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Utilization of Farm Animal Organic Waste as Feeds for Livestock and Poultry

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Abstract

Review was undertaken on utilization of farm animal organic waste as feeds for livestock and poultry. Increasing feed costs and international concern for the conservation of resources have focused attention on the nutrients in animal wastes that have in the past been used largely as fertilizer or as a major source of fuel for villagers in a number of countries. Animal wastes represent a vast reservoir of cheap nutrients, particularly for ruminants. The limitation in using animal waste as feed is that it needs processing. Dehydration, ensiling, chemical and physical treatments can be used to maintain the nutrient composition and increase the palatability and feeding values of the waste. Animal waste can potentially be used not only to maintain animals in the dry time but also to encourage performance quite satisfactorily. Feeding cattle manure in poultry and pigs promotes meat and egg productivity respectively. Pig waste, when processed and properly balanced with other ingredients, may become a potential feed substitute for cattle at levels up to 30%. No differences in the quality of meat from animals fed waste have been detected, nor has there been a problem of consumer acceptance in animal products.

Introduction

Increasing feed costs and international concern for the conservation of resources have focused attention on the nutrients in animal wastes that have in the past been used largely as fertilizer or as a major source of fuel for villagers in a number of countries. Research and field trials in recent years have demonstrated a variety of other uses for manure, including direct feeding of dried manure, a number of systems for separating or processing manure fractions, conversion to biogas (methane), use as feedstock for synthesis gas, pyrrolysis to produce fuel, and some industrial uses (FAO, 2013). Rations containing wet cattle manure were readily consumed by fattening steers and these rations supported gain essentially equal to comparable cattle fed feeds without manure. Cooking or washing manure before mixing it with concentrate for feeding did not improve its feeding value (Anthony, 1970).

Manure processing is presently a subject that enjoys considerable attention targeting in reducing the loss of plant nutrients to the environment, reduction of greenhouse gases and manure handling in agriculture. Separating the liquid and solid fractions of manure by mechanical means may be important, as the liquid fraction would be suitable for high-yielding animals while the solid fraction could be used for maintenance or bedding material or eventually discarded. Cattle manure can be fed either in dry form, chemically treated fresh manure or ensiled with forages, crop residues and other feed ingredients or wastes (Albin et al., 1975). Recycling of animal wastes has always existed in Nature between the same or among diverse species. Rabbits, rats, poultry and pigs are the most typical examples because in specific nutritional situations they consume their own excreta in substantial quantities to meet their requirements of nutrients missing from their diets. Animal wastes can be used as source of feed nutrients for livestock, pig and poultry. The objectives of this paper were to review utilization of farm animal organic waste as feeds for livestock and poultry.

Uses of Organic Animal Waste

Livestock manure has been an asset to crop production since the beginning of organized agriculture. Because these excretions from cattle contain several essential plant nutrients, they contribute to increased crop yields when properly applied to soils. Thus, dairy and other livestock producers can use manure as a valuable source of fertilizer nutrients for crops (Johnson et al., 1975).

Chemical Composition and Feeding Value of Different Animal Wastes

Animal wastes represent a vast reservoir of cheap nutrients, particularly for ruminants. In most countries, waste, particularly from poultry, is easily collected, as it is concentrated in small areas, and its cost, as a raw material for feed, is generally the cost of transport alone. The only expensive item may be processing, but this cost is relatively small and is recoverable from the profit arising out of the low original cost. Feed costs for dairy or beef cattle usually represent 50–80% of the total production costs; this can be reduced to 20–40% by utilizing these new feed resources as donors of protein, minerals and other nutrients (FAO, 2013).

The chemical composition and thus the nutritive value of wastes depend on: species and classes of animals, production capacity, nutrient intake, digestion and absorption, feeding management, plane of nutrition and composition of diets and so on (Goering and Van Soest, 1970). Similarly, Acronyms (2000) reported that the amount of nitrogen found in animal manure depends upon the age and type of animal, feeding rate, type of ration, and storage and handling.

Cattle Manure

Cattle manure is a combination of feces and manure, bedding material, wasted feed, and water. In solid form as pen manure, it has high organic matter content. The organic fraction of manure plays an important role in increasing soil organic matter, improving soil structure and water infiltration. Many of the nutrients in the manure, however, are tied up in the organic fraction and must go through a decomposition process to be converted to the inorganic forms available for plant uptake (Smith and Gordon, 1971). The quantity and quality of dairy manure is related to the body weight of the cow, milk yield, and composition of the ration, water consumption and environment. A dairy cow of 500 kg live weight, producing 15 litres of milk, yields approximately 35 kg of fresh manure per day, containing about 88% moisture or 4.2 kg dry matter which includes solids of the manure and urine. The moisture content of faeces usually ranges from 80 to 85% and that of urine from 94 to 96%.

