Crop Profile for Eggs in Iowa

Prepared May, 2000

General Production Information

A significant number of eggs are produced in the 12 states that comprise the North Central Region. According to the latest USDA-NASS Agricultural Statistics Board Report these North Central states account for over 39% of the total U.S. egg production, with an estimated value of over $134 million (Table 1). The State of Iowa ranks 2nd regionally, and 4th nationally, in egg production (7.5% of U.S. total) with an estimated value of $22,480,000.

Table 1. Egg production data for twelve North Central states, December 1, 1998.[1]

Rank	State	Production (million eggs)	Price (per dozen)	% U.S Production	Value (million $)
1	Ohio	7,395	0.570	9.3%	35.13
4	**Iowa**	**5,969**	**0.452**	**7.5%**	**22.48**
5	Indiana	5,831	0.588	7.3%	28.57
9	Minnesota	3,152	0.480	4.0%	12.61
10	Nebraska	2,706	0.430	3.4%	9.70
14	Missouri	1,732	0.530	2.3%	7.65
16	Michigan	1,395	0.500	1.7%	5.81
20	Wisconsin	1,031	0.514	1.3%	4.42
28	Illinois	838	0.618	1.1%	4.32
30	South Dakota	618	0.430	0.8%	2.21
34	Kansas	392	0.468	0.5%	1.53

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.

43	North Dakota	60	0.450	0.1%	0.23
U.S. Totals		**79,717**	**0.655**	**100%**	**434.95**

[1]*Poultry – Production and Value, 1998 Summary*. USDA-NASS Agricultural Statistics Board Report. Pou 3-1 (99). pp. 1-3.

Laying Hen Inventory

According to the latest USDA-NASS Agricultural Statistics Board Report the 12 states that comprise the North Central Region had a laying hen inventory of 118,009,000 birds (Table 2). This constitutes 37.8% of the total U.S. inventory. The State of Iowa ranks 2nd regionally, and 3rd nationally, with a total laying hen inventory of 23,044,000 birds (7.4% of U.S. total).

Table 2. Laying hen inventory data for twelve North Central States, December 1, 1998.[1]

Rank	State	Inventory (1,000 layers)	Eggs/Layer	% U.S. Inventory
1	Ohio	27,845	266	8.9%
3	**Iowa**	**23,044**	**259**	**7.4%**
5	Indiana	21,787	268	7.0%
9	Minnesota	12,032	262	3.9%
12	Nebraska	10,398	260	3.3%
15	Missouri	6,644	261	2.1%
16	Michigan	5,318	262	1.7%
21	Wisconsin	3,837	269	1.2%
27	Illinois	3,156	266	1.0%

30	South Dakota	2,265	273	0.7%
34	Kansas	1,443	271	0.5%
43	North Dakota	240	250	0.1%
U.S. Totals		**312,058**	**256**	**100%**

[1]*Layers and Egg Production, 1998 Summary*. USDA-NASS Agricultural Statistics Board Report. Pou 2-4 (99). pp. 1-3.

Major Uses of Eggs in Iowa:

- Table eggs (96%)
- Hatching eggs (4%)

Egg Production in Iowa:
Eggs are produced in every county in Iowa. Unfortunately, complete data are not available in regard to the number of eggs produced, or laying hens housed, within individual counties. This lack of county information is due to the provisions of Title 7 of the United States Code, which states that no data are to be published that would disclose the operations of an individual farm. However, the number of farms reporting an operational item is not considered to be a release of confidential information. As a result, it is possible to glean some information and gain insight into changes or trends in egg production that have occurred in Iowa between the last two issues of the *Census of Agriculture* that were conducted in 1992 and 1997.

Between 1992 and 1997 the number of laying hens in Iowa increased from 11,162,662 birds to 21,509,521 birds (Table 3). This represents an increase in laying hen inventory of 92.7% over the 5-year period. However, while the number of laying hens nearly doubled during this time period, the number of farms housing laying hens and producing eggs actually decreased by 29.3%. The only type of operation to show an increase in laying hen numbers during this period were farms that had an inventory of over 100,000 birds. In fact, the number of farms with an inventory of over 100,000 laying hens more than doubled between 1992 and 1997.

Table 3. Inventory of laying hens 20 weeks old and older in Iowa, 1997 and 1992.[1]

	1997	**1992**

Farms with an inventory of:	Number of Farms	Number of Layers	Number of Farms	Number of Layers
1 to 49 layers	1,318	24,530	1,759	32,130
50 to 99 layers	195	11,838	297	18,303
100 to 399 layers	163	27,748	311	53,795
400 to 3,199 layers	29	26,777	71	62,647
3,200 to 9,999 layers	28	207,197	38	240,827
10,000 to 19,999 layers	20	244,880	42	532,349
20,000 to 49,999 layers	21	703,310	31	996,610
50,000 to 99,999 layers	16	1,122,139	23	1,617,053
100,000 or more layers	41	19,141,102	18	7,608,948
Total	**1,831**	**21,509,521**	**2,590**	**11,162,662**

[1]*1997 Census of Agriculture*. Vol.1, Geographic Area Series, Part 15. Iowa: State and County Data. USDA-NASS Publication No. AC97-A-15, March 1999.

