ANIMAL WASTE VALUE—NUTRIENT RECOVERY AND UTILIZATION

W. Brady Anthony

Alabama Agricultural Experiment Station, Auburn, Alabama 36830

ORGANIC waste originating from livestock in the United States far exceeds in quantity the combined organic waste output of the human population—a frightening statistic in a pollution conscious era. In reality, however, with the exception made for special areas, animal waste is currently a nuisance rather than a calamity. By application of 20th century man’s tools, his ingenuity and his willingness to act on fact rather than hearsay, he can convert this oozing mountain of animal organic waste to one of his great resources. A conditioned observation, however, is that the mountain will continue to ooze and man’s effort for containment will be feeble in response to superficial reporting and philosophical prejudices. Another observation is that conventional sanitary engineering concepts developed for human waste disposal offer for animal waste a dead end streed with calamitous consequence. Currently most funded research in animal waste management is designed to use experimental procedures developed for human waste disposal.

The reuse of solid waste is, as Phillip Fradkin (1970) concluded, still a pipe dream. Although Fradkin was speaking of the usual city solid waste, it is obvious that the reuse of animal waste has not been accepted to have merit. In Loehr’s recent paper (1969) on “Animal Waste—A National Problem,” he devoted only two brief paragraphs to the feeding of animal waste to animals and apparently did not consider reuse a method of waste disposal. Likewise, Hermanson and Watson (1970) reviewed animal waste management and did not mention disposal of feedlot waste through feeding.

Space restrictions will not allow a comprehensive review of the work that has been published on the chemistry and nutritive value of animal waste. An attempt has been made to (1) cite selected papers for a historical review, and (2) review current research.

Poultry Waste

Many published reports reveal that poultry manure is a rich source of nitrogen and minerals (Bhattacharya and Fontenot, 1965, 1966; Durham et al., 1966; Anthony, 1967a) and that it can be successfully fed to cattle (Fontenot et al., 1966, Anthony, 1967a). Data published prior to 1968 were reviewed by Anthony (1967a). On September 2, 1967, the Food and Drug Administration issued a policy statement (Kirk, 1967) explaining that use of poultry litter as a feed or as a component of feed was not sanctioned. This action may have caused a minor stir among producers using poultry litter as feed, but observation led this author to believe that few, if any, users of litter gave up the practice. Why should they? Litter was a proven valuable feed component (Fontenot et al., 1966; Bhattacharya and Fontenot, 1965, 1966), it caused no disease (Anthony, 1967a), had not been shown to produce tissue build up of undesirable organic residues, and it was available at relatively low cost.

Although the use of poultry manure as a feed survived its first legal encounter, ill-founded legal regulation and the serious threat of adverse public opinion are presently the primary factors preventing development of realistic plans to recycle animal waste. Current research on feeding poultry manure should shorten the time for widespread public acceptance. Liebholz (1969) recently discussed disease transmission to cattle from poultry by manure feeding and cited data to show that this is unlikely. Brugman et al. (1967) sterilized poultry litter and lowered its feeding value. El-Sabban et al. (1970) measured the utilization of energy and nitrogen by sheep fed rations containing autoclaved (APW) and cooked poultry manure (CPW). Wethers were fed isonitrogenous rations in which nitrogen was supplied by APW, CPW or soybean meal (SBM). Crude protein in rations containing APW and CPW was less digestible than crude protein in the soybean meal ration, but nitrogen retention was not different among the three rations. Steers fin-
ished on rations in which supplemental protein was provided by SBM, APW or CPW (dried) yielded carcasses of similar characteristics and acceptability. Chlorinated hydrocarbon compounds in backfat and arsenic in liver were found in amounts less than 1 ppm. These residue levels were, therefore, far below permissible tolerances.

In Britain the feeding of poultry manure to cattle and sheep appears to have gained wide acceptance (Anonymous, 1969). W. F. Raymond (personal communication) observed a widespread use in Britain of poultry litter in animal feeding and suggested that more might be used for this purpose if the supply permitted. In another development (Calvert, Morgan and Martin, 1970), poultry manure was used successfully for growing fly larvae to produce pupae which were harvested and fed back to chicks as a substitute for soybean meal in their diet. This seems to be an indirect approach that would have physical and practical limitations.

Swine Waste

Published research on the feeding of swine waste is far less extensive than for poultry waste. Diggins, Baker and James (1965) presented a paper reviewing the results of feeding dried pig feces in swine finishing rations. The basal ration was a fortified corn-soybean meal formula and swine fed this formula gained .71 kg per head daily and required 3.63 kg of feed per kilogram of gain. When dried pig feces was substituted in the formula at 15%, daily gain was .78 kg and feed per kg of gain was 3.62 kg; when the dried feces component was increased to 30%, the comparable values were .69 and 4.65. In an Illinois study, swine manure subjected to aerobic digestion (oxidation-ditch residue, ODR) was fed to rats (Harmon, Jensen and Baker, 1969). ODR substituted (24.5%) into a fortified corn-soybean meal diet supported satisfactory gain and feed efficiency; at 49%, it seriously reduced gain. When substituted in a corn-casein diet, ODR at 10.3% supported gain equal to the control ration; at 20.6%, weight gain was not seriously reduced, but feed efficiency was.

