Economic Analysis of Turfgrass-Sod Production in Alabama

by

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ABSTRACT

Turfgrass has been a profitable alternative to more traditional agricultural enterprises for many years. However, the situation changed with the depressed housing market and tough competition in the sod industry. A major purpose of this study was to conduct an economic analysis to determine whether there is a competitive advantage existing for turfgrass-sod production, compared with conventional agricultural enterprises. The study also examined how different turfgrass prices and diesel prices affect sod producers' profits.

To accomplish these objectives, turfgrass-sod and row crop budgets were developed first. Corn, cotton, peanut, and soybean were taken as key row crops in Alabama in this study. Bermudagrass was chosen to represent the 2012 sod production in Alabama. Current budgets were developed for each enterprise. Next, price sensitivity analysis was conducted to examine the competitive advantage of turfgrass-sod production.

Under current sod markets, sod producers may experience more risks than row crop producers. Varying sod prices, diesel fuel prices, and holding length have significant effects on net returns. If expected returns for sod operation drop below the expected returns for alternative row crop rotations, decreasing sod acres in operation and taking traditional agricultural enterprises as an alternative may be an effective way to get more profits.

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INTRODUTCION

In the 1980's, due to the depressed prices for agricultural products, previously profitable farm businesses became economically unstable. Many farmers began to enter alternative enterprises using the resources previously employed by traditional agricultural enterprises (Loyd 1994). Turfgrass was a good choice among various alternatives. After a growth period, turfgrass demand became depressed while row crop prices increased. Many sod farmers eliminated a sod operation or reduced its size in recent years.

Compared with more traditional sectors of U.S. agriculture, little economic analysis is available on the turfgrass industry, especially for recent years. However, the turfgrass industry contributes significantly to the US agricultural industry and it is important to continue monitoring and analyzing the change. In this study, current budgets for Alabama bermudagrass and row crops were developed. Next, models were used to determine the appropriate time to decrease sod production size or exit the market. Corn, cotton, peanuts, and soybeans were chosen as key Alabama row crops for this study.

The study was divided into six sections in the following part. The first section describes the history of the commercial turfgrass-sod industry and provides a brief analysis of recent Alabama sod production. The second section discusses the sod production survey used in this thesis. The third and fourth sections concentrate on developing sod and traditional agricultural budgets for Alabama. The fifth estimates the economic feasibility of turfgrass combined with different row crop mixtures. And the last presents a summary of the study with major results. It also includes the conclusions which could be drawn from the study.

Background

Turfgrass provides various benefits to human activities: including soil erosion control and dust stabilization, providing safe recreational surfaces, and contributing to increase property values and commercial appeal (Beard 1973). The aesthetic attributes of turfgrass are also highly appreciated. According to Behe et al. (2005), large landscape expenditures significantly increase a home's appraised values. Turfgrass is extensively used in many places, such as roadsides, golf courses, and home lawns. Homeowners represent a significant consumer segment that purchases landscape design, installation services, lawn care and landscape maintenance services.

Location specification has characterized the turfgrass-sod industry. Many local factors have impacts on turfgrass-sod production and demand. First, resource availability has significant impact on the turfgrass sod operation. These resources may include climate, soil conditions, water supply, and so on. Second, economic impacts vary by geographic location (Haydu, Hodges, and Hall 2009). Additionally, turfgrass-sod production facilities must be close to a major market since turfgrass is highly perishable and heavy. The product has a shelf life of only around 36 – 72 hours after harvest. Sod may also be damaged from wind, moisture, and temperature. Thus, being close to a major markets is important for sod production. If marketable sod cannot be sold in time, extra expenses will occur, especially for high quality sod. High quality sod has to be maintained in good condition, including weekly or bi-weekly mowing, periodical fertilizing, and weed control. If there are delays until harvested, more expense occurs. That results in a higher cost of entering sod production, as compared with more conventional agricultural production.

A lack of information on local turfgrass-sod production has also characterized the industry. Although the United States Department of Agriculture (USDA) collects information

on the number of sod operators, number of acres produced, and number of acres harvested, the aggregated data is hardly applicable to accomplish economic analysis in specific geographic areas. More significantly, the sod market is dynamic and location specific. The use of out-of-date economic analysis is limited. Therefore, timely economic analysis is imperative, especially under the current economic situation.

Sod History

The United States leads the world in production and marketing of turfgrass-sod. The turfgrass-sod industry was first developed on the east coast in the early 1920s (Cockerham 1988) and sod was first developed into a commercial product in the U.S. The sod productions spread out across the country by the 1930s. Previous literature shows some states, such as Pennsylvania, Florida, and Maryland, had commercially recognized businesses as early as 1930, with the home lawn being the dominant market outlet. In the late 1940s, with the utilization of self-propelled sod cutters, the turfgrass sod industry was able to harvest a sod slab of uniform thickness. The 1950s is defined as the era of "cultured sod" with the introduction of improved disease-resistant selections of Kentucky bluegrass. Almost all today's commercial sod uses commercial turfgrass species.

In the 1970s, sod production technology developed quickly. Improved technology developments took place on sod harvesters, forklifts, mowers and other sod equipment. These developments efficiently decreased operation's labor costs. Plastic netting was also introduced into sod production to increase stabilization and reduce the sod maturity time during this period. Use of netting can reduce the production time by up to 75 percent (Cockerham 1988). Also in this period, turfgrass uniformity and other qualities, such as weed and insecticide control, experienced significant development. With the dramatic development of technology, sod production increased significantly.

According to Cockerham (1988), more than 80% of states had sod producers and sales were estimated at $360 million in 1982. In the 1980's, due to the depressed traditional agricultural business, many farmers began to enter the turfgrass-sod industry as an alternative enterprise (Loyd 1994). Sod acres in production and sales increased by 54 and 125 percent from 1978 to 1987, respectively (Figure 1). This significant development continued in the 1990's. Sod acres in production and sales increased by 68 and 104 percent, respectively. During the period of 1997 to 2007, sod acres in production increased by 32 percent and sales increased 69 persent during this period.

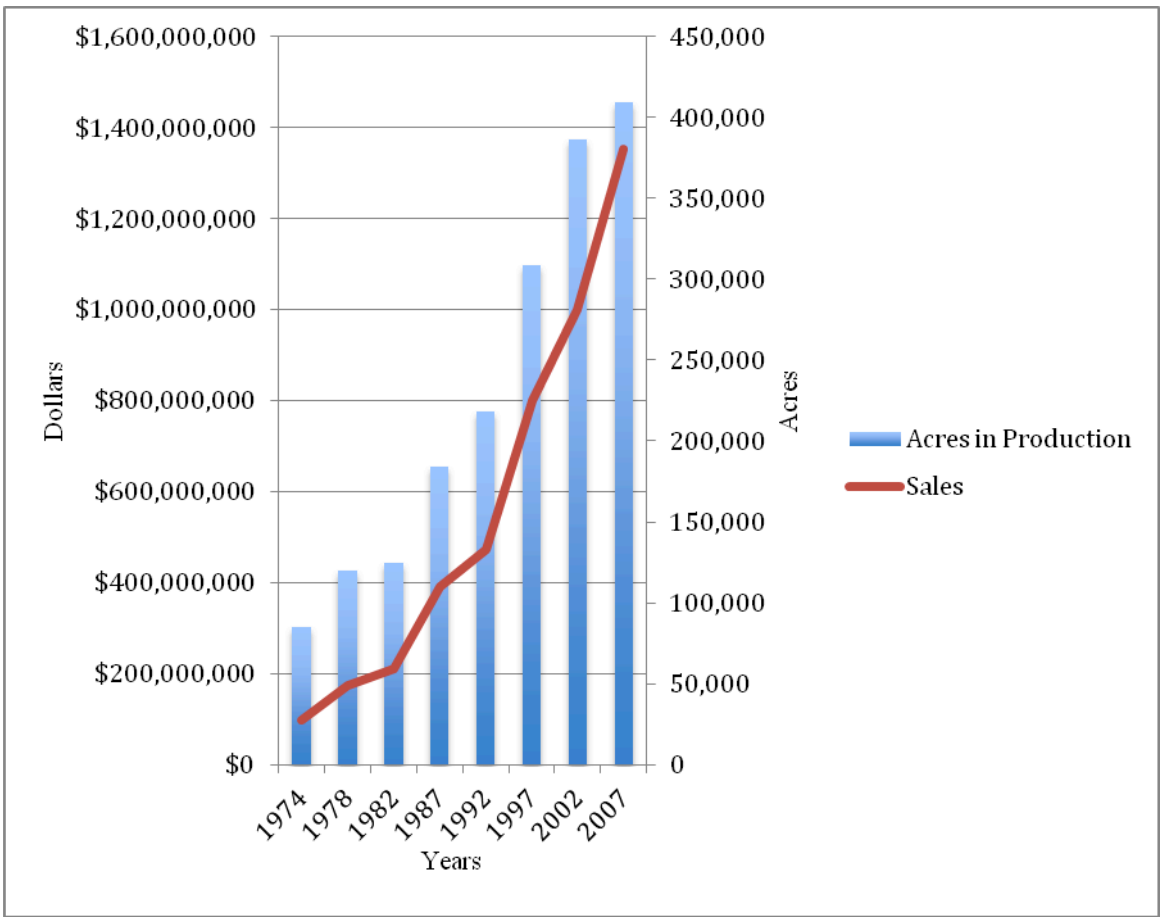

Figure 1. Turfgrass comparison chart from 1974 to 2007 (U.S.).

Source: Census of Agriculture in different years.

Turfgrass-Sod Production in Alabama

Turfgrass contributes significantly to the nation's green industry and Alabama's agricultural industry. The turfgrass-sod industry has grown rapidly in Alabama since 1927 when Auburn University first began turfgrass research in Alabama (White, Adrian, and Dickens 1991). But growth was slowing during the 1940's and 1950's since markets were relatively limited at that time, as population density and economic conditions during this period could not provide strong support for the turfgrass-sod industry. Rapid growth of the sod industry started in the late 1960's, when acreage expanded from 500 acre to 3,300 acres during the period of 1968 to 1979 (White, Adrian, and Dickens 1991).

The turfgrass-sod industry developed dramatically in the 1980's and became an important component of Alabama agricultural (Figure 2). In the 1987 census year, sod sales were reported as 17,480 thousand dollars in Alabama. In 1988, sod production was estimated to take up more than 15,000 acres.

One major reason for the rapid development in the 1980's was the combination of improvements in incomes and the failure of traditional agricultural products. First, the urban and industrial development of Alabama and surrounding states resulted in higher incomes. The risky row crop enterprises also stimulated turfgrass-sod production as an alternative. Figure 3-6 illustrates prices for corn, cotton, peanuts, and soybeans in the 1980's. Data are obtained from the U.S. Department of Agriculture/National Agricultural Statistics service (USDA/NASS 2012). Peanut prices remained fairly stable in this period, because of government programs. However, those programs made it difficult to enter into production or expand acreage.

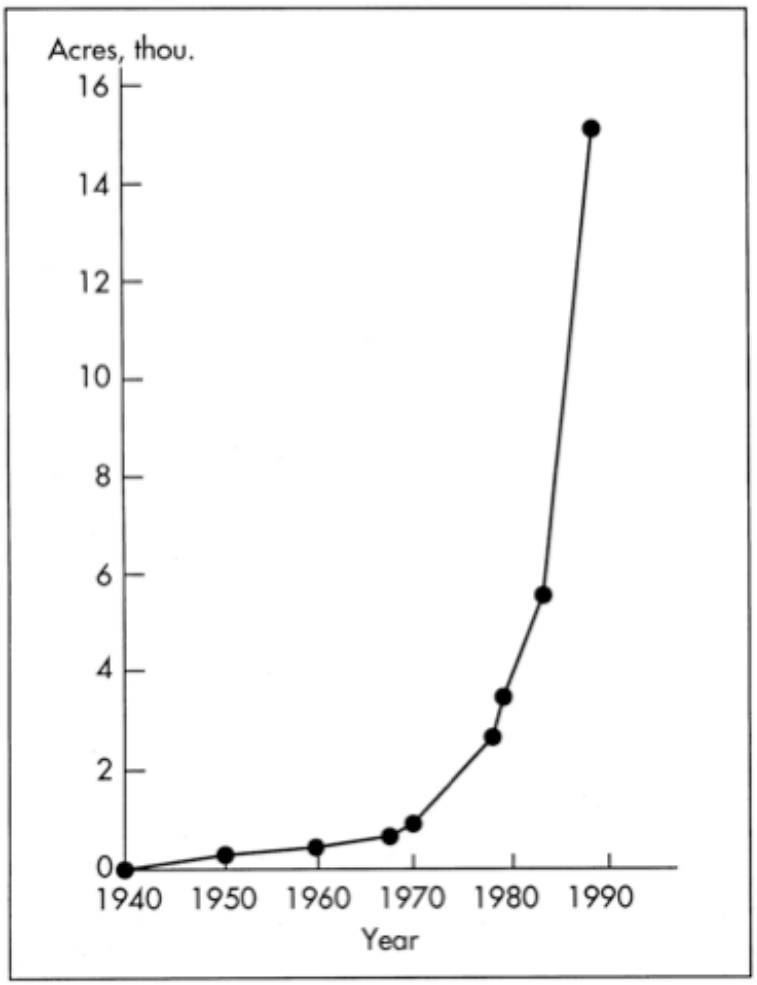

Figure 2. Estimated sod acreage, Alabama (1942 to 1988).
Source: White, Adrian, and Dickens (1991).

In 1992, there were 82 farms with 11,967 acres in sod in Alabama, which ranked third in the United States and accounted for slightly more than 5 percent of the total production (Perez et al. 1995). Forty-five percent of Alabama's sod farms with sod had sales of less than $25,000 in 1987, according to the 1992 Census of Agriculture. Sixty eight percent of Alabama's sod farms were individual- or family-owned operations, 24 percent were corporate-type farms, and 7 percent were partnerships (Perez et al. 1995) . According to the 1997 Census of Agriculture, the total sod acres in production were 17,318 acres. In 2007,

sales value for turfgrass sod harvested was approximately $58 million (2007 Census of Agriculture).

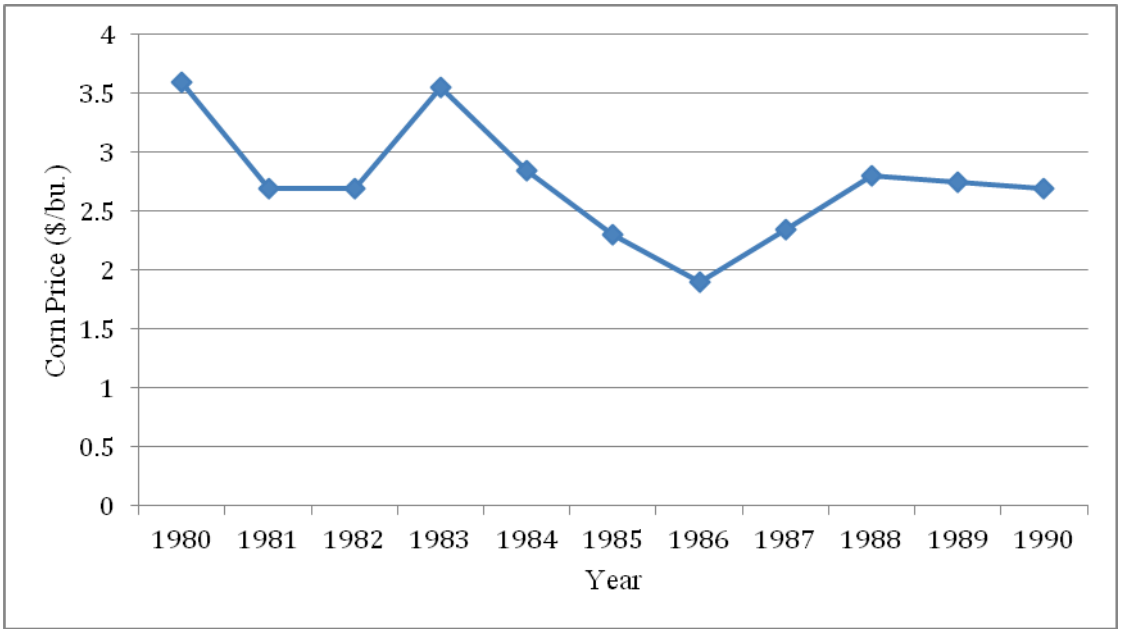

Figure 3. Corn price ($/bu.) in the 1980's.
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

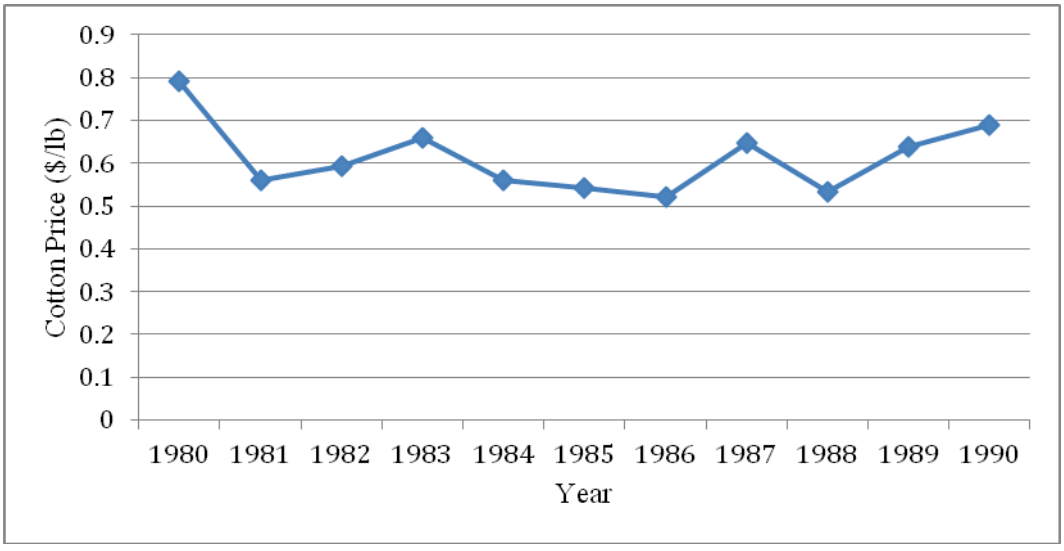

Figure 4. Cotton price ($/lb) in the 1980's.
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

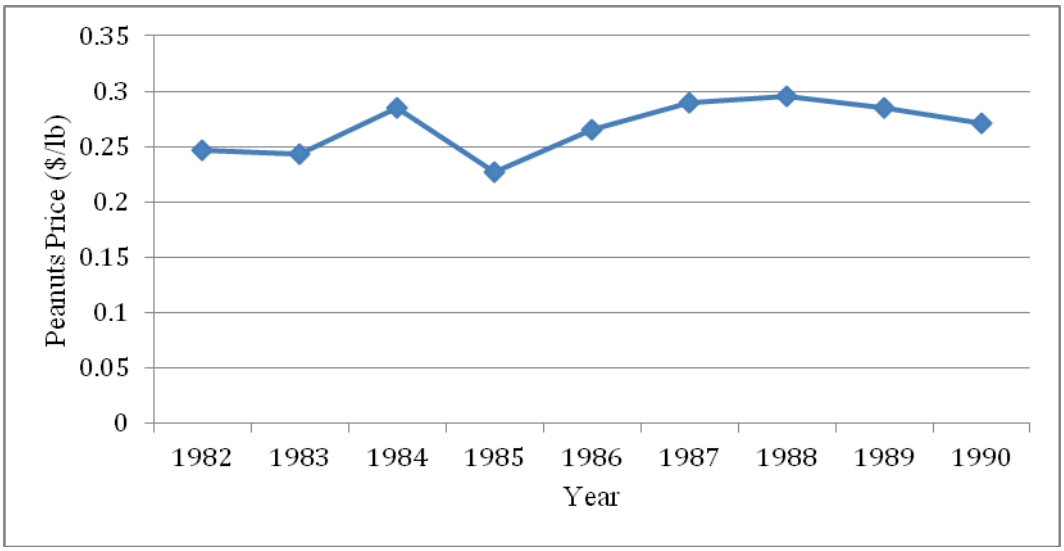

Figure 5. Peanuts price ($/lb) in the 1980's.
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

