SARE Project AS92-1

# DRAFT

Outline and Executive Summary

## Poultry Litter: Potential Threats to Wildlife

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## EXECUTIVE SUMMARY

Poultry litter is an excellent organic fertilizer for Arkansas rice, but should be handled, transported, and applied to fields in a manner and time to minimize some small but significant risks to waterfowl. Litter has been transported comparable distances for cattle feeding and crop fertilization in the Delmarva Peninsula (comparable poultry density, manure quality, wild waterfowl population density) with very few observed problems.

The biological risks of litter provided to waterfowl will be somewhat difficult to ascertain since the pathogens are ubiquitous and endemic in waterfowl and their environment. Toxic metals occur in litter, but also in fertilizers and other soil amendments. By far, the greatest disease risks of the litter transport system will be from waterfowl to domestic poultry. Cleaning and disinfecting vehicles, tires and driver's clothing is essential, particularly if trucks carry new bedding (rice hulls, wood shavings) on their return.

The most severe bacterial risks to waterfowl are chronic salmonellosis, Fowl Cholera, and botulism; the latter two can kill thousands of ducks overnight. The first two may be readily minimized by choosing sources where litter was quite deep in poultry houses; was produced by broilers instead of older turkey or broiler breeders (disease carriers); and was composted or at least deep-stacked. The pathogens are susceptible to sunlight, ammonia, heating, and most common disinfectants. Field application of litter should occur when waterfowl are absent and allow 24 to 48 hours of exposure to sunlight followed by soil incorporation. Type C Clostridium botulinum, the causative agent of botulism, is an anaerobe; forms one of the most toxic substances known to man (botulinum toxin); and reproduces by spores that are extremely resistant to temperature extremes, acids and disinfectants. C. Botulinum lives in dead animal carcasses and rotting vegetation (Decomposing rice stubble?). No dead bird compost or litter showing bird carcasses or large numbers of darkling beetles (intermediate host of clostridia) should be transported to waterfowl areas.

The most severe viral disease risks are Newcastle Disease (ND), avian influenza (AI) and infectious bursal disease (IBD). The ND and AI viruses can be killed with most disinfectants, light and heat. The problems with them are their prevalence in waterfowl, rate of spread, numbers of virus in feces, and the constant mutation of the viruses into new lethal (velogenic) strains. For AI the rate of mutation exceeds the rate of vaccine production. Hence, control of lethal AI strains is by test and slaughter of afflicted domestic flocks, thus generating tremendous economic losses. ND virus from vaccinated domestic poultry may infect waterfowl and mutate unfavorably. IBD transmission to turkeys or waterfowl is infrequent but increasing. Immunosuppression follows and predisposes infected birds to many other diseases. The IBD virus is extremely stable and resistant to decontamination. Domestic poultry are protected from IBD with a live vaccine. Breeders are vaccinated multiple times. Breeder and turkey litter should be avoided. IBD is destroyed by composting.

Mycotic or Fungal diseases per se are a minimal risk. However, the toxic metabolites produced by molds on feed grains and in litter are extremely toxic. Waterfowl are very susceptible to mycotoxins; domestic ducklings are often used as sentinel birds and in bioassays to detect mycotoxins. Toxins excreted by domestic poultry into feces appear as conjugated forms that escape detection by inexpensive, rapid test kits. Several fungi can grow and produce toxins in litter. The main risk is for domestic interfarm transport of fungal spores via shipping of clean bedding. Moldy litter should be rejected.

Pesticides and dewormers may reside in litter from pullet, turkey and breeder operations. Liquid manure from layers often contains insecticides that can be persistent in the environment if misapplied. The wormer piperazine is harmful to ducks. The insecticide cyromazine is structurally similar to triazine herbicides that kill rice. Layer manure, breeder/pullet litter and litter known to have been treated should be avoided.

The control of the intestinal parasites known as the coccidia and Histomonas meleagridis is essential for confinement rearing of broilers and turkeys. Many drugs are available for this and may appear as residues in raw litter. Treatment of bacterial diseases also generates drug residues. Furazolidone, maduramicin, sulfaquinoxaline, halofuginone, arprinocid, dimetridazoles, Ipronidazole, sulfadimethoxine-ormetoprim, Nicarbazin, nitrofurazone, virginiamycin and organic arsenicals have been reported to be toxic to waterfowl at less than recommended therapeutic levels for domestic poultry. Other compounds show waterfowl toxicity if ingested at levels 2 to 5 times recommendations for domestic avians. Incompatible drugs may appear in litter if subsequent flocks are medicated differently.