Cattle Waste

Not too many years ago, steer manure was an acceptable component of swine rations. Snapp (1939) stated that frequently "Pork Credit" was the only profit in cattle finishing. Bohstedt, Grumer and Ross (1943) fed cow manure to pigs and found that free access to it replaced the need for dried brewers' yeast or alfalfa meal in practical corn-vegetable protein rations. They stated that the nutritive value of cow manure for pigs was not entirely a result of the undigested grain it contained. Other research by many groups (McElroy and Goss, 1940; Wegner et al., 1941; Hammond, 1942, 1944; Rubin and Bird, 1946; Lillie, Denton and Bird, 1948) established that the B-complex vitamins are synthesized in the rumen and significant quantities of them are excreted in the feces. The essentiality of these vitamins in swine feeding has been established. Loosli et al. (1949) found that essential amino acids were synthesized in the rumen and that much of these amino acids was lost in the manure. Palafox and Rosenberg (1951) and Durham et al. (1966) fed rations containing manure to laying hens. No deleterious effects were observed from manure feeding to either the animals or the human food products produced by these animals.

Feeding Cattle Manure to Cattle at Auburn. Anthony and Nix (1962) and Anthony (1966) established the feasibility of feeding steer manure to cattle. Feeding manure to fattening cattle resulted in feed savings. In addition, when manure was removed daily for feeding odor and fly problems were reduced. Initially manure was washed and screened to obtain a coarse, fibrous residue for feeding (Anthony, 1968a). Later, the washing and screening were found unnecessary and manure was blended directly with concentrate and fed (Anthony, 1970). Cooked and uncooked manures were fed with equal success. In all the feeding trials it was found that cattle consumed the manure-containing rations readily and did not develop digestive stress even when the ration was a mixture of ground shelled corn and manure.

In the beginning and for several years, the approach at Auburn was to blend fresh feedlot manure or washed manure directly with concentrate. This practice proved highly satisfactory because it (1) largely eliminated noxious accumulation of manure in the feedlot, and (2) improved the efficiency of the cow as a converter of feed to human food. There were, however, certain disadvantages of blending manure directly with grain. In practice it would be difficult to harvest the manure each day to blend with grain prior to feeding. Also, it appeared desirable to develop another means to feed manure that might be more acceptable
than direct blending with grain and feeding. As a result the wastelage concept was developed.

Wastelage. Recycling feedlot manure is feasible and practical by converting it first to silage (Anthony, 1966, 1967b, 1968b, 1969a, b). Wastelage permits use of all manure from a feedlot. One full-fed steer produces sufficient manure to manufacture wastelage (57 parts manure and 43 parts hay, w/w) to supply the roughage and supplement portion of the steer ration and to supply the full ration for one beef brood cow. When the brood cow is allowed a sufficient area of land, her waste is deposited so that it is not noxious to the environment.

Based on results of a number of feeding trials with steers (Bandel, 1969; Anthony, 1969c; Bandel and Anthony, 1969) a ration formulated to contain 40% wastelage and corn has supported more satisfactory rate of gain and feed efficiency than a conventionally formulated, high-concentrate ration. Adding a protein supplement to the wastelage-corn formula improved the rate of gain and feed efficiency only slightly.

The Coastal bermuda hay used to make wastelage has not been selected for quality. Laboratory data have consistently revealed higher dry matter digestibility and higher concentrations of crude protein and minerals in manure than in Coastal hay used in wastelage production. Even with poor quality hay, lambs full-fed wastelage have remained in positive nitrogen balance (Bandel, 1969).

Feeding trials with breeding ewes and breeding beef cows unequivocally established that wastelage can be used successfully as the primary item of food when it is supplemented with vitamin A (Anthony, 1969a, b). Wastelage may be made a superior feed through selection for quality in the forage component used in its manufacture.

Other means of using manure as a feed include yeast fermentation alone or in combination with acid hydrolysis, (Singh and Anthony, 1968; Singh, 1968). Basically it is detrimental to feed quality if manure is even partially decomposed by ubiquitous aerobic microorganisms. Composted manure is not a useful feed (Hansen, Furr and Sherrod, 1969). Currently at Auburn primary consideration is being given to subjecting manure to a lactic acid fermentation (Moore and Anthony, 1970). By controlling the environment, lactic acid is rapidly produced in feedlot manure. With alternate fermentation and neutralization of the acid produced by anhydrous ammonia, the crude protein content of manure can be increased to above 40%. The increased crude protein fraction is primarily bacterial protein and ammonium lactate.

Packing House Waste

Rumen contents have been dried and fed to cattle by Goodrich and Meiske (1969). These authors suggested that the drying temperature may have adversely affected the feeding value of the crude protein component of rumen contents. Rumen contents can be blended with hay and stored as silage (Anthony, 1969c). The most promising method of conserving not only rumen contents but also blood appears to be by ensiling, especially when the ensiling conditions are controlled to provide for rapid lactic acid production (Nilsson, 1970; Wirahadikusumah, 1968). Also, ensiling these products to produce lactic acid may essentially eliminate the probability of bacterial diseases (Nilsson, 1970; Wirahadikusumah, 1968) and parasitic nematodes (Ciordia and Anthony, 1969).

The Future

Engineering innovation to mechanize manure collection and processing is essential if manure is to be commercially recycled. Most likely this will require reassessment of current commitments and reallocation of resources. Responsible action is necessary to gain public acceptance of recycling. The human welfare of the world will be served by immediate action on these points.

Literature Cited


