Simulation to Study the Environmental Impact and Profitability of Beef Farms

C. Alan Rotz, USDA/ARS, Pasture Systems and Watershed Management Research Unit; Dennis R. Buckmaster, Agricultural and Biological Engineering Dept. and John W. Comerford, Dairy and Animal Science Dept., Penn State University, University Park, PA 16802

Introduction: With tighter profit margins and increasing environmental constraints, strategic planning of farm production systems is becoming both more important and more difficult. Animal production is complex with a number of interacting processes that include crop and pasture production, crop harvest, feed storage, grazing, feeding, and manure handling. Computer simulation provides a useful means of integrating these processes to predict the long-term performance, environmental impact, and economics of production strategies. A dairy farm model, called the Dairy Forage System Model or DAFOSYM, provides this type of tool for evaluating dairy farms. Several major modeling efforts have produced and applied beef production models for the U.S. and Canada, but the scope of the farm is limited in each. Nutrient management and environmental impact are also not addressed. Our objective was to create a more comprehensive beef farm model by developing and integrating a beef animal component with DAFOSYM.

Results: A beef herd submodel was created for integration with other farm component submodels to form a whole-farm model capable of simulating a wide range of beef production systems. The herd submodel determines the best available feed or feed mix to meet the fiber, energy, and protein requirements for each of up to six animal groups on the farm. The groups consist of any combination of cows, nursing calves, young heifers, yearling heifers, stockers, and finishing cattle. Protein, energy, and mineral requirements are determined for each group using the Cornell Net Carbohydrate Protein System, level 1. Diets are formulated to meet these requirements with available feeds, and the resulting feed intake, growth, and manure dry matter and nutrient (N, P, and K) excretions are predicted. Required feed characteristics include crude protein, rumen degradable protein, acid detergent insoluble protein, neutral detergent fiber, total digestible nutrients, phosphorus, and potassium concentrations. Feed intake is predicted considering energy intake, potentially limited by fill, and exceeding a minimum roughage requirement. Fill and roughage limits are functions of feed neutral detergent fiber contents adjusted to consider particle size distribution and the relative rate of ruminal digestibility or physical effectiveness of the fiber. The herd submodel was verified to predict feed intakes, nutrient requirements, diets, and manure excretions similar to those recommended or measured for beef animals. Incorporation of the beef herd submodel with other farm models including crop growth, harvest, storage, feeding, grazing, and manure handling provides the Integrated Farm System Model.

Implication: This new Integrated Farm System Model provides a unique research and education tool for evaluating the performance, environmental impact, and economics of beef farms over many weather years. Researchers will use the model to evaluate, compare, and develop new beef production systems that are more environmentally and economically sustainable. The model can also be used through classroom, laboratory, and individual use to study the whole-farm impact of management and technological changes. The model is available for download from the Internet site of the Pasture Systems and Watershed Management Research Unit (http://ars.usda.gov/naa/pswmru). Links are also available from the Grazing Guide website.