A Note on the Application of an AgLeader® Cotton Yield Monitor for Measuring Peanut Yield: An Investigation in Two US states.

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ABSTRACT

Previous researchers demonstrated the ability to adapt an AgLeader® Cotton Monitor to a peanut combine. It was demonstrated that the field weight could be accurately predicted with average errors of less than 10% across all trials when at least five calibration loads are applied. This project focused on expanding previous work performed at the University of Georgia and other peanut optical yield monitor work by incorporating a protective deflector plate for the sensors, obtaining multiple field weights, and using the peanut sale sheets to correlate yield monitor yield to sale weight. This study was a two-university, two-state effort, including Oklahoma State University (Oklahoma), and Mississippi State University (Mississippi). Data collected during this study included multiple loads which included yield monitor weight, field weight, field moisture content, and all the information presented on the standard USDA peanut grade sheet, when available. The multi-state effort allowed for the incorporation of the two major peanut types and for the incorporation of different soil types. The goal of this study was to develop guidelines for using, calibrating, and adapting the AgLeader® Cotton Monitor for peanut harvest. Five calibration loads referenced to buy-point net weight were typically needed to bring error within acceptable limits. Results indicated that multiple local calibrations were needed to ensure high data validity and yield estimation across multiple harvest environments. The data showed that peanut type (virginia, runner and spanish) and variable soil conditions impacted yield estimation.

Keywords: Peanut, Yield Monitor, Moisture Content, Optical Yield Monitor

Precision agriculture has been defined as the more spatially precise management of crop inputs based on knowledge gained from the crop or production field. Typical practices range from a soil sampling scheme to yield data analysis. To perform many of these operations, specific technologies are needed. Yield monitors are common original equipment manufacturer features in today's grain combines and cotton pickers. Yield monitors designed for specialty crops have been slower in development, improvement of accuracy and commercialization than the yield monitors used for grain and cotton. Harsh crop harvest environments, such as those seen during peanut harvest, slow the development and use of yield monitors due to factors including high levels of foreign material, wide diversity in crop uniformity during harvest, lack of equivalent technologies for moisture content quantification and lack of suitable measurement locations on the harvester.

There have been many studies (Durrence *et al.*, 1999; Hamrita *et al.*, 2000; Thomas *et al.*, 1999; Thomasson *et al.*, 2006; Rains *et al.*, 2005; and Vellidis *et al.*, 2001) that have investigated various solutions to accurately measure mass flow of peanuts in a combine. Most of the earlier studies focused on using load cells strategically placed to measure mass flow of peanuts as they travelled through the combine in conveyance augers under the combine. One of the most successful load cell-based systems was the peanut yield monitoring system (PYMS) developed by Vellidis *et al.* (2001). Four load cells were placed beneath the basket located on top of the peanut combine. Typical errors in PYMS were in the $\pm 5\%$ range which is considered to be within an acceptable range for yield estimation. However, a major drawback of PYMS was a low-resolution yield estimation ($<$ 700 kg/ha) as a function of the possible number of discrete divisions across full scale output of the load cells (Vellidis *et al.*, 2001). When using a system such as this, small differences in yield within the area harvested for a load cannot be detected to the level required for making precision, site-specific management decisions. The PYMS system is very accurate in monitoring load weights and can be used as a calibration check for other systems. A system operating on a similar concept was developed by Clemson University (SC, USA) researchers, but designed specifically for measuring cumulative weights of small loads ($<$45.36 kg) associated with research plot studies (Kirk *et al.*, 2012).

