Texas A&M University Agricultural Research and Extension Center at Amarillo

Title: "Cattle Feedlot Odor and Dust Control: Approaches and Recent Results"

Authors: B. W. Auvermann, J. Koziel, D. B. Parker, S. Amosson, L. W. Greene, N. B. Chirase, N. A. Cole, C. B. Parnell, and J. M. Sweeten

- Abstract -

An agricultural engineering, animal science, veterinary, and agricultural economics team in the Amarillo area is developing approaches for air quality management for open-lot beef confinement systems. Open unsurfaced cattle feedyards in the Southern Great Plains can produce odor of high concentration and offensiveness when manure is wet (above 60% wet basis) (Watts et al., 1994, and Sweeten, 2000). Conversely, feedyards can produce organic dust (particulate matter, PM) at relatively high concentrations on an intermittent, diurnal basis when the manure is dry (below 25% wet basis). Basic approaches to mitigate both odor and dust events include: (a) frequent manure harvesting from feedpens, and (b) management of surface moisture content (Sweeten, 2000). Frequent removal of surface manure during the cattle feeding cycle (typically 120-150 days) with precision manure harvesting equipment will help control dust events by minimizing pulverization and entrainment of fine dry manure by cattle hooves with ensuing dust emissions in evening hours (Auvermann et al, 2000). Likewise, maintaining uniform pen drainage with relatively low manure inventories will reduce saturation, minimize prolonged mud problems, and speed surface drying after precipitation (Watts et al., 1994).

Management of surface moisture content also includes potential for adjusting the stocking rate to either increase or decrease effective moisture excretion per unit area from the excreted fresh feces and urine (normally about 6 gal./day/1,000 lbs liveweight moisture) (Sweeten and Lott, 1994). Romanillos and Auvermann (1999) showed a 20% reduction in dust emissions from feedpens where stocking rate was reduced from 150 ft^2/hd to only 75 ft^2/hd. Tradeoffs included equal or slightly reduced cattle rates of gain.

Water applications to pen surfaces can supplement frequent manure collection and stocking rate adjustments for dust control for dry weather conditions (Sweeten and Lott, 1994). The use of sub-

Presented at the Annual Meeting of the American Agricultural Economists Association, Chicago, IL. August 6-9, 2001.

regional or on-site weather data may be useful in the future to guide water application decisions where the feedlot is equipped with sprinklers or mobile tankers.

Multidisciplinary research at Bushland, Amarillo, and Canyon, Texas, has reduced ammonia emissions from simulated feedlot pads by up to 80% with alum treatment vs. control treatment (Shi et al, 1999); quantified endotoxin concentrations in feedlot dust; identified biological markers of oxidative stress in arriving feedlot cattle exposed to dust; determined that antibiotic protection in dust-exposed ruminant animals can increase average daily gains by 54% vs. unprotected animals; and determined 18% lower disease protection as indicated by total antioxidant capacity of blood in calves exposed to feedlot dust (Chirase, 2001).

Dust and odor approaches may alter the design and management of conventional cattle feedyards, and each approach has cost/return factors associated with them.

References Cited

Auvermann, B.W., D.B. Parker, and J.M. Sweeten. 2000. Manure Harvesting: The Key to Feedyard Dust Control in a Summer Drought. E-52, Texas Agricultural Extension Service, Texas A&M University System, Amarillo, TX. 4 p.

Chirase, N.B. 2001. Personal Communication. Texas Agricultural Experiment Station, Texas A&M University Agricultural Research and Extension Center, Amarillo, TX. July.

Romanillos, A. and B.W. Auvermann. 1999. Effect of Stocking Density on Fugitive PM^{10} Emissions from a Cattle Feedyard. Paper No. 99-4192, ASAE/CSAE International Meeting. Toronto, Canada. July 18-21. 11 p.

Shi, Y., D.B. Parker, N.A. Cole, B.W. Auvermann, and L.W. Greene. 1999. Soil Amendments for Minimizing Ammonia Emissions from Feedyard Surfaces. Paper #99-4083, presented at 1999 ASAE/CSAE Annual International Meeting. Toronto, Ontario, Canada. July 18-21. 8 p.

