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COOPERATIVE EXTENSION SERVICE—GREAT PLAINS STATES

GREAT PLAINS
BEEF CATTLE FEEDING HANDBOOK

GPE-7000

Confined Animals and Public Environment

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During the past decade there has been increased public concern about the amount of manure produced by animals in confinement. Regulatory people, researchers, and others have made statements that have compared the amount of animal manure with simple concepts that the public more readily understood. One of these concepts is the relative magnitude of the effect on the public's environment caused by industrial waste, municipal waste, and animal manure.

These simple comparisons, have been quickly understood by the public. This understanding has created concern that has resulted in political action in the form of regulations and in an increased public demand that even more should be done to stop animal waste pollution before it is too late.

New evidence from research has indicated that some of the earlier comparisons do not accurately describe the reality of the situation.

Correct political and regulatory activity requires that the public understands simple concepts that are closer to the reality of the situation.

Pollution Indicators

The major indicators for the magnitude of pollution are, in reality, quantities that need to be known to design a sewage treatment plant. These quantities are total solids, biochemical oxygen demand (BOD), nitrates, and nutrients.

Total Solids — The total solids are the dry materials left after water and other gases have evaporated. The units of total solids are weight. The primary treatment step is to settle these solids from the sewage water. The estimated weight (and volume) of the total solids must be known for the design of the primary step in sewage treatment.

Biochemical Oxygen Demand (BOD) — The BOD is the amount of free oxygen required by aerobic organisms which attack the organic material remaining in the sewage water. BOD is usually expressed in units of weight. Sometimes the term "population equivalent" is used. This is the weight of BOD produced per capita per day. An accepted average characteristic in municipal waste is 0.17 lbs. BOD/capita/day.

Nitrates — Nitrates are a compound form of nitrogen found usually in the soil. Plants utilize nitrates in the growth process to secure nitrogen. However, when the amount of nitrogen contained within nitrates exceeds ten parts per million (ppm) in underground water, there is a chance that the excess nitrates may cause a disorder in human babies, commonly known as "blue baby".

Nutrients — All sewage and manure contains nitrogen, phosphorus, and potash. These nutrients are required for the growth of plants and algae. Properly returned to the land, these nutrients aid in the natural cycle of growth. However, if excess amounts of the nutrients are placed into water, an excess growth of algae and weeds contributes to the eventual stagnation of the water.

Surface Water

Under normal circumstances manure from cattle falls on land where the cattle eat. The amount of total solids or BOD that reaches water depends upon rainfall which causes runoff. Research studies indicate that about 2% of the total possible BOD loading reaches a water stream. Under severe conditions caused by very heavy storms or snowmelt up to 5% of the BOD may reach a stream.

Recent analysis of evidence from research projects indicates that one person contributes as much BOD to water which must be treated as is normally contributed by 10 cows.

There is a difference in magnitude between these

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known facts and the often quoted statement: "One cow has the pollution potential of 18 people". This last statement is misleading. To be more accurate the statement should include the phrase: "If all of the manure fell directly into water".

Feedlot Runoff

Large commercial feedlots were developed in arid climates of Arizona and California. In the mid 1960's, innovative cattlemen on the Great Plains developed the financial arrangements needed to duplicate these "California" feedlots nearer the grain supply.

However, at the beginning of this development climatic conditions were ignored. The resulting phenomenon was spectacular. As shown in Figure 1,