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Rains *et al.* (2005) reported that an optical monitor could be one of the best options for peanut yield monitoring. Extensive work was performed by University of Georgia (GA, USA) researchers during the 2000, 2001 and 2002 peanut harvest seasons testing the AgLeader® cotton yield monitor (AgLeader® Technology, Ames, IA, USA), for use in a peanut combine. The AgLeader® cotton yield monitor is an optical yield monitor that works in a pair of sensors, one an emitter and one a receiver. The system estimates yield based on the amount of time the light beams between the emitter and receiver are broken. A few problems were discovered while using this system in peanuts, including settings in the controlling computer such as fan speed and header height sensor, damage to the optical sensors by the increased presence of foreign material from peanut harvesting than from cotton harvesting, and moisture content of the peanuts. After addressing these issues through additions of baffling and venting in the conveyance duct, Rains *et al.* (2005) reported improved correlations and reduced mean absolute errors in load weights 3% to 10% using the AgLeader® yield monitor. Thomasson *et al.* (2006) reported coefficients of correlation of 0.89 to 0.96 (but not error estimates) between sensor outputs and peanut weights with a reflectance-based optical sensor tested in both Australia and Mississippi, USA. A distinguishing characteristic of the sensor used in this study was that it did not work in a pair (one transmitter and one receiver) as the AgLeader® sensors do. The sensor used by Thomasson *et al.* (2006) had an emitter and receiver on the same side of the duct and measured reflectance of near-infrared light. A single sensor can be advantageous because it eliminates the need for sensor alignment that is critical while using sensor pairs. However, it was noted by Thomasson *et al.* (2006) that reflectance-based measurement, in contrast to the AgLeader® through-beam technology, could result in varying weight to signal ratios caused by an inverse relationship between peanut moisture content and reflectance.

Previous efforts of this study by Porter *et al.* (2012) involved the development of a high-density PVC deflector to protect the sensor pairs and prevent dust accumulation. The deflectors have been successfully used in several US states for at least one harvest season. Additionally, the minimum recommended number of calibration loads was established at four loads (Porter *et al.*, 2012).

The project reported in this paper began in Oklahoma, USA in order to develop a valid way of checking peanut yields for on-the-farm research trials. In Mississippi, USA, yield monitoring was a critical part of a systematic study to improve grower peanut yield and quality. More work was completed to support and continue prior research efforts using optical sensors in peanuts. As with any sensor system, calibration was a key component to proper operation.

Fig. 1. The mounting location of the AgLeader Yield Monitor on a KMC 6-Row Peanut Combine.

Thus, the main goal of this project was to continue to develop standard calibration procedures and identify specific error sources for using an AgLeader® cotton yield monitor for estimating peanut yield. The specific objectives of this study were to evaluate a cotton yield monitor installed on peanut combines by determining correlations between yield monitor weight, gross weight and net weight as reported by the standard grading procedures, and to assess the effects of moisture content and foreign material (FM) on calibration and yield monitor performance.

Materials and Methods

A single AgLeader® sensor pair (model no. 4101069) was retrofitted to the conveying duct of peanut combines in Oklahoma and Mississippi. In Oklahoma, two KMC 3360 6-row peanut combines (Kelley Manufacturing Co., Tifton, Ga, USA) were used (Fig 1). In Mississippi, one KMC 3374 and one Amadas 2108 (Amadas Industries, Suffolk, Va, USA), both 4-row, were tested. The sensor pairs were mounted near the bottom of the clean peanut conveyor duct on all combines in this study.

In all cases, the sensor was used in conjunction with the AgLeader® Insight® monitor, which is a display that provides the ability to track the instantaneous yield of the field, as well as a header height sensor and a Differential Global Positioning

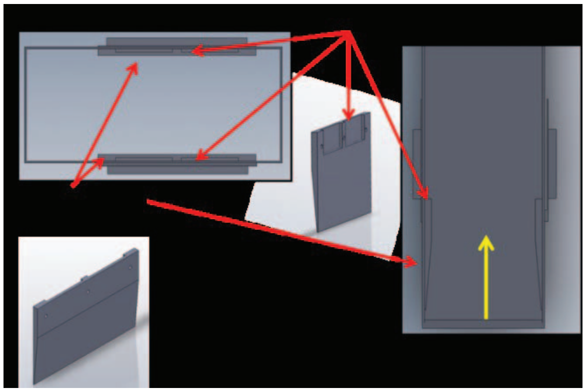

Fig. 2. CAD drawings of the deflector plate mounted inside of the combine chute. From top left clockwise, it is the air vents in the deflector, the back of the deflector with the vents shown, the vents mounted in the chute and a front view of the deflector.

Fig. 4. The peanut wagons and truck scales that were utilized to weigh each calibration and yield load in the field during harvest.

