AN ECONOMIC ANALYSIS OF ADOPTION OF CONSERVATION PRACTICES IN GEORGIA COTTON AND PEANUT PRODUCTION

by

GUY ALBRITTON HANCOCK

(Under the Direction of Yangxuan Liu)

ABSTRACT

Georgia is the second largest producer of cotton and the largest producer of peanuts in the United States. As natural resources become more scarce, these industries have been facing increasing challenges to improve sustainability. Alternative land use practices, such as planting cover crops and adopting advanced irrigation scheduling methods, need to be identified and implemented to ensure water security and efficiency in agricultural production. By interviewing extension agents and agricultural producers, enterprise budgets were developed to reflect alternative land use management practices. These budgets documented cultural practices for cotton and peanut production. Farm-scale production costs and revenues associated with current best management practices (BMP) were included in the enterprise budgets. These bundles of BMPs were evaluated at three scenario levels: intensive, typical, and minimal implementation. This paper utilizes focus groups and economic simulation analysis to compare the alternative BMP scenarios and the impact of these scenarios on land net returns.

INDEX WORDS: Cotton, Peanut, Cover Crop, Budget, Conservation, Georgia

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GUY ALBRITTON HANCOCK

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GUY ALBRITTON HANCOCK

Major Professor:	Yangxuan Liu
Committee:	Alejandro Plastina
	Amanda R Smith
	Jeffrey D Mullen

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Agriculture is one of the leading industries in the state of Georgia, with a farm gate value of over $13 billion (UGA Center for Agribusiness and Economic Development 2019). Consequently, sustaining long-term agricultural production is critical for the state economy. Although all citizens of the state are dependent on agriculture, only 24.9% of Georgia's population who reside in rural areas are disproportionately impacted by the agricultural industry (U.S. Census 2012). Therefore, a thriving agricultural sector greatly benefits the state and especially the rural communities of Georgia.

Some conventional farming practices and tendencies may result in over-irrigation and excessively cultivating the land, and pose a threat to the long-term sustainability of agriculture in Georgia. With the availability of new emerging farm practices and technologies, improving farming efficiency became possible. Planting winter cover crops, installing soil moisture sensors, and utilizing conservation tillage practices are among the farm practices and technologies, which have shown to improve farming efficiency and better usage of natural resources.

Although numerous studies have examined and documented the effectiveness of various conservation practices, little research has been conducted to examine the influence of conservation practices on farming profitability and net returns. To further complicate the task of quantifying the economic impact of utilizing conservation practices, many conservation practices require other conservation practices to be simultaneously adopted. For instance, it is widely known that producers must adopt conservation tillage practices to realize the potential benefits associated with cover crops adoption. If a producer plants winter cover crops but continues to rely on conventional tillage practices, they may not be able to fully utilize the benefits associated with their cover crop adoption such as reducing soil erosion and cultivation. In this thesis, three groups of production strategies, referred as the best management practice bundles, were investigated as ways to manage fertilizer usage, cover crop adoption, and irrigation scheduling methods. The purposes of this research is to study alternative conservation practices by conducting focus group surveys and analyzing these best management practice (BMP) bundles.

1.2 THESIS FORMAT

Two research questions were investigated in this thesis to study the conservation practices of cover crop usage and irrigation management.

The second chapter discusses the motivations of the cover crop utilization and its impacts on environmental benefits and economic profitability. The cover crop utilization portion of this research relies on information collected from focus group interviews to draw conclusions about the revenue and cost changes, and potential benefits and barriers of adopting a single conservation practice of planting cover crops.

The third chapter investigated a larger aspect of collective conservation practices in agriculture by comparing simulated net returns in cotton and peanut production for each of the three different BMP. The best management practices include intensive, typical and minimal implementation. To run net return simulations, individual enterprise budgets were developed for each crop and each of the three BMPs by interviewing extension agents, extension specialists, and agricultural producers.

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CHAPTER 2

AN ECONOMIC ANALYSIS OF COVER CROP UTILIZATION IN GEORGIA COTTON AND PEANUT PRODUCTION[1]

[1]Hancock, G. A. To be submitted to *Journal of the American Society of Farm Managers and Rural Appraisers.*

2.1 ABSTRACT

Georgia is the second largest producer of cotton and the largest producer of peanuts in the United States. These crops combined represent a significant portion of Georgia's economy. As natural resources become more threatened, cotton and peanut industries have been facing increasing challenges to improve environmental sustainability. There are numerous documented farm and environmental benefits of cover crop utilization for cotton and peanut production. However, only a small portion of farmland devoted to cotton and peanuts production is planted with a winter cover crop. One of the major barriers to cover crop adoption is the conflicting information regarding to its economic impact.

This research utilizes focus group interviews to identify the individual cost and revenue changes resulting from cover crop adoption. We adapted the methods utilized in Plastina et al. (2018 a,b,c) to reflect production conditions in cotton and peanut cropping systems in Georgia. This research identifies the benefits and challenges of using cover crops in production systems and the changes to cultural practices that a farmer considers when adopting cover crops.

2.2 INTRODUCTION

Cover crops are known to yield numerous agricultural production benefits as well as positive externalities and environmental benefits to society. Environmental benefits of cover crops have the potential to provide economic benefits to agricultural producers. However, cover crops can also increase farm production costs and impact on crop yield (Shurley, Culpepper, Smith, and Nichols 2014). Many producers face seemingly conflicting economic information regarding the benefits of cover crop adoption (Sustainable Agriculture Research and Education

2012;Boyer et al., 2017). Producers are concerned that by implementing cover crops in their production practices, it might bring more economic uncertainties in their farming operation. This dilemma often results in producers relying entirely on conventional production practices. The goal of this research is to provide producers with additional information to make informed production decisions associated with adopting cover crops.

Plastina et al. (2018 a,b,c) examined the economics and motivations of cover crop use in corn and soybean production in the Midwest. These studies found out that most farmers view winter cover crops favorably (Plastina et al., 2018 a). However, the results indicated that adding cover crops to a production system often decreased net farm returns, except for farmers who utilize cover crops for winter grazing (Plastina, et al., 2018 a). Farmers who utilize cover crops for winter grazing were typically able to increase their profitability (Plastina et al., 2018 a). By using this information, farmers were able to adopt production practices to reduce the uncertainty and improve their profitability associated with cover crop use in the Midwest. However, for Georgia row crop producers, limited research is available in examining the comprehensive economic effects of cover crop usage for cotton and peanut production systems. As a result, most producers in Georgia chose not to adopt cover crops to reduce the uncertainties to their farming operations. This knowledge gap also results in Georgia farmers continuing to rely on conventional production methods without cover crops.

This study examines the individual benefits and costs of cover crop adoption for Georgia cotton and peanut production. The goal of this research is to provide growers with valuable information to help them make informed decisions regarding winter cover crop usage. Since farm management decisions are not always solely based on maximizing profitability in a single year, this project will seek to identify all variables that a farmer considers when making production decisions. The primary objectives of this study are to explore farmer motivations and obstacles to planting cover crops. We also examine the cost and revenue changes associated with conventional production systems compared to production systems with cover crops.

2.3 LITERATURE REVIEW

Cover crops are known to yield economic benefits to farmers and environmental benefits to society. Reduced nitrogen leaching into groundwater is one of the environmental benefits of cover crop usage (Meisinger et al. 1991). Other benefits include weed suppression, increased moisture infiltration, and improved soil fertility. Culpepper et al. (2010) found that rye cover crop had the potential to reduce Palmer Amaranth emergence by 94% in the areas between rows in the field. Truman, Shaw, and Reeves (2005) demonstrated that cover crops in no-till conservation systems increased soil moisture infiltration by 54% compared to a conventional tillage without a cover crop treatment. Furthermore, cereal rye has been reported to collect between 20 to 100 pounds of nitrogen per acre, which can be utilized by the following summer crop (Gaskin, Cabrera, and Kissel 2016). However, according to the 2017 United States Department of Agriculture (USDA) Census of Agriculture, only 12% of harvested cropland in Georgia was planted with cover crops (USDA 2017).

Plastina et. al. (2018 a,b,c) studied the motivations for planting cover crops, budget changes associated with planting cover crops, and the value of individual budget changes observed by producers who planted winter cover crops. Their findings aligned with previous research that insufficient familiarity with cover crops is a major barrier of adoption of cover crops (Nassauer et al., 2011). Based on the methodology developed by Kitzinger (1995), Plastina et. al. (2018 a) utilized focus group interviews to simultaneously gather general information from a group of people . Furthermore, Plastina et. al. (2018 a) also utilized quantitative farm surveys and partial budgets to identify the revenue and costs changes in their research.

Plastina et al. (2018 a) found that controlling soil erosion and improving soil health were the two most commonly stated benefits associated with cover crop adoption. Other benefits reported by focus groups participants ranged from moderating risks to reducing farm production inputs. Furthermore, numerous costs and revenue changes were also reported by participants as a result of planting winter cover crops. In both costs and revenue there were positive and negative budget changes reported to be associated with adopting the conservation practice of planting a winter cover. In some occurrences, different participants reported conflicting budget changes to be associated with a single budget variable. Yield was a major budget revenue variable that farmers reported conflicting outcomes in regards to the change they observe after planting a cover crop. Farmers were almost evenly split in their observed yield change with five farmers reporting a yield increase and four farmers reporting a yield reduction.

A following-up quantitative farm survey was sent to the focus group participants to collect the exact values of the budget changes reported during the focus group interviews (Plastina et al., 2018 a). Information collected in the quantitative farm surveys was then used to develop partial budgets to estimate the impact of cover crops on net returns per acre. Although there were numerous cost reductions and revenue increases reported to be associated with cover crop use, most farmers did not observe overall increase in net returns from planting cover crops.

2.4 DATA AND METHODS

Based on the research methodology and survey instruments developed by Plastina et al. (2018 a), this research investigated the cover crop adoption for Georgia’s cotton and peanut production systems. The individual costs and benefits associated with cover crop use in Georgia were identified for cotton and peanut production.

Focus groups were conducted in four locations across Georgia with farmers who employ both conventional practices without cover crops and practices that incorporate winter cover crops into their production systems. Focus group interviews were conducted in Sylvester, Vienna, Moultrie, and Waynesboro of Georgia with cotton and peanut producers from seven Georgia counties in the central and southern portion of the state. In each interview location, two to six producers were interviewed. In total, 14 farmers participated in the focus group interviews. Two of the first questions asked during the focus group interviews were aimed at identifying original and current motivations for utilizing cover crops. During the focus group discussions, farmers were asked general questions related to how the implementing of cover crops alters their production variables that affect farm budgets. Questions related to how cover crop use impacts farm budgets were broken into the two categories of cost and revenue. Cost questions were designed to identify individual cost changes resulting from cover crop use, and revenue questions were intended to recognize revenue changes observed when farmers plant cover crops. Participants were also asked to describe some of their obstacles with cover crop usage and how they managed their winter cover crops. The consent form and exact questions presented to participants can be seen in figures 1 and 2. Upon completion of the farmer focus groups interviews, the findings from these discussions were carefully analyzed and examined.

2.5 RESULTS

Focus group participants across Georgia each had unique perspectives and methods of utilizing cover crops in their farm operation. Research findings indicate that cover crop use rarely influenced insecticide and fungicide application decisions in cotton and peanut production. As observed in Figure 3, the original motivation for planting cover crops was mostly limiting or preventing soil erosion. After a farmer mentioned soil erosion control as their original motivation for planting cover crops, they were asked to clarify whether they were referring to wind erosion or water erosion. Most commonly, when farmers were posed with this question, they would indicate that both wind and water erosion control were motivations for planting cover crops.

Cover crop management decisions varied from farm to farm, including the type of cover crop planted, termination technique, and methods of establishment. Rye, oats, wheat, hairy vetch, and crimson clover are all types of cover crops that were reported as being used in cover crop systems. Herbicide burn-down was the most commonly adopted method of termination. Some farmers expressed that during the years of excessive rainfall, they were unable to access their fields requiring the use of match and flame to terminate cover crops. Broadcasting and drilling seeds into the ground were found to be the two dominant methods of establishing cover crops. However, one farmer reported that his/her crimson clover reseeded itself each year eliminating the need to replant cover crops annually.

When farmers were asked to identify their current motivations for planting cover crops as opposed to original motivations, the reasons they offered were much more comprehensive as shown in Figure 4. Producers explained that over several years of planting cover crops, they began to reap unintended benefits, such as being able to reduce their number of irrigation applications and reduced weed pressure from the noxious weed palmer amaranth. Although soil erosion control remained the most commonly stated reason for currently planting cover crops, increasing soil water holding capacity, and reduced need for cultivation were more commonly expressed as current motivations for planting cover crops in cotton and peanut production systems. In focus groups, nine farmers indicated that by planting a cover crop they were able to simply terminate the crop with herbicide and plant their cotton and peanuts without other extensive preparation such as field cultivation. Moisture retention over the growing season was another benefit of planting cover crops that was mentioned by eight producers. Remaining cover crop biomass and increased organic matter resulting from planting cover crops enabled farmers to irrigate their crops less frequently and increase productivity in dry-land acres. Weed suppression was also a commonly stated current motivation for planting cover crops.

Interestingly, five farmers reported that drought risk management was an important current motivation in their decision to plant cover crops. Farmers explained that in years of limited rainfall, fields without irrigation were more productive when a cover crop had previously been planted in the previous year, as these fields were able to retain large quantities of water that could be used during dry periods. Conversely, during years of excessive rainfall, it was reported that fields planted after a cover crop were less productive than those not previously planted in a cover crop. Therefore, to neutralize farm production risks farmers would plant some of their acres in cover crops to hedge against drought and not plant cover crops on other acres to hedge against a season of excessive rainfall.