Sweeten, J.M., C.B. Parnell, B.W. Auvermann, B.S. Shaw, and R.E. Lacey. 2000. Livestock Feedlots, Food, and Agricultural Industry. Air Pollution Engineering Manual (2nd edition, W. Davis, ed). John Wiley & Sons, Inc., New York, New York. pp. 488-496.

Sweeten, J.M. 2000. Manure and Wastewater Management for Cattle Feedlots. Review of Environmental Contamination and Toxicology. (D.P. Morgan, ed.) 167:121-153.

Sweeten, J.M. and S.C. Lott. 1994. Dust Management. In: P.J. Watts and R. Tucker, eds., Designing Better Feedlots, Queensland Department of Primary Industries. Toowoomba, Queensland, Australia. pp. 6.23-6.30.

Watts, P.J., M. Jones, S.C. Lott, R.W. Tucker, and R.J. Smith. 1994. Feedlot Odor Emissions Following Heavy Rainfall. Transactions of the American Society of Agricultural Engineers. 37(2):629-636.

Integrating Interdisciplinary Analyses, Multiple Decision Levels and Equitable Allocation into the TMDL Process:

"The Role of Agricultural Economists?"

Verel W. Benson

Total Maximum Daily Load (TMDL) Process

1.) Identifies the amount of various pollutants that can be assimilated by an impaired stream or water body and meet the quality standards for its planned use

2.) Determines the current pollutant load and likely source

3.) Allocates the allowable pollutant loads and future loads to the various sources

TMDL Analyses are often Interdisciplinary

The first of 5 studies discussed today is

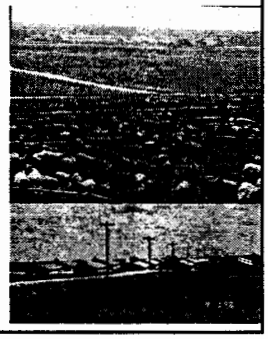
"Cattle Feedlot Odor and Dust Control: Approaches and Recent Results"

B. W. Auvermann, J. Koziel, D. B. Parker, C. B. Parnell, S. Amosson, L. W. Greene, B. Weinheimer, N.A. Cole, and J. M. Sweeten,
Texas A&M Research and Extension Center- Amarillo

Animal Production & Air Quality

Parameters—

- Odor
- Odorants (odorous gases)
- VOCs
- Particulate matter (PM)/ "dust"
- Greenhouse gases



Animal Production & Air Quality
-- Odor Control --

- **Technologies/Approaches**
  - Ration/diet manipulation.
  - Manure treatment/handling.
  - Capture/treatment of emitted gases.
  - Enhanced dispersion.

Animal Production & Air Quality

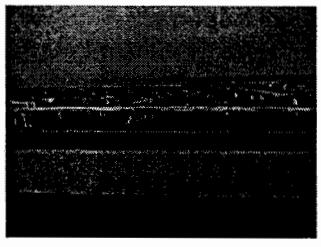
Dust Control Approaches

- Frequent manure harvesting.
- Stocking density adjustment, seasonal.
- Surface treatment
  - Water sprinkling.
  - Oil spray (confinement buildings).
  - Mulching, wetting or binding agents.
- Animal behavior
  - Feeding schedules (?)

Air Quality
Selected Accomplishments--TAMU

- Improved PM_{10} emission factors for feedyards through field research
  - ♦ reduced by 80%.
  - ♦ from 70 down to 15 lbs/1000 hd/day.
  - ♦ 300 tons/yr less PM_{10} emissions.
  - ♦ Emission fees at $35/ton.
  - ♦ potential $10,000/yr/feedyard savings (ave.), emission fees.
- More accurate dispersion model for feedyards (area source).