System (DGPS). The 2010 season was used for checking the feasibility of using the system on collaborating producer's equipment and in a producer's field.

Expanding on the work and taking recommendations from Rains *et al*. (2005), the deflector was made from high-density PVC. Air vent slots were incorporated into the design of the deflectors and slits were cut into the side of the air duct corresponding to the position of the slots. The air vents allowed for clean air to pass over the sensor emitters and receivers to prevent the buildup of dust and dirt (Fig 3). The deflectors prevented both damage and dust accumulation on the sensors. Even with the deflector plate it was discovered and reported by the combine operator that if the Insight® gave a degraded or low sensor signal warning, a quick cleaning of the sensor pairs would solve the problem.

Fig. 3. A representation of the optical sensors after three days of harvest, dust and dirt lightly accumulates, but there is little to no damage due to the deflector plates.

Oklahoma. During the 2011 and 2012 harvest seasons over 400 ha of peanuts were yield mapped near Eakley, OK, USA. Yield checks were performed for two different peanut types including spanish and runner varieties OL06 and OL11, respectively. Twenty-four loads were flagged during both years in the Insight® monitor as calibration loads. Of these loads, 15 were the spanish type and nine were the runner type. The loads were collected into peanut drying wagons which typically hold about two bin loads from a 6-row peanut combine. During 2011, a set of truck scales (Fig 4) was used to weigh each of the loads flagged for calibration. Since a single wagon held two bin loads, the first load weight was recorded to prevent loss of the initial weight before the second load was added to the wagon. A sample was collected from each of the wagon loads of peanuts to obtain field moisture content. Wet weight of the samples was measured in the field. The samples were dried at 29.4 C for 72 h and the dry weight was measured and recorded.

Once a wagon was filled, its unique identifying number was recorded. When all of the calibration loads for a specific field were finished, the peanut buy point was contacted with the wagon numbers. A peanut grade sheet was obtained for each of the individual calibration wagons. Grade sheets contained delivered weight, wagon tare weight and gross weight. The grade sheet also contained moisture content, foreign material, and net sale weight. It is important to note that peanuts are usually delivered to the buy point in one of two conditions, either after being allowed to dry in the field to approximately 10% moisture content in trailers similar to the ones in Fig 4, or delivered to the buy point at initial field moisture and dried at the buy point (which leads to extra cost to the producer). Net weight as represented on a peanut grade sheet is what a producer gets paid for thus it is one of the most important weights during peanut production and yield estimation.

During 2011, calibrations were not applied using the Insight® during the harvest process. All combinations of load calibrations were performed and recorded post-process. The use of post-process calibration procedures allowed for multiple combinations of loads to be used. The 2011 calibrations were applied to the 2012 harvest season, and the errors reported are from those calibrations. More uniform results were collected from the runner peanuts thus those were used for calibration checks. Since a total five loads were collected from the runner type, a combination of calibrations were performed using by using only one load to using all five loads as a calibration. As the number of calibration loads was increased, the overall error of yield prediction was reduced. Porter *et al.* 2012 reported that using up to five calibration loads improved yield prediction accuracy, but after five loads there were no benefits for additional calibration loads. Calibrations for both field weight as collected by the scales in the field and net weight as reported by the peanut grade sheet (calculated by corrected for FM and then correcting gross peanut weight to 7% MCwb (Butts, 1998), were tested in the Insight® Monitor. However, since the net weight is the more important value it was used for all data analysis and calibration procedures.

During 2012, the load weight of individual wagons was not measured in the field but only the individual wagon weights from the buy point were obtained since it was determined that this was the more important weight. Field moisture samples were still collected and analyzed.

Mississippi. Harvest was conducted with the KMC 3374 on 22 October 2012 in Northeast Mississippi. The 20.6 ha field under study consisted of Mantachie loam (0% - 2% slope, occasionally flooded) and Savannah loam (2% - 5% slope) soils (NRCS, 2013). Harvesting with the Amadas 2108 occurred on 2 Nov. 2012 in Central Mississippi. Harvest was again repeated on 26 October 2013 at the Central Mississippi location with the same harvesting equipment. This 10 ha field was established on Memphis silt loam (0% - 2% slope) soil (NRCS, 2013). The soil at the Northeast Mississippi location was heavier and more cohesive that those at the Central Mississippi location. The peanut variety at both sites and over both years was Georgia Green 06-G, a runner variety.