After farmers answered questions about their original and current motivations for planting cover crops, they were asked about their individual budget changes they observed from planting cover crops. In many instances, at least one budget change was associated with a mentioned current motivation for planting cover crops. As observed in Figure 5 and Figure 6, cover crops were reported to have both positive and negative impacts on farm costs and revenues. The majority of budget changes reported to be associated with cover crop use were related to costs rather than revenues for cotton and peanut production.

Aside from the initial costs of establishing a cover crop, such as the costs of seed and fuel used during cover crop planting, numerous positive and negative cost changes were reported to be associated with cover crop adoption. Most cost changes reported in focus groups were cost reductions. However, some producers did report that their decision to plant cover crops increased their cotton and peanut seeding rate, mandated additional herbicides to terminate cover crops, and required purchasing additional farm equipment. However, several farmers did explain that they did not view the cost of a burn-down herbicide application as an additional cost for cover crop. These farmers apply a spring burn-down herbicide, such as glyphosate, even if they do not plant cover crops to eliminate winter weeds.

However, focus group participants did identify a few notable revenue changes resulting from cover crop usage as shown in Figure 6. Reported revenue changes resulting from planting cover crops include occasional yield increases, selling harvestable cover crops, grazing livestock on cover crops, and payments from government programs. Farmers reported conflicting changes about yield resulting from planting cover crops. Five farmers reported that yield for their cash crops increased, while four farmers reported decreased yield. Although both positive and negative yield changes were reported in focus groups, most farmers agreed that cotton and peanut yields were only minimally influenced by a previously planted cover crop. Cost share programs were found to be the most commonly reported revenue change resulting from cover crop use with nine farmers indicating that they received some additional revenue from either the Conservation Stewardship Program (CSP) or the Environmental Quality Incentives Program (EQIP). Finally, two producers reported that they observed a revenue increase from planting cover crops in the form of selling harvested cover crops and providing grazing for livestock.

Figure 7 is a word cloud generated by using the recordings from the focus group interviews. It is observed that soil erosion, cultivation, and irrigation applications are some of the production variables most impacted by cover crop adoption. Although the exact cost of erosion is difficult to quantify, erosion prevention was the leading motivation for planting cover crops among farmers. Farmers explained that controlling erosion saved them money for multiple reasons. By preventing soil erosion, farmers eliminate the cost of repairing field washouts and prevent nutrients from being carried out of their fields. Similarly, focus group participants explained the benefits of planting cover crop to be able to plant cash crops without cultivation, which resulted in fuel saving as field cultivation equipment requires large amounts of fuel to operate. Cover crop residue was reported by eight farmers to decrease irrigation requirements, which saved the farm irrigations expenses.

2.6 CONCLUSION

Qualitative data collected from focus group interviews provides an insightful view of how cover crop utilization affects farm profitability. There are costs and revenue changes associated with this conservation practice. Focus group participants indicated that controlling soil erosion, reducing annual irrigation requirements, and eliminating field cultivation were among the most notable benefits from cover crop adoption. Similarly, the major expenses related to cover crop adoption were the additional cost of cover crop seed, fuel for planting cover crops, herbicide application, and labor. These findings are valuable information in determining how cover crops influence farm profitability. However, to determine the exact value for how cover crops affects profit potential, future research could be beneficial to collect quantitative data. By crafting the findings of this research into more precise survey questions, it would be possible to identify the specific cost and benefit changes associated with the use of cover crops versus conventional practices. Identifying the exact cost and revenue changes resulting from cover crops adoption could enable the production of partial budgets that directly compare the economic impacts to farmers in conventional and conservation cover crop systems (Plastina et al., 2018 a). After such surveys are completed, it would be possible to use this survey data to make estimations about how cover crop utilization influences farm profitability.

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CHAPTER 3

DEVELOPMENT OF BEST MANAGEMENT PRACTICE SIMULATIONS WITH ENTERPRISE BUDGETS FOR PRODUCTION IN THE FLINT RIVER BASIN[1]

[1]Hancock, G. A. To be submitted to *Journal of the American Society of Farm Managers and Rural Appraisers.*

3.1 ABSTRACT

Long-term economic and environmental sustainability of agriculture is necessary because of its productivity in and economic contribution to the region. As populations continue to increase and environmental regulations are signed into law, water security continues to be a threat. Water use and management practices are critical in Georgia. Recent water controversies between Georgia and Florida have escalated to the United States Supreme Court. Alternative land use practices need to be identified and implemented to improve water quality and ensure water use efficiency. By interviewing extension agents and agricultural producers, enterprise budgets were developed to reflect the current land use management practices in the Flint River Basin. These enterprise budgets documented cultural practices for cotton, peanut, Bahia grass, and bermudagrass production. Farm-scale production costs and revenues associated with current best management practices (BMP) were also included in the enterprise budgets. These bundles of BMPs were evaluated at three scenario levels: intensive, typical and minimal implementation. Economic simulation analysis were conducted using @Risk software to compare the alternative BMP scenarios and the impact of these scenarios on land profitability.

3.2 INTRODUCTION

The Upper Floridan Aquifer is vital in sustaining silviculture and agriculture production in large portions of the Southeastern United States (O'Reilly and Kuniansky 2013). Expanding across multiple states, the Upper Floridan Aquifer is the primary water source for millions of individuals in Georgia and Florida (Marella and Berndt 2005). In both Georgia and Florida, agriculture and forestry are major economic engines. The combined annual value of Georgia and

Florida agricultural and forestry production is approximately $25 billion (Georgia Farm Gate Value Report 2018, Florida Agriculture 2018). However, as populations in the region continue to increase, the aquifer is increasingly under the pressure of environmental threats and increased demand for water. Various factors, such as silviculture and agricultural land management practices, lead to differing amounts of environmental pollution and water usage requirements. The amounts of fertilizer and irrigation used in agricultural production are among the practices, which have the greatest impacts on water pollution and usage. Water insecurity could have a negative impact on food security, public health, and the economy. The purpose of this research is to ensure long-term sustainability in water quality and quantity by investigating the on-farm economic impacts of adopting modern agricultural production techniques.

It is well documented that different agricultural management practices have different impacts on the amount of nitrogen leached from the soil and the amount of water necessary to produce crops (Nielsen and Jensen 1990). Lower fertilization levels and more efficient irrigation application are beneficial in promoting water security. However, it is not clear how collective best management production practices influence individual farm profitability. Therefore, a critical aspect of this research is to identify the different costs and revenues associated with each of the best management practice in the Upper Floridan Aquifer region. To determine how farm profitability is impacted by different management practices, detailed enterprise budgets were developed to reflect the differences in costs and revenue between three different levels of management systems. These management systems include intensive (Management System 1), typical (Management System 2), and minimal (Management System 3) conservation management practices. Finally, economic simulation analysis were conducted using

@Risk software to compare the alternative best management practice scenarios and the impact of these scenarios on land profitability.

3.3 LITERATURE REVIEW

Three management systems were compared in this research to study the utilization of strip-tillage, soil moisture sensors, and winter cover crops on water usage and profitability. Each of these conservation practices has been shown to increase farming efficiency in input usage, and promote long-term sustainability in agriculture. Strip-tillage cultivation is the practice of tilling narrow strips for planting in crop stubble prior to planting without disturbing the remaining soil (Nowatzki, Endres, and DeJong-Hughes 2017). Longest (2017) found out that the strip-tillage cultivation practice has minimal impacts on crop yield, but some producers adopt this method in their production systems as it minimizes the disturbance of soil. Soil moisture sensors are used to monitor moisture levels of the soil (Trellis 2019). Zamora et. al. (2018) found out that water savings from the use of soil moisture sensors ranged from 39% to 81% in their research trials from 2015 to 2017.

Many environmental and production benefits are documented to be associated with cover crops use. Cover crop can reduced nitrogen leaching into groundwater and reduce soil erosion (Meisinger et al. 1991; USDA 1936). Production benefits associated with cover crop usage are diverse and range from weed suppression to reductions in crop irrigation requirements. Culpepper et. al. (2010) concluded that cover crop residue is capable of reducing Palmer Amaranth by 94%. Plastina et. al. (2018 a) conducted focus group interviews and identified that weed suppression and erosion prevention were the major motivations for planting cover crops in traditional row crop production systems.

Although there are numerous environmental and crop production benefits associated with adopting conservation farming practices, a significant portion of the value associated with implementing these practices is realized by all residents of the society. Reductions in water use and nitrate loss in agriculture are the most significant public benefits associated with adopting more efficient farming practices. As seen in figures 8 and 9, Karki et al. (2019) found out that more efficient management systems considerably increased water use efficiency and reduced nitrate loss.

Numerous studies have been conducted in the area of crop budgeting and simulation. Dillon (1992) emphasizes that agricultural enterprise budgets that consider components such as variable costs, fixed costs, yield, and crop price are effective tools to help make production decisions. Furthermore, this work discusses how enterprise budgets are helpful in finding breakeven points in production (Dillon 1992). Flanders (2016) illustrates how comprehensive enterprise budgets can enable producers to estimate net returns per acre based on differing possible crop market prices. Similarly, enterprise budgets allow farmers to compare potential net returns for various crops when making planting decisions (Flanders 2016). Despite the potential benefits for enterprise budgets to assist producers in making production decisions to maximize profit, Bradford and Debertin (1985) elaborate on some of the major limitations of enterprise budgets. The factors that place potential limitations on enterprise budgets are economies of scale resulting from varying production costs between farms and discrete budget outputs (Bradford and Debertin 1985).

Once enterprise budgets are developed for a given crop, it is possible to use the Monte Carlo simulation method for product valuation and net return estimation. Hyde and Engel (2002) utilized the Monte Carlo simulation method to identify the breakeven value of robotic milking system (RMS) on dairies with 60, 120, and 180 milking cows. By developing enterprise budgets for each level of milk production, Hyde and Engel (2002) were able to make clear determinations about the maximum amount of money that a farmer could spend on an RMS and breakeven on their investment. Hyde et. al. (2003) estimated the value of Bt corn to southwest Kansas corn farmers by limiting yield damage from pests, such as the European corn borer. This study estimated the value of Bt corn by running simulations with differing yield possibilities for Bt corn and non-Bt corn in the region (Hyde et. al. 2003).

3.4 DATA AND METHODS

The enterprise budgets developed in this study were modeled after the annual crop enterprise budgets published by the University of Georgia Cooperative Extension (Smith et. al. 2018). Production cost data were collected to reflect the cost of growing cotton and peanut in the Lower Flint River Basin for this study. To collect the production cost data, interviews were conducted in Georgia's Lower Flint River Basin with agricultural producers, extension specialists, county extension agents, and fertilizer and chemical suppliers in the summer of 2018. These interviews were conducted in Mitchell, Lee, Miller, Terrell, Dougherty, and Baker counties in Georgia. Enterprise budgets developed from these interviews included the revenues, variable costs, and fixed costs associated with cotton, peanut, bermudagrass, and bahiagrass. In this thesis, the primary focus is the enterprise budgets developed for Georgia cotton and peanut production. Peanut enterprise budgets were developed in collaboration with researchers from the University of Florida (Koirala 2018).

Three enterprise budgets were developed for each of the crops to reflect intensive (Management System 1), typical (Management System 2), and minimal levels (Management System 3) of management systems. The exact production characteristics of each management system are shown in tables 1 and 2. Management System 1 represents the intensive level of management practice, where producers most intensively strive to constantly improve the efficiency of their production systems. Common practices of Management System 1 producers would include actions such as planting cover crops and fully utilizing modern agricultural technology to ensure they are using water as efficiently as possible. Furthermore, Management System 1 producers employ most production practices that minimize nitrogen leaching from the soil such as, taking soil and tissue samples. Management System 2 represents the management practices of a typical producer. Producers in this Management System use some mix of modern practices that would make their farms more efficient. However, producers in this management system tend to be hesitant about experimenting with new practices that do not have a long proven record of accomplishment. These individuals in Management System 2 do not plant cover crops nor conduct uniformity testing on farm irrigation pivots, but they do implement some conservation practices such as utilizing strip-tillage. Management System 3 represents the minimal level of management practices, producers in this level lag behind most producers in adopting modern practices to ensure water and nitrogen usage efficiency. It would not be expected that a Management System 3 producer would plant cover crops, take soil or tissue samples, perform uniformity testing on irrigation pivots, nor use any other practice that would improve farm efficiency. The production practices used by Management System 3 producers could result in the greatest amount of nitrogen leaching from the soil and the least efficient water use.

Although many producers might utilize a mixed bundle of production practices, for budgeting purposes the following tables 1 and 2 represent the exact practices that were considered for each cotton and peanut management system. Each of these different management systems produces different costs, revenues, and in many cases different crop yields. Therefore, different profitability is associated with each of the different management systems. For cotton budgets, \$0.77/lb. was used as the average price for each management system to reflect the current price farmers receive in the market (USDA, ERS 2018). For peanut budgets, \$458/Ton was used as the average price to reflect the current market price for runner-type variety peanuts (USDA, FSA 2018).

Soil and Water Assessment Tool (SWAT) is a river basin model to measure the influence of soil characteristics, management practices, and weather on crop production and its environmental impact. 27 years of crop yield data of a cotton and peanut rotation system from 1990 to 2016 was simulated from SWAT to reflect each of the three best management practice levels (Karki et al. 2019). Although historical data is not always an accurate indicator of future performance, it does provide some level of insight into future outcomes. Table 3 shows the summary of statistics of the simulated yield data for cotton and peanut from the SWAT model. Net returns per acre were measured in enterprise budgets as the difference between yield multiplied by crop market price and minus total cost (total fixed cost and total variable cost) (Flanders 2016).

