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ECONOMIC EVALUATION OF INTEGRATED CROPPING SYSTEM WITH COTTON

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Introduction

Cotton is the primary crop grown in the Southern High Plains of Texas, with 20 percent of the United States cotton crop being produced in this region. Cotton production in the semi-arid High Plains has been very profitable by supplementing precipitation with irrigation water pumped from the Ogallala aquifer. However, for many years, water has been pumped from the aquifer at rates exceeding recharge. Irrigated crop acreage has reduced the Ogallala aquifer water supplies over time. The reduced levels of the aquifer have led to an increased cost of producing cotton as depth of pumping increased over time, causing farmers to look for both new irrigation technology and alternative crop production systems that reduce irrigation water demands. This study addresses reduced irrigation water demands in areas with limited water supplies.

An integrated crop/livestock production system designed to conserve water was implemented at the Texas Tech University research farm, under the SARE/ACE project (Allen, et al). The system contained two crop paddocks adjacent to a bluestem grass paddock that allowed rotational stocker steer grazing throughout the system. The two crop paddocks contained a cotton/wheat/fallow/rye rotation. The alternative system was compared to monoculture cotton crops grown concurrently at the site. The economics of an integrated cotton/forage/livestock system designed to reduce irrigation needs compared to monoculture cotton were evaluated.

Study Area Importance

Approximately 95 percent of water used from the Ogallala Aquifer is used for irrigation. Mary Sager and Cyrus Reed of the Texas Center for Policy Studies estimated Texas High Plains pumping rates of 5.55 acre-inches/year in 1990 and 6.22 acre-inches/year in 1995 (Sager, et al). The safe annual depletion rate meanwhile was estimated at 3.81 acre-inches. The recharge rate for this portion of the aquifer is 0.30 acre-inches annually. This low recharge rate is caused by several factors. The Texas and New Mexico regions of the formation are now a plateau cut off from original water and formation materials from the Rocky Mountains (High Plains Underground Water Conservation District 1). In addition, these regions in the Ogallala formation have low precipitation, high evaporation rates due to dry air and high winds, and clay soils with low permeability (Texas Water Resources Education). For example, Lubbock, Texas, receives an average annual rainfall of 18 inches per year. The average annual evaporation in Lubbock is about 80 inches. Playa lakes can help to recharge the aquifer but often suffer high evaporative losses. Some rivers aid in recharge but some, including the Canadian River in Texas, actually contribute to depletion since their elevations are lower than the aquifer elevation. Rapid depletion of the Ogallala in Texas is compounded by its shallow saturated thickness, which varies from zero to 199 feet. By contrast, in much of Nebraska the Ogallala formation has a saturated thickness from 200 to 1,200 feet.

Lower water levels have caused irrigation costs to rise with some land being removed from production. Short of pulling land from production, farmers can introduce crops with lower water requirements and schedule irrigations to provide more water during critical times in the crop’s growth cycle and less water during less critical times.

Research System Description

The Texas Tech University Plant and Soil Science department conducted an interdisciplinary research and education program to determine the water conservation and economic benefits of an integrated crop/livestock production system. The researchers monitored three trial plots, each with three paddocks and a monoculture cotton field, over a four year period (Figure 1). One paddock contained WW-B. Dahl Old World bluestem grass and served as pasture for feeder steers. The two crop paddocks contained a rye/cotton/wheat rotation and a wheat/fallow/rye rotation. Both rotations were grown each year on alternating paddocks so that cotton was grown on one paddock per year. The small grain rotation was grown on the other paddock as a cover crop to conserve water and provide grazing for the steers. All paddocks were irrigated by an underground drip irrigation system buried 14 inches deep. Drip irrigation is the most effective type of irrigation with efficiency approaching 100 percent. The drip system was chosen to facilitate the research and is not advocated as the irrigation system of choice. Since all areas received irrigation from the same system, irrigation type is not an independent variable in the study.

