (ppm)
Northern Bobwhite (MRID 43492811)	NOEL (% normal hatchlings, surviving from hatch to day 14)	1.5
Mallard Duck (MRID 43492813)	NOEL (reduced egg production)	0.5

Other Laboratory Studies

Potential for acute dermal toxicity was investigated in a laboratory simulation of actual field exposures to treated plants and soil (MRID Nos. 43887007 and 43492814). Exposure pens containing cotton plants and soil were treated at 1X, 2X and 4X the maximum single application rate at that time up to 1.4 lb. a.i./A in a wind tunnel to accurately simulate field application. It should be noted that the current label allows a maximum application of 0.30 lb. a.i./A and a maximum total per season of 0.5 lb. a.i./A. Bobwhites were confined in these pens from 1-24 hours, starting two hours after application. Soil and plant analyses, as well as foot and feather washes, confirmed that chlorfenapyr residues were present. Although the study design was limited in scope and did not permit the quantification of dermal exposures received by the birds, the fact that no effects were observed among birds interacting with treated plants and walking on treated soil indicates that acute dermal toxicity, post application, would not be a concern to species like bobwhite under use conditions.

Measures of Effect -- Avian Toxicity Studies in the Field

Two field studies have been carried out, both in Louisiana. They are applicable to Southern Cotton, and to the extent that bird species are similar in Western Cotton, can be applied there as well.

Field Pen Study in Louisiana Cotton (MRIDs 43492814, 43887007)
Cyanamid performed a simulated field (pen) study (Guideline 71-5). In this study, 500 sq. ft pens (10 x 50 ft) were established that were: (1) placed so that 50% of the pen area was directly in treated cotton (high dose), (2) placed 25 ft from treated cotton (low dose), or (3) were outside treatment or drift areas (control). Treatment was at the maximum label rate of 0.35 lb. a.i./A three times at weekly intervals. It should be noted that the current label allows a maximum application of 0.30 lb. a.i./A and a maximum total per season of 0.5 lb. a.i./A. Within 12 hours after the third application, Northern bobwhite were placed in pens and held in treated or control areas for 21 days. The birds were provided with clean food and water, and observed daily for signs of intoxication or for mortality. At study termination, there was no statistically significant difference in the percentages of mortality between any of the treatments. Mortality in the control pens was 0%, while mortality in pens positioned 25 feet from the treated crop was 2.1% (one bird) and mortality in pens positioned directly over treated cotton was 4.2% (two birds). Review of necropsy and tissue residue data for the gastrointestinal tracts indicates that none of the deaths were compound related. The results suggest that contact and inhalation exposure to residues of chlorfenapyr on soil and plants under simulated field conditions posed a minimal risk to northern bobwhite over a three week period.

Field Study in Louisiana Cotton (MRID 44452616)
A GLP study was carried out in northeastern Louisiana to monitor the potential effects of crop protection chemical applications on birds in and around cotton fields. The study was based on the methods given by the U.S. Environmental Protection Agency for data requirement 40 CFR 158.145 Series 71-5, "Simulated and Actual Field Testing for Mammals and Birds." This study was designed: (1) To use avian censuses and carcass searching to determine whether PIRATE®, applied according to the proposed label, may cause intoxication of, or mortality to, the various bird species associated with cotton fields; (2) to use censuses, and if possible other techniques, including radio telemetry, to determine if under the proposed label, commercial applications of PIRATE may cause intoxication of, or mortality to, Blue Grosbeaks, Blue Jays, Brown Thrashers, Horned Larks, Indigo Buntings, Killdeer, Mourning Doves, Northern Bobwhite, Northern Cardinals, Northern Mockingbirds, and Red-winged Blackbirds resident in and around cotton fields, and (3) to quantify residues of chlorfenapyr, the active ingredient in PIRATE, in food items of insectivorous, granivorous, omnivorous, and predatory birds associated with cotton fields.

From July 4, 1996 to September 14, 1996, the study was conducted in northeast Louisiana. Twelve commercial cotton fields were selected. Eight fields were treated once with an aerial application of PIRATE® at 0.35 lb. a.i./A, while the remaining four fields were used as reference fields. It should be noted that the current label allows a maximum application of 0.30 lb. a.i./A, so this application was about 15% greater than the maximum on the label. All twelve fields received normal maintenance crop protection chemicals at the discretion of the growers. All twelve fields were monitored for bird use and survival using avian censuses, carcass searching, and resighting of color-marked birds, and four fields, two treated and two reference, were monitored using a combination of radio telemetry field techniques. The major conclusions from this study are summarized below. It should also be noted that results from the study can be

used for characterization of ecosystem and receptor characteristics and characterization of exposure.

The relatively low number of observations of birds made within the cotton crop indicates that most birds were not using the crop as their primary habitat. If census data were used as representative of bird distribution through time, bird use of the cotton field was very limited as compared to adjacent areas. There was no apparent shift in the pattern of whether birds were seen in cotton or in the edge either before or after the applications suggesting that the application of PIRATE and its subsequent effects on the cotton field neither attracted nor repelled birds.

The census data indicate that there is no evidence that applications of PIRATE affected the bird abundance on treated fields, further, applications of PIRATE did not appear to affect species diversity on treated fields, nor did treating fields with PIRATE have any apparent affect on species richness.

The results from the telemetry indicate that following a single application of PIRATE, at approximately the maximum proposed label rate of 0.35 lb. a.i./A, birds that survived to the end of the observation period spent, on average, more time on or around the cotton fields than those that died or had an unknown fate. Survival of radio-tagged birds also did not differ among treated and reference fields. A subsequent statistical analysis of the power of the radiotelemetry portion of the study was done. When the treatment and reference fields were pooled, the test could detect a 20% difference in survival between treatment and reference fields 76 to 94% of the time during the first 15 days after application.

The limited degree to which trapped small mammals appeared to contain residues of PIRATE suggests that the potential for secondary exposure of raptors is low. This is further supported by the low numbers of raptors observed during the censuses.

The techniques used during this study indicated that neither bird use of fields nor bird survival were influenced by applications of PIRATE.

Ecological Response Analysis

Tests for acute oral effects of chlorfenapyr have provided dose-response relationships, no observable effect levels, and lowest observable effect levels in three species. Acute effects tests have also been performed with significant degradates in two species. Subchronic and chronic tests have provided no observable effect levels (NOELs) for reproductive endpoints in two species. The laboratory tests provide the standard information on stressor-response relationships required under FIFRA. Interpretation of causality is straightforward, because exposure, either as a bolus or in the diet, has been assured. Based on the toxicity information, it is plausible that effects may occur in the field if exposures are sufficiently high. All of the major degradates, except CL 303268, proved to be significantly less toxic than chlorfenapyr. Recall that CL 303268 is the insecticidally active form of chlorfenapyr. Therefore, CL 303268 had similar toxicity to chlorfenapyr. These results indicate that the risk assessment can be conducted for chlorfenapyr alone.

Based on these studies, the red-winged blackbird is the most sensitive species in the LD_{50} tests and the mallard duck is the most sensitive species in the dietary tests.

Although dermal toxicity was not measured by direct dosing, available information from a laboratory simulation suggests that acute toxicity would not be likely to result from dermal exposures (in particular, walking on soil in treated areas) under use conditions. This indication was corroborated by a field pen study (see above, page 42). Recall that the conceptual model identified ingestion of residues of chlorfenapyr is the most significant potential route of exposure.

A detailed field study in Louisiana provided information on bird usage of cotton agroenvironments and on survival of individual birds after applications at 0.35 lb. a.i./A, and on residues in relevant avian food items. Bird usage of cotton agroenvironments was low and not affected by application of chlorfenapyr. Survival of individual birds was not affected by application of chlorfenapyr (see above, page 42).

Stressor-response relationships have been established in the laboratory and in the field. The laboratory data will be used to develop stressor-response profiles (see page 95). However, we will first present additional critical information on the ecosystem and receptors at risk.

Measures of Ecosystem and Receptor Characteristics: Biotic Factors - Bird Species and Use of Fields

Detailed summaries of new ecosystem characterization studies not previously reviewed by EPA are provided in Appendix 4.

Avian Species and Their Use of the Cotton Agroenvironment.
Cyanamid has performed extensive studies and literature reviews of the bird species associated with cotton and their feeding and breeding habits. This information can be found in several Cyanamid reports, including the 1993 and 1995 avian censuses, the Arizona field study, the Louisiana field study, and the Geographic Information System study. All of this information was reviewed and the common species associated with the cotton agroenvironment were identified. Detailed information on the species identified, their feeding and breeding habits, is presented in Appendix 5. Based on the information, the birds associated with the cotton agroenvironment were divided into feeding guilds and the guilds which would be at most risk from ingestion of food items potentially containing chlorfenapyr were identified. Species were selected from each of these potentially high risk guilds. These focal species are given in Table 3. Although not present at time of application of chlorfenapyr, mallards have been observed resting in wet areas in the South during periods of migration. We will therefore also consider potential exposure to mallards via the soil. For the present assessment, birds of prey will not be explicitly considered. This feeding guild was observed infrequently in cotton agroenvironments.

TABLE 3. Focal Species Associated with Cotton Agroenvironments

Guild Designation	Location	Species	Body weight (g)	Diet [1]
A	Southern Cotton	Carolina Wren	18.7	94% insects and spiders: 22% lepidopteran larvae, 19% hemipterans, 14% coleopterans, 13% orthopterans, 11% arachnids, 5% hymenopterans, 3% dipterans and others. 6% plant material: seeds from bayberry, sweet gum, poison ivy, sumac, smartweed, and other such as acorn or fruit pulp.
B	Southern Cotton	White-eyed Vireo	11.4	In breeding season: Insects include moths, butterflies, and caterpillars, flies, beetles, spiders and egg cases, damselflies, mayflies, cockroaches, stink bugs, leafhoppers, lacewings, bees, ants, wasps, scale insects, and grasshoppers. Plant matter includes: Sumac, dogwood, poison ivy, pokeweed, wax myrtle. In winter takes a wide variety of insects but relies more heavily on plant matter. 90% of diet is animal matter and 96% of that is insects. Lepidoptera comprised 30.5% (9.8% adults, 20.7% larvae), 20% leafhoppers, 13% beetles, 13% grasshoppers, 11.6% flies and hymenoptera.
C	Southern Cotton	Northern Cardinal	44.6	Insects (caterpillars, grasshoppers true bugs, beetles) and seeds or fruit (bristlegrass, blackberry, grape corn); 71% animal, 29% veg.
C	Beltwide	Blue Grosbeak	28.4	Insects, snails, and seeds of wild and cultivated grasses. Forages opportunistically taking orthopterans (long- and short-horned grasshoppers and crickets), beetles (weevils, scarab beetles, leaf beetles, click beetles, wood borers, and long-horned beetles), true bugs (squash bugs, stink bugs, tree hoppers), cicadas, caterpillars of sphynx moths, cotton cutworms. Seeds include bristlegrass, panicgrass, dropseedgrass, wheat, oats, rice, corn and alfalfa.
D	Beltwide	Mourning Dove	119	99% seeds with composition varying locally. Generally little information on spring and summer. Favors agricultural grains when available, such as corn, wheat, grain sorghum, various millets, buckwheat, and peanuts. Nonagricultural seeds include variety of grasses (*Poa, Paspalum, Setaria, Brachiaria*), spurges (*Croton*), goosefoots (lambquarters), saltbushes, composites (sunflowers), ragweeds, pokeweed, poppies, amaranths (pigweed), smartweed, hemp, purslanes (mustards) and pines.
G	Beltwide	Red-winged Blackbird	52.6	Non-breeding - mostly plant such 38%corn, 36% weed seeds, also sorghum, wheat, tree seeds, and insects (TN); 70.8% corn, 21.6% other plant material, and 7.5% arthropods (OH); or 91-98% plant matter of which 40-73% was sunflower seeds (ND). During breeding – primarily animal, but varies with access to agricultural fields. In Ontario near agricultural area—51% insects and 42% waste grain, in nonagricultural areas—84% insects and 3% waste grain, in Manitoba in agricultural areas diet was 70% animal and in marshes, 100% animal matter. Insects include weevils, beetles, caterpillars, grubs, cankerworms, grasshoppers, ants.

Guild Designation	Location	Species	Body weight (g)	Diet [1]
M	Beltwide	Mallard Duck	956	Consumes 82-93% plant matter. 3-12% soil. Seeds of grasses, reeds, trees, bushes; waste grain, freshwater snails & mollusks, aquatic insects, tadpoles, fishes/eggs. Note: only soil will be evaluated in this assessment.

1. Diets presented were investigated in greater detail once these species were identified as focal species. Therefore the enumeration of diet items here is more detailed than the diets given in the information on species identified as using cotton, Appendix 5.

The diets above will be used in developing exposure profiles from measured residues in the Exposure Analysis Section (see page 83) and from the ALERT® and PIRATE® use patterns. All seven species will be used for the assessment in both Southern and Western Cotton, even though only the last four species range across the entire Cotton Belt. This procedure will provide an assessment for ecological homologs of the Carolina Wren, White-eyed Vireo, and Northern Cardinal in Western Cotton.

Endangered Species

Although this risk assessment is primarily for non-threatened and non-endangered avian species, the findings and conclusions are applicable to all species. It is important to note that in all the avian censuses and field studies, only one endangered species, the Brown Pelican (*Pelicanus occidentalis*), was observed in the Arizona census in 1995.

Additional reference information on the adjacency of endangered species habitat to cotton fields is available from the results of the GIS study (MRID Nos. 44452606 and 44452607). Utilizing these references, analysis of the fifteen sites across the Cotton Belt (AL, AZ, CA, GA, LA, MS, OK, SC, TN and TX) showed that only one threatened or endangered species, snowy plover (*Charadrius alexandrinus*), had ever been previously observed at one study site (CA) within 50 meters of cotton.

Cyanamid is a founding member of an industry wide task force, the FIFRA Endangered Species Task Force, which is working with the EPA in a cooperative research program to develop and implement a program which will adequately protect threatened and endangered species.

Ecosystem and Receptor Characteristics: Biotic Factors - Extent and Characteristics of Acreage Planted to Cotton

Studies have been conducted using a geographic information system (GIS) and remote sensing to characterize and quantify aspects of the environment relevant to avian risk and environmental fate modeling (see Appendix 4). This information can be used to evaluate the cotton agroenvironment as avian habitat.

A non-guideline GIS pilot study (MRID 44452606) was carried out in cotton-growing regions in the southern United States. The pilot study examines the utility of, and methods for, using a GIS and remote sensing to measure and quantify aspects of the environment for purposes of conducting a risk assessment and for environmental fate modeling.

Two counties in the southern United States, Leflore County, Mississippi and Brazos County, Texas, were selected to represent wetland (non-irrigated) and dryland (irrigated) cotton growing regions, respectively. Satellite imagery was used to determine characteristics of cotton fields,

their surrounding habitats, and the juxtaposition of cotton with surface water, both flowing and static. To assist in assessing drift potential from a crop protection chemical application to a cotton field into bodies of water, high resolution aerial images were used to closely evaluate the composition and characteristics of buffer vegetation surrounding bodies of water. Existing soil type, hydrologic, elevational, and transportation data were combined with the remotely acquired data in a GIS to more fully describe cropping practices involving cotton so that the information could be included in run-off models.

The habitat classifications were 81% accurate in Brazos County and 89% accurate in Leflore County. The amount of land in cotton, other agricultural crops, native vegetation classes, water, and other categories (primarily cities, buildings, and roads) was determined. Cotton fields in both counties were relatively flat with slopes of generally less than 1%, indicating low potential for runoff. Land use/land cover categories included in the determination of extent of avian habitat included hardwoods, cypress, woodlands, brush, tall grass, grass/pasture, and riparian. It was acknowledged that cities, agricultural fields and open water could also be considered as avian habitat. In Leflore county, only 12% of the avian habitat, and in Brazos County, only 3% of the avian habitat was within 30 meters of cotton. This kind of information helps to put into perspective the level of risk bird populations may be exposed to regarding crop protection chemical applications.

A non-guideline GIS definitive study (MRID No. 44452607) was carried out in cotton-growing regions all across the United States. The primary objective of this study was to quantify the environmental characteristics which influence exposure of birds and aquatic organisms resulting from the use of chlorfenapyr on cotton. Twenty locations throughout the cotton-growing regions of the United States were selected, and fifteen were fully characterized. Only those areas within one mile of agricultural lands (including row-crops and tree crops) and within the political boundaries of the United States were included in the characterization to reduce the potential bias produced in the summary statistics from the inclusion of large, contiguous nonagricultural areas. Satellite imagery was used to determine characteristics of cotton fields, their surrounding habitats, and the juxtaposition of cotton with surface water, both flowing and static. The numbers of cotton fields, the total cotton acreage, the maximum, minimum and mean field sizes, total cotton field perimeter lengths, minimum, maximum, and mean perimeter lengths within each study site were reported. Existing soil type, hydrologic, elevational, and transportation data were combined with the satellite data in a GIS to characterize the cotton fields according to their slope, soil type and the land cover classes within 10 meters (33 ft) or 50 meters (164 ft).