Animal Production & Air Quality

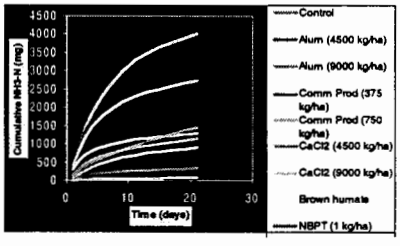


- Reduced dust emissions by frequent manure scraping (~50%) and increased stocking density (~20%).
- Reduced TSP 25-50% with pilot water curtain.

Air Quality and Feeder Cattle Health
ARS/TAMU/WTAMU

- ♦ Quantified endotoxin concentrations in manure dust.
- ♦ Identified two biological markers of oxidative stress in cattle subjected to transportation + dust stressors.
- ♦ Antibiotic protection of dust-exposed calves increased ADG 54% vs. unprotected calves.

Air Quality Selected Accomplishments
ARS/TAMU/WTAMU



- Reduced ammonia emissions from feedyard manure by 80%, chemical treatment (*in vitro*) with Alum vs. control.

Guidelines for Sprinkler Design and Use

- Capacity should be 0.25-0.5"/day
- Exclude region near feed bunk
- H_2O demand proportional to manure depth
- Large droplets: less drift, greater compaction
- Holding pond effluent: untested; definitely useful for roads; *understand contingencies*
- Prioritize areas: where is water needed most?

Take-Home Messages

- Applying water to the feedyard surface, either passively or actively, is not a cure-all
- Frequent manure harvesting (>1 per turn) will decrease water requirements and increase water effectiveness
- Use the off-season to get ready
- Prioritize within the yard *and* the corral

Manure Harvesting Frequency: The Feedyard Manager's #1 Tool for Dust Control During a Summer Drought

Auvermann, B. W., D. B. Parker and J. M. Sweeten

TAEX Electronic Publication E-52

URL:

texaserc.tamu.edu/catalog/topics/Natural_Resources.html

Solutions May Involve Multiple Marketing Decision Levels

The second of 5 studies discussed today is

"Practical Aspects of Manure Marketing"

H. L. Goodwin
University of Arkansas

Jim Wimberly
Foundation for Organic Resources Management

Increased Regulatory / Social Pressures on the Environment

- Water quality impacts with traditional use
- Need to pursue environmentally sound alternatives
  - ➢ on-/near-farm: economically OK, environmentally not
  - ➢ off-farm: environmentally OK, economically not
- Off-farm management options
  - ➢ centrally coordinated enterprises
  - ➢ value-added manufacturing (VAM) & sales

Poultry Litter Marketing Channels

Raw Litter Production ⇨ Currently in abundance

Assembly / Aggregation ⇨ Informal/local (THE KEY)

Value-added Manufacturing / Processing ⇨ Available

Wholesaling / Brokering ⇨ Can be developed

Retailing ⇨ Can be developed

Consumption (End-User) ⇨ Needs better identification

Today's Situation Regarding Aggregation

- Existing clean-out contractors…
  - ➢ provide raw litter management services
  - ➢ relatively small, local
  - ➢ simple infrastructure
  - ➢ independent
  - ➢ not focused on alternative / distant markets
  - ➢ financially constrained

Current Market Constraints on Effective Manure Usage

- ➢ Competition from other, more convenient nutrient sources
- ➢ Inaccurate market valuation of manure as a resource
- ➢ Inadequate infrastructure necessary to export large quantities of litter at distances exceeding 10 – 20 miles
- ➢ Overall negative market sentiment toward using manure as a soil amendment
- ➢ Variable manure quality (nutrient content, moisture, etc.)
- ➢ Seasonal variation in demand for manure
- ➢ Burdensome regulatory/record-keeping requirements