Both cotton and livestock are important industries in the High Plains. However, the two enterprises are rarely combined by farmers and ranchers. By using land in the cover crop rotation for grazing purposes, researchers were able to generate profit from a feeder steer herd and hedge against the yield and profit risk of a monoculture cropping system, as well as conserve water for the following year's cotton crop (Segarra). Twenty-one 500-pound Angus cross steers were purchased and turned out on the bluestem in early January and taken off mid-July. In addition to the bluestem, the cattle were supplemented by grazing the wheat and rye in season. The cattle achieved an average daily gain of 1.8 pounds in the grazing system. In mid-July cattle were sent to the feedlot. In late summer, nitrogen and water were applied to the bluestem to stockpile forage for the following spring's grazing. In October, seed was harvested from the grass, providing another source of income to producers.

In the integrated system, cotton was planted in May and harvested in October or November. Winter wheat was immediately planted as a cover crop. The wheat was grazed out and the land left fallow from July until September when rye was planted as a cover crop. Rye was grazed until mid-April and terminated in late April to prepare for cotton planting. Minimal tillage was used as needed to prepare beds. Weed control was done through pesticide use, mostly Roundup Ultra (*Glyphosate, isopropylamine salt*) mixed with ammonium sulfate and Staple (*Pyrithiobac-sodium*), and by hand hoeing.

Model Simulation

To allow the results of this research to be projected to farms in surrounding areas, CroPMan version 3.2 was used to model both yields and the economics of the integrated system (Gerik, et al). CroPMan (Crop Production and Management Model) was developed by Blackland Research and Extension Center, Texas Agricultural Experiment Station, Temple, Texas. The program is based on the Environmental Policy Integrated Climate (EPIC) program also developed by Blackland Research Center.

Soil and plant characteristics were entered into CroPMan to simulate conditions of the research. Management was modeled through the crop budgets, which included planting, harvesting, machine operations, irrigation and chemical use dates, prices and agronomic practices. For past years, actual weather data from the university farm's weather station, supplemented by data from a nearby United States Department of Agriculture (USDA) weather lab, was entered into the program through Weather Analyzer. CroPMan generates predictions for weather in future years based on averages from the Lubbock International Airport weather station, located near the farm. Simulations run in CroPMan were validated against observed crop yields achieved by the plant and soil science researchers.

Results

After the CroPMan model was calibrated based on past years' inputs, yields and economic data, the model was used to project yields and profits 20 years into the future. Future cotton crops were projected using FiberMax 989 RR BR, as used in the 2003 crop year. In preliminary testing, the integrated cotton system model validated well over the four years of research data. The integrated system model predicted average yields of 1451.58 lb lint/acre for the integrated system for a twenty-year period. The monoculture cotton system predicted yields averaged 1478.62 lb lint/acre for the same period. However, due to the lower variable costs and decreased yield variability associated with the integrated system, it was more profitable than the monoculture cotton system. Predicted returns for the cotton crop above variable costs averaged $404/acre for the integrated system. For the monoculture cotton system, predicted returns above variable costs averaged $313/acre. In addition to increased per-acre profitability of the cotton crop, the integrated system provides alternative sources of income as well. Seed harvested from the bluestem grass can be sold as a highly profitable enterprise. Stocker calves are also sold mid-summer.

The integrated system offers benefits besides profitability. The integrated crop/livestock system used about 23 percent less irrigation water than the monoculture cotton system. The integrated system also decreased nitrogen fertilizer requirements by 38 percent, as well as decreasing herbicide and pesticide requirements.

Conclusion

The integrated crop/livestock system demonstrated a higher profitability than a monoculture cotton system in terms of cotton yields and production costs alone. Future economic research will continue to study the profitability of the integrated system. This research will also include the costs and returns of the beef stocker cattle and of the bluestem grass seed production. This modeling effort will allow these research results to be simulated on alternative soils and landscapes found throughout the Southern High Plains.