A great deal of agricultural and pesticide-related information is summarized at the county level (Census of Agriculture 1992; USA Counties 1996). To help put the Geographical Information System results in perspective, it proved useful to look at the number of counties within each state in the Cotton Belt that plant cotton. An analysis was performed using public information on cotton acres harvested as follows: using Part 51 of the Census of Agriculture, the values for 1992 acres harvested by county were obtained. The USA Counties database was used to obtain the size of each county in square miles. The county acreage was then calculated by multiplying the number of square miles in the county by 640 acres. Percentage of the county acreage harvested as cotton could then be calculated. For each state, the number and acreages of all counties, irrespective of whether they harvested cotton, were also obtained. Finally, each county was classified according to ecoregion. Information is presented by state and county first.

Over the entire Cotton Belt, despite the importance of cotton on both a local and regional level, it is surprising how few counties possess large proportions of their area devoted to this crop. Only eight counties exceeded 30% of their areas planted to cotton. Of the 499 counties where cotton was planted, 424 had less than 9% of their acreage in cotton. More than half (301/499) of the counties where cotton is planted have less than 3% of their acreage in cotton. Furthermore, less than half of the counties (499 out of 1299) in the states where cotton was planted had cotton. There was no cotton planted in the other 800 counties in cotton-producing states. This fact shows that there will be no potential for exposure to chlorfenapyr in many areas of the Cotton Belt.

The distribution of percentages of each county that were planted to cotton are provided for Southern and Western Cotton below.

	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	30-33	33-36	>33	Totals	Total Counties
CA	2	4	1	0	0	0	0	0	1					8	58
AZ	9	1												10	15
NM	7	1	1											9	33
TX	9	3	0	1	1	0	0	1						15	32
Western Cotton Total	27	9	2	1	1	0	0	1	1	0	0	0	0	42	138
TX	58	24	11	6	3	3	2	0	2	1	1			111	223
OK	17	3	1	1	1									23	77
AR	10	4	3	1	5	0	1	1	0	0	1			26	75
MO	2	2	0	0	0	0	1	1	0	0	0	0	1	7	114
LA	9	5	1	2	0	0	2	2	0	0	2			23	64
MS	27	10	1	3	1	5	2	1	1	2				53	82
TN	11	4	0	1	3	1	1					1		22	95
AL	40	2	4	1	0	1	0	0	0	0	0	1	1	50	59
GA	48	14	2	2	0	1								67	159
FL	9													9	67
SC	22	3	1	1										27	46
NC	21	13	4	1										39	100
Southern Cotton Total	274	84	28	19	13	11	9	5	3	3	4	2	2	457	1161
Grand Total	301	93	30	20	14	11	9	6	4	3	4	2	2	499	1299

Using information on ecoregions (Bailey 1996), the percentages of each ecoregion within a state that is planted to cotton can be estimated by state. The following two tables provide this information for Southern and Western Cotton. It can be seen that only small percentages of a given ecoregion are planted to cotton in an individual state.

Southern Cotton

State	Ecoregion	Total Acres	% of Area Planted to Cotton
Alabama	Hot Continental	1,568,640	6.20
	Subtropical	30,894,080	1.07
	Total	32,462,720	1.31
Arkansas	Hot Continental	10,162,560	0.00
	Hot Continental (Mountainous)	1,566,720	0.00
	Subtropical	17,518,720	5.40
	Subtropical (Mountainous)	4,059,520	0.00
	Total	33,307,520	2.84
Florida	Savanna	5,952,000	0.00
	Subtropical	28,547,840	0.14
	Total	34,499,840	0.12
Georgia	Hot Continental	110,720	0.00
	Hot Continental (Mountainous)	2,065,920	0.03
	Subtropical	34,846,720	1.22
	Total	37,023,360	1.15
Louisiana	Subtropical	27,863,040	2.96
	Total	27,863,040	2.96
Mississippi	Subtropical	30,000,000	4.43
	Total	30,000,000	4.43
Missouri	Hot Continental	19,155,200	0.01
	Prairie	22,743,680	0.00
	Subtropical	2,161,280	14.43
	Total	44,060,160	0.71
North Carolina	Hot Continental (Mountainous)	6,608,640	0.00
	Subtropical	24,539,520	1.45
	Total	31,148,160	1.14
Oklahoma	Hot Continental	2,043,520	0.00
	Prairie	17,858,560	0.09
	Subtropical	1,985,280	0.00
	Subtropical (Mountainous)	3,207,040	0.00
	Temperate Steppe	9,191,680	0.00
	Tropical/Subtropical Steppe	9,646,720	2.90
	Total	43,932,800	0.67
South Carolina	Hot Continental	1,696,000	0.02
	Subtropical	17,562,880	1.09
	Total	19,258,880	0.99
Tennessee	Hot Continental	21,455,360	1.19
	Hot Continental (Mountainous)	1,835,520	0.00
	Subtropical	3,061,760	11.15
	Total	26,352,640	2.27

State	Ecoregion	Total Acres	% of Area Planted to Cotton
Texas	Prairie	44,890,880	1.08
	Subtropical	17,808,640	0.06
	Temperate Steppe	3,324,800	0.00
	Tropical/Subtropical Steppe	63,578,240	4.25
	Total	129,602,560	2.47
Overall Total		[illegible]	[illegible]

Western Cotton

State	Ecoregion	Total Acres	% of Area Planted to Cotton
Arizona	Tropical/Subtropical Desert	39,020,160	1.10
	Tropical/Subtropical Steppe	33,707,520	0.00
	Total	72,727,680	0.59
California	Mediterranean	27,237,120	3.84
	Mediterranean (Mountainous)	16,903,040	0.00
	Tropical/Subtropical Desert	17,921,280	0.10
	Total	62,061,440	1.71
New Mexico	Temperate Steppe	1,409,920	0.00
	Temperate Steppe (Mountainous)	4,278,400	0.00
	Tropical/Subtropical Desert	21,125,760	0.24
	Tropical/Subtropical Steppe	20,207,360	0.02
	Tropical/Subtropical Steppe (Mountainous)	30,643,840	0.00
	Total	77,665,280	0.07
Texas Rio Grande Valley	Tropical/Subtropical Desert	22,368,640	0.27
	Tropical/Subtropical Steppe	15,577,600	2.21
	Total	37,946,240	1.07
Overall Total		250,400,640	0.76

The reverse of the above summary, that is the percentage of each state planted to cotton within an ecoregion, can be estimated by ecoregion for Southern and Western Cotton. Whether one summarizes the percentage of the landscape in cotton by county, by state, or by ecoregion, the results are similar. Overall, there is a relatively small percentage of the acreage planted to cotton.

Southern Cotton

Ecoregion	State	Total Acres	% of Area Planted to Cotton
Hot Continental	Alabama	1,568,640	6.20
	Arkansas	10,162,560	0.00
	Georgia	110,720	0.00
	Missouri	19,155,200	0.01
	Oklahoma	2,043,520	0.00
	South Carolina	1,696,000	0.02
	Tennessee	21,455,360	1.19
	Total	56,192,000	0.63
Hot Continental (Mountainous)	Arkansas	1,566,720	0.00
	Georgia	2,065,920	0.03
	North Carolina	6,608,640	0.00
	Tennessee	1,835,520	0.00
	Total	12,076,800	0.01
Prairie	Missouri	22,743,680	0.00
	Oklahoma	17,858,560	0.09
	Texas	44,890,880	1.08
	Total	85,493,120	0.59
Savanna	Florida	5,952,000	0.00
	Total	5,952,000	0.00
Subtropical	Alabama	30,894,080	1.07
	Arkansas	17,518,720	5.40
	Florida	28,547,840	0.14
	Georgia	34,846,720	1.22
	Louisiana	27,863,040	2.96
	Mississippi	30,000,000	4.43
	Missouri	2,161,280	14.43
	North Carolina	24,539,520	1.45
	Oklahoma	1,985,280	0.00
	South Carolina	17,562,880	1.09
	Tennessee	3,061,760	11.15
	Texas	17,808,640	0.06
	Total	236,769,760	2.16
Subtropical (Mountainous)	Arkansas	4,059,520	0.00
	Oklahoma	3,207,040	0.00
	Total	7,266,560	0.00
Temperate Steppe	Oklahoma	9,191,680	0.00
	Texas	3,324,800	0.00
	Total	12,516,480	0.00

Ecoregion	State	Total Acres	% of Area Planted to Cotton
Tropical/Subtropical Steppe	Oklahoma	9,646,720	2.90
	Texas	63,578,240	4.25
	Total	73,224,960	4.08
Overall Totals		489,611,680	1.83

Western Cotton

Ecoregion	State	Total Acres	% of Area Planted to Cotton
Mediterranean	California	27,237,120	3.84
	Total	27,237,120	3.84
Mediterranean (Mountainous)	California	16,903,040	0.00
	Total	16,903,040	0.00
Temperate Steppe	New Mexico	1,409,920	0.00
	Total	1,409,920	0.00
Temperate Steppe (Mountainous)	New Mexico	4,278,400	0.00
	Total	4,278,400	0.00
Tropical/Subtropical Desert	Arizona	39,020,160	1.10
	California	17,921,280	0.10
	New Mexico	21,125,760	0.24
	Texas - Rio Grande	22,368,640	0.27
	Total	100,435,840	0.55
Tropical/Subtropical Steppe	Arizona	33,707,520	0.00
	New Mexico	20,207,360	0.02
	Texas - Rio Grande	15,577,600	2.21
	Total	69,492,480	0.50
Tropical/Subtropical Steppe (Mountainous)	New Mexico	30,643,840	0.00
	Total	30,643,840	0.00
Overall Total		250,400,640	0.78

The above summaries relate to the total area planted to cotton; not all of this area will be treated for the cotton pests on the ALERT® and PIRATE® labels. An estimate of the avian habitat area that might be impacted as a result of treatment of the pests on the ALERT and PIRATE labels was made as follows.

By using the average acres above economic threshold from published economically infested acreages (Head 1989, 1990, 1991, 1992, 1993; Williams 1994, 1995, 1996, 1997) for pests on the labels, the average field size (from the GIS), the number of acres in the 164 ft. (50 meter) border areas, and the proportions of the border comprising the different land cover classes (GIS), the number of acres of each land cover class potentially exposed following applications for the major pests can be estimated as shown in the following table. For the mite treatments, only the GIS information from the Mediterranean and Desert ecoregions was used. To calculate the number of acres exposed in the 50 m border areas, the average number of acres in the border for the ecoregions was multiplied by the proportion of fields represented by the

acres above threshold value, and then multiplied by the proportion of fields treated. The results for mites correspond to potential exposure in Western Cotton, while the results for the other pests are mainly applicable to exposure in Southern Cotton. It should be noted that these figures represent 100% of the potential acreage that could be treated. Chlorfenapyr would not have the 100% market share that these acreages represent. For example, a highly conservative overestimate assumes 19% of the total acres planted to cotton may receive a chlorfenapyr application (see page 27). This is based on applications to 20% of the acres infested with resistant budworm/bollworm (1.4M acres); 50% infested with mites (0.6M acres) and 50% infested with beet armyworms (0.4M acres).

	Mites	Bollworm/ Budworm	Beet Armyworm	Fall Armyworm	Total (acres)	%[1]
Acres Above Threshold	*1,103,342*	*6,764,362*	*881,299*	*378,042*	*9,127,045*	*1.2*
Average Field Size (acres)	*66.03*	*34.76*	*34.76*	*34.76*		
Proportion Treated	*0.16*	*2*	*0.16*	*0.09*		
Treated Cotton Fields	*16,711*	*194,596*	*25,353*	*10,875*		
Average 164-ft Border (acres)	*20.14*	*14.33*	*14.33*	*14.33*	*63.13*	*0.00*
Exposed Border (acres)	*53,848*	*5,577,107*	*58,129*	*14,026*	*5,703,110*	*0.77*
Other Ag. (acres)	*23,081*	*1,996,471*	*20,809*	*5,021*	*2,045,382*	*0.27*
Roads (acres)	*5,817*	*378,082*	*3,941*	*951*	*388,791*	*0.05*
Bare ground/urban (acres)	*18,015*	*838,894*	*8,744*	*2,110*	*867,763*	*0.11*
Canals/Ditches (acres)	*3,380*	*51,005*	*532*	*128*	*55,045*	*0.00*
Clouds/Cloud shadows (acres)	*797*	*65,846*	*686*	*166*	*66,775*	*0.00*
Intermittent streams (acres)	*197*	*72,143*	*752*	*181*	*73,273*	*0.00*
Desert scrub (acres)	*2,840*	*59,279*	*618*	*149*	*62,886*	*0.00*
Rivers/Streams (acres)	*21*	*44,877*	*468*	*113*	*45,479*	*0.00*
Lakes/Ponds acres)	*43*	*16,650*	*174*	*42*	*16,909*	*0.00*
Wetlands (acres)	*-*	*11,147*	*116*	*28*	*11,291*	*0.00*
Grass/Pasture (acres)	*672*	*1,066,778*	*11,119*	*2,683*	*1,081,252*	*0.14*
Brush/Weeds (acres)	*-*	*383,446*	*3,997*	*964*	*388,407*	*0.05*
Mud Flats (acres)	*-*	*-*	*-*	*-*		
Bays (acres)	*-*	*-*	*-*	*-*		
Catfish Ponds (acres)	*-*	*1,315*	*14*	*3*	*1,332*	*0.00*
Bottomland Forest (acres)	*-*	*35,978*	*375*	*90*	*36,443*	*0.00*
Upland Forest (acres)	*-*	*3,890*	*41*	*10*	*3,941*	*0.00*
Forest/trees (acres)	*212*	*566,256*	*5,902*	*1,424*	*573,794*	*0.07*
Riparian (acres)	*261*	*133,670*	*1,393*	*336*	*135,660*	*0.01*

[1] Percent of the total acreage in the Cotton Belt of 740,000,000.

The above acreages represent only a small fraction of the total acreage in the Cotton Belt. Besides being relevant to ecosystem and receptor characteristics, the above information is also germane to "Factors that Modify/Mitigate Exposure to Residues" (see page 77), and functions to reduce potential exposure to chlorfenapyr at the county, state, or ecoregion level.

Ecosystem and Receptor Characteristics -- Biotic Factors - Insects in Cotton as an Avian Food Source

In this section, we present information which indicates that cotton fields are relatively poor sources of food for insectivorous birds, and that, based on feeding efficiency (energy)

considerations, insectivorous birds are more likely to spend time in other areas than cotton fields.

As the basis of this observation, we summarize here biomass estimates for insects (including pests, predators, beneficials and species not in any of these categories) in cotton, and in areas adjacent to cotton, as indicated by a comprehensive study using a GIS. Table 4 summarizes the estimated insect biomass in cotton, soybeans and pasture-grasslands.

Table 4. Average Arthropod Biomass per Acre in Wild Plant Hosts, Cotton, Soybean, Pasture-grasslands Plant Ecosystem During the Cotton Growing Season.[1]

	Arthropod Biomass g/acre						
Plant hosts	April - early June	Early - mid June	Early - mid July	July/ Aug.	August/ Sept.	Sept./ Oct.	**Season average**
Wild plant hosts	8.2	8.2					NA
Cotton - pests		68	4,380	2524	580	1,389	2,218
Cotton - beneficials		139	1,048	890	926	1,077	985
Cotton total		207	5,428	3,414	1,505	2,465	3,472
Soybean			10,426	56,493	39,145	39,093	36,289
Pasture-grasslands[2]	320	320	320	320	320	320	320

[1]Where values are missing, data were not collected. See Appendix 7 (Ruberson 1997, Mackum and Baker 1990, Pitre et al. 1987, and Stadelbacher 1981).
[2] Key pest species only. Biomass of total arthropod population not represented.

GIS data showed that other agriculture, which would frequently be soybeans, and pasture, were the most common vegetation types grown adjacent to cotton. Results show that throughout the season, soybeans represent a vastly greater potential food source for insectivorous birds. Birds are therefore unlikely to spend much time in cotton.

The information helps to explain why avian censuses and field studies have shown that birds do not use cotton fields intensively. It must be emphasized that the estimates above are for *unmanaged fields;* as such, they overestimate the biomass in fields that are managed to control insects and weeds. Based on economic thresholds, the insect biomass in managed fields is expected to be less than 500 grams per acre. Given the caloric requirements of birds, it is clear that this low biomass could only support a few birds, even if these birds gleaned every insect on an acre of cotton. More details on the biomass estimates can be found in Appendix 7 where food consumption for birds commonly associated with cotton agroenvironments is estimated using equations from Nagy (1987). Given the caloric needs of birds and the biomass of insects in managed cotton fields, it can be seen that cotton fields themselves cannot support large numbers of birds. Besides being germane to ecosystem and receptor characteristics, the above information is also germane to "Factors that Modify/Mitigate Exposure to Residues," and functions to reduce both the likelihood of exposure to chlorfenapyr and the residue levels birds are likely to encounter (see page 77).