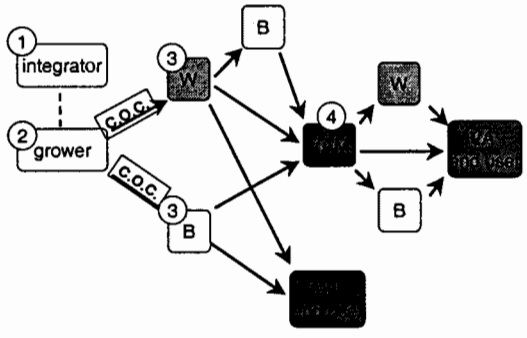
Need for a Third Party Enterprise

- Existing industry structure not conducive
- Need for an entity with primary litter management as purpose
  - ➢ Handles litter after it is removed from houses
  - ➢ Not involved in poultry production
  - ➢ No geographical or political boundaries
  - ➢ Litter handling responsibilities (& liabilities) removed from industry participants

Roles of a Litter Bank

- Coordinate and Aggregate Raw Materials
- Coordinate (or perform) downstream contracting
  - ➢ Handlers
  - ➢ Transporters
  - ➢ Manufacturers
  - ➢ End Users
- Optional services
  - ➢ Nutrient management plans
  - ➢ Certified transport / application (raw / processed)

Off-farm Litter Management



Potential Structural Options

- Electronic Structure
  - Matching buyers and sellers of litter
  - Coordinating timing of house clean-out
  - Coordinating litter handling/hauling to :
    - end-users
    - storage facilities
    - Value Added Mfgs
- Physical Structure
  - House clean-out and hauling away from houses
  - Operating litter transfer stations
  - Litter warehousing prior to delivery
  - Litter delivery to Value Added Mfgs or end-users
  - Owning / operating Value Added Mfg facilities

Equitable Allocation Requires Economic & Environmental Assessment

The third of 5 studies discussed today is

"Economic and Environmental Impacts of Utilizing Feedlot Manure Integrated with Conservation Tillage in Irrigated Agriculture, Texas High Plains"

Erda Wang and *Wyatte Harman*
Texas A&M, Blackland Research and Ext. Center- Temple

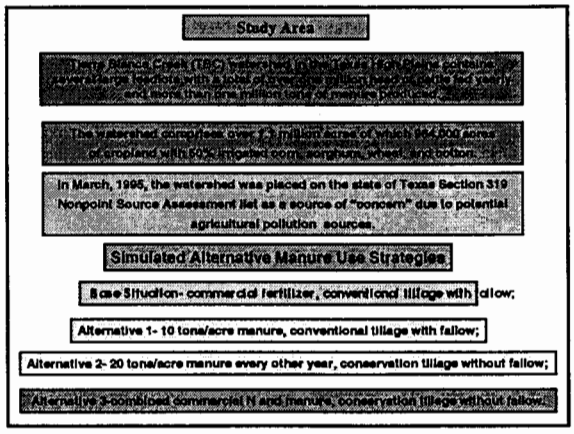
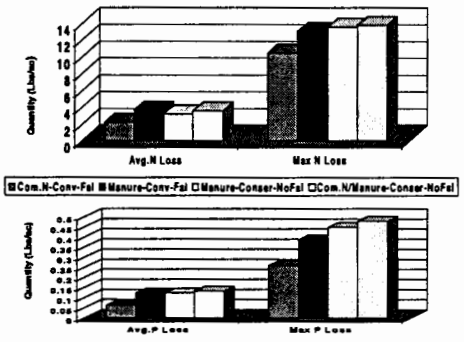
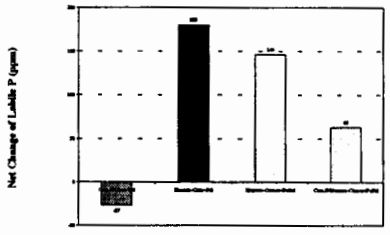


Figure 1. Yearly Average and Total Maximum N and P Losses over 96 Years



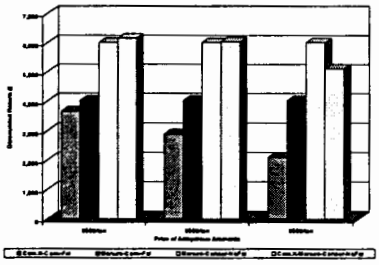
- Manure applications resulted in higher N and P losses than the Base, commercial fertilizer.
- Yearly maximum N and P losses were about four times the average losses.
- Conservation tillage, w/o fallow had little impact on average losses but increased maximum P.