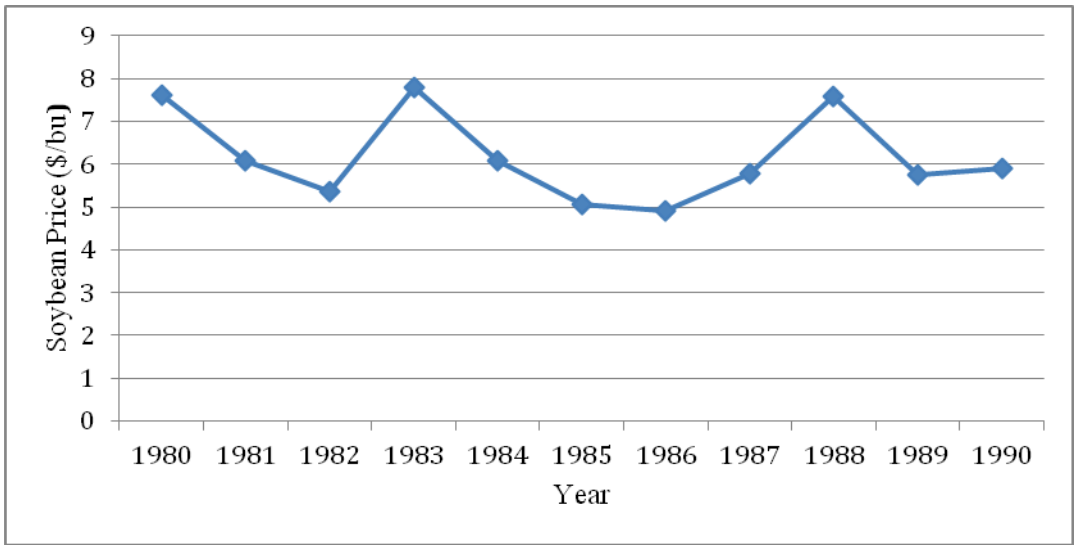

Figure 6. Soybeans price ($/bu) in the 1980's.
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

Alabama turfgrass-sod demand in this century can be roughly reflected by the condition of new housing starts (Haydu, Satterthwaite, and Cisar 2005). Figure 7 presentes residential construction building contracts in dollars from 2002 to April 2012 in Alabama. The amount of construction building contracts in dollars doubled in 2006 compared with 2002. However, it has decreased since 2007 as new owned housing units have decreased

dramatically since 2007. Alabama's housing start decline follows a national trend. According to Hedberg and Krainer (2011), national housing starts from 2008 to 2011 dropped to the lowest level since the Census Bureau began collecting data in 1963. Figure 8 shows annual new privately owned housing units started (in thousands) from 1970 to 2010 in the U.S.

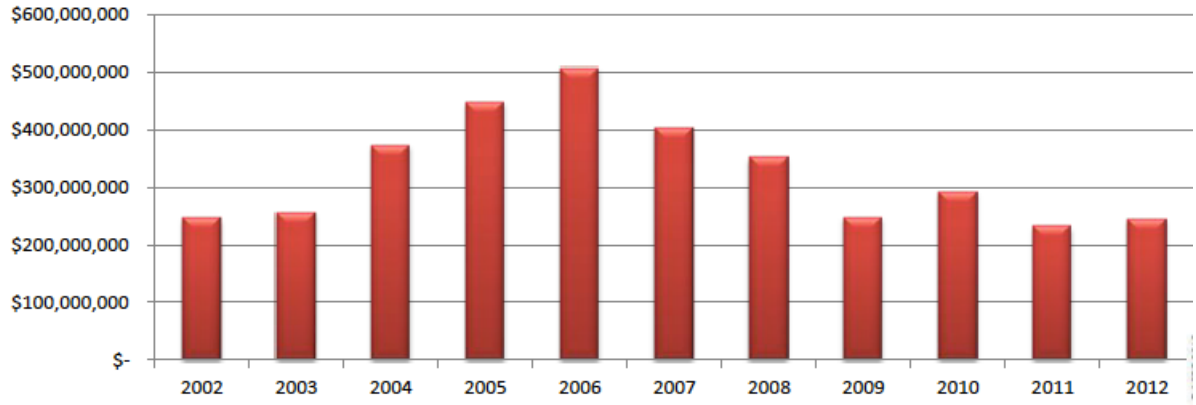

Figure 7. Alabama residential construction building contracts in dollars (2002-2012).
Source: Alabama New Construction Report (April, 2012).

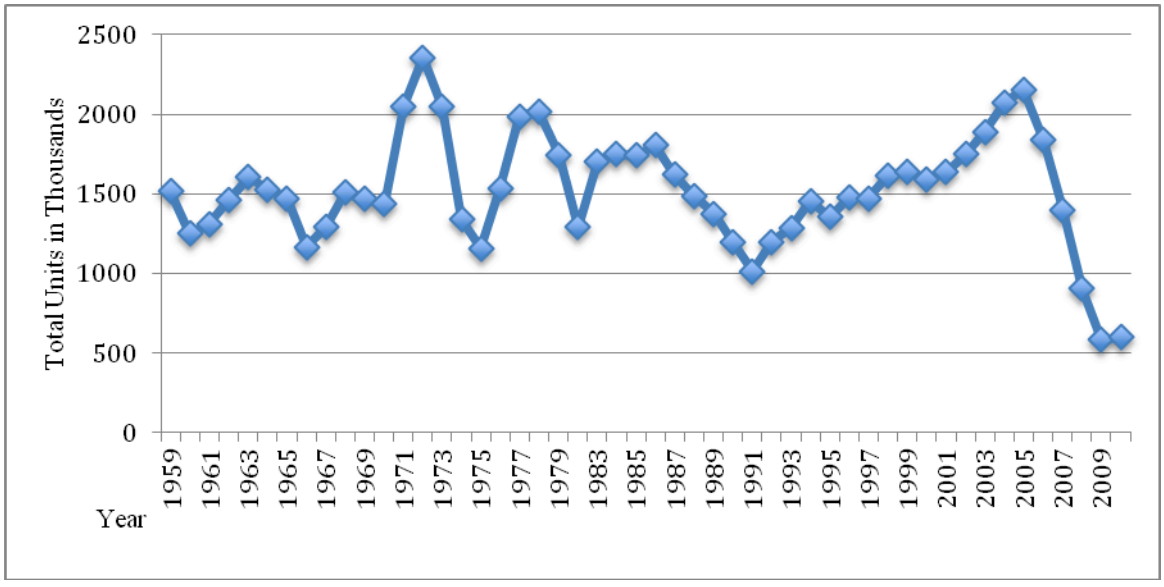

Figure 8. New privately owned housing units started in thousands (1959-2010).

Source: U.S. Census Bureau. Historical Data, Started. Retrieved from http://www.census.gov/construction/nrc/historical_data/>
Construction Reports, New Residential Construction. Retrieved from http://www.census.gov/const/www/newresconstindex.html.

Not only new housing constructions affected the sod industry, but the row crop market also influenced the sod industry. Figures 9 through 12 illustrate normalized crop prices for corn, cotton, cottonseeds, peanuts, and soybeans from the late 1990s to the present. In the late 1990s and early part of the 2000s, prices of traditional row crops were often low. From 2006 to 2011, corn prices increased relative to historical levels, at times exceeding $6.00 per bushel. Soybean prices have also been high over this time period. While peanut prices fell relative to the late 1990s, a change in government policy has made peanut production a possibility for a larger number of producers.

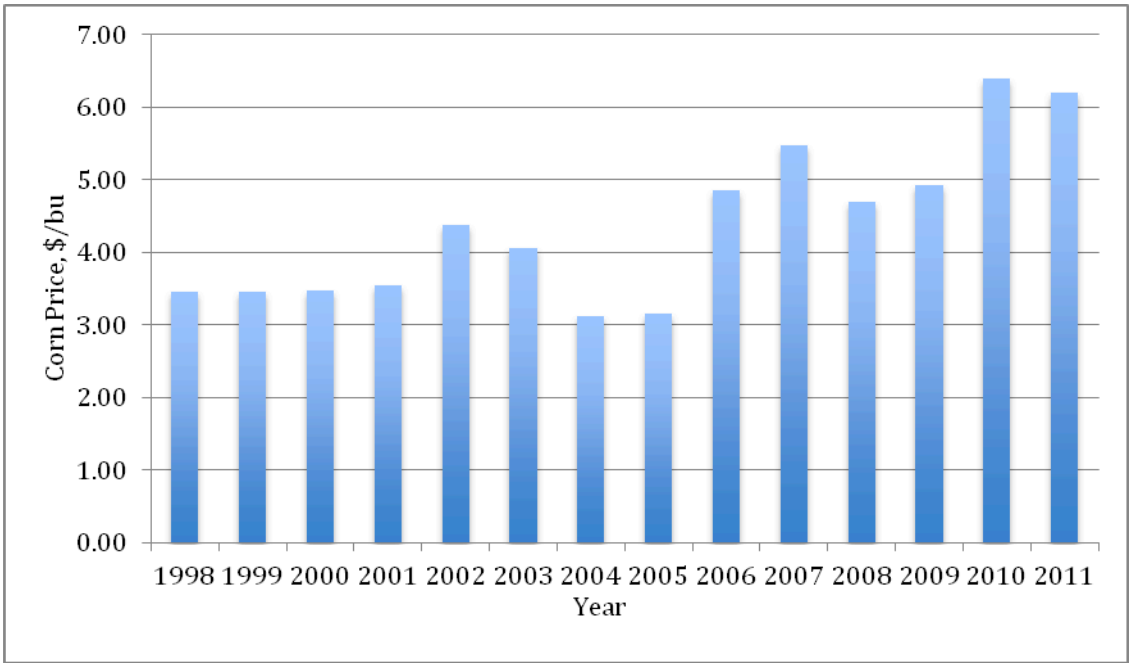

Figure 9. Corn price in Alabama from 1988 to 2011 ($/bu).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

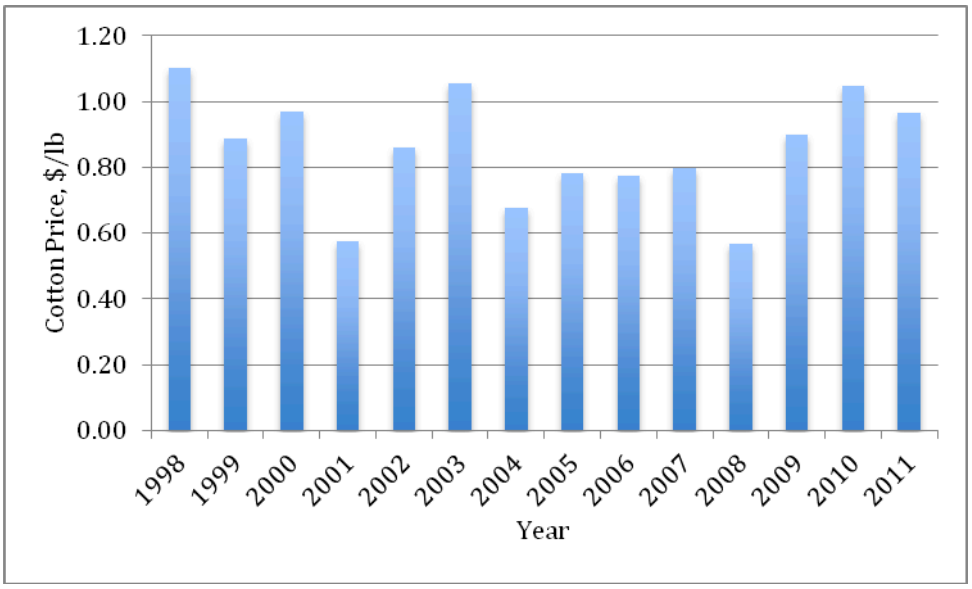

Figure 10. Cotton price in Alabama from 1988 to 2011 ($/lb).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

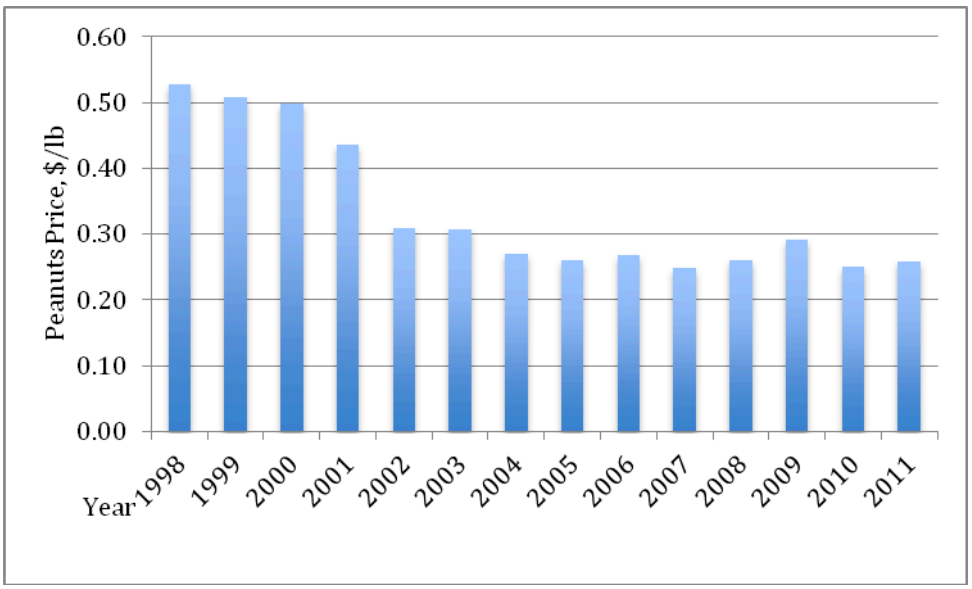

Figure 11. Peanut price from 2002 to 2011 ($/lb).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

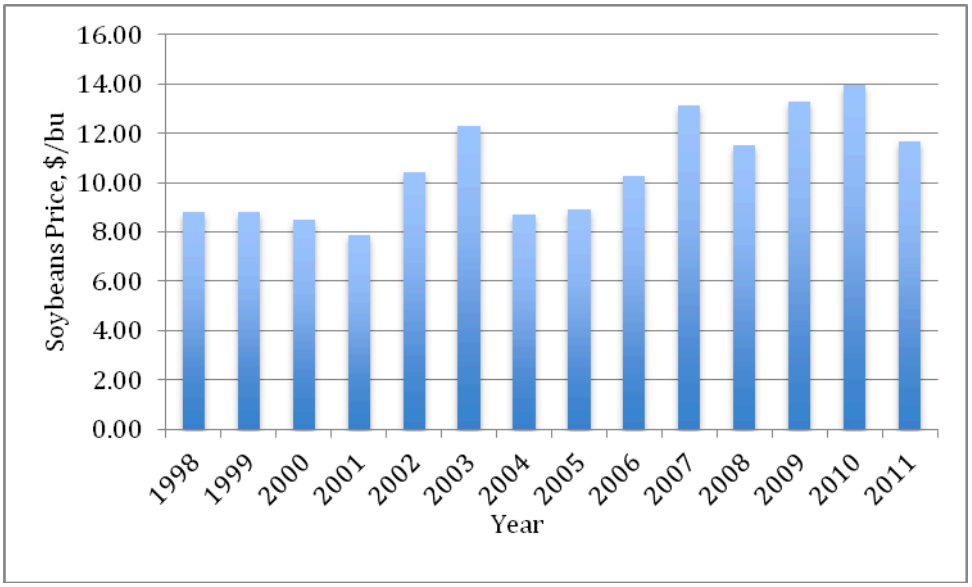

Figure 12. Soybean price from 1998 to 2011 ($/bu).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

The combination of depressed traditional agriculture enterprises and favorable economic and construction industry encouraged the turfgrass-sod industry to grow tremendously in the 1990s and early 2000s. Many farmers turned their traditional agriculture enterprises into sod production to take advantage of the expanding industry. The turfgrass industry experienced significant growth due to strong demand for sod. Sod sales increased from less than 250 million in 1988 to 870 million in 2009 for Alabama. However, this situation changed in recent years due to the depressed housing market and recovered row crop market. We can see row crop prices have increased since 2006 (Figure 9-12), while the new owned housing units have decreased dramatically since 2007 (Figure 8). Besides the effects from other industries, the tough competition between sod producers is also an important contributor to many farmers eliminating their sod production in recent years. During our interviews, sod farmers reported intense competition in the sod industry. They said too many producers entered this industry in previous years since people saw the sod industry developed fast and some publications reported possibly high profits. Due to the

changes of relative industries and tough competition in the sod industry, some sod growers relocated their resources by reducing sod operations.

According to previous surveys of the industry as well as our interviews and surveys, Alabama produces mostly warm-season grasses, including hybrid bermudagrass, centipedegrass, zoysiagrass, and St. Augustinegrass (Perez et al. 1995). Bermudagrass, centipedegrass, and zoysiagrass were found to be most popular in Alabama (Cain, et al. 2003a). All of Alabama's warm-season grass production is vegetatively established from sprigs or plugs, except for common centipedegrass and bermudagrass. Sod growers normally plant warm-season grasses between mid-April and mid-July. Most producers are reluctant to establish warm-season grasses after September 1 because of the potential for winter injury to new plantings (White, Adrian, and Dickens 1991). Sod growers in northern Alabama can harvest bermudagrass three times every two years and they can often harvest bermudagrass twice a year in South Alabama. Centipedegrass and zoysiagrass have longer growth periods. Normally zoysiagrass crops can be harvested 18 months after planting (Perez et al. 1995). In this study, only bermudagrass is chosen as the key turfgrass species in Alabama and it is assumed that it can be harvested twice a year in Alabama. To satisfy the market, most sod producers must also produce other species, but bermudagrass has been the source of the largest per acre profits, traditionally (Loyd 1994).

According to Perez et al. (1995), more than half of Alabama sod producers shipped their sod out of state to Florida, to New Orleans, and to Atlanta. Small sod operations shipped their sod less than 35 miles and it was 175 miles on average for large sod operations (White, Adrian, and Dickens 1991). But this situation changed due to soaring fuel prices. The majority of our interviewees said they don't ship to long distance since the fuel cost was too high.

LITERATURE REVIEW

Some previous studies have been conducted on economic analysis of the turfgrass industry. Table 1 lists available economic impact studies of the turfgrass industry in Alabama.

