SUMMARY

The goal of this project was to evaluate the performance and economic return of GPS based auto-guidance when used in peanuts produced in a variety of tillage systems under rolling terrain. The project was conducted concurrently by Auburn University and University of Georgia scientists in Alabama and Georgia, respectively. This report presents only the results from the Georgia portion of the project.

GPS-based auto-steer on tractors allows the operator to place the tractor to within 1 inch of the desired center line. When used for planting and digging, auto-steer has the potential of eliminating producer concerns about properly centering the equipment in a completely closed canopy especially when crops are planted using contour farming. This project was specifically designed to evaluate how auto-steer can reduce digging losses when used in a strip tillage cropping system on relatively steep slopes and contours.

An experiment was established on a 24 ac field in Turner County, Georgia. The field was divided into alternating 12-row strips of peanuts planted and inverted using auto-steer alone hereafter referred to as AutoPilot, auto-steer enhanced by a “passive” guidance system that controls the implement hereafter referred to as TrueGuide, or traditional techniques hereafter referred to as Manual. Planting, inverting, and harvesting were done with 4-row equipment. Thus each strip consisted of 3 passes of the equipment. The same tractor, planting, and inverting equipment was used for all operations. The tractor was a JD 7700 belonging to the University of Georgia Precision Ag Team and was equipped with a state-of-the-art Trimble AutoPilot® auto-steer system provided at no cost by Trimble.

The field contained several non-parallel terraces. The cropping pattern was established parallel to the first terrace which required the tractor to cross the other two terraces at sharp angles on fairly steep slopes during planting and inverting. During planting and inverting, the auto-steer system experienced some difficulty maintaining parallel paths while in high curvature conditions but overall, the auto-steer system performed well.

Peanuts were planted on May 11-12, 2011, inverted on September 29-30, 2011, and harvested on October 05-06, 2011. Yield data were collected from each pass (middle 4 rows) of each strip. Average yields were 5152 lb/ac, 5422 lb/ac, and 5472 lb/ac for the Manual, AutoPilot, and TrueGuide treatments, respectively. AutoPilot outperformed Manual by 270 lb/ac while TrueGuide outperformed Manual by 320 lb/ac.
INTRODUCTION

Studies have shown that switching from traditional single rows to a twin-row pattern along with using conservation crop management strategies can improve soil quality, reduce diseases such as Tomato Spotted Wilt Virus (TSWV), and increase yields while enhancing profitability. Yet producers have been slow to adopt these improvements because of perceived potential yield losses during digging and inversion operations. Peanut canopy coverage increases in narrow single-row or twin-row planting patterns compared to traditional wide single-row planting patterns. This spacing makes rows less visible at harvest and thus makes it more difficult for the tractor operator to center the equipment on the target rows (Beasley, 1970; Henning et al., 1982). Furthermore, many peanut producers have expressed concern with reduced pegging in crop residues when using conservation tillage. Yet four-years of data from controlled studies in Florida, Georgia, and Alabama indicate that (i) twin-row peanuts have a 500 lb/ac yield advantage over single-row peanuts; (ii) crop residues have minimal impact on pegging, and (iii) yields from peanuts grown under conservation tillage are equal to yields from peanuts grown under conventional tillage systems (Rowland et al., 2007).

GPS based auto-steer on tractors allows the operator to place the tractor to within 1 inch of the desired center line. When used for planting, spraying, and digging, auto-steer has the potential of eliminating producer concerns about properly centering the equipment in a completely closed canopy especially when crops are planted using contour farming. Specific potential benefits of auto-steer are: (i) avoiding/eliminating digging losses caused by improperly centering equipment during digging; (ii) enabling twin-row planting patterns to be used in conservation tillage systems because row-centering over a single subsoil slot is no longer an issue; (iii) extending the hours of planting, digging and other operations because visibility is no longer an issue; and (iv) improving overall field efficiency because auto-steer allows the tractor operator to focus on the field operation rather than driving.

The goal of this project was to evaluate the performance and economic return of GPS based auto-guidance when used in peanuts. The project was specifically designed to evaluate how auto-steer can reduce digging losses when used in a strip tillage cropping system on relatively steep slopes with contours. The project was conducted concurrently by Auburn University and University of Georgia scientists in Alabama and Georgia, respectively. This report presents only the Georgia portion of the project.

METHODS

An experiment was established on a 28 ac field in Turner County, Georgia (Figure 1). The field was divided into alternating 12-row strips of peanuts planted and inverted using auto-steer alone hereafter referred to as AutoPilot, auto-steer enhanced by a “passive” guidance system that controls the implement hereafter referred to as TrueGuide, or traditional techniques hereafter referred to as Manual. The TrueGuide is designed for implements pulled by a ball hitch which allows true articulation between the tractor and the implement. Articulation allows the tractor to position itself so that the implement is centered on the desired path. Since both of the implements used in this study were pulled using a 3-point hitch, the TrueGuide treatment was incorporated into the study to evaluate its performance under the conditions described rather than to evaluate at it as a production alternative for southeastern peanut growers. The experimental design resulted in 102 passes, 34 replicated strips, and between 10 and 11 replicates for each treatment (Figure 2).
Planting, inverting, and harvesting were done with 4-row equipment. Thus each strip consisted of 3 passes of the equipment. The same tractor, planting, and inverting equipment was used for all operations. The tractor was a JD 7700 belonging to the University of Georgia Precision Ag Team and was equipped with a state-of-the-art Trimble AutoPilot® auto-steer system provided at no cost by Trimble. Throughout planting and inverting, technical support staff from Ag Technologies in Cordele, a Trimble distributor and the company which installed the Trimble auto-steer system on the UGA tractor, were present to ensure that the auto-steer system was performing properly. This two-year study would not have been possible without their material and technical support.