Many mineral elements are found in poultry litter. Levels of specific elements will vary as a function of management practices for domestic flocks. Litter can contain levels of Cu, As, Cd, Mg, and B sufficient to cause problems within a short time if ingested by wild waterfowl. After years of litter usage, Cu, Se, B, As, Zn, and Cd may buildup in soil, crops and floodwaters. This buildup 1) allows invertebrates to bioaccumulate elements to levels toxic for waterfowl; 2) produces phytotoxicity of crops and plants essential for the aquatic habitat of ducks and geese.

Using only broiler litter will decrease disease vectors. A survey of feed and water medication usage by poultry firms will identify litter containing fewer drug residues, pathogens, and minerals. Deep-stacked and/or composted litter will be virtually free of pathogens, mycotoxins, and residues. Direct ingestion of litter by waterfowl should be prevented. Thorough cleaning and disinfecting of transport trucks will minimize diseases.

Thus, poultry litter fertilizer can be used to advantage by Arkansas rice farms provided it is selected, handled and applied properly.

LISTED BELOW ARE THE DISINFECTANTS APPROVED FOR AVIAN INFLUENZA:

BIOGARD K185 - Biolabs, Inc., Decatur, Georgia 404-378-1753

TEXTROL - Biotex Industries, Inc., 1212 Menlo Dr., Atlanta, Georgia 404-351-7048

* ONE STOKE ENVIORION - Vestal Labs, New Jersey - 201-351-0251

BACTOPHENE - Auxford Chemicals, Inc., Atlanta, Georgia - 404-452-1100

LIBFLEX - 1 Whiz Chemicals, Bale, Pennsylvania - 215-825-3555

DHV/khg 2/13/84

* Recommended by Arkansas State Veterinarian as best overall disinfectant.

From: AR Diagnostic Laboratory
of The Livestock and Poultry Commission
Springdale Laboratory
3405 N. Thompson
Springdale, AR 72764
TEL: (501) 751-4869
FAX: (501) 751-0358

Table 8. EPA Approved Insecticides Used in Egg and Poultry Production. (Condensed from: Nolan, M. P. 1989 Insecticide Use Chart for Egg and Poultry Producers OSU Coop Ext Service Circ. 805)

| Insecticide Generic/(Trade R ) Name | Mode of Use On Birds | On Litter | Fly Control |
|---|---|---|---|
| Bomyl (True Grit Blue) | No | No | Bait Only |
| Carbaryl (Sevin) | Yes | Yes | Yes |
| Chlorfenvinphos (Birlane, Cmpd. 4072, Supona) | No | No | Under Layer Cages Only |
| Chlorpyrifos (Dursban, Lorsban) | No | Turkey Range Only | Paint on Only |
| Cyromazine (Larvadex) | No | No | Feed Thru Layers Only |
| Dichlorvos (DDVP, Vapona) | Yes | Yes | Yes |
| Dimethoate (Cygon, Defend, Rebelate) | No | No | Under Layer Cages Only |
| Disodium Octaborate Tetrahydrate (Red Zone Darkling Beetle Control) | No | Soil & Wall Treatment Only | No |
| Erythrosine B (Synerid Bait) | No | No | Bait Only |
| Fenthion (Baytex, Entex, Tiguvon) | No | No | Yes |
| Malathion (Cythion) | Yes | Yes | Yes |
| Methomyl (Lannate, Nudrin) | No | No | Bait Only |
| Naled (Dibrom) | Yes | Yes | Yes |
| Nicotine Sulfate (Blackleaf40) | Yes | Yes | No |
| Orthoboric Acid (Safecide) | No | Soil & Wall Treatment Only | No |
| Permethrin (Ambush, Atroban, Ectiban, Fenvalerate, Permaban, Pramex, Pounce) | Yes | Yes | Yes |
| Pyrethrins, Pyrethrums | Yes | Yes | Yes |
| Tetrachlorvinphos or Stirofos (Rabon) | Yes | Yes | Yes |