Table 1. Previous Economic Impact Studies of the Turfgrass Industry in Alabama

Year Reported	Title	Authors
1981	Commercial Turfgrass-Sod Production in Alabama	Adrian, Yates, and Dickens
1985	Turfgrass-Sod Marketing in Alabama	Adrian, Lokey, and Dickens
1991	Alabama's Turfgrass-sod Industry	White, Adrian, and Dickens
1995	Economic Feasibility of Turfgrass-Sod Production	Adrian, Loyd, and Duffy
1995	Competitive relationship of three warm-season turfgrass species	Adrian, Duffy, and Loyd
2003	Turfgrass Production: Economies of Size, Optimal Product Mix, and Price Sensitivity	Cain, Adrian, Duffy, Guertal
2003	Turfgrass-Sod Production in Alabama: Economics and Marketing	Cain, Adrian, Duffy, Guertal
2004	Turfgrass-Sod Production: an Economic Evaluation	Adrian, Cain, Duffy, Guertal, Prevatt

Adrian, Yates, and Dickens (1981) indicate that bermudagrass was the most widely grown and marketed sod species in Alabama. The average total cost for sod production in Alabama was $901 per acre in 1978. Fuel costs accounted for 20 percent of variable costs for large firms, while they accounted for 11 percent of variable costs for small- and medium-sized firms.

Adrian, Lokey, and Dickens (1985) applied the ordinary least squares method to analyze certain socioeconomic characteristics that influenced sod demand. Sod price elasticity of demand in Alabama was estimated to be 1.83. They also concluded that property

owners would like to purchase sod to add to a property's aesthetic quality and to increase property value, eventually.

White, Adrian, and Dickens (1991) indicate that bermudagrass sold at 0.82 per square yard in 1978; while it was sold at $0.90 for the same unit in 1988. If the price in 1978 is evaluated in 1988 dollars, the price in 1978 would be $1.65 per unit. Therefore, considering inflation, the sod prices decreased from 1978 to 1988. Returns to management were $495.85, $1.197.96 and $1,952.40 per acre for sod firms smaller than 100 acres, 100 to 300 acres and larger than 300 acres, respectively.

Adrian, Loyd, and Duffy (1995) analyzed the feasibility of incorporating turfgrass-sod production into existing farm operations. They also conducted a price sensitivity analysis to examine species advantages among bermudagrass, zoysiagrass, and centipedegrass. They indicated that bermudagrass was the most profitable turfgrass species among bermudagrass, zoysiagrass, and centipedegrass. They also indicated that price changes had limited effect on the profit maximizing combination. Although there was economical feasibility of incorporating sod production into existing traditional agricultural enterprises, they recommend farmers pay attention to the differences between sod markets and traditional agricultural markets.

In a related study, Adrian, Duffy, and Loyd (1995) used a multiperiod linear programming model to determine optimal combinations of turfgrass species based on a seven-year planning horizon. They found that production cycles have important effects on profits. Bermudagrass was the most profitable turfgrass species because of its shorter production cycle and positive influence on cash flow.

Cain et al. (2003a) noted that there were economies of size both in establishment and reestablishment of turfgrass in Alabama. Bermudagrass was the most profitable turfgrass species on every farm size. Their analysis indicated that the break-even prices for

bermudagrass ranged from $0.95 per square yard for a 100-acre sod operation to $0.77 per square yard for a 1,200-acre sod operation. They also stated that the farm level turfgrass prices were somewhat slow to increase.

Cain et al. (2003b) stated that as the size of the sod operation increases, there is more possibility to decrease total costs. They also state the returns to management for the mix of grasses in the fifth year for Alabama were $1,090, $1,285, $1,729, $1,885, and $2,083 for 100, 250, 550, 850, and 1,200 acres of sod farms, respectively. They note that bermudagrass can be harvested twice a year, and in that case variable costs are essentially doubled but fixed costs do not change.

Adrian et al. (2004) indicated that the farm level price of bermudagrass had increased 1 percent annually while the total sod production costs for smaller operations had increased about 9 percent. Thus, sod growers' profits decreased. It is also stated in this study that many sod growers expanded their sod sizes in operation to get more total income.

SURVEYS AND INTERVIEWS

Introduction

The most recent survey information relative to sod is the 2007 Census of Agriculture. In order to collect updated information relative to the current economic situation of Alabama turfgrass-sod production, a brief turfgrass production survey was developed online. To compensate for the limits of online surveys, face-to-face interviews were also conducted.

Online Surveys

The survey was created and operated through Qualtircs. The online survey was anonymous and the questionnaire is listed in the appendix.

The survey was launched in February 2012, and lasted for a month. Fifty-four emails were sent out to existing sod producers with a survey invitation. The online survey was only available to invited sod producers and managers, who could get access to the survey through the links embedded in invitation emails. A list of Alabama sod producers to contact was based on information from Alabama Turfgrass Association (ATA). Since few producers responded to the survey, reminders were sent twice following the initial invitation emails. To assist with this effort, Alabama Farmers Federation (ALFA) posted the online survey under their headlines page intending to make the survey more popular. However, only four usable surveys were collected through the online survey.

Among the four surveys, one provided answers to partial questions. Therefore, some of our survey summary discussed later is based on three surveys instead of four.

According to the surveys, the average farmland is 2000 acres in 2012. All of the surveyed farms had other enterprises besides turfgrass, typically row crops. The average number of workers employed in-season and off-season were 5 and 2, respectively. All of the responding sod farms had irrigation facilities. Only three farms provided details on sod operations in this survey. Average acres of sod production were 204 in 2006, and it was around 99 in 2011, a 51 percent decrease.

All respondent farms planted non-certified bermudagrass in 2011. Some also had centipedegrass and/or zoysiagrass. Corn, cotton, peanuts, soybeans, and wheat were also planted. Average acres of row crops were 662 in 2011 and 450 in 2006. Thus, average row crop acres increased 47 percent from 2006 to 2011, while sod acres deceased 51 percent from 2006 to 2011. Age of the turfgrass operations averaged 15 years, and all respondents had many years' experience of growing sod.

About 68 percent of sales originated from turfgrass. All farms harvested sod in pallets. Some also had large roll and/or harvested as sprigs. About 74 percent of bermudagrass can be typically harvested and it was 88 percent for centipedegrass and 66 percent of zoysiagrass, according to the responses to the survey.

Turfgrass prices varied widely in the four surveys. The average on-the-farm non-certified bermudagrass was priced at $1.34 per square yard. The average centipedegrass price was $1.81 per square yard. And the average zoysiagrass price was $3.15 per square yard.

Some farms set a maximum delivery distance; however, the threshold value varied widely. The delivery fee was charged in different ways. Some sod operators said they have different prices between delivered sod and on-the-farm sod. Some have the same sod prices no matter if sod is delivered or not, but an additional delivery fee is charged.

As to their sod operation plans for 2012, none of them planned to increase sod acreage. One wants to keep the same acreage as in 2011, one was unsure, and the other two will decrease their sod acreages.

In comments, producers cited the low demand for the products and the bad housing market as factors limiting the growth of the farm's overall farming business. One respondent indicated that the farm may leave sod operation next year. One respondent said water rights were a real issue for them and recommended state legislation to limit the power of eminent domain.

Interviews

To complement the online survey, face-to-face interviews were also conducted to collect information. I visited three sod farms with Dr. Duffy and Dr. Han. We talked with sod producers and managers and asked questions related to price received, advertising techniques, planting plans, and so on. Respondents also provided comments about problems they faced in sod operation and market.

During the interviews, sod producers indicated the competition in the sod market was tougher in recent years. They noted that sod production needed more labor input than row crops. Because of the low sod demand and prices, most of our interviewees indicated they were thinking of decreasing sod planting areas, similar to what was reported in the online survey.

None of interviewed sod producers provided us with information on the exact amounts of needed inputs for sod operation. Sod farm managers indicated sod associations and agents provided advertisements for them if they registered in some associations or buy certification from some agents.

Compared with other survey methods, this online survey received fewer responses (Cain et al. 2003; Falconer and Niemeyer 2006). Mail surveys, phone surveys, and interviews may be more effective for obtaining production information from growers.

TURFGRASS BUDGETS

Turfgrass-sod production is location specific. Sod markets differ depending on many factors as discussed in previous chapters. Therefore, location-specific budgets need to be developed for turfgrass varieties. In this study, bermudagrass is chosen as a key turfgrass variety in Alabama. Due to the high costs of collecting primary data on Alabama sod production, secondary data from various sources were used to develop a composite turfgrass-sod industry for Alabama in this study.

The most commonly used turfgrass types in Alabama for sod production are bermudagrass and zoysiagrass. This study focuses on bermudagrass. Bermudagrass is a perennial warm-season grass introduced from Africa (Christians and Engelke 1994). It is a popular species used as turfgrass throughout Alabama. No recent research publications concerning the economic aspects of bermudagrass production are available for Alabama. This chapter is intended to represent the cost structure for a hypothetical 500-acre bermudagrass sod operation for the 2012 crop year. Because the major research question in this study is the appropriate time to eliminate a sod operation or reduce its size, costs in this study are for maintenance and harvest costs, and first-year establishment costs are not considered. Although a wide variety of machines and equipment are available, the relevant common characteristics are similar. The cost estimations are not specific to any sod farm, but are intended to reflect the average cost for an operation of this type in Alabama.

All 500 acres are assumed to be used for sod production. Barns, roads and other non-cultivated facilities were not included in the 500 acres. In the first year of production, less

grass is available for harvest, but this situation is not included in this research, since only established bermudagrass sod farms are considered in this study.

Machinery Costs

Machinery and equipment are major cost items in turfgrass and row crops production. The costs of owning and operating machinery are often exceeded only by the cost of land use (Hunt 2008). More expensive equipment prices and higher diesel price have caused machinery and power costs to rise in recent years. Machinery costs are related to machinery age, the product produced, number of acres in cultivation, and the geographic area. The true costs are unknown until the equipment is sold or worn out. So the most accurate method of determining machinery cost involves a complete record of actual costs (Schuler and Frank 1991). An alternative approach is to estimate costs based on assumed machine life, annual use hours, and fuel and labor prices from experience and the open literature and industry resources.

The Mississippi State Budget Generator (MSBG) is a widely used budget generator for building crop and livestock budgets. Three frequently used resources to estimate budgets for row crops are the MSBG, Minnesota Machine Cost Estimates published annually and American Society of Agricultural and Biological Engineers machinery data and formulas (ASABE Standards, 2011). Although there are some publications related to sod production costs, it is hard to find estimators and procedures for sod budget calculations. The following provides the procedures for calculating sod machinery costs used in this study and some relevant supporting data.

Machinery costs are incurred when machines are purchased, owned, and operated. Two major categories in machinery costs are ownership and operating costs. Ownership costs are also referred to as indirect or fixed costs, since they are fixed with the amount of annual

use and not relative to the acreages of operation. Operating costs are also called variable or direct costs, since they vary directly with the amount of machine use.

The first step to estimate machinery costs is to collect the basic data, such as list price, purchase price, salvage value, economic life, annual hours of use and interest rate on the capital invested. Published literature and dealers also provided important information used in this study. Specifically, economic life and annual hours of use followed Falconer and Niemeyer (2006) and were adjusted appropriately following interviews with local growers and other experts in this area. List and purchased prices were collected from budgets published by Mississippi State University for 2012, equipment dealers, manufactures' websites and shopping websites. In some cases, the list price is similar to purchase price, but usually some discount is available. For some equipment, for which only the list price or purchased price were available, the purchase price is assumed as 85 percent of its list price, following the study by the University of Illinois Extension Service (UICES, 2012).

The study of Falconer and Niemeyer (2006) used as a basis for this budget was completed in 2006. Compared with data in those studies, machinery purchase costs have increased. Detailed information on such costs will be reported in this chapter. Farm diesel fuel was priced at $3.65 per gallon based on information from Alabama Cooperative Extension System for summer, 2012 (Runge 2012). Besides the impact from diesel price rising, high farm diesel prices are also closely linked with high natural gas prices. For agricultural purposes, the price of natural gas is closely tied to the production cost of fertilizer. Therefore, sod producers should notice higher input costs due in large part to higher fuel prices.

The interest rate for the budget is 6.5%, based on the figure used by the Alabama Cooperative Extension System. A labor figure of $11.25 per hour charge for labor costs were used in this study based on local sod operation managers' survey response. Economic life for

sod equipment was collected through published sod studies (Cain et al. 2003b;Adrian et al. 2004; Falconer and Niemeyer 2006). Variables used in estimating costs are presented in Table 2.

Table 2. Factors Used in Calculating Machinery Costs

Item	Percentage or Rate		Source
Purchase Price	85%	of list price	Publication from University of Illinois Extension, 2012
Fixed Interest Cost	6.50%	of remaining value	Alabama Cooperative Extension System
TIH*	1.75%	of average value	Calculated in this study
Diesel Fuel	$3.65	per gallon	Alabama Cooperative Extension System
Lubrication Cost	15%	of fuel costs	Publication from University of Illinois Extension, 2012
Labor Charge	$11.25	per hour	Local sod interviews
Labor Time	1.2	times equipment hours	Estimating Farm Machinery Costs, Edwards, W. M. (2011)

Note: TIH: Taxes, insurance and housing.

Ownership Costs

Ownership costs cannot be avoided unless the machine is sold, so the estimation is important for total costs. Ownership costs include depreciation, interest (opportunity cost), taxes, insurance, and housing and maintenance facilities.

Depreciation

Depreciation is defined as a noncash expense that reflects a loss in value of machinery due to age, wear, and obsolescence (Kay, Edwards, and Duffy 2011). It is considered a fixed cost during accounting procedures. Annual depreciation can be estimated using the straight-line or declining balance methods. The straight-line method (average annual depreciation) was used in this research and the equation is as follows:

$$(1) \qquad \text{Depreciation, \$/year} = \frac{\text{cost - salvage value}}{\text{economic life}}$$

Where “cost” equals the purchase price. The salvage value can be estimated as a percentage of the new list price. Annual use hours and economic life are considered when estimating salvage value. Salvage values can be obtained from the open literature, but those data are estimated based on row crop operations. Since a sod operation is different from traditional row crop operations, salvage values for row crop machinery may be inapplicable for turfgrass machinery. In this case, I estimated salvage values for turfgrass equipment in this study.

Salvage Value

According to ASABE Standards, salvage value is estimated as a percent of the list price for farm equipment at the end of n years of age and after h average hours of use per year using the following equation:

(2) $SV_n=100[C_1-C_2(n)^{0.5}-C_3(h^{0.5})]^2$

Coefficients are collected from ASABE Standards (2011). Table 3 lists the coefficients and estimated salvage values for tractors. Salvage values for tractors ranges from 20 percent to 56 percent.

Table 3 Remaining Value Coefficients for Tractors

Equipment type	C1	C2	C3	n	h	Remining Value
Farm tractors						
Small <60 kW (80 hp)	0.981	0.093	0.0058	14	1000	20%
				10	800	27%
Medium 60−112 kW (80-150 hp)	0.942	0.1	0.0008	14	800	30%
Large >112 kW (150 hp)	0.976	0.119	0.0019	10	350	31%
Small <60 kW (80 hp)	0.981	0.093	0.0058	10	800	52%
Medium 60−112 kW (80-150 hp)	0.942	0.100	0.0008	14	800	30%
Large >112 kW (150 hp)	0.976	0.119	0.0019	10	350	32%
Mower	0.756	0.067	---	7	800	21%
Harvester	0.791	0.091	---	20	1800	15%
Drag	0.891	0.11	---	20	25	16%
Disk	0.891	0.11	---	20	15	16%
Roller	0.891	0.11	---	20	800	16%
Landplane	0.891	0.11	---	20	20	16%
Planter	0.883	0.078	---	30	20	29%
Shredder	0.943	0.111		7	250	20%

Note: Inflation effects are not considered in this estimation.

Interest

Investing in a machine prevents capital from being used for an alternative investment. When borrowed money is used to purchase machinery, the interest cost is based on the loan interest rate. If equity capital is used, the rate to charge will depend on the opportunity cost. In this study, the average interest rate is assumed to be 6.5 percent (Runge 2012).

The cost of annual interest can be calculated by multiplying the interest rate by the average value, following the study of Kay, Edwards, and Duffy (2011):

Interest = average value × interest rate

Where the average value is estimated from the equation (Kay, Edwards, and Duffy 2011)

$$\text{(3)} \qquad \text{Average value} = \frac{\text{cost} + \text{salvage value}}{2}$$

On an annual basis, interest and depreciation are relatively constant no matter how many acres are operated. As operation acres increases, annual depreciation and interest costs are spread over more acres. So costs per acre decline as acres of operation increase for a given

implement size. Previous studies show a 25 percent decrease occurs with a 50 percent increases in acreage (UICES, 2012).

Taxes, insurance and housing (TIH)

Taxes, insurance and housing are considered as ownership costs, but these three costs are much smaller than depreciation and interest costs. Taxes on off-road farm machinery are levied in Alabama only during the year of purchase. Alabama has a 1.5 percent sales and use tax rate for farm machinery (Alabama Department of Revenue). This is a one-time cost and added to the initial purchase cost.

Insurance is the annual charge for insurance to cover loss or damage to the machine. If insurance is not carried, the risk is assumed as the value for insurance in this study. It changes with the machine's value, types of coverage, insurance rates, etc. Approximately 0.75 percent of the machine' average value can be calculated as a typical annual charge for insurance (Runge 2012).

Shelter could result in better machinery maintenance, less repair costs and higher salvage value. In Meador's survey of dealer opinions, sheltered machinery was valued from 10-23 percent more at trade-in time than machinery stored outdoors and the benefits are greater for more complex machines than tillage implements (Hunt 2008). During our site visits, we found that most farmers do have shelter for their field equipment. If the equipment is not housed, a charge is included in this study to reflect additional wear and tear. A value of 1.0 percent is often used to calculate machinery housing costs (Kay, Edwards, and Duffy 2011).

Sales tax was included in purchase prices, so the TIH was calculated as 1.75 percent of the average equipment values.

Total ownership costs can be estimated based on above data and formulas. For example, the annual ownership costs for a small tractor with 1000 hours of annual use is $2,375. The costs are $3,275 and $13,462 for mid-size and large-size tractors, respectively. Next, the annual ownership costs were divided by annual hours of use to get average ownership cost per hour of use. Machines' annual hours of use were collected through previous studies. Hourly costs are $2.38, $4.09, and $38.46 for small-size, med- size and large-size tractors, respectively.

Ownership costs are calculated based on new purchase price. Some sod growers may have lower ownership costs since they bought used equipment, use older, depreciated one, or get free equipment from family.

Operating Costs

Operating costs are incurred only when the machine is used, including repairs and maintenance, fuel, lubrication, and labor. There is no operating cost if the equipment is not used, but these costs increase with the hours of use.

Repairs and Maintenance Costs

Repair and maintenance costs are relative to routine maintenance, wear and tear and accidents. They vary widely since soil types, climate and other conditions are different on different farms. They are also affected by various management policies and operator skills. Studies show that repair and maintenance costs are not constant over a machine's life (Hunt 2001; Edwards 2011, ASABE 2011). The costs are low early in the machine's life and higher as the machine accumulates more hours of operation. Average annual repair costs are often estimated as a percent of the list price of the machine. The formula for repair and maintenance costs is (Kay, Edwards, and Duffy 2011):

(4) Repair and maintenance costs/hour= $\sigma \times$ list price $\times$ annual use hours $\div$ 100

Where σ is the average repair costs 100 hours of use. Coefficients were collected from Hunt (2008) and Kay, Edwards, and Duffy (2011). The values of repair and maintenance unit, percent of 100 hours of use, do not include the differences caused by the variation of machine size and accumulated usage. Table 4 lists some average repair costs per 100 hours of use as a percent of the new list price for sod operation machines.

