Transportation Logistics and Ownership of New Cotton Harvesting Technology on Economic Feasibility of Producers to Grow Cotton
FY 2011

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Researchers also sought to identify cost savings from the new alternative cotton harvest and transportation equipment designed to improve the marketing supply chain for cotton in the Mid-South region. Results indicated that, assuming yield growth is constant across cotton, corn and soybeans, measurable net returns changes could have been accomplished by reducing production costs per acre for cotton.

FINAL REPORT

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Background

Cotton has faced measurable challenges in the past decade that have threatened its ability to be a sustainable commodity for Mid-South producers. While cotton acreage has seen some volatility since the 1996 Farm Bill ("Freedom to Farm") that decoupled production decisions from commodity program acreage, measurably reduced acreage since 2007 combined with poor growing and/or harvest conditions has lowered overall cotton production. In a recently completed FSMIP project, the authors investigated the relative profitability of cotton compared with cotton and soybeans between 1997 and 2008 (Fannin and Paxton 2011).

In this analysis, the authors investigated the net returns (total revenues minus total variable costs) for cotton producing Mid-South counties in Arkansas, Louisiana and Mississippi. They calculated the opportunity net returns foregone if producers in each county had planted the most profitable commodity (either corn or soybeans) on all the acres of cotton they had planted. If cotton was less profitable than corn or soybeans in a given year, then the opportunity returns would be greater than the actual returns. If cotton was more profitable, then the opportunity returns would be less.

Results indicated that over the 12 year period, the net revenue foregone by not planting the more profitable commodity (either corn or soybeans in a given year) resulted in producers giving up 35% greater net returns. Even more interesting was the fact that producers gave up only 21% greater returns between 1997 and 2002, but over 43% between 2003 and 2008. The most obvious explanation for the profits foregone would likely be producers not switching to more profitable corn or soybean acreage in 2007 and 2008. However, net returns foregone between 2007 and 2008 were only 37%.

Overall, these results point out that Mid-South row-crop producers were foregoing profits by growing cotton in the immediate years prior to the high corn price year of 2007. The decision to reduce cotton acreage and increase corn and soybean acreage from 2007 forward was likely as much about these foregone profits from earlier years as was the corn price spike in 2007. The corn price spike just pushed these producers beyond a "tipping point" to plant a larger proportion of their acreage in alternative commodities to cotton.

Technological Change in Cotton Harvesting

At the same time cotton production began to wane in the Mid-South, the farm machinery industry introduced new harvest technology. This technology, developed separately by John Deere and Case IH, combined two key elements of the harvesting process, the picking of the cotton bolls from the cotton plant (traditionally handled by the

conventional cotton picker) and the compressing of cotton into modules for transportation and ginning (traditionally handled by the conventional cotton module builder). These combination cotton picker/module builder harvesters have attributes that are similar to hay balers. The harvester in the field picks cotton. The module simultaneously grows and is compressed inside the harvester. Finally when the compressed module reaches the optimal size, it is wrapped and extracted from the harvester in the field.

Such technological change has potential benefits for the producer – particularly in an environment where acreage for cotton is competing with corn and soybeans on net returns. Assuming yield growth is constant across the three commodities, measurable net returns changes could have been accomplished by reducing production costs per acre for cotton. The new harvesting technology has potential cost savings to producers as well as cotton ginners along the supply chain.

First, these new technology harvesters save producers labor costs at harvest. Traditional cotton harvesting technology requires an individual operating the cotton picker, an individual driving the boll buggy that the uncompressed cotton is being dumped into, and one to two individuals working the module builder that the uncompressed cotton from the boll buggy is transferred into to create the compressed modules. The number of seasonal workers can increase if the producer is operating multiple pickers simultaneously in a field. The new technology module harvesters create labor cost savings in the field by reducing the labor needed to harvest cotton to only one operator of the harvester and one operator to pick up these modules in the field and stage them in high ground locations for gins to collect.

Second, the new technology harvesters have potential cost savings to gins. The modules created by the new technology harvesters vary in size. For example, round bales from the John Deere harvester generates on average 3.7 bales at the gin compared to an average of 16 bales from the traditional module. Hence, the round bales are equivalent to approximately 23% the cotton compressed in traditional modules (Wilcutt et al 2009). The Case IH bales generate a square bale approximately 41% the size of the traditional module. These smaller modules generate alternative transportation options for gins. Traditional modules were sufficiently large that specific module hauling trucks were created that loaded and transported the module from the staging locations at the edge of cotton fields to the gins. The smaller modules from the new technology harvesters can be loaded onto more conventional flatbed 18-wheeler style trailers (specifically the John Deere round bale system). Such trailers can typically transport five to eight of these smaller modules from field to gin. The Case IH modules would use a slightly different system based on the approach by Hamann et al (2009) when they proposed the half-bale option for a 53' flat bed trailer.

There are two potential benefits to gins. The first is that gins can transport more cotton in one round trip with flat bed trailers (or modified forms) than in the same round trip with traditional module haulers. Second, traditional module haulers have few axles resulting in heavy weight loads per axle. In most cases, these axle weight loads restrict modules to travel on non-interstate highways (Hamann et al 2009). Further, ginners in some states

have to obtain special exemptions/permits to haul these heavy loads on state highways. In some cases, they may have to avoid some routes altogether because of weight restrictions on bridges. Hence, the smaller modules being transported by flat bed trailers have the potential so save transportation costs of the ginner from both reduced overall round trips and shorter more efficient round trip routes because of increased roads that these trailers can use.

In both the cotton producer and ginner cases, potential cost savings exist. However, the optimal use and ownership of these inputs is critical to the cotton marketing supply chain. New technology harvesters are measurably more expensive than traditional harvesters. Because cotton pickers can essentially only be used to harvest cotton (unlike combines that with different headers that can harvest multiple commodities) these harvesters can depreciate quickly. Given the varying profitability of cotton relative to alternative commodities is likely to continue into the near and intermediate future, many producers see cotton having to compete for acres against corn and soybeans rather than an environment in the Mid-South where cotton maintained a plurality or majority acreage advantage over alternative row crops in prior years. As a result, a producer's long-term planting expectations for cotton may be lowered to the point where they may not believe that investments in new more, expensive cotton harvesting technology will be cost effective.