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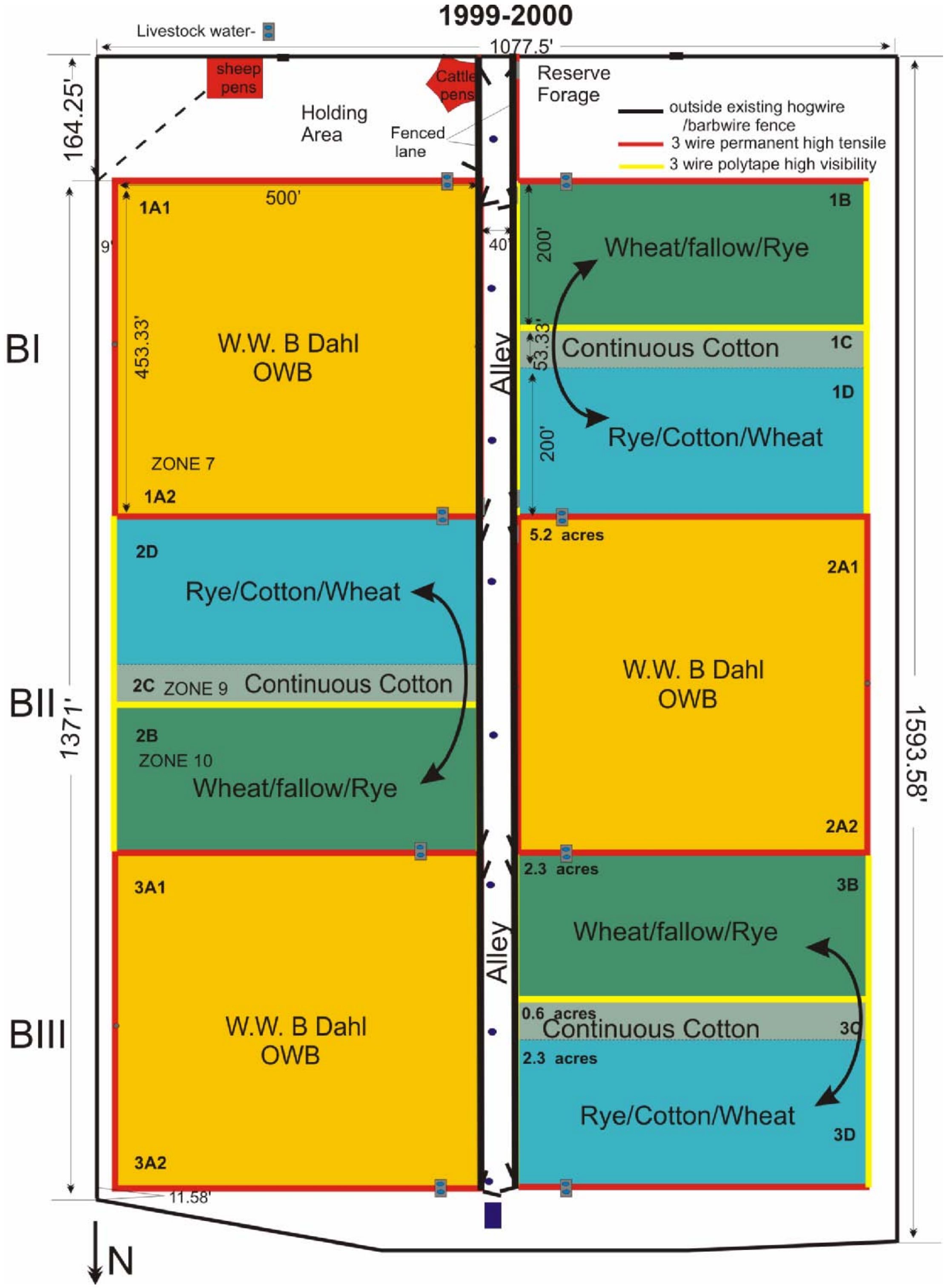

Figure 1: Field Plot Design, SARE/ACE Project, Texas Tech University Research Farm, New Deal, Texas.