Cultural Practices

Iowa benefits from having a temperate climate, a readily accessible and affordable feed supply, an increased egg-breaking industry, and a readily available and reliable source of labor that are conducive to intensive poultry production systems. Over the past decade egg production in Iowa has shifted away from small independent producers towards larger agribusinesses and/or corporations.

Modern egg production systems use expensive equipment and specially designed houses to accommodate large numbers of laying hens with minimal labor input. Laying hens are typically kept in tiered cages, with 3-4 birds/cage. Larger houses may have back-to-back tiers of cages and 2-5 walkways running the length of the house. These houses may be either a wide-span or high-rise design. Wide-span houses are one-story structures. The floor is usually concrete and is often recessed beneath the cages to form a shallow pit. Manure is removed frequently by a mechanical cable-operated scraper or by flushing with large quantities of water. High-rise houses (also called deep pit houses) are two-story structures that have walkways and banks of tiered cages located on the second story. No floor exists beneath the cages and manure is allowed to drop and accumulate on the concrete floor of the first story. Manure may accumulate for at least a year before it is removed by tractor-mounted front-end loaders. In cooler climates, such as Iowa, both wide-span and high-rise houses are usually enclosed and incorporate fans for ventilation control.

Caged laying hens are typically placed in houses at 18-20 weeks of age. When egg production starts to decline (usually in 12-14 months) the hens are either replaced or molted for a second, shorter, egg-laying period. In large facilities egg collection and feed delivery are handled by automatic conveyer-belt systems. In small facilities feeding and egg collection may be done by hand. In all types of houses water is provided to the laying hens through various types of automatic watering systems placed in or next to the cages.

Type of House	House Construction	Manure Collection	Frequency of Manure Removal
Wide-span	One story	On floor or in shallow pits	Weekly to monthly
High-rise	Two story	In deep pits (first story of house)	Yearly

Insect Pests

House flies, Northern fowl mites, litter beetles, and lice are the four major insect/mite pests of caged laying hens in Iowa. A brief narrative detailing the biology, economic importance, and control of these pests is provided. Other poultry pests, such as the red mite, bed bug, sticktight flea, and fowl tick, are rarely encountered in modern caged layer facilities in Iowa and are not considered in this profile.

House Flies

Description and Biology:
The common house fly, *Musca domestica*, is the most common and abundant fly species found in and around caged layer facilities. House flies readily deposit eggs in manure, spilled feed, or other moist decaying organic matter that may be found in and around the facility. House fly eggs typically hatch in 1-

2 days whereupon the larvae burrow into and feed on the breeding material. Larvae complete their development in about 4-6 days and then seek a drier environment in which to pupate. Adults emerge about 5-6 days later. The entire life cycle can be completed in as little as 7-14 days, depending on temperature. In environmentally controlled caged layer facilities conditions may exist that would allow flies to breed continually throughout the year.

Economic Importance:
House flies are not known to cause direct losses in egg production. Although flies have been incriminated in the transmission of several avian pathogens, their exact role in the epizootiology of these diseases in uncertain. Flies have also been incriminated in the transmission of numerous human diseases and are therefore considered to be a nuisance and public health hazard. As a result, lawsuits and threats of legal constraint have been instigated against producers for failure to properly control flies dispersing from their facilities to neighboring residences or businesses. Flies can also directly annoy employees and deposit unsightly and unsanitary fecal and regurgitation spots on eggs, walls, rafters, lights, and other resting surfaces.

Chemical Control:
Chemical control has always been an integral component of fly management in caged layer facilities. Available application methods include residual surface sprays, space sprays, and baits applied as adulticides and feed additives and residual manure surface sprays applied as larvicides. However, with the exception of products containing the active ingredient cyromazine, larvicide applications are not recommended or included in this profile due to their detrimental effects on beneficial arthropods and other nontarget organisms that may be present in the manure. Overall, reliance on chemical control is decreasing due to rising application costs, increased environmental concerns and constraints, regulatory limitations on use patterns, the development of insecticide resistance in the targeted pest, and a reduction in the development of new insecticide products.

The following active ingredients are labeled for fly control in and around caged layer facilities. Attempts have been made to include the most readily available and commonly used formulations.