Dried manure contains 13.3-13.4% ash, 1.2-1.6% nitrogen, 77.77-83.5% NDF, 50.5-52.7% ADF, 35.4% cellulose and 32% hemicelluloses (Pennington *et al.,* 1914). The cell wall, NDF, hemicelluloses, cellulose, lignin and ash contents of lactating dairy cattle manure (percent dry matter) were reported respectively as 66, 41, 21, 25 13 and 9 (Smith *et al,* 1973). The same report revealed that percent of total nitrogen in waste of beef, dairy cattle , sheep and poultry to be 50, 60, 50 and 25. Manure from a commercial cattle feedlot about 45% of which was wheat straw bedding, contained on a dry matter (DM) basis, 14.8% crude protein, 14% ash, 0.83% calcium, 0.69% phosphorus, 30.5% crude fiber, and 2.6% fat (Thorlacius, 1976).

The composition of dairy manure varies considerably with the composition and nature of the diet (forage vs. concentrates). The prevailing volatile fatty acid in fermented manure (within 1–4 days) is lactic acid; its level is responsible for a pH value ranging from 4.7 to 6.5. The content of organic matter of dairy manure is 86–90%, and that of mineral matter 10–14%, but the ratio varies considerably with diet composition. For liquid manure systems, it is important that the pit be agitated vigorously before sampling so samples of top water and settled solids are blended, while for solid manure, several cores should be taken throughout the manure. Good sampling procedures are necessary since the nutrients in manure are not distributed evenly between the liquid and solid portions. Dried manure has organic matter and a composition similar to very poor quality hay (Pennington *et al.,* 1914). Remarkable differences in the nutritive value of the liquid and solid fractions of cattle manure were found by Menear and Smith (1973). While the press cake (solid fraction) was high in cell-wall content, the liquid fraction was rich in crude protein, at a level comparable with that of soybean meal. The quantity of nitrogen recovered in the liquid fraction averaged 44%. In addition, the liquid fraction, being low in cell-walls, could serve as protein concentrate for cattle and other livestock species.

Poultry Litter

Broiler litter is the most valuable animal waste because of its high protein content, of which about 45–67% is present as true protein, 18–30% as uric acid and 12–17% as ammonia. A smaller amount is represented by creatine (2–4%) and other N constituents. In comparison to other animal wastes, broiler litter is also relatively high in feed energy. The factors influencing the chemical composition, and thus the nutritional value, of poultry litter are numerous: nature of bedding material, quantity of bedding material per surface unit, density of birds per unit, type of bird, length of rearing period, production intensity, level of nutrition, content of lactose, Mg, Cl, Na and K, ambient temperature and humidity, housing, feed wastage, litter management, nature of ingredients in the ration, moisture content after disposal, type of storage and storage time.

In trials with sheep, Fontenot *et al.*, (1966) reported a TDN value for broiler litter 59.8% (on dry basis); Dřevjany and Müller (1968) in digestion trials with steers (160–180 kg) realized an average TDN value of 52% (range 46–61%) and in 13 samples of broiler litter collected recently in Mauritius (Müller, 1978), it was found that a calculated TDN value for ruminants was between 62 and 67%. This high value was apparently attributable to broiler litter with low ash content (7.6–14.1%). Sheep, being the most suitable ruminants for *in vivo* experiments, have been used in most studies involving the feeding of poultry waste. Like cattle, sheep are excellent converters not only of roughages but also of NPN sources. Poultry waste is utilized by sheep in the same manner as by cattle, and because of their lower plane of nutrition and rather longer period of winter feeding, sheep can also utilize poultry waste of poorer quality and with a higher portion of bedding, normally unsuitable for cattle under intensive feeding management.

In the trials of Jordan *et al.* (1968), a ration containing 22% poultry litter was fed to gestating ewes. The ewes fed this ration gained 130g/day, while control ewes fed a soybean-meal-based ration gained 110g/day. Other performance parameters were similar for both groups, but there was some indication that ewes fed dried poultry litter had a slightly lower lambing percentage. Mclnnes *et al.* (1968), in experiments with 6-month-old lambs, reported that lambs fed with a mixture of 235 g of poultry litter and 190 g of wheat meal performed as well as those fed 365 g of wheat meal per day. Brugman *et al.* (1964) found that lambs fed on a ration comprising 50% broiler litter and 50% barley, gave better results than those of lambs fed barley and 20% sawdust. De Gálmez *et al.* (1970) reported that lambs fed rations containing 38, 58 and 68% poultry litter, based on rice hulls, gave results comparable with those fed on an all-lucerne hay ration.