Characterization of Environmental Exposure

This section presents information relating to the level of chlorfenapyr residues in air, in avian feed items, including vegetation, insects/invertebrates and soil, and factors that affect the potential for birds to be exposed to those residues.

The major factors which will govern the residue levels of chlorfenapyr in the cotton agroenvironment are: application rates, frequency of application and application method. The labels allow for multiple applications at a total annual use rate of 0.5 lb. a.i./A, with a maximum single application of 0.3 lb. a.i./A. Applications may be made with a minimum interval of five days between applications. Because of the requirements on the label and commercial application procedures, it is expected that initial levels of chlorfenapyr will be similar in the agroenvironment across the Cotton Belt.

Measures of Exposure – Residues in the Air due to Spray Droplets

Chlorfenapyr has a low vapor pressure and concentrations in the air from volatilization from plant or soil surfaces will be very low. There is a theoretical possibility that birds may inhale spray droplets during the few moments between the time the spray is applied and it settles on the plant or soil surface. Such residues in air were measured in the Georgia small-scale exposure study (MRID No. 43493814). The maximum concentration in air, for a 0.4 lb. a.i./A treatment, was 5 nanograms per liter (ng/l).

We eliminated inhalation as a significant exposure pathway based on physical and chemical characteristics of chlorfenapyr (see page 33). The following calculation provides additional justification for eliminating inhalation as a route of exposure in this assessment. EPA (1993) has published an allometric equation for inhalation rate, which is:

$$\text{Inhalation Rate (mL/minute)} = 284\ \text{Weight}^{0.77}$$

In the above formula, weight is measured in kilograms. Assuming the maximum observed concentration of chlorfenapyr in the air, 5 ng/l, a 200 gram bird could inhale 592 ng of chlorfenapyr in 24 hours. Further assuming 100% absorption, the body burden would be 0.027% of the lowest LD_{50}, 2.2 mg/kg. Based on this analysis the risk from inhalation exposure is insignificant, even in the few hours after application of chlorfenapyr. Therefore, no further consideration will be given to exposure by inhalation in this assessment.

Measures of Exposure -- Residues in Avian Vegetative Food Items and Cotton Plants

In addition to the Georgia small-scale exposure study (MRID No. 43492814), four field studies (MRID No. 44452605) were performed in Mississippi to quantify levels and characterize degradation of chlorfenapyr in the cotton agroenvironment (i.e., cotton, seed heads, and soil). An additional field study (MRID No. 44452608), designed to determine the levels of residues in weed seeds/seed heads that may result from simulated drift amounts of chlorfenapyr, was also conducted.

These studies were designed to elucidate the distribution, variability and rate of decline of residues from vegetation (including avian feed items in the field borders). The studies also provide information of the effect of aerial vs. ground application, and different rates and intervals of application.

The information from these studies can be used for characterization of residues in soil and whole cotton plants in the treated field and residues on avian food items in the field borders.

There is variation in the measurements of rates of degradation of chlorfenapyr across the Cotton Belt. However, the use rates and duration of time that the compound is effective in controlling insects are similar across the Cotton Belt, strongly suggesting similar degradation rates. Furthermore, it can be expected that insects will succumb to lethal levels of chlorfenapyr in similar periods of time. As we will show, the half-lives on cotton plants and weed seeds and seed heads reported in this submission are similar to the half-lives obtained in residue rate of decline (ROD) studies for a variety of crops in many locations throughout the world (see page 67). Thus there is no reason to expect large differences in degradation rates on plant materials across the Cotton Belt.

Vegetation

Tables 5 and 6 summarize the data from the new studies for vegetative food items and cotton plants (see Appendix 6). Data from the individual measurements are presented graphically in the figures that follow the tables.

TABLE 5. Cotton Plant Residue (ppm)

Study	Total lb.	Total # apps (Interval)	Sample Unit	Approx. Days After Last Application							
				0.1	sd	1	sd	3	sd	7	sd
[1]MRID 44452605											
MS EUP Grnd 1	1.05	3 (3 wk)	Whole	4.6	2.15						
MS EUP Grnd 2	1.05	3 (3 wk)	Whole	6.5	1.75						
MS EUP Aerial 1	1.05	3 (3 wk)	Whole	4.9	4.3						
MS EUP Aerial 2	1.05	3 (3 wk)	Whole	5.1	1.7						
MRID 43492814											
GA Sm Sc Exp	0.4	1	Upper Leaves	98.9	0.95	62	27.13	45	20.33	27	5.49
GA Sm Sc Exp	0.2	1	Leaves	34	5.26	27	3.83	9	1.73	1.4	1.25
MRID 43492814 & MRID 43887007											
LA Pen Study	1.05	3 (1 wk)	Leaves	56.03	24.8						
[2]MRID 44452616											
LA Field Study	0.35	1	Leaves			51.1					
MRID 44452609											
Insect Field	0.2	1	Leaves	45.9	26.7	14.3	na	7.00	2.5	1.50	0.99
	0.35	1	Leaves	60.5	15.3	30.6	na	15.02	4.7	3.28	3.52

[1] These values represent the average from four unreplicated samples, each of which is a composite of 10 whole cotton plants.
[2] Only one sample was analyzed.

TABLE 5. Cotton Plant Residue (ppm) (cont.)

Study	Total lb.	Total # apps (Interval)	Sample Unit	Approx. Days After Last Application 14	sd	21	sd	30	sd
[1]MRID 44452605									
MS EUP Grnd 1	1.05	3 (3 wk)	Whole	2.4	0.93			0.6	0.27
MS EUP Grnd 2	1.05	3 (3 wk)	Whole	2.1	0.87			0.6	0.15
MS EUP Aerial 1	1.05	3 (3 wk)	Whole	2.6	1.11			0.4	0.07
MS EUP Aerial 2	1.05	3 (3 wk)	Whole	1.1	0.32				
MRID 43492814									
GA Sm Sc Exp	0.4	1	Upper Leaves	7	0.22			3	0.26
GA Sm Sc Exp	0.2	1	Leaves	<0.5				<0.5	
MRID 43492814 & MRID 43887007									
LA Pen Study	1.05	3 (1 wk)	Leaves			1.75	2.1		
[2]MRID 44452616									
LA Field Study	0.35	1	Leaves						
MRID 44452609									
Insect Field	0.2	1	Leaves	0.58	0.36	0.33	0.3	0.10	0.23
	0.35	1	Leaves	0.43	0.65	0.36	0.81	0.51	0.71

[1] These values represent the average from four unreplicated samples, each of which is a composite of 10 whole cotton plants.
[2] Only one sample was analyzed.

TABLE 6. Vegetative Avian Food Item Residues (ppm)

Study	Total lb.	Total # apps (Interval)	Sample Area (ft from field border)	Approx. Days After Last Application 0.1	sd	1	sd	3	sd	7	sd
MRID 44452605											
MS EUP Grnd 1	1.05	3 (3 wk)	0 - 10	0.36	0.16						
			10 - 25	0.16	0						
			25 - 50	0.22	0.04						
MS EUP Grnd 2	1.05	3 (3 wk)	0 - 10	0.3	0.13						
			10 - 25	0.25	0.04						
			25 - 50	0.14	0.02						
MS EUP Aerial 1	1.05	3 (3 wk)	0 - 25	0.3	0.02						
			25 - 75	0.24	0.15						
			75 - 150	0.26	0.01						
MS EUP Aerial 2	1.05	3 (3 wk)	0 - 25	0.44	0.31						
			25 - 75	0.15	0.11						
			75 - 150	0.07	0.06						
MRID 43492814											
GA Sm Sc Exp	0.4	1	0 - 50	<0.5		<0.5		<0.5		<0.5	
GA Sm Sc Exp	0.2	1	0 - 50	<0.5		<0.5		<0.5		<0.5	
[1]MRID 44452616											
LA Field Study	0.35	1	0			20.5					
[1]MRID 44452608											
Weed Seed	1.05	3 (1 wk)	0	36.5		42.5		22.2		17.7	
Weed Seed	0.54	3 (1 wk)	0	7.99		16.3		13.05		6.92	
Weed Seed	0.105	3 (1 wk)	0	2.52		1.79		1.22		0.86	
Weed Seed	0.03	3 (1 wk)	0	0.64		0.76		0.51		0.31	

[1] Samples were composited before analysis.

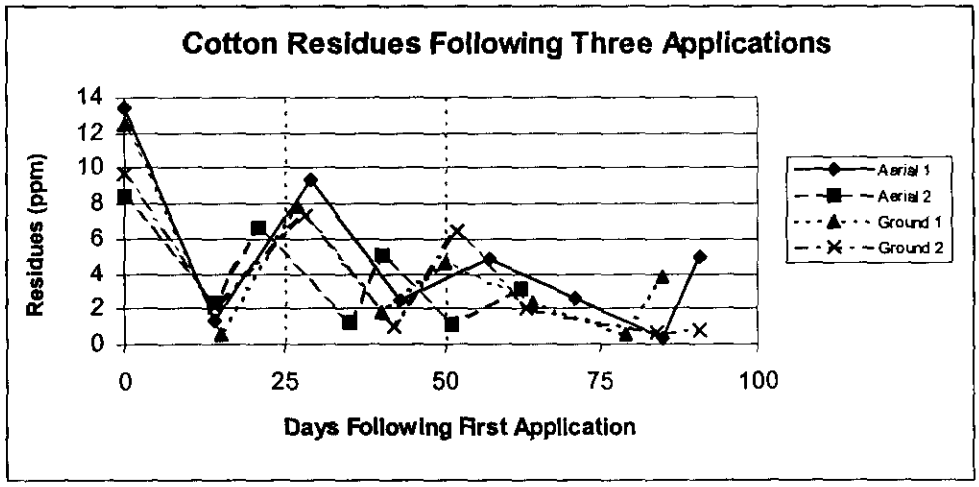
TABLE 6. Vegetative Avian Food Item Residues (ppm) (cont.)

Study	Total lb.	Total # apps (Interval)	Sample Area (ft from field border)	Approx. Days After Last Application							
				7	sd	14	sd	30	sd	60	sd
MRID 44452605											
MS EUP Grnd 1	1.05	3 (3 wk)	0 - 10			0.81	0.39	0.3	0.25	0.09	0.06
			10 - 25			0.58	0.35	0.09	0.06	0.1	0.02
			25 - 50			0.39	0.14	0.06	0.04	0.08	0.03
MS EUP Grnd 2	1.05	3 (3 wk)	0 - 10			0.18	0.08	0.12	0.02	0.08	0.007
			10 - 25			0.14	0.03	0.1	0.007	0.08	0
			25 - 50			0.12	0.05	0.1	0.02	0.08	0.02
MS EUP Aerial 1	1.05	3 (3 wk)	0 - 25			0.41	0.28	< 0.05		< 0.05	
			25 - 75			0.24	0.21	< 0.05		0.06	0.05
			75 - 150			0.15	0.11	< 0.05		< 0.05	
MS EUP Aerial 2	1.05	3 (3 wk)	0 - 25			0.12	0.007			0.06	0.05
			25 - 75			0.12	0.13			0.05	0.04
			75 - 150			0.07	0.13			< 0.05	
MRID 43492814											
GA Sm Sc Exp	0.4	1	0 - 50	<0.5		0.51		<0.5			
GA Sm Sc Exp	0.2	1	0 - 50	<0.5		<0.5		<0.5			
[1]MRID 44452616											
LA Field Study	0.35	1	0								
[1]MRID 44452608											
Weed Seed	1.05	3 (1 wk)	0	17.7		16		5.79			
Weed Seed	0.54	3 (1 wk)	0	6.92		5.12		1.85			
Weed Seed	0.105	3 (1 wk)	0	0.86		0.78		0.44			
Weed Seed	0.03	3 (1 wk)	0	0.31		0.31		0.17			

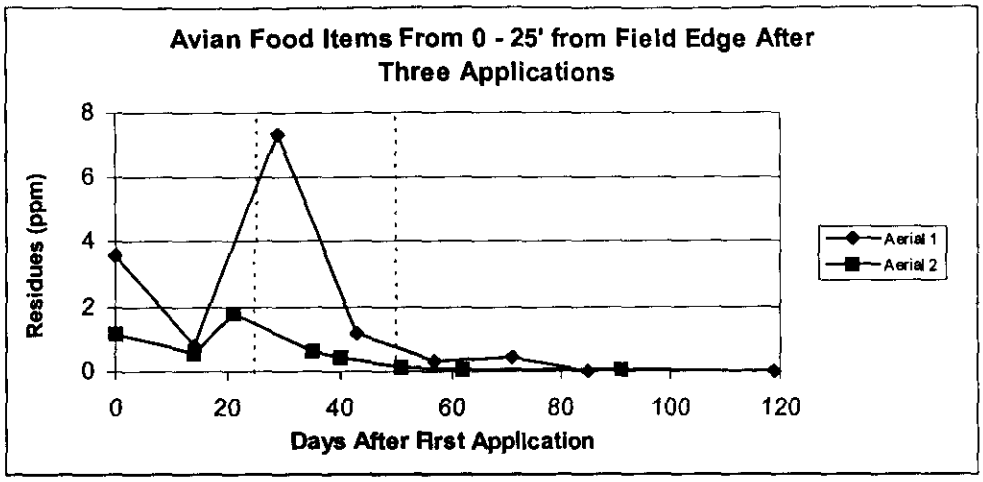
[1] Samples were composited before analysis.

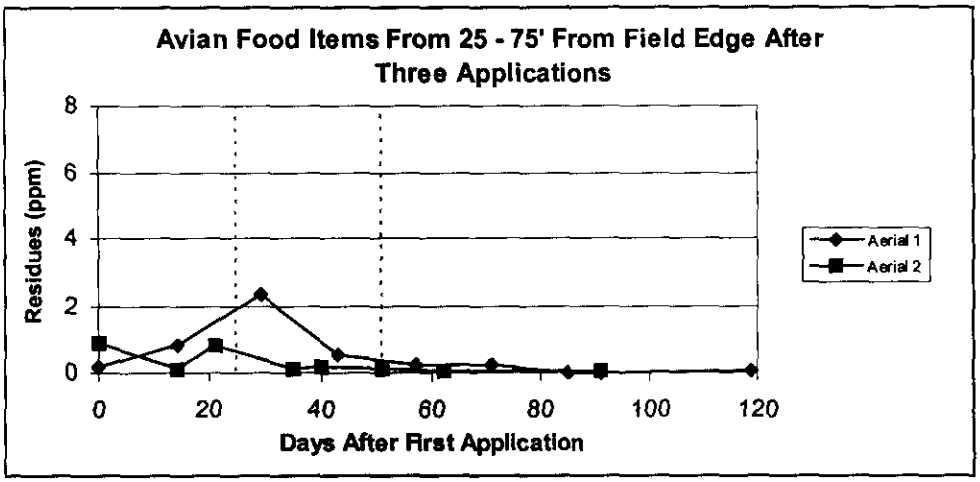
The graphs that follow depict the decline of residues found in the various matrices measured. Applications (indicated by vertical, dashed lines) of 0.35 lb. a.i./A were made on approximately day 0, 25 and 50 for both the aerial and ground treatments.

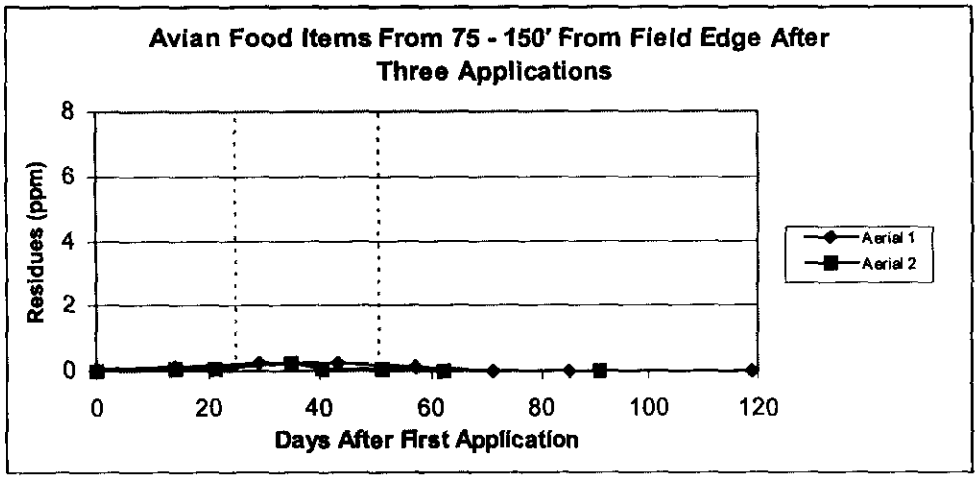
The measured residues on cotton, for whole plants, did not differ dramatically following aerial or ground applications. The final measurements for each study were made of the cotton trash.