Further, gins that have historically owned their own module hauling trucks (and have had to absorb high depreciation costs of a highly specific asset), have the opportunity to evaluate the ownership decision in their transportation decisions. Gins that are a part of a multi-enterprise operation (farm, grain elevator, or warehouse) may own tractor-trailers and flat bed trailers that could be utilized during cotton harvest season. Such joint use of assets could reduce maintenance and repair costs by reducing a duplicate fleet of module haulers. Further, individual gin enterprises may consider contracting to private sector haulers for a portion or all of their module hauling needs. Our proposed research attempts to understand these costs and how they affect the cotton marketing supply chain.

Goals and Objectives

Goal

The overall goal of this project was to identify cost savings from alternative cotton harvest and transportation equipment technologies/equipment to improve the marketing supply chain for cotton in the Mid-South United States.

Objectives

1) Develop a business plan including pricing schedule for a custom cotton harvesting operation using a payoff schedule for fixed cost investments in 3, 5 and 10 years.

2) Evaluate the sensitivity of returns to cotton production budgets based on ownership of traditional cotton pickers, ownership of combination picker/module builder technology, and outsourced cotton harvesting based on pricing schedules outlined in Objective 1.

3) Estimate transportation cost changes to cotton ginners from a 25%, 50%, 75% and 100% shift in gin's cotton acreage ginned from traditional modules to combination picker/module builder modules.

4) Measure cost efficiency of Mid-South Cotton Gins

Approach and Key Findings

Objective One Approach
A complete comparative cost analysis of the onboard module cotton harvest systems with the traditional harvest system was completed by co-project investigator Salassi and highlighted in Salassi, Deliberto, and Falconer (In Press). The research focused on the roll of picker performance rates and variable costs under alternative field speed and field efficiencies. Further, a comparative fixed cost analysis was applied and compared between traditional cotton harvesters vs module builders.

There are several variables that impact the relative costs of these two harvest systems. First, traditional harvest systems require a cotton picker; a boll buggy and tractor to carry transferred picked cotton from field to the module building area; a module builder and module builder tractor, and the fuel and labor inputs to operate the machinery. The onboard module harvest systems require only a combination cotton harvester/module builder and a round bale hauler tractor (and their labor and fuel inputs). Cotton module harvest systems save on total equipment used in the harvest as well as additional labor costs of operating each piece of equipment in exchange for spending more total dollars on the module harvester.

A second factor, performance rate, otherwise known as effective yield capacity, measures the rate in acres per hour harvested and impacts the amount of time and variable costs used in the harvesting process. This yield capacity is considered an area where cost savings are obtained using the onboard module harvester system. Effective yield capacity is impacted by both the theoretical maximum speed generated by the harvester as well as the stops for maintenance, emptying of harvester (emptying into boll buggy for traditional harvest system; emptying round bale modules in module system), harvester maintenance, etc.

These two key factors driving relative costs were assessed by Salassi, Deliberto, and Falconer for two of the most common harvester systems – the John Deere 7660 (6-row traditional harvest system) and the John Deere 7760 (6-row module harvest system). Data

collection methods for cotton producers from selected Mid-South states are highlighted in Salassi, Deliberto, and Falconer[1].

Objective One Key Findings
Based on performance rates, the module harvester showed over a 38% improvement over the traditional harvester with the module harvester generating a harvest rate of 9.40 acres per hour over the traditional harvester at 6.77 acres per hour.

This information was combined with other data collected to calculate total harvest costs per acre between the traditional and the module harvest system. A capital recovery factor (Kay, Edwards, and Duffy 2004) was applied that identifies the annual payment that will recover the initial fixed cost investment of equipment used in the respective harvesting systems that recovers both the initial investment lost through depreciation as well as the interest costs on the investment.

An interest rate of 5.25% and 10-year life expectancies on both the traditional and module cotton harvesters as well as 30% salvage value of both harvesters at the end of the 10-year period were assumed. The ten year useful life of both harvesters is based on 250 hours of use each year.

Consequently, since the performance rates between the two harvesters differ. The traditional harvester harvests approximately 1,692 acres per year (250 hours @ 6.77 acres/hour) compared to 2,350 acres per year harvested with the module harvester (9.40 acres/hour). Salassi, Deliberto, and Falconer presented harvest costs of the two systems assuming the cotton producer has at least 2,350 acres to harvest in order to meet their expected harvest costs per acre reported.

To more precisely address project objectives, Salassi, Deliberto, and Falconer findings were adjusted by equating the total acreage harvested by both systems equally and comparing their total costs. Module builder acreage harvested was adjusted to total 1,692 acres per year. By doing so, total hours of usage per year drops to 180 hours per year. Highlights of the comparative costs under this scenario are presented in Table 1.

Table 1. Comparative Cost of Six Row Traditional and Module Harvesting Systems, 2014.

		Cost Per Acre				
Harvest System		**Capital**	**Fuel**	**Repair**	**Labor**	**Total**
		Recovery				
6 Row Traditional		$40.41	$18.64	$10.44	$7.95	$77.43
6 Row Module		$40.32	$12.29	$9.44	$3.31	$65.36

[1] Due to low adoption rates of the Case-IH Module Express 625 picker in the Mid-South, it was decided to focus exclusively on the John Deere 7760 Module Builder for this analysis.

As can be seen in the table, total cost per acre for the traditional cotton harvesting system (basket harvester) was estimated at $77.43. Approximately 61% ($47.49) of that total cost came from fixed and variable costs of the harvester itself with 39% ($29.94) coming from the boll buggy and module builder components of the traditional harvest system. The module builder harvest total costs were estimated at $65.36 per acre, or $12.07 less than the traditional harvest system. Of the total, $55.30, or 84.62% of the module harvest system total costs are in the fixed and variable costs of operating the module builder itself. As can be induced from the analysis, the savings generated from the onboard module harvest system come from the elimination of the fixed and variable costs (including labor costs) of the additional boll buggy and large module building components of the traditional system.

It should be noted that under this comparison, the module harvester would only operate 1,800 hours over the 10 year life expectancy of the harvester, or 72% of the life expectancy in operating hours. Hence, the $65.36 could be considered a upper bound on the cost per acre. The reduced hours would likely result in the owner obtaining a value for the module harvester above salvage value given that it could potentially have additional years of service to another owner. Alternatively, the existing owner could harvest additional years with the module harvester spreading out the fixed costs of the harvester over additional acres reducing the per acre total harvest cost.