<u>Permethrin</u>
Chemical Class: Pyrethroid

- **Formulation**: 1% EC
  Type of Application: Residual surface spray
  Dilution/Rate: RTU; apply 1 gal./7,300 sq. ft.
  Restrictions: None

- **Formulation**: 5.7% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 1 qt./10 gal. water; apply 1 gal. spray/750 sq. ft.
  Restrictions: None

- **Formulation**: 5.7% EC
  Type of Application: Residual surface spray
  Dilution/Rate: RTU; mist 4 oz./1,000 sq. ft.
  Restrictions: None

- **Formulation**: 5.7% EC
  Type of Application: Space spray applied through overhead system
  Dilution/Rate: 1 qt./10 gal. oil; apply 4 oz. spray/1,000 cu. ft.
  Restrictions: None

- **Formulation**: 7.4% EC
  Type of Application: Residual surface spray
  Dilution/Rate: RTU; mist 20 oz./7,200 sq. ft.
  Restrictions: None

- **Formulation**: 10% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 1 qt./25 gal. water; apply 1 gal. spray/750 sq. ft.
  Restrictions: None

- **Formulation**: 10% EC
  Type of Application: Residual surface spray
  Dilution/Rate: RTU; mist 4 oz./1,000 sq. ft.
  Restrictions: None

- **Formulation**: 10% EC
  Type of Application: Space spray applied through overhead system
  Dilution/Rate: 1 qt./25 gal. oil; apply 4 oz. spray/1,000 cu. ft.
  Restrictions: None

- **Formulation**: 11% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 1 pt./10 gal. water; apply 1 gal. spray/750-1,000 sq. ft.
  Restrictions: None

- **Formulation**: 38.4% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 4 oz./12.5 gal. water; apply 1 gal. spray/750 sq. ft.
  Restrictions: None

- **Formulation**: 42.5% EC
  Type of Application: Residual surface spray

Dilution/Rate: 0.25 pt./10 gal. water; apply 1 gal. spray/750-1,000 sq. ft.
Restrictions: None

- **Formulation**: 25% WP
  Type of Application: Residual surface spray
  Dilution/Rate: 6 oz./11 gal. water; apply 1 gal. spray/750 sq. ft.
  Restrictions: None

- **Formulation**: 24.7% WSB
  Type of Application: Residual surface spray
  Dilution/Rate: 6 oz./11 gal. water; apply 1 gal. spray/750 sq. ft.
  Restrictions: None

Lambda-cyhalothrin
Chemical Class: Pyrethroid

- **Formulation**: 9.7% CS
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

- **Formulation**: 10% EC
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

Cyfluthrin
Chemical Class: Pyrethroid

- **Formulation**: 11.8% SC
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

- **Formulation**: 24.3% EC
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

- **Formulation**: 6% CS
  Type of Application: Residual surface spray
  Dilution/Rate: 1 oz./gal. water; apply 1 gal. spray/1,000 sq. ft.

Restrictions: Birds can not be present during treatment

- **Formulation**: 20% WP
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

Pyrethrins
Chemical Class: Botanical

- **Formulation**: 0.5% EC
  Type of Application: Space spray
  Dilution/Rate: Dilution varies; apply 1-2 oz. spray/1,000 cu. ft.
  Restrictions: Birds can not be present during treatment

- **Formulation**: 1% EC
  Type of Application: Space spray
  Dilution/Rate: Dilution varies; apply 1-2 oz. spray/1,000 cu. ft.
  Restrictions: Birds can not be present during treatment

- **Formulation**: 3% EC
  Type of Application: Space spray
  Dilution/Rate: Dilution varies; apply 1-2 oz. spray/1,000 cu. ft.
  Restrictions: Birds can not be present during treatment

- **Formulation**: 0.5% A
  Type of Application: Space spray
  Dilution/Rate: RTU; apply for 1-2 sec./1,000 cu. ft.
  Restrictions: Birds can not be present during treatment

- **Formulation**: 1% A
  Type of Application: Space spray
  Dilution/Rate: RTU; apply for 1-2 sec./1,000 cu. ft.
  Restrictions: Birds can not be present during treatment

Chlorpyrifos
Chemical Class: Organophosphate

- **Formulation:** 20% CS
  Type of Application: Residual surface spray
  Dilution/Rate: 2-5 oz./gal. water; apply 1 gal. spray/1,000 sq. ft.
  Restrictions: Birds can not be present during treatment

Dichlorvos
Chemical Class: Organophosphate

- **Formulation**: 43.2% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 1 qt./25 gal. water; apply 1 qt. spray/1,000 sq. ft.
  Restrictions: Ventilate immediately after treatment if birds are present

- **Formulation**: 1% A
  Type of Application: Space spray
  Dilution/Rate: RTU; apply for 1-2 sec./1,000 cu. ft.
  Restrictions: None

Tetrachlorvinphos
Chemical Class: Organophosphate

- **Formulation**: 50% WP
  Type of Application: Residual surface spray
  Dilution/Rate: 4-8 lb./25 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: None