Pig Waste

The chemical composition and quantity of pig waste depends upon several factors: age, live weight, breed, feed and water intake, digestibility of the ration, housing, environment and waste management. The production of solid pig waste ranges from 0.6 to 1.0% of dry matter per day calculated on body weight. Low-digestibility rations yield relatively more manure. With the increase of body weight the quantity of pig waste decreases significantly (Henning and Poppe, 1977). Faeces represent about 46% and urine 54% of wastes on fresh basis, but on dry basis faeces represent 77% and urine 23%. The pH of pig manure is in the range 7.2–8.3. The chemical composition of manure also changes rapidly with time after excretion (Harmon, 1974).
The biochemical routes of bacterial decomposition of manure can be divided into the aerobic process (resulting in carbon dioxide, nitrites, and nitrates, dissolved nitrogen and soluble sulphates) and anaerobic action (yielding gases such as methane, ammonia, hydrogen sulphate and carbon dioxide).

Processing Methods of Manure

Dehydration

Dehydration is widely applied for commercial purposes, because dried waste can be used either as feed or as urban fertilizer (Sheppard *et al*. 1975). Drying reduces the bulk of animal wastes to 20-30% of the original volume (Surbrook *et al*., 1971) Nevertheless; it is usually a costly process, involving substantial investment and operational costs. Animal wastes must be processed immediately to prevent the rapid decomposition of organic matter and to conserve its nutritive properties.

Losses of the most valuable substances in poultry litter — crude protein — vary considerably according to the drying method and nature of the processing; ensiling completely preserves the nutritive value. The following energy and nitrogen losses as a result of various drying techniques were reported by Shannon and Brown (1969):

Table 1. Energy and nitrogen losses of manure on the different drying methods

Drying method	Energy loss (%)	N loss (%)
Freeze dry	1.3	4.8
Vacuum dry at 40°C	12.0	28.0
Forced-air oven at 60°C	5.5	4.6
Forced-air oven at 100°C	3.2	7.8
Forced-air oven at 120°C	2.8	10.6

Chang *et al.* (1975) found that the dehydration technique determines the final quality of dried poultry waste, particularly the content of crude protein. Nevertheless, apart from ensiling, the drying process is still less wasteful of nitrogen (crude protein) than other animal waste management systems. The nitrogen losses in an oxidation ditch amount to 53%, aerated storage 55%, aerobic digester 90%, holding pond 35%, anaerobic storage 50%, feedlot surfaces 62%, sprinkler system 23% and land surface disposal 31%.

Ensiling

Ensiling of animal wastes is more acceptable than dehydration on ethical grounds. Ensiled cattle manure appears to be nutritionally superior to the dried product (Lucas *et al*., 1975). Animal wastes can be ensiled together with crop residues, forages and other roughages, provided that there are sufficient moisture (40–65%) and soluble carbohydrates to ensure the quality of the fermentation process. The ratio of crop residues or other roughages to livestock wastes is adjusted to obtain a minimal moisture content of about 40%; moisture should not exceed 70%. Molasses (1–3%) or other sources of fermentable carbohydrates must be added if sufficient soluble carbohydrates are not present in the ingredients for ensiling. The digestibility of cellulosic constituents can be improved by adding alkali in the form of sodium, potassium or ammonium hydroxide. Where available, liquid or gaseous ammonia or even bleaching agents could be used.

In view of the fact that animal wastes contain high mineral levels, preference should be given to additives which do not increase the mineral content and thus do not add to the accumulation of undigestible material. Ensiling is a simple process which not only prevents the losses on a total crude protein but also converts part of the NPN into protein-bound protein (true protein). Table 2 shows the effect of ensiling on nitrogen composition.

Table 2. Effect of ensiling on nitrogen composition

	Estimated moisture %	Total nitrogen % of DM	Composition of total nitrogen			
			Protein %	Non-protein %	Uric acid %	Ammonia %
Before ensiling	22	6.25	43.5	56.5	34.4	15.7
	40	6.50	42.8	57.2	37.8	20.2
After ensiling	22	6.27	48.9	51.1	32.4	17.8
	40	6.36	48.6	51.4	38.4	19.5

Source: Caswell *et al*., 1976.

Lower moisture content (22%) apparently reduces the level of uric acid and displaces ammonia nitrogen from the silage. The results indicate that low moisture (22%) affected the nutritive value of litter in all aspects, while 40% moisture ensured preservation of silage by lowering the pH and yielding a sufficient level of lactic and acetic acid. Both treatments reduced total bacterial count; coliforms were completely eliminated in the silage with 40% moisture. Moisture content in the silage has a significant effect on the ratio of the main nitrogenous fractions as appears from Table 85. The ammonia level rises linearly with moisture content, as does the uric acid content when the moisture content is 30% or more. These changes appear to be due to the protein nitrogen, in view of the decline in proteinbound protein at 50% moisture. The authors attribute the decrease in uric acid to favourable conditions for coryneform bacteria frequently found in the litter.