Next, a breakeven price per acre matrix was developed for the module harvesting system. This matrix is presented in Table 2 below.

Table 2. Multi-Year Payoff Plans under Alternative Harvest Scenarios.

	Annual Acres Harvested					
	1000	**1500**	**2,350**	**2,500**	**4,700**	**7,833**
3 Year	$243.76	$167.79	$112.84	$107.02	$64.35	$44.95
5 Year	$161.45	$112.92	$77.81	$74.09	$46.83	
10 Year	$100.05	$71.99	$51.43	$49.53		
Hours Required	106	160	250	266	500	833
# 8 Hour Days	13.30	19.95	31.25	33.24	62.50	104.16

In this table, the rows represent the number of years to pay off the fixed investment. For example, a three-year payoff schedule of the fixed investment would require higher annual (or monthly) payments on equipment notes as compared to a ten-year payoff schedule assuming the same annual acres harvested. The annual acreage in the columns range from 1,000 and 1,500 acres on the low end, 2,350 acres (the annual acreage required to evenly distribute the 2,500 lifetime module harvester hours over 10 years), and 4,700 and 7,833 acres (the annual average acreage required to evenly distribute 2,500 lifetime module harvester hours over five and three years respectively). Also included is a scenario of 2,500 hours to evaluate costs if a producer is able to extend the total lifetime hours of module harvester before being fully depreciated.

There are a few key break-even cells in the table that should be reference points for evaluation of the other cells. First, the 10 year, 2,350 acres harvested cell ($51.43) represents the breakeven price per acre when evenly distributing the total lifetime hours of the harvester (2,500) over a 10 year life expectancy -- the maximum year acreage allowed at its performance rate of 9.4 acres per hour. A producer that has fully depreciated his/her traditional harvesting equipment and expects to harvest annually an average of 2,350 over 10 years would have this amount of total cost per acre in the module harvesting system. A business plan that custom harvested using module builders would have to price below $51.43 to attract cotton producers that would harvest annually at least 2,350 acres of cotton.

However, this is likely not the market for someone who intended to custom harvest using a module harvester. Based on Table 2, a producer committing to grow 1,500 acres of cotton per year for ten consecutive years could afford a module harvesting system ($71.99) over the traditional harvesting system costs from Table 1 ($77.43). However, for farms that harvest less than 1,500 acres, the costs become more prohibitive for these farms with the module harvest system. For a 1,000 acre farm, the cost spread over ten years ($100.05) would exceed a traditional harvest system. A business plan with custom harvesting using round modules would need to focus on these smaller sized cotton farms.

For example, according to the Census of Agriculture (2014) for Louisiana, 414 of its 467 cotton farms produced less than 1,000 acres of cotton in 2012. These small farms grew their cotton on 137,283 acres, 61% of the state's total cotton acreage. Similarly, in Mississippi, 46% of the state's cotton acreage was located on farms harvesting less than 1,000 acres. For Arkansas, farms harvesting less than 1,000 acres represent 32.4% of the total, 35.1% in Tennessee, and 30.0% in Missouri.

The distribution of acreage in the Mid-South states suggest that a full-time custom harvesting operation is most likely to see feasibility focusing on those states such as Louisiana and Mississippi where smaller cotton farms dominate. As traditional cotton harvesting systems of these smaller farms are sold or fully depreciate, an outsourced harvesting alternative may be an essential linkage in maintaining the cotton marketing system for portions of the Mid-South.

Objective Two Approach

In this objective, the relative sensitivity in returns to cotton producers from using alternative module harvesting systems vs. traditional harvesting system was evaluated. This objective was accomplished by looking at alternative cost and returns budgets to Mid-South cotton production systems. Given the findings of Objective One, costs and returns for Louisiana and Mississippi were the focus of this objective given that these two states were most likely to support a custom module harvesting system due to the relatively higher percentage of small cotton farms. First, Louisiana cost and returns budgets based on work by Deliberto, Hilbun, and Salassi (2014) were evaluated.

Objective Two Key Findings
Two production systems, a dryland conventional cotton production system with eight row production equipment with 38 inch row spacing, and irrigated 12 row production equipment with 38 row spacing on alluvial soils in Louisiana. Summary costs and returns are presented in Table 3 below.

Table. 3. Louisiana Cost and Returns for Selected Dryland and Irrigated Conventional Cotton Production Systems Per Acre, 2014.

Cotton Production System	Yield Per Acre (lbs.)	Total Income ($)	Total Direct Expenses ($)	Total Fixed Expenses ($)	Total Expenses ($)	Returns Above Total Expenses ($)	Net Returns with Module Harvest Sys. ($)
Dryland	950	760	519.99	100.31	620.3	139.7	187.27
Irrigated	1,100	880	560.17	151.24	711.41	168.59	216.16

Source: Deliberto, Salassi, and Hilbun, January 2014.

As can be seen from the table, there were projected positive net returns above total expenses for both dryland and irrigated cotton based on a projected cotton lint price of $0.80 per pound for the 2014 season. Producers would have used this budget prior to planting season to make cotton planting decisions. These returns were based on harvest cost expenses for a four-row basket harvester (dominant traditional harvester in Louisiana) with traditional boll buggy and module builder harvest system components totaling $99 per acre.

Net returns with the module harvest system assume that a producer would be able to obtain custom harvesting services at $51.43 per acre, the break-even price for a module harvester operating 250 hours annually per year. Based on that assumption, a cotton producer with dryland cotton could have potentially increased his/her net returns per acre by 34% if he/she could have someone custom harvest at the $51.43 rate. Under the irrigated model, the net returns would have increased 28%. As previously mentioned, Louisiana produces a majority of its total cotton acres in farm sizes under 1,000 acres. In seasons where cotton is profitable to grow (as 2014 was projected), demand for a custom module harvesting system may potentially exist especially as an increasing number of these small cotton producers sell or fully depreciate their existing cotton harvesting equipment. As shown in Objective One, harvest cost per acre makes it cost prohibitive for these small producers to purchase the new module harvesters, opening the door for custom harvesting solutions to become established.