Tetrachlorvinphos + Dichlorvos
Chemical Class: Organophosphate

- **Formulation**: 28.7% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 1 gal./25 gal. water; apply 1 gal. spray/500-1,000 sq. ft.
  Restrictions: None

Dimethoate
Chemical Class: Organophosphate

- **Formulation**: 23.4% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 1 gal./25 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: Birds can not be present during treatment

- **Formulation**: 43.5% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 0.5 pt./3 gal. water; apply 1 gal. spray/500-1,000 sq. ft.
  Restrictions: Birds can not be present during treatment

<u>Malathion</u>
Chemical Class: Organophosphate

- **Formulation**: 57% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 2.5 oz./gal water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: None

<u>Trichlorfon</u>
Chemical Class: Organophosphate

- **Formulation**: 80% SP
  Type of Application: Residual surface spray
  Dilution/Rate: 1 lb./8 gal. water; apply 1 gal. spray/500 sq. ft.
  Restrictions: Birds can not be present during treatment

<u>Methomyl</u>
Chemical Class: Carbamate

- **Formulation**: 1% B
  Type of Application: Dry bait
  Dilution/Rate: RTU; apply 4 oz./500 sq. ft.
  Restrictions: None

<u>Cyromazine</u>
Chemical Class: Insect Growth Regulator

- **Formulation**: 2% SL
  Type of Application: Residual surface spray
  Dilution/Rate: 5 qt./25 gal. water; apply 1 gal. spray/100 sq. ft.
  Restrictions: 1-day slaughter interval

- **Formulation**: 1% Premix
  Type of Application: Feed additive
  Dilution/Rate: RTU; mix 1 lb./ton of feed
  Restrictions: 3-day slaughter interval

<u>Pyriproxifen</u>
Chemical Class: Insect Growth Regulator

- **Formulation**: 1.3% EC

Type of Application: Residual surface spray
Dilution/Rate: 1 oz./gal. water; apply 1 gal. spray/1,500 sq. ft.
Restrictions: Birds can not be present during treatment

Cultural Control:
Manure management and other cultural practices that eliminate or minimize fly breeding materials is the most important and effective approach to fly control in and around caged layer facilities. Moisture control is an important part of manure management. Houses should be designed to allow for proper and complete drainage and air movement. Good ventilation and elimination of water leaks will promote manure drying. Dry manure (<50% moisture) is unattractive and unsuitable for fly development and greatly enhances the establishment and activity of naturally occurring fly predators and parasites. Very wet manure (>85% moisture) is also unsuitable for fly development.

Frequent manure removal can eliminate most fly development in caged layer facilities. Ideally, manure removal should be done at weekly intervals to interrupt the fly life cycle. Unfortunately, weekly manure removal is not feasible in today's modern egg production facilities that are designed to accumulate manure for extended periods of time. In facilities where manure is infrequently removed, leaving a pad of dry manure after cleanout will encourage manure drying and serve as a refuge for naturally occurring fly predators and parasites. Removal of only one portion of the manure mass at a time will also enhance the establishment of natural enemies in the cleaned areas.

Biological Control:
Biological control agents (i.e. predators, parasites, pathogens) play a significant role in the control of flies in caged layer facilities. These include both naturally occurring agents as well as those commercially available for augmentive release. The establishment and survival of these agents is greatly enhanced by the cultural control strategies discussed above. The histerid beetle, *Carcinops pumilio*, and the macrochelid mite, *Macrocheles muscaedomesticae*, are the primary naturally occurring predators of fly eggs and larvae in poultry manure. The black garbage fly, *Ophyra aenescens*, has been employed as a house fly predator in some poultry facilities and may displace the house fly if populations become well established. Other insects, such as certain species of litter beetles, are not considered to be house fly predators but do occur in poultry manure where they expedite drying and may make the manure less suitable for house fly development. Several species of parasitic pteromalid wasps in the genera *Muscidifurax* and *Spalangia* occur naturally and are also commercially available for augmentive release. In some cases these releases have resulted in reductions of fly populations, while at other times the results have been disappointing. To date, the reasons for success or failure are poorly understood. Several naturally occurring pathogens (i.e. fungi, bacteria, viruses, protozoans) have also been shown to cause mortality in flies but little is presently known regarding their potential use as a management tool.

Northern Fowl Mites

Description and Biology:
The Northern fowl mite, *Ornithonyssus sylviarum*, is an obligate, bloodfeeding, external parasite of domestic and wild birds. Adults are extremely small (1/26-inch) and usually dark red to black in color. Female mites typically glue their eggs to the feathers of the host bird. These eggs hatch into nonfeeding larvae in about 1-2 days. In less than 2 days these larvae molt and develop into protonymphs. Protonymphs feed on blood for 1-2 days before developing into nonfeeding deutonymphs. Deutonymphs subsequently develop into bloodfeeding adult mites in about 1-2 days. Under ideal conditions the entire life cycle can be completed in less than one week.

