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Use of animal wastes for fertiliser

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The use of animal wastes as fertiliser

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The trend to intensify animal production by concentrating animals on a small area and importing feed from outside the feeding area, offers many opportunities for economies of operation. However, it leads to the concentration of waste products, dung and urine.

Farmyard manures have for many years been used as fertilisers, and their value is appreciated by market and home gardeners. However, the production of cheaper and more easily handled artificial fertilisers has reduced the demand for these manures.

Expansion of intensive livestock units has been rapid, and producers are finding it necessary to take active, and sometimes costly steps, to dispose of manure. For this reason, the use of animal wastes as fertilisers has received renewed attention. In South Australia, manures are available from intensive livestock units producing broiler chickens, eggs and pig meat. Smaller amounts of manure come from dairies and sheep yards.

This article discusses the value of animal manures as fertilisers and the extent to which they can replace artificial fertilisers.

Amounts of manure

The amount of manure depends on the type, weight and age of animals, and the composition of their feed. In addition, the volume of waste can often depend on the amount of water added to the manure and urine during the hosing down of sheds and pens, and from rainfall. The type of sheds and yards may therefore affect the total volume of waste for disposal.

Poultry

Broiler chickens. The amount of manure produced by broiler chickens is equal to about half the weight of feed consumed. This amounts to about 2.5 tons (2.5 tonnes) per batch of 1,000 broilers, or about 10 tons per 1,000 birds per year.

Laying hens. Australian and overseas measurements indicate that 1,000 layers produce about 1.5 to 2.0 tons of fresh manure per week, or about 10 per cent of their liveweight daily or 70 to 100 tons (71 to 101.5 tonnes) per 1,000 birds per year).

Pigs

A pig weighing about 150 lb. (68 kg) liveweight produces about one gallon of undiluted waste per day. This amount consists of about 65 per cent faeces and 35 per cent urine (totalling about five to nine per cent of total bodyweight daily). Shed and pen washings can increase this to two to four gallons (9 to 18 litres) per head per day.

For pigs the following approximate conversion rates have been found to apply:

Weight of faeces = 0.6 x weight of feed consumed

Volume of urine = 0.6 x volume of water consumed

Cattle

The waste output for a 1,000 pound (453 kg) beast is about nine gallons (41 litres) per day of manure plus urine (about seven to nine per cent of bodyweight daily). This amounts to about 3,000 gall. (13,500 litres) or 10 to 15 tons (10 to 15 tonnes) of slurry per year.

