INTEGRATING BIOPHYSICAL AND ECONOMIC MODELS FOR ASSESSING IMPACTS OF CHANGE ON GRAZINGLAND ECOSYSTEMS

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ABSTRACT
PHYGROW, a hydrologic-based forage simulation model, was parameterized to represent a typical South Texas ranch engaged in the production of cattle and meat goats with an indigenous population of white-tailed deer. Forage production and associated stocking rates for two cattle: goat ratios were simulated for 20 years. Two, ten-year weather scenarios, one representing normal conditions (30% drought years) and one representing dryer weather conditions (50% drought years) were analyzed. Management decision rules were developed for the region to produce estimates of annual animal production and operating cost for the enterprises in each of the four scenarios. These performance and cost data were then used as input into FLIPSIM, a firm level income and policy simulator, along with relevant product and input price data for the region. Integration of modeled results produced useful information showing the socioeconomic consequences for a typical South Texas firm impacted by alternative climatic conditions and management strategies.

KEYWORDS
Simulation, Model integration, Economic impacts, Grazingland ecosystems, Policy assessment

INTRODUCTION
Over the past half-century a large number of issues related to human use of grazinglands have been analyzed. Many of these analyses, however, have failed to provide the reliability, robustness and usefulness for managers and policy makers that similar efforts directed at agronomic production have produced (Bernardo and Conner, 1990). Several factors contribute to this analytical difficulty including the complexity of a system where the product of interest comes from herbivores using grazed forages; the heterogeneity of range ecosystems; the adverse and highly variable climatic conditions associated with rangelands; and the difficulty in understanding the underlying ecological forces that govern grazingland productivity. Conner (1994) suggested that assessing the socioeconomic impacts of change (technological, institutional or environmental) on grazinglands could be accomplished using a procedure whereby a region is characterized by modeling a set of representative farms using the output of a plant growth model as input to an animal production model, then using the output from the animal model as input to a firm level economic performance model. The study reported herein was undertaken to determine the feasibility of this proposed procedure.

METHODS
Data for a typical South Texas ranch were used to parameterize PHYGROW (RSG, 1995) as described in a companion paper (ID No. 1387) prepared for presentation at this Congress (Stuth et al. 1997). Two cattle:goat ratios, 70:30 and 50:50, were selected to represent alternative management strategies available to a firm operator. Twenty years of simulated forage production and associated stocking rates from PHYGROW were divided into two ten-year periods one representing a normal climatic scenario with about 30% drought years and the other representing a dryer climatic scenario with about 50% drought years. Drought years were defined as those in which the stocking rate output from PHYGROW was less than 80% of the long-term average. The stocking rates for the four, ten-year period scenarios were used with a set of decision rules prescribed by range animal scientists and ranch managers familiar with cattle and meat goat enterprises in the South Texas area to estimate annual animal production levels and deviations from normal (average) annual operating cost for the two enterprises.

The annual animal production levels and operating cost deviations were used as input data in the Firm Level Income and Policy Simulator (FLIPSIM) (Richardson and Nixon, 1986). FLIPSIM is a dynamic, recursive and stochastic model that simulates the impact on the financial and economic characteristics of a specified farm or ranch firm of alternative institutional, technological or managerial environments over a specified time period (number of years). Product and input prices and annual yields (production levels) are exogenous to the model and must be specified by the user either by directly entering annual values or prescribing a probability distribution from which annual values may be randomly sampled. In this study, product and input prices parameters for the South Texas representative farm were obtained from the FAPRI/AFPC Baseline 1996 dataset (Richardson, 1996).

RESULTS AND DISCUSSION
A summary of selected indicators of the economic and financial condition of the representative firm that would be expected after ten years under each of the four prescribed scenarios can be found in Table 1. Under the normal weather scenario, the 70:30 cattle: goat ratio produces less decline in real net worth, higher average annual cash receipts and net income but lower average annual returns to assets and equity and a higher net income risk index than does the 50:50 ratio. The net income risk index indicates the probability that net income in any given year will not be sufficient to meet required expenses thus resulting in an increase in debt.

Under the dryer weather scenario, declines in real net worth are greater, cash receipts, net incomes and returns to assets and equity are lower regardless of cattle:goat ratio than under the normal weather scenario. As in the normal weather scenario, however, the 70:30 cattle goat ratio produces higher receipts and net income and net income risk index than the 50:50 ratio.

These results are indicative of the fact that in this region, goats, while generally less profitable than cattle, require less annual operating cost, less capital investment and exhibit less variation in annual receipts and net income. The lower variation in net incomes from goats compared to cattle is due both to the goats' forage availability being less impacted by variations in annual precipitation and less year to year change in prices received for meat goats compared to weaned calves sold from the cow-calf enterprise.

This study illustrates that useful results can be achieved by incorporating ecological and socioeconomic models. The framework developed herein represents an evolutionary effort in the task of streamlining and refining our ability to adequately assess the ecological and socioeconomic impacts of change on grazingland ecosystems. In so doing, this study offers evidence that our efforts

to develop truly integrated models where the impacts of socioeconomic actions on the grazingland ecosystem could also be internalized and accounted for should be continued.

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