2. Most cattle are backgrounded prior to going into confinement units, thus the major respiratory infections are over prior to their entry into confinement.
3. Direct observation of animals is difficult because of the limited space allowed for them (16 to 20 sq. ft.). Thus, many sick animals are missed for a period of time. Catwalks or more time with the cattle would alleviate this problem.
4. When a disease outbreak does occur, ringworm, respiratory diseases, warts and lice spread readily from animal to animal because of their close proximity.
5. Recovery of sick animals is more rapid in confinement than in an open lot because of reduced chill factor.
6. Leg trouble is frequently observed and a majority of this is from animals stepping on one another resulting in contusions and in some cases leading to a generalized septicemia and arthritis. The same injuries are observed on the tails of animals.

Processing Manure and its Utilization

John B. Herrick, *D.V.M.*
Extension Veterinarian
Iowa State University
1101 Blackwood Circle
Ames, Iowa 50010

Feeding feces is by no means a new concept, even though it has only recently received publicity due to public concern as it fits in the overall picture of environment pollution abatement. Early in the 1940's cow manure was looked upon as a source of B-complex vitamins. Hammond (1942) reported on studies in which cow manure was used as a source of certain vitamins for growing chickens and later (Hammond, 1944) where cow manure or dried rumen contents was substituted for alfalfa meal in poultry diets. Bohstedt, Grummer, and Ross (1943) used cattle manure as a carrier of B-vitamins in rations for pigs. Lillie, Denton, and Rind (1948) demonstrated that cow manure contained a growth factor giving essentially the same gain response in chicks as crystalline B_{12}.

Anthony and Nix (1962) reported a study for which one of the objectives was to develop an effective means of disposing of organic residues voided by confined cattle through refeeding. This early study involved the feeding of washed wet fecal residues. Excellent gains (3 lbs./day) were obtained for the three yearling fattening steers in the trial with 40% of the feed coming from washed fecal residue. No outward symptoms of harm nor difficulties in consumption were observed. Additional trials with wet fecal residue were conducted at Auburn University (Anthony, 1966) where gains of 3.60 lbs./day were obtained with Holstein bulls.

This practice was abandoned (Anthony, 1966) in favor of whole feedlot feces recycling. Combining feedlot feces with concentrates (40:60 ratio) was not a satisfactory practice based on animal weight gain and carcass grade. Blending fresh manure with high energy feeds lowered performance and digestion coefficients. It was theorized that manure contained a growth depressing factor since no intake and palatability problems were encountered. However, washing and heat treatment rendered feedlot cattle manure a useful feed for cattle by lowering the basal feed dry matter required per unit gain.

A later approach was to combine feedlot manure (57 parts) and ground bermudagrass hay (43 parts) for making a high dry matter silage (Anthony, 1966, 1967, 1968, and 1969). Manure from all-concentrates had no nutritional advantage over manure from animals fed haylage for making the high dry matter manure silage. Dry matter, crude protein, and cellulose digestion coefficients were essentially the same for the two manure sources as measured with steers. The manure-Bermuda haylage also maintained ewes in better physical condition with less total dry matter than when only Bermudagrass hay was fed.

Anthony (1967, 1968) developed the "Wastelage Concept" for effectively using feedlot manure as a feed. His reports (1967, 1968, and 1969) indicate success based on the equal or nearly equal daily gains, lower parakeratosis, and equal carcass grades (choice). Wastelage was also used successfully for ewes and beef cattle kept for reproduction. Low birth weights of lambs were improved by vitamin A injections. Cattle performed as well on wastelage as they did on corn silage. However, both groups were supplemented with a protein-mineral-vitamin A mix.

Only one-half of the daily manure excreted could be reused in grain: manure rations (Anthony, 1970). Little difference was found in nutrient value between cooked and washed manure. High grain rations containing wet manure were consumed well. These rations supported gains similar to cattle fed feeds without manure, although the total daily dry matter

intakes were increased for manure-fed groups.

All-concentrate feedlot manure has been fed to pullets (6 weeks of age) and during laying at 10, 25, and 40% replacement levels for milo in a basal mix where milo represented approximately 70% of the basal ration (Durham, Thomas, Albin, and others, 1966). Manure was air-dried and ground before being mixed in the rations. Increased manure feeding resulted in increased feed consumption, but there were no significant differences in egg production or mortality. In another experiment, digestibility-metabolism and fertility were measured in hybrid pullets. The 10% manure treatment produced significantly more eggs. Digestibility of dry matter, energy, and ether extract, nitrogen retention and level of consumption were significantly different for each level of manure fed. No differences were found in fertility due to ration.