Table 4. Average Repair Costs per 100 Hours of Use, Percent of New List Price

Machine	Percent of List Price
Tractors	
Two-wheel-drive tractor	0.83
Four-wheel-drive tractor	0.50
Tillage	
Moldboard plow	5.00
Heavy-duty disk	3.00
Tandem disk harrow	3.00
Chisel plow	3.75
Field cultivator	3.50
Spring-tooth harrow	3.50
Roller harrow	2.00
Rotary hoe	3.00
Rotary tiller	5.33
Seeder	
Row crop planter	5.00
Grain drill	5.00
Harvesters	
Forage Harvester, pull type	2.60
Forage harvester, self-propelled	1.25
Other machines	
Mower rotary	8.75
Windrower, self-propelled	1.83
Rake	2.40

Table 4. Continued

Machine	Percent of List Price
Fertilizer spreader	6.67
Boom sprayer	4.67
Forage blower	3.00

Source: Hunt, Donnell (2008), Standards of American Society of Agricultural Engineers.

Fuel and Lubrication Costs

The average fuel consumption (in gallons per hour) for farm tractors without reference to any specific implement can be estimated from the maximum power takeoff horsepower of a tractor, with these following formulas (Kay, Edwards, and Duffy 2011):

(5) Gallons per hour = 0.060 × PTO hp (gasoline)

(6) Gallons per hour = 0.044 × PTO hp (diesel)

Fuel cost per hour then can be estimated by multiplying the estimated fuel use by the purchase price of the fuel. Diesel fuel price dramatically increased in recent years. Figure 13 is the annual diesel prices in the U.S. from 1994 to 2011. This price increased by 42 percent in 2011, compared with 2006. In this study, only off-road diesel fuel price was used and the purchase price is assumed to be $3.65 per gallon (Runge 2012). Off-road diesel fuel is mainly sold for use in equipment and vehicles which are operated on farms and railways, in construction, and for electric power generation. It is not subject to the State and Federal retail sales taxes. A rough estimation method for off-road diesel fuel prices is to deduct sales taxes from on-highway diesel fuel prices. In Alabama, the fuel tax is 46.3 cents per gallon.

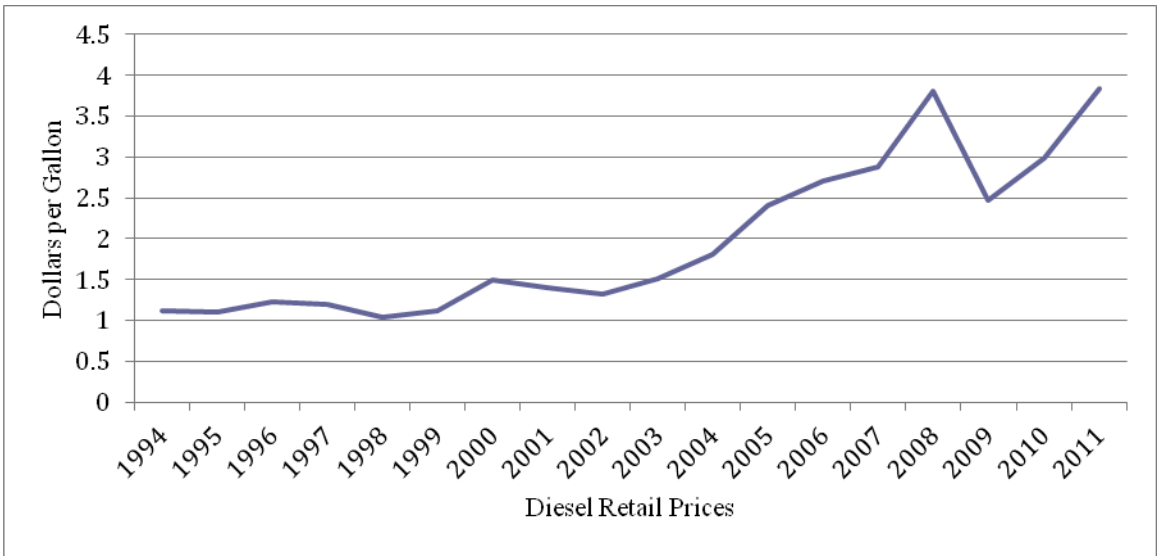

Figure 13. Annual diesel fuel price in the U.S. (1994-2011).

Source: U. S. Energy Information Administration; Koske (1994).

According to Kay, Edwards, and Duffy (2011), total lubrication costs on most farms average about 15 percent of fuel costs. Therefore, total lubrication costs can be estimated by multiplying the fuel costs by 0.15. The cost for nonpowered machines is generally ignored since it is small (Carrow, Johnson, and Burns 1987).

The formulas for fuel costs are applicable for most machines used in sod farming, but not for forklifts. Diesel costs for forklifts were calculated differently in this study. Three main types of forklift are battery-powered forklifts, internal combustion engine forklifts and fuel-cell forklifts, classified by their propulsion systems (Gaines, Elgowainy, and Wang 2009). The most commonly used forklifts in Alabama turfgrass production are internal combustion engine (ICE) forklifts with diesel as the engine power. Engines for this type of forklifts range from 25 hp to 115 hp or even larger engines. The purchase costs are lower for ICE-powered forklifts, compared with the other two classifications, but the maintenance costs are high. Gavin Nawrocki, who is the manager of Best Rental, told us their

forklifts need service after every 250 hours of use and the service costs around $125 (Nawrocki 2012).

Fuel costs for forklift can be estimated by the following two formulas (Department of the Army U.S. Army Corps of Engineers 2011):

(7) Fuel factor (gal/bhp - hr) = $\frac{\text{Horsepower factor (HPF)} \times \text{lbs fuel per bhp} - \text{hr}}{\text{lbs of fuel per gal}}$

(8) Fuel costs/hr = fuel factor (gal/bhp - hr) × housepower (hp) × fuel cost/gallon (gal)

The fuel factor in gallons per brake horsepower-hour (bhp-hr) is relative to horsepower factor (HPF), pounds fuel per bhp-hr and pounds of fuel per gallon. The HPF is the horsepower factor used in the fuel and electricity consumption formulas and represents a percent of full-rated horsepower being used by the engine on average. The HPF for the forklift is 65 (US Army Corps of Engineers 2011). Pounds fuel per bhp-hr is an average based on a variety of engine application from manufacturer engine data. For diesel, 0.34 lbs per bhp-hr is used and 0.55 is used for gasoline. Fuel factor (gal/bhp-hr) is the factor to determine the weight of the fuel consumption. Seven and 6 lbs per gal for diesel and gasoline, respectively, are used as constants to calculate hourly fuel costs (U.S. Army Corps of Engineers 2011). Therefore, the fuel factor is 0.032 gal/bhp – hr. For a 57 hp forklift, the fuel cost per hour is $6.57.

Labor Costs

Operating labor is assumed to be an hourly wage rate. Labor costs for managers are not included in this part. Labor per acre for an implement operation such as a mower is estimated by using the work rate on the implement instead of the tractor. The total labor costs should include time spent on repairing, fueling, lubricating, and moving equipment between fields and the farmstead (Koske 1994)). Actual hours of labor usually exceed field machine time by 10 to 25 percent based on published studies. In this study, 20 percent was added to machinery

field time to better estimate the actual labor costs. The local wage rate was estimated at $11.25 per hour based on our survey.

Custom hire or Rental Costs

These components should be considered when sod farms rent equipment or hire custom operators to perform certain machinery operations. Custom rates vary based on acreages, hours, and some other conditions. But both online survey and site visits did not show any Alabama sod farm used custom operators or rented equipment in recent years. Therefore, this part is ignored in my study.

Machinery Costs

Total machinery costs are the sum of ownership costs and operating costs. Costs for implements or attachments depend on tractor power and are estimated in the same way as for tractors. When tractors or other self-propelled units are used to pull implements, ownership and operating costs are calculated separately for the power unit and for the attachment. Then these components are added together to estimate the combined cost of performing the operation. Fuel and lubrication costs were assigned only to the power unit.

They can be converted to a cost per acre or per unit if the field capacity per hour is known. The formula for field capacity in acres per hour is

(9) $$\text{Field capacity} = \frac{\textbf{speed (mph)} \times \textbf{width (feet)} \times \textbf{field efficiency (\%)}}{8}.25$$

This equation follows the instruction in Kay, Edwards, and Duffy (2011). Field efficiency is a percentage of the time a machine is effectively operating to the total time the machine is committed to the operation. Some sod machines' field efficiencies and operating speeds are listed in Table 5.

Table 5. Ranges and Average Values in Typical Field Efficiencies and Implement Operating Speeds for Sod Operation

Operation	Equipment	Field Efficiencies, %			Operating Speeds [MPH]		
		Range		Average	Range		Average
Tillage	Moldboard plow	88	74	81.0	3.1	5.6	4.35
	Disk harrow	90	77	83.5	3.7	6.2	4.95
	Field cultivator, chisel plow	90	75	82.5	3.7	5.6	4.65
Cultivation							
	Rotary hoe	88	80	84.0	5.6	12.4	9
Seeding							
	Grain drill with fertilizer	80	65	72.5	3.0	6.2	4.6
Harvesting							
	Mower	75	85	80	3.0	6.0	4.50
	Harvester	76	50	63.0	3.7	6.2	4.95
	Rake	89	62	75.5	3.7	5.6	4.65
Miscellaneous							
	Sprayer	80	55	67.5	4.3	6.2	5.25
	Rotary stalk chopper, mower	85	65	75.0	3.7	6.2	4.95
	Fertilizer spreader	90	60	75.0	3.7	6.2	4.95

Source: Hunt (2008); ASABE Standards (2011).

The total cost covers both the implement and the associated power unit's cost of operation. Operating costs can be controlled, such as by changing the amount of annual use and improving efficiency. The costs increase as acreage increases, while ownership costs are

constant no matter how many acres are covered. Therefore, as the acreage increases, unit ownership cost decreases.

List of Machines

The turfgrass-sod budgets are intended to represent the cost structure for a hypothetical 500-acre bermudagrass production for the 2012 crop year. Typically used sod machines for a 500-acre bermudagrass farm include tractors, mower units, a tractor-mounted harvester, one or two forklifts, a roller, sprayer unit, an aerator and irrigation facilities. Large machines are more time-efficient. They are important to sod growers for labor cost savings, especially when bad weather shortens the available work time. Some machines are discussed in this section to provide more detailed information.

Tractors

Tractors for sod farms usually have turf tires or flotation tires to reduce damage to the turf. The tractors and implements should match for efficiency. Three tractors with different sizes were included in this study to estimate the costs for towing implements based on the study of Falconer and Niemeyer (2006). Three tractor sizes included in this study were 50, 80, and 150 horsepower (hp). Annual hours of use on these three tractors followed the results in Falconer and Niemeyer (2006). All purchase prices for the three tractors derived from the 2012 Mississippi Budget Generator (MSBG). For two-wheel drive tractors, the repair and maintenance rate was 83 percent per 100 hours of use. Table 6 – 8 provides detailed items for the costs.

Table 6. Machinery Cost for Small-Size Tractors

Step 1: List basic data	
Small-Size Tractor RB 2WD 50 hp	
List price	$26,471
Purchase cost	$22,500
Salvage value (20% of new list price, calculated by this research)	$5,294
Average value	$13,897
Ownership life (years)	14
Estimated annual use (hours)	1000
Interest rate	6.5%
Fuel cost ($/gallon)	$3.65
Labor cost ($/hour)	$11.25
Step 2: Calculate ownership costs	
Depreciation	$1,229
Interest	$903
Taxes, insurance and housing	$347
Total annual ownership costs	$2,480
Ownership costs per hour	$2.48
Step 3: Calculate operating costs	
Repairs	$2,197
Diesel fuel	$12,848
Lubrication and filters (15% of fuel costs)	$1,927
Labor	$13,500
Total annual operating costs	$30,472
Operating cost per hour	$30.47
Step 4: Calculate total cost per hour	
Ownership cost per hour	$2.48
Operating cost per hour	$30.47
Total cost per hour	$32.95

Table 7. Machinery Cost for Mid-size Tractors

Step 1: List basic data	
Mid-Size Tractor RB 2WD 80 hp	
List price	$37,765
Purchase cost	$32,100
Salvage value (30% of new list price, calculated by this research)	$11,329
Average value	$21,715
Ownership life (years)	14
Estimated annual use (hours)	800
Interest rate	6.5%
Fuel cost ($/gallon)	$3.65
Labor cost ($/hour)	$11.25
Step 2: Calculate ownership costs	
Depreciation	$1,484
Interest	$1,411
Taxes, insurance and housing	$543
Total annual ownership costs	$3,438
Ownership costs per hour	$4.30
Step 3: Calculate operating costs	
Repairs	$2,508
Diesel fuel	$10,278
Lubrication and filters (15% of fuel costs)	$1,542
Labor	$10,800
Total annual operating costs	$25,128
Operating cost per hour	$31.41
Step 4: Calculate total cost per hour	
Ownership cost per hour	$4.30
Operating cost per hour	$31.41
Total cost per hour	$35.71

Table 8. Machinery Cost for Large-size Tractors

Step 1: List basic data	
Large-Size Tractor RB 2WD 150 hp	
List price	$132,941
Purchase cost	$113,000
Salvage value (32% of new list price, calculated by this research)	$42,541.18
Average value	$77,771
Ownership life (years)	10
Estimated annual use (hours)	350
Interest rate	6.5%
Fuel cost ($/gallon)	$3.65
Labor cost ($/hour)	$11.25
Step 2: Calculate ownership costs	
Depreciation	$7,046
Interest	$5,055
Taxes, insurance and housing	$1,944
Total annual ownership costs	$14,045
Ownership costs per hour	$40.13
Step 3: Calculate operating costs	
Repairs	$3,862
Diesel fuel	$4,497
Lubrication and filters (15% of fuel costs)	$675
Labor	$4,725
Total annual operating costs	$13,758
Operating cost per hour	$39.31
Step 4: Calculate total cost per hour	
Ownership cost per hour	$40.13
Operating cost per hour	$39.31
Total cost per hour	$79.44

The total cost for small-size, mid-size and large-size tractors are $32.95, $35.71, and $79.44 per hour, respectively. Generally, larger machines require more investment, but they normally have better efficiency. This advantage is important especially when bad weather shortens the available working times.

Harvester

Sod is ready for harvest when it has sufficiently matured and can provide enough strength to remain intact with adhering soil for handling and transport (Adrian, Yates, and Dickens 1981). A thinner soil layer is better for handling and rapid establishment, but it will be

difficult to retain enough moisture to keep the sod fresh until installation. So 1/2 - to 5/8- inch of soil attached is normally recommended. The tractor-mounted harvester typically requires three people, including one driver. The cut sod is placed on a pallet that holds the load together during handling and transit.

Large sod farms commonly use tractor-mounted and/or self-propelled harvesters. Slabs and rolls are typical harvesting methods. A Kesmac 2150 Slab Sod Harvester was included in this study. Following Falconer and Niemeyer's study (2006), the annual hours of use is about 1,800 hours. According to ASABE standards, for a harvester with 20 years of economic life and 1800 hours of annual use, the salvage value is 15 percent of new list price. The ownership cost per hour is about $1.46 and the operating cost per hour is around $64.57. The total cost per hour for the harvester in this study was $66.03 per hour. Detailed information is reported in the following table (Table 9).

Table 9. Machinery Cost for Harvesters

Step 1: List basic data	
Harvester (56hp)	
List price	$52,800
Purchase cost	$44,880
Salvage value (15% of new list price, calculated by this research)	$7,920
Average value	$26,400
Ownership life (years)	20
Estimated annual use (hours)	1800
Interest rate	6.5%
Fuel cost ($/gallon)	$3.65
Labor cost ($/hour)	$11.25
Step 2: Calculate ownership costs	
Depreciation	$449
Interest	$1,716
Taxes, insurance and housing	$462
Total annual ownership costs	$2,627
Ownership costs per hour	$1.46
Step 3: Calculate operating costs	
Repairs	$24,710
Diesel fuel	16188.48
Lubrication and filters (15% of fuel costs)	$2,428
Labor (3 people)	$72,900
Total annual operating costs	$116,227
Operating cost per hour	$64.57
Step 4: Calculate total cost per hour	
Ownership cost per hour	$1.46
Operating cost per hour	$64.57
Total cost per hour	$66.03

Aerator

A sod aerator is used to reduce soil compaction between crops. In this study, an 8-foot aerator was included in the budgets. The combined cost for the aerator and a 50-hp tractor is around $42.25 per hour. Its field efficiency and operating speed is 83.5 percent and 6 mph, respectively. Based on equation (8), the calculated field capacity is 4.81 acres per hour. Therefore, the combined costs for an aerator is about $7.65 per acre. Detailed machinery costs for aerators are listed in Table 10.

Table 10. The Combined Cost for Aerators

	50 hp Tractor		8 ft Aerator
Annual ownership costs	$2,480		$727
Annual hours of use	1000		200
Ownership cost per hour	$2.48		$3.63
Operating costs per hour			
Fuel and lubrication	$15		
Repairs	$2.20		$2.91
Labor	$10.80		
Total cost per hour	$30.25		$6.54
Combined cost per hour		$36.79	
Field capacity, acres per hour		4.81	
Combined cost per acre		$7.65	

Disk

Disking is a common farm operation. A rotary tiller may follows the disking to break up the clods for heavy soils, such as clays and clay loams (Cockerham 1988). A 14-foot disk was included in the machinery list in this study. For a 20-year useful life with 150 hours of annual use, the salvage value was 34 percent of the new list price based on calculation in this study. The field efficiency of the disk was 85 percent and the average operating speed was 4.75 mph, according to the 2012 Mississippi State budget generator. So the calculated field efficiency was 6.85 acres per hour for a 14-foot disk. Combined with an 80 hp tractor, the total cost of a 14-foot disk was estimated as $7.16 per acre.

Table 11. Combined Cost for Disks

	80 hp Tractor		14 ft Disk
Annual ownership costs	$3,438		$1,238
Annual hours of use	800		150
Ownership cost per hour	$4.30		$8.26
Operating costs per hour			
Fuel and lubrication	$15		
Repairs	$3.13		$5.08
Labor	$13.50		
Total cost per hour	$35.71		$13.34
Combined cost per hour		$49.05	
Field capacity, acres per hour		6.85	
Combined cost per acre		$7.16	

Landplane

A landplane is designed to smooth the soil. Land preparation is important to sod growers. Many sod farms use a landplane to smooth soil and apply a roller to roll it in preplanting soil preparation. Preplant fertilizer is applied after smoothing. Longer units could provide better precise smoothing and commonly range between 30 to 80 feet. In this study, a 16-foot landplane is included in the budgets depending on the situation that I can only get reliable data for this size. Sod growers may use a smaller one in operation. The purchase price for a 16-foot landplane was derived from the 2012 Mississippi budget generator.

The average purchase price for the 16-foot landplane was estimated as $10,900 in the 2012 Mississippi budget generator. Field efficiency and operating speed were 85 percent and 4.0 mph based data also from the Mississippi budget generator. Field Capacity would be around 6.59 acres per hour as average condition. If a 50 hp tractor is applied to draw the landplane, the combined cost would be $13.98 per acre for a 500-acre sod farm. Table 12 presents the sheet for the combined costs.

Table 12. Combined Cost for Landplanes

	50 hp Tractor		16 ft Landplane
Annual ownership costs	$2,480		$960
Annual hours of use	1000		20
Ownership cost per hour	$2.48		$48.02
Operating costs per hour			
Fuel and lubrication	$15		
R & M	$2.20		$11.22
Labor	$13.50		
Total cost per hour	$32.95		$59.24
Combined cost per hour		$92.20	
Field capacity, acres per hour		6.59	
Combined cost per acre		$13.98	

Mower

Mowing is perhaps the second most important turfgrass cultural practice after irrigation (Koske 1994). Besides controlling turfgrass length and growth, mowing could also control weeds since most weeds are intolerant to close mowing.

