Southeast Climate
EXTENSION | Advancing Climate Extension in Agriculture

Sod-Based Rotation

A Management Option for Climate Variability and Change

Introduction

Adapting to climate variability and change can be achieved through a broad range of management alternatives and technological advances. While decision making in agriculture involves many aspects beyond climate, including economics, social factors, and policy considerations, climate-related risks are a primary source of yield and income variability. Existing strategies, like sod-based rotation can help producers minimize the risks associated with climate variability and change as well as improve their resource-use efficiency.

What is sod-based rotation?

A sod-based rotation incorporates two or more consecutive seasons of a perennial grass into a conventional row-crop rotation. One example of a sod-based rotation is an adaptation of the conventional peanut/cotton rotation that farmers follow in North Florida. In a four-year, sod-based rotation, bahiagrass is grown for two years, followed by a year of peanuts, and then a year of cotton (Figure 1). In North Florida, bahiagrass is commonly used in the sod-based rotation because it is comparatively easy to establish and it grows well in low fertility soils and under low input management. Bahiagrass can be grazed, cut for hay, or harvested for seed as a means of income. Adding livestock can make the system more productive and can improve the use of the bahiagrass.

Figure 1. Illustration of conventional and sod-based peanut/cotton rotations. Credits: Daniel Dourte

USDA NIFA United States Department of Agriculture National Institute of Food and Agriculture

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How does a sod-based rotation reduce climate-related risks?

Many soils in the southeastern United States have high sand content, low organic matter, and compaction layers. These soil deficiencies can make agricultural systems especially prone to stresses from variability in climate, namely dry spells and droughts. The sod-based rotation can reduce climate-related risks as follows:

- Improved soil water-holding capacity, potentially reducing impacts of dry spells and droughts. The greater soil water-holding capacity results from the increased soil organic matter (from perennial root growth and increased soil cover). The root mass produced by perennial grass is around 20,000 lb/ac, compared to about 4,000 lb/ac for an annual cover crop.
- Increased infiltration rate and reduced bulk density, resulting from an increase in soil macropores related to greater root mass and biological activity for soils in a sod-based rotation.

Field data from 2002-2007 at Quincy, FL, show that water-use efficiency of peanut under sod-based rotation was 15% greater in irrigated fields and 19% greater in dryland fields compared to water-use efficiency of peanut in a conventional rotation (Zhao et al. 2008). Here, water-use efficiency is defined as the ratio of crop yield to the sum of irrigation and rainfall. This data suggest yield increases have resulted from improvements in soil water-holding capacity. In the very dry years of 2006 and 2007, peanut yields in a sod-based rotation were 13% greater than those under conventional rotation (Zhao et al. 2008).

What are the agronomic benefits?

Perennial forages have been shown to significantly decrease drainage volumes and nitrate leaching compared to annual crop rotations (Randall et al. 1997). Integrating livestock and perennial crops into traditional corn/soybean rotations in Iowa has lowered annual soil erosion rates by 75% (Burkart et al. 2005). The improved residue cover at the soil surface and the expansion of plant root zones under perennial crops reduce runoff and keep more water and nitrogen in the soil profile. This can result in numerous agronomic benefits. Peanut yields following two years of bahiagrass were 25% greater (more than 600 lb/ac) than yields following cotton in field experiments from 2002-2004 in Quincy, FL (Katsvairo et al. 2007). Cotton yields from the same field experiments increased about 10% (Figure 2). The agronomic benefits and soil improvements of a sod-based rotation are as follows:

Agronomic Benefits

- Greater nutrient-use efficiency (less nitrates leached from soil)
- Higher yields at lower-than-conventional rates of applied nitrogen
- Increased root activity at greater depths, which results in improved water and nutrient-use efficiency
- Reduced incidence of disease and pests

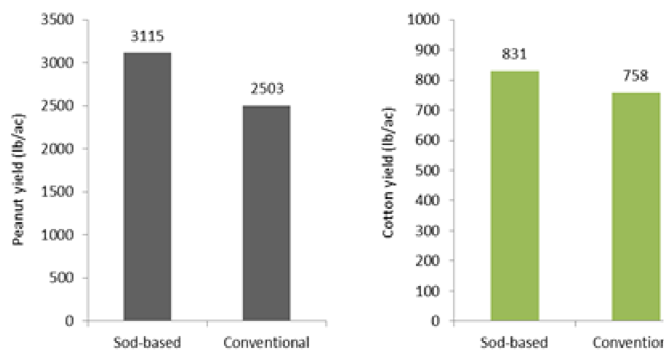

Figure 2. Yield differences in peanut and cotton for sod-based and conventional rotations, using averages of dryland and irrigated fields for 2002-2004 (data from Katsvairo et al. 2007). Credits: Figure by Daniel Dourte.

