



Research and experience have shown that proper management is the key to using dairy manure to fertilize crops without creating environmental problems.

Dairy manure can be used safely

Jewell L. Meyer ■ Roy S. Rauschkolb ■ Earl H. Olson

Environmental concerns have caused considerable change in methods of handling and using dairy manure in California. This is chiefly because salts in manure, including those which are plant nutrients, may find their way into surface and ground waters. Research and experience, however, have shown that, with proper management, dairy manure can provide nutrients to grow crops with little if any significant impact on the environment. The key phrase is "proper

management," which includes appropriate handling, storage, and application.

Dairy manure has long been recognized as a source of plant nutrients, especially nitrogen. (Its phosphorus and potassium content also can add appreciably to its value, but only where those elements are deficient in the soil.) The manure from three to five cows can provide enough nitrogen to grow an acre of corn and winter cereal in a double-cropping system. The problem is to apply

this amount of nitrogen while minimizing the environmental effects of the total salts in manure.

Recent U.C. research to develop such management systems has shown:

1. *The kinds and amounts of salts and plant nutrients in dairy manure.*

Each day, a mature, 1,400-pound dairy cow on a ration with alfalfa hay as roughage excretes 1.77 pounds of nitrate (NO_3)—0.4 pound nitrogen (N)—plus 1.85 pounds of other salts, such as potas-

sium, calcium, chloride, and sulfate. That is a total of 3.62 pounds of salts daily. Other types of roughage may produce slightly more or less total salts, but the amount of nitrogen stays about the same. In any case, the salts come mostly from hay, grain, and silage.

2. What happens to salts and plant nutrients during storage in manure piles and in manure storage ponds.

Stored manure loses much of its nutrients and other salts. A major cause of loss—downward movement through the soil—can be prevented by leaving intact the natural soil seal under a manure pile. Storage ponds are also self-sealing.

3. The amount of salts seeping downward below the soil surface in fields heavily treated with manure.

Application rates of both 12 and 30 tons yearly over 15 years caused some increases in soil salinity at the 3- to 5-foot depth, but crop production was not affected even with the 30-ton rate. At 10 feet and below, the higher rate slightly increased salinity (by 100 to 200 parts per million) in water percolating downward.

Nitrogen losses

After manure leaves the cow, several chemical and biological reactions change the form of the nitrogen, reducing its concentration and availability. At first, the principal compounds containing nitrogen are amino acids and urea. Shortly after elimination, this nitrogen is converted to ammonia, which then starts to disappear through volatilization. In a few days to a few weeks, 20 to 50 percent of the nitrogen in piled manure may be lost into the atmosphere in this way. (One way to conserve the nitrogen is rapid drying and dry storage.) In manure holding ponds, most of the nitrogen also is converted to ammonia. Volatilization from ponds depends on pH, temperature, and time, but in any case significant losses take place if the ponds are not emptied frequently. In fact, whether manure is in liquid or dry form, the key to conserving nitrogen is to incorporate the manure into the soil as soon as possible.

In a continuous cropping system, providing enough nitrogen for satisfactory yield without excessively concentrating salts depends on: methods of handling, storing, and applying manure; rate of application; and the amount and rate of nitrogen release in the soil. Taking these factors into account, different

management systems are used for dry manure and for holding-pond manure.

Dry manure

First, it is necessary to determine nitrogen content of the manure and the rate at which that nitrogen will become available to the crop after the manure is in the soil.

Because nitrogen content varies as a result of handling, storage, and application methods, it is necessary either to obtain a laboratory analysis or to assume a certain nitrogen percentage. Problems of obtaining a representative sample may make laboratory analysis impractical. However, with reasonably good management, dairy manure will contain at least 1 percent nitrogen; hence, that figure can be assumed.

Research has shown that only part of the nitrogen in soil-incorporated manure is available for plant use during the first year. Much smaller and rapidly decreasing amounts become available in succeeding years. Average expected rates of this nitrogen release—called “decay series”—have been worked out. For example, old, dried, corral manure commonly releases 35 percent of its total nitrogen in the first year, 15 percent of the remainder (9.75 percent of the total) in the second year, and 10 percent of the remainder (5.5 percent of the total) in the third year.

After a shorter storage period, however, dry manure releases nitrogen more rapidly—40 percent in the first year, 25 percent of the remainder in the second, and 6 percent of the remainder in the third.

The “decay series” means that, with continued annual applications to the same land, a smaller amount of added manure is needed each year to provide the same amount of available nitrogen in the soil. As more manure builds up in the soil and less is added, a balance is finally reached at which the amount of nitrogen applied in manure each year approximately equals the amount released in the soil.

The required tonnage of manure drops rapidly during the first year or two. For example, to release 200 pounds of nitrogen per acre per year, slightly more than 25 tons of manure will be required the first year, about 18 tons the second year, about 13 tons the tenth year, and about 12 tons the twentieth year. Generally, the amount applied in the tenth year will be about half as much as in the first.

Liquid manure

In determining the acreage on which to spread dairy manure from a holding pond, it is assumed that about 80 percent of all manure handled in a flush-down system goes into the holding pond. (About 10 percent of daily manure production falls in the holding corral and milking area, 30 percent in the feeding area, and 40 percent in the lanes and sleeping area. The remainder falls outside the flush-down zone.)

The first step is to calculate the amount of manure in storage:

$$\frac{\text{Cows in herd} \times 80\% \times \text{days ponded}}{365} = \text{cow-years manure in storage}$$

The next step involves an assumption about nitrogen losses from the pond: 70 percent of the nitrogen remains for storage periods up to 30 days, and only 50 percent remains after 60 days. Using these figures, the next calculation is:

$$\frac{\text{Cow-years manure in storage} \times \text{nitrogen remaining}}{4 \text{ (cows per acre)}} = \text{acres on which to apply manure}$$

For example, assuming a 100-cow herd and storage for 90 days (50 percent loss), the following calculations can be made:

$$\frac{100 \times 0.80 \times 90}{365} = 19.73 \text{ cow-years manure in storage}$$

$$\frac{19.73 \times 0.50}{4} = 2.47 \text{ (or } 2\frac{1}{2}\text{) acres, on which one pondful of liquid manure can be spread each year}$$

Field trials have shown reasonable crop responses using this procedure, when adapted to local conditions. However, it is essential to dilute the holding-pond water at the time of application, both for better distribution and to prevent undesirable salt effects on growing crops. Generally, three parts of irrigation water to one part of pond water is suitable for crops to which it is usually applied.

Whether dry or liquid manure is used, improved management with less nitrogen loss will mean less total salt added to the soil, because less manure per acre will be needed to meet the nitrogen requirements of crops.

Jewell L. Meyer is Area Soils and Water Specialist, Parlier; Roy S. Rauschkolb is Extension Soils Specialist, University of California, Davis; and Earl H. Olson is Farm Advisor, Stanislaus County.