News From New Bolton Center...

School of Veterinary Medicine
UNIVERSITY OF PENNSYLVANIA

Today's dairy farmer must be a superb livestock and business manager, an agronomist, economist, soil, water, and waste management expert.

Awareness of the long-term impact of agricultural run-off on streams, rivers, and ground water has led to legislation governing the number of animals a farmer can keep on a given piece of land and how the disposal of animal waste is handled. The farmer has the formidable task of maintaining a profitable dairy herd with minimal impact on the land.

This complex task can be accomplished with the aid of computer models. Researchers at University of Pennsylvania's Center for Animal Health and Productivity (CAHP) at the New Bolton Center campus, who earlier developed a feeding strategy model for dairy herds, are now looking to create a more complex model to integrate not only feeding strategies but also cropping and manuring strategies to keep the production and health of a herd at maximum while reducing its environmental impact.

"We are looking at the entire dairy farm, its soil management, and the feed crops that can economically utilize animal wastes," said Dr. James Ferguson, associate professor of nutrition. "At first we looked mainly at feeding strategies for production and health, and we didn't worry too much about the waste products and their composition. However, manure and urine nitrogen can contribute to pollution of soil and water, so we began to develop feeding formulas to reduce the level of nitrogen in dairy cow wastes."

"We're looking at the whole cycle of nitrogen utilization on the farm...to use manure nutrients to grow the right crops to feed the cow to get the right balance of nutrients to get the best efficiency of utilization by the cow," said Dr. Charles Ramberg, professor of nutrition and director of the CAHP. "It's an integrated approach."

Pennsylvania produces twenty-five million tons of manure per year. The major component of manure is residue from animal feed stuffs, undigested feeds and metabolic waste products. A smaller portion of manure is bedding and waste water. Therefore feed formulation can have a significant impact on manure composition. Feed formulation is an important component of a nutrient management plan. By optimizing the utilization of nutrients in a ration by altering feed sources, both the amounts and types, it is possible to maximize the production of milk or meat while minimizing the amount of nitrogen produced by the animal, thus reducing manure volume and manure nutrient content.

Of particular interest is research strategies which exam feeding practices which can lower the protein content of the ration yet maintain milk production. A particularly useful strategy is to improve the amino acid supply of the diet through use of supplemental amino acids while reducing total protein content. By optimizing feed formulation and achieving the right amino acid "profile," a dairy cow requires less nutrients to produce the same amount or more milk, research at New Bolton Center's experimental farm has shown. Dr. Ramberg said, "... nitrogen in the wastes can be reduced by 25% or more."

Achieving that may require an unusual mix of ingredients, some of which are grown on the farm, others from commodity purchases available through traditional means. "Some of these are not conventional things that cows would normally eat," Ramberg said. "Things like fish meal and other ingredients that have specific characteristics."

Most dairy farmers grow a portion of the feed for their animals. So it is important that the manure produced is managed and utilized effectively to grow crops appropriate to feed back to the animals while minimizing run-off and leaching loss.
Cows have a complex digestion system where food is broken down with the aid of bacteria and the bacterial products are absorbed by the cow. When feeding a cow, the bacteria must be kept in mind, in essence cow and bacteria must be fed. "We must look at what happens to the feed in cow's rumen," said Dr. Ferguson. "The rumen bacteria need protein to support and grow fermentation. That process breaks down the cellulose and starch into volatile fatty acids which provide energy to the cow. Bacteria break down feed protein into ammonia which is then converted to microbial protein that is later absorbed in the cow's intestine. But if there is too much rumen degradation of feed protein, excess ammonia is produced in the rumen. The excess ammonia is absorbed, converted to urea and excreted in urine, mixing with fecal waste to form manure. Urea in manure is subject to various losses such as volatilization, leaching and runoff."

The issue is further complicated by the fact that microbial protein alone is not enough to keep a cow in good health and high milk production. The feed must be balanced in such a way to provide carbohydrates that supply energy, just enough feed protein to be utilized by the bacteria, and additional feed protein that can be absorbed by the cow in the intestines. To add to the complexity, it must be taken into account what type of feed crops can be raised economically by the farmer.

"We look at soil productivity level and management history," said Dr. Ferguson. "Then we build a feeding and cropping program. The cropping program considers the needs to feed the animals and to utilize the manure. For example, the land may be ideal for alfalfa, but alfalfa fixes nitrogen from the air and when fed as silage, contains too much rumen degradable protein. Therefore, to improve the farm utilization of nitrogen, alfalfa may need to be fed as hay in addition to haylage and combined with corn silage at amounts which improve feed efficiency and manure utilization. In addition, we may recommend that a rye cover crop follow corn to take up the residual nitrogen in the soil."

The New Bolton Center researchers have developed a reduced protein feeding program that increased milk production and decreased nitrogen waste. It also reduced the feed cost. This is just the first step. By developing a computer model that encompasses the entire cycle from growing feed crops to milk production to fertilizing croplands to planting, the New Bolton Center researchers hope to develop a strategy that will enable the farmer to have maximum milk production with minimal adverse environmental consequences while making a profit. The work at University of Pennsylvania is supported by USDA/CSRS moneys, Pennsylvania Farm Bureau, Friends of Pennsylvania Agriculture, Pennsylvania Department of Agriculture, the Center for Animal Health and Productivity at New Bolton Center, and a number of corporations.

For more information on nutrient management visit the Center for Animal Health and Productivity Web site at cahp.www.nbc.upenn.edu or call (610)-444-5800.