Catfish have been successfully raised on diets in which 50% of the ration was feedlot manure (Durham, Thomas, Albin, and others, 1966), where care was taken not to deplete the oxygen supply in the pond. Manure-fed fish made the more rapid growth during the early part of study than they did later in the study.

Some work has been reported in which yeast was grown on fluidized and aerated cattle manure (Anthony, 1969; and Singh and Anthony, 1968). Lignified fiber was removed and discarded. The solubles (68% of the original manure) were fed to rats. The rats developed diarrhea (Singh and Anthony, 1968) which was attributed to the high mineral content.

Ammonification of anaerobically fermented feedlot manure increased protein (CP) from 17 to 48% and was as acceptable to lambs as was ammonium lactate (Moore and Anthony, 1970).

Smith, Goering, and Gordon (1969) measured the influence of chemical treatments on digestibility of ruminant feces. Treating orchardgrass and alfalfa cow feces with sodium hydroxide and sodium peroxide resulted in large decreases in fibrous content. Cell wall (CW) digestibility was increased severalfold as measured by an *in vitro* fermentation technique.

Sheep consumed corn silage rations containing 25% of the total DM as either untreated or 3% sodium peroxide-treated orchardgrass cattle feces as well as they did an all corn silage ration (Smith, Goering, and Gordon, 1969). Addition of 3% sodium peroxide to feces increased average DM, 29; nitrogen, 25; CW, 55; cellulose, 41; and hemicellulose, 90 digestibility units over that of the untreated feces. Body weights of the sheep remained unchanged throughout the experiment.

The cost of feed is the largest single item of expense in the production of cattle. The ability to reduce this expense would result in a higher net return to the feeder.

Wastes which accumulate at concentrated feeding operations consist primarily of the fecal material, although there may be inclusions of spilled feed, urinary deposits and hair.

Fecal waste characteristics vary, depending upon the diet being fed, its manner of preparation, the health, performance and past history of the animals being fed, the length of time which the material resides on the pen floor and the climatic exposure experienced. This material, as collected, contains a range of 30 to 70% solids of which 90% are volatile solids. The organic nitrogen content of slightly over 2% results in a crude protein (N x 6.25) value of 12.9%. The amino acids present in this material account for slightly less than 40% of the crude protein value, the remainder consisting of various non-protein nitrogen sources.

Analysis of typical feedlot manure is crude protein, 12.9% or 258 lbs./ton; fat, 1% or 20 lbs./ton; fiber, 33% or 662 lbs./ton; MFE, 47.8% or 956 lbs./ton and ash, 5.2% or 104 lbs./ton.

An 800-pound average steer will produce approximately 8% of its body weight daily in urine and feces. This means 64 pounds of manure daily and over a ton per year.

The results to date indicate that for successful animal performance fecal material can be used as 10% of the diet or the utilization of 1/3 of the waste material. Digestion trials show that animal waste show that digestion coefficients are low with respect to both dry matter and nitrogen. Therefore, animal wastes should be so processed that its nutrients will be more readily available.

Research indicates that cattle excreta, even when processed through an oxidation ditch system, has both protein and mineral nutritional properties. However, it varies considerably in its nutrient composition when mixed with control rations.

Cattle excreta scraped from concrete floors has been ensiled with corn silage. From 20 to 42% of the ration was cattle excreta. No difficulties were experienced in getting the cattle to consume excreta silage. The aroma, visual observation and PH of the silage excreta was the same as found in corn silage. As much as 50% of the cattle excreta was recycled in this fashion and replaced the protein supplement in the final month or two of the feeding period when little or no protein supplement is needed.

Wastes produced at feedlot facilities must be considered assets and must be recycled in one manner or another. Anaerobic fermentation is another way of producing an animal feed ingredient as well as a fuel in the form of methane or in making ammonia.

There are questions that are unanswered. Will feed additives or their metabolities in cattle manure present a residue problem when recycled? Will pathogens found in manure such as salmonella ssp. present a problem in the recipients of the recycled manure? To date these problems do not seem insurmountable in that trials conducted have not recognized this as a problem. Further, there is no FDA rating on the use of recycled manure when used as feed at the present time. However, there are no restrictions particularly if the waste is accumulated and recycled

from the premises where it will be utilized.

It appears in view of high feed grain costs, protein shortages and a procedure to utilize a liability into an asset that recycling manure will be a part of many cattle feeding operations.