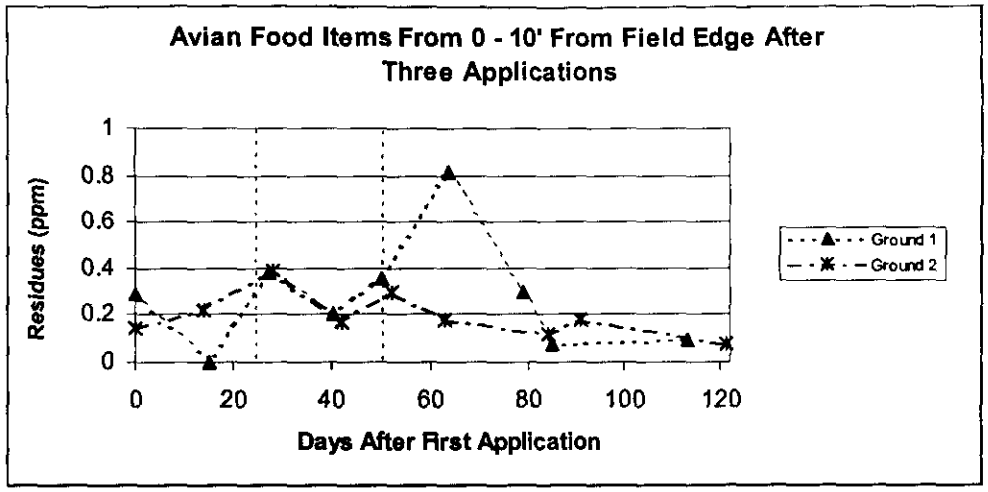
The following discussion refers to the three figures on the next page. In both aerial studies, the residues on avian food items (primarily seed heads) collected from 0 to 25 ft from the field edge peaked following the second application. Residues were negligible by approximately 100 days following the initial application. A similar peak in the residues on avian food items was measured immediately following the second application in the area from 25 to 75 ft from the field edge. The magnitude of the peak was considerably reduced. The magnitude of the residues measured in avian food items from 75 to 150 ft from the edge of the field following aerial applications was minimal.

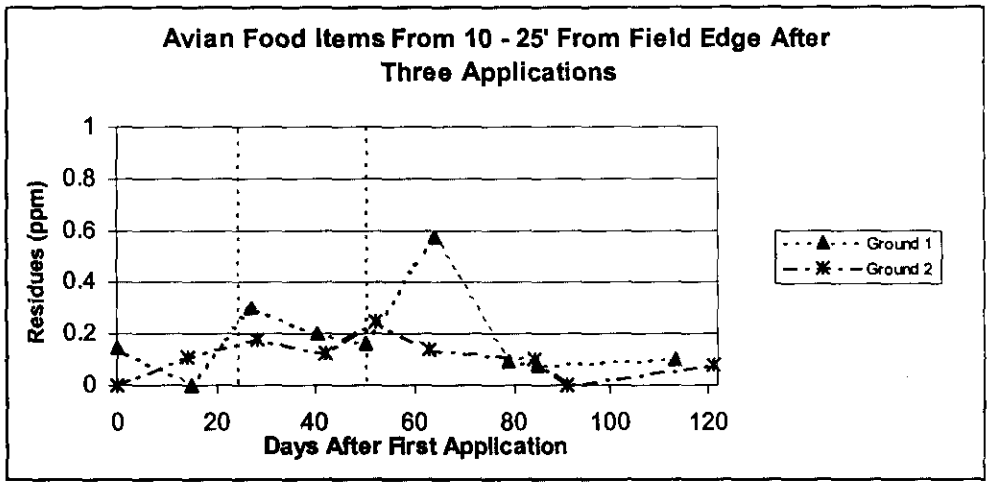

Avian Food Items From 0 - 25' from Field Edge After Three Applications
Residues (ppm)
8
6
4
2
0
0
20
40
60
80
100
120
Days After First Application
Aerial 1
Aerial 2

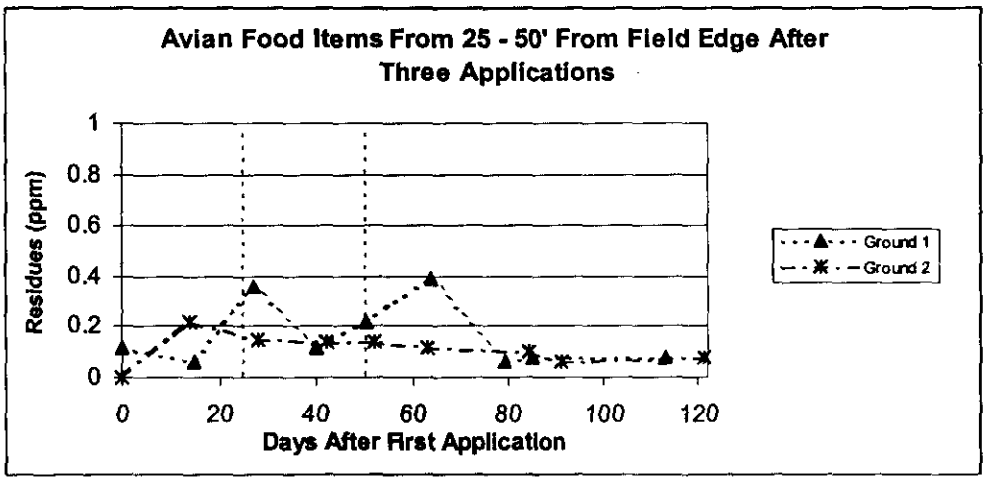

Avian Food Items From 25 - 75' From Field Edge After Three Applications
Residues (ppm)
8
6
4
2
0
0
20
40
60
80
100
120
Days After First Application
Aerial 1
Aerial 2


Avian Food Items From 75 - 150' From Field Edge After Three Applications
Residues (ppm)
8
6
4
2
0
0
20
40
60
80
100
120
Days After First Application
Aerial 1
Aerial 2

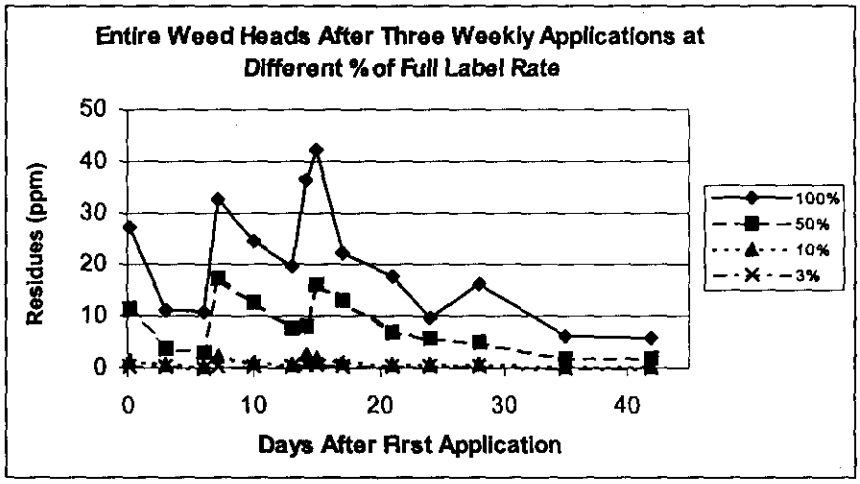
The following discussion refers to the graphs on the next page. Following ground applications, the residues measured in avian food items collected even within 10 ft of the field edge contained less than 1 ppm. The decrease with distances from the field in the studies with ground applications was not as great as the decrease in the studies with aerial application. Following ground applications, similar levels of residues were measured in avian food items collected from 25 to 50 ft from the edge of the cotton as were measured in avian food items collected from 75 to 150 ft from the cotton edge following aerial applications.


Avian Food Items From 0 - 10' From Field Edge After Three Applications
Residues (ppm)
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
Days After First Application
Ground 1
Ground 2

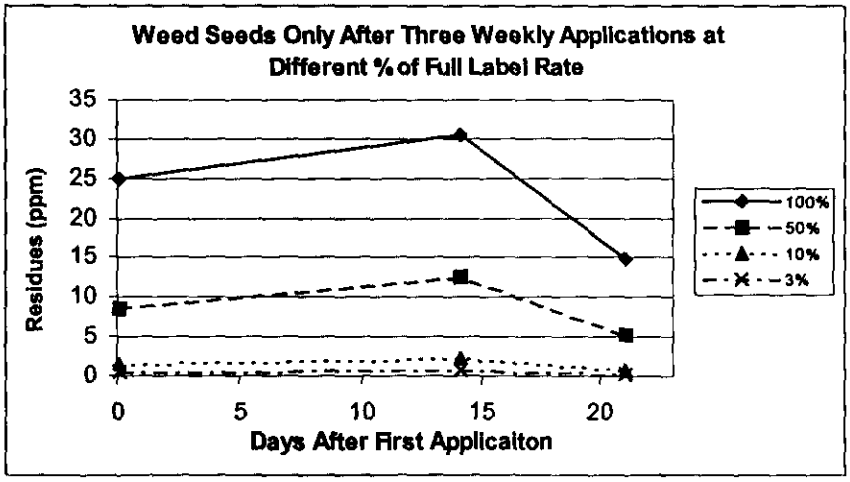

Avian Food Items From 10 - 25' From Field Edge After Three Applications
Residues (ppm)
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
Days After First Application
Ground 1
Ground 2


Avian Food Items From 25 - 50' From Field Edge After Three Applications
Residues (ppm)
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
Days After First Application
Ground 1
Ground 2

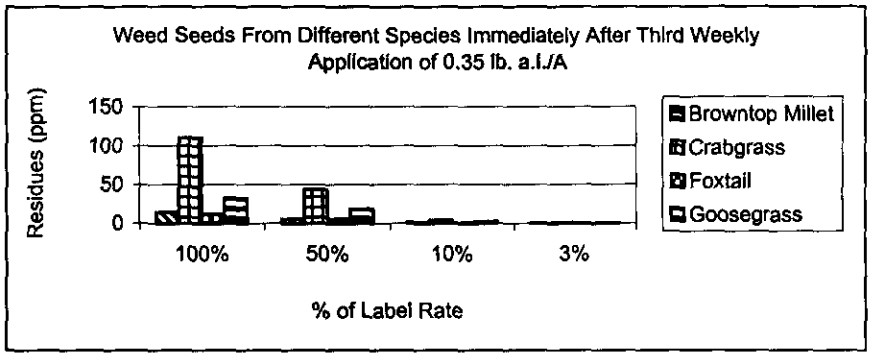
A study was performed in Mississippi on weed seeds that had been planted and raised like crops. The objective of measuring the residues on seed heads or in seeds at different applications was to measure the amounts of residues possible after different amounts of drift were deposited on areas at different distances from the cotton field. The amounts of drift simulated were 100% (direct overspray 0.35 lb. a.i./A), 50% deposition, 10% deposition, and 3% deposition. The residues decline substantially between weekly applications. In those areas receiving simulated 3% deposition, minimal residues (<1 ppm) were measured, even immediately following the applications. The residues measured at the simulated 10% deposition rate were similar to those found at 25 - 75 ft from the cotton edge following aerial applications. The residues measured at the simulated 3% deposition rate were similar to those found 75 - 150 ft from the field edge following aerial applications and at 0 - 10 ft following ground applications. Applications in this study were made on day 0, 7 and 14.



Weed seeds were removed from the seed heads to evaluate whether collecting entire seed heads biased the residues either upward or downward. The values collected from seeds alone did not differ substantially from those collected from the entire seed head.



The following graph shows results from samples from four different species of planted weeds were collected immediately after the third weekly application to assess whether different individual weed species would capture differing amounts of the deposition. Not surprisingly, there were differences among the species.



The level of transient residues in crabgrass and goose grass seed heads, from fields directly oversprayed with 1.05 lb. a.i./A chlorfenapyr, reached 110 ppm and 32.6 ppm, respectively. These values are not relevant to actual field use, as the current label allows a maximum total per season of 0.5 lb. a.i./A, so this application was about 50% greater than allowed on label. Extensive use of herbicides, which is common in cotton production, assures that available vegetative avian food items are at a minimum. Vegetation data collected from twelve cotton fields evaluated in Louisiana (MRID 44452616) indicated that crabgrass comprised <2% of the total ground cover within fields and <4% of the vegetation along the field edges. Similarly, the percent of goose grass in the ground cover was insignificant, about 0.15% within the field and <0.7% along the field edge. Hence, residues on vegetative food items are not expected to pose incremental risk to avian species under actual usage conditions.

Evaluation of Relevant Crop Residue Data: Crop Rate of Decline (ROD) Studies for Establishment of Tolerances

There are numerous studies which show the levels and rates of decline of chlorfenapyr in raw agricultural commodities. These studies are used to establish tolerances for human consumption of treated crops. The key variables, application rate and amount, residue after the last application, and estimated half-lives for decline, are provided in the following table.

Crop	Total Application g. a.i./ha in Residue Study	Time Zero Residue Level (ppm)	Approximate Half-lives and average half life (days)
Apples*	1120	0.22	7 - 28 Avg.=17.5
Peaches*	900	0.73	7 - 14 Avg.=10.5
Nectarines*	890	0.35	14 -28 Avg.=21
Strawberries*	440	0.46	3 - 21 Avg.=7.1
Grapes*	700	0.49	14 - 27 Avg.=17.7
Potatoes (MRID 43996205)	800	<0.05	NA
Cabbage (MRIDs 43996206 43700702)	340	1.62	1 - 14 Avg.=8
Cauliflower (MRID 43996206)	580	0.13	3 - 14 Avg.=8.5
Leafy Vegetables (MRID 43992607, 43638904)	270	8.2	3 - 10 Avg.=4.75
Eggplant (MRID 43996204)	869	0.21	5 - 21 Avg.=9.25
Peppers (MRID 43996204)	1740	0.40	7 - 16 Avg.=11.6
Tomatoes (MRIDs 43996204, 43753604)	860	0.56	3 - 21 Avg.=9.9
Melons*	640	0.23	3 - 22 Avg.=11.25
Sugarbeets*	490	2.43	8 - 19 Avg.=12.75
Oilseeds (cotton) (MRIDs 42770238, 43492860)	Only data was for harvest	NA	NA
Cucumbers*	1200	0.32	3 - 28 Avg.=11

*Data from European trials (to be provided upon request).

It can be seen from the above table that half-lives of chlorfenapyr in the various crops are relatively short, a circumstance which parallels information for avian plant food items (see above). Most half-lives averaged less than 14 days.

Measures of Exposure - Residues in Insects

Residues measured in insects in the field, such as the ones described below, are significantly lower than the Hoerger and Kenaga (1972) nomogram estimates used by EPA for the traditional Tier 1 RQ assessment. For example, presentations and abstracts from the 18th Annual Meeting of SETAC (Society of Environmental Toxicology and Chemistry), November 16-20, 1997, in San Francisco, showed that EPA's standard procedure overestimates residue levels in invertebrates by 6-100X (D. L. Fischer and L. M. Bowers, "Summary of Field Measurements of Pesticide Concentrations in Invertebrate Prey of Birds," and L. W. Brewer *et al.*, "Comparison Between Measured Insect Residue Values and Predicted According to U.S. EPA Standard Procedures").

The abundance of insects in treated cotton fields is an important variable that affects the likelihood of a bird receiving a toxic dose from insect feed items. It has been shown above that insect biomass in cotton fields is low compared to biomass in soybean fields (see page 54).

Residues in Beet Armyworm Larvae and Adults

A non-guideline GLP study (Summary was MRID 44452609. Full report submitted 1/15/98) was carried out in cotton in Georgia. The objective of this study was to determine the level of residues of chlorfenapyr in or on insects following application of two rates of PIRATE® (AC 303630 3SC) immediately after application and up to 28 days post-application to evaluate potential exposure to birds. The application rates included 0.35 lb. a.i./A, which is about 15% higher than the current maximum label rate.

Table 7 summarizes the results of this study. It can be seen that residue levels in either the moths or the larvae were low compared to predictions from the Hoerger and Kenaga nomogram. Does this mean that there was a bias in the collection procedures in the present study? We do not feel that a significant bias occurred for the larvae, because at the high rate, we would expect 100% control. Furthermore, measured residue levels for the day 1 and day 3 samples were similar. The day 1 samples were collected in the fields, where intoxicated insects could have fallen off the cotton plants. However, for the day 3 samples, larvae were placed on cotton leaves held in plastic cups, so 100% of the exposed larvae were collected. The purpose of sampling moths was to estimate levels in flying insects, so the light trapping technique used would not introduce a bias. Recall also from above that the Hoerger and Kenaga estimates have been shown to be higher than measured residue levels in other studies.

A major issue in doing studies such as this one is the difficulty of finding sufficient numbers of insects in the field. This necessitates the compositing of samples, which makes characterization of inter-individual variability in residue levels difficult. In the study this difficulty was partly circumvented by using laboratory-reared insects to get adequate biomass in the samples. Also, samples at a given time were taken in triplicate, so estimates of variability could be made.

The variation in insect residue concentrations (beet armyworm) was typical of what would be expected for biological data. However, this variation is likely to reflect the true variation in the field as opposed to sampling or analytical error. In reality, insects are inherently variable in their exposure (L. Brewer, personal communication).