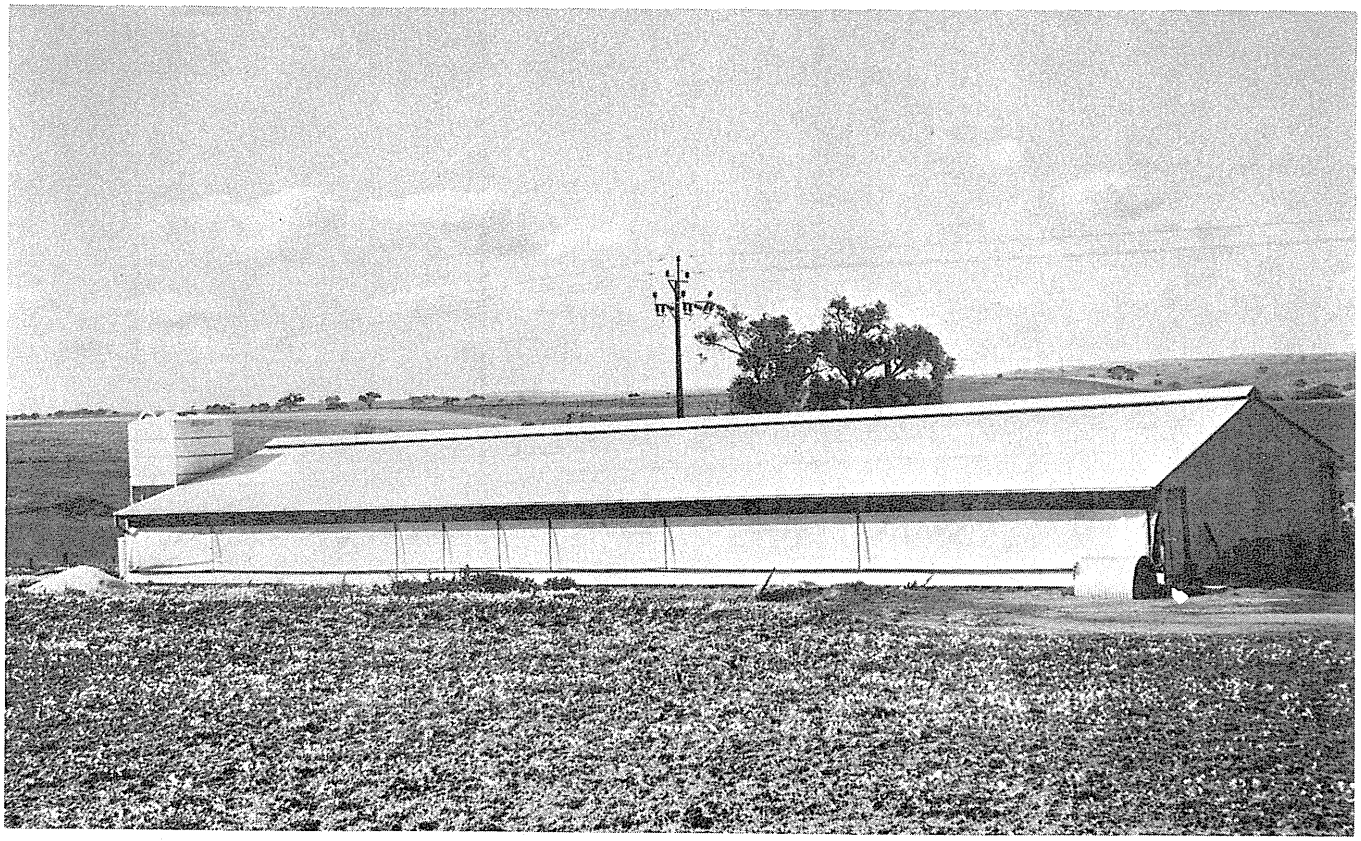
Waste composition

Animal manures contain organic materials both suspended and soluble, a bacterial population, soluble salts excreted by the animal, and water. The amount of water varies greatly, but it generally depends more on the amount of water added to the excrement, than the actual water output from the animal.

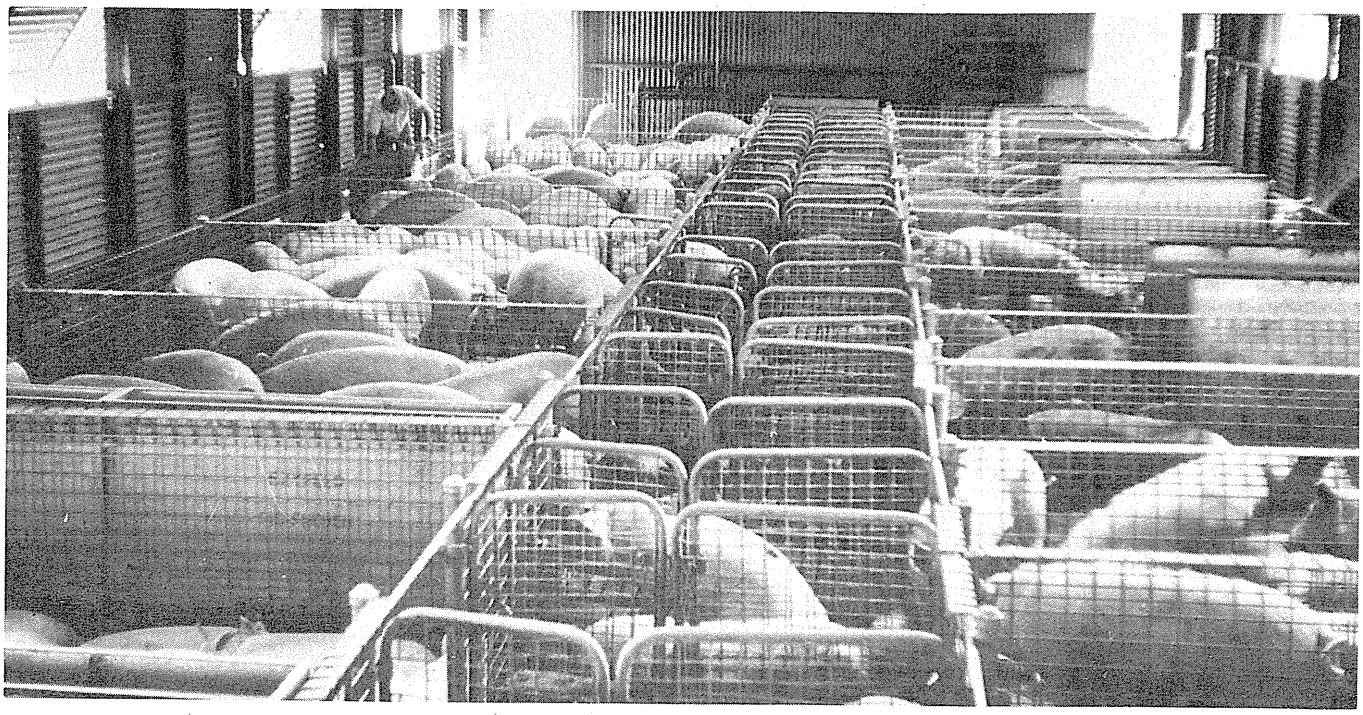
Three plant nutrients, nitrogen, phosphorus and potassium, are present in useful amounts in animal wastes. The waste can therefore be considered as a fertiliser.