Chemical Treatments

The prime objectives of chemical treatments of animal wastes are to eliminate pathogenic bacteria, preserve nutrients, improve the nutritive value and increase the feed intake of the waste. Caswell *et al*. (1975) compared several processes for pasteurizing wastes: dry heat (150°C for 20 minutes), autoclaving (10 minutes or longer), para-formaldehyde fumigation and treatment with ethylene oxide. All treatments totally eliminated coliforms present in unprocessed litter. Dry heat treatment was less effective in reducing total bacterial count than autoclaving, which yielded the best results at 121°C and 1.05 kg/cm^2 steam pressure for 30 minutes. Fumigation with ethylene dioxide (EO) at 22°C for 120 minutes at depth of litter 76 mm gave results comparable to those for PFA at the 4% level.

The effect of processing on the fate of various nitrogenous fractions (total N, protein N, NPN, uric acid and NH_3 N) was as follows:

i. Dry-heat treatment of litter resulted in substantial losses in all N fractions, the greatest loss being in ammoniacal N (from 0.88% to 0.36%);
ii. Autoclaving resulted in the smallest losses in all N fractions and significantly increased the level of protein-bound N derived from NPN;
iii. PFA treatment at all levels increased the content of protein N of litters processed at 25 mm depth (from 2.22% to 2.75–2.79%) but was ineffective at 6 mm depth except at the 4% level;
iv. EO fumigation reduced total N, protein N and NH_3 N.

Mechanical Treatments

Various mechanical processes, mainly involving cattle and pig wastes, are aimed at reducing volume and separating liquid and solid fractions.

A. Grinding and Separation

The effect of grinding and pelleting dry cattle manure was studied by Smith (1976). Grinding had little or no effect on the digestibility of individual constituents. In fact, ground manure showed a substantial decrease in cell-wall and cellulose digestibility and in N retention, possibly due to a by-pass of rumen digestion because of the reduction in particle size. Mercio and Johnson (1978) attempted to improve the nutritive value of the solid fraction separated from manure by a vibrating screen (8 mesh/cm). The solid fraction was fed to cattle either fresh, ensiled or alkaline treated (7% NaOH). The results are shown in Table 3. The highest voluntary intake of dry matter was recorded with NaOH-treated screened manure solids (SMS) incorporated into rations at the 30% level (on DM).

Table 3. Effect of processing screened manure solids on intake and digestibility

Level of SMS fed	Form of SMS	DMD %	Feed intake (kg)	Digestibility in %			
				NDF	ADF	Cellulose	Lignin
30	fresh	66	8.5	43	43	54	22
30	ensiled	65	5.6	49	45	47	11
30	NaOH treated	70	9.3	53	49	63	24
45	NaOH treated	66	8.6	51	41	62	22
60	NaOH treated	64	5.6	52	45	60	13

Source: Mercio and Johnson, 1978.

At the University of Nebraska, a conical 500-micron screen separator was used to separate feedlot manure into two fractions, coarse and fine. Their chemical composition is given in Table 4. The fine fraction contained 92% of the total manure protein and 82% of digestible solids, while fibre was evenly distributed. The fine fraction appeared to be nutritionally superior to the coarse fraction. The nutritional differences between fractions appear to be attributable to the level of cell walls (fibre) and other undigestibles derived from roughage, while high-concentrate feeding of cattle yields a manure with high IVDMD in both fractions, as well as in the whole manure.

Table 4. Feedlot manure: composition of coarse and fine fractions

	Coarse fraction %	Fine fraction %
Dry matter	80	20
Digestible solids	18	82
Crude protein	8	92
Crude fibre	45	55

B. Oxidation Ditch

The oxidation ditch is a technologically advanced aerobic process applicable to all livestock waste. It comprises a continuous open-channel ditch and an aeration motor that circulates the liquid in the ditch and supplies oxygen. The aerobic action converts organic matter into single-cell protein, enabling the protein level in pig rations to be reduced by 15% (Day, 1977). Feeding oxidation ditch mixed liquor (ODML) in the form of nutrient-rich drinking water or adding it to a regular ration (2:1) was developed by Day and Harmon (1974). The nutritive value of ODML is high in terms of protein (25–50% on DM) and essential amino acids, but the energy content is low because of the high mineral matter level.

