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# POLLUTION PROBLEMS ASSOCIATED WITH FEEDLOT PRODUCTION OF LIVESTOCK

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## SUMMARY

The environmental pollution potential of feedlots—odour, flies, noise, runoff, ground water and soil contamination—is discussed. It is concluded that the majority of these problems can be avoided in new operations by careful site selection with particular attention to climatic conditions, waste handling, runoff retention and “foreign” drainage diversion.

## INTRODUCTION

Feedlot livestock production may be an efficient system by which to convert feed into meat, but it has the serious drawback that the waste products of this conversion, faeces and urine, are concentrated within the feedlot confines. Waste disposal is a problem shared by both open lots and the confinement housing systems. This paper will be concerned with the pollution potential of this accumulation while animal health problems will be considered elsewhere in this symposium (Morris, 1974).

Just how large is this accumulation of manure likely to be? Manges *et al.* (1972) report that 3.5 kg of dry manure is produced per kg of beef, or approximately 4.67 kg per head per day. Loehr (1968) expresses daily manure production as 28.3 l per day. Madden and Dornbush (1972) measured daily waste output from a 410 kg steer as: 0.14 kg total Kjeldahl nitrogen, 4.1 kg chemical oxygen demand, 0.68 kg biochemical oxygen demand and 0.045 kg total phosphate. Perhaps these results are more easily appreciated when expressed as 2 t/ha and 5.2 t/ha of dry manure per day to be removed from feedlots stocked at 18.6 m<sup>2</sup> and 9.3 m<sup>2</sup> per head, respectively (Gilbertson *et al.*, 1972).

Assuming that there is no profitable method of using livestock manure (Loehr, 1968), the feedlot operator must find a low-cost method of disposing of 1.7 t dry manure per head per year if no *in situ* reduction of manure takes place. Fortunately, reduction does take place; in the case of an open lot, Gilbertson *et al.* (1972) observed that as much as 50% of the manure can be decomposed by mounding and composting. Notwithstanding *in situ* reduction of manure by decom-

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position, the operator is faced with a mammoth task. Unfortunately, a few badly planned and/or managed operations have given feedlots the reputation of being major sources of pollution. Some of these pollution problems will be discussed so that, hopefully, some of the mistakes made overseas can be avoided in New Zealand.

#### ODOUR, FLIES AND NOISE

When cattle manure decomposes under anaerobic or near anaerobic conditions, foul odours are generated by the production of metabolic by-products such as hydrogen sulphide, organic sulphides, ammonia and amines (White *et al.*, 1972). On the feedlot, odour production can be minimized if manure is kept dry since there is an inverse ratio between aeration and moisture content. The situation can be complicated in that ammonia production is not exclusively an anaerobic process. Stewart (1970) observed that 90% of applied nitrogen can be lost as  $\text{NH}_3$  under dry (aerobic) soil conditions while only 25% was lost under moist soil conditions. Volatilized ammonia not only creates an offensive odour but can cause eutrophication of downwind expanses of water (Hutchinson and Viets, 1969). Dry manure and liquid manure do not offer the same fly-breeding opportunities as semi-solid manure. The obvious danger of insecticide residues in the beef is a good reason why satisfactory manure handling should not be replaced by excessive insecticide use.

There must be a certain amount of noise associated with a large feeding operation — from feed preparation, vehicular traffic and the cattle themselves. The combination of odour, flies and noise does not make feedlots ideal neighbours. Urban encroachment on feedlot areas usually results in problems for the feedlot operators (Harley, 1971; Colyer and Levi, 1972), in that the laws of nuisance do not protect the operator from just complaints of those who build close by an established operation. "I was here first", is no defence in today's environmental conscious society.

#### RUNOFF

Runoff from a feedlot following snow melt or a storm can be expected to carry with it dissolved and suspended solids. The exact chemical composition of feedlot runoff is highly variable and is influenced by the intensity of the storm, slope of the lot, stocking rate, nature of rations being fed and the quantity of manure on the lot. Feedlot runoff can in general terms be said to have a high bacterial population (McCoy and Crabtree, 1970), a high ammonium content (20 ppm  $\text{NH}_4^+ - \text{N}$ ) and a high biochemical oxygen demand. Fish kills have re-

sulted from uncontrolled feedlot runoff through the deoxygenation of receiving waters (Loehr, 1969), and from the introduction of toxic substances such as undissociated  $\text{NH}_4\text{OH}$  which is lethal to fish at a concentration between 1 and 2 ppm  $\text{NH}_3 - \text{N}$  (Scott, 1973).