The proportions of the different components depend on many factors, including the type, size and weight of the animals, the composition of the feed, and the type of housing and bedding materials. In addition, the conditions of storage of manure during and after collection affect the composition. For example, lagoon treatment removes much of the organic material and nitrogen compounds. Nitrogen, in the form of ammonia, is lost to the air from drier manures, and soluble materials can be leached and washed away from manure heaps kept out of doors and exposed to the weather.

Hydrated lime, gypsum and superphosphate are good absorbers of ammonia (and other gases).



Large sheds for poultry production are a common sight in the Adelaide Hills and are a good source of manure.



Sheds for intensive pig meat production produce large amounts of manure.

They have been used in the United States to prevent nitrogen loss from poultry manures while still in the shed by mixing 100 to 400 lb. of these materials to each ton of manure (45.3 to 180 kg per tonne). If superphosphate is added, the relatively low phosphate content of poultry manure is overcome.

It is clear therefore, that steps can be taken to improve and conserve the fertiliser value of animal effluents.

Analyses of effluent samples from South Australia and overseas provide the results listed in Table 1. The wide range in analysis values is mainly due to the varying levels of dilution of the faeces and urine by washing and rain water. The higher nutrient figures indicate the composition of undiluted manure plus urine.

Table 1: Poultry manure (South Australian figures).

All figures as per cent dry weight

	Water	Nitrogen	Phosphorus	Potassium
Broiler sheds	13–41	2.1–3.8	0.6–1.3	0.6–1.3
Cage sheds	7–37	2.7–4.0	1.1–2.6	0.8–1.3
Litter sheds	14–30	2.1–2.7	1.3–1.9	0.7–1.4
Calcium	1.4%			
Sulphur	0.3%			
Sodium	0.12%			
Magnesium	0.2%			
Iron	0.002%			
Chlorine	0.18%			

Trace elements

Copper	9.25 p.p.m.
Manganese	71.4 p.p.m.
Cobalt	0.09 p.p.m.
Zinc	20.7 p.p.m.
Iodine	13.7 p.p.m.

Liquid waste

	% Nitrogen	% Phosphorus	% Potassium
Pigs	0.22–0.54	0.038–0.23	0.133–0.357
Cattle	0.34–0.74	0.038–0.179	0.033–0.780
Poultry	0.9 –1.42	0.191–0.344	0.332–0.871

These figures can be recalculated to give the analysis results in terms of amounts of nutrient per ton of manure or per 1,000 gall. of liquid (see Table 2).

Table 2: Poultry manure — pounds per ton of dry manure.