Reel, rotary and reel mowers are principal turfgrass mower types. The selection of mower type affects turf quality. The reel mower is most often used to mow high-quality grass at 25 millimeter or less and the rotary mower is primarily used for cutting low- to medium-quality turf. Rollers on a mower could produce smooth and uniform sod quality. The flail mower is basically used when the quality of the turf is less essential (Carrow, Johnson, and Burns 1987). Mowing frequency depends on turfgrass species, economics, seasons and so on. Before harvesting, mowing frequency may be increased to produce better sod quality.

In the budget sheets, a 15-foot Kesmac 7 Gang Reel Mower and a 25-foot Kesmac 11 Gang Reel Mower are discussed as examples. According to Falconer and Niemeyer (2006), the ownership life and annual hours of use are 7 years and 800 hours for both large and small

mowers for a 500-acre sod farm. Based on this information, the salvage values are calculated as 21 percent of their list prices, following ASABE standards. The total fixed costs for the smaller mower and the larger mower are $3,311 and $4,392, respectively. The field capacity is 6.55 and 10.91 acres per hour, respectively. The repair and maintenance cost is about $21.44 and $51.80 per hour, respectively. Combined with a 50 hp tractor, respectively, the total cost was estimated as $8.95 and $8.27 per acre. Table 13 – 14 present detailed data for the two sizes of mowers.

Table 13. Combined Cost for Small Mowers

	50 hp Tractor		15' Mower
Annual ownership costs	$2,480		$3,279
Annual hours of use	1000		800
Ownership cost per hour	$2.48		$4.10
Operating costs per hour			
Fuel and lubrication	$15		
R & M	$2.20		$21.44
Labor	$13.50		
Total cost per hour	$32.95		$25.54
Combined cost per hour		$58.49	
Field capacity, acres per hour		6.55	
Combined cost per acre		$8.94	

Table 14. Combined Cost for Large Mowers

	50 hp Tractor		25' Mower
Annual ownership costs	$2,480		$4,349
Annual hours of use	1000		800
Ownership cost per hour	$2.48		$5.44
Operating costs per hour			
Fuel and lubrication	$15		
R & M	$2.20		$51.80
Labor	$13.50		
Total cost per hour	$32.95		$57.23
Combined cost per hour		$90.19	
Field capacity, acres per hour		10.91	
Combined cost per acre		$8.27	

Irrigation

Irrigation systems are not necessary for row crop operations in Alabama, while it is necessary for turfgrass to achieve consistent commercial quality. The most common cause of sprigger planting failure is improper watering (Cockerham 1988). In our online surveys, some sod farmers reported they need more water, but some said they can get enough water for irrigation and the precipitation in the beginning of 2012 was good.

Commonly used irrigation systems includes traveling cable-tow system, center-pivot, underground pipe with guns or sprinklers, above-ground aluminum pipe with guns or sprinklers, automatic sprinkler with underground pipe. Irrigation selection is usually situation dependent. In this study, I applied the center-pivot irrigation system due to data availability. A center-pivot irrigation system could decrease labor cost, while a movable system may have more economic benefits than a permanent system if the land is leased, although it may be involved with more worker interaction (Cain et al. 2003a). Irrigation equipment costs were based on a per-acre average cost of purchasing and maintaining the irrigation equipment. The major components of the center pivot irrigation system are the well and pump, diesel engine, and pivots. The application pattern varies through the whole year. Data for purchase price, repair and maintenance costs for center-pivot irrigation system were derived from the Mississippi Budget Generator and are presented in Table 15.

Table 15. Purchase Price and Repair and Maintenance Costs of A Center-Pivot Irrigation Sytem

Item Name	Unite of Measure	Purchas Price	Useful Life	R&M
		dollars	years	$/yr
Engine, 1/4 CP, 65	ac-in	$11,200	20	$8,400
Pivot, 1/4 CP	1320'	$81,000	20	32400
Well & Pump, 1/4 CP	each	$16,250	25	9750

Source: The Mississippi State Budget Generator (2012).

The standard well depth is 120-foot or less, and the depth for a deep well is between 120 and 240 feet (Hogan and Service 2007). According to the Mississippi Budget Generator, the purchase price for a well and pump (1/4 cp) is $16,250. Lifetime repair and maintenance is 60 percent of purchase price with 25 years economic life. For a 1/4 cp engine, the purchase price is $11,200. Lifetime repair and maintenance is 75 percent of purchase price, and useful life is assumed as 20 years. As to a ¼ cp pivot, the purchase price is around $81,000. Lifetime repair and maintenance is 40 percent of purchase price, with 20 years of useful life.

In this study, according to Max Runge (personal communication, May, 2012), the ownership costs for irrigation ranged from $100 to $120 per acre, and the operation costs are $10 to $12 per acre. Average values are used in this study which are $110 and $11 per acre for fixed costs and variable costs, respectively.

Fertilization

Nitrogen is the most important nutrient for turfgrass. A variety of quickly available nitrogen fertilizers, such as ammonium sulfate (21 percent N) and urea (45 percent), are available for sod farmers. These forms are less expensive and response is quick but the effect only lasts for several days (Koske 1994). Slow-release nitrogen fertilizers could last for two months and their release rate depends on temperature, moisture, etc., but these are more expensive.

Micronutrients are also needed if soil tests recommend them, but they are not included in this budget.

Bermuda and zoysiagrass respond well to ample fertilization. The amount and frequency of fertilizers are also affected by economics. If sod orders are strong, more fertilizers will be applied to stimulate turfgrass growth. In this study, the price for 13-13-13 and 21-0-0 is $512 and $480 per ton, respectively based on information derived from Alabama Cooperative Extension System.

Pest, Weed, Insect and Disease Control

Weeds can be introduced to a sod field in various ways. Mowing is an effective control for some broadleaf weeds, such as pigweed and morning glory, since those weeds are intolerant to close mowing. Sod growers also can apply chemicals like herbicides and insecticides to prevent these problems. In this study, some herbicides and insecticides are included in sod budgets, following Falconer and Niemeyer's study (2006). Detailed information is listed in budgets.

Other Costs

Pallets

A per pallet price of $4.90 was used in this study based on information from local sod farmers.

Land

Land is an essential component for sod production. The access to land can happen through ownership, lease, or other arrangement. Land cost varies widely depending on various factors, such as location and soil quality and types. According to Zhou et al. (2010), Alabama’s average of rental rates paid for bare cropland with irrigation and without

irrigation were $75 and $41 per acre, respectively. And the average values of Alabama bare cropland were $2, 326 per acre in nominal value and $1,867 per acre in real value. In this study, the land cost per acre was assumed as $75 per acre (Zhou et al. 2010).

Office and Administrative

An office is needed to deal with various administrative and sales activities. These tasks may include taking calls, making records and scheduling daily work. In this study, the manager and an assistant are assumed to handle these works. The manager's salary is calculated based on information provided by local sod producers. The assistant's salary is calculated depending on the average income in Alabama.

Budget

For established sod, the dominant operation activities include maintenance activities, irrigation and harvest. According to Cain et al. (2003), the fixed costs are the same for one harvest and two harvests. The variable costs for two harvests are calculated as the double of one harvest, except the cost for pallets, assuming they can be recycled. Transportation costs are excluded from the budgets. Detailed cost information is listed in Table 16 and Table 17.

Table 16. Estimated Costs per Acre of Bermudagrass Production, Alabama, 2012 (One Harvest)

Item	Unit	Quantity	Price dollars	Amount dollars
1. Direct Expenses				
Fertilizer				
13-13-13	ton	0.2500	512.00	128.00
21-0-0	ton	0.8000	480.00	384.00
Herbicides	acre	1.0000	145.74	145.74
Insecticides	acre	1.0000	33.48	33.48
Pallets	each	85.0000	4.90	416.50
Other				
Pickup-Foreman	acre	1.0000	24.25	24.25
Pickups-General	acre	1.0000	29.10	29.10
Operator Labor				
Tractors	hour	10.1119	11.25	113.76
Self Propelled	hour	68.4977	11.25	770.60
Bermuda Maintenance	hour	3.7500	11.25	42.19
Fuel				
Tractors	gal	17.4064	3.65	63.53
Self Propelled	gal	16.9198	3.65	61.76
Repair & Maintenance				
Implements	acre	1.0000	9.30	9.30
Tractors	acre	1.0000	17.13	17.13
Self Propelled	acre	1.0000	30.53	30.53
Bermuda Maintenance	acre	1.0000	28.63	28.63
Irrigation	acre	1.0000	11.00	11.00
Interest on Variable Capital	dollars	0.0650	1154.58	75.06
Total Direct Expensed				2384.56
2. Fixed Expenses				
Manager	acre	1.0000	163.00	163.00
Assistant	acre	1.0000	45.97	45.97
Implements	acre	1.0000	35.39	35.39
Tractors	acre	1.0000	39.93	39.93
Self Propelled	acre	1.0000	30.24	30.24
Irrigation	acre	1.0000	112.50	112.50
Amortized Est. Cost	acre	1.0000	449.70	449.70
Bermuda Maintenance	acre	1.0000	175.02	175.02
Barn	each	0.0025	9442.16	23.61
Road & Loading Pads	each	0.0025	1888.43	4.72
Land Rent	acre	1.0000	75.00	75.00

Table 16 Continued.

Item	Unit	Quantity	Price dollars	Amount dollars
Utilities	acre	1.0000	35.00	35.00
Insurance	acre	1.0000	7.47	7.47
Miscellaneous	acre	1.0000	100.00	100.00
Interests on Fixed Capital	acre	1.0000	84.34	84.34
Total Fixed Expenses				1381.88
3. TOTAL COST OF ALL SPECIFIED EXPENSES				3766.44

Table 17. Estimated Costs per Acre of Bermudagrass Production, Alabama, 2012 (Two Harvests)

Item	Unit	Quantity	Price dollars	Amount dollars
1. Direct Expenses				
Fertilizer				
13-13-13	ton	0.5000	512.00	256.00
21-0-0	ton	1.6000	480.00	768.00
Herbicides	acre	1.0000	291.47	291.47
Insecticides	acre	1.0000	66.96	66.96
Pallets	each	85.0000	4.90	416.50
Other				
Pickup-Foreman	acre	2.0000	24.25	48.50
Pickups-General	acre	2.0000	29.10	58.20
Operator Labor				
Tractors	hour	20.2238	11.25	227.52
Self Propelled	hour	136.9954	11.25	1541.20
Bermuda Maintenance	hour	7.5000	11.25	84.38
Fuel				
Tractors	gal	20.2238	3.65	73.82
Self Propelled	gal	33.8395	3.65	123.51
Repair & Maintenance				
Implements	acre	2.0000	9.30	18.60
Tractors	acre	2.0000	17.13	34.27
Self Propelled	acre	2.0000	30.53	61.06
Bermuda Maintenance	acre	2.0000	28.63	57.26
Irrigation	acre	2.0000	11.00	22.00
Interest on Variable Capital	acre	0.0650	2074.27	134.83
Total Direct Expensed				4284.09
2. Fixed Expenses				
Manager	acre	1.0000	163.00	163.00
Assistant	acre	1.0000	45.97	45.97
Implements	acre	1.0000	35.39	35.39
Tractors	acre	1.0000	39.93	39.93
Self Propelled	acre	1.0000	30.24	30.24
Irrigation	acre	1.0000	112.50	112.50
Amortized Est. Cost	acre	1.0000	449.70	449.70
Bermuda Maintenance	acre	1.0000	175.02	175.02
Barn	each	0.0025	9442.16	23.61
Road & Loading Pads	each	0.0025	1888.43	4.72
Land Rent	acre	1.0000	75.00	75.00

Table 17 Continued.

Item	Unit	Quantity	Price dollars	Amount dollars
Insurance	acre	1.0000	8.05	8.05
Utilities	acre	1.0000	35.00	35.00
Miscellaneous	acre	1.0000	100.00	100.00
Interests on Fixed Capital	acre	1.0000	84.38	84.38
Total Fixed Expenses				1382.49
3. TOTAL COST OF ALL SPECIFIED EXPENSES				5666.58

ROW CROPS BUDGETS

Row crop budgets are presented in this chapter. Corn, cotton, peanuts and soybeans were considered as key row crops in this research. Crop yields and prices were estimated based on historic data in order to accomplish the budgets for 2012.

Estimated Crop Yields

Differences in soil fertility, climate and farm operation cause farms to have different crop yields. The yields are unknown until the harvest is complete. The U.S. Department of Agriculture (USDA) is the main public source of crop yield forecasts. The other main source of data is the National Agricultural Statistics Service (NASS) of the USDA. The later one uses a complex and comprehensive methodology to forecast U.S. average yields. Since there is no available crop yield forecast applicable for the current research, I predicted the output prices and crop yields based on historic data.

Historic data from 1998 to 2011 were used to predict 2012 yields of corn, cotton and soybean for non-irrigated farm. Since earlier yields were affected by drought and may not be accurate predictors of future yields, only 2002 to 2011 ten-year yield data were used to predict peanut in this study. Historic crop yield data were collected from NASS and are listed in Table 18 and 19. Figure 14 – 17 illstrate the changes of yields in recent years.

Table 18. Historic Yields of Corn, Cotton and Peanut in Alabama (1998-2011)

YEAR	Corn	Cotton	Soybeans
1998	63	559	22
1999	103	535	16
2000	65	492	18
2001	107	730	35
2002	88	507	24
2003	122	772	36
2004	123	724	35
2005	119	747	33
2006	72	579	20
2007	78	519	21
2008	104	787	35
2009	108	668	40
2010	116	682	26
2011	114	762	33

Source: National Agricultural Statistics Service (NASS). Retrieved from: http://quickstats.nass.usda.gov/

Table 19. Historic Yields of Soybeans and Peanut in Alabama (2002-2011)

YEAR	Peanut
	lbs/acre
2002	2,110
2003	2,750
2004	2,800
2005	2,750
2006	2,500
2007	2,550
2008	3,500
2009	3,300
2010	2,600
2011	3,000
Mean	2,786
Expected Yield	**3,178**

Source: National Agricultural Statistics Service (NASS). Retrieved from: http://quickstats.nass.usda.gov/

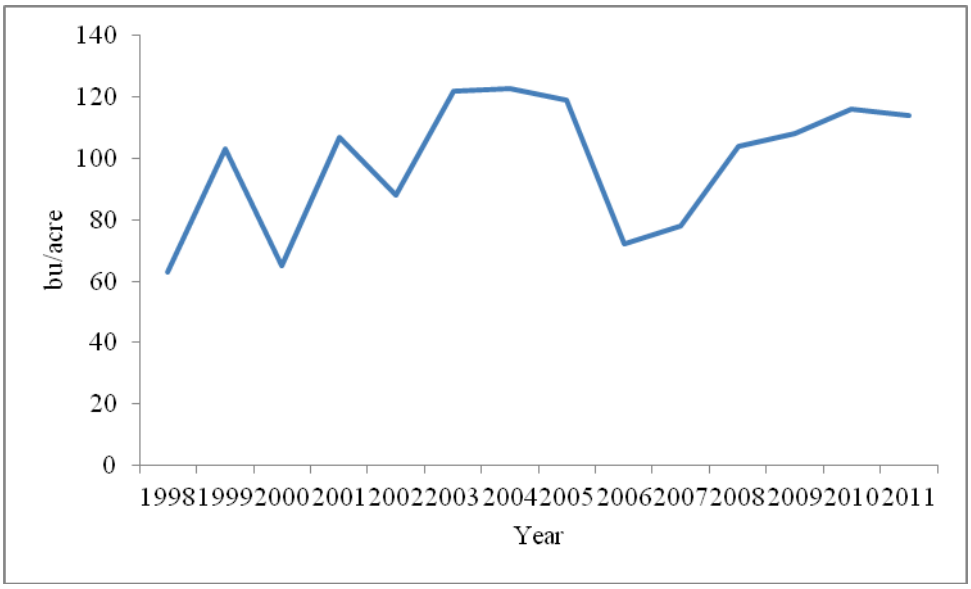

Figure 14. Historic corn yields in Alabama (1998-2011).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

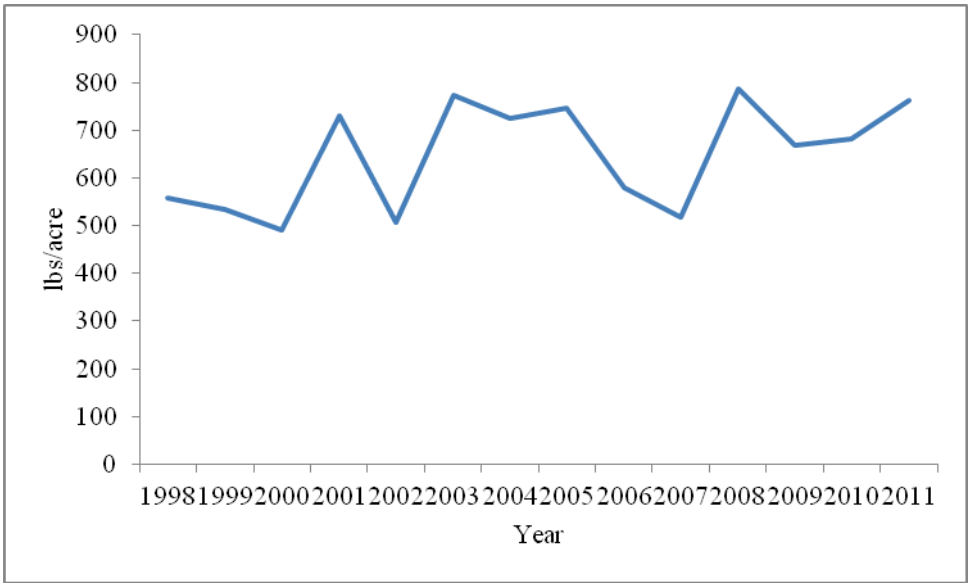

Figure 15. Historic cotton yields in Alabama (1998-2011).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

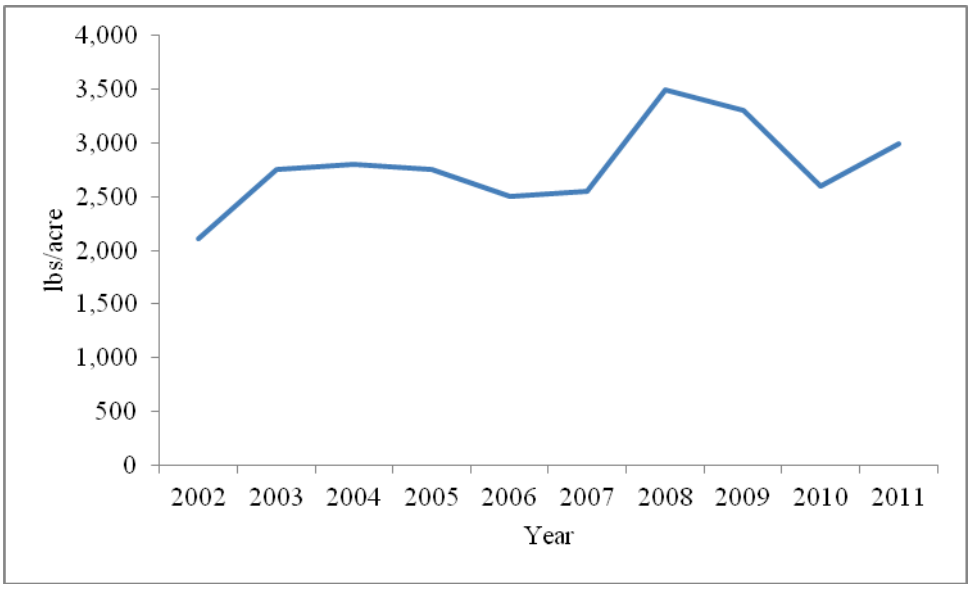

Figure 16. Historic peanut yields in Alabama (2002-2011).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