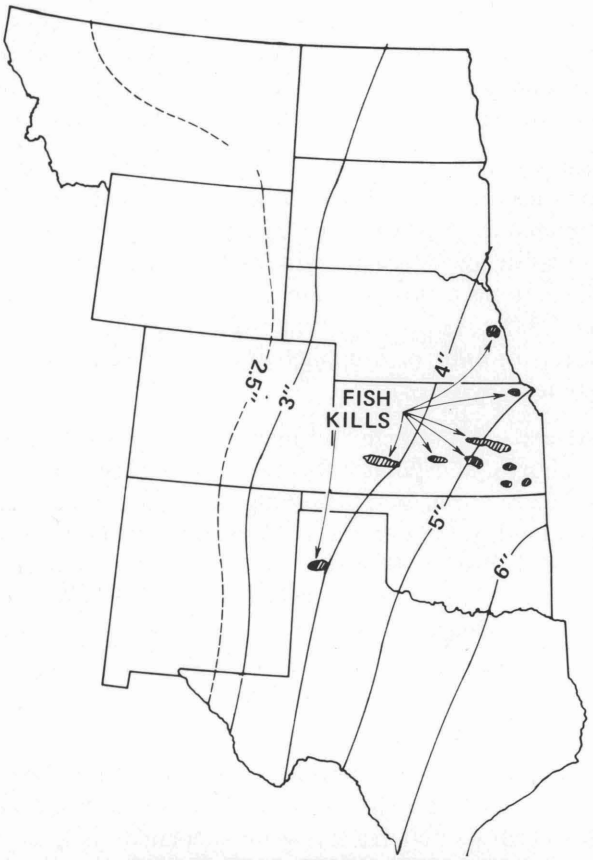

Figure 1. Fish kills occured in thunderstorm regions where large feedlots were located next to lakes or flowing streams.

the feedlots were built in a convective thunderstorm area. These high intensity storms caused rainfall runoff from the surface of the feedlots.

The runoff from the feedlots on the Great Plains carried organic material that had a high oxygen demand. Also this runoff traveled as a slug down the public streams. The oxygen within the slug was consumed. As the slug passed along, fish were suffocated. The average pollutional loading on a stream was relatively minor but the effect of a few hours without oxygen was spectacular.

Cattlemen and USDA personnel in the Great Plains were caught by surprise but they reacted swiftly. Cattlemen and their associations either sponsored or supported state legislation to require runoff control facilities for all large commercial feedlots. By the end of the 1960's, the five states that lay in the area of the high intensity thunderstorms were enforcing state regulations to control feedlot runoff.

In October, 1972, an aerial survey of four Great Plains states was made by two Agricultural Engineers from Iowa State University. An estimated 94.3% of the cattle on feed in these four states were being fed in lots that had runoff control structures. Another 4.6% of the cattle on feed were in lots having control structures, but because of poor management runoff still reached streams. Less than 1% of the cattle on feed were in lots without control facilities for runoff.

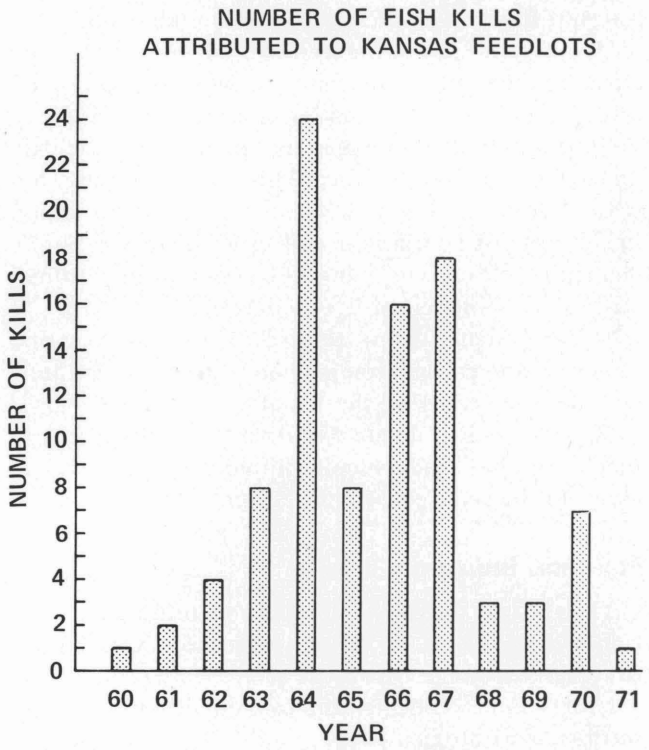

Figure 2. Since the mid 1960's fish kills caused by feedlots in Kansas have declined to previous low levels.

This survey supported previous evidence of rapid achievement of runoff control compiled by the Kansas State Department of Public Health. Figure 2 shows fish kills in Kansas which were attributed to feedlots. Note that the largest number of fish kills occurred in the years 1964-67. Kansas regulations went into effect on Jan. 1, 1968. The resulting reduction of fish kills since 1968 is partially credited to swift compliance with the regulations.

Subsurface Water

The major concern for subsurface water is a possible nitrate buildup that may cause blue babies. Early studies indicated that there appeared to be an increase in nitrates in areas that had feedlots. However, recent research evidence indicates that there is little nitrate buildup under active feedlots or runoff holding ponds. In fact, most recent research indicates there is actually a decrease in nitrates immediately beneath the surface of feedlots.