Figure 2. Change in P Concentration between Year 1 and Year 96, Top 2 Inches of Soil



Impacts:
- Balancing commercial fertilizer with crop needs minimized soil P loadings.
- All manure strategies increased P loading.
- Reduced rate of manure combined with commercial N minimized P loadings relative to other manure use strategies.

Figure 3. Discounted Net Economic Returns by Alternative Manure Application Strategy



Impacts :
- Using manure generated higher economic returns than commercial fertilizer.
- Both combined use of commercial N and manure as well as 20 tons/ac of manure applied every other year resulted in similar economic returns.
- Combining commercial N with manure minimized soil P loadings resulted in equal returns even if the price of anhydrous ammonia increased 50%.

Impacts at the Community Decision Level

The fourth of 5 studies discussed today is

"Projected Economic Impacts of the Hog Industry to Rural Economies in Iowa, North Carolina, and Tennessee"

Burton English, Jamey Menard, and Kim Jensen
U. of Tennessee

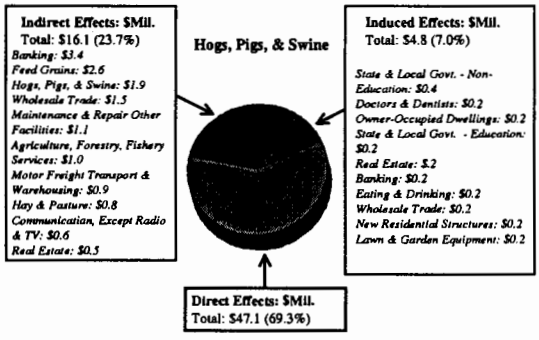
Table 1. Estimated Direct Economic Activity for Hogs, Pigs, & Swine and Meat Packing Plants by Region.

Region:	TIO* (Million $) Hogs, Pigs, & Swine
Iowa	2,413.4
N. Carolina	1,322.9
Tennessee	106.8
Study Area	51.7
Region:	**Meat Packing Plants**
Iowa	5,275.8
N. Carolina	2,237.0
Tennessee	517.7
Study Area	116.8

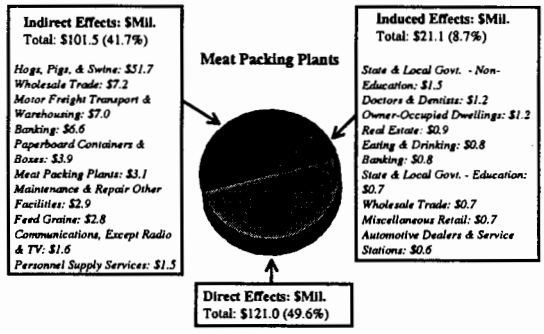
*Total Industry Output

Model Adjustments to Estimate Impacts

Top Ten Sectors Impacted for Study Area



Top Ten Sectors Impacted for Study Area



- **Change in feed purchase patterns of small vs. large scale hog facilities (small facilities -- local purchases, large facilities -- non-local?)**
- **Change in property values and tax collections for property located near hog facilities**
- **Change in production costs because of increased environmental regulations requiring greater non-polluting waste management systems (for example, moratorium on open-air anaerobic lagoons and sprayfields)**

Impacts at the Regional Decision Level

The final study discussed today is

"Regional Implications of Economic and Environmental Alternatives that Balance Phosphorus on Representative Broiler Farms in Southwest Missouri"

Verel Benson, D. Todd Farrand, Robert E. Young,III, and Peter Zimmel, U. of Missouri

