Agriculture
UtahStateUniversity COOPERATIVE EXTENSION

extension.usu.edu
March 2011 AG/NutrientManagement/2011-01pr

The Fundamentals of Nutrient Management

Jim Bowcutt, Clark Israelsen, Rhonda Miller, Ph.D.
Utah State University Extension
Neils Hansen, Natural Resource Conservation Service

Introduction

For generations, farmers, ranchers, and livestock producers have taken pride in being good stewards of their land, air, and water resources as they produce a safe and abundant food supply. With time, operations have increased in size making some aspects of agriculture more difficult. Manure and wastewater management are often an issue; and runoff from farm fields and feedlots can contaminate ground and surface water with nitrogen, phosphorus, bacteria, and sediment. Many of Utah's water sources are used for human consumption, recreation, and fisheries, necessitating clean, non-degraded water.

To address some of the issues posed by large operations, the Environmental Protection Agency (EPA) and United States Department of Agriculture (USDA) adopted the *Unified National Strategy for Animal Feeding Operations* in 1999. This strategy is based on a national performance expectation that all animal feeding operations (AFOs)[1] develop site-specific nutrient management plans (NMPs). This was followed by a Concentrated Animal Feeding Operation (CAFO) rule in 2003 and a revised CAFO rule in 2008. The CAFO rules prohibit any discharge to water sources, and require Nutrient Management Plans (NMPs) and National Pollutant Discharge Elimination System (NPDES) permits for many CAFOs.

Figure 1. Heifers in confinement.

In Utah, the state is authorized to enforce the EPA regulations. Through cooperative efforts between agricultural agencies, industry and producer groups, and regulatory agencies, the state is currently working on the *Utah Strategy - Phase II*, which will adopt the latest EPA regulations and make them state law.

Economic Benefits of Nutrient Management

The objective of nutrient management is to use essential nutrients wisely for optimum economic benefit, while minimizing environmental impacts. Nutrient management methods must make both economic and environmental sense.

“Will the project pay for itself” is an important management decision when considering a waste management system. One may also ask if the expenditure is a cost or an investment. Cost and benefit analysis is a means of comparing the positive and negative effects of a proposed change on net farm income. A benefit may consist of additional income or reduced expenses, while costs may result from reduced income or additional expenditures. Waste management facilities are typically of sufficient scale that it may take several years for them to offset their cost in reclaimed benefits.

Some of the obvious benefits of an approved nutrient management system are the avoidance of penalties or fines by becoming compliant with the regulations. Typically there is also reduced labor through increased efficiency, better utilization of manure nutrients, and reduced fertilizer expenditures. In almost every case there is the potential of government cost-sharing to help reduce the farmer's cost.

Manure Handling Systems

Manure is a valuable resource. Manure benefits plant growth, improves soil structure, and increases fertility. Responsible farmers who manage manure wisely gain its maximum benefits while protecting the environment.

Properly designed storage facilities enable manure spreading when conditions are favorable for nutrient use by crops. Longer storage periods generally offer greater flexibility in managing land application operations and maximizing crop uptake and utilization. Proper application of manure means applying manure at the proper rate, time, and manner so that it can effectively be utilized by crops, leading to maximized yields. It also entails efficient use of farm labor and equipment. A manure storage system can save time and minimize equipment wear and tear. By applying manure only in the spring and fall when it can best be used by crops, farmers can avoid the hassle of daily hauling and spreading. Seasonal spreading also allows growers the opportunity to conserve nutrients and reduce runoff, erosion, and stream pollution. Injecting manure below the soil surface or working it into the soil conserves nitrogen and helps reduce odors.

Figure 2. Mechanized barn cleaner.

Figure 3. Manure spreader.

Environmental Impacts

Nutrients in the wrong places can harm the environment. Currently in the State of Utah and throughout the Western United States, phosphorus and nitrogen have been identified as pollutants of concern in various water bodies. While nutrients can have positive effects on crops when applied properly, they can also have devastating effects on the ecosystem when they enter local waterways.

When nutrients enter aquatic systems, they are taken up by organisms such as algae and other photosynthesizing organisms. An excess of nutrients can create large algal blooms that often smell bad and block sunlight from reaching the vegetation that grows at the bottom. Large algal blooms can also reduce oxygen levels as the algae die and begin to decompose. This lack of oxygen can result in large fish kills in ponds, reservoirs and slow moving streams.

Nutrient Management Planning

When developing a nutrient management plan, the entire operation should be considered: the nutrients produced, the fields where they can be applied, and the desired crops and yields. An effective nutrient management plan will make all of these components work together to maximize the use of the available nutrients and increase crop yields, while staying in compliance with state water quality standards. Often times nutrient management plans are written by professionals; however, without proper understanding and implementation at the farm level, the desired environmental and economic results are not likely to occur (Beegle et al., 2000).

Soil Tests

Soil tests are an important tool used in developing a nutrient management plan. Soil tests help eliminate the guessing game when it comes to fertilizer applications and provide information on the soil characteristics, such as soil texture and permeability. These factors affect site vulnerability, and the amount of manure that can be safely applied (Hatfield & Stewart, 1998).

Soil tests can show if there is a surplus or a deficiency of nutrients in the soil, or if more organic matter would be helpful. If there is a shortage of nutrients, additional manure or commercial fertilizers may be needed. If there is a surplus of nutrients, then no manure or commercial fertilizer may be needed to achieve the maximum crop yield; and, one may need to find a different location to apply manure.

Interpreting a soil test report can be challenging. The common units for soil tests are often given in milligrams/ kilograms or parts per million (ppm), and several different parameters may be provided. While all of the parameters may be helpful in some way, the ones needed for developing a nutrient management plan are nitrate-nitrogen and phosphorus

Figure 4. Manure applied to crop ground.