Northern fowl mites spend the majority of their life on the host bird and are usually aggregated near the vent area. At times, these mites may leave the host bird in large numbers and aggregate on cage structures or eggs. Northern fowl mites can survive 2-4 weeks after being separated from the host bird under suitable temperature and humidity conditions. While mites can infest birds throughout the year, problems are usually more severe during the cold weather months.

Infestations of Northern fowl mites can originate from several sources. The most frequent method of transmission is through mite-infested personnel, equipment, or egg crates brought into the caged layer facility. Transmission may also result from infested hatcheries and contract started-pullet farms, or from mite-infested trucks and crates used to carry infested birds. Finally, wild birds can harbor Northern fowl mites and may initiate an infestation if they are allowed access into the caged layer facility.

Economic Importance:
Northern fowl mites are considered to be the most economically important external parasites of poultry in the United States. Most of these losses occur in caged layer operations where millions of dollars are lost annually as a result of treatment costs and decreases in egg production. In addition to production losses, mites seen crawling on eggs may make workers reluctant to enter houses or handle the eggs.

Chemical Control:
Chemical control is the only method available for controlling Northern fowl mite infestations once they have become established in a caged layer facility. Application methods include sprays or dusts applied directly to the birds as well as sprays or dusts applied to the premises. The type of application method can have a pronounced effect on control and, although widespread mite resistance has been reported, many control problems can be attributed to inadequate application.

The following active ingredients are labeled for Northern fowl mite control in caged layer facilities. Attempts have been made to include the most readily available and commonly used formulations.

Permethrin
Chemical Class: Pyrethroid

- **Formulation**: 5.7% EC
  Type of Application: Direct spray (bird treatment)

Dilution/Rate: 1 qt./25 gal. water; apply 1 gal. spray/100 birds
Restrictions: None

- **Formulation**: 10% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 qt./50 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 11% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 pt./25 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 42.5% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 0.25 pt./25 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 25% WP
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 lb./30 gal. water; apply 1-2 oz. spray/bird
  Restrictions: None

- **Formulation**: 0.25% D
  Type of Application: Direct dust (bird treatment)
  Dilution/Rate: RTU; apply 1 lb./100 birds
  Restrictions: None

Tetrachlorvinphos
Chemical Class: Organophosphate

- **Formulation**: 50% WP
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 2 lb./25 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 50% WP

- Type of Application: Residual surface dust treatment
  Dilution/Rate: RTU; apply 2.5 oz./100 sq. ft.
  Restrictions: None

<u>Tetrachlorvinphos + Dichlorvos</u>
Chemical Class: Organophosphate

- **Formulation**: 28.7% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 gal./50 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

<u>Malathion</u>
Chemical Class: Organophosphate

- **Formulation**: 57% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 oz./gal. water; apply 1 gal. spray/100-150 birds
  Restrictions: None

- **Formulation**: 5% D
  Type of Application: Direct dust (bird treatment)
  Dilution/Rate: RTU; apply 1 lb./100 birds
  Restrictions: None

- **Formulation**: 5% D
  Type of Application: Residual surface dust treatment
  Dilution/Rate: RTU; apply 1 lb./50-60 sq. ft.
  Restrictions: None

<u>Carbaryl</u>
Chemical Class: Carbamate

- **Formulation**: 41.2% Suspension
  Type of Application: Residual surface spray
  Dilution/Rate: 4 qt./100 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 43% F
  Type of Application: Residual surface spray
  Dilution/Rate: 4 qt./100 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 80% SP
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 4 oz./5 gal. water; apply 1 gal. spray/100 birds

Restrictions: 7-day slaughter interval

- **Formulation**: 80% SP
  Type of Application: Direct mist (bird treatment)
  Dilution/Rate: 6 oz./gal. water; mist 1.5 gal./1,000 birds
  Restrictions: 7-day slaughter interval

- **Formulation**: 80% SP
  Type of Application: Residual surface spray
  Dilution/Rate: 5 lb./100 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 50% WP
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 6 oz./5 gal. water; apply 1 gal. spray/100 birds
  Restrictions: 7-day slaughter interval

- **Formulation**: 50% WP
  Type of Application: Direct mist (bird treatment)
  Dilution/Rate: 10 oz./gal. water; mist 1.5 gal./1,000 birds
  Restrictions: 7-day slaughter interval

- **Formulation**: 50% WP
  Type of Application: Residual surface spray
  Dilution/Rate: 2 lb./25 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 5% D
  Type of Application: Direct dust (bird treatment)
  Dilution/Rate: RTU; apply 1 lb./100 birds
  Restrictions: 7-day slaughter interval

Cultural Control:
Northern fowl mite problems can be prevented through the use of cultural control practices. Mite-infested wild birds can introduce an infestation and should be prevented from entering the facility. Fortunately, the conversion to closed housing systems for most caged layer facilities has eliminated much of this concern. Mites can also enter a facility through contaminated personnel, equipment, egg flats, egg cases, etc. Therefore, greater reliance on strict biosecurity measures and on the sanitization of flats, crates, and other equipment can prevent an infestation. Finally, Northern fowl mite infestations can be prevented by eliminating mites in pullet flocks before they are moved to the layer houses.