TABLE 7. Insect Avian Food Item Residues (ppm)

Study	Total lb.	Total # apps	Sample Area (ft from field border)	Approx. Days After Last Application 0.1	1	3	7	14	21	30
[1]MRID 43492814	0.4	1	0	5.71		1.29		<0.5		
GA Sm Sc Exp			0 - 50	<0.5		<0.5		<0.5		
GA Sm Sc Exp	0.2	1	0	0.963		0.724		<0.5		
			0 - 50	<0.5		<0.5		<0.5		
[2]MRID 44452609	0.2	1	Larvae	1.28 ± 0.31	0.37 ± 0.27	0.39 ± 0.08	0.14 ± 0.03	0.10 ± 01	0.02 ± 0.02	<0.005
Insect Field Study			Adults	4.25 ± 2.13			0.03 ± 0.03	0.15 ± 0.15	0.39 ± 0.01	0.35 ± 0.16
			Other				0.03 ± 0.03			
	0.35	1	Larvae	2.48 ± 0.74	1.85 ± 0.16	1.02 ± 0.24	0.28 ± 0.05	<0.005	<0.005	<0.005
			Adults	3.68 ± 0.55			<0.005	0.12 ± 0.07	1.06 ± 0.39	0.05 ± 0.05
			Other	2.69 ± 2.51			0.11 ± 0.02			

[1] Because of low numbers of insects in the small scale studies, samples were composited.
[2] For Insect Field Study, mean ± standard error.

wrong not ~~<0.005~~
report in ~~0.70~~ ~~<.5~~
<.05 <.5
<.05 <.5
<.05

CY190

Residues in Earthworms Inhabiting Cotton Fields
EPA has raised concerns about the relatively long half-life of chlorfenapyr in soil and the potential for residues in earthworms. The circumstance could theoretically lead to exposure for birds that eat worms.

Results from the small-scale exposure study in Georgia cotton had shown that there were very low earthworm populations in the sandy soil where that study was conducted. As a follow-up to this study, another study is in progress. It is designed to measure levels of chlorfenapyr in soil and in the earthworms inhabiting that soil, and to estimate earthworm populations in Louisiana cotton fields. In preliminary work, fields treated in August of 1996 were sampled in the late spring of 1997 in an effort to assess abundance. Earthworms were present in some fields and not in others at that time. Extensive samples were taken in July 1997; at that time, earthworm populations were not measurable or very low. It appears that worms migrate downward in response to the drying and heating of the soil in the summer.

Initial realistic worst-case estimates of the levels of chlorfenapyr in earthworms, for the purposes of avian exposure assessment, can be made as follows. Soil residue data show levels and rates of decline in Mississippi soils (see page 74). Chlorfenapyr residues are mainly in the upper 0-3 inches. The levels observed in soil in the Mississippi studies are well below levels that caused toxic effects to earthworms in laboratory studies. It is reasonable to assume that the lack of bioaccumulation in the bluegill indicates the same is true for the earthworm. Residue levels of chlorfenapyr in earthworms should then be similar to levels in the soil. The theoretical estimates of soil avian exposures discussed below are therefore applicable.

The difficulty in finding enough earthworms to sample in treated fields, and the implications of low earthworm abundance for avian exposure and risk, are the same as for insects, discussed above. It seems reasonable that birds seeking earthworms would forage in other areas than cotton fields.

Measures of Exposure - Soil and Sediment

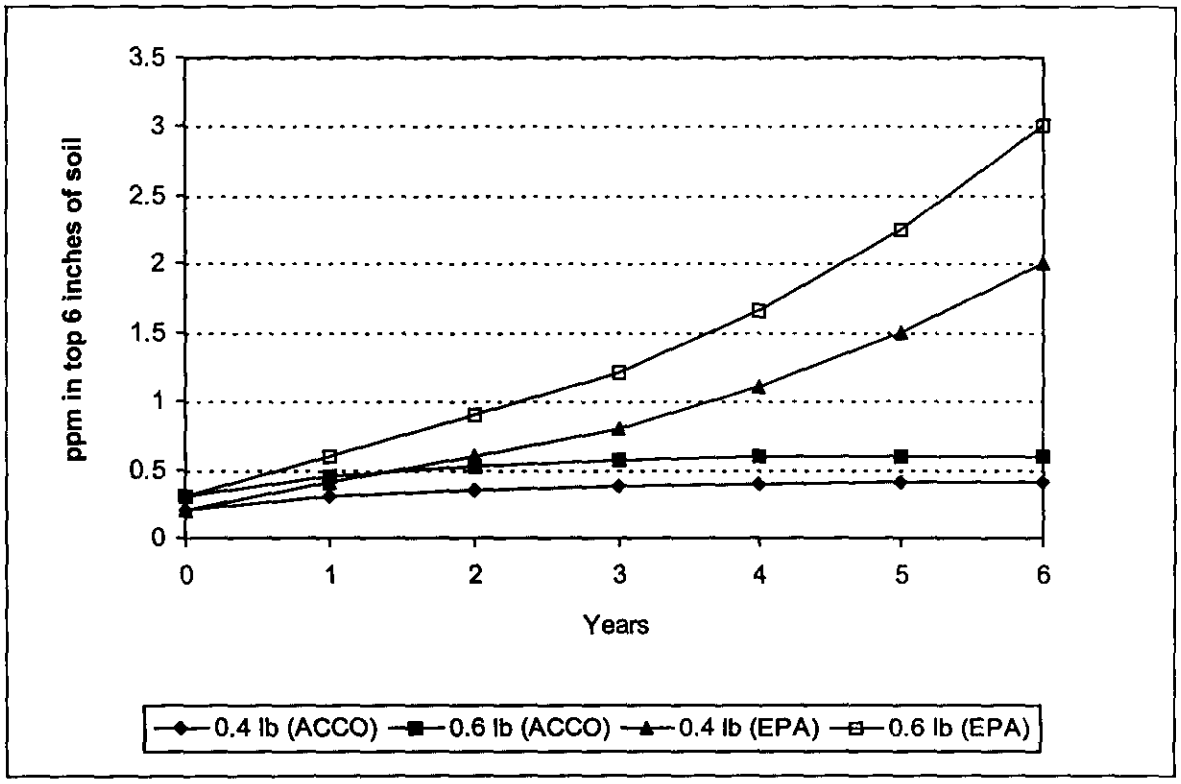
Theoretical Estimates
Theoretical calculations were performed to gain an initial understanding of the magnitude of potential risk that residues of chlorfenapyr in soil pose to birds using cotton. Using the Universal Soil Loss Equation, it is possible to estimate residue concentration in soil over time. The results are dependent on (1) the rate and frequency of chlorfenapyr application, and (2) the half-life of residues in soil. EPA has predicted a continuing accumulation of chlorfenapyr in soil with repeated applications over time. EPA assumed a half-life of residues in soil of 1370 days (~4 yr.), which was reported from a laboratory study that measured physical and chemical processes, but did not include microbial metabolism or degradation (MRID No. 42770243), which are significant under field conditions. When the aerobic soil metabolism of chlorfenapyr was evaluated under an improved laboratory test system designed to ensure a viable microbial population (MRID No. 44452621), an average half-life of 352 days was calculated. Cyanamid has performed extensive field studies. The average half-life under field conditions was 275-280 days (MRID No. 44452623) Therefore, one year is a conservative worst-case estimate of soil half-life to use for purposes of chronic risk assessment.

Figure 4 shows the predicted soil concentrations for a 6-year period at two maximum annual application rates, 0.4 lb. a.i./A and 0.6 lb. a.i./A (the proposed cotton label has a maximum rate of 0.5 lb. a.i./A). Using the realistic worst-case half-life estimate of one year results show that residues do not continue to accumulate, but instead, level off around year 4 at a level

dependent on application rate. The repeated application of 0.6 lb. a.i./A/year produces a theoretical worst-case "steady state" concentration of about 0.5 ppm at 4 years. The 0.5 lb. a.i./A rate being proposed by Cyanamid would correspond to a predicted soil concentration of ~0.4 ppm at 4 years. Due to indeterminate pest outbreak cycles, it is unlikely that chlorfenapyr will be applied at maximum rates every year.

The NOEC in the mallard reproduction study was 0.5 ppm. Even if we were to make the obviously unsupported assumption that the mallard spends 100% of its time in chlorfenapyr-treated cotton field, and that 100% of its diet consists of soil, its exposure would be below the reproductive NOEC if chlorfenapyr were repeatedly applied at a rate of 0.5 lb. a.i./ acre/ year.

Figure 4: Predicted Soil Concentrations[1]



[1]EPA - Half-life based on lab data (4 years); ACCO - Half-life based on Cyanamid field data (average 1 year)

Field Study Data

Evidence of the dissipation of chlorfenapyr under field use and its lack of accumulation to theoretically predicted levels, is provided by the results of two multi-year soil accumulation studies conducted in Europe (MRID No. 44452624). A total of nine applications (3 per year) of chlorfenapyr were made at a rate of approximately 0.18 lb. per a.i./A. However, the low levels of chlorfenapyr in the 0-4 inch soil core, immediately after the ninth application (0.13 and 0.22 ppm), are well below the theoretical maximum (1.22 ppm) that could occur from the cumulative effect of these multiple applications. The lack of accumulation of chlorfenapyr following use after multiple years is thus corroborated by the results of these European field studies.

The results from the four field studies (MRID No. 44452605) contain information about residues in soils following ground and aerial applications at various rates and intervals. In these studies, applications of 0.35 lb. a.i./A were made on approximately day 0, 25 and 50. There was not a consistent pattern to indicate whether greater residues would reach the soil following an aerial or ground application. The majority of the residue was confined to the upper 3 inches of the soil profile. Although low levels (up to 60 ppb) of chlorfenapyr were detected in the 3-6 in. and 6-12 in. soil segments in two of the sites at time points following a cumulative rainfall of 10.8 inches, these detections are inconsistent and insignificant. The detected residue was probably due to pushing the wet muddy surface soil to the lower levels with the sampling tube. However, as illustrated in following graphs (see page 76), chlorfenapyr residues in subsequent soil samples for these segments were at practically non-quantifiable levels, further indicating that the earlier samples were contaminated during the sampling process of the wet soil (Appendix 6). Overall the data demonstrate rapid dissipation of the product, with no significant movement downward in the soil.

In addition, information from guideline soil dissipation studies (MRID Nos. 43492850, 44452622) is available. While these studies significantly overestimate the magnitude of soil residue because they entail direct application to bare ground (no interception by cotton plants), the results indicate the rate of disappearance of residues from soils under various conditions. Table 8 summarizes relevant results. The figures that follow the table present individual trial results graphically. Applications of chlorfenapyr are indicated by vertical dashed lines.

TABLE 8. Field Residue in Upper (0-6") Soil Layer (ppb)

Study	Total lb.	No. apps. (Interval)	Approx. Days After Last Application									
			0.1	sd	7	sd	14	sd	30	sd	60	sd
[1]MRIDs 43492850, 44452622												
CA ROD - Madera	2.0	5 (1 wk)	260	80	243	66	304	86	172	74	103	22
CA ROD - Hickman	2.0	5 (1 wk)	559	47	383	119	259	104	496	146	282	237
MS ROD	2.0	5 (1 wk)	639	172	481	89	481	160	428	21	221	48
TX ROD	2.0	5 (1 wk)	707	177			709	336	939	185	847	218
FL ROD	2.0	5 (1 wk)	393	108	336	118	358	53	482	46	322	162
[2]MRID 44452605												
MS EUP Grnd 1	1.05	3 (3 wk)	197	87			238	87	112	16	61	17
MS EUP Grnd 2	1.05	3 (3 wk)	288	115			521	165	198	35		
MS EUP Aerial 1	1.05	3 (3 wk)	143	43			225	89	137	45	153	103
MS EUP Aerial 2	1.05	3 (3 wk)	242	41			114	42	184	40	316	167
MRID 43492814												
GA Sm Sc Exp	0.4	1	158	42	94	30	170	97	104	56		
GA Sm Sc Exp	0.2	1	95	5	45	4	87	27	76	35		
MRID 43492814, 43887007												
LA Pen Study	1.05	3 (1 wk)	380	177					251[4]	65		
[3]MRID 44452623												
NC 14C	0.4	1	274						58		59	

[1] These values represent the average from three replicated samples, each of which is a composite from six soil cores.

[2] These values represent the average from four unreplicated samples, each of which is a composite from six soil cores.

[3] Soil samples (0-3") were composited before analyses.

[4] *This sample was taken 21 days after the last application.*

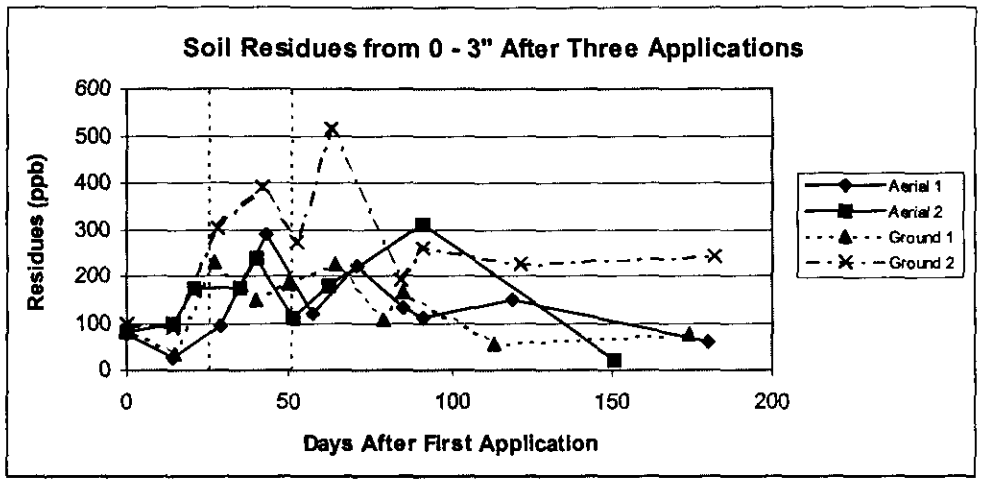
TABLE 8. Field Residue in Upper (0-6") Soil Layer (ppb) (cont.)

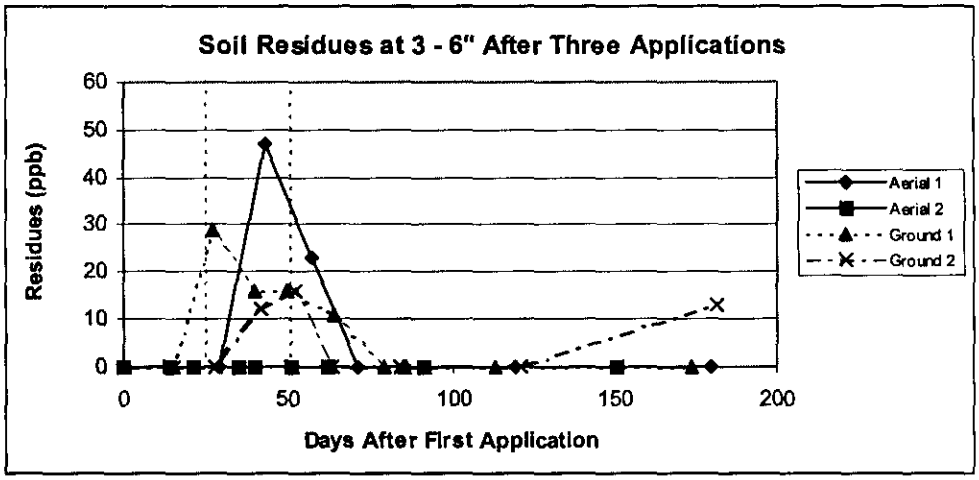
Study	Total lb.	No. apps. (Interval)	Approx. Days After Last Application													
			90	sd	120	sd	150	sd	180	sd	240	sd	270	sd	360	sd
[1]MRIDs 43492850, 44452622																
CA ROD - Madera	2.0	5 (1 wk)	86	10	109	64	155	63			24	17			48	25
CA ROD - Hickman	2.0	5 (1 wk)	438	226	232	100	248	196			723	383			179	186
MS ROD	2.0	5 (1 wk)	409	41	303	93	366	38			267	76			227	27
TX ROD	2.0	5 (1 wk)	1149	289			538	77			487	125			410	59
FL ROD	2.0	5 (1 wk)	166	94	212	29	192	122			253	17			216	94
[2]MRID 44452605																
MS EUP Grnd 1	1.05	3 (3 wk)			82	35										
MS EUP Grnd 2	1.05	3 (3 wk)			258	173										
MS EUP Aerial 1	1.05	3 (3 wk)			66	58										
MS EUP Aerial 2	1.05	3 (3 wk)			26	4										
MRID 43492814																
GA Sm Sc Exp	0.4	1														
GA Sm Sc Exp	0.2	1														
MRID 43492814																
LA Pen Study	1.05	3 (1 wk)														
[3]MRID 44452623																
NC 14C	0.4	1	30						71				54		19	

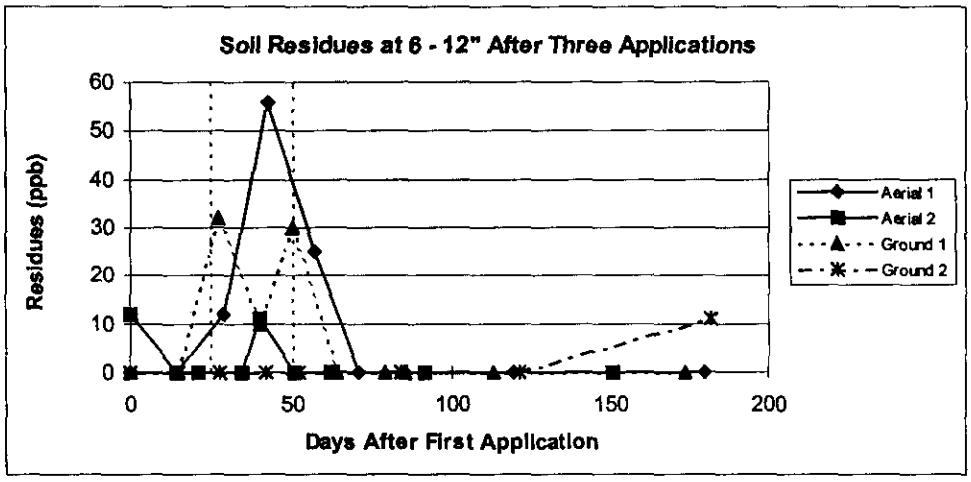
[1] These values represent the average from three replicated samples, each of which is a composite from six soil cores.