However, the feasibility of these custom solutions is highly dependent on having sufficient quantities of small farms growing cotton to custom harvest. The 2015 crop year for cotton does not project the potential for small farms in the Mid-South to grow cotton. This is highlighted by looking at early 2015 cost and returns budgets produced by the other Mid-South state with a measurable percentage of farms with small cotton acreage – Mississippi. These cost and returns are highlighted in Table 4.

Table. 4. Mississippi Cost and Returns for Selected Dryland and Irrigated Convention Cotton Production Systems Per Acre, 2014.

Cotton Production System	Yield Per Acre (lbs.)	Total Income ($)	Total Direct Expenses ($)	Total Fixed Expenses ($)	Total Expenses ($)	Returns Above Total Expenses ($)	Net Returns with Module Harvest Sys. ($)
Dryland	900.00	576.90	669.14	100.25	769.39	-192.49	-166.49
Irrigated	1,100.00	705.10	775.91	165.39	941.30	-236.20	-210.20

Source: Cotton 2015 Planning Budgets. Mississippi State University Budget, October 2014.

The Mississippi cost and returns budgets are based on a cotton lint price of $0.64 per pound for the 2015 year. It should be noted that Cotton Planning Budgets for Mississippi also include a "cotton seed" revenue source. Producers typically refer to cottonseed revenue received by a producer as a "gin seed rebate." These rebates can vary from gin to gin with some gins offering very low rebates (if any at all) and others high rebates. While occasionally offered at the beginning of planting season to secure cotton harvest acreage for the gin, they are typically determined after the end of the cottonseed marketing season after cotton has been harvested. Since Louisiana cost and returns budgets do not include this revenue source, it was decided to exclude it from the basic analysis for comparison purposes. The gin seed revenue for Mississippi excluded from this analysis totaled $186 per acre for irrigated cotton and $152 per acre for dryland cotton.

As can be seen from Table 4, returns above total expenses range from a loss of $192 per acre for dryland cotton to $236 per acre for irrigated cotton. Unlike Louisiana that built their 2014 budgets based on a four-row basket harvester, Mississippi built their budgets based on a six-row basket harvester. In discussions with Dr. Larry Falconer, Agricultural Economics faculty member at Mississippi State, and co-author in Salassi, Deliberto and Falconer, when comparing six row traditional and module builder harvesters, the per acre savings shown in that article represent an upper bound savings to producers in the 2015 Mississippi Cotton Planning Budgets choosing module harvesters.

The $26.00 per acre savings from the article ($77.43 traditional six row harvest system cost per acre minus $51.43 six row module harvest system cost per acre) was applied to the returns above total expenses column to obtain the net returns using the module harvest system alternative. Under this scenario, net returns are still negative. They remain negative even under a scenario considering only direct expenses. Only in a scenario where one is budgeting the cottonseed rebate revenue can a producer show a positive return above direct expenses.

These scenarios show the vulnerability of a highly debt financed custom module harvesting startup business. While research results shows in Objective One that it may be feasible for a custom harvester to price competitively if business can harvest sufficient cotton acreage to pay off the module harvesting equipment in a three or five year time window. Unfortunately, results from Objective Two show that the more volatile price swings that can occur for cotton may make it difficult for a custom harvester to obtain

sufficient acreage as smaller producers switch to more profitable commodities year to year making it difficult to meet threshold acreage needed to maintain cash flow and solvency in such a startup.

Objective 3 Approach

The primary goal of this objective was to identify cost savings from alternative cotton harvest module technologies and transportation equipment with the intent that cotton producers and ginners would identify and adopt these cost saving practices. Specifically, this objective proposed identifying transportation cost changes from cotton ginners increasing the percentage of cotton being ginned from cotton module harvesters by 25%, 50%, 75%, or 100%. In this section the research procedure is highlighted, statistical results from the survey are presented, and issues faced in addressing the original objective based on questionnaire completion and results.

To accomplish this objective, module transportation questions were added as a part of the Southern Cotton Ginners Association (SCGA) tri-annual cost of ginning survey, the projects key industry partner in this project. This survey instrument was disseminated in May-June 2014 for ginners to complete based on costs of the 2013 ginning season. SCGA collected survey instrument results from which we analyzed data to address the research objective. The survey instrument is included in the Appendix.

In survey development, SCGA suggested the term "round modules" used to identify modules developed by the alternative module harvesters since in the short window from when the proposed project was approved until when the survey instrument was disseminated, the John Deere 7760 cotton module harvester became the dominate module harvesting technology. Consequently, most gins that would be adjusting to an increasing number of cotton producers using module harvesters would be retrofitting their gin processing activities as well as adjusting their transportation decisions based on round modules generated from the John Deere module harvester.

A total of 29 surveys that were completed were deemed usable for statistical analysis. These 29 responses represent 17.57% of total cotton gins (165) that operated in the Mid-South region according to USDA Cotton Ginnings (2014). The breakdown of survey responses by the five state Mid-South states was as follows: Arkansas (10), Louisiana (4), Mississippi (8), Missouri (5), and Tennessee (2). Due to the small number of observations by state, statistical results are based on the five states combined to avoid point estimates with high confidence intervals for individual state averages.

Objective 3 Key Findings

Total bales ginned by these survey respondents totaled 500,000 bales or approximately 17,000 bales per respondent. Approximately 48% of total bales ginned were sourced from cotton from round modules in 2013. This compares to only 14% from the SCGA 2010 survey. Other key descriptive statistics of cotton ginners are highlighted in Table 5.

Table 5. Selected Mid-South Cotton Gin Statistics, 2013 Gin Season.

Bales Ginned	Days Operated	% Round Module	% of Gin Held by Largest Owner
16,691.55	45.94	47.66	58.03
% of Bales Ginned on Land Controlled by Gin Ownership	**Average Longest Haul from Farm to Gin (mi)**	**%Round Bales Hauled w/Module Trucks**	**% of Gins Outsourced Hauling Some Round Modules**
66.52	57.25	77.27	56.52

The next step was to identify cost affiliated with module harvesting. Cotton producers would harvest cotton using their own harvest equipment and place the harvested cotton (either in traditional loaf-style rectangular modules or the smaller round modules) from module harvesters at the end of rows in fields. Cotton gins would then arrange for the cotton to be collected and transported from field to gin. Shipping costs are the responsibility of the gin. Consequently, the change in technology from traditional modules to smaller round modules has implications for gins, their shipping costs, and the technology/procurement method for transporting modules.

