Environmental Impact of a System of Confinement, Housing and Animal Waste Utilization

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Summary

The production of food for the health and well-being of the world's population will be the highest priority for the next century. Veterinarians must continue to expand their role in animal and human health and, in cooperation with other sciences, extend their influence and expertise into the total area of efficient animal production. Confinement housing and recycling of animal excreta for supplemental use as a feed ingredient offer a viable and economic alternative for more effective land utilization, food production and human health.

Introduction

Why, at this 11th International Congress of Diseases of Cattle in Tel Aviv, Israel, should I attempt to encourage veterinarians to direct their attention to a better understanding of the environmental impact of systems for intensive animal production for human nutrition and health? Why was a special session during the 1979 XXI World Veterinary Congress devoted to a discussion of the adaption of veterinary teaching to intensive animal production for human nutrition? Why did the 155 member states of WHO, during the 1980 33rd World Health Assembly in Geneva, Switzerland establish a goal of health for all by the year 2000 and urge unprecendeted efforts for attainment by all people of the world by the year 2000, a level of health that will permit them a socially and economically productive life?

Discussion

The answers to these questions become more apparent when considered in relationship to the socio-economic changes brought about by exponential increases in world population:

Dawn of history to 1849 to reach 1 billion
80 years to 1929 to double to 2 billion
30 years or 1959 to reach 3 billion
17 years or 1976 to pass 4 billion
Projected to reach 6 billion by the year 2000

The accompanied increased demand for better quality food shelter and health, depletion of natural resources, including fossil fuels, and technological advances in agriculture, industry, physical, biological and medical sciences are exerting a tremendous influence on world order. A progressive, and in many instances, a disorderly redistribution of the world's natural resources and wealth is occurring. In spite of events, which at times may seem chaotic and possibly counter productive, we must continue to exert an optimistic course of action for orderly development of an acceptable standard of nutrition, health and quality of life for the world's people without downgrading those acceptable standards prevalent in many segments of society throughout the world today.

Veterinarians have historically been involved with the production and health of animals used for draft, transportation, food, fiber, companions, sport, warfare and research, as well as giving attention to the world's fauna and the public's health. As Pritchard (3) has so clearly discussed, animal disease constitutes one of the most important present constraints to efficient livestock production in both developed and lesser developed countries of the world. Diseases afflicting agriculturally important animals vary in nature from highly contagious epidemic infections capable of wiping out entire populations of animals, to endemic, subclinical disease and nutritional disorders that reduce productivity and potential in different and obscure ways. Zoonotic animal diseases are important because they cause illness and death in people who come in contact with sick animals or consume infected animal products. Others are important because they affect draft animals that provide power for cultivation of crops, and transport of agricultural commodities.

Numerous references can be presented pro and con concerning the food energy lost by producing and feeding livestock as compared with direct consumption of vegetable diets. Many anthropologists and nutritionists believe human populations that are conditioned to prefer animal sources of protein are better prepared for the inevitable and unexpected stresses of life. (4) I personally believe this; and, therefore, challenge the veterinary profession, in cooperation with every other related science, technology,

business and governmental agency to proceed in an unprecedented effort through research, education and demonstration to put into operation more efficient systems for producing proteins of animal origin that the populations of the world can afford to eat. The veterinarian's greatest contribution to both feeding mankind and providing a profit to the producer is to improve feed utilization by maintaining healthy animals. (5)

The structure and methods of agricultural production have made progressive changes in an effort to meet world demand for grain, oilseeds, fiber, livestock and products of animal origin. As more and more available tillable land has been put into crop production or lost to agriculture, many phases of livestock and poultry production have changed to intensive semi- or complete-confinement systems. Revolutionary developments in animal housing, related structures and the environment were necessary in order that a satisfactory ecological balance could prevail under the environmental impact within the unit as well as in adjacent and distant areas where the quality of life of animal and human populations may also be affected.

In Livestock housing and related structures, environmental control includes: (6)

1. Building design, surface--temperature, wetness and cleanliness.
2. Ventilation for modification of humidity and air quality.
3. Feed and water--quality, quantity, availability, ration preparation and feeding methods.
4. Veterinary health programs, handling, facilities, traffic patterns, noise and other stress-producing influences.
5. Waste management, utilization and pollution abatement.
6. General management, which is a critical requirement to the successful operation of all systems.

