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PROJECTED NUTRIENT CYCLES OF TWO DIFFERENT DAIRY FARM SYSTEMS

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SUMMARY

In a large part of the world, dairy products contribute substantially to the daily human intake of energy and protein. The global population is set to increase by two billion before 2010, which will require an increase in animal protein production of 155 percent. Instead of increasing, the dairy farm numbers in the Carolinas and Virginia have declined by one-third during the last decade. With an increasing global population and associated requirements for animal protein, dairy production has the oppurtunity to increase. The dairy industry, however, contributes considerably to the pollution of the environment. Therefore the possibilities of alternative dairy farm systems that are acceptable from both the environmental and the economic point of view have to be explored.

In spring of 1995, an integrated researchproject, to develop dairy farming systems, started at the research facility at the Department of Animal Science of the North Carolina State University (NCSU). The primary objective of this regional Center for Sustainable Dairy Farming is to evaluate the profitability and the environmental sustainability of two systems: one was based on row crops and conventional confinement housing and feeding , and the other system was based on intensively managed pastures.

This study addresses the environmental part of both systems, and projects nutrient balances based on input and output of nutrients from both the conventional confinement housing and feeding system and the dairy system based on intensively managed pastures. This study also emphasizes the comparison between the two systems for nutrient losses to the environment.

In both systems, 76 acres, 72 dairy cows and 305 lactating days were used for this study. The herd consisted, of 48 Holsteins and 24 Jerseys in each system. A total mixed ration (TMR) was fed to the dairy cows in the conventional system. The pasture based-system had a spring- and fall-calving herd, and grass species in the pasture based system provided grazing 10 months of the year.

To achieve the goal for the conventional system, the manure-worksheet and data on nutrientflows from Van Horn were used. For the pasture-based system, the Forage Animal Resource Management-program provided the available amount of grass on pasture. With the DART-Ration program, rations were formulated for both the conventional- and pasture-based herd. A Dutch grassland management model from CABO-DLO (Agricultural Research Institute) was used to

give data on nutrient flows in the pasture-based system.

In the conventional system, losses of nutrients from excreted feces and urine occur due to volatilization, surface runoff and leaching. Losses of nitrogen and phosphorus also occur due to soil and harvesting losses. Part of the manure remains as sludge and nutrients remain there for future use. The input of nutrients into the system are from manure, fertilizer and rainfall. To balance the soil in the conventional system, yearly applications of 3255.8 lbs N and -1721.2 lbs P are needed, respectively. Therefore, N needs to be added to the system and, unless adjustments can be made, P is predicted to accumulate.

Losses of nutrients in the pasture-based system occur due to volatilization, leaching, chemo-denitrification, and grazing and harvesting losses. Part of the manure is collected in the lagoon when the dairy cows are in the milking parlor. Input of nutrients in the organic and inorganic soil are from N-fixation of legumes, fertilizer and manure. Balancing the nutrients in the soil of the pasture based system can be realized by yearly application of nitrogen and phosphorus of 3997.1 lbs N and 265.2 lbs P. Without application of fertilizer, depletion of both nutrients will take place.

The predicted total losses of nitrogen to the environment are more than 20 percent lower in the pasture-based system. The predicted reduction of phosphorus loss to the environment is 9 percent for the pasture-based system. Pollution of the environment with nutrients is lower for the pasture-based system, because of less nitrogen volatilization, nutrient surface runoff and leaching. For sustainable environmental balancing of nitrogen in both systems, 43 and 50 acres are needed, respectively, for the conventional and the pasture-based system. For balancing phosphorus these numbers are 88 and 67 acres, respectively, for the conventional- and the pasture-based system.

This study showed us that pollution of the environment with nutrients is lower in the pasture-based system. In the future, when more studies are done on nutrient flows, a dynamic model should be able to calculate nutrient flows for each farm to result in a sustainable balance of nutrients on commercial dairy farms.