Biological Control:

No natural enemies have been identified and no biological control measures are commercially available for the management of Northern fowl mites in caged layer facilities.

Litter Beetles

Description and Biology:
Several species of litter beetles may inhabit poultry manure. Of primary importance is the lesser mealworm, *Alphitobius diaperinus*, which often reaches high populations in high-rise caged layer facilities. Lesser mealworm eggs are deposited in poultry manure and hatch into larvae in about 4-7 days. Larvae feed on spilled feed, manure, dead birds, and cracked eggs and following pupation complete their development to the adult stage in 40-100 days, depending on temperature and food quality. As populations increase within the facility mature larvae leave the manure in search of more isolated pupation sites. In so doing, the larvae may tunnel into polystyrene, polyisocyanurate, and fiberglass thermal insulation materials to construct pupal cells. These tunnels are further expanded when newly emerged adults leave the tunnels in search of food.

Economic Importance:
Lesser mealworms may cause economic losses in several ways. First, the destruction of thermal insulation materials may result in increased energy consumption and the costly replacement of these materials. Second, when infested manure is spread on fields during warm weather months adult beetles may migrate to nearby homes and businesses and constitute a public nuisance. Third, they are known to harbor many important avian pathogens, such as *Salmonella typhimurium*, *Escherichia coli*, tapeworms, and avian leukosis virus.

Chemical Control:
Chemical control continues to be an integral component of litter beetle management in caged layer facilities. However, obtaining satisfactory control is extremely difficult if conditions are favorable for beetle survival and reproduction. In such instances, producers have little choice but to rely on chemical control as a building protectant rather than a control strategy.

The following active ingredients are labeled for litter beetle control in caged layer facilities. Attempts have been made to include the most readily available and commonly used formulations.

Lambda-cyhalothrin
Chemical Class: Pyrethroid

- **Formulation**: 9.7% CS
  Type of Application: Residual surface spray
  Dilution/Rate: 0.8 oz./gal. water; apply 1 gal. spray/1,000 sq. ft.
  Restrictions: Birds can not be present during treatment

Cyfluthrin
Chemical Class: Pyrethroid

- **Formulation**: 11.8% SC
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

- **Formulation**: 24.3% EC
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

- **Formulation**: 20% WP
  Type of Application: Residual surface spray
  Dilution/Rate: Dilution and rate vary on the type of surface to be treated
  Restrictions: Birds can not be present during treatment

- **Formulation**: 1% D
  Type of Application: Residual surface dust
  Dilution/Rate: RTU; apply ½-1 lb./1,000 sq. ft.
  Restrictions: Birds can not be present during treatment

Tetrachlorvinphos
Chemical Class: Organophosphate

- **Formulation**: 50%WP
  Type of Application: Residual surface spray
  Dilution/Rate: 2 lb./25 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: None

- **Formulation**: 50%WP
  Type of Application: Residual surface dust
  Dilution/Rate: RTU; apply 0.75 oz./100 sq. ft.
  Restrictions: None

Tetrachlorvinphos + Dichlorvos
Chemical Class: Organophosphate

- **Formulation**: 28.7% EC
  Type of Application: Residual surface spray

Dilution/Rate: 1 gal./25 gal. water; apply 1 gal. spray/500-1,000 sq. ft.
Restrictions: None

Carbaryl
Chemical Class: Carbamate

- **Formulation**: 41.2% Suspension
  Type of Application: Residual surface spray
  Dilution/Rate: 50 qt./100 gal. water; apply 2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 43% F
  Type of Application: Residual surface spray
  Dilution/Rate: 50 qt/100 gal. water; apply 2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 80% S
  Type of Application: Residual surface spray
  Dilution/Rate: 62.5 lb./100 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 50% WP
  Type of Application: Residual surface spray
  Dilution/Rate: 2 lb./25 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 20% B
  Type of Application: Dry bait
  Dilution/Rate: RTU; apply 8-12 oz./1,000 sq. ft.
  Restrictions: None

Pyriproxifen
Chemical Class: Insect Growth Regulator

- **Formulation**: 1.3% EC
  Type of Application: Residual surface spray
  Dilution/Rate: 1 oz./gal. water; apply 1 gal. spray/1,000 sq. ft.
  Restrictions: Birds can not be present during treatment