A variety of structures for confinement systems and waste management and utilization are in use throughout the world. Major climatic considerations involved in the selection of livestock housing and waste management systems are temperature, precipitation, evaporation, wind direction and velocity, and solar radiation. Ideally, the livestock facility should be located in an agricultural area, downwind from nearby residential areas and on sufficient land to permit traffic in animal, feed and waste handling, treatment and utilization without creating a nuisance (8). It is not within the scope of this presentation to discuss the merit and limitation of each system in use today, but rather to list references (1-12) from which veterinarians may secure detailed information, and with the cooperation of agricultural engineers, nutritionists, agronomists, and economists can accurately assess the environmental and by so doing be qualified to advise clients on a confinement system which will most likely meet production objectives.

Waste management, utilization and pollution abatement are among the most important and limiting factors in the location of a confinement operation and in the public and regulatory acceptance of that operation. Animal waste represents a valuable resource and alternatives for utilization for either raw or processed waste including land fertilization, animal feed ingredients, substrate for microbial and protein synthesis and methane production. (8)

A total confinement pollution-free system was developed in Ohio, U.S.A. by W. C. Hackett, D.V.M., in 1970 (10). The design criteria included a series of eight pole barns 1470 ft. long x 67 ft. wide with steel struss half-monitor roofs, open side walls for ventilation, but screened with chicken wire mesh and equipped with electronically operated lumite curtains for closure in inclement weather. The barns were strategically located in 2 x 4 rows 500 feet apart on graded and compacted clay sites, running 10° northwest, facing east-west to take advantage of the prevailing winds for natural ventilation. A drive-through feeding, handling, and cleaning alley provides ready access to the continuous feeding manager and 20 pens in each barn. The system design included business office, employees' quarters, veterinary receiving and processing facilities, a feed mill and an adjacent solid waste aerobic thermophilic bacterial digester for processing manure and bedding for use as animal feed, plant fertilizer and soil conditioner. The digester design and principle of operation is similar to those in use by municipalities in many parts of the world for sewage and solid waste disposal. The digester is housed in a 700 ft. x 120 ft. steel building. Two 400-ton capacity concrete vats with perforated floors enable high pressure fans to force air through the bio-mass. Therophilic bacterial action causes the temperature to rise to 160-180° F. A mechanical mixer periodically turns the contents to assure uniform digestion. The digestion criteria and animal waste processing and utilization system developed at the Ohio feedlot have been adapted for incorporation into any capacity or species confinement, livestock or poultry production system.

The advantages of mechanical aerobic thermophilic processing are:

1. A stable organic material without offensive odor which can be stored.
2. A product free from weed seeds and pathogens.
3. A product with about 0.5% nitrogen, 0.4% phosphorus and 0.2% potassium useful as a soil conditioner and garden fertilizer.
4. A valuable feed ingredient, especially when poultry excreta is mixed and composted with the raw cattle manure.

Arndt *et al.* (8) recommendations for utilizing the nutrients in animal excreta are:

1. *Formulation in Diets.* Animal excreta should be formulated into diets in the same manner as other dietary ingredients--based upon the chemical content, nutritive content and digestibility. Mere substitution of animal excreta for a percentage of complete diet or adding animal excreta to a well-formulated diet based upon total diet should be formulated from the composition of all of the

ingredients--including the animal excreta.

2. *Target Animal.* The ruminant is the logical target animal for maximizing the utilization of animal excreta nutrients because:

a. The protein equivalents are residual dietary protiens, single cell protein (microbial) and non-protein nitrogenous (NPN) compounds--the latter, which makes up the largest percentage, is useful only for ruminants.

b. The ruminant is better equipped (enzymatically to degrade the high levels of nucleic acids in single cell protein than nonruminants.

c. The microbiological activity of the rumen and release energy from residual fiber (cellulose) in the material and release other nutrients which may be encapsulated or entrapped by fiber.

3. *Determine the Chemical Composition.* The chemical composition and digestibilites of the material should be determined before formulation. Parameters to be considered are dry matter, proteinequivalents, gross energy and minerals.

4. *Performance-Limiting Factors in Levels.* The high mineral content of animal excreta is likely the performance-limiting factor of levels which can be successfully incorporated into well-formulated diets. Often the high mineral levels are the result of soil addition during collection and can be reduced by dilution with bedding material, litter material, *et cetera.*

Animal excreta, including bedding and associated material, is more valuable as a feed nutrient than as a fertilizer (Yeck et al., 1975). By recovering feed nutrients from animal excreta we have partial solutions to waste disposal and water pollution problems. At the same time we are lowering the cost of producing animal products (thus lowering the cost to the consumer) and increasing supplies of essential minerals and available nitrogen which permits the conservation of natural resources. (8).

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