Questions 18-22 of the survey were included in the questionnaire to address the module transportation cost and structure. Based on results from the 2010 survey, and a small pre-test of potential survey questions from on-site visits to cotton gins in 2013, it was believed that there was a sizeable distribution in both the proportion of cotton ginned coming from round modules as well as the methods used by gins to transport the equipment. However, results received were unexpected and have implications for cost analysis in Objective Three and efficiency analysis in Objective Four.

When evaluating ginners that used their own equipment, just over three-quarters (77%) used only their own module hauling trucks. In fact, even the remaining 23% of ginners that mixed module hauling trucks with flatbed trailers and other modified equipment picked up at least 60% of their round modules with traditional module hauling trucks. These results likely suggest cotton gins still have sizeable assets on their balance sheets in the form of module trucks and the "sunk cost" of these assets is a rational cost minimizing economic decision.

At the same time, approximately 56% of ginners stated they outsourced to a private hauler some or all of their round modules. These results suggest that ginners are choosing options to transport cotton from farm to gin that does not involve using their own equipment 100% of the time.

Due to the response rate and inconsistency in response structure by ginner from question to question, it is difficult to tease out statistically significant results. There was a question included that might provide insight. In Question #21 of the survey, after asking what percentage of cotton a ginner hauled with module trucks, flatbed trailers, and other (using equipment you owned), a question was asked concerning a distance between field and gin

where the ginner switched between module truck and flatbed trailer. Further, based on the answer to that question, what were the reasons for switching or not switching?

Almost all gins (96%) stated that they did not have a set mileage in which they switched from using module trucks to some other form of transportation with their own equipment (flatbed trailer, etc.). Several responses were received highlighting the reasons for not having a specific mileage. The major reasons included "not enough volume" or "all cotton relatively close to gin." At the same time, over half of these gins also outsourced some of the transportation of their round bale modules to private haulers. With such few observations (only six of the ginners provided text-based responses to the question), it is difficult to draw any solid statistical inference. However, the small amount of evidence these responses suggest factors driving transportation decisions.

As stated before, gins with existing module trucks to haul cotton from gin already have the sunk cost of transportation equipment; consequently, their only variable costs of operation from year-to-year includes maintenance and repair of the trucks plus the variable costs of fuel per round trip from farm to gin based on distance. Based on survey results, gins that outsourced to custom hauler paid approximately $25 per round module hauled ($24.86).

Unfortunately, because gin respondents did not provide their cost per bale to haul traditional or round modules using their own module trucks, this project is unable to tease out the 25% to 100% sensitivity in transportation cost changes due to increased transportation of round bale modules. However, as mentioned previously, in the three years between gin cost surveys, round bale modules went from 14% to almost 48%, a 343% increase. This increase was much higher than researchers imagined at the proposal development stage and suggests that the largest producers are adopting these module harvesters at a much faster rate than previously expected. The largest producers likely penciled the per acre cost savings Objective One identified and switched at a rapid pace during this period. Gins were forced to adapt more quickly to these alternative modules, and thus, are continuing to use legacy transportation equipment (e.g. module trucks) until such a period of time that these trucks have been depreciated.

When taking the collection of survey results in total, their findings suggest that many gins in the Mid-South do not source a high percentage of cotton they gin from long distances. Consequently, the gains in cost savings by hauling a few additional round modules in a typical flatbed configuration does not provide sizeable fuel savings per mile compared to hauling four modules in a traditional module truck. Further historically lower cotton production levels from past decades suggest that ginners may be less willing to invest in flatbed trailers and tractors when private agricultural hauling options are available. The outsourced option provides reduced "asset fixity" in the hauling equipment (especially when the gin owner does not have complimentary business operations to use the truck and trailer during other times of the year) as well as flexibility to pick up cotton during peak harvest times when a gin may have all of their trucks operating at full capacity and there is excess hauling demand to be met or a module truck is in the shop and the private

hauler can be used to maintain sufficient inventory of cotton in the gin yard to keep the gin operating at full capacity.

Objective Four Approach

To accomplish this objective, the original goal was to take new semi-parametric approaches to efficiency analysis as highlighted by Nedelea and Fannin (2013) from the rural health sector and apply it to cotton ginning. Unfortunately, during further analysis after this publication, the project investigator found out the proposed technique chosen would be inappropriate in measuring efficiency due to small sample size that came from response rate of the survey instrument.

The second option evaluated by the project investigators was to use traditional parametric efficiency techniques such as the efficiency stochastic frontier analysis. While this approach can be problematic if the incorrect functional form is chosen, there are a few previous published studies that have used flexible functional forms that could be chosen for the analysis that would mitigate this problem.

The original plan was to use data from the costs gins incurred from using their own equipment combined with the outsourced hauling cost data. Unfortunately, after completing the descriptive statistical analysis, there were few if any complete responses provided by gins to the question of transportation costs from module trucks or flatbed trailers they owned. The only transportation cost data provided by gins that was deemed reliable was the outsourcing cost per round module provided by the percent of ginners who outsourced. Consequently, this number was even too small to perform a parametric analysis and generate parameter estimates with any statistical confidence.

As a result, the approach taken to address efficiency was an indirect approach. The approach assumed that cotton gins that outsource were choosing so to minimize costs. As a result, the attributes of those gins that outsource should point to the profile of gins that would increase cost efficiency by choosing to outsource. Correlating factors were then identified with those gins that do choose to outsource. Results from this approach should then assist those gins evaluating the decision to outsource based on the factors identified.

Identifying which attributes of gins from the survey may suggest an increase likelihood of outsourcing round bale modules to a custom hauler. It was hypothesized gins outsource to custom haulers when the gin has a higher percentage of its cotton sourced from cotton fields far removed from the location of the gin. There were several questions (Questions #18-20) that could be used. Further correlations were evaluated on the percentage of total cotton ginned based on distance from field to gin (< 5 miles, 5 to 10 miles, 11 to 25 miles, and >25 miles). It was expected those gins that have a higher percentage of their cotton sourced from fields >25 miles away to have a higher likelihood of outsourcing and lower likelihood for those gins with most of their cotton sourced less than five miles from the gin.

To estimate this correlation, a point biserial correlation coefficient was applied. This correlation coefficient allows for measuring correlation between a continuous variable

and the dichotomous variable (the decision to outsource). The results are highlighted in Table 6.