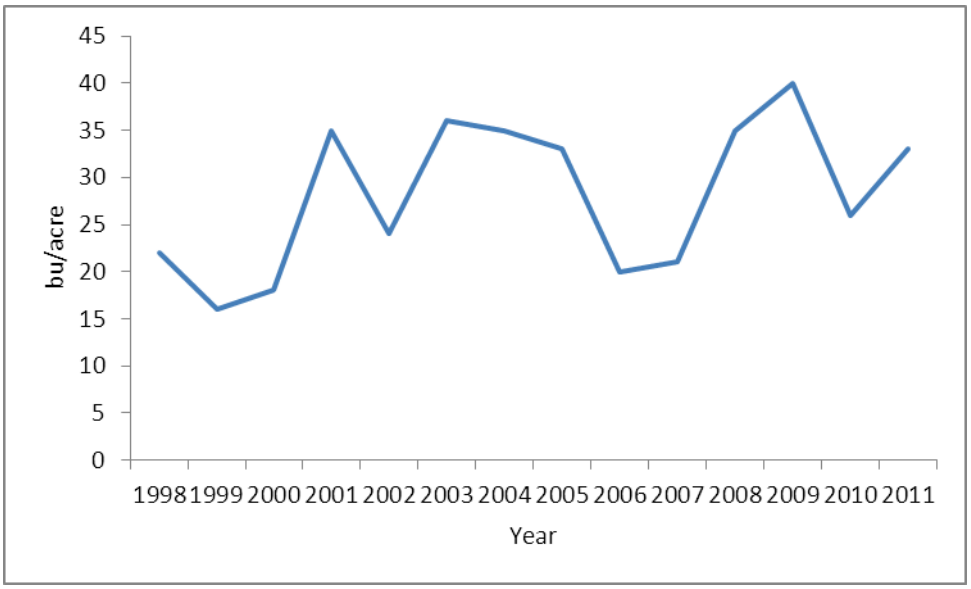

Figure 17. Historic soybeans yields in Alabama (2002-2011).
Source: National Agricultural Statistics Service (NASS). Retrieved from http://quickstats.nass.usda.gov/

Ordinary least squares (OLS) regression was used in trend estimation within crop yields since Swinton and King (1991) conclude OLS generates more accurate coefficient

estimates for a small sample without outliers. Regression results are reported in Table 20. The P values are 0.14, 0.08, 0.11 and 0.11 for corn, cotton, peanuts and soybeans, respectively. There is a significant trend in cotton. It is also found that the yields of peanut and soybean have trends, if a p-value of 0.15 is used as a cut-off. Although this is an unusually high value, because of the small sample size, a trend is assumed in estimating this budget. A simple mean yield was used as the estimated yield for corn, while a projected yield from the regression model was used for yields of cotton, peanut and soybean. The estimated yield for 2012 Alabama corn is 99 bu/acre. The projected cotton, peanuts, and soybeans yield for non-irrigated farms is 742 lbs/acre, 3178 lbs/acre, and 35 bu/acre, respectively. For irrigated row crop yields, yields reported in Georgia Agricultural and Applied Economic Extension System are used in this study. It is 200 bu/acre, 1200 lbs/acre, 1620 lbs/acre, 4200 lbs/acre, and 60 bu/acre for irrigated corn, cotton, cottonseed, soybean, and peanut, respectively.

Table 20. OLS Regression Results of Crop Yields

VARIABLES	Corn	Cotton	Peanuts	Soybeans
Year	2.127	12.62**	71.27*	0.848*
	(1.342)	(6.674)	(39.55)	(0.489)
Constant	-4,166	-24,653**	-140,223*	-1,672*
	(2,690)	(13,379)	(79,364)	(981.1)
Observations	14	14	10	14
R-squared	0.173	0.230	0.289	0.200
P Values	0.14	0.08	0.109	0.109

Note: for corn, cotton and soybeans, historic yield data from 1998 to 2011 were applied in the regression; while only historic yield data from 2002 to 2011 were used to predict peanuts yield in 2012.
Note: standard errors in parentheses;
** p<0.1, * p<0.15.

Estimated Crop Price

I collected farm products producer price index (PPI) data from 1998 to 2011 from the Bureau of Labor Statistics and crop price data from NASS to normalize crop prices. The PPI and

crop price are shown in Table 21 and 22. Next, the PPI was used to normalize crop prices. The normalized crop prices are presented in Table 23 and 24 with the base that the PPI for 2011 farm product is 1.

Table 21. Historical PPI, Cotton, Cottonseed and Soybean Prices (1998-2011)

Year	PPI	Crop Price			
		Corn	Cotton	Cottonseed	Soybeans
		$/bu	$/lb	$/ton	$/bu
1998	104.6	1.94	0.62	111	4.93
1999	98.4	1.82	0.47	79	4.63
2000	99.5	1.85	0.52	92	4.54
2001	103.8	1.97	0.32	76	4.38
2002	99	2.32	0.46	85.5	5.53
2003	111.5	2.42	0.63	98.5	7.34
2004	123.3	2.06	0.45	91	5.74
2005	118.5	2	0.5	81.5	5.66
2006	117	3.04	0.48	90.5	6.43
2007	143.4	4.2	0.61	135	10.1
2008	161.3	4.06	0.49	196	9.97
2009	134.6	3.55	0.65	129	9.59
2010	151	5.18	0.85	132	11.3
2011	186.7	6.2	0.97	204	11.7
Mean		3.04	0.57	114.36	7.27

Table 22. Historical PPI, Peanut Prices (2002-2011)

Year	PPI	Peanut
		$/lb
2002	99	0.16
2003	111.5	0.18
2004	123.3	0.18
2005	118.5	0.17
2006	117	0.17
2007	143.4	0.19
2008	161.3	0.23
2009	134.6	0.21
2010	151	0.2
2011	186.7	0.26
Mean		0.34

Table 23. Normalized Corn, Cotton, Cottonseed and Soybean Prices (1998-2011)

Year	Corn	Cotton	Cottonseed	Soybean
	$/bu	$/lb	$/lb	$/bu
1998	3.46	1.1	0.1	8.80
1999	3.45	0.89	0.07	8.78
2000	3.47	0.97	0.09	8.52
2001	3.54	0.58	0.07	7.88
2002	4.38	0.86	0.08	10.43
2003	4.05	1.05	0.08	12.29
2004	3.12	0.68	0.07	8.69
2005	3.15	0.78	0.06	8.92
2006	4.85	0.77	0.07	10.26
2007	5.47	0.8	0.09	13.15
2008	4.7	0.57	0.11	11.54
2009	4.92	0.9	0.09	13.30
2010	6.4	1.05	0.08	13.97
2011	6.2	0.97	0.1	11.70
Mean	4.37	0.85	0.08	10.59
Expected Price	**5.97**	**0.85**	**0.08**	**13.41**

Table 24. Normalized Peanut Prices (2002-2011)

Year	Peanuts
	$/lb
2002	0.31
2003	0.31
2004	0.27
2005	0.26
2006	0.27
2007	0.25
2008	0.26
2009	0.29
2010	0.25
2011	0.26
Mean	0.27
Expected Price	**0.25**

OLS regression results are reported in Table 25. Historic data from 1998 to 2011 were used in the regression for corn, cotton, cottonseed and soybean. But only data from 2002 to

2011 were used for price estimation of peanut. There is a significant trend in corn, peanuts and soybeans price but not for cotton and cottonseed. Estimated crop price is also reported in Table 23 and 24, using the mean value for cotton and cottonseed and a price estimated from the regression models for corn, soybeans and peanuts. Therefore, the estimated price for corn, cotton, cottonseeds, peanuts, and soybeans are $5.97 per bushel, $0.85 per pound, $0.08 per pound and $13.41 per bushel.

Table 25. Regression Results of Crop Prices

VARIABLES	Corn	Cotton	Cottonseed	Peanuts	Soybeans
Year	0.213***	-0.00367	0.000879	-0.00479**	0.376***
	(0.0440)	(0.0116)	(0.000959)	(0.00203)	(0.0914)
Constant	-423.5***	8.212	-1.679	9.880**	-743.5***
	(88.18)	(23.21)	(1.922)	(4.072)	(183.2)
Observations	14	14	14	10	14
R-squared	0.662	0.008	0.065	0.410	0.586
P Values	0.0004	0.767	0.377	0.046	0.001

Note: for corn, cotton and soybeans, historic price data from 1998 to 2011 were applied in the regression; while only historic yield data from 2002 to 2011 were used to predict peanuts yield in 2012.
Note: standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Estimated Returns

Per acre returns over variable costs and returns over total costs are estimated for the four crops (Table 26 – 29). Because this study was conducted earlier than the release of Alabama Cooperative Extension System 2012 enterprise budgets, the 2011 Alabama budgets were used as the base of variable and fixed costs of producing corn, cotton, peanuts and soybeans. 2012 Alabama farm diesel price is ranked from $3.50 to $3.80 per gallon (Runge, 2012). The mean value ($3.65/gal) was used in this research.

Table 26. Enterprise Budget for Non-Irrigated Corn, Alabama, 2012 (Reduced Tillage)

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Corn	bu.	99.00	5.97	591.03
2. VARIABLE COSTS				
Seed	1000k	28.00	2.85	79.80
Seed Treatment	acre	0.00	10.50	0.00
Tech Fee	acre	1.00	0.00	0.00
Fertilizer				
Nitrogen	units	160.00	0.68	108.80
Phosphate	units	60.00	0.50	30.00
Potash	units	60.00	0.58	34.80
Micronutrients	acre	1.00	8.00	8.00
Lime (Prorated)	tons	0.33	35.00	11.55
Herbicides	acre	1.00	30.00	30.00
Insecticides	acre	1.00	7.00	7.00
Fungicides	acre	1.00	0.00	0.00
Nematicide	acre	1.00	0.00	0.00
Consultant/Scouting Fee	acre	0.00	5.00	0.00
Irrigation	ac/in	0.00	12.00	0.00
Drying	bu.	99.00	0.28	27.72
Hauling	bu.	99.00	0.25	24.75
Crop Insurance	acre	1.00	26.00	26.00
Aerial Application	acre	0.00	9.00	0.00
Labor (Wages & Fringe)	hour	1.60	11.25	18.00
Tractor/Machinery	acre	1.00	19.00	19.00
Interest on Operating Capital	dol.	212.71	0.065	13.83
TOTAL VARIABLE COST				439.25
RETURNS ABOVE VARIABLE COST				151.78
3. FIXED COSTS				
Tractor/Machinery	acre	1.00	26.00	26.00
Irrigation	acre	0.00	125.00	0.00
Land Ownership Cost	acre	1.00	75.00	75.00
General Overhead	dol.	439.25	0.08	35.14
TOTAL FIXED COSTS				136.14
4. TOTAL COST OF ALL SPECIFIED EXPENSES				575.39
RETURNS ABOVE ALL SPECIFIED EXPENSES				15.64

Table 27. Enterprise Budget for Non-Irrigated Cotton, Alabama, 2012 (Reduced Tillage)

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Cotton Lint	lbs	742.00	0.85	630.70
Cottonseed	lbs	1001.7	0.08	80.14
Total Revenue				710.84
2. VARIABLE COSTS				
Seed	bag	0.13	567.00	73.71
Seed Treatment	bag	0.00	17.00	0.00
Tech Fee (RF/BG2)	bag	0.00	0.00	0.00
Fertilizer				
Nitrogen	units	90.00	0.68	61.20
Phosphate	units	60.00	0.50	30.00
Potash	units	60.00	0.58	34.80
Micronutrients				
Lime (Prorated)	tons	0.33	35.00	11.55
Herbicides				
Burndown/Planting	acre	1.00	24.32	24.32
Post	acre	1.00	25.63	25.63
Lay-By	acre	1.00	8.19	8.19
Insecticides				
Planting	acre	1.00	0.00	0.00
Early Season	acre	1.00	2.50	2.50
Mid Season	acre	1.00	2.50	2.50
Late Season	acre	1.00	12.50	12.50
Systemic Fungicides	acre	0.00	2.00	0.00
Growth Regulator	oz.	13.33	0.75	10.00
Defol/Harvest Aid	acre	1.00	13.00	13.00
Consultant/Scouting Fee	acre	0.00	6.00	0.00
Irrigation	ac/in	0.00	12.00	0.00
Crop Insurance	acre	1.00	28.00	28.00
Aerial Application	acre	0.00	9.00	0.00
Boll Weevil Eradication	acre	1.00	0.65	0.65
Cover Crop Establishment.	acre	1.00	25.00	25.00
Labor (Wages & Fringe)	hour	2.45	11.25	27.56
Tractor/Machinery	acre	1.00	19.00	19.00
Ginning	lbs	742.00	0.08	59.36

Table 27 Continued.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
Warehousing	bale	1.55	10.50	16.23
Classing/Promotion Fee	bale	1.55	6.82	10.54
Cottonseed Credit	tons	0.51	120.00	-61.20
Interest on Operating Capital	dol.	205.06	0.065	13.33
TOTAL VARIABLE COST				448.37
RETURNS ABOVE VARIABLE COST				262.46
3. FIXED COSTS				
Tractor/Machinery	ACRE	1.00	98.43	98.43
Irrigation	ACRE	0.00	125.00	0.00
Land Ownership Cost	ACRE	1.00	75.00	75.00
General Overhead	DOL.	448.37	0.08	35.87
TOTAL FIXED COSTS				209.30
4. TOTAL COST OF ALL SPECIFIED EXPENSES				657.67
RETURNS ABOVE ALL SPECIFIED EXPENSES				53.16

Table 28. Enterprise Budget for Non-Irrigated Peanut, Alabama, 2012 (Reduced Tillage)

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Peanut	lbs	3178	0.25	794.50
2. VARIABLE COSTS				
Seed	lbs	100.00	1.40	140.00
Innoculant	acre	1.00	0.00	0.00
Fertilizer				
Phosphate	units	40.00	0.50	20.00
Potash	units	40.00	0.58	23.20
Boron /Micronutrients	acre	1.00	10.00	10.00
Lime (Prorated)	tons	0.50	35.00	17.50
Herbicides	acre	1.00	55.55	35.00
Insecticides	acre	1.00	45.40	40.00
Fungicides	acre	7.00	7.50	52.50
Nematicide	acre	1.00	0.00	0.00
Consultant/Scouting Fee	acre	0.00	6.00	0.00
Irrigation	ac/in	0.00	12.00	0.00
Drying	tons	1.59	30.00	47.67
Cleaning	tons	1.59	12.00	19.07
Hauling	tons	1.59	17.50	27.81
Crop Insurance	acre	1.00	20.00	20.00
Check Off	tons	1.59	2.50	3.97
Labor (Wages & Fringe)	hour	2.75	11.25	30.94
Tractor/Machinery	acre	1.00	50.00	50.00
Interest on Operating Capital	dol.	268.83	0.065	20.43
TOTAL VARIABLE COST				558.09
RETURNS ABOVE VARIABLE COST				236.41
3. FIXED COSTS				
Tractor/Machinery	acre	1.00	60.00	60.00
Irrigation	acre	0.00	125.00	0.00
Land Ownership Cost	acre	1.00	75.00	75.00
General Overhead	dol.	558.09	0.08	44.65
TOTAL FIXED COSTS				179.65
4. TOTAL COST OF ALL SPECIFIED EXPENSES				737.73
RETURNS ABOVE ALL SPECIFIED EXPENSES				56.77

Table 29. Enterprise Budget for Non-Irrigated Soybean, Alabama, 2012

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Soybean	bu.	35	13.41	469.35
2. VARIABLE COSTS				
Seed & Inoculant	bag	1.25	50.00	62.50
Fertilizer				
Phosphate	uints	60.00	0.50	30.00
Potash	uints	60.00	0.58	34.80
Lime (Prorated)	tons	0.33	35.00	11.55
Herbicides	acre	1.00	30.96	30.96
Insecticides	acre	1.00	4.70	4.70
Fungicides	acre	1.00	14.00	14.00
Nematicide	acre	1.00	0.00	0.00
Consultant/Scouting Fee	acre	0.00	6.00	0.00
Irrigation	ac/in	0.00	12.00	0.00
Drying	bu.	35.00	0.00	0.00
Hauling	bu.	35.00	0.25	8.75
Crop Insurance	acre	1.00	20.00	20.00
Aerial Application	acre	0.00	5.00	0.00
Labor (Wages & Fringe)	acre	1.20	11.25	13.50
Tractor/Machinery	hours	1.00	25.22	25.22
Interest on Operating Capital	acre	127.99	0.065	8.32
TOTAL VARIABLE COST	dol.			264.30
RETURNS ABOVE VARIABLE COST				205.05
3. FIXED COSTS				
TRACTOR/MACHINERY		1.00	48.02	48.02
IRRIGATION	acre	0.00	125.00	0.00
LAND OWNERSHIP COST	acre	1.00	75.00	75.00
GENERAL OVERHEAD	acre	264.30	0.08	21.14
TOTAL FIXED COSTS	dol.			144.16
4. TOTAL COST OF ALL SPECIFIED EXPENSES				408.46
RETURNS ABOVE ALL SPECIFIED EXPENSES				60.89

Although dryland crop production is far more common than irrigated crop production in Alabama, turfgrass producers may have sufficient irrigation available for row crops. Accordingly, budgets for irrigated crops were also developed. Because of the lack of data on irrigated yields in Alabama, the irrigated yields were taken from budgets prepared by the Georgia Extension System. Fertilizer, herbicide, and other chemical use are adjusted for irrigated acres, based on the 2011 Alabama Cooperative Extension figures. Variable and fixed costs for the irrigation are taken from the same source.