Economic simulations were conducted for each management system to identify how different farm practices impact farm profitability for cotton and peanut production. Monte Carlo simulation was conducted by using @Risk (Modeling With @Risk: A Tutorial Guide 2016). Crop yield distributions generated from SWAT and enterprise budgets for each crop were entered into @Risk Software for each of the different management systems to determine how each management system impacts the net return per acre for cotton and peanut production. This software enables the user to collect numerous data points by drawing possible inputs based on an entered distribution for an unknown variable. After simulated yield distributions from SWAT were entered into @Risk enterprise budget spreadsheets, 500 simulation iterations were run to develop net return distributions for cotton and peanut produced in each of the Management Systems 1-3. Finally, the average net returns per year for cotton-cotton-peanut rotation system were developed by taking weighted average net returns per acre for cotton and peanuts in a three-year rotation system. The value of net returns per acre in this rotation were calculated by using simulated cotton and peanut net returns in the following formula:

$$\boldsymbol{Average\ Annual\ Net\ Return\ Per\ Acre}$$
$$= \boldsymbol{2/3 \times Cotton\ Net\ Return + 1/3 \times Peanut\ Net\ Return}$$

3.5 RESULTS

The enterprise budget developed for each management system reveals how production costs were different for each Management System, as shown in tables 4 – 9. As seen in table 4, the costs of using soil moisture sensors, planting cover crops, and soil and tissue sampling maximized the individual number of costs in cotton production for Management System 1. The variable cost for Management System 1 cotton production was found to be $536.51 per acre and the fixed cost per acre was identified at $315.36 per acre, resulting in a total production cost of $851.87 per acre. Table 5 is the enterprise budget developed for Management System 2. The cost difference between systems Management System 2 and Management System 3 is that Management System 2 incurred the cost of soil and tissue sampling and Management System 3 did not include the cost of sampling. Variable and fixed cost per acre for Management System 2 production was found to be $590.26 and $316.45 per acre, resulting in a total cost of $906.71 of per acre. Management System 3 production resulted in the highest production cost per acre despite only minimal production inputs being utilized to increase water and nutrient efficiency. The total cotton production cost per acre for Management System 3 was calculated to be $993.02 with variable and fixed costs estimated to be $660.62 and $332.40 per acre as is seen in table 6.

The trends in the production costs observed in cotton remained consistent for peanut budgets as well with the more efficient systems being the least costly. Management System 1 peanut total cost per acre was $925.91 with variable and fixed costs of $587.95 and $337.96 per acre, respectively. Variable costs of $607.71 and fixed costs of $294.16 per acre resulted in a total cost of production of $901.27 per acre in Management System 2. Finally, the Management System 3 total cost per was $933.61 per acre with variable and fixed costs of $637.23 and $296.38 per acre. As with cotton, additional efficiency inputs, such as installing soil moisture sensors did increase some costs associated with peanuts production. Summarized cotton and peanut budgets are displayed in figures 10 and 11.

For cotton production, simulation results indicated that Management System 1 is more profitable than Management Systems 2 and 3. Cumulative distribution functions for cotton and peanut management systems are seen in Figures 12-17. Net returns for cotton in Management System 1 averaged at $333.33 per acre with 50% of simulated net returns falling between $195.02 and $470.78 per acre. Net returns for cotton in Management Systems 2 and 3 were only marginally different and much lower than those in Management System 1. Management System 2 cotton returns averaged at $-2.76 with 50% of values falling between the values of $-172.40 to $166.50 per acre. Simulated net returns for cotton per acre in Management System 3 averaged at $-1.78 with 50% of net return values ranging from $-183.34 to $180.27.

Peanut net returns were much more consist than cotton returns across all three management systems. Simulation results indicated that average net returns were negative in all management systems considered for Georgia Peanut production. However, simulation results indicate that Management System 2 yield the most desirable net returns per acre of any of the three Management Systems. Management System 1 peanut net returns per acre averaged at $-122.97 with 50% of values falling in the range of $-174.23 to $-71.60. Peanuts in Management System 2 were found to have an average net return of $-93.99 with 50% of net return values ranged from $-136.61 to $-51.32 per acre. Management System 3 peanuts net returns averaged at $-118.30 per acre with 50% of net returns falling between the values $-161.11 and $-75.69 per acre.

The weighted average annual net return for a 3-year cotton-cotton-peanut rotation system reflected that cotton has the larger influence on the weighted average net return. Management System 1 generated the highest weighted average annual net return. The weighted average annual net return in Management System 1 averaged at $181.12 per acre with 50% of values falling between $86.17 to $274.67 per acre. For Management System 2, weighted average annual net return averaged at $-33.00 and 50% of values were between $-137.48 and $77.57. 50% of Management System 3's weighted average annual were between $-155.42 and $80.25 with average net returns of $-40.64 per acre. Figures 18 through 20 summarized the simulated net returns for cotton, peanut, and cotton-cotton-peanut rotation systems.

3.6 CONCLUSIONS

Cotton and peanut enterprise budgets for each management system reveal that additional costs and investments need to be made by producers as water and nutrient efficiency increases for cotton and peanut production. However, reductions in fertilizer and irrigation costs, resulting from adopting more efficient farming practices, reduce total production costs for both cotton and peanut production. These lower production cost could economically justify lower crop yields per acre in both cotton and peanut production. Nevertheless, the yield data considered in this research indicated that there are not substantial yield reductions resulting from adopting more efficient production practices, but rather yield increases in some instances. Therefore, the more efficient management systems in farm resources resulted in greater net returns per acre than the less efficient systems. These findings indicate that farmers could adopt more environmentally friendly farming practices such as planting cover crops and utilizing soil moisture sensors without sacrificing substantial yield and net returns. By adopting an advanced bundle of best management practices farms could improve their level of profitability. Although utilizing modern farming practices to improve resource efficiency does require more intensive management, economic simulations reveal that utilizing the most advanced production techniques maximize net returns per acre in cotton and peanut production systems. Finally, it is important to note that after an extended period of time of using the modern conservation practices, producers would likely begin to realize yield increases as their soil organic matter and overall soil quality increases. Conversely, producers who do not take steps to conserve their resources and prevent erosion will likely experience long-term yield reductions as their soil becomes depleted.

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CHAPTER 4

CONCLUSION AND POLICY IMPLICATIONS

Agriculture is an essential economic engine across the United States that supports large portions of rural Americans (National Conference of Rural Legislatures 2018, USDA ERS 2019). Therefore, the long-term sustainability of agriculture production in these rural areas is a critical aspect of preserving the economic viability. Maintaining the long-term sustainability of agriculture will depend on producers' willingness and ability to implement the most efficient and sustainable production methods. There are numerous production practices such as planting winter cover crops and installing soil moisture sensors that are documented to enable farmers to more efficiently and sustainably produce crops while not rapidly exhausting natural resources.

Focus group interviews were conducted in Georgia and identified the factors producers consider when deciding whether they should plant cover crops on their farm. The results revealed that cotton and peanut producers' original and current motivation for planting cover crops was to control soil erosion. Results also indicated that cover crop adoption results in numerous costs and revenue changes. Some focus group participants did report negative crop budget changes when they planted cover crops, such as yield reductions and increased herbicide applications. Other farmers also reported positive budget changes, such as cost reductions in soil erosion repairs, irrigation applications, and cultivation.

Economic simulation analysis was conducted for alternative Best Management Practice (BMP) bundles. Three collective packages of production strategies and techniques were analyzed, including Management System 1, Management System 2, and Management System 3.

Management System 1 represents a producer that utilizes nearly all available resources to maximize natural resource efficiency. Management System 2 represented typical producers who adopt moderately efficient cotton and peanut production practices. Management System 3 represents a producer that does not tend to adopt any new technologies or practices that could improve farm resource efficiency. At initial glance, it might seem that producers who spend additional time and money on adopting more efficient practices would increase their production costs to a level that being profitable would not be possible. However, simulated net returns from this analysis indicated that producers in more efficient management systems commonly have comparable and occasionally greater net returns than producers who utilize older, less efficient practices in their cotton and peanut production systems.

Investing time and money into new technology and conservation production methods such as planting cover crops, installing soil moisture sensors, and utilizing conservation tillage production methods is certainly a challenge for many farmers. However, adopting these modern practices will be necessary to ensure the long-term sustainability for cotton and peanut production on Georgia's cultivated cropland. Furthermore, net returns from simulations based on three management systems showed that utilizing the most efficient production strategies could increase net returns per acre for Georgia cotton and peanut production.

Although the analysis in this work indicates that adopting modern conservation practices does yield numerous production benefits, there are some barriers preventing many farmers from utilizing them. Some of these barriers includes skepticism about the new technology, difficulty in changing in farming tradition, and initial investment requirements. Skepticism surrounding new technology will likely continue to be an issue until producers see it being successful over an extended period of time. Farming tradition is another factor that likely slows down the adoption of modern conservation practices, as many farms are passed down from generations to generations. Therefore, farmers might be hesitant to deviate from their conventional production practices established by the previous generations. Finally, initial investment outlay might deter producers from utilizing soil moisture sensors and cover crops as these practices require initial investment without a guaranteed return on investment.

Without a doubt, the conservation practices discussed in this study have the potential to benefit crop producers and society as a whole. However, considering that producers have the ability to transition from various efficiency levels, it is essential that policymakers support polices that promote practices such as planting cover crops and installing modern irrigation technologies. This task can be accomplished by continuing the support programs such as the Conservation Stewardship Program (CSP) and the Environmental Quality Incentives Program (EQIP), facilitated by the United States Department of Agriculture to encourage environmentally responsible farming operations.

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APPENDIX

Table 1. Cotton Management Systems by Characteristics

COTTON, GA

	Management System 1	Management System 2	Management System 3
Tillage	Strip Tillage	Conventional Tillage	Conventional Tillage
Irrigation Equipment	Soil Moisture Sensors (SMS)	None	None
Irrigation Management	Monitor SMS	UGA Checkbook	Minimum 1 ac-in per week
Irrigation Efficiency	85% efficient	80% efficient	80% efficient
Fertilizer Equipment	Custom Spread Lime, P&K Side Dress N	Custom Spread Lime, P&K Side Dress N	Custom Spread Lime; Disc P & K Side Dress N
Custom Spreading	Grid Sample + Variable Lime, P & K	Lime, P & K	Lime
Soil Fertility Management	Soil + Tissue Test	Soil Test	None
Fertilizer	$^1/_3$ ton Lime 30 lb N Starter Fertilizer 70 lb N Side Dress	$^1/_3$ ton Lime 2 ton Chicken Litter 70 lb N Side Dress	$^1/_3$ ton Lime 2 ton Chicken Litter 30 lb N After Planting, 90 lb N Side Dress
Fertilizer Application	Custom Spread Lime, P & K Side Dress N	Custom Spread Lime, P & K Side Dress N	Custom Spread Lime; Disc P & K Side Dress N
Cover Crops	Rye, no baling	None	None

Table 2. Peanut Management Systems by Characteristics

PEANUT, GA

	Management System 1	Management System 2	Management System 3
Tillage	Strip Tillage	Conventional Tillage	Conventional Tillage
Vine Residue	Leave on Field	Leave on Field	Leave on Field
Irrigation Equipment	Soil Moisture Sensors (SMS)	None	None
Irrigation Management	Monitor SMS	UGA Checkbook	Minimum 1 ac-in per week
Irrigation Efficiency	85% efficient	80% efficient	70% efficient
Fertilizer Equipment	Custom Spread Lime and Gypsum	Custom Spread Lime and Gypsum	Custom Spread Lime and Gypsum, Disk Chicken Litter
Soil Fertility Management	Soil + Tissue Test	None	None
Fertilizer	½ ton Lime, ½ ton Gypsum	½ ton Lime, ½ ton Gypsum	½ ton Lime, ½ ton Gypsum 2 ton Chicken Litter, prior to plant
Cover Crops	Rye, no baling	None	None

Table 3. Cotton and Peanut Yield Data Summary (MS 1-3).