	Nitrogen	Phosphorus	Potassium
Broiler sheds	47–85	13–29	13–39
Cage sheds	60–90	25–58	18–29
Litter sheds	47–60	29–43	16–31

Liquid waste — pounds per 1,000 gall.

	Nitrogen	Phosphorus	Potassium
Pigs	22–25	4–23	13–36
Cattle	34–74	4–18	78
Poultry	90–142	19–34	33–87

Using this information we can therefore calculate the actual nutrient output of various farm animals in terms of pounds per animal per year (Table 3). Because levels vary greatly, these calculations should be taken only as an estimate of animal nutrient output.

Table 3: Nutrient output in faeces and urine — in pounds per animal per year.

The figures in brackets are results obtained in South Australia; the remainder are from overseas publications.

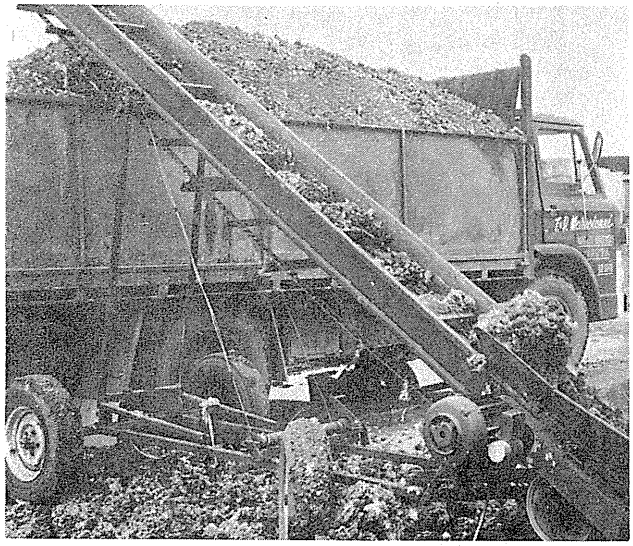
	Nitrogen	Phosphorus	Potassium
Broiler chickens	0.78	0.15	0.25
Laying hens	2.3 – 5.2 (2.6)	0.25 – 0.4	0.4 – 1.0
Pigs	8.23 (17)	1.6 – 5 (1)	3 – 10 (6.2)
Feedlot beef	40 – 70	14	18 – 84
Dairy cows	140	28	144

In addition to these nutrients, farmyard manures contain large amounts of organic matter. Trace elements are also present, sometimes in such high concentrations that the rate of manure application must be restricted. For example, copper is added to the feed ration of broiler chickens and pigs to increase their growth rate. A large proportion of this copper is excreted in the faeces, and if heavy dressings of this manure are used as fertiliser, dangerous increases in the soil copper level can result.

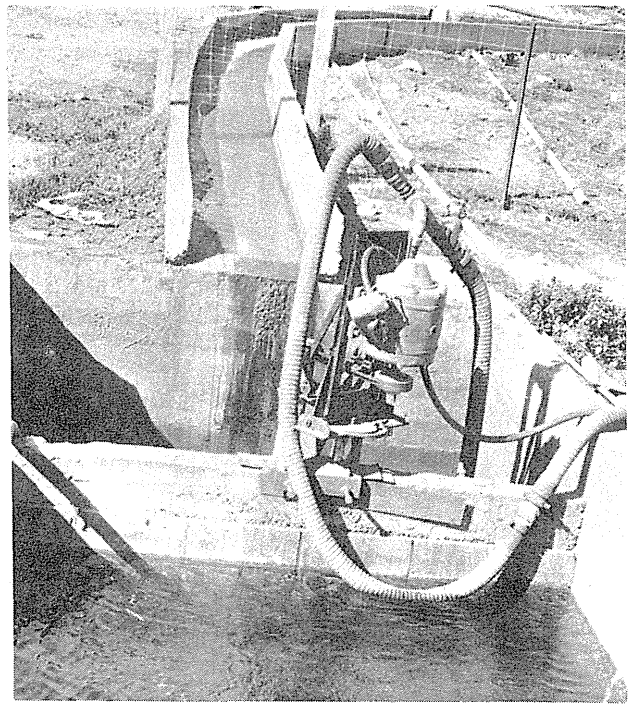
Piggery effluent is usually very saline, with large amounts of sodium and bicarbonate. Completely undiluted piggery effluent contains about 28,000 p.p.m. of total salts. Dilution with washing water generally reduces this to about 10,000 p.p.m. of total salts.