There is a sound explanation of this phenomenon. The manure from the animals fall upon the feedlot surface. It is stirred by the animals hooves. As the manure continues to buildup the bottom layer becomes compacted while the surface layer remains loose. Because there is still energy in the manure microorganisms continue their metabolic process. The microorganisms in the surface layer can use the oxygen that is mixed into the manure. Nitrates are one of the waste products of the metabolism of the organisms in the surface layer. See Figure 3.

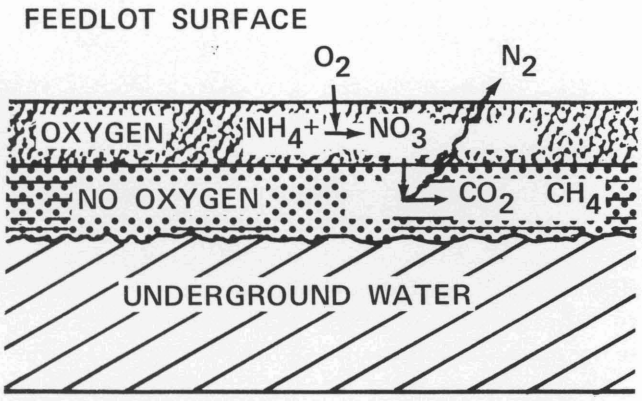

Figure 3. Bacteria on feedlot surface utilize oxygen (O_2) and combine it with ammonium ions (NH_4+) to produce nitrates (NO_3). However, nitrates do not go into ground water because the bacteria in the lower layer of manure do not have free oxygen. They must strip oxygen molecules from the nitrates. The result is free nitrogen (N_2).

However, the microorganisms in the compacted lower layer do not have oxygen available to complete their metabolism. They are desperate for oxygen molecules. They strip the oxygen from the nitrate compounds. Nitrogen gas, which constitutes 75.8% of the air, is created.

In cases where the feedlot surface is lightly stocked, is maintained for only a portion of the year or is abandoned without cleaning, natural processes break up the compacted lower layer and allow nitrates to move downward toward groundwater. However, an adequately stocked, active feedlot results in conditions that reduce nitrate movement to groundwater.

Solid Waste

The cost of processing of solid wastes from municipalities and industries is at least 40 times greater than hauling all animal manure produced in confinement back to the land. Approximately 80 - 100 million tons of animal manure must be hauled each year. As shown in Figure 4, 110 million tons of industrial waste and 250 million tons of residential solid waste must be processed each year.

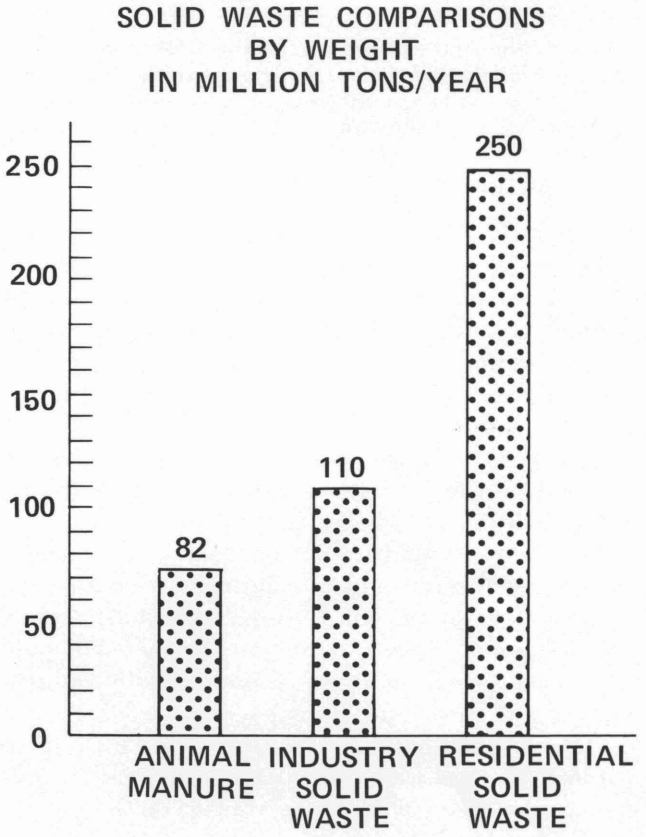

Figure 4. The manure weight hauled from confined animals is less than ¼ of the solid waste weight hauled from cities and industries.