MS 1 - Cotton		MS 2 - Cotton		MS 3 - Cotton	
Mean	1550.8	Mean	1147.6	Mean	1240.9
Median	1600.9	Median	1105.4	Median	1197.5
Min	1075.4	Min	573.9	Min	619.5
Max	2034.9	Max	1805.0	Max	1892.4
Standard Deviation	279.3	Standard Deviation	343.7	Standard Deviation	369.2
Count	18	Count	18	Count	18

MS 1 - Peanut		MS 2 - Peanut		MS 3 - Peanut	
Mean	3490.0	Mean	3677.2	Mean	3688.4
Median	3554.3	Median	3787.1	Median	3803.9
Min	2861.9	Min	3171.6	Min	3217.3
Max	3978.8	Max	4055.5	Max	4067.2
Standard Deviation	354.8	Standard Deviation	309.5	Standard Deviation	303.0
Count	9	Count	9	Count	9

Table 4. Cotton Enterprise Budget - Management System 1

Expected Yield	**1550**	**Lbs/Acre**		**34250**	
		$ 0.77	**Price/Lb**	**Seed/Acre**	
Expected Income/Acre	**$ 1,193.50**				
Variable Costs	**Unit**	**No. Units**	**$/Unit**	**Cost/Acre**	**$/Lb**
Land Rent	Acre	0	$ 190.00	$ -	$ -
Crop Insurance	Acre	1	$ 8.00	$ 8.00	$ 0.005
Seed	1000/Seed	34.25	$ 2.76	$ 94.53	$ 0.061
Lime	Ton	0.33	$ 36.50	$ 12.05	$ 0.008
Poultry Litter	Ton	0	$ -	$ -	$ -
Nitrogen	Lbs	100	$ 0.45	$ 45.00	$ 0.029
Phosphate	Lbs	70	$ 0.37	$ 25.90	$ 0.017
Potash	Lbs	80	$ 0.28	$ 22.40	$ 0.014
Other Nutrients	Acre	1	$ 5.00	$ 5.00	$ 0.003
Pre-Emergent	Acre	1	$ 7.55	$ 7.55	$ 0.005
POST	Acre	1	$ 37.90	$ 37.90	$ 0.024
Layby	Acre	1	$ 13.60	$ 13.60	$ 0.009
Hand Weeding	Acre	1	$ 10.00	$ 10.00	$ 0.006
Scouting	Acre	1	$ 10.00	$ 10.00	$ 0.006
Stink Bug Treat.	Acre App.	2.2	$ 5.50	$ 12.10	$ 0.008
PGR	Ounces	36	$ 0.05	$ 1.84	$ 0.001
Defoliant & Boil Opener	Acre App.	1	$ 12.33	$ 12.33	$ 0.008
Irrigation Acre-Inch	Acre App.	4.833	$ 8.00	$ 38.66	$ 0.025
Fuel & Lube	Gallon	1.1	$ 2.58	$ 2.84	$ 0.002
Repairs & Maintenance	Acre	1	$ 27.41	$ 27.41	$ 0.018
Labor	Hours	1.99	$ 13.00	$ 25.87	$ 0.017
Interest on Operating	$ 412.973	6	6%	$ 12.39	$ 0.008
Ginning	Lbs	1550	$ 0.08	$ 124.00	$ 0.080
Storage & Warehousing	Bale	3.13	$ 10.50	$ 32.81	$ 0.021
Marketing, Boards, Etc.	Bale	3.13	$ 6.06	$ 18.94	$ 0.012
Cottonseed Credit	Ton	0.97	$ 125.00	$ (121.09)	$ (0.078)
BWEP	Bale	3.13	$ 0.75	$ 2.34	$ 0.002
Nutrient Monitoring/Mgt	Acre	1.00	$ 3.00	$ 3.00	$ 0.002

Grid Sampling & Custom Spreading	Acre	1.00	$ 23.00	$ 23.00	$ 0.015
Tissue Sampling	Acre	0.10	$ 25.00	$ 2.50	$ 0.002
Cover Crop Seed	Lbs	51.00	$ 0.25	$ 12.75	$ 0.008
Cover Crop Burndown	Acre	1.00	$ 12.90	$ 12.90	$ 0.008
Total Variable Cost				**$ 536.51**	**$ 0.346**
Net Return Above Variable Cost			**$ 656.99**	**$ 0.424**	

Fixed Costs					
Tractor & Sprayer	Acre	1	$ 49.49	$ 49.49	$ 0.032
Equipment/ Implements	Acre	1	$ 5.87	$ 5.87	$ 0.00
Irrigation	Acre	1	$ 130.00	$ 130.00	$ 0.08
Soil Moisture Sensors	Acre	0.007	$ 600.00	$ 4.29	$ 0.003
Picker/BB/MB	Acre	1	$ 72.06	$ 72.06	$ 0.05
Misc. Overhead		% of Var. Cost	5%	$ 26.83	$ 0.02
Management		% of Var. Cost	5%	$ 26.83	$ 0.02
Total Fixed Costs				**$ 315.36**	**$ 0.203**
Total Costs				**$ 851.87**	**$ 0.55**
Expected Net Return				**$ 341.63**	**$ 0.22**

The above enterprise budget is based on a 140 acre farm operation under a single irrigation pivot.

Table 5. Cotton Enterprise Budget - Management System 2

Expected Yield	**1147**	**Lbs/Acre**		**34250**	
		$ 0.77	**Price/Lb**		**Seed/Acre**
Expected Income/Acre	**$ 883.19**				
Variable Costs	**Unit**	**No. Units**	**$/Unit**	**Cost/Acre**	**$/Lb**
Land Rent	Acre	0	$ 190.00	$ -	$ -
Crop Insurance	Acre	1	$ 8.00	$ 8.00	$ 0.007
Seed	1000/Seed	34.25	$ 2.76	$ 94.53	$ 0.082
Lime	Ton	0.33	$ 36.50	$ 12.05	$ 0.011
Poultry Litter	Ton	2	$ 50.00	$ 100.00	$ 0.087
Nitrogen	Lbs	70	$ 0.45	$ 31.50	$ 0.027
Phosphate	Lbs	70	$ 0.37	$ 25.90	$ 0.023
Potash	Lbs	80	$ 0.28	$ 22.40	$ 0.020
Other Nutrients	Acre	1	$ 5.00	$ 5.00	$ 0.004
Pre-Emergent	Acre	1	$ 7.55	$ 7.55	$ 0.007
POST	Acre	1	$ 37.90	$ 37.90	$ 0.033
Layby	Acre	1	$ 13.60	$ 13.60	$ 0.012
Hand Weeding	Acre	1	$ 10.00	$ 10.00	$ 0.009
Scouting	Acre	1	$ 10.00	$ 10.00	$ 0.009
Stink Bug Treat.	Acre App.	2.2	$ 5.50	$ 12.10	$ 0.011
PGR	Ounces	36	$ 0.05	$ 1.84	$ 0.002
Defoliant & Boil Opener	Acre App.	1	$ 12.33	$ 12.33	$ 0.011
Irrigation Acre-Inch	Acre App.	4.874	$ 8.50	$ 41.43	$ 0.036
Fuel & Lube	Gallon	11.1	$ 2.58	$ 28.64	$ 0.025
Repairs & Maintenance	Acre	1	$ 27.41	$ 27.41	$ 0.024
Labor	Hours	1.99	$ 13.00	$ 25.87	$ 0.023
Interest on Operating	$ 528.038	6	6%	$ 15.84	$ 0.014
Ginning	Lbs	1147	$ 0.08	$ 91.76	$ 0.080
Storage & Warehousing	Bale	2.31	$ 10.50	$ 24.28	$ 0.021
Marketing, Boards, Etc.	Bale	2.31	$ 6.06	$ 14.01	$ 0.012
Cottonseed Credit	Ton	0.72	$ 125.00	$ (89.61)	$ (0.078)
BWEP	Bale	2.31	$ 0.75	$ 1.73	$ 0.002
Nutrient Monitoring/Mgt	Acre	1.00	$ 1.00	$ 1.00	$ 0.001
Tissue Sampling	Acre	0.10	$ 25.00	$ 2.50	$ 0.002
Soil Sampling	Acre	0.10	$ 7.00	$ 0.70	$ 0.001

Total Variable Cost				**$ 590.26**	**$ 0.515**
Net Return Above Variable Cost			**$ 292.93**	**$ 0.255**	

Fixed Costs					
Tractor & Sprayer	Acre	1	$ 49.49	$ 49.49	$ 0.043
Equipment/Implements	Acre	1	$ 5.87	$ 5.87	$ 0.01
Irrigation	Acre	1	$ 130.00	$ 130.00	$ 0.11
Soil Moisture Sensors	Acre	0.000	$ -	$ -	$ -
Picker/BB/MB	Acre	1	$ 72.06	$ 72.06	$ 0.06
Misc. Overhead		% of Var. Cost	5%	$ 29.51	$ 0.03
Management		% of Var. Cost	5%	$ 29.51	$ 0.03
Total Fixed Costs				**$ 316.45**	**$ 0.276**
Total Costs				**$ 906.71**	**$ 0.79**
Expected Net Return				**$ (23.52)**	**$ (0.02)**

The above enterprise budget is based on a 140 acre farm operation under a single irrigation pivot.

Table 6. Cotton Enterprise Budget - Management System 3

Expected Yield	**1240**	**Lbs/Acre**		**34250**	
		$ 0.77	**Price/Lb**	**Seed/Acre**	
Expected Income/Acre	**$ 954.80**				
Variable Costs	**Unit**	**No. Units**	**$/Unit**	**Cost/Acre**	**$/Lb**
Land Rent	Acre	0	$ 190.00	$ -	$ -
Crop Insurance	Acre	1	$ 8.00	$ 8.00	$ 0.006
Seed	1000/Seed	34.25	$ 2.76	$ 94.53	$ 0.076
Lime	Ton	0.33	$ 36.50	$ 12.05	$ 0.010
Poultry Litter	Ton	2	$ 50.00	$ 100.00	$ 0.081
Nitrogen	Lbs	120	$ 0.45	$ 54.00	$ 0.044
Phosphate	Lbs	70	$ 0.37	$ 25.90	$ 0.021
Potash	Lbs	80	$ 0.28	$ 22.40	$ 0.018
Other Nutrients	Acre	1	$ 5.00	$ 5.00	$ 0.004
Pre-Emergent	Acre	1	$ 7.55	$ 7.55	$ 0.006
POST	Acre	1	$ 37.90	$ 37.90	$ 0.031
Layby	Acre	1	$ 13.60	$ 13.60	$ 0.011
Hand Weeding	Acre	1	$ 10.00	$ 10.00	$ 0.008
Scouting	Acre	1	$ 10.00	$ 10.00	$ 0.008
Stink Bug Treat.	Acre App.	2.2	$ 5.50	$ 12.10	$ 0.010
PGR	Ounces	36	$ 0.05	$ 1.84	$ 0.001
Defoliant & Boil Opener	Acre App.	1	$ 12.33	$ 12.33	$ 0.010
Irrigation Acre-Inch	Acre App.	9.114	$ 9.00	$ 82.03	$ 0.066
Fuel & Lube	Gallon	12.96	$ 2.58	$ 33.44	$ 0.027
Repairs & Maintenance	Acre	1	$ 28.58	$ 28.58	$ 0.023
Labor	Hours	1.99	$ 13.00	$ 25.87	$ 0.021
Interest on Operating	$ 597.104	6	6%	$ 17.91	$ 0.014
Ginning	Lbs	1240	$ 0.08	$ 99.20	$ 0.080
Storage & Warehousing	Bale	2.50	$ 10.50	$ 26.25	$ 0.021
Marketing, Boards, Etc.	Bale	2.50	$ 6.06	$ 15.15	$ 0.012
Cottonseed Credit	Ton	0.78	$ 125.00	$ (96.88)	$ (0.078)
BWEP	Bale	2.50	$ 0.75	$ 1.88	$ 0.002
Total Variable Cost				**$ 660.62**	**$ 0.533**
Net Return Above Variable Cost			**$ 294.18**	**$ 0.237**	

Fixed Costs					
Tractor & Sprayer	Acre	1	$ 47.57	$ 47.57	$ 0.038
Equipment/Implements	Acre	1	$ 16.71	$ 16.71	$ 0.01
Irrigation	Acre	1	$ 130.00	$ 130.00	$ 0.10
Soil Moisture Sensors	Acre	0.000	$ -	$ -	$ -
Picker/BB/MB	Acre	1	$ 72.06	$ 72.06	$ 0.06
Misc. Overhead		% of Var. Cost	5%	$ 33.03	$ 0.03
Management		% of Var. Cost	5%	$ 33.03	$ 0.03
Total Fixed Costs				**$ 332.40**	**$ 0.268**
Total Costs				**$ 993.02**	**$ 0.80**
Expected Net Return				**$ (38.22)**	**$ (0.03)**

The above enterprise budget is based on a 140 acre farm operation under a single irrigation pivot.

Table 7. Peanut Enterprise Budget - Management System 1

Expected Yield	**1.75**	**Ton/Acre**			
		$ 458.00	**Price/Ton**		
Expected Income/Acre	**$ 801.50**				
Variable Costs	**Unit**	**No. Units**	**$/Unit**	**Cost/Acre**	**$/Lb**
Crop Insurance	Acre	1	$ 8.00	$ 8.00	$ 4.57
Seed	Lbs	140	$ 0.83	$ 116.20	$ 66.40
Lime/Gypsum	Ton	0.5	$ 105.00	$ 52.50	$ 30.00
Boron	Lbs	0.5	$ 6.00	$ 3.00	$ 1.71
Phosphate	Lbs	0	$ 0.44	$ -	$ -
Potash	Lbs	0	$ 0.32	$ -	$ -
Hand Weeding	Acre	1	$ 15.00	$ 15.00	$ 8.57
Scouting	Acre	1	$ 10.00	$ 10.00	$ 5.71
Weed Control	Acre	1	$ 29.16	$ 29.16	$ 16.66
Disease Control	Acre	1	$ 92.69	$ 92.69	$ 52.97
Irrigation Acre-Inch	Acre App.	3.92	$ 8.00	$ 31.36	$ 17.92
Harvest Machinery				$ -	
Fuel	Gallon	7.9	$ 2.58	$ 20.38	$ 11.65
Repairs and Maintenance	Acre	1	$ 27.57	$ 27.57	$ 15.75
Labor	Hours	2.5	$ 13.25	$ 33.13	$ 18.93
Interest on Operating	Percent	$ 219.178	6%	$ 13.81	$ 7.89
Cleaning	-	0.5775	$ 20.00	$ 11.55	$ 6.60
Drying	-	1.17	$ 30.00	$ 35.18	$ 20.10
Marketing	-	1.75	$ 3.00	$ 5.25	$ 3.00
NPB Checkoff	Dollars	0.01	$ 621.25	$ 6.21	$ 3.55
Preharvest Machinery				$ -	
Fuel	Gallon	9.2	$ 2.58	$ 23.74	$ 13.56
Repairs and Maintenance	Acre	1	$ 19.73	$ 19.73	$ 11.27
Nutrient Monitoring/Mgt	Acre	1.00	$ 3.00	$ 3.00	$ 1.71
Irrigation Monitoring/Mgt	Acre	1.00	$ 7.50	$ 7.50	$ 4.29

Grid Sampling & Custom Spreading	Acre	1.00	$ 23.00	$ 23.00	$ 13.14
Total Variable Cost				**$ 587.95**	**$ 335.97**
Net Return Above Variable Cost			**$ 213.55**	**$ 122.03**	

Fixed Costs					
Harvest Machinery	Acre	1	$ 83.05	$ 83.05	$ 47.46
General Overhead	% of VC	$ 586.58	5%	$ 29.33	$ 16.76
Management	% of VC	$ 586.58	5%	$ 29.33	$ 16.76
Preharvest Machinery	Acre	$ 1.00	$ 56.96	$ 56.96	$ 32.55
Soil Moisture Sensors	Acre	1.000	$ 4.29	$ 4.29	$ 2.451
Pivot	Acre	1	$ 94.00	$ 94.00	$ 53.71
VRI	Acre	1	$ 41.00	$ 41.00	$ 23.43
Total Fixed Costs				**$ 337.96**	**$ 193.119**
Total Costs				**$ 925.91**	**$ 529.09**
Expected Net Return				**$ (124.41)**	**$ (71.309)**

The above enterprise budget is based on a 140 acre farm operation under a single irrigation pivot.