Objective Four Key Findings
The results showed no pattern that would be consistent with a hypothesis that increased distance increased the likelihood that a ginner would outsource the hauling of round modules. None of the distance related correlation coefficients were statistically significant (as measured by p-values of 0.05 or lower).

Table 6. Correlation Coefficients on the Decision to Outsource Round Bale Module Hauling.

Attributes	Point Biserial Correlation Coefficient	P-Value
Distance		
Longest Distance Field to Gin (miles)	0.23	0.38
% Ginned < 5 miles	0.04	0.88
% Ginned 5 to 10 miles	0.26	0.23
% Ginned 11 to 25 miles	-0.20	0.34
% Ginned 25 miles	-0.07	0.75
Other		
% Round Bales	-0.05	0.83
Gin Days Operated	0.33	0.11
Number of Bales Ginned	**0.45**	**0.02**

Based on these results, project investigators reviewed additional survey results to evaluate and see if any correlation pattern existed between the likelihood to outsource (positive or negative) with any other variables. Several additional variables were tested including such variables as number of bales ginned and percentage of total modules ginned that were round modules. These results are also highlighted in Table 6.

The results showed that while the percentage of total modules that a gin harvests from round modules is not significantly correlated to the likelihood of outsourcing, total bales ginned is significantly positively correlated with the decision to outsource.

Since 2013 continued to be a year with reduced cotton production across the Mid-South, many gins were able to meet their transportation needs with module trucks exclusively even from increased distances due to existing sunk cost investments from their module truck fleet and the need to maintain seasonal employment of these truck drivers throughout ginning season. Only those gins with larger ginning volumes could capture value by outsourcing to custom haulers. These results suggest that while the economics of distance for alternative hauling systems created by the module harvester may exist on paper, the legacy infrastructure of traditional module harvesting systems by gins combined with low cotton production levels in the Mid-South have resulted in reduced demand for alternative transportation systems of the raw cotton product in the marketing system from field to gin.

Current and Future Benefits/Beneficiaries from Research

The current beneficiaries of this project include several stakeholders along the cotton marketing supply chain. The major findings from this research highlight a direct cost savings for cotton producers growing in excess of 1,500 acres of cotton each year. At 1,500 acres of cotton produced, annually, the cost savings of the module harvesting system start to exceed the costs to harvest cotton using the traditional system of basket harvesters, boll buggies, and separate module builders. Cotton ginners that expect to average planting 1,500 acres or more over 10 consecutive years and have fully depreciated traditional harvesting equipment would see cost savings and the resulting increase in net returns per acre by investing in the alternative module harvesting system.

Future beneficiaries of the research include both cotton gins and smaller cotton producers. For cotton gins, the module harvesting system results in greater harvesting rates per hour compared to the traditional system. Under this scenario, cotton produced near gins in the Mid-South can be harvested in a more compressed harvest time window. If cotton prices rebound to increase overall cotton acreage in the Mid-South, cotton gins will benefit by allowing many of them to move from operating at reduced capacity (many at only one 8 to 12 hour shift) to two shifts. As shown in the results, as volume increases, the benefit of the round modules is that gins can use both their legacy module trucks as well as outsourced custom haulers using flatbed and modified flatbed trailers. Consequently, cotton modules sit out at the row edges of fields for fewer days and gins are able to gain additional operating efficiencies due to running multiple shifts.

This research suggests that small cotton producers may benefit as well in the future from the round module harvest system. While producers harvesting less that 1,500 acres do not see financial benefits from investing in the round module harvest system, a growing number of producers in the Mid-South have sold cotton harvesting equipment due to planting alternative commodities over several consecutive years due to higher relative prices/returns (e.g. corn soybeans). If cotton prices rebound to make cotton more profitable on a relative basis, results from this study suggest an opportunity for custom cotton harvesting exists – especially for states that have a historically higher proportion of small cotton farms (e.g. Louisiana and Mississippi). These results suggest an outsourced custom harvesting option may be viable. However, it is difficult from this research to know whether the custom harvesting would originate from existing large producers that have round module harvesters providing the service, a full-time custom harvester that would go from state to state throughout the Mid-South harvest season to obtain sufficient acres to make the business profitable, or a cotton gin that would integrate backwards in the marketing chain to custom haul in order to increase cotton volume and gain cost efficiencies from increased cotton ginned.

Recommendations for Future Research

This research pointed to several potential future research projects. First, research identifying at what relative price ratios would cotton have to reach in comparison to major commodity alternatives (e.g. corn and soybeans) to increase the percentage of acres

planted on a given Mid-South row crop farm would be valuable to ginners. In addressing this question, researchers would need to identify how the availability of either owned infrastructure by the farmer or availability of custom harvesting would increase/decrease proposed acreage.

This research also pointed to the need to understand the capacity and age of legacy cotton module transportation systems by gins. Cotton gins continue to use existing module trucks to harvest new round bale modules. Research identifying the average age and quantity of module trucks per gin would give an indication of how these sunk costs investments will influence the future demand for custom module transportation alternatives in the marketing supply chain under a historically lower cotton production environment.

Additional Information for the Project

A journal publication from this research is currently In Press. The citation for this project is listed below:

Salassi, Michael E., Michael A. Deliberto, and Lawrence L. Falconer. (2015, In Press). Comparative Costs of Onboard Module Building Cotton Harvest Systems. *Journal of the American Society of Farm Managers and Rural Appraisers.*

The Cotton Ginning Survey Instrument is located in the Appendix.

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Appendix.

Ginning Information Survey -- 2013 Season

Section 1. Ginning Costs. This section includes questions from Tommy Valco on your ginning costs from the 2013 season. These are identical questions asked from previous ginning cost surveys sent out by SCGA.

Capacity

1. Number of bales ginned: _____ Actual Days Operated _____

   Number of Shifts _____ Hours per Shift _____

2. Type cotton ginned:
   Machine picked _____% → Round Modules _____ %
   Stripped, field cleaned _____%
   Stripped, not field cleaned _____%

3. Avg hourly ginning rate: _____ bale/hr Rated Gin Capacity: _____ bale/hr.

Energy Usage

4. Total electricity used during season:
   _____KWH.

5. Total cost of electricity used during season: $ _____.
6. Total drier fuel used during season:
   _____ Gallons of liquified gas **OR** _____ cubic feet of natural gas.