References

Hammond, J. C. 1942. Cow manure as a source of certain vitamins for growing chickens. Poultry Sci. 21:554. - Hammond, J. C. 1944. Dried cow manure and dried rumen contents as a partial substitute for alfalfa meal. Poultry Sci. 23:471. - Bohstedt, C., Grummer, R. H., and Ross, O. B. 1943. Cattle manure and other carriers of B-complex vitamins in rations for pigs. J. Anim. Sci. 2:373. - Lillie, R. J., Denton, C. A., and Rind, H. R. 1948. Relation of vitamin B_{12} to the growth factor present in cow manure. J. Biol. Chem. 176:1477. - Anthony, W. B., and Nix, R. 1962. Feeding potential of reclaimed fecal residue. J. Dairy Sci. 45:1538. - Anthony, W. B., and Nix, R. 1966. Utilization of animal waste as feed for ruminants. Management of Farm Animal Wastes (Proceedings National Symposium, May 5-7), 109. - Anthony, W. B., and Nix, R. 1967. Manure-containing silage–Production and nutritive value. (Abstract) J. Anim. Sci. 26:217. - Anthony, W. B., and Nix, R. 1968. Wastelage–A new concept in cattle feeding. (Abstract) J. Anim. Sci. 27:289. - Anthony, W. B., and Nix, R. 1969. Cattle manure: Reuse through wastelage feeding. Proceedings of the Conference on Animal Waste Management, Cornell University, Ithaca, N.Y., 105. - Anthony, W. B., and Nix, R. 1970. Feeding value of cattle manure for cattle. J. Anim. Sci. 30:274. - Moore, J. D. and Anthony, W. B. 1970. Enrichment of cattle manure for feed by anaerobic fermentation. J. Anim. Sci. 30:324. - Smith, L. W., Goering, H. K., and Gordon, C. H. 1969. Influence of chemical treatments upon digestibility of ruminant feces. Proceedings Conference on Animal Waste Management, Cornell University, Ithaca, N.Y., pg. 88. - Smith, L. W., Goering, H. K., and Gordon, C. H. 1970. *In vitro* digestibility of chemically-treated feces. J. Anim. Sci. 31:1205. - Vetter, R. L, Christensen, R. D. 1973. Feeding value of animal waste nutrients from a cattle confinement oxidation ditch system. AS Leaflet R182. - Vetter, R. L., and Burroughs, Wise. 1974. Nutritive value of cattle excreta ensiled and fed to feedlot cattle prior to the final finishing period. AS Leaflet R195.

Palatability and Digestibility of Feedlot Waste in Ruminant Rations

Kenneth E. McClure
Animal Science Department
Ohio Agricultural Research and Development Center
Wooster, Ohio 44691

Animal manures have been used as a source of livestock feed for many years. Hogs have been used in the feedlot to salvage undigested feed that passed through cattle. In fact, growth responses, beyond that to be expected from the grain present, have been noted in both chickens and hogs feeding on cattle manure. One of these previously "unidentified growth factors" has since been identified as Vitamin B-12. This vitamin at one time was commonly referred to as the "cow manure factor."

Research has been conducted in recent years incorporating poultry litter in beef cattle and sheep rations as a source of protein. The results indicate this can be done successfully. Poultry litter has also been recycled in broiler and layer rations with no palatability problems with either the birds fed these rations or the people which consumed the meat and eggs produced by these birds. In fact, taste panel studies showed a slight preference for meat from litter-fed broilers in one report. Several researchers have fed cattle manure back to cattle and sheep in finishing rations and to gestating and lactating females with promising results.

We have conducted some studies on the feeding of cattle and sheep manure at the Ohio Agricultural Research and Development Center. These rations have been reasonably well accepted by cattle and sheep.

An experiment was conducted with sheep to determine the digestibility of feces (no urine or bedding) from cattle which had been fed rations containing two forms of dry corn grain - whole shelled corn (WSC) and crimped corn (CC) alone and with 20 lbs. of corn silage daily. The dry matter digestibility of the all-corn fed cattle feces was 40% (one ration contained 94% feces from all-corn fed cattle) whereas, the dry matter digestibility of the silage fed cattle feces was 19%.

In another experiment three 600 lb. steers were fed an all-concentrate ration and bedded with chopped wheat straw. The manure was packed in 55 gallon barrels with plastic liners, with no additions, and allowed to ferment. The pH of the manure was 7.5 when removed from the pen and dropped to 4.5 to 5.0 after fermentation.

This fermented manure was fed as the sole ration for 60 days to two 700 lb. steers. The steers consumed up to 50 lbs. per head daily of this fermented manure and maintained their weight during this period.

In a third experiment corn stover was used as bedding for cattle fed an all concentrate ration in group pens. The resulting manure was allowed to accumulate for 75 days. It was then removed and stacked with flail manure spreaders after the addition of 10% ground shelled corn. The stack was covered with sheet plastic and allowed to ferment.

This corn-stover-bedded fermented manure was fed to cattle housed in individual pens and compared