Table 8. Peanut Enterprise Budget - Management System 2

Expected Yield	**1.84**	**Ton/Acre**			
		$ 458.00	**Price/Ton**		
Expected Income/Acre	**$ 842.72**				
Variable Costs	**Unit**	**No. Units**	**$/Unit**	**Cost/Acre**	**$/Lb**
Crop Insurance	Acre	1	$ 8.00	$ 8.00	$ 4.348
Seed	Lbs	140	$ 0.83	$ 116.20	$ 63.152
Lime/Gypsum	Ton	0.5	$ 105.00	$ 52.50	$ 28.533
Boron	Lbs	0.5	$ 6.00	$ 3.00	$ 1.630
Phosphate	Lbs	0	$ 0.44	$ -	$ -
Potash	Lbs	0	$ 0.32	$ -	$ -
Hand Weeding	Acre	1	$ 15.00	$ 15.00	$ 8.152
Scouting	Acre	1	$ 10.00	$ 10.00	$ 5.435
Weed Control	Acre	1	$ 29.16	$ 29.16	$ 15.848
Disease Control	Acre	1	$ 92.69	$ 92.69	$ 50.375
Irrigation Acre-Inch	Acre App.	8.4	$ 8.50	$ 71.40	$ 36.522
Harvest Machinery				$ -	
Fuel	Gallon	7.9	$ 2.58	$ 20.38	$ 11.077
Repairs and Maintenance	Acre	1	$ 27.57	$ 27.57	$ 14.984
Labor	Hours	2.5	$ 13.25	$ 33.13	$ 18.003
Interest on Operating	Percent	$ 237.098	6%	$ 14.94	$ 8.118
Cleaning	-	0.6072	$ 20.00	$ 12.14	$ 6.600
Drying	-	1.23	$ 30.00	$ 36.98	$ 20.100
Marketing	-	1.84	$ 3.00	$ 5.52	$ 3.000
NPB Checkoff	Dollars	0.01	$ 653.20	$ 6.53	$ 3.550
Preharvest Machinery				$ -	
Fuel	Gallon	9.2	$ 2.58	$ 23.74	$ 12.900
Repairs and Maintenance	Acre	1	$ 19.73	$ 19.73	$ 10.723
Nutrient Monitoring/Mgt	Acre	1.00	$ 1.00	$ 1.00	$ 0.543
Irrigation Monitoring/Mgt	Acre	1.00	$ 7.50	$ 7.50	$ 4.076

Grid Sampling & Custom Spreading	Acre	0.00	$ 23.00	$ -	$ -
Total Variable Cost				**$ 607.71**	**$ 329.951**
Net Return Above Variable Cost			**$ 235.61**	**$ 131.075**	

Fixed Costs					
Harvest Machinery	Acre	1	$ 83.05	$ 83.05	$ 45.136
General Overhead	% of VC	$ 601.54	5%	$ 30.08	$ 16.35
Management	% of VC	$ 601.54	5%	$ 30.08	$ 16.35
Preharvest Machinery	Acre	$ 1.00	$ 56.96	$ 56.96	$ 30.96
Soil Moisture Sensors	Acre	0.000	$ 4.29	$ -	$ -
Pivot	Acre	1	$ 94.00	$ 94.00	$ 51.09
VRI	Acre	0	$ 41.00	$ 0	$ 22.28
Total Fixed Costs				**$ 294.16**	**$ 182.154**
Total Costs				**$ 901.27**	**$ 512.11**
Expected Net Return				**$ (58.55)**	**$ (54.11)**

The above enterprise budget is based on a 140 acre farm operation under a single irrigation pivot.

Table 9. Peanut Enterprise Budget - Management System 3

Expected Yield	**1.84**	**Ton/Acre**			
		$ 458.00	**Price/Ton**		
Expected Income/Acre	**$ 842.72**				
Variable Costs	**Unit**	**No. Units**	**$/Unit**	**Cost/Acre**	**$/Lb**
Crop Insurance	Acre	1	$ 8.00	$ 8.00	$ 4.348
Seed	Lbs	140	$ 0.83	$ 116.20	$ 63.152
Lime/Gypsum	Ton	0.5	$ 105.00	$ 52.50	$ 28.533
Boron	Lbs	0.5	$ 6.00	$ 3.00	$ 1.630
Phosphate	Lbs	0	$ 0.44	$ -	$ -
Potash	Lbs	0	$ 0.32	$ -	$ -
Hand Weeding	Acre	1	$ 15.00	$ 15.00	$ 8.152
Scouting	Acre	1	$ 10.00	$ 10.00	$ 5.435
Weed Control	Acre	1	$ 29.16	$ 29.16	$ 15.848
Disease Control	Acre	1	$ 92.69	$ 92.69	$ 50.375
Irrigation Acre-Inch	Acre App.	12.12	$ 9.00	$ 109.08	$ 59.696
Harvest Machinery					
Fuel	Gallon	7.9	$ 2.58	$ 20.38	$ 11.077
Repairs and Maintenance	Acre	1	$ 27.57	$ 27.57	$ 14.984
Labor	Hours	2.5	$ 13.25	$ 33.13	$ 18.003
Interest on Operating	Percent	$ 251.978	6%	$ 15.87	$ 8.627
Cleaning	-	0.6072	$ 20.00	$ 12.14	$ 6.600
Drying	-	1.23	$ 30.00	$ 36.98	$ 20.100
Marketing	-	1.84	$ 3.00	$ 5.52	$ 3.000
NPB Checkoff	Dollars	0.01	$ 653.20	$ 6.53	$ 3.550
Preharvest Machinery					
Fuel	Gallon	9.2	$ 2.58	$ 23.74	$ 12.900
Repairs and Maintenance	Acre	1	$ 19.73	$ 19.73	$ 10.723
Nutrient Monitoring/Mgt	Acre	0.00	$ 3.00	$ -	$ -
Irrigation Monitoring/Mgt	Acre	0.00	$ 7.50	$ -	$ -

Grid Sampling & Custom Spreading	Acre	0.00	$ 23.00	$ -	$ -
Total Variable Cost				**$ 637.23**	**$ 346.319**
Net Return Above Variable Cost			**$ 205.49**	**$ 111.681**	

Fixed Costs					
Harvest Machinery	Acre	1	$ 83.05	$ 83.05	$ 45.136
General Overhead	% of VC	$ 623.74	5%	$ 31.19	$ 16.95
Management	% of VC	$ 623.74	5%	$ 31.19	$ 16.95
Preharvest Machinery	Acre	$ 1.00	$ 56.96	$ 56.96	$ 30.96
Soil Moisture Sensors	Acre	0.000	$ 4.29	$ -	$ -
Pivot	Acre	1	$ 94.00	$ 94.00	$ 51.09
VRI	Acre	0	$ 41.00	$ 41.00	$ 22.28
Total Fixed Costs				**$ 296.38**	**$ 183.361**
Total Costs				**$ 933.61**	**$ 529.68**
Expected Net Return				**$ (90.89)**	**$ (71.28)**

The above enterprise budget is based on a 140 acre farm operation under a single irrigation pivot.

Figure 1: Focus Group Consent Form

Department of Agricultural and Applied Economics
College of Agricultural & Environmental Sciences
UNIVERSITY OF GEORGIA

An Economic Analysis of Cover Crop Utilization in Georgia Cotton and Peanut Production

Goals

Science-based information on the potential return on investment for cover crops in the in Southern Coastal Plain is very limited. The first goal of this project is to develop and promote the use of partial budgets for cover crops in southern cotton and peanut row crop farming. The marginal benefits and the marginal costs of cover crops will be compared against a control scenario of leaving the land fallow during winter to assess the annual net benefit of adopting cover crops.

Timeline

Meetings will be conducted with groups of experienced cover crop farmers each to record farm management practices, associated changes in costs and revenues related to the practice. Based on the information collected through the focus groups, a survey instrument will be made available to validate and expand on the original results. A final report with benchmark partial budgets will be complete in 2019.

Privacy of the data

Data collected through the focus groups and the survey will be de-identified: the names and/or physical addresses of the respondents will not be recorded. Only regional averages (not identifiable data) will be made publicly available in the final report and all other publications stemming from this project.

If you have any questions related to this research project, you can contact Dr. Yangxuan Liu at (229) 386-3512 – Yangxuan.Liu@uga.edu, Ms. Amanda Smith at (229) 386-3512 – a.Smith@uga.edu, Dr. Alejandro Plastina (515) 294-6160 – Plastina@iastate.edu or Guy Hancock at (229) 425-6279 – ghancock@uga.edu.

Dr. Yangxuan Liu
Assistant Professor
University of Georgia

Ms. Amanda Smith
Public Service Associate
University of Georgia

Dr. Alejandro Plastina
Assistant Professor
Iowa State University

Guy Hancock
Graduate Research Assistant
University of Georgia

Sign me up!

Participation in the Focus Groups is voluntary. I hereby acknowledge my intention to participate in the Focus Groups and survey planned for this study, in exchange, receive a detailed cost-benefit analysis of cover crop for my farm.

Name _________________________________ Signature ____________________ Date ________

Address____

Telephone (____)______________________ Email _______________________________________

Figure 2: Focus Group Questions

Department of Agricultural and Applied Economics
College of Agricultural & Environmental Sciences
UNIVERSITY OF GEORGIA

An Economic Analysis of Cover Crop Utilization in Georgia Cotton and Peanut Production

<u>Date and Location</u>

Focus Group Discussion. Moderator: Guy Hancock

Question 1: "Please tell us who you are, where your farm is, what your soil types are, and the year when you first planted cover crops."

Question 2: "Think back to when you did not plant cover crops, what prompted you to plant cover crops the first time?"

Question 3: "What drives you to plant cover crops today?"

Question 4: "Please describe your multi-year rotations that include both cotton and peanuts in most of your acres with cover crops <u>versus the multi-year rotations without cover crops</u>."

Question 5: "Describe the **differences in management practices** for a cotton-peanut or cotton-cotton rotation with cover crops <u>versus a rotation without cover crops</u>."

Question 6: "Compared to the alternative of leaving land fallow during winter, what **new or additional revenue** have cover crops generated for you?"

Question 7: "Compared to the alternative of leaving land fallow during winter, what **costs have you actually eliminated or reduced** in a cotton-peanut or cotton-cotton rotation by using cover crops?"

Question 8: "Compared to the alternative of leaving land fallow during winter, what **new or additional costs** have you actually incurred in a cotton-peanut or cotton-cotton rotation due to cover crops?"

Question 9: "Compared to the alternative of leaving land fallow during winter, what **revenue have you actually lost or seen decline** in a cotton-peanut or cotton-cotton rotation due to cover crops?"

Question 10: "How many acres do you farm and how many of those acres are currently planted in a cover crop?"

