USDA Agricultural Research Service

PASTURE SYSTEMS AND WATERSHED MANAGEMENT RESEARCH UNIT

FACT SHEET

Integrated Farming Systems Research

Developing Profitable and Environmentally Sound Farming Systems for Animal Production

The Integrated Farming Systems Project is one of three major projects in the Pasture Systems and Watershed Management Research Unit at University Park, Pennsylvania. The mission of this unit is to conduct research leading to the development of land, water, plant, and animal management systems, which ensure the profitability and sustainability of northeastern grazing and cropping enterprises while maintaining the quality of ground and surface waters.

More Sustainable Farms are Needed. Dairy and beef farms are major contributors to the economy of the northeast region. Increasing production costs, static or declining product prices, and environmental issues though, are jeopardizing the long-term sustainability of these farms. More efficient, economical, and environmentally sound production practices are needed.

Integrated crop, pasture, and livestock farms form complex physical and biological systems. Only by studying the farm as a whole can improved practices be developed that maintain a reliable food supply, a strong agricultural economy, and a safer environment.

Our goal is to develop and apply software tools for comprehensive evaluation of the impacts and interactions of farm management on air and water quality while maintaining or improving farm profitability. Specific objectives are to:

- Quantify management effects on gaseous emissions from animal, feed, and manure sources on dairy farms.
- Quantify carbon sequestration potential of temperate grasslands.
- Validate and use farm and watershed scale models to assess the effects of conservation practices on farm management and our soil and water resources.

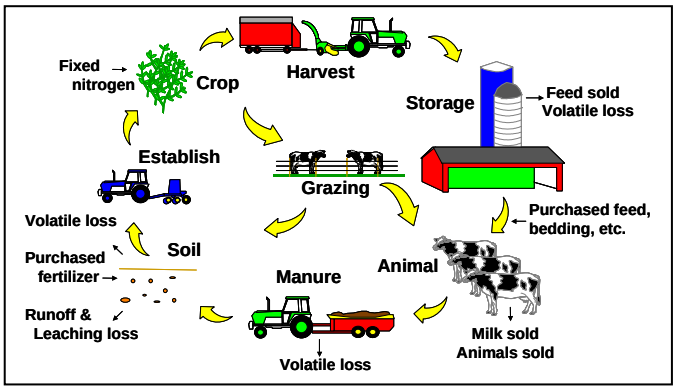
Prepared by the ARS Pasture Systems and Watershed Management Research Unit. For additional information contact Dr. Alan Rotz (814-865-2049; Al.Rotz@ars.usda.gov; http://ars.usda.gov/naa/pswmru).

Gaseous Emissions. We are developing process-based relation-ships that predict the formation, disassociation, and loss of gaseous compounds from animal, feed and manure sources on farms. These are being integrated into a model and software tool for estimating emissions from dairy and beef farms as influenced by animal and manure management.

Carbon Sequestration. Carbon sequestration by forage crops is being determined by measuring the net carbon balance in grazed pastures, harvested grassland, and switchgrass fields managed for bioenergy production. We are developing a remote sensing tool that estimates carbon fluxes from small, rotationally-grazed pastures.

Watershed Evaluation. We are refining and validating models that assess the effects of conservation practices on water quality from watersheds. Models are used to determine optimal choices for the selection and placement of conservation practices and to determine uncertainty associated with watershed environmental impact assessments.

Farming Systems. We are refining and using a farm simulation model to evaluate alternative strategies for dairy and beef production. Simulation is used to establish practices that are environmentally sound while maintaining or improving farm profit.



Over the past few years, we have evaluated a variety of production practices for dairy and beef farms. These studies emphasize the evaluation of management effects on farm performance, environmental impact and economics. Some examples include:

Organic Dairy Production. With increasing production costs and a stable or declining real price for milk, smaller dairy farms in the northeastern US are having greater difficulty remaining economically viable. Organic production may provide an option for sustaining smaller farms. Through whole-farm simulation based upon extensive information gathered from four actual farms in Pennsylvania, we conclude:

- Organic production is a viable option for improving the economic return of smaller dairy farms, but long-term sustainability of this advantage is dependent on the persistence of a substantial margin between conventional and organic milk prices.
- Organic production may create environmental concerns. Farm level accumulations of soil P and K are a concern on farms that heavily utilize poultry manure as a crop nutrient source, and runoff loss of P is a concern on organic farms using annual crop production because of the greater number of tillage operations required for weed control.