Table #. Insecticide Residues. Review of the Merck Index and Fish & Wildlife Service Reports and Others on the Uses and Lethal Doses of EPA Approved Insecticides that Could Reside in Litter.

| Insecticide<br><br>Generic Name | Uses | Lethal Doses<br>Route; Species;<br>$LD_{50}$ (mg/kgBW) | US Fish and Wildlife Serv Contaminant Hazard Rev.#* |
|---|---|---|---|
| Carbofuran** | Used in Rice Production.<br>Insecticide, Nematocide, Acaricide | NOT USED in Poultry Prod.<br>Compare lethal doses.<br>Oral; Mice; 2 | 85(1.3) |
| Bomyl | Insecticide | Oral; Rat; 32 | No |
| Carbaryl | Contact Insecticide | Oral; Rat; 250 | No |
| Chlor-fenvinphos | Insecticide | Acutely toxic to fish.<br>Oral; Rat; 9.66 | No |
| Chlorpyrifos | Insecticide, Acaricide | Oral; Rat; 145 | 85(1.13) |
| Cyromazine | Insect growth regulator Insecticide, Ectoparasiticide | Phytotoxic to Rice?<br>(Very similar to Triazine Herbicides) | 85(1.18) |
| Dichlorvos | Insecticide, Antihelmintic | Oral; Rat female; 56 | No |
| Dimethoate | Systemic & Contact Insecticide | Toxic to Ducks ***<br>Oral; Rat; 250 | No |
| Disodium Octaborate Tetranydrate | Darkling Beetle Control | Oral; Duck female;<br>Embryotoxic<br>~300 mg/kg FW**** | 85(1.20) |
| Erythrosine B | Fly Bait | (FDA Food Color FD&C #3)<br>Oral; Rat; 2258 | No |
| Fenthion | Ectoparasiticide | Oral; Rat male; 215 | No |
| Malathion | Insecticide, Pediculicide Ectoparasiticide | Oral, Rat female; 1000 | No |
| Methomyl | Insecticide | Oral; Rat male; 17 | No |
| Naled | Insecticide, Acaricide | Oral; Rat; 250<br>Dermal; Rat; 800 | No |
| Nicotine Sulfate | Insecticide, Fumigant, Ectoparasiticide, Antihelmintic | (Highly Toxic)<br>Oral; Mice; 230 | No |

| | | | |
|---|---|---|---|
| Orthoboric Acid | Darkling Beetle Control | Oral; Duck female; Embryotoxic ~300 mg/kgFW**** | 85(1.20) |
| Permethrin | Insecticide | "Supertoxic" to aquatic arthropods. Oral; Quail; >4000 Oral; Rat female; 3800 | 2(24) |
| Pyrethrins, -chrums | Natural Insecticide, Scabicide, Ectoparasiticide | Destroyed by Sunlight Oral; Rat; >1200 | No |
| Tetrachlor-vinphos or Stirofos | Insecticide | Oral; Rat; 1100 | No |

* For in-depth wildlife toxicity data for ducks and aquatic systems.

** Listed for comparison to products approved for use in poultry. Carbofuran is much more toxic and is sprayed directly on rice in paddies that attract migratory waterfowl.

*** M. P. Nolan personal communication.

**** FW = Fresh weight of substances eaten.

Table. Mineral Tolerances of Avian and Related Animals. (Adapted from NRC80, 77, 84 and Other Sources.)