Figure 3. Original Stated Reasons for Planting Cover Crops

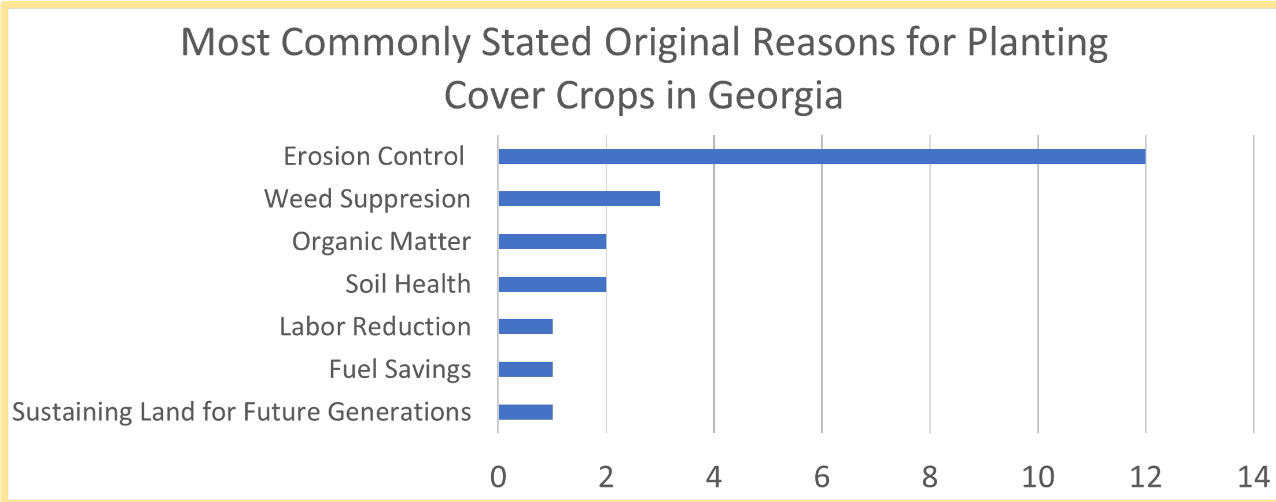


Figure 4. Reasons Stated for Currently Planting Cover Crops

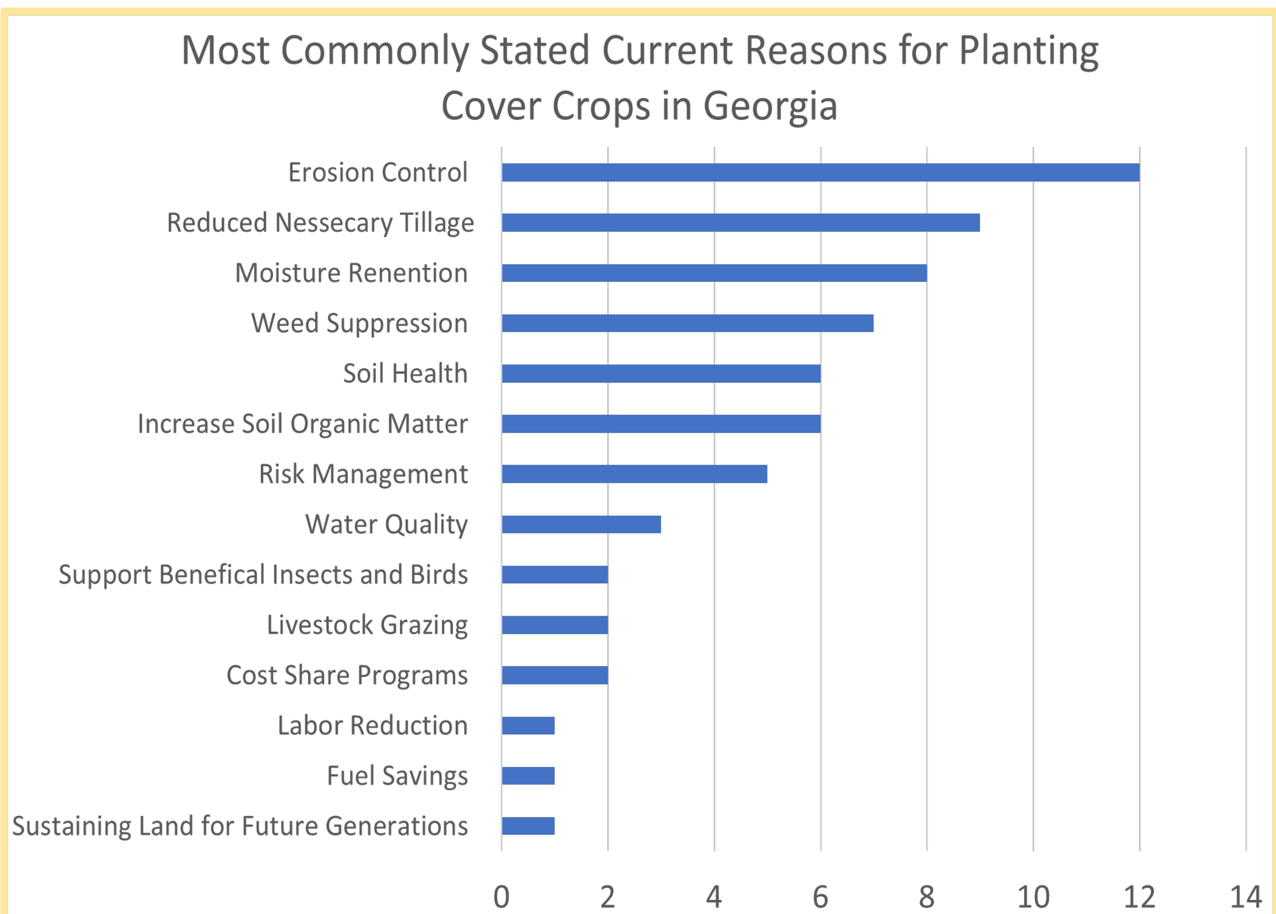


Figure 5. Reported Cost Changes Associated with Cover Crop Use

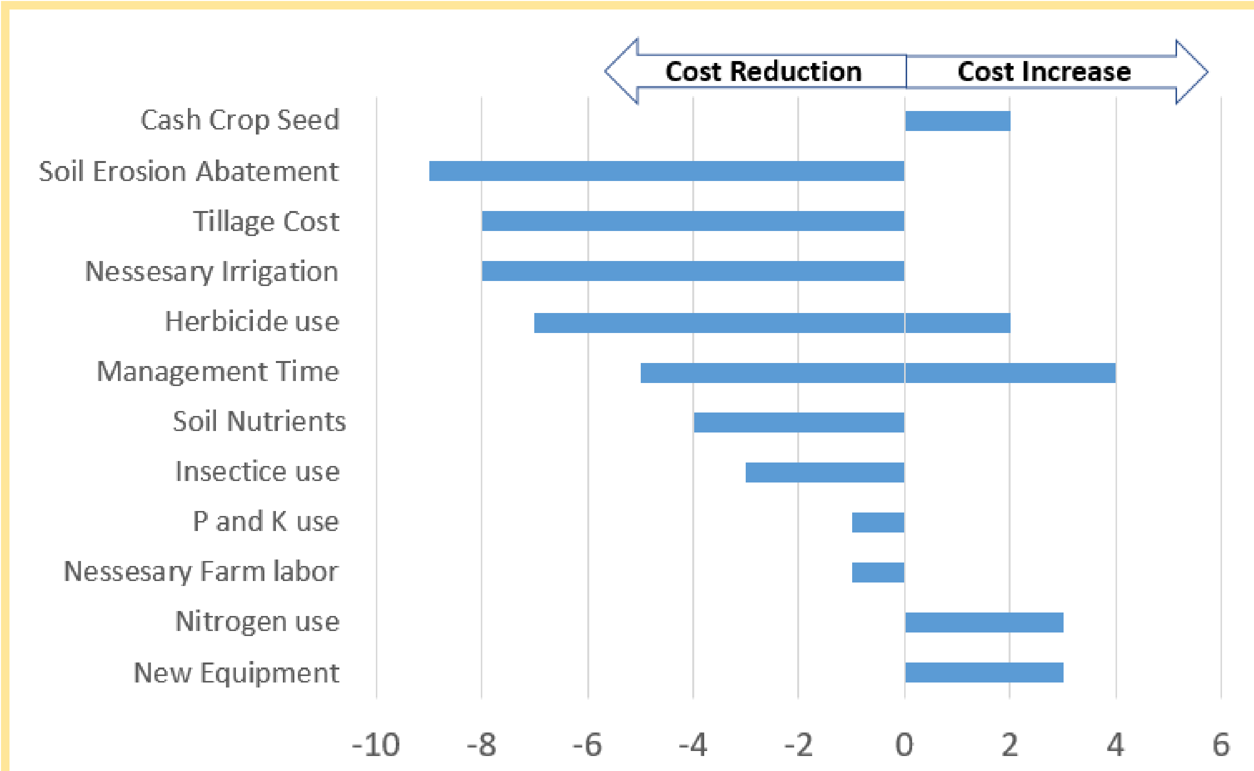


Figure 6. Reported Revenue Changes Associated with Cover Crop Use

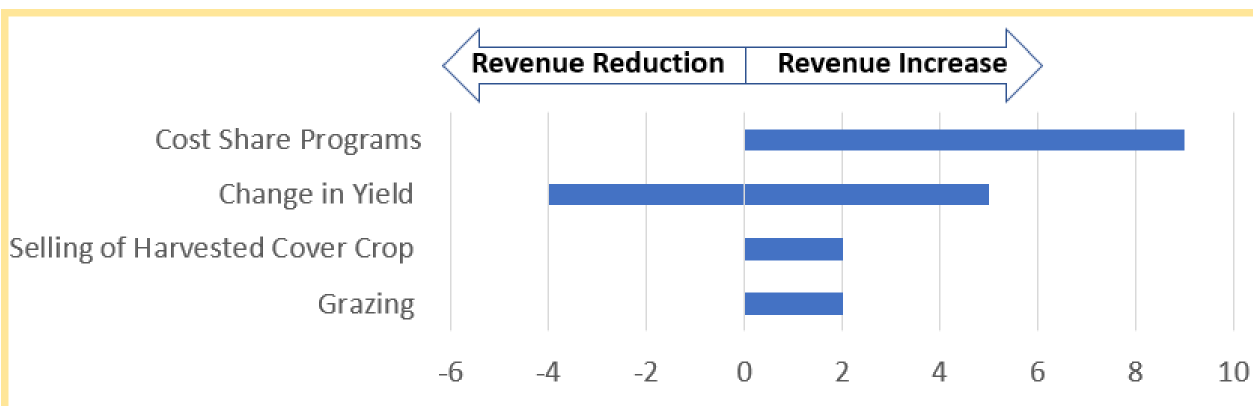
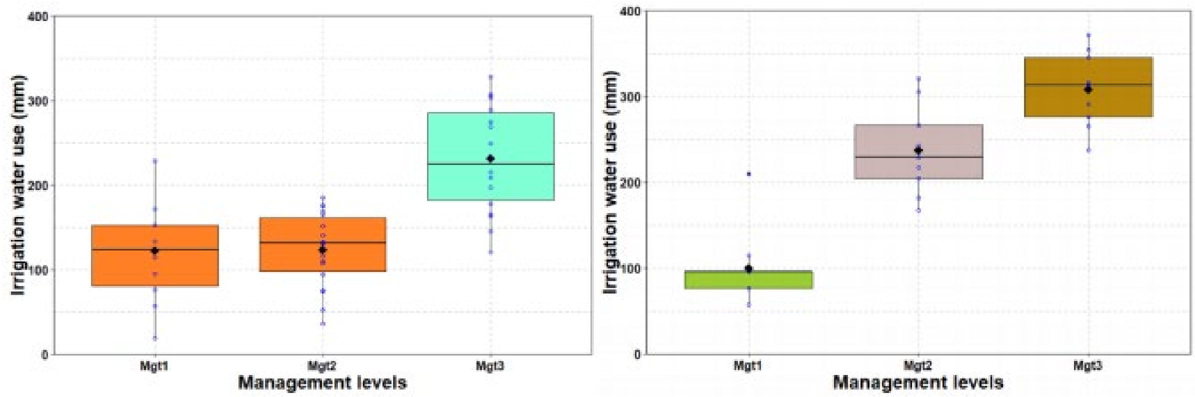


Figure 7. Focus Group Word Cloud

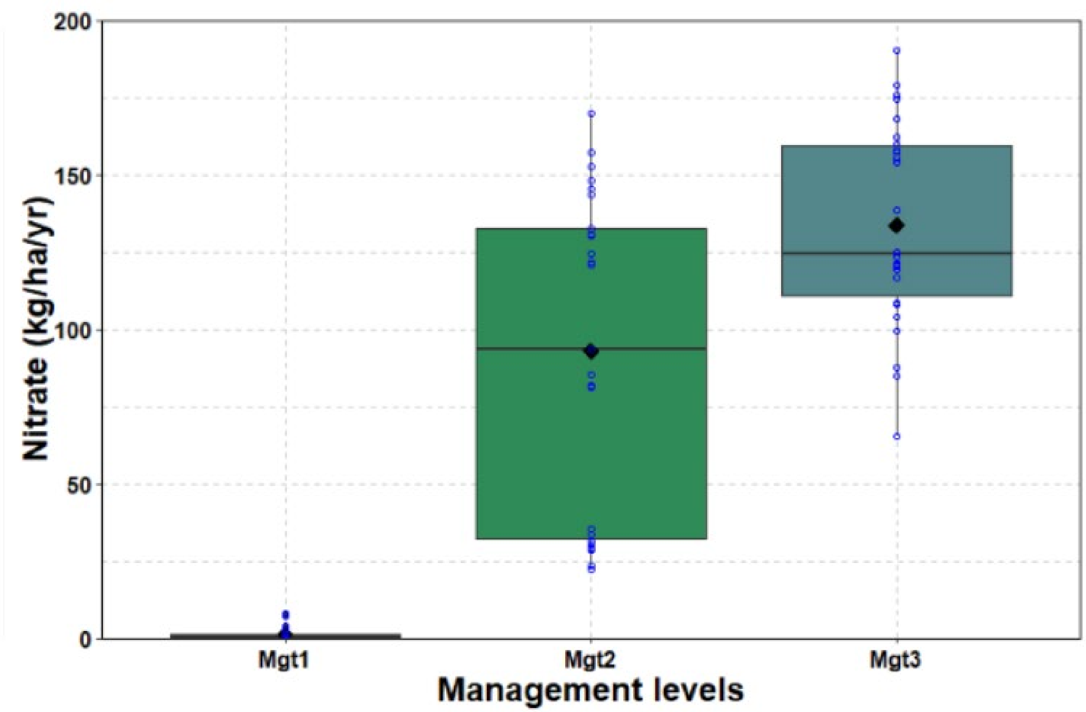
Figure 8: Simulated Cotton and Peanut Water Use by Management Systems

(Cotton left & Peanut right)



Karki et al. (2019). Used with permission.