Table 30. Enterprise Budget for Irrigated Corn, Alabama, 2012 (Reduced Tillage)

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Corn	bu.	200.00	5.97	1194.00
2. VARIABLE COSTS				
Seed	1000k	28.00	2.85	79.80
Seed Treatment	acre	0.00	10.50	0.00
Tech Fee	acre	1.00	0.00	0.00
Fertilizer				
Nitrogen	units	293.33	0.68	199.47
Phosphate	units	90.00	0.50	45.00
Potash	units	125.00	0.58	72.50
Micronutrients	acre	1.00	12.00	12.00
Lime (Prorated)	tons	0.33	35.00	11.55
Herbicides	acre	1.00	30.00	30.00
Insecticides	acre	1.00	27.00	27.00
Fungicides	acre	1.00	0.00	0.00
Nematicide	acre	1.00	0.00	0.00
Consultant/Scouting Fee	acre	0.00	5.00	0.00
Irrigation	ac/in	8.00	12.00	96.00
Drying	bu.	200.00	0.28	56.00
Hauling	bu.	200.00	0.25	50.00
Crop Insurance	acre	1.00	26.00	26.00
Aerial Application	acre	0.00	9.00	0.00
Labor (Wages & Fringe)	hour	1.60	11.25	18.00
Tractor/Machinery	acre	1.00	19.00	19.00
Interest on Operating Capital	dol.	371.16	0.065	24.13
TOTAL VARIABLE COST				766.44
RETURNS ABOVE VARIABLE COST				427.56
3. FIXED COSTS				
Tractor/Machinery	acre	1.00	26.00	26.00
Irrigation	acre	1.00	125.00	125.00
Land Ownership Cost	acre	1.00	75.00	75.00
General Overhead	dol.	766.44	0.08	61.32
TOTAL FIXED COSTS				287.32
4. TOTAL COST OF ALL SPECIFIED EXPENSES				1053.76
RETURNS ABOVE ALL SPECIFIED EXPENSES				140.24

Table 31. Enterprise Budget for Irrigated Cotton, Alabama, 2012 (Reduced Tillage)

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Cotton Lint	lbs	1200.00	0.85	1020.00
Cottonseed	lbs	1620	0.08	129.60
Total Revenue				1149.60
2. VARIABLE COSTS				
Seed	bag	0.13	567.00	73.71
Seed Treatment	bag	0.00	17.00	0.00
Tech Fee (RF/BG2)	bag	0.00	0.00	0.00
Fertilizer				
Nitrogen	units	120.00	0.68	81.60
Phosphate	units	80.00	0.50	40.00
Potash	units	80.00	0.58	46.40
Micronutrients				0.00
Lime (Prorated)	tons	0.33	35.00	11.55
Herbicides				0.00
Burndown/Planting	acre	1.00	24.32	24.32
Post	acre	1.00	25.63	25.63
Lay-By	acre	1.00	8.19	8.19
Insecticides				0.00
Planting	acre	1.00	0.00	0.00
Early Season	acre	1.00	10.00	10.00
Mid Season	acre	1.00	7.00	7.00
Late Season	acre	1.00	10.00	10.00
Systemic Fungicides	acre	0.00	2.00	0.00
Growth Regulator	oz.	13.33	0.75	10.00
Defol/Harvest Aid	acre	1.00	13.00	13.00
Consultant/Scouting Fee	acre	0.00	6.00	0.00
Irrigation	ac/in	8.00	12.00	96.00
Crop Insurance	acre	1.00	28.00	28.00
Aerial Application	acre	0.00	9.00	0.00
Boll Weevil Eradication	acre	1.00	0.65	0.65
Cover Crop Establishment.	acre	1.00	25.00	25.00
Labor (Wages & Fringe)	hour	2.45	11.25	27.56
Tractor/Machinery	acre	1.00	19.00	19.00
Ginning	lbs	1200.00	0.08	96.00
Warehousing	bale	2.50	10.50	26.25
Classing/Promotion Fee	bale	2.50	6.82	17.05
Cottonseed Credit	tons	0.81	120.00	-97.20

Table 31 Continued.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
Interest on Operating Capital	dol.	278.81	0.065	18.12
TOTAL VARIABLE COST				617.83
RETURNS ABOVE ALL SPECIFIED EXPENSES				531.77
3. FIXED COSTS				
Tractor/Machinery	acre	1.00	98.43	98.43
Irrigation	acre	1.00	125.00	125.00
Land Ownership Cost	acre	1.00	75.00	75.00
General Overhead	dol.	617.83	0.08	49.43
TOTAL FIXED COSTS				347.86
4. TOTAL COST OF ALL SPECIFIED EXPENSES				965.69
RETURNS ABOVE ALL SPECIFIED EXPENSES				183.91

Table 32. Enterprise Budget for Irrigated Peanut, Alabama, 2012 (Reduced Tillage)

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Peanut	lbs	4200	0.25	1050.00
2. VARIABLE COSTS				
Seed	lbs	100.00	1.40	140.00
Innoculant	acre	1.00	0.00	0.00
Fertilizer				
Phosphate	units	40.00	0.50	20.00
Potash	units	40.00	0.58	23.20
Boron /Micronutrients	acre	1.00	10.00	10.00
Lime (Prorated)	tons	0.50	35.00	17.50
Herbicides	acre	1.00	35.00	35.00
Insecticides	acre	1.00	40.00	40.00
Fungicides	acre	7.00	7.50	52.50
Nematicide	acre	1.00	0.00	0.00
Consultant/Scouting Fee	acre	0.00	6.00	0.00
Irrigation	ac/in	8.00	12.00	96.00
Drying	tons	2.10	30.00	63.00
Cleaning	tons	2.10	12.00	25.20
Hauling	tons	2.10	17.50	36.75
Crop Insurance	acre	1.00	20.00	20.00
Check Off	tons	2.10	2.50	5.25
Labor (Wages & Fringe)	hour	2.75	11.25	30.94
Tractor/Machinery	acre	1.00	50.00	50.00
Interest on Operating Capital	dol.	332.67	0.065	20.43
TOTAL VARIABLE COST				685.77
RETURNS ABOVE VARIABLE COST				364.23
3. FIXED COSTS				
Tractor/Machinery	acre	1.00	60.00	60.00
Irrigation	acre	1.00	125.00	125.00
Land Ownership Cost	acre	1.00	75.00	75.00
General Overhead	dol.	685.77	0.08	54.86
TOTAL FIXED COSTS				314.86
4. TOTAL COST OF ALL SPECIFIED EXPENSES				1000.63
RETURNS ABOVE ALL SPECIFIED EXPENSES				49.37

Table 33. Enterprise Budget for Irrigated Soybean, Alabama, 2012

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE
1. INCOME				
Soybean	bu.	60	13.41	804.60
2. VARIABLE COSTS				
Seed & Inoculant	bag	1.25	50.00	62.50
Fertilizer				
Phosphate	uints	60.00	0.50	30.00
Potash	uints	60.00	0.58	34.80
Lime (Prorated)	tons	0.33	35.00	11.55
Herbicides	acre	1.00	64.45	64.45
Insecticides	acre	1.00	4.70	4.70
Fungicides	acre	1.00	27.60	27.60
Nematicide	acre	1.00	0.00	0.00
Consultant/Scouting Fee	acre	0.00	6.00	0.00
Irrigation	ac/in	8.00	12.00	96.00
Drying	bu.	60.00	0.00	0.00
Hauling	bu.	60.00	0.25	15.00
Crop Insurance	acre	1.00	20.00	20.00
Aerial Application	acre	0.00	5.00	0.00
Land Rent	acre	1.00	41.00	41.00
Labor (Wages & Fringe)	hours	1.20	11.25	13.50
Tractor/Machinery	acre	1.00	25.22	25.22
Interest on Operating Capital	dol.	223.16	0.065	14.51
TOTAL VARIABLE COST				460.83
RETURNS ABOVE VARIABLE COST				343.77
3. FIXED COSTS				
TRACTOR/MACHINERY	acre	1.00	48.02	48.02
IRRIGATION	acre	1.00	125.00	125.00
LAND OWNERSHIP COST	acre	1.00	75.00	75.00
GENERAL OVERHEAD	dol.	460.83	0.08	36.87
TOTAL FIXED COSTS				284.89
4. TOTAL COST OF ALL SPECIFIED EXPENSES				745.71
RETURNS ABOVE ALL SPECIFIED EXPENSES				58.89

The net returns for non-irrigated corn, cotton, peanut and soybean are $15.64, $53.16, $56.77, and $18.10, respectively. For irrigated crop, the net returns are $140.24, $183.91,

$49.37, and $58.89 for corn, cotton, peanut, and soybean, respectively. In this study, irrigated crops have higher net returns, except peanut. For peanut, non-irrigated production has slightly higher returns than irrigated production.

Corn and cotton are common crops grown in rotation with peanuts or soybeans in Alabama. The rotation with different planting date, life cycles and growth habits can increase the diversification of weed management practices since many fungal pathogens and plants parasitic nematodes which could infect peanuts are not sustained on monocotyledonous crops (Cox and Sholar 1995; Johnson et al. 2001). Since cotton is more profitable than corn, cotton is used to rotate with peanuts in South Alabama, and it is planted in rotation with soybeans in North Alabama. In South Alabama, assuming there are two-year cotton and one-year peanuts, the annual profit comes from two-thirds of cotton and one-third of peanuts, and its about $142.24 and $41.47 per acre for irrigated and non-irrigated crop production, respectively. In North Alabama, the annul profit is about $116.64 and $54.97 per acre for irrigated and non-irrigated crop production, respectively, deriving from half of cotton and half of soybeans.

SENSITIVITY ANALYSES

In this chapter, sensitivity analysis was conducted to compare the different net returns for turfgrass-sod production with different assumed sod prices, fuel prices and holding length. The most profitable row crop mixtures were also defined in this chapter.

Net Returns for Turfgrass-Sod

Marketable sod is normally produced in 6 to 24 months. The growing season for re-establishing early season bermudagrass is around 4 months both for South and Central Alabama. The re-establishement is assumed to be 6 and 10 months for late season bermudagrass for South and Central Alabama, respectively (J. Adrian, Loyd, and Duffy 1995). Many of the warm season grasses used in sod production will regrow without being replanted. Bermudagrass and zoysiagrass with rhizomes can grow back from the rhizomes left below the harvester's blade (Cockerham 1988). The actual growing length depends on grass species, temperature, and soil conditions. Time typically required to produce a marketable sod from initial establishment and reestablishment are listed as growing months in Table 34.

Table 34. Growing Time Required for Some Turfgrass

	Growing Months	
Turfgrass Cultivar	Establishment	Re-establishment
Tifgreen 328	6 to 12	3 to 6
Tifway 419 Bermuda	6 to 12	4 to 8
Emerald zoysiagrass	12 to 24	13 to 20
Matrella Zoysiagrass	23 to 24	15 to 20
Meyer (Z52) Zoysiagrass	12 to 24	11 to 18

Source: Koske (1994); LSU Ag Center.

From the 1970s, plastic netting has been used to shorten mature length. According to Cockerham (1988), much younger sod can be harvested with the assistance of netting and 25 percent or more sod could be cut. A common way to install netting is to seed first and then simply roll the netting out over the seeded area. However, netting may be buried too deep for the sod cutter blade, and may cause a considerable loss at harvest. In this study, I did not include netting, but historical sod survey showed it is used in some Alabama sod farms (Cain et al. 2003b).

Sod is recommended to be cut, loaded, delivered, and installed on the same day. Typically, sod is harvested on demand and is cut only to meet particular days' orders. During low demand or low price period, many producers keep their sod in fields and try to sell at higher prices at a later time, rather than harvesting the sod. For warm-season grasses, the basic technique for sod harvesting is the ribbon-cut method. 1- to 2- inch wide ribbons or strips are left in the field between the harvested strips for re-establishment.

Production losses, harvest inefficiencies, and turfgrass stock required for sod reestablishment reduced the actual production of marketable sod. Marketable sod is available on 73.5 percent of the total areas of production based on the online survey responses. As

noted in the discussion in the introduction of this study, most sod farms can harvest twice a year, but the production condition may be changed by the market. In Alabama, sod has to be prepared for late-season re-establish before May 1. If the previous sod hasn't been sold by May 1, the strips cannot produce the second crop.

In the 2011 Ancillary Georgia Sod Producers Inventory Survey, the average on-the-farm price for Bermudagrass was 12.0 cents per square foot, which equals to $1.08 per square yard. The average price per square yard for delivered price varies from $1.08 per square yard to $2.34 per square yard, with an average price of $1.47 per unit. Assuming that the diesel price is $3.65 per gallon and sod price is $1.08 per square yard, net returns for one harvest and two harvests are presented in Table 35 and Table 36.

Table 35. Estimated Costs and Returns per Acre of Bermudagrass Production, Alabama, 2012 (One Harvest)

Item	Unit	Quantity	Price dollars	Amount dollars
1. Income				
Bermudagrass	sq. yd.	3557.4000	1.08	3841.99
2. Direct Expenses				
Fertilizer				
13-13-13	ton	0.2500	512.00	128.00
21-0-0	ton	0.8000	480.00	384.00
Herbicides	acre	1.0000	145.74	145.74
Insecticides	acre	1.0000	33.48	33.48
Pallets	each	85.0000	4.90	416.50
Other				
Pickup-Foreman	acre	1.0000	24.25	24.25
Pickups-General	acre	1.0000	29.10	29.10
Operator Labor				
Tractors	hour	10.1119	11.25	113.76
Self Propelled	hour	68.4977	11.25	770.60
Bermuda Maintenance	hour	3.7500	11.25	42.19
Fuel				
Tractors	gal	17.4064	3.65	63.53
Self Propelled	gal	16.9198	3.65	61.76
Repair & Maintenance				
Implements	acre	1.0000	9.30	9.30
Tractors	acre	1.0000	17.13	17.13
Self Propelled	acre	1.0000	30.53	30.53
Bermuda Maintenance	acre	1.0000	28.63	28.63
Irrigation	acre	1.0000	11.00	11.00
Interest on Variable Capital	dollars	0.0650	1154.75	75.06
Total Direct Expensed				2384.56
Returns Above Direct Expenses				1457.43
3. Fixed Expenses				
Manager	acre	1.0000	163.00	163.00
Assistant	acre	1.0000	45.97	45.97
Implements	acre	1.0000	35.39	35.39
Tractors	acre	1.0000	39.93	39.93
Self Propelled	acre	1.0000	30.24	30.24
Irrigation	acre	1.0000	112.50	112.50
Amortized Est. Cost	acre	1.0000	449.70	449.70

Table 35 Continued.

Item	Unit	Quantity	Price dollars	Amount dollars
Bermuda Maintenance	acre	1.0000	175.02	175.02
Barn	each	0.0025	9442.16	23.61
Road & Loading Pads	each	0.0025	1888.43	4.72
Land Rent	acre	1.0000	75.00	75.00
Utilities	acre	1.0000	35.00	35.00
Insurance	acre	1.0000	7.47	7.47
Miscellaneous	acre	1.0000	100.00	100.00
Interests on Fixed Capital	acre	1.0000	84.34	84.34
Total Fixed Expenses				1381.88
4. TOTAL COST OF ALL SPECIFIED EXPENSES				3766.44
Returns Above Total Specified Expenses				75.56

Table 36. Estimated Costs and Returns per Acre of Bermudagrass Production, Alabama, 2012 (Two Harvests)

Item	Unit	Quantity	Price dollars	Amount dollars
1. Income				
2. Direct Expenses				
Fertilizer				
13-13-13	ton	0.5000	512.00	256.00
21-0-0	ton	1.6000	480.00	768.00
Herbicides	acre	1.0000	291.47	291.47
Insecticides	acre	1.0000	66.96	66.96
Pallets	each	85.0000	4.90	416.50
Other				
Pickup-Foreman	acre	2.0000	24.25	48.50
Pickups-General	acre	2.0000	29.10	58.20
Operator Labor				
Tractors	hour	20.2238	11.25	227.52
Self Propelled	hour	136.9954	11.25	1541.20
Bermuda Maintenance	hour	7.5000	11.25	84.38
Fuel				
Tractors	gal	20.2238	3.65	73.82
Self Propelled	gal	33.8395	3.65	123.51
Repair & Maintenance				
Implements	acre	2.0000	9.30	18.60
Tractors	acre	2.0000	17.13	34.27
Self Propelled	acre	2.0000	30.53	61.06
Bermuda Maintenance	acre	2.0000	28.63	57.26
Irrigation	acre	2.0000	11.00	22.00
Interest on Variable Capital	acre	0.0650	2074.62	134.85
Total Direct Expensed				4284.09
Returns Above Direct Expenses				3399.89
3. Fixed Expenses				
Manager	acre	1.0000	163.00	163.00
Assistant	acre	1.0000	45.97	45.97
Implements	acre	1.0000	35.39	35.39
Tractors	acre	1.0000	39.93	39.93
Self Propelled	acre	1.0000	30.24	30.24
Irrigation	acre	1.0000	112.50	112.50
Amortized Est. Cost	acre	1.0000	449.70	449.70

Table 36 Continued.

Item	Unit	Quantity	Price dollars	Amount dollars
Bermuda Maintenance	acre	1.0000	175.02	175.02
Barn	each	0.0025	9442.16	23.61
Road & Loading Pads	each	0.0025	1888.43	4.72
Land Rent	acre	1.0000	75.00	75.00
Insurance	acre	1.0000	8.05	8.05
Utilities	acre	1.0000	35.00	35.00
Miscellaneous	acre	1.0000	100.00	100.00
Interests on Fixed Capital	acre	1.0000	84.38	84.38
Total Fixed Expenses				1382.49
4. TOTAL COST OF ALL SPECIFIED EXPENSES				5666.58
Returns Above Total Specified Expenses				2017.40

If the farm only harvest turfgrass-sod once a year and it can be sold as soon as it is ready to harvest, the quantity is around 3557 square yard and the total income is about $3766.44, assuming the unit price is $1.08. Assuming diesel price is $3.65 per gallon, the returns above total expenses are about $75.56 per acre. The net returns are around $2017.40 per acre if the sod can be harvested twice when the average sales price is $1.08 per square yard.

Weeks before harvesting, sod is recommended to be conditioned to enhance its quality. More frequent fertilizer schedule and mowing are typical cultivations. Using a blower to remove mowing clippings improves the sod's appearance as well. But the cost for purchasing and operating blowers was not included in this study.

Sod prices are quite variable, depending on the market, sod quality, and some seasonal factors. Under current sod market conditions, producers may experience difficulties selling all marketable sod at a good price. Figure 18 shows the changes of net returns with different sod prices.

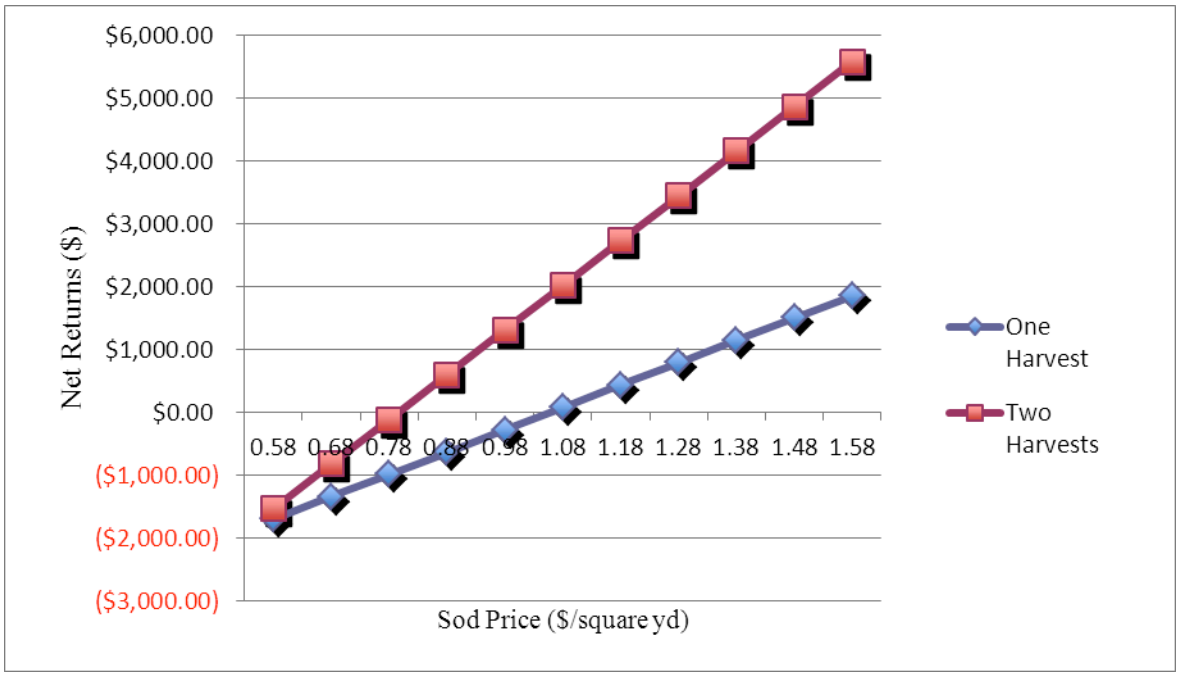

Figure 18. Net returns based on different sod prices.