[2] These values represent the average from four unreplicated samples, each of which is a composite from six soil cores.

[3] Soil samples (0-3") were composited before analyses.


Soil Residues from 0 - 3" After Three Applications
Residues (ppb)
600
500
400
300
200
100
0
0
50
100
150
200
Days After First Application
Aerial 1
Aerial 2
Ground 1
Ground 2


Soil Residues at 3 - 6" After Three Applications
Residues (ppb)
60
50
40
30
20
10
0
0
50
100
150
200
Days After First Application
Aerial 1
Aerial 2
Ground 1
Ground 2


Soil Residues at 6 - 12" After Three Applications
Residues (ppb)
60
50
40
30
20
10
0
0
50
100
150
200
Days After First Application
Aerial 1
Aerial 2
Ground 1
Ground 2

The potential concentrations of chlorfenapyr in pond water and sediments have been modeled in connection with an aquatic organism risk assessment (MRID No. 44452602). The following table summarizes maximum time-weighted sediment concentrations which were obtained. In all cases, sediment concentrations were higher in the early application scenarios in the Cotton Belt.

Region	Application	Instantaneous Concentration ppb (ug/kg)	96-Hour Concentration ppb (ug/kg)	21-Day Concentration ppb (ug/kg)
4[1]	Early[2]	528	528	526
5	Early	470	469	467
6	Early	618	618	617
7	Early	419	419	417
4	Late[3]	461	461	459
5	Late	364	363	360
6	Late	542	542	540
7	Late	310	310	308
11	0.2 lb. June & 0.3 lb. July	137	137	135

[1]4 - AL, GA, KY, NC, SC,TN, VA; 5 - FL; 6 - AR, LA, MO, MS, OK; 7 - TX; 11 - CA, AZ
[2]Early - applications of 0.3lb. a.i./A on July 17 followed by 0.2 lb. a.i./A on July 15.
[3]Late - applications of 0.3lb. a.i./A on August 15 followed by 0.2 lb. a.i./A on August 21.

Soil and sediment residues are overestimates of avian exposures because (1) the percentage of the avian diet that is soil is low; (2) chlorfenapyr binds tightly to soil and is not significantly bioavailable.

Factors that Modify/Mitigate Exposures to Residues

The Risk Quotient method, as traditionally used by EPA, compares an estimated environmental concentration to a concentration that causes observable toxicity. The EEC entails uncertainties and overestimates exposure, to the extent that there are factors which limit the bird's potential to contact the environmental residues. In this section we discuss several such exposure "modifying factors", and draw upon available information to develop qualitative or quantitative estimates of their impact on exposures of individual birds and local and regional populations.

Although it is not possible at present to incorporate modifying factors into an RQ calculation, consideration of these factors gives important insights into the uncertainties inherent in the RQ method, and the degree to which the RQ overestimates (or underestimates) actual risk to birds.

Ingestion of Soil

Beyer *et al.* (1994) used acid-insoluble ash in scat to develop estimates of the percentage of the diet that is soil or sediment for various wildlife species. Estimates for avian species ranged from <2% for Blue-winged Teal and Ringnecked Ducks, to 17-30% for Stilt and Semipalmated Sandpipers. The Canada Goose, American Woodcock and Wild Turkey ingested about 8-10% of the diet as soil/sediment. These values include soil ingested directly, in or on food items, and indirectly via preening of feathers.

Bioavailability of Chlorfenapyr Residues

Information is available that is germane to the issue of bioavailability of chlorfenapyr residues. In this discussion, we use the term "bioavailability" to refer to the difference between a residue in an environmental medium to which an organism may be exposed, and the fraction of that residue that is actually available to be transferred to that organism as a result of contact or ingestion. A further consideration is the fraction of that exposure that is available to the target tissue in the bird (i.e., the effective dose). Lacking adequate data, we will not consider dose issues in this analysis, but will instead make the conservative assumption that exposure = effective dose.

Chlorfenapyr is adequately bioavailable from laboratory diet preparations, as shown by laboratory toxicity results. We assume that chlorfenapyr would be similarly bioavailable if birds ingested residues on vegetative feed items found in the cotton agroenvironment.

Because chlorfenapyr is relatively persistent in soil under some conditions, and because birds ingest soil both directly and indirectly, via preening, the bioavailability of soil residues is an important variable in assessing avian exposure and risk from these sources.

Overview of Bioavailability from Soil and Implications for Avian Exposure Assessment

Previous research with soil-bound chemicals has shown that the major factors affecting exposure of hydrophobic chemicals sorbed to soil particles include bioavailability, organic carbon content, fine particle enrichment and particle size (Erstfeld, *et al.* 1996; Nessel *et al.* 1992; Gough 1991; Paustenbach 1989; Umbreit, *et al.* 1986). Other studies have determined that the bioavailability of hydrophobic organics absorbed through gastrointestinal exposure from contaminated soils may differ from the exposure to the pure chemical (Nosek *et al.* 1992; Kadry *et al.* 1991; Witmer *et al.* 1991).

Frequently, the oral exposure assessment of soil-bound organic compounds to organisms may be inappropriate because these models fail to consider four important issues:

- soil sorption and desorption processes that would tend to alter their bioavailability upon soil ingestion are not taken into account;
- aging of soil-bound residues and accompanying greater irreversibility from soil matrices are ignored;
- the kinetics of desorption from soil relative to the transit time in the gastro-intestinal tract is not addressed; and
- the physiology of the avian digestion, including the important role of enzymes and gut pH conditions are not used in the exposure assessment methodology.

Environmental fate data indicate that chlorfenapyr and its major metabolite, CL 312094, are strongly adsorbed by soils with K_{oc}s of 11500 and 3060, respectively. This characteristic accounts for the fact that most of the material after application will become rapidly absorbed to soil organic matter. Once adsorbed, both compounds become more tightly bound, as reflected by higher $K_{oc/des}$ of 27279 and 6362, respectively, thus reducing their ability to be removed from soil, and thereby reducing avian exposure potential.

Comparing K_{oc}s for both sorption and desorption indicates stronger binding during desorption, which signifies greater irreversibility of the desorption process. Thus, the high binding capacity and resistance to desorption of both compounds from soil and sediment are major factors in reducing the exposure potential of soil-bound residues to avian species.

Kinetics of Desorption of AC 303630 from Soil Relative to Transit Time in the Avian Digestive Tract

At Cyanamid's request, Dr. Karen Erstfeld of Rutgers University, an expert in bioavailability and soil exposure assessment, evaluated the bioavailability of soil-bound chlorfenapyr and its implications for avian risk. The following is Dr. Erstfeld's derivation of a bioavailable dose and risk characterization.

The kinetics of desorption can be viewed to be analogous to a two-compartment open model system in pharmacokinetics and may be useful to describe the bioavailability of chemical components in soil and sediment matrices, and thus approach a more realistic estimate of the actual exposure to soil-bound hydrophobic organics.

Estimation of Avian Bioavailable Dose

An assessment of risk to birds from ingestion of soil bearing chlorfenapyr residues or soil-dwelling organisms should include a comparison of the bioavailable dose (BD) in the avian gut to the no observable effect level (NOEL) in an acute oral or an avian reproduction study. If BD > NOEL, there may be a cause for concern. If BD < NOEL, the risk to avian species is mitigated.

Therefore, the relative rates of desorption from soil and the transit time through the digestive tract become important in the estimation of a bioavailable dose, which for chlorfenapyr, is influenced by the "slow" rate of desorption from the soil and the "fast" transit time through the gut.

Based on the conservative assumptions listed below, the maximum bioavailable chlorfenapyr concentration, (i. e. the bioavailable quantity per gram of soil), in the avian digestive tract, is calculated to be approximately 0.500 ppb, where

Bioavailable Quantity (BQ) (*ng*) = Concentration in soil (ppb or $^{ng}/_{g}$) x Rate of desorption ($^{1}/h$)
x Amount of soil ingested (g) x Duration of Exposure (h)

Assumptions:

- Concentration of chlorfenapyr in soil is 500[3] ppb or 500 $^{ng}/_{g}$
- Amount of soil ingested is 10g
- Rate of desorption (bioavailable intake rate)[4] is 4.17 X 10^{-5}/h
- Duration of Exposure (Transit time in avian gut)[5] of 24 h

[3] A worst-case residue concentration of 500 ppb in sandy soil is assumed, based on results from the Melrose, Florida, field dissipation study where five applications at 0.4 lb a.i./A were made, MRID Nos. 43492850 and 44452622. The proposed label limits application to 0.5 lb. a.i./A.

[4] A worst-case first order desorption rate of 0.001/day, i. e., 4.17 x 10^{-5}/hour from sandy soil is calculated based on 10% chlorfenapyr found desorbed in water over 100 days, MRID No. 43904202;

[5] A conservative estimate of 24 hours is used for the transit time through the avian digestive tract, usual range is from 3-24 hours. Note that the pH of the avian GI tract ranges from about 2 for pure gastric secretions to 6-8 for pancreatic and intestinal enzymes (Sturkie 1986).

Thus, for chlorfenapyr, the Bioavailable Quantity

$= 500\ ^{ng}/_{g} \times 10\ g \times 4.17 \times 10^{-5}/\ h \times 24\ h$
$= 500{,}400 \times 10^{-5} ng = 5.00\ ng$

The Bioavailable Dose (BD) is defined as:

$$\text{Bioavailable Dose (ng/g)} = \frac{\text{Bioavailable Quantity (ng)}}{\text{Body weight (bw) (g)}}$$

The table below compares the Bioavailable Dose (BD) to the NOEL to characterize the risk to avian species.

Species	Avg. Body weight bw (g)	NOEL PPB ng/g	Chlorfenapyr (ng) in 10 g of Soil	Bioavailable Quantity (BQ) (ng)	Bioavailable Dose (BD) BQ/bw ng/g	BD / NOEL
Northern Bobwhite	200	8000 (acute)	5000	5.0	2.5×10^{-2}	3.1×10^{-6}
	200	1500 (repro)*	5000	5.0	2.5×10^{-2}	1.6×10^{-5}
Mallard	1000	2000 (acute)	5000	5.0	5.0×10^{-3}	2.5×10^{-6}
	1000	500 (repro)*	5000	5.0	5.0×10^{-3}	1.0×10^{-5}
RWBB	55	600 (acute)	5000	5.0	9.1×10^{-2}	1.5×10^{-4}

*Even under the extremely conservative assumptions that 100% of the avian diet, over several consecutive days will be treated soil bearing 500 ppb of chlorfenapyr, the extremely low bioavailable concentration in soil (0.5 ppb), significantly mitigates any potential for the reproductive NOEL (500 ppm) for the most sensitive species, to be exceeded.

For chlorfenapyr, the ratio of the bioavailable dose to the NOEL for acute avian or reproductive effects is significantly less than 1; thus the risk to avian species, from ingesting soil-bearing chlorfenapyr residues, is negligible. Based on the above highly conservative assumptions, a 1000 g mallard duck would have to ingest 1000 g of treated soil bearing 500 ppb of chlorfenapyr residues, for any chronic/reproductive effects to occur. Thus, it is apparent, that avian species inhabiting the cotton agroenvironment are not expected to be adversely effected, either acutely or chronically, by residues of chlorfenapyr in treated soils.

Unavailability of Surface Residues for Estimation for Exposure

Estimation of the levels of chlorfenapyr residues that may be dislodged from different environmental surfaces is important in defining exposure. The following summary discusses the potential dislodgeability of chlorfenapyr residues from treated cotton plants. Residues that are dislodged by rainfall could potentially impact soil under the plant. Surface residues are also potentially available for dermal exposure to organisms. Under commercial application

conditions, these are expected to be the only surface residues of potential ecotoxicological significance.

Although a foliar wash-off study using a rainfall simulator has not yet been conducted, results of several cotton efficacy trials demonstrate that chlorfenapyr is "rainfast" within one hour after application (i.e., does not wash off to the extent that efficacy is altered). The lipophilic nature of chlorfenapyr causes tight binding to the waxy cuticle of cotton leaves, so residues on surfaces are also unlikely to be available for dermal exposure. Chlorfenapyr can be chemically extracted (MRID No. 43492814) from cotton leaves using a 20-minute rigorous extraction of 1-inch diameter leaf discs in a detergent wash. However, it is important to note that these exhaustive conditions, which are designed to measure dislodgeability for calculating worker exposure, are clearly not applicable to estimating wash-off from plants following a rainfall event or uptake by avian feathers or skin on contact.

Refined Conceptual Model(s)

The initial conceptual model for exposure of individual birds to chlorfenapyr in cotton described the possible routes by which birds could be exposed to the compound (see pages 32-35). It also enumerated the various environmental compartments into which chlorfenapyr might partition in the cotton agroenvironment. The information and analyses provided in the above sections allow refinement of the initial model for individual birds as follows. First, the most significant route of exposure to the compound will be ingestion. Dermal and inhalation exposure will be of much lesser significance. Second, the food items that potentially will be significant are insects in treated and untreated portions of the agroenvironment and non-cotton plant material in the treated or untreated portions of the agroenvironment, especially weed seeds and small fruits. These food items are significant because of the way chlorfenapyr partitions in the environment and because of the bird species that use the cotton agroenvironment. Contaminated soil and earthworms from the treated area may also be sources for ingestion of chlorfenapyr, but we have shown them to be insignificant contributors to the total exposure and risk. (Recall that residue levels in earthworms and earthworm populations in Louisiana cotton fields are being measured in an ongoing study.) Due to the low solubility of chlorfenapyr in water, ingestion of water is not expected to provide significant exposure. Third, chlorfenapyr is not persistent in insects or in plant material. It is somewhat more persistent in soils and by implication, in earthworms. And fourth, the major metabolites of chlorfenapyr are equal of lesser toxicity than the parent compound. Therefore the assessment can be conducted on the parent compound.

The characteristics of cotton fields and their borders were measured in the geographical information system and summarized by ecoregion. The extent of cotton acreages by county was also tabulated and summarized by state and ecoregions. This information on a larger spatial scale can be used to draw inferences about risk to regional populations from the use of chlorfenapyr.

Refinement of Potentially Significant Exposure Pathways

In light of the information presented earlier and summarized above, including census data and information from the literature about birds using the cotton agroenvironment, it is possible to reevaluate and further refine the potentially significant exposure pathways conceptualized earlier in Table 2 (page 35). Table 9 summarizes these refinements. The possible effects on individuals that will be considered in the balance of this assessment are highlighted in Table 9.

TABLE 9. *Avian Exposure for Chlorfenapyr on Cotton: Relative Exposure Contribution of Potentially Significant Pathways.*

Route of Exposure	Potentially Significant Pathways	Relative Contribution to Total Potential Exposure
Dermal	Spray droplets Plant surfaces Bare soil Sediment	Negligible[1] Low[2] Negligible[3] Low[4]
Ingestion	Spray droplets	Negligible[5]
	In/on insect/invertebrate diet items **In/on plant material diet items**	**Major** **Major**
	On soil/sediment	Low[6]

[1] Based on surface area and coverage by applied spray, a bird present at application is unlikely to accumulate a dermally toxic dose.
[2,3] Bobwhite quail confined in pens containing plants and soil treated at up to 4X the maximum single application rate exhibited no toxic signs.
[4] Behavior of birds likely to use cotton agroenvironment makes dermal exposure to sediments containing high levels of chlorfenapyr unlikely. The mallard may be exposed via sediment in the off-season (fall and winter), but ingestion is likely the dominant route.
[5] Ingestion via preening likely to be negligible as compared to direct ingestion via dietary items.
[6] Theoretical worst-case calculations show soil/sediment exposures do not present significant risks. Except for the mallard resting in wet areas during migration, birds using cotton are not sediment feeders.