Manure Application Rates

With manure application, phosphorus is usually the limiting nutrient. Generally, plants need less phosphorus than nitrogen and in lower ratios than exist in manure. If the soil test results (Olsen method) are below 50 ppm for phosphorus, one can apply manure based on the nitrogen needs for the crops. If the soil tests are between 50-100 ppm, then one should spread manure based on phosphorus needs. However, if the soil tests are over 100 ppm of phosphorus, manure should not be applied to that field. In emergency situations, manure can be applied at one-half of the crop's phosphorus needs (see Table 1). This is very difficult to do without renting or purchasing specialized equipment that can apply a ton or less of manure per acre.

Table 1. Manure spreading guidelines.

Phosphorus Level (Olsen method)	**Manure Application**
Phosphorus < 50 ppm	Spread based on nitrogen needs
Phosphorus 50 -100 ppm	Spread based on phosphorus needs
Phosphorus > 100 ppm	Don't apply manure, or in emergencies apply ½ phosphorus needs

Crop Nutrient Requirements

Nutrient needs vary for different crops (See Table 2). To determine the needs for your crops, contact your local Extension Agent, Soil Conservation District or Natural Resource Conservation Service (NRCS) office. Soil tests provide application recommendations based on yield goals.

Table 2. Crop nutrient uptake guide. Pounds of nutrient per production unit.

CROP	**Unit**	**N**	**P_20_5**	**K_20**
Alfalfa	tons	56.60	13.30	60.00
Alfalfa Haylage	tons	33.48	9.11	33.41
Barley	bu	1.45	0.55	1.45
Corn Grain	bu	0.90	0.37	0.87
Corn Silage	tons	9.00	3.10	9.00
Grass Hay	tons	40.00	12.86	58.80
Grass Pasture	tons	31.60	12.70	58.80
Oats	bu	1.15	0.40	1.45
Onions	cwt	0.30	0.13	0.27
Potatoes	cwt	0.50	0.18	0.70
Safflower	lbs	0.05	0.03	0.05
Sorghum/Sudan grass	tons	13.60	3.68	17.40
Sweet Corn	tons	17.80	11.04	13.92
Wheat (Fall Dry)	bu	2.00	0.75	2.00
Wheat (Irr)	bu	1.70	0.70	2.00

Manure Nutrient Content

Another important part of developing a nutrient management plan is knowing how much manure is produced and the nutrient content of the manure. Nutrient concentrations in manure can be higher in one type of animal than another. This may be the result of their diet, or just their digestive system. For example, turkey manure contains much more nitrogen than manure from a beef cow (See Table 3). Manure nutrient tests are a required part of an NMP.

.

Table 3. Manure characteristics for 1000 pound animal unit.

Type of Animal	Dry Manure Production Values-As Excreted					
	N (lb/day)	**P_2O_5** (lb/day)	**K_2O** (lb/day)	**Volume** (ft^3/d)	**Weight** (lb/day)	**Moisture** (%)
Beef (Cow)	0.33	0.27	0.31	1.02	63	88
Beef (Feeder)	0.21	0.32	0.04	0.93	18	45
Beef (Yrlng)	0.30	0.23	0.24	0.89	55	87
Dairy (Dry)	0.36	0.11	0.28	1.32	82	88
Dairy (Lact)	0.45	0.16	0.31	1.29	80	88
Ducks	0.70	0.69	0.60	0.73	46	75
Goats	0.45	0.11	0.31	0.63	40	75
Heifers	0.31	0.09	0.29	1.37	85	89
Horses	0.28	0.11	0.23	0.81	50	78
Poultry (Layer)	0.83	0.71	0.41	0.96	61	75
Poultry (Pull)	0.62	0.55	0.31	0.73	46	75
Sheep	0.45	0.16	0.36	0.63	40	75
Swine (Boar)	0.15	0.11	0.12	0.34	21	91
Swine (Gest)	0.19	0.14	0.15	0.44	27	91
Swine (Grow)	0.42	0.37	0.27	1.02	63	90
Swine (Lact)	0.47	0.34	0.36	0.96	60	90
Swine (Nurs)	0.60	0.57	0.42	1.70	106	90
Turkey (w/litter)	0.88	0.92	0.54	0.38	24	34
Turkeys	0.74	0.64	0.34	0.69	44	75

Getting Help

NRCS can determine the amount of animal waste your operation will produce in a year based on the numbers and types of animals in your operation. This information helps determine the storage requirements needed to contain all of the waste. It also helps determine if enough land is available to spread the manure, if additional fields are needed, or if other options should be pursued. Each animal feeding operation needs to be able to store a minimum of 120 days of animal waste. Previously, winter application of manure was legal on fields that are relatively flat and not adjacent to any water bodies; however, winter applications are no longer allowed. This includes manure, runoff from corrals, and parlor water from dairies.

Development of a nutrient management plan can be very beneficial to any agricultural operation. It can save money, help increase crop yields, and help your operation stay in compliance with state water quality standards. If you have a desire to develop a nutrient management plan for your operation, you can contact your local University Extension, Soil Conservation District or NRCS office. A certified nutrient management specialist will help you understand state requirements, and improve the overall productivity of your operation.

References

Beegle, D., O. Carton, and J. Bailey. 2000. Nutrient management planning: justification, theory, practice. Journal of Environmental Quality. 29: 72-79.

Hatfield, J. L., and B. A. Stewart. 1998. Animal waste utilization: effective use of manure as a soil resource. CRC Press.

This publication is issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Noelle E. Cockett, Vice President for Extension and Agriculture, Utah State University.