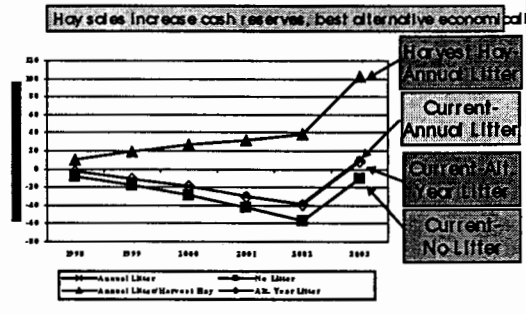
Phosphorus in SW Missouri

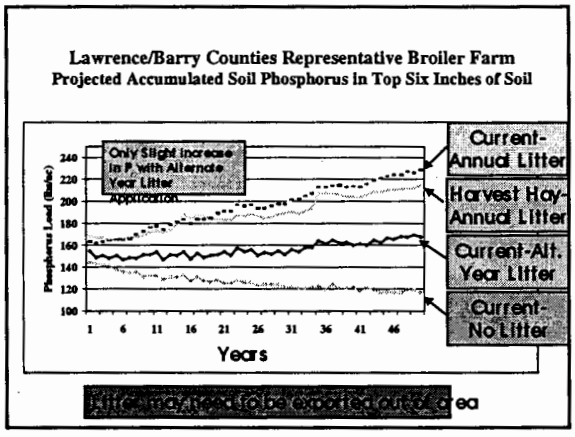
Currently livestock manures in SW Missouri contain more Phosphorus than can be recycled locally by agricultural production without large accumulations in the upper soil layers

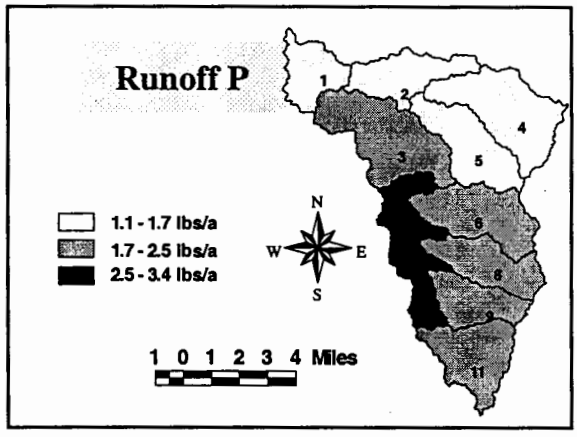
Accumulation of Phosphorus in the upper soil layers will lead to increased Phosphorus in runoff water

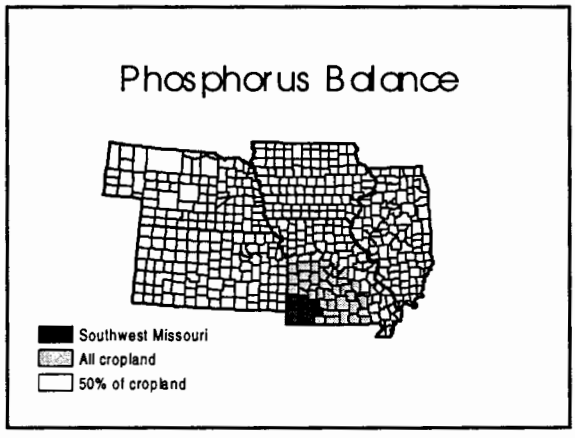
Increased Phosphorus in runoff will likely lead to increased plant and algae growth in streams and lakes resulting in reduced oxygen in the water for other aquatic life

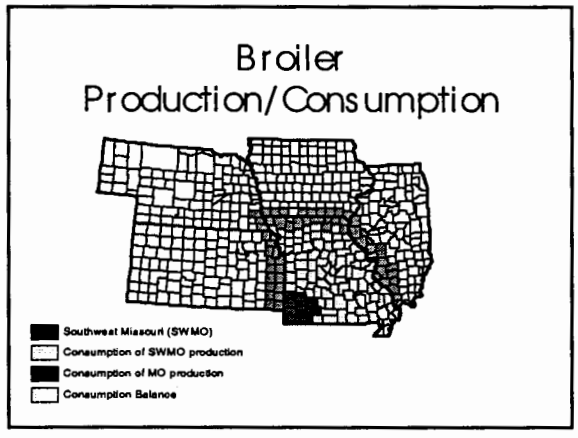
Ending Cash Reserves for Lawrence and Barry Counties Contract Broiler Representative Farm