Figure 9: Simulated Cotton and Peanut Nitrate Loss by Management Systems



Karki et al. (2019). Used with permission.

Figure 10. Cost per Acre by Management System for Cotton

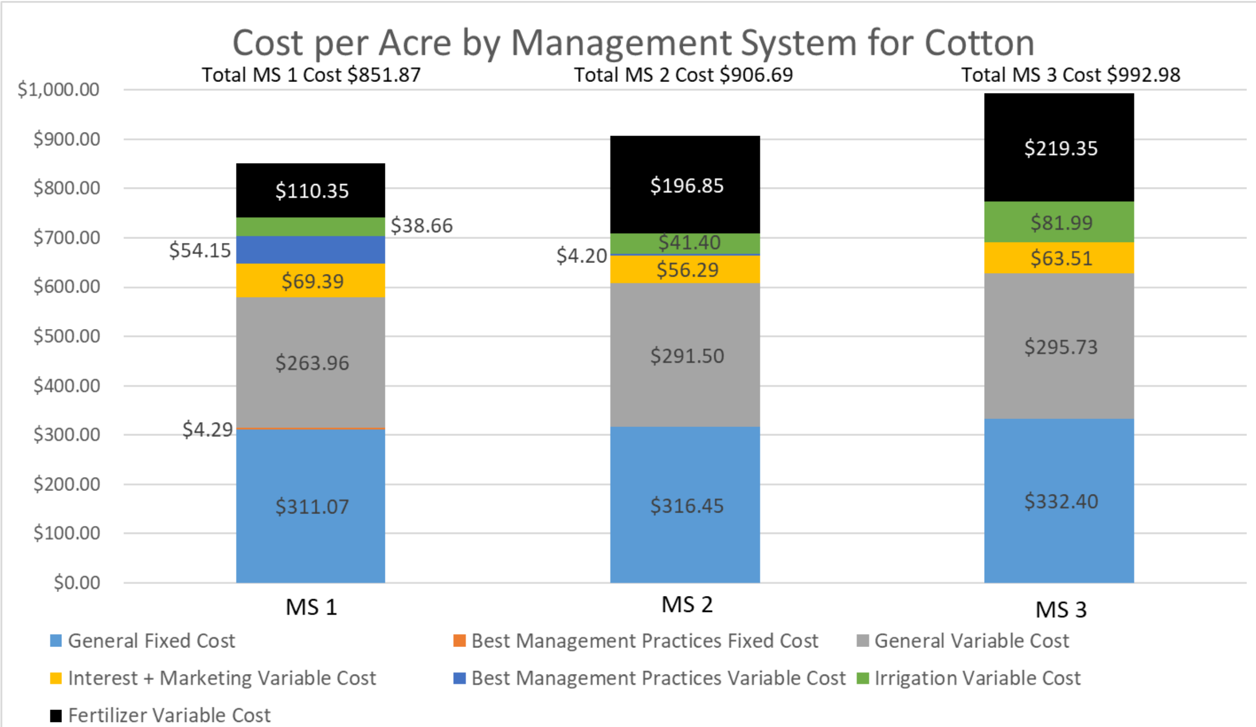


Figure 11. Cost per Acre by Management System for Peanut

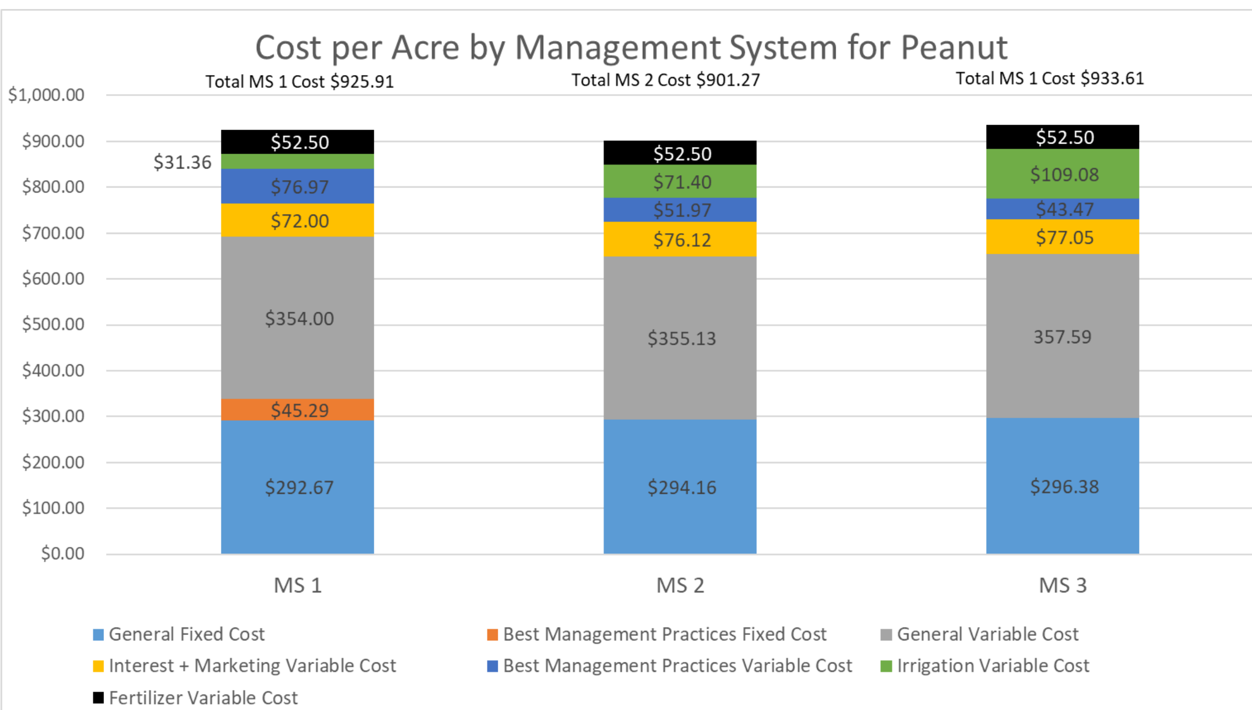


Figure 12. Cotton Cumulative Distribution Function - Management System 1

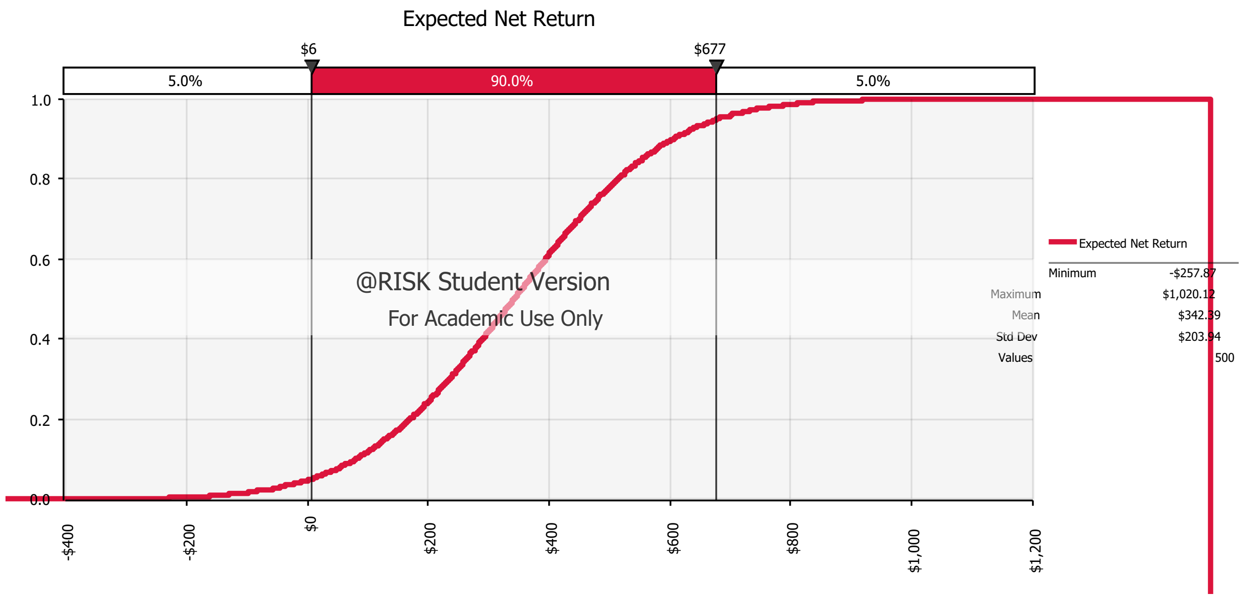


Figure 13. Cotton Cumulative Distribution Function - Management System 2

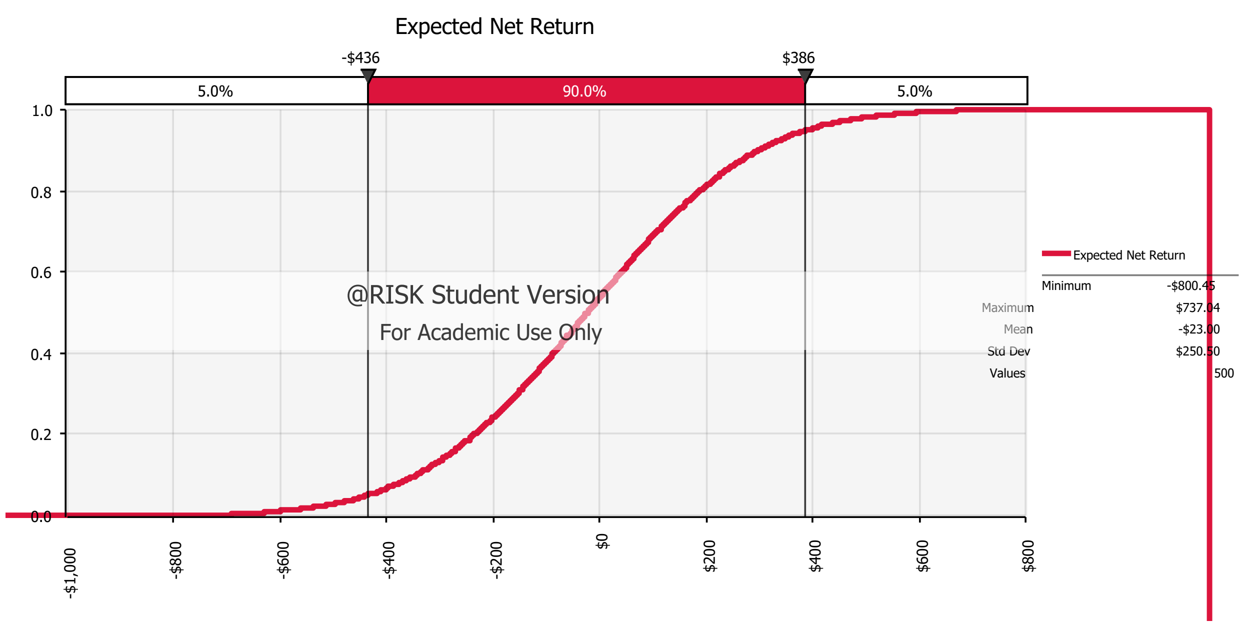


Figure 14. Cotton Cumulative Distribution Function - Management System 3

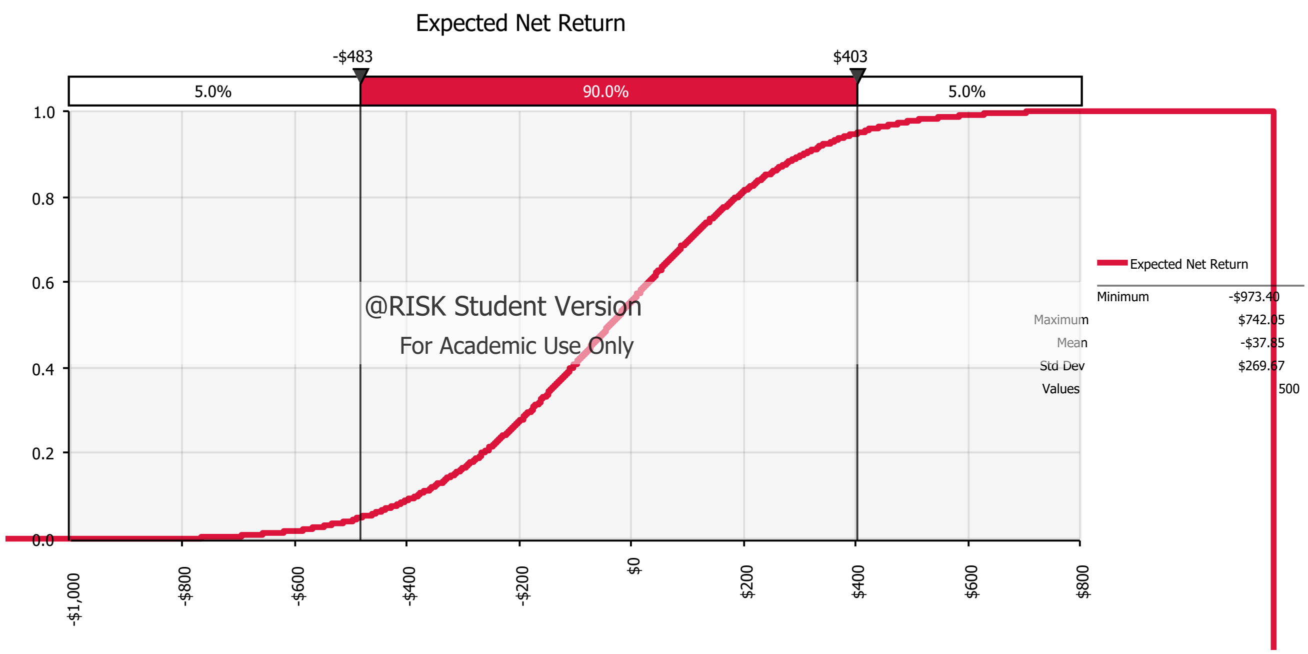