Exposure Analysis Based on Refined Conceptual Model(s)

Exposure of individual and local bird populations will be governed by: the characteristics of chlorfenapyr, the use pattern of chlorfenapyr, the bird species present, and by usage of the cotton agroenvironment by birds. Birds may be exposed to chlorfenapyr by ingestion of insects, non-cotton plant material, soil, and possibly earthworms. It should be noted that the focal species identified, based on detailed analysis of birds associated with the cotton agroecosystem, do not typically consume large amounts of soil or earthworms. It should also be noted that the items containing the greatest residue levels will be on the treated field and residues will decrease with distance from the treated field. Data have been developed on the levels and rates of decline of chlorfenapyr residues in the most significant avian food items. These data can be used to estimate likely exposure levels based on compositions of the diet.

Chlorfenapyr will be used in two different ways, as shown in the PIRATE® and ALERT® labels, and the use patterns roughly correspond to Southern and Western Cotton. ALERT will be used starting in May in Western Cotton for control of mites. ALERT will also be used starting in July in Western Cotton for control of the budworm, bollworm, and the armyworm complex. PIRATE will be used starting in July in Southern Cotton for control of the budworm, bollworm and the army worm complex.

The bird species that are potentially exposed to chlorfenapyr because they frequent the cotton agroenvironment have been enumerated. There were differences between areas of the Cotton Belt in bird usage of the fields and the predominant species, although some species were ubiquitously associated with cotton agroenvironments. Based on the census, survey, and field study results, seven species are proposed as representative of bird usage of cotton

agroenvironments – Carolina Wren, White-eyed Vireo, Northern Cardinal, Blue Grosbeak, Mourning Dove, Red-winged Blackbird, and Mallard Duck.

Cotton insect management practices are governed by scouting and economic thresholds. It was shown that the expected biomass of insects in managed fields is relatively low. Field study results for Louisiana correlate well with the observation that both insect and weed biomass are low in managed fields. Estimates for the time birds spend in fields are available. The data show that the field borders will be more heavily used than the cotton fields themselves. The composition of these borders has been characterized. Due to crop management practices, cotton fields are not prime foraging habitat for birds. Exposure of regional populations depends on the extensiveness of the cotton production. The bird species observed to be associated with the cotton agroenvironment are not exclusively bound to them. These species can utilize other habitats and are likely to be distributed throughout a county or an ecoregion. Estimates of the proportions of states and ecoregions will be used to draw inferences about risk to regional populations.

Ecological Effects Analysis Based on the Refined Conceptual Model(s)

The ecological entities at risk are birds feeding within the cotton agroenvironments. These animals may suffer mortality or reduced reproduction due to oral exposure to chlorfenapyr. Grass-eating and predatory birds do not appear to be at risk. Usage of the cotton agroenvironments by these species during the time chlorfenapyr is applied is low. Residues in food sources for predatory birds also appears to be low (see Appendix 6).

Avian Exposure Profile

In this section we develop four avian exposure profiles (scenarios) that will capture the range of exposures likely to occur and will allow for a comprehensive risk characterization. Based on the foregoing information and analysis, there are three components to each of these scenarios: how chlorfenapyr is applied; the usage of cotton fields by birds; and the amount of residue on seeds, insects or fruits. The first component of each scenario is the use pattern. Two use patterns are assumed. One is an early season application made to Western Cotton to control mites. This application is made by ground equipment at the rate of 0.15 lb. a.i./A. The second use pattern is late season application to Southern and Western Cotton for control of worms. Two applications totaling 0.5 lb. a.i./A will be made by air.

The second component of each scenario is bird usage of cotton fields. For the purposes of this assessment, we have defined three levels for bird usage of the cotton agroenvironment. In the "high exposure" level, birds are assumed to forage 100% of the time on the treated field. In the "moderate exposure" level, birds are assumed to forage 50% of the time in the treated field and 50% of the time in the field border. Recall that the borders are assumed to be 0 - 50 feet for ground application and 0 - 150 feet for aerial application, the area with potential to receive drift. In the "low exposure" level, birds are assumed to forage 100% of the time in the 0 - 50 or 0 - 150 foot borders. Based on information from field studies, we feel that the high exposure level is a worst case, the moderate exposure level is biased to overestimate actual exposure, and the low exposure level is most typical of actual exposures

The third component of each scenario is the amounts of residue on seeds, insects, or fruits, and their degradation over time. Values were obtained for these food items on the treated field as well as in the 0 - 50 or 0 - 150 borders. Residue levels were determined for the day after application and, to factor in degradation of chlorfenapyr in the environment, 10 days after

application. The residue value for seeds on the treated field was obtained from the Weed Seed Study, Table 6 (page 59). The residue value one day after three weekly applications totaling 0.54 lb. a.i./A was 16.3 ppm. This value reflects the current label that allows multiple applications at 5 - 7 day intervals totaling 0.5 lb. a.i./A. The residue value of 0.12 ppm for weed seeds off the treated field was obtained by averaging the day 0.1 values from the four MS EUP studies (See Table 6) and dividing by two to reflect the current 0.5 lb. a.i./A limit. Since the average values over the three distances (0 - 10, 10 - 25, and 25 - 50 feet for ground and 0 - 25, 25 - 75, and 75 - 150 for air) were virtually identical, values for air and ground applications were pooled. The ratio between the weed seed residue on the field, 16.3 ppm, and the value off the field, 0.12 ppm provided a lower limit for matrices where off field residues were not available. Residues in insects were 4.15 ppm, which is the average of 5.71 ppm from the Georgia Small-Scale Exposure Study and the maximum day 0.1 residues from the Insect Field Study (see Table 7, page 70) for moths, 4.25 ppm, and larvae, 2.48 ppm. Residue levels in insects off the treated field were theoretically set at one-tenth of the residue levels of insects on the treated field, 0.41 ppm. This value is conservative compared to the over 100-fold difference between weed residues on and off the treated field. The residue value for fruits, 0.5 ppm, was obtained by averaging values for grapes, strawberries, and tomatoes from the table on residues in raw agricultural commodities. Because no data were available for residues in fruits off the treated field, a one-tenth factor was used. Therefore, estimated residue in fruit and insects off the treated field may likely by up to 10-fold less than levels used in this analysis.

Scenario 1 is applicable to both Southern and Western Cotton and assumes multiple applications totaling 0.5 lb. a.i./A have been made to a field. It assumes the final application was made between early to mid-July through mid-September; and the birds are present shortly after the final application when residues are at their maximum.

Scenario 1: Residues immediately following the last application for a total of 0.5 lb. a.i./A.

Diet component	ppm in field	ppm in buffer	percent in field	percent in buffer	Exposure Level
seed	16.33	0.12	100%	0%	High
insect	4.15	0.41	100%	0%	
fruit	0.5	0.05	100%	0%	
seed	16.33	0.12	50%	50%	Moderate
insect	4.15	0.41	50%	50%	
fruit	0.5	0.05	50%	50%	
seed	16.33	0.12	0%	100%	Low
insect	4.15	0.41	0%	100%	
fruit	0.5	0.05	0%	100%	

Scenario 2 is also applicable to both Southern and Western Cotton and assumes multiple applications have been made to a field totaling 0.5 lb. a.i./A. It also assumes the final application was made between early to mid-July through mid-September; however, it assumes the residues have degraded for ten days prior to birds visiting the field. The same three levels of exposure are assumed. The seed degradation half-life is assumed to be approximately ten days from Table 6, so both on-field and off-field seed residue values are half those presented in Scenario 1. The half-life for degradation of insect residues is assumed to be less than three days, so insect residues are assumed to degrade to negligible amounts. The half-lives from the fruit residue studies ranged from 3 to 27 days with a mean average half-life of 11.5 days, so the fruit residues were assumed to degrade by approximately one-half.

Scenario 2 Residues ten days after the last application for a total of 0.5 lb. a.i./A.

Diet component	ppm in field	ppm in buffer	percent in field	percent in buffer	Exposure Level
seed	8.2	0.06	100%	0%	High
insect	0	0	100%	0%	
fruit	0.25	0.03	100%	0%	
seed	8.2	0.06	50%	50%	Moderate
insect	0	0	50%	50%	
fruit	0.25	0.03	50%	50%	
seed	8.2	0.06	0%	100%	Low
insect	0	0	0%	100%	
fruit	0.25	0.03	0%	100%	

Scenario 3 is applicable only to Western Cotton and assumes a single application at 0.15 lb. a.i./A. It assumes the application was made prior to early July and the birds are present shortly after the application when residues are at their maximum. The same three levels of exposure are presented. For on the field, the seed residue value from Scenario 1 was adjusted linearly downward from an application of 0.5 lb. a.i./A to 0.15 a.i./A (factor of 0.3) because no on-field seed data were available for this rate. For seeds off the field, the residue level was set at 0.05 ppm; this is greater than would be calculated from the observed 100-fold difference between weed residues on and off the field noted for Scenario 1. For insects on the field, the mean residue values for Day 0.1 moths and larvae from the 0.2 lb. a.i./A from the Insect Residue Study were averaged with the Day 0.1 on-field insects (from the 0.2 lb. a.i./A treatment) from the Georgia Small-Scale Exposure Study. The off-field insects were estimated to be 10% of the

on-field insects. The on-field fruit values were derived by multiplying the fruit residue values in Scenario 1 by 0.3. The off-field fruit residue values were set at 0.05, again, greater than expected from the observed 100-fold difference between weed residues on and off the field noted for Scenario 1.

Scenario 3. Residues immediately following a single application of 0.15 lb. a.i./A.

Diet component	ppm in field	ppm in buffer	percent in field	percent in buffer	Exposure Level
seed	4.9	0.05	100%	0%	High
insect	2.16	0.22	100%	0%	
fruit	0.15	0.05	100%	0%	
seed	4.9	0.05	50%	50%	Moderate
insect	2.16	0.22	50%	50%	
fruit	0.15	0.05	50%	50%	
seed	4.9	0.05	0%	100%	Low
insect	2.16	0.22	0%	100%	
fruit	0.15	0.05	0%	100%	

Scenario 4 is also only applicable to Western Cotton. It again assumes the residues from Scenario 3 have degraded for ten days prior to birds visiting the field. The same degradation half-lives that were used to create Scenario 2 from Scenario 1 were applied to create Scenario 4 from Scenario 3.

Scenario 4. Residues ten days after the 0.15 lb. a.i./A application in Scenario 3.

Diet component	ppm in field	ppm in buffer	percent in field	percent in buffer	Exposure Level
seed	2.5	0.03	100%	0%	High
insect	0	0	100%	0%	
fruit	0.08	0.03	100%	0%	
seed	2.5	0.03	50%	50%	Moderate
insect	0	0	50%	50%	
fruit	0.08	0.03	50%	50%	
seed	2.5	0.03	0%	100%	Low
insect	0	0	0%	100%	
fruit	0.08	0.03	0%	100%	

Seven focal species were identified to represent different feeding guilds consuming varying levels of seeds, insects and fruits. By incorporating the different proportions that each dietary component contributes to the overall species diet, it is possible to calculate either the total dietary concentration (ppm) or the total possible daily exposure (mg a.i./kg/day). The total dietary concentration is most applicable to those individuals or species exhibiting diets similar to the focal species that spend many days feeding on or around a treated cotton field. The total possible daily exposure is more applicable to either flocking species that may only visit a field for a short time, but feed heavily during that period, or migrants that visit a field for only a short period during migration. Additionally, soil residue values measured 60 days following the final field application are used to estimate the amount of exposure to mallard ducks feeding in flooded fields during fall migration.

The residue and amounts of time birds may spend on or around the fields are presented in each of the scenarios above. Those values are used as multipliers to the proportion of the diet contributed by each diet component to provide the potential residues in the diet. These values can be summed to provide the total dietary concentration. To calculate the total daily exposure, the metabolic rates for either passerine or non-passerine birds were applied as appropriate, along with the caloric content of the different diet components and the weights of the birds (Nagy 1987). Caloric content of the diet components and the metabolic rates are those presented in the EPA's Exposure Manual. Body weights are those presented in Appendix 5.

0.04998
43.62
0.00758

Exposure Scenario 1: Dietary concentrations or daily consumption for residues of chlorfenapyr resulting from 0.5 lb. a.i./A in multiple late season applications for either Southern or Western Cotton.

Species (Exposure Level)	Diet Comp.	Prop. Of Diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Carolina Wren	seed	0.03	0.490		0.102	0.003	
(H)	insect	0.94	3.901		11.183	2.333	
	fruit	0.03	0.015	4.406	0.519	0.000	2.336
Carolina Wren	seed	0.03	0.247		0.102	0.001	
(M)	insect	0.94	2.143		11.183	1.282	
	fruit	0.03	0.008	2.398	0.519	0.000	1.283
Carolina Wren	seed	0.03	0.004		0.102	0.000	
(L)	insect	0.94	0.385		11.183	0.230	
	fruit	0.03	0.002	0.391	0.519	0.000	0.231
White-eyed Vireo	seed	0	0.000		0.000	0.000	
(H)	insect	0.9	3.735		7.391	2.421	
	fruit	0.1	0.050	3.785	1.194	0.005	2.427
White-eyed Vireo.	seed	0	0.000		0.000	0.000	
(M)	insect	0.9	2.052		7.391	1.330	
	fruit	0.1	0.028	2.080	1.194	0.003	1.333
White-eyed Vireo	seed	0	0.000		0.000	0.000	
(L)	insect	0.9	0.369		7.391	0.239	
	fruit	0.1	0.005	0.374	1.194	0.001	0.240
Northern Cardinal	seed	0.145	2.368		0.941	0.050	
(H)	insect	0.71	2.947		16.197	1.070	
	fruit	0.145	0.073	5.387	4.811	0.008	1.128
Northern Cardinal	seed	0.145	1.193		0.941	0.025	
(M)	insect	0.71	1.619		16.197	0.588	
	fruit	0.145	0.040	2.851	4.811	0.004	0.617
Northern Cardinal	seed	0.145	0.017		0.941	0.000	
(L)	insect	0.71	0.291		16.197	0.106	
	fruit	0.145	0.007	0.316	4.811	0.001	0.107
Blue Grosbeak	seed	0.4	6.532		1.852	0.426	
(H)	insect	0.6	2.490		9.762	0.856	
	fruit	0	0.000	9.022	0.000	0.000	1.282
Blue Grosbeak	seed	0.4	3.290		1.852	0.215	
(M)	insect	0.6	1.368		9.762	0.470	
	fruit	0	0.000	4.658	0.000	0.000	0.685
Blue Grosbeak	seed	0.4	0.048		1.852	0.003	
(L)	insect	0.6	0.246		9.762	0.085	
	fruit	0	0.000	0.294	0.000	0.000	0.088
Mourning Dove	seed	0.99	16.167		7.235	0.983	
(H)	insect	0.01	0.042		0.257	0.000	
	fruit	0	0.000	16.208	0.000	0.000	0.983
Mourning Dove	seed	0.99	8.143		7.235	0.495	
(M)	insect	0.01	0.023		0.257	0.000	
	fruit	0	0.000	8.166	0.000	0.000	0.495

Species (Exposure Level)	Diet Comp.	Prop. Of Diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Mourning Dove (L)	seed	0.99	0.119		7.235	0.007	
	insect	0.01	0.004		0.257	0.000	
	fruit	0	0.000	0.123	0.000	0.000	0.007
Red-winged Blackbird (H)	seed	0.45	7.349		3.305	0.462	
	insect	0.55	2.283		14.197	0.616	
	fruit	0	0.000	9.631	0.000	0.000	1.078
Red-winged Blackbird (M)	seed	0.45	3.701		3.305	0.233	
	insect	0.55	1.254		14.197	0.338	
	fruit	0	0.000	4.955	0.000	0.000	0.571
Red-winged Blackbird (L)	seed	0.45	0.054		3.305	0.003	
	insect	0.55	0.226		14.197	0.061	
	fruit	0	0.000	0.280	0.000	0.000	0.064
Mallard Duck (H)	soil	0.08	0.007		0.559	0.000	
Mallard Duck (M)	soil	0.08	0.004		0.559	0.000	
Mallard Duck (L)	soil	0.08	0.001		0.559	0.000	

Exposure Scenario 2: Dietary concentrations or daily consumption for residues of chlorfenapyr ten days following the final of application resulting from 0.5 lb. a.i./A in multiple applications for late season applications for either Southern or Western Cotton.