Drugs given to animals may also be present in their waste. Research work in the United Kingdom is aimed at finding the effect these drugs may have on animals eating forage fertilised by the waste.

Solid and liquid manures can be easily handled with the right equipment



Poultry manure being loaded with a conveyor.



Electric pumps designed for slurries can be used for loading tankers, or for operating sprinkler irrigation systems.

Trailers towed by tractors, with power take-off operated pumps, offer a convenient method for transporting slurries.

Transmission of these drugs, and of diseases to animals grazing forage immediately after the manure has been spread must therefore be considered. It is probably desirable to rest fodder paddocks for four to six weeks after the manure application before grazing.

Manure application rates

Unfortunately, a tendency to apply animal wastes at heavy rates does exist, simply to save time and money. As with any fertiliser, very high application is not only wasteful, it may create problems.

Although nitrogen is a valuable nutrient it can also be responsible for a number of problems if the waste is applied heavily. A limit of 300 lb. per acre per year of nitrogen is therefore suggested as a maximum application rate. There are a number of reasons for this recommendation.

Except in some irrigation situations application of nitrogen greater than 100 lb. per acre generally gives little additional plant response over lighter applications. No extra response can be expected for applications above 300 lb. of nitrogen per acre per year.

Very high nitrogen applications can cause the accumulation of toxic levels of nitrate nitrogen in fodders. Cattle or sheep eating this herbage may suffer from nitrate poisoning and grass tetany, both of which are fatal diseases.

The risk of both ground water and surface water pollution increases with increasing fertiliser application. Water containing greater than 10 parts per million of nitrate nitrogen is unfit for human consumption. Sheep and cattle are also adversely affected by water containing nitrates.

Nutrients present in water storages such as dams and reservoirs encourage the growth of algae. If this growth is permitted, oxygen may be used from the water, resulting in the death of fish and other water life. Odours and poisons which render the water dangerous to birds, animals and man are produced, and the water becomes a liability.

Extremely heavy manure applications will kill plants in the same way as high rates of artificial fertilisers. Eventually the soil is made useless for plant growth.

Application of undiluted liquid wastes causes leaf burning due either to a high nitrogen content (as in poultry manures) or to high salt levels (e.g. piggery waste). This can be avoided by dilution before application, or by irrigating the crop or pasture immediately afterwards with good quality water to wash effluent off the leaves.

High nitrogen fertiliser applications can reduce plant root growth. As a result, grazing animals may pull the plants out of wet soil.

However, these problems will only occur if manure applications are excessive. Careful application at conservative rates can produce good plant growth responses.

Animal manures contain a mixture of nutrients only found in expensive artificial fertilisers. The organic matter improves soil structure and tilth, thereby making cultivation easier and improving water infiltration. Such effects are most apparent and desirable on very clayey soils, although organic matter improves the fertility of sandy soils.

The trace elements in animal manures are significant and can be important on some soils.

Overseas results indicate that over half the nitrogen and potassium applied in cattle, pig and poultry manures is available to the plant during the year of application. The remainder adds to the store of nutrients in the soil, and becomes available in following years. Prolonged use of manures can therefore result in a steady build up of soil fertility.

To summarise, it is not possible to suggest an optimum rate of manure application because of the variation in soil, crop and manure composition. A maximum application of 300 lb. per acre of nitrogen is the only guide.

This amount may not provide a balanced fertiliser dressing, particularly of phosphate, the level of which is often low compared to nitrogen and potassium. Therefore, it may be necessary to boost the phosphate level by the addition of superphosphate to the manure. Alternatively, phosphate can be applied to the field in the normal manner.

If analysis of the manure is not possible the figures in Tables 1 and 2 can be used to estimate the amounts of the main nutrients. These figures can be used to calculate the number of animals which will produce 300 lb. (136 kg) of nitrogen per year (see Table 4)

Table 4: Number of animals which produce 300 lb. (136 kg) of nitrogen per year.