Compost for Feeding

There are several methods of composting, but basically they can be divided into static or dynamic processes. In the static process the semi-dry manure, alone or together with other organic material, is spread in layers and turned over once or several times during the composting process. The moisture content should be within the range of 40–50%; otherwise, anaerobic processes take place. In the dynamic process the material is constantly revolved in a digester, and the prevailing microflora is usually represented by bacteria. The significant fungal infestation takes place later, except that when the organic material remains in the digester for a longer period, fungal development replaces the bacterial population in the final stage of the fermentation process. The organic matter content of processed compost is a decisive factor in establishing the quantity that can be used in ruminant diets. It is therefore necessary to use fresh compost immediately after processing to avoid its mineralization, which results in lowering its organic matter content.

From the author's experience (Müller, 1975), it appears that the level of compost in ruminant rations could be in the range of 15–40%. The composting process, geared to a ripe compost, is wasteful in terms of energy (carbon) and other nutrients: an input of 100 kg of solids results in an output of 40 kg solids, 60 kg solids being lost in the form of CO_2 and other gases. Accordingly, in producing fresh compost for ruminant feeding, the process must be shorter to limit mineralization, but long enough to eliminate pathogens. The mass balance of such a process is more favourable, as losses on carbon are restricted to 15–30%. Aeration of the waste by turning enables the aerobic thermophilic process to be completed within 7–14 days, while mechanical processes with forced aeration can take only 2–4 days.

Feeding Manure to Livestock, Poultry and Pigs

Feeding Manure to ruminants

The simplest approach to refeeding cattle wastes is to remove the air dried waste from feedlots, grind it and mix it in rations. Dried manure added to feedlot cattle rations at levels of 20 to 60 percent has been studied by Albin and Sherrod (1975). It was concluded that the manure is nutritionally valuable and that acceptance is not a problem. However, recycling through feedlot cattle removes only about 30 percent of the dry matter of manure. An approach to solving the problem of manure removal is to feed it to cows on winter range. Hull *et al.* (1973) fed 75 percent dried manure pelleted with 25 percent barley to pregnant cows on range. Initially the cows refused the pellets, but a two- to three-week adjustment period resulted in pellet consumption of 5.5 to 8.2 kg per head per day.

Steer manure has been fed to finishing beef cattle either mixed fresh with other feeds or as waste lage. When fed fresh, the manure is collected daily from the pen and blended with the ration in the ratio of 2:3. The mixture is kept in a closed container overnight and fed the following day. When fed as wastelage, fresh manure is mixed with ground grass hay in the ratio or 57:43 and stored in a silo, where it ferments and acquires a silage odour. The product has been combined with concentrates for feeding to finishing cattle and has also been used as the sole feed for ewes and beef cows. A complete ration recommended for feedlot cattle consists of 40% fresh cow manure mixed with 42% cracked maize and 18% maize silage. The mixture is ensiled for ten days before feeding. When wastelage is fed alone for a long period, it may be necessary to add vitamin A and phosphorus or feeds rich in these growth factors. Feeding manure to dairy cows produces no effect on lactation or milk taste.

Digestion trial results indicate considerable variations in nutrient digestibility (Albin and Sherrod, 1975). Manure from cattle fed high concentrate rations generally showed a dry matter digestibility of 40 to 50 percent, while that from high forage rations had digestibilities as low as 16 percent, although in this case digestibility may have been reduced by the heating temperature of 120°C. Protein digestibility likewise showed a wide range from 15 to 70 percent. Dairy cattle wastes have a higher content of fibre than wastes from feedlot cattle because of the difference in feeding practices. Tinnimit *et al.,* (1972) obtained 29 percent digestibility of dry matter and Smith *et al.* (1969) found equally low values for dairy manure from cattle fed an all-forage diet.

The most comprehensive cattle manure processing and refeeding studies have been carried out. Anthony (1969) fed different levels of silage (wastelage) based on 57% of fresh cattle manure and 47% of chopped hay. In experiments with washing, autoclaving, cooking and ensiling, the latter proved to be the most effective and also the most practical. The results indicated that cattle performed quite satisfactorily even when fed a very high level of dairy cattle manure (6.34 kg DM/head/day). Feedlot manure from beef cattle fed 80% concentrate and 20% roughage was tested by Braman (1976) as a feed component for heifers. The manure, scraped from concrete floors, contained 17.1% crude protein, 20.1% crude fibre and 9.6% ash. In a metabolism trial, the protein value of the manure (fed dehydrated) was compared to that of cottonseed meal. Relatively high DM digestibility was achieved: 82% for the maize/cottonseed-meal ration and 77% for the maize/manure ration. In a feeding trial, a mixture of 60% feedlot manure, 35% peanut hulls and 5% ground maize was ensiled and compared with a conventional ration comprising hay, maize silage and maize grain (FAO, 2013).