Boric Acid
Chemical Class: Boron Compound

- **Formulation**: 100% IC
  Type of Application: Residual surface spray
  Dilution/Rate: 1-2 lb./gal. water; apply 3 gal. spray/100 sq. ft.
  Restrictions: None

- **Formulation**: 100% IC
  Type of Application: Residual surface dust treatment
  Dilution/Rate: RTU; apply 1-2 lb./100 sq. ft.
  Restrictions: None

- **Formulation**: 30% B
  Type of Application: Dry bait
  Dilution/Rate: RTU; apply 1-2 lb./100 sq. ft.
  Restrictions: None

Cultural Control:
Frequent manure removal can eliminate litter beetle problems from caged layer facilities. Unfortunately, modern high-rise facilities are designed and managed to remove manure at yearly, or more infrequent, intervals. Opening buildings and exposing the litter beetles to subfreezing temperatures for a week or longer can also be a simple and inexpensive cultural control practice for producers in northern states. This practice, however, is only feasible in empty houses where birds will not be present and where precautions can be taken to insure that water lines will not freeze.

Biological Control:
No biological control measures are commercially available for the management of litter beetles in caged layer facilities. Several natural enemies of the lesser mealworm have been identified, including protozoa, fungi and parasitic mites, but much in-depth research and development will be needed before any of these agents are commercially available.

Lice

Description and Biology:
Several species of chewing lice can infest poultry. Of these, the chicken body louse, *Menacanthus stramineus*, is the most common species found on caged laying hens. Chicken body lice are host specific and spend their entire life on the host bird. Female lice glue their eggs (nits) to the feathers of the host bird. These eggs hatch into nymphs in about 4-7 days. Nymphs have the same feeding habits as adults and resemble adults except that they are smaller in size. Nymphs eventually develop into adult lice after undergoing several molts. Under ideal conditions the entire life cycle can be completed in about 3-4 weeks.

Chicken body lice have chewing mouthparts and do not pierce the skin to feed on blood. Instead, these lice feed by chewing on dry skin scales, feathers, and exudates. Both nymphs and adult lice can be found on the feathers or skin surface and move rapidly when disturbed. Both nymphs and adults can survive for up to a week after being separated from the host bird. Lice populations can fluctuate greatly but generally tend to increase in number during the cold weather months.

Infestations of chicken body lice can originate from several sources. These sources include lice-infested materials or equipment brought into the facility, lice-infested hatcheries or contract started-pullet farms, lice-infested trucks or crates used to carry infested birds, and lice-infested wild birds that are allowed access into the caged layer facility.

Economic Importance:
The feeding activity of chicken body lice causes a tremendous amount of irritation. Infested laying hens become restless and do not feed normally. Heavy infestations have been shown to reduce egg production (up to 46%), decrease weight gain, and lower bird vitality.

Chemical Control:
Chemical control is the only method available for controlling lice infestations once they have become established in a caged layer facility. Application methods include sprays or dusts applied directly to the birds as well as sprays or dusts applied to the premises.

The following active ingredients are labeled for lice control in caged layer facilities. Attempts have been made to include the most readily available and commonly used formulations.

Permethrin
Chemical Class: Pyrethroid

- **Formulation**: 5.7% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 qt./25 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 10% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 qt./50 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 11% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 pt./25 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 42.5% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 0.25 pt./25 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 0.25% D
  Type of Application: Direct dust (bird treatment)
  Dilution/Rate: RTU; apply 1 lb./100 birds
  Restrictions: None

<u>Tetrachlorvinphos</u>
Chemical Class: Organophosphate

- **Formulation**: 50% WP
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 2 lb./25 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

- **Formulation**: 50% WP
  Type of Application: Residual surface dust
  Dilution/Rate: RTU; apply 2.5 oz./100 sq. ft.
  Restrictions: None

<u>Tetrachlorvinphos + Dichlorvos</u>
Chemical Class: Organophosphate

- **Formulation**: 28.7% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 gal./50 gal. water; apply 1 gal. spray/100 birds
  Restrictions: None

<u>Malathion</u>
Chemical Class: Organophosphate

- **Formulation**: 57% EC
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 1 oz./gal. water; apply 1 gal. spray/100-150 birds
  Restrictions: None

- **Formulation**: 5% D
  Type of Application: Direct dust (bird treatment)
  Dilution/Rate: RTU; apply 1 lb./100 birds

Restrictions: None

- **Formulation**: 5% D
  Type of Application: Residual surface dust treatment
  Dilution/Rate: RTU; apply 1 lb./50-60 sq. ft.
  Restrictions: None

Carbaryl
Chemical Class: Carbamate

- **Formulation**: 41.2% Suspension
  Type of Application: Residual surface spray
  Dilution/Rate: 4 qt./100 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 43% F
  Type of Application: Residual surface spray
  Dilution/Rate: 4 qt./100 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 80% SP
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 4 oz./5 gal. water; apply 1 gal. spray/100 birds
  Restrictions: 7-day slaughter interval