Broiler chickens (5 broods, 12 months)	372
Laying hens	85 (mean output of 3.5 lb. (1.6 kg)/ bird)
Pigs	20
Feedlot beef cattle	4
Dairy cows	2

Therefore, for a population of 200 pigs (of about 150 lb. (68 kg) bodyweight) the manure should be spread over 10 acres (4.0 hectares) to apply about 300 lb. of nitrogen per acre (136 kg per hectare).

Similarly, the manure from 425 laying hens should be spread over five acres (2.0 hectares) to supply 300 lb. of nitrogen per acre (136 kg per hectare).

Value of manure if used as fertiliser

The monetary value of stock effluent as a fertiliser can be estimated if we assume the effluent has equal plant nutrient value as artificially manufactured fertiliser (and it may have even higher value because of its trace element content). The manure value per beast can be calculated from the following nutrient values:

Nitrogen	8.3 cents per pound (18.3 cents per kilogramme) (as in urea)
Phosphorus	11.9 cents per pound (26 cents per kilogramme) (as in superphosphate)
Potassium	5.8 cents per pound (12.7 cents per kilogramme) (as in muriate of potash)

Fertiliser value (in cents per animal per year)

	Nitrogen	Phosphorus	Potassium	Total
Broiler chickens	6.5	1.8	1.45	9.75
Laying hens	29.1	3.8	4.06	18.26
Pigs	128	39.3	37.7	205
Beef cows	456	167	296	919
Dairy cows	1163	334	840	2337

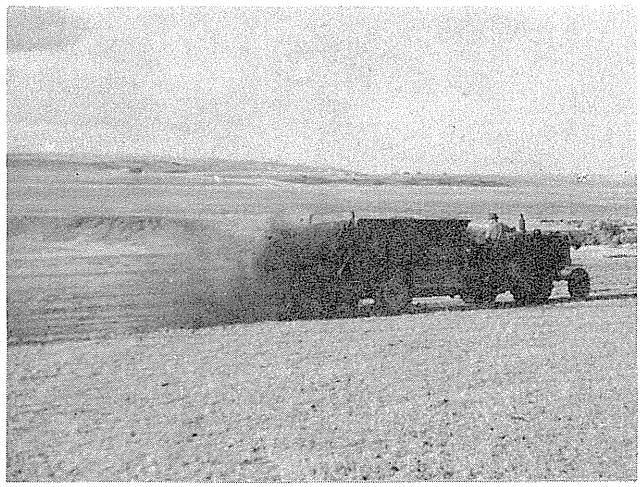
Note that, if any of the nutrients in the manure are not required in a particular situation, then such nutrients have no value. For example, in a situation where only phosphorus applications are needed, then the total value of the broiler chicken manure shown above as 9.75 cents becomes 1.8 cents per bird per year.

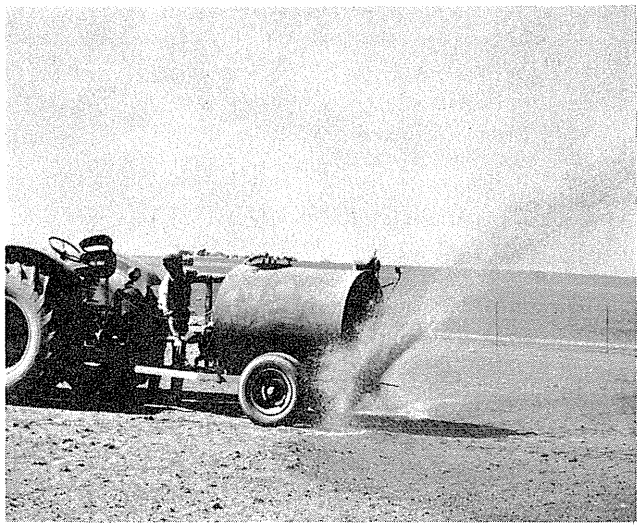
Manure spreading

Methods of application

Poultry manure, and perhaps relatively dry cow manure can generally be readily transported and spread in a solid form.