| Element | Class of Animals | Age or wt | Element Quantity (ppm) | Element Source | Duration | Route | Effects | Reference |
|---|---|---|---|---|---|---|---|---|
| Al | Chicken | 1 da | 500 | $AlCl_3$ | unknown | Diet | ↓Bone Ash | Storer & Nelson 1968 |
| | | | 1000 | $Al_2(SO_4)_3$ | | Diet | ↑Mortality | |
| Sb | Chick | 1 wk | 24 mg/l | $SbH_3$ (gas) | unknown | Air | Hemolysis ↑Mortality | Steele et. al. 1944 |
| As | Duck | 1130g | 345 | Arsanilic acid | Single dose | Diet | Max. single dose tolerated | Frost et. al. 1955 |
| Ba | Chicken | Young | 218 | $BaCO_3$ or | unknown | Diet | ↓Gain | Tsucins et. al. 1969 |
| | Chicken | Young | 1390 | $BaCl_2$ | | | ↑Mortality | |
| B | Chicken | Embryo | ≈25 | $Na_2B_4O_7 \cdot 4H_2O$ | 21 d | Egg Conc. | ↑Mortality | Lee 1989 |
| | | Hen | 300 | " " | Chronic | Diet | ↓Hatch | Lee & Emmel 1990 |
| Br | Chick | 1 d | ≥5000 | NaBr | 28 d | Diet | ↓Gain | Doberens et. al. 1965 |
| | | | ≤20000 | | | | ↑Mortality | |
| Cd | Hen | Adult | 3 | $CdSO_4$ | unknown | Diet | ↓Egg Prod. | Leach et. al. 1979 |
| | Quail | 1 d | 75 | $CdCl_2$ | 28 d | Diet | ↑Mortality | Jacobs et. al. 1969 |
| Ca | Chicken Duck | ≤8 wks | ≥2.5% | $CaCO_3$ | weeks | Diet | ? Rickets ↓Blood P | Many ? varied |
| Cr | Chick | Young | ≥2000 | $CrCl_3$ | 21 d | Diet | ↓Gain | Hill & Matrone 1970 |
| Co | Chick | Young | ≥10≤50 | unknown | unknown | Diet | ↑Mortality ↓Gain | Turk & Kratzer 1960 |
| | | | 200 | $CoCl_2 \cdot 6H_2O$ | | Diet | | Hill 1974 |
| Cu | Duck | 3 d | 100 | $CuSO_4 \cdot 5H_2O$ | 3 wk | Diet | ↑Growth | King 1975 |
| | Crayfish | ? | 60 ug/l | " " | Chronic | $H_2O$ | Death | Hubschman '67 |
| | Minnows | ? | >118 ug/l | " " | " " | $H_2O$ | Death | Brungs et. al. 1976 |
| | T. Geese | Adult | 100 | " " | Winter | Pond $H_2O$ | Necrotic Gizzards | Henderson & Winterfield 1975 |
| | Chicken | Young | >324 1270 | $CuSO_4 \cdot 5H_2O$ " " | 4 wk 4 wk | Diet " | M. Dys. ↑Mortality | Mayo et. al. 1956 |
| F | Chicken | Young | 750 ppm | Phosphate Rock | unknown | Diet | ↓Gain | Kick et. al. 1933 |

Table 4. Mineral Tolerances of Avian and Related Animals. (Adapted from NRC80, 77, 84 and Other Sources.)