Figure 15. Peanut Cumulative Distribution Function - Management System 1

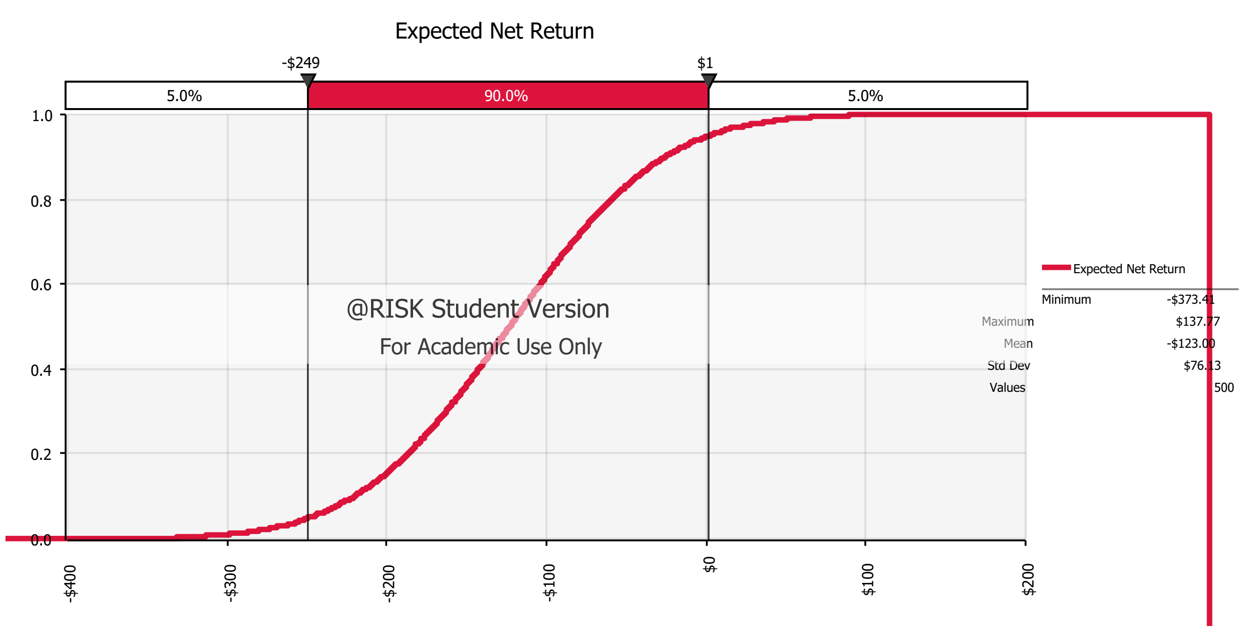


Figure 16. Peanut Cumulative Distribution Function - Management System 2

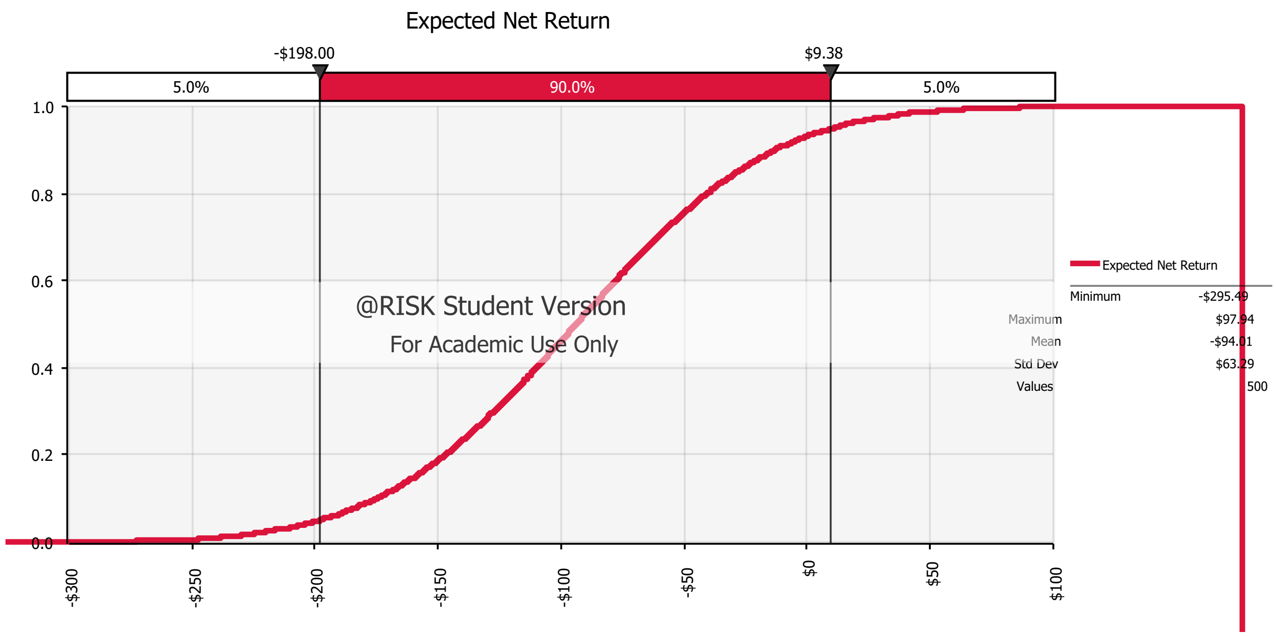


Figure 17. Peanut Cumulative Distribution Function - Management System 3

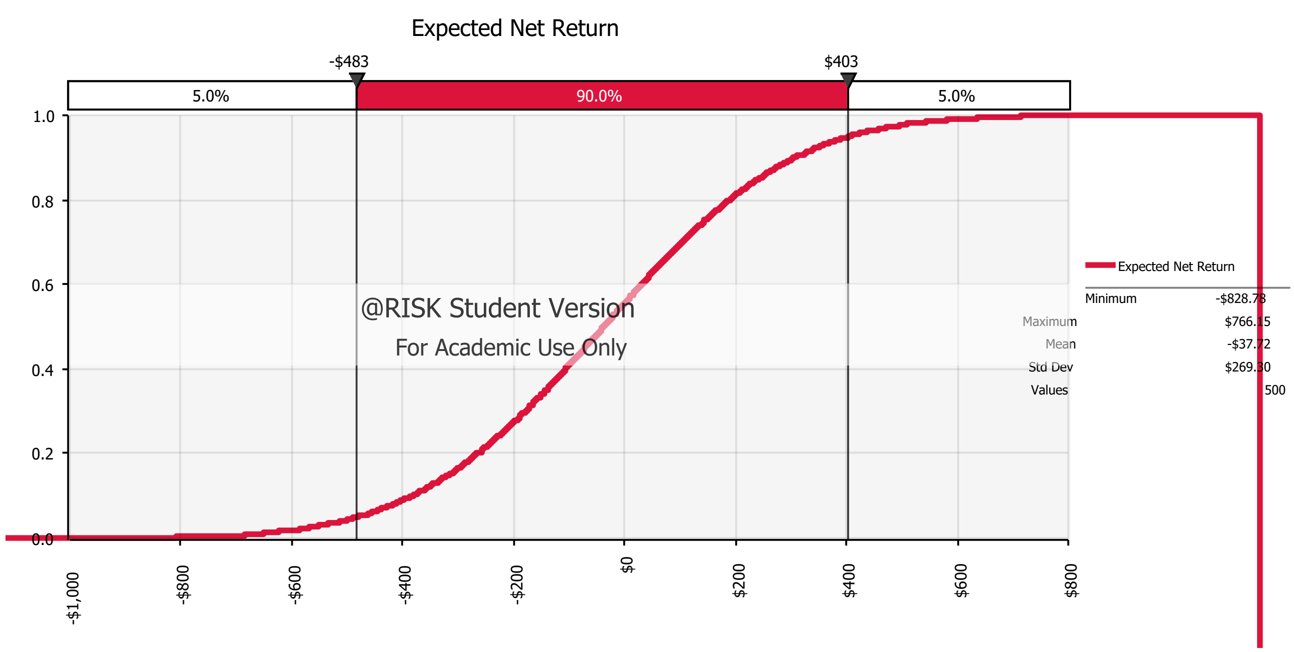


Figure 18. Boxplots for Simulated Cotton Net Returns per Acre by Management Systems

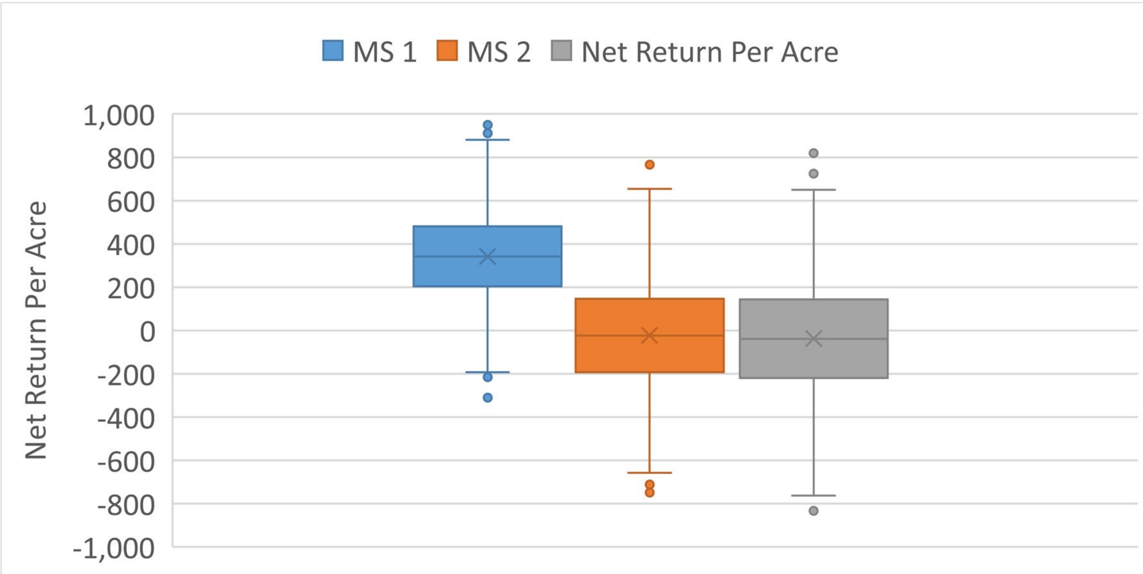


Figure 19. Boxplots for Simulated Peanut Net Returns per Acre by Management Systems

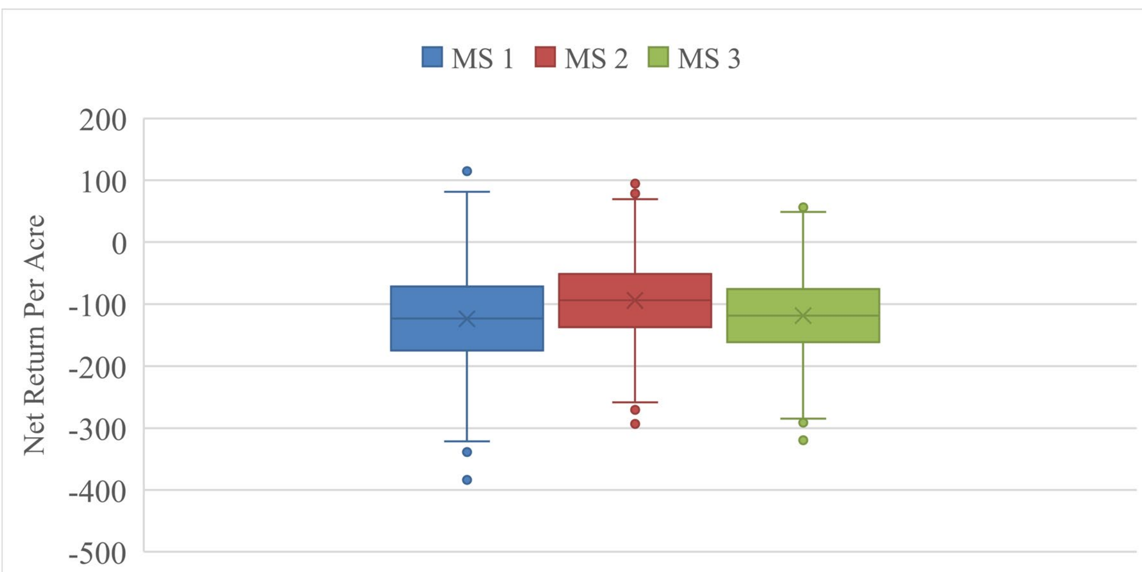


Figure 20. Boxplots for Simulated Cotton-Cotton-Peanut Rotation Net Returns per Acre by Management Systems