Species (Exposure Level)	Diet Comp.	Prop. of Diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Carolina Wren	seed	0.03	0.246		0.102	0.0013	
(H)	insect	0.94	0.000		11.183	0.0000	
	fruit	0.03	0.008	0.254	0.519	0.0002	0.0015
Carolina Wren	seed	0.03	0.124		0.102	0.0007	
(M)	insect	0.94	0.000		11.183	0.0000	
	fruit	0.03	0.004	0.128	0.519	0.0001	0.0008
Carolina Wren	seed	0.03	0.002		0.102	0.0000	
(L)	insect	0.94	0.000		11.183	0.0000	
	fruit	0.03	0.001	0.003	0.519	0.0000	0.0000
White-eyed Vireo	seed	0	0.000		0.000	0.0000	
(H)	insect	0.9	0.000		7.391	0.0000	
	fruit	0.1	0.025	0.025	1.194	0.0026	0.0026
White-eyed Vireo.	seed	0	0.000		0.000	0.0000	
(M)	insect	0.9	0.000		7.391	0.0000	
	fruit	0.1	0.014	0.014	1.194	0.0015	0.0015
White-eyed Vireo	seed	0	0.000		0.000	0.0000	
(L)	insect	0.9	0.000		7.391	0.0000	
	fruit	0.1	0.003	0.003	1.194	0.0003	0.0003
Northern Cardinal	seed	0.145	1.189		0.941	0.0251	
(H)	insect	0.71	0.000		16.197	0.0000	
	fruit	0.145	0.036	1.225	4.811	0.0039	0.0290
Northern Cardinal	seed	0.145	0.599		0.941	0.0126	
(M)	insect	0.71	0.000		16.197	0.0000	
	fruit	0.145	0.020	0.619	4.811	0.0022	0.0148
Northern Cardinal	seed	0.145	0.009		0.941	0.0002	
(L)	insect	0.71	0.000		16.197	0.0000	
	fruit	0.145	0.004	0.013	4.811	0.0005	0.0007
Blue Grosbeak	seed	0.4	3.280		1.852	0.2139	
(H)	insect	0.6	0.000		9.762	0.0000	
	fruit	0	0.000	3.280	0.000	0.0000	0.2139
Blue Grosbeak	seed	0.4	1.652		1.852	0.1077	
(M)	insect	0.6	0.000		9.762	0.0000	
	fruit	0	0.000	1.652	0.000	0.0000	0.1077
Blue Grosbeak	seed	0.4	0.024		1.852	0.0016	
(L)	insect	0.6	0.000		9.762	0.0000	
	fruit	0	0.000	0.024	0.000	0.0000	0.0016
Mourning Dove	seed	0.99	8.118		7.235	0.4936	
(H)	insect	0.01	0.000		0.257	0.0000	
	fruit	0	0.000	8.118	0.000	0.0000	0.4936
Mourning Dove	seed	0.99	4.089		7.235	0.2486	
(M)	insect	0.01	0.000		0.257	0.0000	
	fruit	0	0.000	4.089	0.000	0.0000	0.2486

Species (Exposure Level)	Diet Comp.	Prop. of Diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Mourning Dove	seed	0.99	0.059		7.235	0.0036	
(L)	insect	0.01	0.000		0.257	0.0000	
	fruit	0	0.000	0.059	0.000	0.0000	0.0036
Red-winged Blackbird	seed	0.45	3.690		3.305	0.2319	
(H)	insect	0.55	0.000		14.197	0.0000	
	fruit	0	0.000	3.690	0.000	0.0000	0.2319
Red-winged Blackbird	seed	0.45	1.859		3.305	0.1168	
(M)	insect	0.55	0.000		14.197	0.0000	
	fruit	0	0.000	1.859	0.000	0.0000	0.1168
Red-winged Blackbird	seed	0.45	0.027		3.305	0.0017	
(L)	insect	0.55	0.000		14.197	0.0000	
	fruit	0	0.000	0.027	0.000	0.0000	0.0017

Exposure Scenario 3: Dietary concentrations or daily consumption for residues of chlorfenapyr resulting from 0.15 lb. a.i./A in a single application for control of early season mites in Western Cotton.

Species (Exposure Level)	Diet Comp.	Prop. of diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Carolina Wren	seed	0.03	0.147		0.102	0.0008	
(H)	insect	0.94	2.030		11.183	1.2142	
	fruit	0.03	0.005	2.182	0.519	0.0001	1.2152
Carolina Wren	seed	0.03	0.074		0.102	0.0004	
(M)	insect	0.94	1.119		11.183	0.6690	
	fruit	0.03	0.003	1.196	0.519	0.0001	0.6694
Carolina Wren	seed	0.03	0.002		0.102	0.0000	
(L)	insect	0.94	0.207		11.183	0.1237	
	fruit	0.03	0.002	0.210	0.519	0.0000	0.1237
White-eyed Vireo	seed	0	0.000		0.000	0.0000	
(H)	insect	0.9	1.944		7.391	1.2603	
	fruit	0.1	0.015	1.959	1.194	0.0016	1.2619
White-eyed Vireo.	seed	0	0.000		0.000	0.0000	
(M)	insect	0.9	1.071		7.391	0.6944	
	fruit	0.1	0.010	1.081	1.194	0.0010	0.6954
White-eyed Vireo	seed	0	0.000		0.000	0.0000	
(L)	insect	0.9	0.198		7.391	0.1284	
	fruit	0.1	0.005	0.203	1.194	0.0005	0.1289
Northern Cardinal	seed	0.145	0.711		0.941	0.0150	
(H)	insect	0.71	1.534		16.197	0.5570	
	fruit	0.145	0.022	2.266	4.811	0.0023	0.5743
Northern Cardinal	seed	0.145	0.359		0.941	0.0076	
(M)	insect	0.71	0.845		16.197	0.3068	
	fruit	0.145	0.015	1.218	4.811	0.0016	0.3160
Northern Cardinal	seed	0.145	0.007		0.941	0.0002	
(L)	insect	0.71	0.156		16.197	0.0567	
	fruit	0.145	0.007	0.171	4.811	0.0008	0.0577
Blue Grosbeak	seed	0.4	1.960		1.852	0.1278	
(H)	insect	0.6	1.296		9.762	0.4455	
	fruit	0	0.000	3.256	0.000	0.0000	0.5733
Blue Grosbeak	seed	0.4	0.990		1.852	0.0646	
(M)	insect	0.6	0.714		9.762	0.2454	
	fruit	0	0.000	1.704	0.000	0.0000	0.3100
Blue Grosbeak	seed	0.4	0.020		1.852	0.0013	
(L)	insect	0.6	0.132		9.762	0.0454	
	fruit	0	0.000	0.152	0.000	0.0000	0.0467
Mourning Dove	seed	0.99	4.851		7.235	0.2949	
(H)	insect	0.01	0.022		0.257	0.0000	
	fruit	0	0.000	4.873	0.000	0.0000	0.2950
Mourning Dove	seed	0.99	2.450		7.235	0.1490	
(M)	insect	0.01	0.012		0.257	0.0000	
	fruit	0	0.000	2.462	0.000	0.0000	0.1490

Species (Exposure Level)	Diet Comp.	Prop. of diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Mourning Dove	seed	0.99	0.050		7.235	0.0030	
(L)	insect	0.01	0.002		0.257	0.0000	
	fruit	0	0.000	0.052	0.000	0.0000	0.0030
Red-winged Blackbird	seed	0.45	2.205		3.305	0.1386	
(H)	insect	0.55	1.188		14.197	0.3207	
	fruit	0	0.000	3.393	0.000	0.0000	0.4592
Red-winged Blackbird	seed	0.45	1.114		3.305	0.0700	
(M)	insect	0.55	0.655		14.197	0.1767	
	fruit	0	0.000	1.768	0.000	0.0000	0.2466
Red-winged Blackbird	seed	0.45	0.023		3.305	0.0014	
(L)	insect	0.55	0.121		14.197	0.0327	
	fruit	0	0.000	0.144	0.000	0.0000	0.0341

Exposure Scenario 4: Dietary concentrations or daily consumption for residues of chlorfenapyr ten days following 0.15 lb. a.i./A resulting from a single application for control of early season mites in Western Cotton.

Species (Exposure Level)	Diet Comp.	Prop. of Diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Carolina Wren	seed	0.03	0.075		0.10	0.0004	
(H)	insect	0.94	0.000		11.18	0.0000	
	fruit	0.03	0.002	0.077	0.52	0.0001	0.0005
Carolina Wren	seed	0.03	0.038		0.10	0.0002	
(M)	insect	0.94	0.000		11.18	0.0000	
	fruit	0.03	0.002	0.040	0.52	0.0000	0.0003
Carolina Wren	seed	0.03	0.001		0.10	0.0000	
(L)	insect	0.94	0.000		11.18	0.0000	
	fruit	0.03	0.001	0.002	0.52	0.0000	0.0000
White-eyed Vireo	seed	0	0.000		0.00	0.0000	
(H)	insect	0.9	0.000		7.39	0.0000	
	fruit	0.1	0.008	0.008	1.19	0.0008	0.0008
White-eyed Vireo.	seed	0	0.000		0.00	0.0000	
(M)	insect	0.9	0.000		7.39	0.0000	
	fruit	0.1	0.006	0.006	1.19	0.0006	0.0006
White-eyed Vireo	seed	0	0.000		0.00	0.0000	
(L)	insect	0.9	0.000		7.39	0.0000	
	fruit	0.1	0.003	0.003	1.19	0.0003	0.0003
Northern Cardinal	seed	0.145	0.363		0.94	0.0077	
(H)	insect	0.71	0.000		16.20	0.0000	
	fruit	0.145	0.012	0.374	4.81	0.0013	0.0089
Northern Cardinal	seed	0.145	0.183		0.94	0.0039	
(M)	insect	0.71	0.000		16.20	0.0000	
	fruit	0.145	0.008	0.191	4.81	0.0009	0.0047
Northern Cardinal	seed	0.145	0.004		0.94	0.0001	
(L)	insect	0.71	0.000		16.20	0.0000	
	fruit	0.145	0.004	0.009	4.81	0.0005	0.0006
Blue Grosbeak	seed	0.4	1.000		1.85	0.0652	
(H)	insect	0.6	0.000		9.76	0.0000	
	fruit	0	0.000	1.000	0.00	0.0000	0.0652
Blue Grosbeak	seed	0.4	0.506		1.85	0.0330	
(M)	insect	0.6	0.000		9.76	0.0000	
	fruit	0	0.000	0.506	0.00	0.0000	0.0330
Blue Grosbeak	seed	0.4	0.012		1.85	0.0008	
(L)	insect	0.6	0.000		9.76	0.0000	
	fruit	0	0.000	0.012	0.00	0.0000	0.0008
Mourning Dove	seed	0.99	2.475		7.24	0.1505	
(H)	insect	0.01	0.000		0.26	0.0000	
	fruit	0	0.000	2.475	0.00	0.0000	0.1505
Mourning Dove	seed	0.99	1.252		7.24	0.0761	
(M)	insect	0.01	0.000		0.26	0.0000	
	fruit	0	0.000	1.252	0.00	0.0000	0.0761

Species (Exposure Level)	Diet Comp.	Prop. of Diet	Dietary Conc.	Total ppm	Grams Consumed Wet Wt.	mg a.i./kg/day	Total mg/kg/day
Mourning Dove	seed	0.99	0.030		7.24	0.0018	
(L)	insect	0.01	0.000		0.26	0.0000	
	fruit	0	0.000	0.030	0.00	0.0000	0.0018
Red-winged Blackbird	seed	0.45	1.125		3.31	0.0707	
(H)	insect	0.55	0.000		14.20	0.0000	
	fruit	0	0.000	1.125	0.00	0.0000	0.0707
Red-winged Blackbird	seed	0.45	0.569		3.31	0.0358	
(M)	insect	0.55	0.000		14.20	0.0000	
	fruit	0	0.000	0.569	0.00	0.0000	0.0358
Red-winged Blackbird	seed	0.45	0.014		3.31	0.0008	
(L)	insect	0.55	0.000		14.20	0.0000	
	fruit	0	0.000	0.014	0.00	0.0000	0.0008

Response Profile

The ecological entities in this assessment are bird species associated with cotton agroenvironments. The possible effects from exposure to chlorfenapyr include mortality and reduced reproduction. There is little uncertainty about the use pattern and use rates for chlorfenapyr. The bird species that are likely to be exposed have been determined. And there is relatively little uncertainty regarding the effects of chlorfenapyr, if a bird receives a sufficient dose.

The benchmark toxicity values that will be used in **Risk Characterization** follow. For the Carolina Wren, the White-eyed Vireo, the Northern Cardinal, and the Blue Grosbeak, all passerines, the toxicity value for another passerine, the Red-winged Blackbird, was used. For the Mourning Dove, the toxicity values for another upland game bird, the Northern Bobwhite, were used. Data were available for the Red-winged Blackbird and the Mallard.

Species	Acute Oral LD_{50} (ppm)	Acute Dietary LC50 (ppm)	Chronic NOEC (ppm)
Carolina Wren	2.2	11.3	0.5
White-eyed Vireo	2.2	11.3	0.5
Northern Cardinal	2.2	11.3	0.5
Blue Grosbeak	2.2	11.3	0.5
Mourning Dove	34	132	1.5
Red-winged Blackbird	2.2	11.3	0.5
Mallard Duck	10.3	8.6	0.5

Comments on the Analysis Phase for Chlorfenapyr in Cotton

To characterize exposure, data regarding residue levels of chlorfenapyr and their decline in the cotton agroenvironment, in avian food items, in raw agricultural commodities intended for human consumption, and in soil have been summarized. Residues on avian feed items are reduced significantly as distance from the treated field increases. Residues decline significantly within days of application. Levels in soil after repeated applications have been predicted by theoretical calculations; however, the predicted levels do not pose acute or chronic risk to the most sensitive species. Furthermore, predictions of accumulation are not borne out by field measurements under actual product usage conditions.

Several important factors which mitigate exposure to residues have been identified and their potential impact on avian risk has been quantitatively estimated where possible. Risk quotients, as historically applied by EPA, do not take into consideration the significant influence these factors exert on exposure and risk. Exposure mitigating factors include the limited degree to which birds directly or indirectly ingest soil, limited bioavailability of chlorfenapyr residues from soil and the unavailability of surface residues for exposure.

Several lines of evidence have been presented which collectively provide strong support for the conclusion that birds do not spend a significant amount of time in cotton. Current and historical Information on insect pest management in cotton (chemical usage), and estimates of insect biomass in managed cotton fields as compared to other crops grown in the same areas, strongly suggest that cotton fields are not attractive food sources for birds. This line of reasoning is supported by avian census observations that bird usage of cotton fields is low. The amount of time birds spend in cotton critically influences exposure and risk.

To characterize effects, laboratory and field study data have been summarized. The benchmark toxicity values that will be used in the Risk Characterization are derived from EPA-required laboratory studies of acute oral, acute dietary, chronic and reproductive toxicity.

The cotton agroenvironment has been characterized with regard to bird species, habitats and ecoregions, using a variety of information sources, including GIS data, avian censuses, and the scientific literature. Based on the species of birds that use cotton, seven representative or "focal" species have been selected for the risk assessment.

The cotton agroenvironment has also been characterized with respect to the relative area (by state and by ecoregion) planted to cotton. A quantitative estimate of the amount of habitat that could be affected by chlorfenapyr has been derived; that amount is very low compared to the acreage of the Cotton Belt, less than 0.5%. Considering the proposed PIRATE® and ALERT® labels, and chlorfenapyr usage, a highly conservative overestimate assumes 19% of the total acres planted to cotton may receive a chlorfenapyr application. This is based on applications to 20% of the acres infested with resistant budworm/bollworm; 50% infested with mites and 50% infested with beet armyworms.

When doing any risk assessment, gaps in specific knowledge are addressed by using assumptions. This introduces some "uncertainty" into the risk estimate, to the extent that the assumptions may not accurately represent the true picture. By developing *conservative* assumptions, the risk assessor attempts to assure that any uncertainty lies in the direction of overestimating the actual risk. Although there is an extensive data base on chlorfenapyr, it is necessary to make assumptions regarding certain details of chlorfenapyr's effects and behavior in the environment. Some of the assumptions used are consistent with the general ecorisk

assessment approaches and principles laid out in the EPA *Framework*, for example, (1) the inherent sensitivity of birds in the wild is similar to the sensitivity of the three species tested in the laboratory; and (2) environmental conditions in the wild do not significantly enhance the toxicity of chlorfenapyr to birds. Other assumptions are specific to chlorfenapyr and cotton. They are supported by available data or information, and represent what Cyanamid believes to be a conservative approach. These assumptions include: (1) the dietary compositions and amounts of food eaten by birds in the wild are adequately represented by the diets selected for the seven focal species: (2) the bioavailability of chlorfenapyr residues in insects, weed seeds, and other substrates to birds is 100%; (3) the residue levels and degradation patterns observed for chlorfenapyr in Georgia, Louisiana, and Mississippi are applicable to conditions in other parts of the Cotton Belt, and; (4) the patterns of cotton planting and the need for insecticide usage in cotton during the last 34 and 8 years, respectively, adequately forecast future patterns.

The uncertainties that these assumptions contribute to the risk estimates will be discussed in *more detail in the Uncertainty Analysis, page 106.*