Feeding Manure to Poultry

Palafox and Rosenburg (1951) included oven-dried and air-dried cow manure in layer and breeder rations at levels of 5, 10 and 15 percent of the diet. Egg production, hatchability and body weight were equal to control up to the 10 percent level. No significant differences were observed in shell thickness or egg quality, but higher levels of dried cow manure produced darker yolks. Lipstein and Bornstein (1971) observed no toxic effects when dried cow manure was fed to very young chicks; however, it produced decreased growth rates and feed utilization in broilers due to the low content of metabolizable energy.

Bird and Marvel (1943) reported great growth and hatchability improvement by feeding 10% faeces to battery-kept birds. Whitson *et al*. (1946) reported that drying cow manure at 80°C produced better results with layers than at 45°C. The latter temperature affected egg production while the former did not. Hatchability was normal on either ration. Turner (1947) reported that the performance of male chicks fed manure from lactating cows was reduced when the manure exceeded 10% of the ration, while pullets responded well to 20%. Bird *et al*. (1948) reported that 5% of dried cow manure was an effective supplement in growing turkeys. The growing turkey has a critical need of an unknown dietary factor which occurs in cow manure, fishmeal and, probably in smaller quantities, in meat meal. The authors apparently referred to APF (animal protein factor), Slinger *et al*. (1949) reported that a supplement of 5% dried cow manure was effective when fed to turkeys in a maize/soybean ration.

Palafox and Rosenberg (1951) observed that oven-dried or sun-dried cow manure, when substituted for mash, satisfactorily supported egg production and reproduction, but not at the 15% level. Lipstein and Bornstein (1971) observed that dried cow manure (36.4% ash) as a mineral supplement had no toxic effect when fed to chicks. Under a UNDP/FAO programme in Singapore, 10% beef cattle manure (with wood shaving bedding) was successfully fed to layers (Müller, 1974) to economize on hen rations.

Table 5. The effect of feeding manure to laying hens

Treatments	1–16 weeks		17–32 weeks	
Parameters	Control	Cattle waste	Control	Cattle waste
Egg production (%)	77.6	80.5	60.5	69.9
Avg. egg weight (g)	53.3	54.0	58.6	59.4
Feed intake (day/g)	98.8	99.3	96.8	104.6
Feed consumption (kg)	11.06	11.13	10.8	11.7
Feed efficiency (kg/kg egg)	2.39	2.29	2.73	2.52
Body weight gain (g)	207	207	250	200
Mortality (%)	5.0	3.8	5.3	1.3

Source: Müller, 1974.

Feeding cattle manure to laying hens had no significant effect on egg production or fertility of the eggs.

Feeding manure to pigs

Bohstedt *et al*. (1943) observed that free access to fresh cow manure permits pigs to avoid deficiencies in B-complex vitamins which may result “if only the usual 5% or less ground alfalfa hay is fed in the ration. A very interesting light is shed on the helpful supplementary effect of cattle manure which is not due to any whole undigested corn it may contain”.

Squibb and Salazar (1951) fed pigs a ration containing sun-dried fresh cow manure which was readily consumed. However, because of the energy imbalance of the ration (high fibre) the pigs' performance was poor. Putnam (1971) reported experiments with feeding pigs with beef feedlot manure subjected to several treatments. Treated beef manure was successfully fed up to 85% of the total ration. Cattle manure mixed with molasses (40% manure, 40% molasses and 20% conventional balancing ingredients) was readily consumed by pigs. The results were not comparable to those of commercial pig formula, but the economics were said to be in favour of a ration containing the mixture. A cattle/pig recycling situation involving individual classes of pigs under a semi-intensive feeding system is outlined in Table 6. When rations are carefully balanced, substantial savings could be made on pig feed.

Table 6. The effect of feeding cattle manure to pigs on intake

Class of pigs	Average feed consumption (kg)		Level of cattle manure fed	
	per day	per day	%	kg/year
Growing	2.0	730	7	51.1
Finishing	3.0	1,095	10	109.5
Gestation	3.0	1,095	15	164.3

In feeding cattle manure to pigs, it must be borne in mind that only manure from cattle fed high-concentrate rations will be suitable, while manure derived from higher roughage rations would contribute very little or could even produce negative results.

Feeding Pig Waste

Pig waste is a biomass that changes rapidly from the time of excretion. It creates a serious pollution problem. Pig waste amounts to about 1% of weight of the pig, and from the nutrition standpoint it is much poorer than poultry waste. Approximately 15–20% of nutrients by-pass the digestion. Much however depends upon the plane of nutrition and other factors. The magnitude of the feeding potential has been evaluated in several studies. Diggs *et al*. (1965) fed dried pig manure collected from concrete floors to pigs; the results summarized in Table 7, indicate that incorporating the waste at the 30% level depressed growth and feed efficiency.