Carbon Sequestration and Greenhouse Gas Emissions. Continuous, field-scale carbon dioxide monitoring systems were used to quantify the net carbon flux and carbon sequestration potential of perennial grasslands in the northeastern US. Mature cool-season pastures were found to be net carbon sources to the atmosphere, whereas, a two- to three-year-old switchgrass field was a net sink. Models were also developed and used to predict net whole-farm emissions of greenhouse gases (GHG). Dairy farms were found to be net emitters of GHG, and the amount of emission varied based on the management of the farm. Net GHG emissions per unit of milk produced were lowest from a full confinement system (56 lb CO_2e/cwt milk). For the first 25 years or more after conversion to a perennial grassland system, GHG emissions can be substantially reduced through carbon sequestration providing net farm emissions from a rotationally grazed, grass-based system that are substantially less (36 lb CO_2e/cwt milk) than that of the crop-based confinement farm. These comprehensive carbon flux and greenhouse gas emission data provide a basis for developing cost-effective management strategies to reduce emissions and improve sequestration on our farms.

Best Management Practices. Simulations of actual dairy farms in New York were used to evaluate the use of precision feed management (PFM) in reducing P losses in the Cannonsville Reservoir Watershed. PFM reduces soil-P build-up by limiting feed and fertilizer purchases and increasing high-quality homegrown forage production. More accurate feeding of P (based on P required in animal diets) along with increased productivity of grass forage and increased proportion of forage in the diet eliminated whole-farm P imbalances, reduced soluble P lost to the environment by 18%, and reduced annual feed supplement purchases by 7.5 kg/cow for dietary mineral P and up to 1.3 t/cow for protein concentrates. Moreover, when a land management practice of converting corn to grass was added, annual reductions in sediment-bound P loss from converted land averaged 7.6 kg/ha. Slight increases in purchased corn grain were predicted to offset reductions in corn silage production and feeding rates, with no appreciable change in the farm P balance due to land conversion. These model-based studies conducted on a farm-by-farm basis complement farm planning efforts by exploring innovative farming systems, and they set economic and environmental benchmarks for potential benefits of PFM strategies.

Other Recent Studies.

- Simulation of an Angus cattle farm in Maryland illustrated that conversion from a corn and permanent pasture system to all grassland with more intensive rotational grazing increased ammonia volatilization 16%, but reduced nitrate leaching 25%, reduced denitrification loss 50%, and reduced surface runoff loss of P 75%, while increasing annual farm profit by $15,000.
- Use of a free-stall barn, bottom-loaded slurry storage, and direct injection of manure into the soil reduced ammonia emissions by 35-50% and total phosphorus loss about 20% compared to other commonly used dairy housing and manure handling systems, typically with some improvement in farm profitability.
- Compared to conventional tillage with a moldboard plow, use of conservation tillage and no-till systems reduced phosphorus loss by 46% and 57%, respectively, with small increases in farm profitability.
- Single-event rainfall experiments estimated that losses of dissolved P from small manured plots decreased by up to 90% with immediate incorporation while total P losses did not change significantly. However, transfer of dissolved P in applied manure diminished with time. Long-term, farm-scale modeling indicated that average losses of dissolved P would decrease by 8% and total P losses would increase by 77% due to increased erosion caused by soil disturbance during manure incorporation.

Providing Assistance to Producers and their Advisors. Evaluations of alternative production systems provide information that helps direct and encourage producers, and those consulted by producers, toward management options that improve their farms' potential impacts on the environment while improving profitability. For those interested in analyzing and comparing production systems, a version of the farm simulation model is available from our Internet site [http://ars.usda.gov/naa/pswmru] that can be downloaded and installed on any computer using a Microsoft Windows® operating system.