Soil Improvements

- Higher soil water-holding capacity
- Increase in earthworm population
- Greater proportion of mycorrhizal fungi
- Greater proportion of micro-organisms harboring unsaturated fatty acids, indicating greater organic matter and less compacted and less disturbed soils

- Greater microbial biomass carbon, indicating greater biologically active pool of carbon
- More enzyme activity, indicating higher rates of potential mineralization of organic compounds, hence more plant-available forms of nutrients in the soil
- Greater proportion of stable soil aggregates as revealed by aggregate stability studies, enzyme activities, and fungal population

Especially in dryland systems, the effects of a sod-based rotation—1) increasing root zone depth, 2) increasing infiltration rates, and 3) increasing soil water-holding capacity—all can result in important agronomic improvements over a conventional rotation.

What are the impacts on production costs?

A small-farm (200 acre) economic model has been used to compare profits of a conventional cotton-cotton-peanut rotation to a sod-based cotton-peanut rotation. Annual profits for the sod-based rotation were $35,500 for bahiagrass hay harvest and $45,000 for bahiagrass grazing. For the conventional rotation, profits averaged $15,700 annually (Marois et al. 2002). One of the main factors contributing to the improved profit potential of the sod-based rotation is an estimated $7,000/year reduction in input costs compared to the conventional rotation. A spreadsheet of an economic model for a sod-based rotation can be accessed at http://nfrec.ifas.ufl.edu/programs/bahiagrass_cattle_peanuts_cotton_2011.xls. Sod-based rotations can decrease production costs through the following:

- Year-round use of the land, improving nutrient-use efficiency,
- Reduced fuel costs from less tillage and lower pest management inputs,
- Decreased water and fertilizer inputs (Allen et al. 2007), and
- Reduced nematicide and fungicide applications (Katsvairo, Rich, and Dunn 2006).

What is the investment cost?

The initial costs to implement a sod-based rotation depend on a producer's current integration of livestock. A producer with livestock will likely already have the equipment to use perennial grass as forage or the fencing to incorporate grazing. Bahiagrass planting can be accomplished using a standard seed drill, no-till drill, or broadcast seeder. If a producer does not have access to the required seeding equipment, this will add to the investment cost. For producers without livestock, one option for implementing a sod-based rotation is cooperating with neighboring producers who have livestock. This can decrease the investment costs associated with incorporating livestock. A second option for producers without livestock is to cut and sell hay.

What are the impacts on greenhouse gas emissions?

The substantial reduction in fuel consumption and the increase in soil organic matter suggest that a sod-based rotation has an improved carbon balance when compared to a conventional rotation. Sod-based rotations have been shown to consistently increase soil carbon. Similar to conservation tillage, a sod-based rotation can decrease greenhouse gas emissions through reduction in tillage, which results from consecutive years of perennial grass. Also, a sod-based rotation can increase soil carbon sequestration as a result of the larger root biomass and vegetative soil cover compared to conventional annual rotations.

What are the barriers and incentives for implementation?

Barriers

- Increased management skills and information
- Altered or new equipment to match changed farming practices
- If a producer does not already have livestock, it is expensive to incorporate livestock, adding substantial managerial effort and investment costs without short-term economic benefit (Franzluebbers 2007). (A sod-based rotation can be implemented without livestock because grass can be cut for hay, but having livestock greatly increases the profitability by providing

better use of forages and improved nutrient cycling.)

Incentives

- Enhanced yields and quality of crops
- Reduced input costs
- Improved soil quality, making the system viable for providing ecosystem services and long-term sustainability

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Authors

David Wright, professor and Extension specialist, Agronomy Department, North Florida Research and Education Center, Quincy, FL; Jim Marois, professor, Department of Plant Pathology, North Florida Research and Education Center, Quincy, FL; Clyde Fraisse, assistant professor, Department of Agricultural and Biological Engineering; and Daniel Dourte, research associate, Department of Agricultural and Biological Engineering; Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.