The average cost of hauling manure back to the land is about $2.00 a ton. This low cost is achieved because the manure is located in one pile, it needs no collection, sorting or processing and it has good fertilizer value on adjacent farmland. Manure from a crop on 9 acres can usually be recycled through animals and returned to 1 acre of land. Feeding operations exist in locations where there is good crop land for grain production. The return of manure to adjacent farmland is therefore highly possible. The economics of manure applied to land are shown in Figure 5.

The solid waste produced by a municipality must be collected at an average cost of $14.00 a ton and must then be processed at an average cost of $4.00 a ton. Because of the mixture of materials in the municipal waste it is not readily useful as fertilizer.

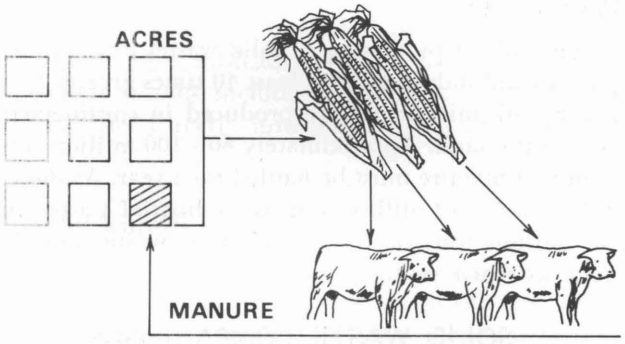

Figure 5. Nine acres of crops produce feed for 3 beef cattle on full feed for a year. The manure from these cattle will provide enough nutrients to re-fertilize only one acre for the following growing seasons.

Manure Quanity

The estimates of 80 - 100 million tons of manure to be hauled each year vary substantially from the original statements that predicted 1.5 billion tons of manure production. The calculations made in the original estimate of 1.5 billion tons of manure did not include factors for confinement, moisture, or the ration.

Nearly 84% of all cattle in the United States are not in confinement. Their manure is distributed by the animals themselves onto pasture and grazing land. Manure production from all hogs, all chickens, and the 16% of the cattle in confinement is less than ⅓ of the weight of the solid waste handled by municipalities alone. Manure that must be hauled is only 19% of the total solid waste produced by municipalities, industries, and animal systems.

The original estimates of the total amount of manure produced were computed on the basis of fresh manure containing 85% water. Manure on the ground rapidly loses moisture by evaporation. Most manure that is hauled has approximately 30 to 50% water. Thus the manure that must be hauled weighs ½ as much as the original estimates.

There is a tendency to call fresh manure "solid waste" even though it contains 85% water. This tendency contributes to a misunderstanding if the manure is compared to other solid waste with 0 - 10% water.

The original estimates for the total manure produced used data that was then available. This was the amount of dry solids from dairy animals. Dairy animals normally use a high roughage ration with digestion ranging between 60 and 70% of the ration. More of the ration must be eaten to secure the necessary energy.

The major number of animals in confinement are fed for meat production. These animals utilize a high concentrate ration with a digestion between 75 to 90%. They eat a lesser amount of ration to secure their growth energy. The dry solid material produced by animals on a high concentrate ration is about ½ of the dry solids coming from a dairy animal.

Total U.S. Manure Production vs Manure to Be Hauled

Total Manure Produced	=	1500.00 Million Tons
Reduction factor for confinement only		× 0.25 Million Tons
Manure produced in confinement	=	3.75 Million Tons
Reduction factor for high energy ration		× 0.50
Manure from high energy ration	=	182.50 Million Tons
Reduction factor for moisture evaporation		× 0.50
Total weight of manure hauled		91.25 Million Tons

Summary

1. High intensity rainfall from convective thunderstorms causes runoff from feedlots. The high oxygen demand of the runoff slug suffocates fish as the slug travels downstream. Swift compliance to regulations has resulted in 94.3% of the cattle on feed now being placed in lots that have runoff control facilities.

2. There is little evidence of nitrate buildup under active feedlots.

3. 80 - 100 million tons of manure must be hauled to adjacent crop land. However, the cost of processing solid waste from municipalities and industries is at least 40 times greater than hauling animal manure produced in confinement.

4. Estimates of the total solid materials produced by animals must consider factors for confinement, moisture, and the type of ration.

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