The breakeven price for one harvest and two harvests are $1.06 and $0.80 per square yard, respectively, based on the assumptions used in the budgets. If the sod price increases to $1.18 per square yard, the net returns reach $431.24 and $2728.77 per acre for one harvest and two harvests, respectively.

The diesel price was assumed at $3.65 per gallon for above discussion. During our interviews, I noted that the increasing diesel price is a big concern for sod growers. The costs for delivery were not included in this study. Higher diesel prices result in higher machinery costs. The net returns for one harvest are $81.68 per acre when the diesel price is $3.35 per gallon; while it is $87.80 per acre if diesel price is $3.05 per gallon. In this case, the net returns above all expenses except delivery costs increased 7 percent if diesel price decreases 9 percent. Figure 19 illustrates the different net returns with variable diesel prices. The net returns for one harvest is presented on the left vertical axis, and the net returns for two

harvests are showed on the right vertical axis. From Figure 19, we can see diesel price has a significant effect on the net returns.

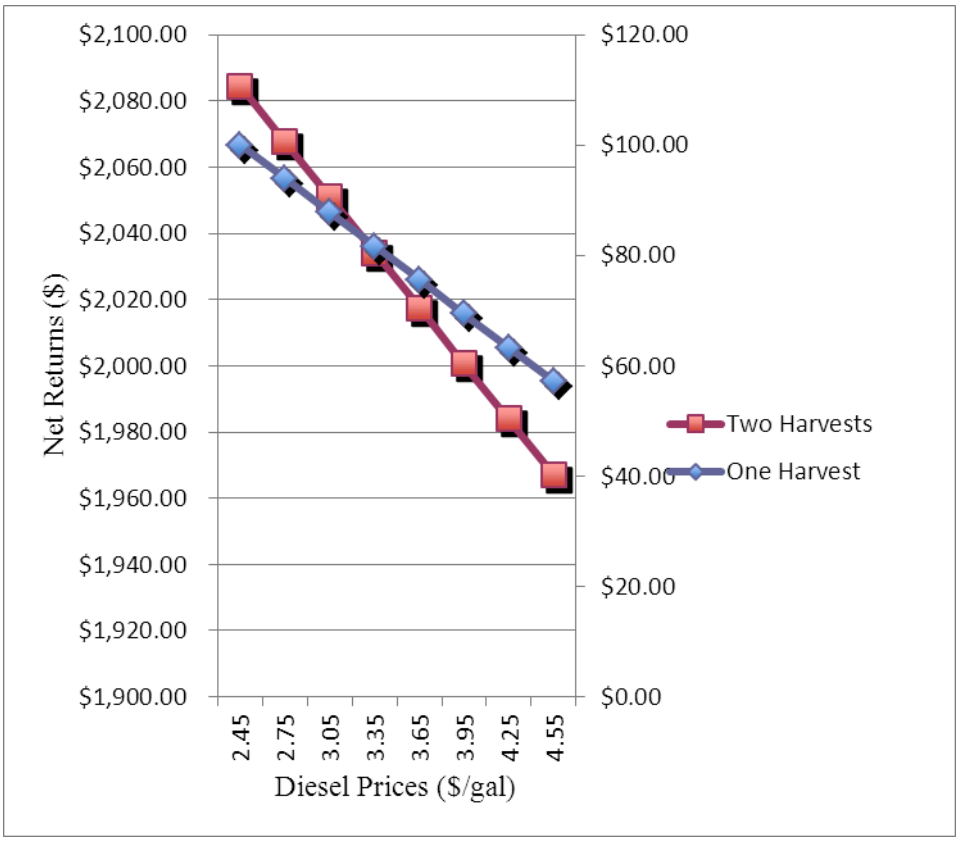

Figure 19. Net returns based on different diesel fuel prices.

If sod is held in fields because there is no ready market at the time, sod farms have to pay additional maintenance costs. After one month, the application of 25 pounds per acre of nitrogen is recommend every month to prevent sod losing color. Mowing is also necessary in order to maintain sod quality, but the mowing frequency is varied in different sod farms. According to the producers interviewed, some farms mow once a week and some mow twice a week after maturation. Figure 20 illustrates the net returns with twice a week mowing frequency and Figure 21 shows the net returns for once a week mowing frequency if sod needs to be held after it is ready for harvest. It is assumed that sod can be harvested twice a year if it is sold before the 12th week following its spring maturation. There is only one

annual crop if sod is held in fields more than 12 weeks. The blue lines show the net returns for one harvest; while the red ones represent two harvests.

The net returns are $2017.29 per acre if sod is sold at $1.08 per square yard when it is first marketable. If there is no demand at that time, the sod producer could decrease unit price to attractive more demand or hold sod in fields to wait for later demand. With twice a week mowing frequency, the net returns for holding 12 weeks are $1790.95 per acre. After the 12th week, under the assumption of one crop this year, the total net return for one acre is negative $174.77. If prices decrease to $0.98 per unit, the net returns would be around $1305.81 per acre if sod is sold when first marketable in the spring and harvested again in the fall.

If the sod is only harvested once per year, the net returns with $1.08 per unit price are $75.56 per acre if it is sold when it is first marketable. If the sod farm decrease sod price to sell it when it first marketable, for example to $0.98 per square yard, the net returns are negative $280.24 per acre, which means sod farms can lose less if they hold sod in fields for a while to wait for the demand. The situation is similar for mowing marketable sod once a week, except less additional costs (Figure 20).

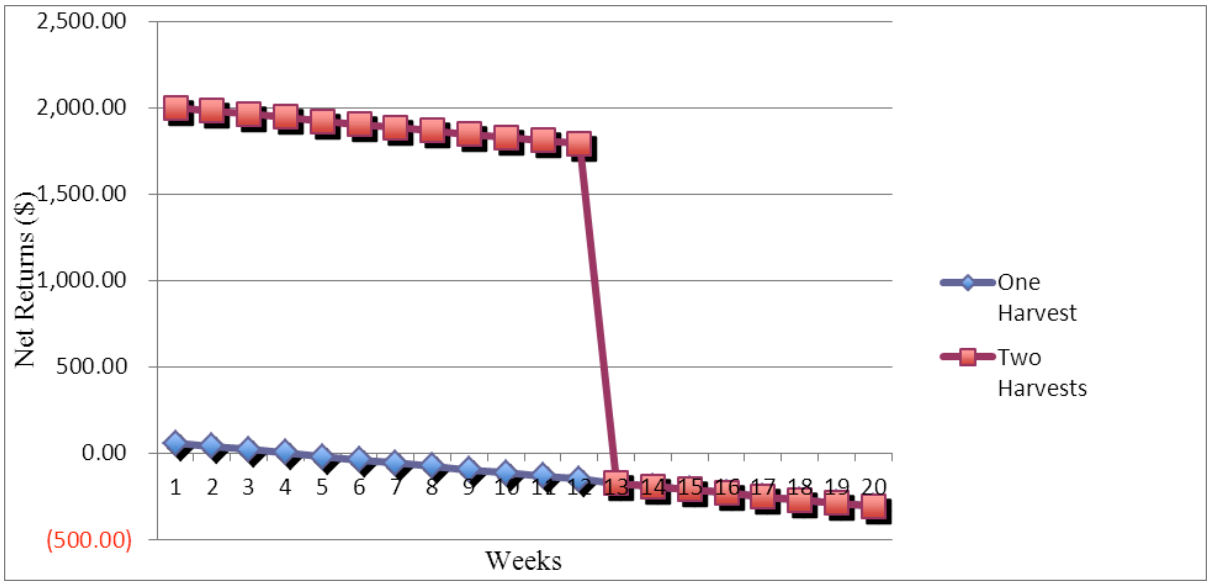

Figure 20. Net returns with different holding length (weekly mowing frequency=2).

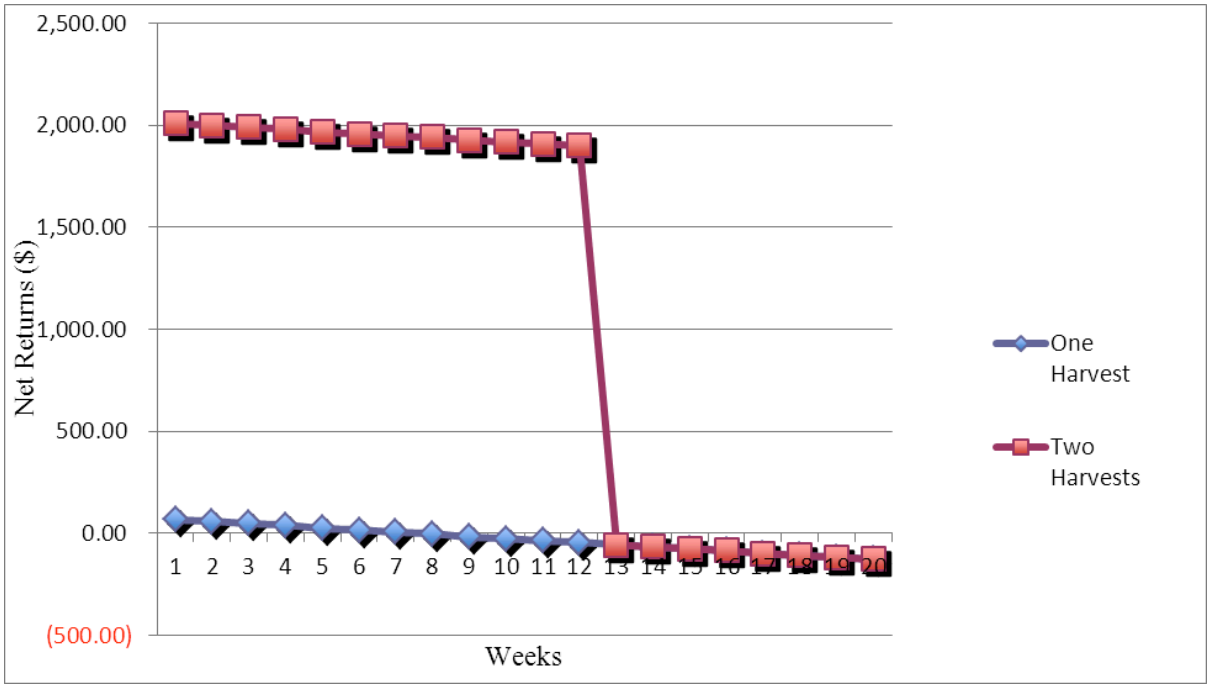

Figure 21. Net returns with different holding length (weekly mowing frequency=1)

For sod producers, how to adjust production and marketing is risky. Based on the above discussion, sod producers may find it beneficial to decrease sod prices in some acceptable range to ensure the later-season re-establishment. However, if the farm can only

produce one crop a year, holding sod in fields to wait for better demand may result in higher profits. Further, demand for sod may be mostly dependent on the state of the real-estate market and thus not that price responsive, so that reducing the price may not lead to much increase in sales.

Net Returns for Row Crops

The net returns for corn, cotton, peanuts, and soybeans, discussed fully in Chapter row crop budgets, are summarized in Table 37.

Table 37. Net Returns per Acre for Key Row Crops in Alabama

Row Crops	Net Returns Non-Irrigated $/acre	Net Returns Irrigated $/acre
Corn	15.64	140.24
Cotton	53.16	183.91
Peanut	56.77	49.37
Soybeans	18.10	58.89

Because producers typically use rotations, a return for rotations is calculated. For South Alabama, a typical rotation is two years of cotton or two years of corn and one year of peanuts. In North Alabama, the rotation is typically cotton or corn and soybeans. Given the above returns, the cotton-peanuts rotation is used for South Alabama and cotton-soybeans for North Alabama. The adjusted annual net returns for non-irrigated row crops are thus $41.47 and $54.97 per acre for South and North Alabama farms, respectively. They are $142.24 and $116.64 per acre for South and North Alabama farms, respectively. If sod is only harvested once a year and the unit price is $1.08 per square yard, the net returns are $75.56 per acre, which is lower than the rotation of row crops. But sod farmers may get better returns than row crop farms if sod producers can sell their product in a timely manner.

SUMMARY AND CONCLUSIONS

Turfgrass-sod production and marketing are experiencing changes in Alabama in recent years. Compared with the prior situation that turfgrass-sod was taken as an alternative to traditional agricultural enterprises, many sod producers are considering diminishing the size of their sod operation. A lack of economic data has characterized this industry. Results of this study should improve this situation.

Three major objectives of this study were to: (1) build turfgrass budgets based on most recent information and sources; (2) determine budgets for key row crops in Alabama for 2012; (3) conduct sensitivity analysis to compare sod profits with different price polices and compare profits among different crop productions.

Data used in this study were collected through online surveys, on-farm interviews, and various second hand resources. Compared with other survey responses, online surveys have less responding producers. Mail and phone calls probably could get more effective responses. This experience may be considered for future researchers in this area.

Because of recent difficult economic conditions, sod producers may be experiencing more risks than row crop producers. For row crops, prices and yields are variable. For sod, risk is experienced through uncertainty of being able to market the product in a timely way. Different holding lengths for the marketable sod result in widely varying (and unpredictable) net returns. None of sod producers in our online surveys and interviews have plans to expand their sod production. Sod producers indicated that they would decease or just keep the current

sod acres in production. If expected returns for sod drop below the expected returns for the alternative row crop rotations, sod producers may decide to produce row crops instead. Decreasing sod acres and moving back to traditional agricultural enterprises may be an effective strategy under the current sod market conditions.

A shortcoming of this study is that only bermudagrass was included in this study to represent the current sod production. Bermudagrass is the most commonly produced sod in Alabama, but zoysiagrass and centipedegrass are also planted in most sod farms. This shortcoming would be considered in my future research. Another shortcoming is that the work assumes 500 acres of sod production, while many sod producers in the state have smaller operations. Fixed costs per acre in smaller operations are generally higher, which would reduce the per-acre profits for turfgrass for these units. Further research is needed on costs and returns for smaller size operations.

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APPENDIX

ONLINE SURVEY

Q1 How many acres in total do you operate in your farm business in the current year (2012)?

Q2 Of the total land you operate, how many acres are used

Item Names	Acres
to plant turfgrass-sod	
to grow row crops	
to produce hay or forage	
as pasture for grazing livestock	
to produce timber	
other (please specify)	

Q3 How many separate parcels of land do you operate?

Q4 Where are the parcels located, by county, and when was your operation established on this parcel?

Parcel Size (in acres)	County	Year Established or Acquired (example: 2003)

Q5 How many people do you normally employ?

Types	Acres
In season	
Off season	

Q6 Do you irrigate any of your turfgrass or crops?

Yes	
No	

Q7a Now please indicate the level of turfgrass production for your operation in 2011 and 2006, in terms of type of production method:

	Certified acres in 2011	Non-Certified acres in 2011	Certified acres in 2006	Non-Certified acres in 2006
Sod				
Sprigs				
Seed				
Other (specify)				
Other (specify)				
Other (specify)				

Q7b Please indicate the level of turfgrass production for your operation in 2011 and 2006, in terms of variety of turfgrass produced.

	Certified acres in 2011	Non-Certified acres in 2011	Certified acres in 2006	Non-Certified acres in 2006
Fescue				
Bermudagrass				
Centipedegrass				
Zoysiagrass				
St. Augustinegrass				
Other (specify)				
Other (specify)				
Other (specify)				
Other (specify)				

Q8 What major crops are grown on your farm? Please indicate whether you have planted the listed crops in the past 5 years and the number of acres planted in 2011 and 2006

	Grown in the past 5 years?		Acres Planted in 2011	Acres Planted in 2006
	Yes	No	Acres	Acres
Corn				
Cotton				
Peanut				
Soybean				
Wheat				
Hey/Forage Crops				
Other (specify)				
Other (specify)				
Other (specify)				
Other (specify)				

Q9 Including sales of turfgrass, crops, livestock, poultry and miscellaneous agricultural products (including the landlord's share) and government agricultural payments over the past 3 years, which category represents the average yearly total gross value of sales from this operation?

___ Less than $50,000

___ $50,000 to $99,999

___ $100,000 to $249,999

___ $250,000 to $499,999

___ $500,000 to $999,999

___ $1,000,000 and over

Q9a What percentage of sales in Question #9 comes from turfgrass production?

Q10 How do you harvest sod? Please check all that apply

	Harvest Type			
	Large Roll	Small Roll	Stacked on Pallet	Harvested as Sprigs
Fescue				
Bermudagrass				
Centipedegrass				
Zoysiagrass				
St. Augustinegrass				
Other (specify)				
Other (specify)				
Other (specify)				
Other (specify)				
Other (specify)				

Q10a What percentage of each acre of your turfgrass grown can you typically harvest?

(Example: 90%)

	Percent
Bermuda	
Centipede	
Zoysia	
Other (specify)	
Other (specify)	
Other (specify)	
Other (specify)	

Q11 What price do you currently receive for sod?

	Price		Unit	If you have a second pricing system, please provide that information
	On-the-farm	Delivered	(e.g. square yard, large roll, etc)	(e.g. square yard, large roll, etc)
Fescue				
Bermuda				
Centipede				
Zoysia				
St. Augustinegrass				
Other (specify)				
Other (specify)				
Other (specify)				

Q12 If your price does not include delivery, please explain what you charge to deliver.

Q12a Is there a maximum distance that your farm will deliver?

___ Yes

___ No

Q12a What is the maximum distance that your farm will deliver?

Q13 Do you now or have you ever charged a fuel surcharge for delivery?

___ Yes

___ No

Q13a If you have ever charged a fuel surcharge, please explain the pricing.

Q14 In 2012, my plans for turfgrass are to produce

___ about the same amount

___ more turfgrass

___ less turfgrass

___ Unsure

Q15 If you plan to produce more turfgrass in 2013, approximately how many additional acres do you plan to produce?

Q16 If you plan to produce less turfgrass in 2012, approximately how many fewer acres do you plan to produce?

Q17 What factors are most important to you in considering how much turfgrass to produce in a given year? Please select as many as apply.

___ the price of turfgrass-sod

___ the price of other crops

___ the amount of land available for turfgrass production

___ ability to sell turfgrass when it is ready to harvest

___ availability of labor

___ machinery availability

___ capital for production inputs

___ other (please explain)

___ Other (specify)

___ Other (specify)

Q18 What factors limit the growth of your overall farming business? Please select as many as apply.

___ land not available

___ not enough labor

___ not enough capital for expansion

___ not interested in expansion

___ other (please explain)

Now please tell us a little bit about yourself.

Q1 In what year did you begin to operate any part of your farm?

Q2 For how many years have you been producing turfgrass?

Q3 Are you employed off the farm?

___ Yes

___ No

Q3a How many hours per week on average are you employed off the farm?

Q4 What is your (the farm operator's) gender?

___ Male

___ Female

Q5 What is your race?

___ White or Caucasian

___ American Indian

___ Black or African American

___ Asian or Pacific Islander

___ Other (please specify)

Q6 Are you Hispanic, Latino, or Spanish origin?

___ No, not of Hispanic, Latino, or Spanish origin

___ Yes, Mexican, Mexican Am., Chicano

___ Yes, Puerto Rican

___ Yes, Cuban

___ Yes, another Hispanic, Latino, or Spanish origin--please specify, for example, Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.

Q7 What is the highest level of formal education you have completed?

___ Some high school

___ High school or GED equivalency

___ Trade school

___ Some college

___ College graduate

___ Postgraduate

Q8 Please provide any feedback you think is important in the space below.