Good equipment makes land spreading of manures easy





Liquified manure can be sprayed on land using special irrigation equipment, or it can be spread from tankers. The choice between these two methods depends on the amount of liquid to be handled, and the distance to the area for application. It may be necessary to add some water to semi-liquid manures to make sprinkler application possible.

Hydraulic handling of liquid manures may be an easier and less disagreeable task than handling

more solid manures because the handling can be mechanised. However, adding water increases the volume of effluent to be handled and stored, and often increases the smell of the material. For these reasons, efforts should be made to keep water additions to a minimum.

Research work in the United States is testing whether soil injection of liquid wastes is a practical method for disposal. With this method, slurries are placed beneath the soil surface using a tanker and a modified single furrow plough. Although still in the development stage, this method offers a number of advantages. For example, it may allow complete utilisation of the nutrients, as well as eliminating any odour problem.

Care in application

Care is needed to avoid the spread of bad odours from slurries during and after land spreading, particularly if the application is done near residential areas.

Spraying into the air spreads the odours, and it is not a recommended method for foul smelling slurries. Such slurry should therefore be spread thinly early in the morning on dry days, so that it dries quickly thereby reducing odour. Spreading when the wind blows odours away from neighbours is recommended.

Transport of slurries from the stock to the paddock for spreading should be done in completely covered and sealed tanks to avoid spillage on roadways and tracks.

Run-off from sloping paddocks may occur if too much slurry is applied to a small area, or if it is applied to a saturated soil. This run-off can easily contaminate streams, rivers and farm dams. It may be desirable to store the manure to allow spreading when conditions are suitable.

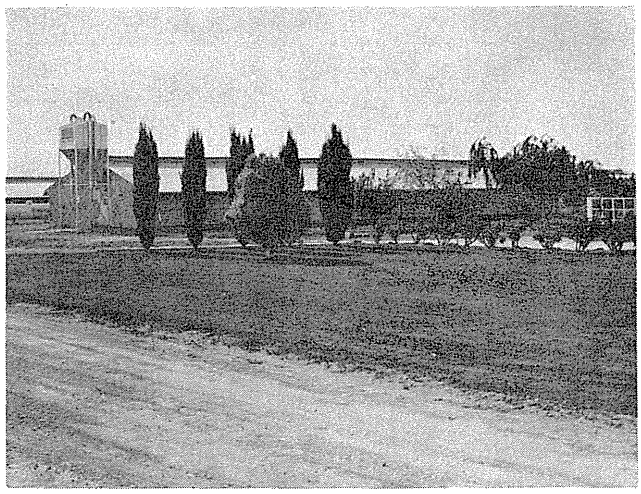
The importance of careful management of manure spreading to avoid both stream pollution and bad odours can not be over-estimated. Many intensive stock units in the United States and elsewhere have been forced to close due to ineffective control of these pollutants. The maintenance of good public relations is important.

A note on irrigation

Using slurries for irrigation is not feasible unless large amounts of good quality water are available to mix with the effluent.

Irrigation of pastures in the Adelaide Hills for example, needs at least 500,000 gall. of water per acre per year simply to supply the water needs of the plants. If this were provided in the form of piggery effluent of average composition (about 1,500 parts per million of total nitrogen), the nitrogen application would be about 3.3 tons per acre, equivalent to 7.3 tons of urea fertiliser. To put it another way, with a limit of 300 lb. of nitrogen per acre, the amount of water which the effluent can contribute is only 20,000 gall.

It is therefore obvious that the effluent can not be considered as a source of water for irrigation. It can however, be used quite safely and advantageously as an additive to irrigation water. In this way it is disposed of easily, and its nutrient content is utilised.



Neighbours are likely to be more co-operative if the buildings and surroundings are attractive, as part of a good relations policy.

Summary

1. Animal manures contain large amounts of nutrients, and are therefore useful as fertilisers. Applications of artificial fertilisers should then be reduced accordingly.

2. Spreading should not cause pollution of land or water supplies, be a nuisance to neighbours, or be a health hazard.

3. Management of the livestock enterprise to keep the volume of waste as small as possible will reduce the cost of disposal.

4. The maintenance of good relations with neighbours is extremely important to the continued existence of any intensive livestock enterprise.

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