| Element | Class of Animals | Age or wt | Element Quantity (ppm) | Element Source | Duration | Route | Effects | Reference |
|---|---|---|---|---|---|---|---|---|
| I | Chicken | 27 wk | >625 ppm | KI | 6 wk | Diet | ↓ Egg Prod ↓ Hatch | Arrington et. al 1967 |
| Fe | Chicken | 1 d | >400 & <1600 | $FeSO_4 \cdot 7H_2O$ | 28 d | Diet | Rickets & ↓Gain | McGhee et. al. 1965 |
| | Turkey | 1 wk | 440 | $Fe_2(SO_4)_3$ | 12 wk | Diet | ↓Bone Ash | Woerpel & Balloun 1964 |
| Pb | Ducks | mature | >6mg/kgBW | $Pb(NO_3)_2$ | 24-41 d | Diet | Death | Coburn et. al. 1951 |
| | Chickens | 4 wk | >100 & <1000 | Pb acetate | 28 d | Diet | ↓Gain | Damron et. al. 1969 |
| | Geese | ? | ? | Pb shot | ? | Diet | Death & ↓Hatch | Cook & Trainer 1966 |
| Mg | Chicks | 1 d | >0.3% | MgO | 4 wk | Diet | Rickets & Death | Lee & Britton '90 |
| | Chickens | 1 d | >0.64% | $MgCO_3$ | 4 wk | Diet | Death & ↓Gain | Nugara & Edwards '63 |
| Mn | Turkey | Young | 4800 | $MnSO_4 \cdot H_2O$ | 21 d | Diet | ↓Gain | Vohra & Kratzer '68 |
| Hg | Duck | 5d | 3.3 | Methyl Mercuric dicyandiamide | 35 d | Diet | No Effect | Gardiner 1972 |
| | | | 33 | | | | $LD_{90}$ | |
| Mo | Chicken | Young | 200-300 | $Na_2MoO_4$ | unknown | Diet | ↓Gain | Davies et. al. 1960 |
| | | | 6000 | $(NH_4)_2MoO_4$ | | | $LD_{33.3}$ | |
| Ni | Chick | 1 d | 300 | Ni Sulfate | 4 wk | Diet | ↓Gain | Weber & Reid 1968 |
| | | | 1300 | Ni Acetate | | | ↓Gain | |
| P | Chick | 1 d | 1.6% - 2.0% | $(NH_4)H_2PO_4$ | 21 d | Diet | Rickets & Death | McGillivary & Smidt 1974 |
| Se | Chicken Duck Hen | Adult | 10 | Se Methionine | unknown | Diet | Embryo-toxic Deformity | Moxon 1937 |
| Si | - | - | - | Fibrous Silicates | - | - | Ascites | Anecdotal |
| Ag | Chick | 1 d | 200 | $Ag_2SO_4$ | 21 d | Diet | ↑Mortality | Hill et. al. 1964 |
| | Turkey | 1 d | 300-900 | $AgNO_3$ | 35 d | Diet | Enlarged Heart Gizzard Dystrophy | Jensen et. al. 1974 |
| NaCl | Duck | young | 3.4% | NaCl | 21 d | $H_2O$ | ↓F. Intake ↓Gain | Krista et. al. 136 |
| | Duck | 1 d | 1.0% | | | $H_2O$ | ↑Mortality | |

Table 5. Mineral Tolerances of Avian and Related Animals. (Adapted from NRC80, 77, 84 and Other Sources.)

| Element | Class of Animals | Age or wt | Element Quantity (ppm) | Element Source | Duration | Route | Effects | Reference |
|---|---|---|---|---|---|---|---|---|
| Sr | Chick | 1 d | 6000 | $SrCO_3$ | 4 wk | Diet | ↓Tibia Ash ↓ Gain | Weber et. al. 1968 |
| | Hens | 6 mo | 50,000 | $SrCO_3$ | 4 wk | | ↓Egg Prod. | Doberens et. al. 1967 |
| S | Chick | 8-21 d | 185 | $K_2SO_4$ | 7 wk | Diet | ↓Gain ↓ Feed Eff | Sasse & Baker 1974 |
| Sn | Chicken | Adult | 35 | Triethyl Tin Hydroxide | 15 wk | Diet | Anorexia | Stoner et. al. 1955 |
| W | Chick | 1 d | 45 | $Na_2WO_4$ | 35 d | Low Mo Diet | ↓Gain ↑Mortality | Higgins et. al. 1954 |
| V | Chick | Young | 25 | $NH_4VO_3$ | 34 d | Diet | ↓Ox-Phos | Hathcock et. al. 1966 |
| | Duck | 1 yr | 10-100 | $VOSO_4$ | | Diet | ↑Tissue & Brain [] | White & Dieter 1978 |
| | Hen | Adult | 15 | $NH_4VO_3$ | 38 d | Diet | ↓Albumin Quality | Berg 1963 |
| | Chick | Young | 2000 | $ZnSO_4$ | unknown | Diet <0.5 ppm Se | Exudative Diathesis ↓Se | Jensen 1975 |
| | Duck | 1 wk | 3000 | $ZnCO_3$ | 60 d | Diet | Anorexia ↓Reproduct Paralysis | Gasaway & Buss 1972 |
| $NO_3$ | Turkey | Young | ~200 (N) 900 ($NO_3$) | $NaNO_3$ | - | $H_2O$ | ↓Gain ↑Mortality | Adams et. al. 1967 |
| $NO_2$ | Chick | Young | 658 (N) 2162 ($NO_2$) | $KNO_2$ | - | Diet | ↓Vit A liver Enlarge Thyroid | Bell & Roberts 1963 |
| | Chick | Young | 365 (N) 1200 ($NO_2$) | $NaNO_2$ | - | $H_2O$ | | |