The major findings of feedlot runoff studies, by Swanson *et al.* (1972) and Madden and Dornbush (1972), may be summarized as follows:

- (1) Runoff may not be expected from a rainfall event of 1.2 cm or less unless rainfall has occurred within the previous 72 hours.
- (2) Fifty per cent. of runoff may be attributed to rainfall events which may not produce runoff from the general surrounding area.
- (3) Typically only 5% of the total waste is potentially likely to be removed by runoff. This can be reduced to less than 2% by diverting "foreign" drainage, reducing runoff velocity and the installation of minimum runoff detention facilities.
- (4) Phosphorus removal is closely correlated with total solids removal which is directly affected by rainfall intensity and runoff velocity.
- (5)  $\text{NH}_4^+ - \text{N}$  and  $\text{NO}_3^- - \text{N}$  content decreases with continuing precipitation, *i.e.*, is very rapidly leached from the manure.

#### GROUND WATER CONTAMINATION

The nitrogen content of manure is generally considered to pose the greatest threat to ground water quality. Fortunately, only the oxidized inorganic forms, particularly  $\text{NO}_3^- - \text{N}$ , have any significant mobility in soil. Miekle *et al.* (1970) found that the manure pack on a level dirt lot reduced infiltration to 0.08 cm/h and that there was very little accumulation of  $\text{NO}_3^- - \text{N}$  in the ground water. Much of the total applied nitrogen can be lost as ammonia (Stewart, 1970), and much of that which is oxidized to  $\text{NO}_3^-$  is readily and harmlessly eliminated from the feedlot as gaseous nitrogen by denitrification (Broadbent and Clark, 1965). Although, the precise threat to any particular aquifer posed by a supercolumnar feedlot depends upon local soil and climatic conditions, it is reasonable to conclude that feedlots should not be sited over or near useful unconfined shallow aquifers. Paving the feedlot surface could provide protection for the ground water but probably at the expense of surface waters because of increased runoff.

## SOIL CONTAMINATION

The soil is the most common ultimate disposal site for feedlot wastes be they in solid or slurry form. Alternative disposal procedures including re-cycling by re-feeding (Anthony, 1972), incineration and bagging for sale as garden soil conditioner may provide practical solutions for a small proportion of operations. Continued manure applications to soil providing nitrogen in excess of that removed by plant growth could pose a nitrate threat to ground water. Very high application rates (greater than 100 t/ha) have been shown to depress crop yield (Mathers and Stewart, 1972). The accumulation of salts following successive applications could result in  $\text{Na}^+$  or  $\text{K}^+$  replacing  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  by ion exchange resulting in soil dispersion producing poor drainage. Although the use of soil as a manure disposal site rather than a nutrient re-cycling system is likely to adversely affect conventional agricultural crop production, the sacrifice of a small land area as a manure sink may make economic if not environmental sense.

## DISCUSSION

The primary considerations for pollution control in a feedlot are climate and site location. In practice, however, feed availability and marketing facilities must also be taken into account. Within New Zealand rainfall is the most important climatic consideration. Dry areas offer advantages in the control of odour, runoff and ground water contamination. A sizeable moisture deficit also allows the evaporation of some excess liquids. This advantage can be offset, at a higher capital cost, by the use of confinement housing instead of open lots.

The selection of a waste management system, essentially either solid or liquid manure handling, is to a large extent dictated by the climate and "housing" provided. Storage capacity of a liquid system must be adequate to prevent the operator from being forced to discharge the waste under adverse conditions, while a solid handling system should facilitate accumulation under acceptable conditions so that cleaning is required only about every six months. Butchbaker *et al.* (1972) in ranking beef waste management systems on economic criteria gave the premier place to unpaved open feedlots with detention ponds for runoff control using evaporation to dispose of the liquid. On pollution control criteria, however, the prime place went to cold confinement housing, slatted floors, and the collection of slurry by cable scraper to a shallow storage pit for disposal by irrigation. Pollution control adds cost to beef production so commercially the lowest cost system satisfying local requirements will be the system of choice.

In an attempt to avoid some of the more serious pollution problems experienced overseas, the following guidelines are advanced (adapted from Olson, 1971):

- (1) Locate away from towns and recreational areas.
- (2) Locate so that prevailing winds carry odour and dust away from areas of potential complaint.
- (3) Have the waste management plan approved by the local catchment board before commencing operation.
- (4) Locate away from water courses.
- (5) Locate near top of a slope to reduce problem of diverting "foreign" drainage.
- (6) Control runoff by providing solids settling basin and liquid retention pond.
- (7) Divert runoff from higher ground by constructing diversion berms.
- (8) Provide adequate land for waste disposal for conventional agricultural practice. Nitrogen loadings suggest solid manure handling requires 0.15 ha per head and slurry disposal 0.032 ha per head.

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