- **Formulation**: 80% SP
  Type of Application: Direct mist (bird treatment)
  Dilution/Rate: 6 oz./gal. water; mist 1.5 gal./1,000 birds
  Restrictions: 7-day slaughter interval

- **Formulation**: 80% SP
  Type of Application: Residual surface spray
  Dilution/Rate: 5 lb./100 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 50% WP
  Type of Application: Direct spray (bird treatment)
  Dilution/Rate: 6 oz./5 gal. water; apply 1 gal. spray/100 birds
  Restrictions: 7-day slaughter interval

- **Formulation**: 50% WP
  Type of Application: Direct mist (bird treatment)

Dilution/Rate: 10 oz./gal. water; mist 1.5 gal./1,000 birds
Restrictions: 7-day slaughter interval

- **Formulation**: 50% WP
  Type of Application: Residual surface spray
  Dilution/Rate: 2 lb./25 gal. water; apply 1-2 gal. spray/1,000 sq. ft.
  Restrictions: 7-day slaughter interval

- **Formulation**: 5% D
  Type of Application: Direct dust (bird treatment)
  Dilution/Rate: RTU; apply 1 lb./100 birds
  Restrictions: 7-day slaughter interval

Cultural Control:
The same cultural control practices previously discussed for Northern fowl mites can also be used to prevent the establishment of lice problems in caged layer facilities.

Biological Control:
No natural enemies have been identified and no biological control measures are commercially available for the management of lice in caged layer facilities.

Contacts

Iowa State University:
Ken H. Holscher, extension entomologist
Jerry L. Sell, extension poultry scientist
Darrell W. Trampel, extension veterinarian
Sorrel Brown, PIAP state liaison for Iowa

Iowa Egg Council:
Iowa Agricultural Statistics Service

North Central Region Contacts:

Illinois
Dr. Richard A. Weinzierl
Department of Crop Sciences

University of Illinois
Urbana, IL 61801
Phone: 217-333-6651
Fax: 217-333-5245
e-mail: weinzier@uiuc.edu

Indiana

Dr. Ralph E. Williams
Department of Entomology
Purdue University
West Lafayette, IN 47907-1158
Phone: 765-494-4560
Fax: 765-494-2152
e-mail: ralph_williams@entm.purdue.edu

Iowa

Dr. Ken H. Holscher
Department of Entomology
Iowa State University
Ames, IA 50011-3140
Phone: 515-294-5967
Fax: 515-294-8027
e-mail: kholsche@iastate.edu

Kansas

Dr. Donald E. Mock
Department of Entomology
Kansas State University
Manhattan, KS 66506
Phone: 785-532-4749
Fax: 785-532-6258
e-mail: dmock@oz.oznet.ksu.edu

Michigan

Dr. Edward Walker
Department of Entomology
Michigan State University
East Lansing, MI 48824
Phone: 517-432-2366
Fax: 517-353-4354
e-mail: walker@msu.edu

Minnesota
Dr. Roger Moon
Department of Entomology
University of Minnesota
St. Paul, MN 55108
Phone: 612-624-2209
Fax: 612-625-5299
e-mail: rdmoon@tc.umn.edu

Missouri
Dr. Robert D. Hall
Department of Entomology
University of Missouri
Columbia, MO 65211
Phone: 573-882-8254
Fax: 573-882-1469
e-mail: hallr@missouri.edu

Nebraska
Dr. John B. Campbell
Department of Entomology
West Central Center
University of Nebraska
North Platte, NE 69101-9495
Phone: 308-532-3611
Fax: 308-532-3823
e-mail: wcrc007@unlvm.unl.edu

North Dakota
Dr. Phillip A. Glogoza
Department of Entomology
North Dakota State University
Fargo, ND 58105
Phone: 701-231-7581
Fax: 701-231-8557
e-mail: pglogoza@ndsuext.nodak.edu

Ohio
There are no individuals at Ohio State University presently responsible for Livestock/Poultry Pest Management

South Dakota

Dr. Michael A. Catangui
Department of Plant Science
South Dakota State University
Brookings, SD 57007
Phone: 605-688-4597
Fax: 605-688-4602
e-mail: michael_catangui@sdstate.edu

Wisconsin

Mr. Phillip J. Pellitteri
Department of Entomology
University of Wisconsin
Madison, WI 53706
Phone: 608-262-6510
Fax: 608-262-3322
e-mail: pellitte@entomology.wisc.edu

Acknowledgements:
We would like to thank and acknowledge Dr. Ralph Williams, Purdue University; Dr. Roger Moon, University of Minnesota; and Dr. John B. Campbell, University of Nebraska for their helpful and insightful review of this profile.