Peanuts were planted on May 11-12, 2011 using strip tillage techniques although there was relatively little ground cover on the field at planting. Strip tillage and planting were done in a single operation (Figure 3). The field contained three non-parallel terraces. The cropping pattern was established parallel to the first terrace (center of the field in Figures 1 and 2) which required the tractor to cross the other two terraces at sharp angles on fairly steep slopes during planting and inverting. The auto-steer reference line (commonly referred to as the A-B line) was also established parallel to the first terrace. “Trimming” or manually correcting the tractor’s path while in auto-steer mode was not used.

The crop was inverted with a 4-row KMC inverter without problems on September 29-30, 2011 (Figure 4). Peanuts were harvested October 05-06, 2011 using a 4-row KMC peanut combine. Yield data were collected from each pass of each strip by weighing the mass of the peanuts with a wagon pulled onto truck scales with 5 lb resolution (Figure 5).

**RESULTS**

Because of the extended drought, the peanut grower decided to harvest the dry corners of the field separately from the irrigated peanuts. As a result, about 5 acres were harvested without yield data being collected. The remaining area was 23.4 acres (Figure 6). Passes 61-63, originally a Manual treatment replicate, were not included in the yield results because they were accidentally partially inverted using auto-steer.

The auto-steer systems performed well with no technical problems at either planting or inverting. We did notice that when the TrueGuide was engaged, the auto-steer system occasionally had difficulty maintaining the centerline under high curvature conditions. Theoretically, this was caused by the auto-steer system’s onboard computer attempting to place the implement on the centerline but being inhibited by the 3-point hitch connection to the tractor.

The experimental design contained strips with high, medium, and low curvature. In addition to evaluating the results for the entire field, we also segregated the data into these curvature categories (Figure 7). To evaluate the effect of curvature, the following passes were evaluated together:

- High curvature – passes 1-18, 58-60
- Medium curvature – passes 19-54
- Low curvature – passes 64-102
- All curvatures – passes 1-102
Table 1 presents the yield results from each of the treatments. Mass was recorded as described above for each of the 102 f-row passes. The area of each 4-row pass was calculated using the FarmWorks® geographic information system software. Yield was calculated by dividing mass by pass area. The average yield of all passes was 5152 lb/ac, 5422 lb/ac, and 5472 lb/ac for the Manual, AutoPilot, and TrueGuide treatments, respectively. AutoPilot outperformed Manual by 270 lb/ac while TrueGuide outperformed Manual by 320 lb/ac (Table 1).

TrueGuide performed poorly under high curvature conditions with average yields 208 lb/ac less than Manual and 295 lb/ac less than AutoPilot (Table 1). This was most likely caused by the 3-point hitch used to pull the implements. As discussed earlier, TrueGuide is designed for a ball hitch which allows the auto-steer system to adjust the position of the implement by changing the orientation of the tractor. With 3-point hitch systems this is not possible. Instead the entire assembly (tractor + implement) must be repositioned. Under high curvature conditions, this is problematic. In contrast, under low curvature conditions TrueGuide outperformed Manual by 877 lb/ac (Table 1).

In this experiment, the AutoPilot treatment consistently outperformed Manual with performance increasing as curvature decreased. Under high curvature conditions, AutoPilot outperformed Manual by 87 lb/ac. Under low curvature conditions AutoPilot outperformed Manual by 460 lb/ac. In general, the ability of the AutoPilot to keep an implement on the centerline decreases as curvature increases. Economic analyses will be conducted cumulatively for the 2010 and 2011 growing season and will be reported later.

**Conclusions**

Using auto-steer to plant and invert peanuts results in yield increases and appears to be an important tool for peanut growers interested in improving their production efficiency. We recommend the study be repeated using a “passive” guidance system that controls the position of the implement once implements for peanut planting and inverting with ball-type hitches become available. In the meantime, it appears that using a “passive” guidance system to control the position of the implement under low curvature conditions provides a significant yield advantage even with 3-point hitch implements.

Table 1. Yield results from the 2011 auto-steer study in Georgia.

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1 AutoPilot – Manual;
2 TrueGuide – Manual
ACKNOWLEDGEMENTS

Mr. Keith Barnette was our grower-partner for this project. He allowed us to conduct the project on his land and contributed greatly to the project's success.

Trimble and Ag Technologies (Cordele, GA) provided a state-of-the-art AgGPS Autopilot system for the project as well as technical support during planting and inverting.

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REFERENCES


**Figure 1.** Twenty-eight acres of this field in Turner Co., Georgia were used for the study. The field was enlarged in the spring of 2011 to accommodate a new center pivot irrigation system. Our experimental design has been superimposed on the photograph showing the original field boundaries.

**Figure 2.** Schematic of the experimental design used during the 2011 study. Each strip consisted of 12 rows of peanuts planted, inverted, and harvested in 3 passes with 4-row equipment. The colors represent each of three treatments – AutoPilot, TrueGuide, and Manual. The number in each strip represents the total number of passes to that point beginning with the center of the field and moving outwards.
Figure 3. Peanuts were planted on May 11-12, 2011 using strip-tillage techniques. The tractor was equipped with a Trimble AgGPS Autopilot® system.

Figure 4. Inverting peanuts on September 29-30, 2011. Trimble staff and the cooperating grower are in the cab of the tractor.
Figure 5. Recording the mass of peanuts harvested from a pass. Four-wheel peanut wagons were mounted on truck scales with 5 lb resolution.
Figure 6. The opaque areas were harvested separately by the grower because they were not irrigated. These areas were not included in the yield results.

Figure 7. The colored opaque areas represent the replicates (strips) which were in low, medium, and high curvature strips.