Table 7. Effect of refeeding pig manure to pigs

Performance	Level of pig manure in pig diet (%)		
	0	15	30
Average daily gain (g)	709	777	695
Feed/gain	3.61	3.62	4.66
Average daily intake (kg)	2.56	2.81	3.24

Source: Diggs *et al*., 1965.

Flachowsky (1975) tests the feeding value of pig waste to bulls. The performance in all groups was quite satisfactory, although, the diet containing 50% pig manure, exhibited somewhat lower gain. Nevertheless, these experiments clearly demonstrated that pig waste, when processed and properly balanced with other ingredients, may become a potential feed substitute for cattle at levels up to 30%.

Table 8. Feeding dried pig faeces to finishing bulls (252 days)

Parameters Unit		Level of pig faeces (% DM)		
		0	30	50
Initial weight (pig/head)	kg	150.2	149.6	149.9
Pellets intake head/day	kg DM	7.98	7.58	8.20
Hay intake head/day	kg DM	0.43	0.84	0.84
Gain head/day	kg	1.23	1.18	1.00

Source: Flachowsky, 1975.

Recycling of pig waste to cattle, sheep and pigs is possible at 10–30% DM level in the ration providing the waste is properly balanced and processed, and the content of critical nutrients (cell walls, ash, copper, drugs and other undesired constituents) does not exceed the tolerance level beyond which the performance of livestock would be adversely affected.

Summary

The dehydration of cattle excreta for use as an ingredient in cattle feed is clearly uneconomical.

Research studies have clearly demonstrated that cattle waste will be eaten in large quantities by cattle and sheep, and that it contains nutrients that can be utilized. Protein is the most valuable nutrient. The feeding trials reviewed indicate the wide variation encountered in the nutritive value of cattle manure. This is attributed to differences in the ration fed, the surface from which the manure was collected, and storage or drying conditions. Manure from cattle fed high forage rations generally has a low feed value. Manure can be chemically treated to improve the digestibility of fibre, but the process has not been economic. Processing methods to separate a major part of the fibre and insoluble minerals have been developed, but expensive machinery and drying of the high-protein fraction from manure are required. This protein fraction has been shown to be of value to both cattle and non-ruminant animals.

Feeding trials with fresh or dried cattle manure and manure products have not resulted in any evident disease or pathological conditions. Nevertheless, the practice is not widely approved by regulatory agencies. No differences in the quality of meat from animals fed waste have been detected, nor has there been a problem of consumer acceptance in cases where it was studied.

References

Albin, R.C., and L.B. Sherrod, 1975. Nutritional value of cattle feedlot waste for growing fishing beef cattle. ASAE Publ. PROC-275:211.
Anonyms , 2000. All contents copyrighted.All rights reserved. http://ag.arizona.edu/animalwaste/