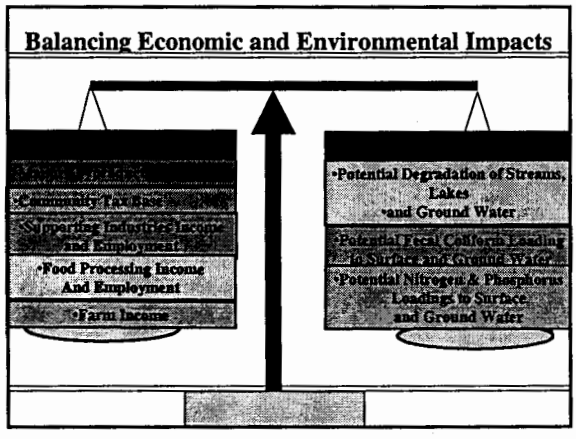


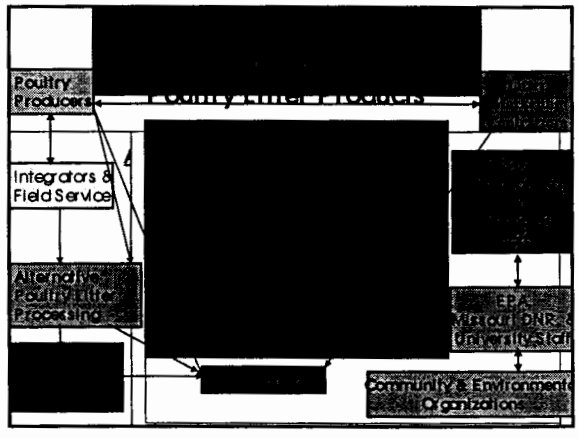

Lawrence/Barry Counties Representative Broiler Farm
Projected Accumulated Soil Phosphorus in Top Six Inches of Soil
Only Slight Increase in P with Alternate Year Litter Application
Current-Annual Litter
Harvest Hay-Annual Litter
Current-Alt. Year Litter
Current-No Litter
Phosphorus Load (lbs/ac)
240
220
200
180
160
140
120
100
1
6
11
16
21
26
31
36
41
46
Years
Litter may need to be exported out of area

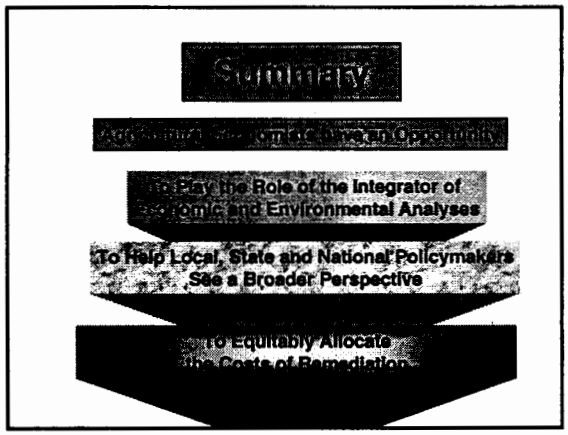

Runoff P
1.1 - 1.7 lbs/a
1.7 - 2.5 lbs/a
2.5 - 3.4 lbs/a
N
W
E
S
1 0 1 2 3 4 Miles
1
2
3
4
5
6
8
11


Phosphorus Balance
Southwest Missouri
All cropland
50% of cropland


Broiler
Production/Consumption
Southwest Missouri (SWMO)
Consumption of SWMO production
Consumption of MO production
Consumption Balance


Balancing Economic and Environmental Impacts
•Food Processing Income And Employment
•Farm Income
•Potential Degradation of Streams, Lakes and Ground Water
•Potential Nitrogen & Phosphorus Loadings to Surface and Ground Water


Poultry Producers
Integrators & Field Service
Alternative Poultry Litter Processing
Community & Environmental Organizations


Summary
To Play the Role of the Integrator of
Economic and Environmental Analyses
To Help Local, State and National Policymakers
See a Broader Perspective
To Equitably Allocate