7. Total cost of drier fuel for season:
   _____ .

Labor Costs

8. Total seasonal labor cost: $_____ Avg. Number of season workers_____.
   Include: seasonal wages, workers comp. insurance, social security, fringe benefits, etc. (Do not include permanent, full- time employees.)

9. Total full time labor cost: $ _____ Avg. Number full-time workers _____.
   Include: bonuses, workers comp. insurance, social security, fringe benefits, etc. If these employees spend part of their time on associated businesses such as bale warehousing, farm supplies, etc., please include only your estimate of the part applicable to ginning.

Other Costs

10. Cost of Bagging _____$/bale and Ties ***circle one*** (Wire or Plastic) _____ $/bale.

11. Cost of repairs and maintenance: $_____
    (Do not include capital improvements, capacity increases, or system modifications.)

12. Capital Improvements or Modifications: $_____

13. Description of Improvements_____

14. Module Traps $_____ Round Module Wraps $ _____

Section 2. Current Issues. This section includes questions about the ginning structure in the Mid-South. Questions will help SCGA better understand trends and challenges facing the industry in coming years.

Ownership Structure

15. How many owners does your gin have?_____
(Count direct/extended family members as one owner)
What percent of gin ownership is concentrated in the largest owner_____%?

16. What percentage of your total cotton ginned in 2013 was cotton produced on land either owned or controlled by gin ownership?_____

17. Did your gin (or its ownership) custom harvest any of the cotton not on land owned/controlled by gin ownership? 2013? (Yes/No) Number of gin's total bales_____ % of these round bales_____

Transportation

18. What percentage of the cotton ginned in 2013 was transported from fields with a given distance from the gin? (total should sum to 100%)
< 5 miles_____% 5 to 10 miles_____% 11 to 25 miles_____% >25 miles_____%

19. What was the longest distance you transported modules from field to gin in 2013?
_____miles.

20. What percentage did this longest hauled cotton make up your total cotton ginned in 2013? _____%

21. What percentage of the round modules was transported with the following gin owned equipment?
Traditional module trucks _____% Average Hauling Costs per module $_____
Semi-Tractor Trailer (flatbed, other) _____% Average Hauling Costs per module $_____
Other Modified Trailer _____% Average Hauling Costs per module $_____

Is there a given distance from the gin at which you switch from hauling using module trucks to other equipment? (Yes / No) If yes, what distance_____? If no, why not?_____

22. Did you outsource to custom haulers to transport round modules to the gin in 2013? (Yes / No).

If Yes, what percent of the round modules was custom hauled_____%
What was your average cost per round modules custom hauled $_____

Outlook for 2014 and Beyond

23. How many bales do you expect to gin in 2014?____

24. What percentage of the cotton you expect to gin in 2014 will be sourced from fields how far away from the gin? (total should sum to 100%)
< 5 miles_____% 5 to 10 miles_____% 11 to 25 miles_____% >25 miles_____%

25. What percent of cotton in 2014 do you expect to gin from traditional modules?_____% On-board module harvesters?_____% (total should sum to 100%)

26. In the next three years, what is the probability your gin
    a. increases % of cotton modules transported by custom hauliers?_____
    b. adds custom harvesting or increases % of custom harvesting?_____

27. In the next three years, what is the probability your gin
    a. increases the number of producers you gin for? _____
    b. decreases the number of producers you gin for? _____
    c. goes out of business or is purchased by a competitor gin?_____

STATE: ____ GIN NAME (Optional): _____

Person furnishing information (Optional): _____

Individual information will be kept confidential. Thanks for your help! If you have questions about completing this survey, contact Tommy Valco, (662) 686-5255 or Thomas.Valco@ars.usda.gov

RETURN OR **FAX TO:** Southern Cotton Ginners Association, 874 Cotton Gin Pl. Memphis, TN 38106, FAX 901/947-3103

Ginning Infrastructure Summary Findings

SCGA Annual Meeting
Memphis, TN
March 1, 2011

LSU AgCenter
Research & Extension

Financial Support

- Project funded by USDA Agricultural Marketing Service Federal State Marketing Improvement Program
- Project Number USDA 12-25G-0888
- Project Duration Sep 2009 – Feb 2012

Project – 3 Parts

- Part 1 – Spatial Gin Infrastructure Change from reduced acreage period
- Part 2 – Relative Profitability of Cotton relative to Corn and Soybeans over Reference Period
- Part 3 (Revised)– Understand Future Direction of Gin Infrastructure
- Today we re-emphasize Part 1 and discuss future direction with Part 3