Anthony, W. B., 1966. Utilization of animal waste as feed for ruminating animals. Proc. Nat'l. Syrup. of Animal Waste Manage. ASAE Pub. No. SP- 0366:109.
Anthony, W. B., 1970. Feeding Value of Cattle Manure for Cattle**.** *J ANIM SCI* 1970, 30:274-277.
Bohstedt, G., Grummer and O. B. Ross. 1943. Cattle manure and other carriers of B-complex vitamins in rations for pigs. J. Anim. Sci. 2:373.
Bird, H.R., S.J. Marsden and W.L. Kellogy, 1948. Supplements for soybean meal in turkey diets. Poult. Sci, 27:53–59.
Braman, B. 1976. Feedlot waste protein, energy values shown. Feedstuffs, Oct. 11.
Brugman, H.H., H.C. Dickey, B.E. Plummer and B.R. Poulton. 1964. Nutritive value of poultry litter. J. Anim. Sci., 23:869 (Abstr.)
Caswell, L.F., J.P. Fontenot and K.E. Webb, 1975. Effect of processing treatment on pasteurization and nitrogen components of broiler litter and on nitrogen utilization by sheep. J. Anim. Sci. (40), 4:750–758.
Chang, T.S., D.J. Currigan and E. Linden, 1975. Ammonia content of caged layer excreta. Res. Rep. 269. Michigan St. Univ. Agri. Exp. Sta., East Lansing, Feb. 1975.
Diggs, B.G., B. Baker and F.G. James, 1965. Value of pig feces in swine finishing rations. J. Anim. Sci., 24:291. (Abstr.)
Drevjany, L. and Z. Muller, 1968. The effect of bedding material on vitamin content in broiler litter. Rep. Res. Inst. Biofactors in Anim. Nutr. Horni Pocernice (In Czech.)
Fontenot, J.P., A.N. Bhattacharya, C.L. DRAKE AND W.H.MCCLURE. 1966. Value of broiler litter as a feed for ruminants. ASAE Publ. SPO 366:105.
Goering, H.K. and P.J. Van Soest, 1970. Forage fiber analyses (apparatus, procedures, and some applications). USDA Agric. Hndbk. 379.
Hamron, B.W. 1974. Potential for recycling swine waste. Feedstuffs (46), 9:40.
Hennig, A. and S.Poppe, 1977. Animal wastes as a feed. St. zem. nakl., Praha (In Czech.)
Hull, J.L. and J.B. Dobie, 1973. Feedlot animal waste compared with cotton-seed meal as a supplement for pregnant range cows. ASAE Paper No. 73–4506.
Johnson, W.L., J.C. Wilk and A.H. Rakes, 1975. Refeeding value of screened dairy Manure solids. J. Anim. Sci. (41), 1:241.
Jordan, R.M., H.E. Hanke, G.C. Marten and J.W. Rust. 1968. Poultry litter and oyster shells for gestating ewes. Univ. Minn. Agri. Exp. Sta. Bull. No. 489:10–11.
Lucas, D.M.,J.P.Fontenot and K.E. Webb, 1975. Composition and digestibility of cattle fecal waste. J. Anim. Sci. (41), 5:1480–1486.
Mcinnes, P., P.J. Austin and D.L. Jenkins. 1968. The value of a poultry litter and wheat mixture in the drought feeding of weaner sheep. Aust. J. Exp. Agri. Anim. Husb., 8:401–404.
Menear, J.R. and L.W. Smith, 1973. Dairy cattle manure liquid:solid separation with a screw press. J.Anim.Sci. (36), 4:788-791.
Mercio, T.A.P. and W.L. Johnson, 1978. Digestibility and intake of rations with fresh, ensiled, or NaOH-treated screened manure solids. 70th Ann. Mtg., ASAS, Michigan St. Univ. East. Lansing, July 9–13. (Abstr. 629.)
Müller, Z., 1975. Livestock waste as future energy resources. Proc. 5th Inter. ERE Symp., Kuala Lumpur, Feb.19, 1975, p. 287–297.
Müller, Z. 1978. Project on recycling of organic waste in Indonesia.
Palafox, A.L. and M.M. Rosenberg, 1951. Dried cow manure as a supplement in a layer and breeder ration. Poul. Sci. 30:136.
Putnam, P.A. and J. Bond, 1971. Drylot feeding patterns for the reproducing beef cow. J. Anim. Sci. (33), 5:1086. USDA.
Shannon, D.W.F. and W.O. Brown, 1969. Losses of energy and nitrogen on drying poultry excreta. Poult. Sci., 48:41–43.
Sheppard, C.C., C.J. Flegal, H.C. Zindel, T.S. Chang, J.B. Gerrish, M.L. Esmay and F.Walton, 1975. Modifications of the Michigan St. Poult. In-House Drying System, Proc. 3rd Inter. Symp. Mgmt Lvstk. Wastes. ASAE, 1975,74.
Smith, L.W. 1976. The nutritional potential of recycled wastes. Proc. Tech. Consult. on New Feed Resources. FAO. Rome, 1977.
Smith, L.W. and C.H. Gordon, 1971. Dairy cattle manure-cornmeal rations for growing heifers. J. Anim. Sci., 33:300. (Abstr.)
Smith, L.W., 1973. Nutritive evaluations of animal manures. Symposium:processing agricultural and municipal wastes. George E. Inglett (Ed.). Avi. Publ. Co., Westport, CT.

Surbrook, T.C., C.C. Sheppard, J.S. Boyd, H.C. Zindel and C.J. Flegal, 1971. Drying poultry waste. Lvstk. Waste Mgmt. and Pollut. Abatement. Proc. Inter. Symp. on Lvstk. Wastes. ASAE, Michigan, Apr. 19–22, p. 192–194.

Thorlacius, S.O., 1976. Nutritional Evaluation of Dehydrated Cattle Manure Using Sheep. Canadian Journal of Animal Science, 1976, 56(2): 227-232, 10.4141/cjce, 1976, 56(2): 227-232, 10.4141/cjas76-027

Turner, C.W., 1974. Dried lactating cow manure in the ration of growing chickens. Poult. Sci., 26:143–149.

Whitson, D., H.W. Titus and H.R. Bird, 1946. The effect of feeding cow manure on egg production and hatchability. Poult. Sci., 25: 143–147.