CONSIDERATIONS OF MANURE APPLICATION TO ALFALFA[1]

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INTRODUCTION

California is home to more than 1.2 million dairy cows and their replacements. This dairy population consumes millions of tons of by-products from processing human foods, forages, and other feedstuffs. The animals convert these feeds into a valuable food resource. Unfortunately, the conversion of feeds to milk is not completely efficient and manure is produced. In fact, the average cow can excrete between 250 and 350 lbs of nitrogen per year. Potentially 10 to 50% of this nitrogen is conserved during manure management. This leaves some 15,000 to 105,000 tons of nitrogen to be managed.

Manure is collected, stored, treated, handled and utilized. The method of collection determines in large part the end utilization of the manure. Manures collected in a liquid form are utilized through irrigation systems. Manures collected in a solid form are either stored or directly land applied through spreaders or can be composted, co-composted, incinerated, or digested.

One of the great challenges of incorporating manure into crop production systems is utilizing manure to its greatest potential without adverse effects on crop production or natural resources. Several key components should be evaluated related to liquid and solid manure applications.

LIQUID MANURE SOURCES

Determining nutrient content. The nutrient content of manure water is variable. Some parameters which affect manure water nutrient composition include: diet fed to animals, age, breed and production status of the animal, nutrient content of excreted manure, amount of manure collected, dilution of manure with flush or wash waters, quantity of fresh water added daily, recycling of water for flushing, duration of water in holding ponds, and climatic conditions. **The high variability of nutrient content of manure waters indicates that no good book value exists for estimating nutrient content.**

When ponds are sampled, specific nutrients should be evaluated Ammonium nitrogen, total nitrogen, phosphorus and potassium

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[1]Data reported here have resulted from multiple projects during the last 3 years. Participation and input on joint projects have been appreciated from UCCE Specialists Larry Schwankl and Terry Prichard and UCCE Farm Advisors Tom Shultz, Carol Collar, Jerry Higginbotham and Allan Fulton.

should be evaluated. Additionally, location specific problems may indicate that salinity, calcium, magnesium or some other element should be evaluated. Nitrate nitrogen is not in anaerobic ponds at any great concentration. Nitrate nitrogen is found in aerated ponds.

Two dairy ponds were used to determine appropriate methodology for sampling. Stepwise sampling was used. The protocol included pre-dewatering sampling from six locations at the surface, and at five foot increments at each location from the surface to the bottom. Ponds were sampled a few weeks later during the spring dewatering. At the dewatering, samples were taken four times daily for ten days. Results of the sampling are in Table 1. Nutrient content of pre-dewatering pond samples usually overestimated nutrient content of manure water compared to dewatering samples. If nutrient analyses from sampling a pond prior to dewatering were used to determine application rates, nutrients would in fact be under applied to fields.

Neither pond had an agitator. In a storage structure where an agitator is present, values of pre-dewatering may be closer to those of the dewatering values.

Table 1. Average nutrient content of dairy pond water from pre-dewatering and dewatering samples and percent difference between pre-dewatering and dewatering samples.

	Ca	Mg	NH4N	TKN	K	TS
	----------pounds/ac-in----------					
Pre-dewatering						
Herd 1	18.3	7.9	26.0	43.4	40.7	6760
Herd 2	16.7	12.3	72.1	268.3	100.8	na
Dewatering						
Herd 1	12.0	5.6	21.3	27.8	30.0	285
Herd 2	18.8	13.2	61.4	228	78.0	na
Difference----------%						
Herd 1	56.0	40.6	21.8	56.2	35.8	2271
Herd 2	-11.1	-6.8	17.3	17.7	29.3	na

Nutrients in manure water can be beneficial to growing crops when applied appropriately. In addition to plant nutrients, the electrical conductivity of manure waters can improve water infiltration rate when irrigation waters have little electrical conductivity (30-60 umhos).

Challenges when using manure water. It is critical to have efficient and uniform irrigations when manure nutrients are used. Excess application of irrigation and manure waters can result in

runoff or deep percolation of nutrients, potentially contaminating water resources. Also, appropriate applications that are not uniform can result in contamination of groundwaters.