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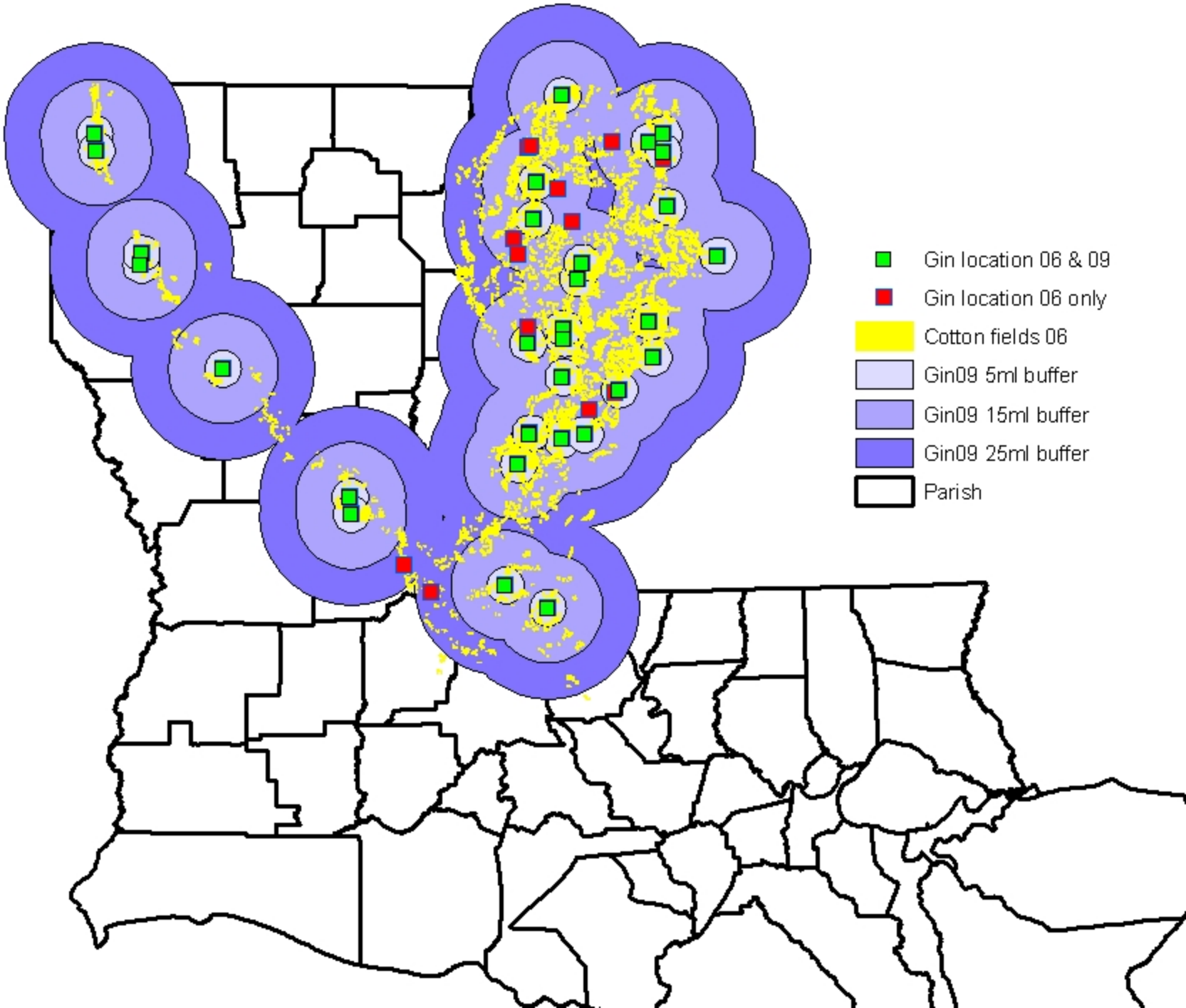
Gin location 06 & 09
Gin location 06 only
Cotton fields 06
Gin09 5ml buffer
Gin09 15ml buffer
Gin09 25ml buffer
Parish

2006 Fields with 2009 Gins

	Nearest	Second	Third
	Miles	Miles	Miles
Average	8.33	13.65	21.21
Median	6.86	12.39	19.52
Std. Dev.	5.69	6.88	10.67
< 5 miles	34.00%	6.90%	0.57%
< 10 miles	68.88%	35.76%	12.27%
< 15 miles	85.89%	62.90%	33.51%
< 25 miles	99.19%	92.07%	69.18%

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Ginning Information Survey

- Combination of Ginning Cost Survey (Tommy Valco) and ginning industry trends (Fannin and Paxton)
- Surveys received early May through early July 2011
- Total responses received 41 (for Fannin and Paxton Section)
- Represents approximately 23% of total surveys sent

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Survey Results

- Percentage of cotton ginned that was owned/controlled by gin ownership 2010
  - 55%
- Percentage of cotton ginned that was owned/controlled by gin ownership in 2007
  - 51%

Ginning Survey Results

- Expected Distance traveled from field to gin for 2011 based on gin

		Field to Gin Distance (% of Bales Ginned)			
		<5 miles	5 to 10 miles	11 to 25 miles	>25 miles
Bales Ginned	< 15K	16.94	34.20	36.11	12.75
	15K-30K	13.71	33.50	39.57	13.23
	>30K	8.17	25.51	35.43	18.39

Average longest hauled cotton increased from 36 to 43 miles between 2007 and 2010 surveys across all gin sizes

Ginning Survey Results

- Larger Gins expected a greater percentage of 2011 bales to have come from on-board module harvesters (9% average in 2010)

		% Traditional	% On-Board Module Harvesters
Bales Ginned	< 15K	88.55	11.45
	15K-30K	80.07	19.93
	>30K	63.57	36.43

Ginning Survey Results

- Asked ginners over the next three years what was the percent probability they would have 1) the same # of producers, 2) add new producers, 3) go out of business

		Same # Producers	Add New Producers	Go Out of Business
Bales Ginned	< 15K	82.72	7.38	9.89
	15K-30K	78.27	18.94	2.79
	>30K	90.40	8.80	0.80

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Synthesis of Preliminary Findings

- On-board harvester modules a growing percentage of modules ginned
- This technological change leads to a number of future questions each gin will have to answer
  - Do I invest to handle these new modules?
  - What technologies change in the supply chain? handling equipment, hauling, etc.
  - How does ownership along the supply chain change?

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New Study

- Federal State Marketing Improvement Program approved second phase of cotton ginning research study
- Focused on transportation logistics and ownership issues surrounding new onboard module harvester technology
- Original $20k investment by Foundation has now leveraged an additional $126K, or a multiplier of 6, over 2 funded studies

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Thank You!

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Changes in Mid-South Cotton Ginning Infrastructure

SCGA Mid-Year Meeting
New Orleans, LA
July 17, 2012

LSU AgCenter
Research & Extension

Financial Support

- Project funded by USDA Agricultural Marketing Service Federal State Marketing Improvement Program
- Project Number USDA 12-25-G-1277
- Project Duration Sep 2011 – Aug 2013
- Extends AMS Cotton Ginning Research funded by Project Number USDA 12-25G-0888

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- Surveys received early May through early July 2011
- Total responses received 41 (for Fannin and Paxton Section)
- Represents approximately 23% of total surveys sent

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Ginning Survey Results

- Expected Distance traveled from field to gin for 2011 based on gin

	Field to Gin Distance (% of Bales Ginned)			
	<5 miles	5 to 10 miles	11 to 25 miles	>25 miles
MO	17.75	43.77	33.95	4.53
TN	10.83	22.17	47.83	19.17
AR	15.63	43.48	31.88	9.01
MS	23.13	28.00	32.50	16.38
LA	9.00	21.00	45.83	24.17

Average longest hauled cotton increased from 36 to 43 miles between 2007 and 2010 surveys across all gin sizes

Thank You!

- J. Matthew Fannin

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