Manure waters may have 0.3 to 5.0 percent solids. The size of the particles is variable. The total amount of solids applied during an irrigation can be significant depending on the percent of solids in water and the quantity of water applied. Observation and monitoring of settled manure solids during an irrigation indicated solids settled out in the first one to two hundred feet of the field. Two sets of measurements have evaluated settled manure solids. The first set estimated 750, 105 5.4, 8.9, and 67 lbs of dry solids applied per 100 sq ft at distances of 100', 1/4, 1/2, 3/4, and 4/4 of the distance from the valve. The field length was approximately .5 miles long and the irrigation was approximately 12 hours. Data from a second field yielded 184.7, 101.6, and 62.5 lbs of dry solids applied per 100 sq ft at distances of 50', 100', and 200' from the valve. The field length was less than .25 miles and the irrigation event was less than 6 hours. Negligible amounts of solids were collected at quarter points in the field.

Although few fields have been evaluated, it appeared that the amount of distance needed for solids to settle is a function of check width, flow rate of water when entering the field and field roughness. Management practices may need to be altered if large deposition of solids occur at the head of the field. Large accumulations of solids during an irrigation, particularly the pre-irrigation, may delay cultivation practices. This delay would be necessary to allow the soil to dry sufficiently so equipment could easily enter and exit fields.

One method to reduce accumulation of solids at the head of the field is to reduce the solids entering the field. This can be done by increasing the dilution of the manure water with ditch or ground water. Alternatively, manure water can be run during a portion of irrigating each check. This practice may effectively reduce total solids when further dilution during the entire irrigation cannot be changed.

Few solids are recovered in the remainder of the field unless tail water is allowed to collect. Stagnated tail water eventually percolated or evaporated, leaving small amounts of fiber. These fiber particles were markedly smaller in length than the settled particles at the head of the field.

Siphons can be used during irrigations. However, many solids can settle in irrigation ditches. These can clog siphons during further irrigations. Solids management in ditches becomes an important component of irrigation operations.

The solids content of manure waters can be managed to minimize crop losses. Certainly, excess accumulation of solids at the head of fields can result in plant death. Producers can

alternate field applications of manure waters to minimize large accumulations of solids at the head of any one field. An alternative management measure is to sacrifice the heads of older fields. Another approach is to minimize application of liquids with higher solids content to a particular crop. In most instances, this can be accomplished by using top waters from a relatively full pond on alfalfa. This leaves the lower, thicker waters for cereal grain crops.

QUANTIFICATION OF APPLICATION RATE OF MANURE WATERS

Certainly, one of the greater challenges of nutrient management is the quantification of manure water application rates. Manure waters have particular physical qualities (large fiber particles, amounts of foreign materials--twine, trash, etc) that make monitoring of water flow through conventional propeller meters inappropriate. Flow rate can be accomplished by use of a non-invasive doppler meter. The minimum requirements are to have straight lengths of full flowing pipe. Appropriate conditions must exist to use doppler meters.

A more tedious method to calculate application rate is to determine the volume of water leaving the pond via volumetric measurements. The challenge is to quantify the drop in volume of the pond, in the absence of having waters entering the pond. If it is done, the drop multiplied by surface area can be used to calculate application rate.

USE OF DATA

Once the nutrient content of manure water and the flow rate of water are known, one can calculate application rates to the field. Laboratory results reported in parts per million can be converted to lbs/ac-in of water applied by multiplying by the factor of .2268.

It is important to realize that the calculated value is the average estimated value applied to the field or check. It is almost certain that irrigation waters will be applied non-uniformly. This will also distribute nutrients non-uniformly. On the average, a particular quantity of nutrients are applied to a field. This may be the agronomic rate. However, there can be excessive or deficient applications of nutrients at particular parts of the field.

APPLICATION OF SOLID MANURES

Manures should be analyzed to determine the appropriate application rate based on nutrient content. Composted materials may be more desirable than the corral cured materials. Proper composting of manures will kill viable weed seeds. Application of uncomposted materials may distribute weed seeds and undigested grain particles throughout the field.

Consideration should be given to the age of the stand and season of the year prior to application of solid manure. The physical impact of the machinery used to apply manure should be considered. Soils can be further compacted. Plants can be macerated. Additionally, one should calculate the amount of manure applied per acre. One question is can the alfalfa plants survive the depth of manure to be applied? Another question is does the manure carry too much salt? Again, it is important to integrate manure applications with the plant growth stage and irrigation practices.

CONCLUSIONS

There are many questions to address prior to utilizing manures as a nutrient source for alfalfa. Answers to these questions can serve to aid in decisions regarding preferential times to apply manures. Modifications in management practices may still allow for manure utilization while maintaining acceptable alfalfa yields.

REFERENCES FOR FURTHER READING

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