A separate calibration was used at each site and for each year, consisting of five calibration loads. Loads were measured with a set of portable truck scales (DX-300, Intercomp, Medina, MN, USA). The trailer carrying harvested peanuts between the combine and transport was a two-axle trailer; axle and tongue weights were both measured. The capacity of the truck scales limited the amount of peanuts that could be weighed during each calibration load to a single combine load.

Representative samples were collected from each calibration load because the growers' buy points utilized 13.7 m plenum-bottom trailers. It was not feasible to maintain discrete loads in individual trailers delivered to the buy point. Samples were collected, placed in sealed containers, and graded by USDA certified inspectors at the buy point. Standard peanut grade reports included foreign material (FM), loose-shelled kernels (LSK), moisture content (MC), and other grade factors reported on a wet-basis percentage (% wb). Calibration load net weight was calculated by correcting for FM and then correcting gross peanut weight to 7% MCwb (Butts, 1998). The 2012 data from the Central Mississippi site was not available due to an error at the buy point.

Results and Discussion

Rains *et al.* (2005) reported, the buildup of dirt and dust on the sensors hindered their operation. Based on the Rains *et al.* (2005) study a deflector (Fig 2) was designed, built, and installed to further protect and prolong the life of the optical sensors from debris in the conveying system. As observed during previous years of the study, the improved sensor deflector prevented excessive wear to and dust accumulation on the sensor pairs. The sensor deflector did not accumulate any extra dust, dirt, or foreign matter, due to design and venting in the system. During initial installation, care was taken to obtain proper alignment of the emitter and receiver to ensure maximum signal strength while in operation.

Oklahoma. Data for the 24 loads collected from the nine fields are shown in Table 1. The net weight for all loads exceeded 3500 kg. The loads in Table 1 are listed in the order that they were harvested. The net weight, gross weight, % foreign matter and LSKs were obtained from the inspection sheets at the buy point. The net weight is the gross weight minus foreign matter and moisture corrections. The net weights collected from the five loads of one field named the Blood field were used for calibration and the errors based on this calibration are shown in Table 1. The calibration number generated by the AgLeader monitor was 3797 and the

Table 1. Summary data for the 24 Oklahoma loads utilized for calibrating and verifying accuracy for the Ag Leader Yield Monitor collected during 2011 and 2012.

Wagon Label/Field	Type	Foreign Material (%) [a]	Least Shelled Kernels (%) [a]	Moisture Content (%) [b]	Monitor Estimated Weight (lbs) [c]	Gross Weight (lbs)[d]	% Error	Net Weight (lbs)[e]	% Error
2011									
LK1/Blood	Spanish	5.0	1.0	18.2	4104.5	4436.1	-7.5	4172.1	-1.8
LK16/Blood	Spanish	5.0	1.0	20.5	4312.7	4617.6	-6.6	4342.7	-0.9
SK11/Blood	Spanish	5.0	2.0	15.1	4339.5	4517.8	-3.9	4206.2	3.0
LK27/Blood	Spanish	4.0	2.0	16.3	4130.5	4372.6	-5.5	4113.6	0.2
LK15/Blood	Spanish	6.0	2.0	14.8	4156.4	4526.9	-8.2	4169.9	-0.5
LK41/S. Harvey	Spanish	6.0	0.0	14.5	3668.6	4118.6	-10.9	3871.4	-5.4
SK14/S. Harvey	Spanish	6.0	0.0	12.4	3652.3	3900.9	-6.4	3666.8	-0.6
Total					28364.5	30490.5	-7.0	28542.7	-0.6
LK41/Deckboat	Runner	1.0	2.0	25.3	4280.0	5261.7	-18.7	5104.7	-16.3
LK1/Deckboat	Runner	1.0	3.0	21.1	4172.7	5180.0	-19.4	4974.5	-16.3
LK17/Deckboat	Runner	1.0	3.0	25.0	3628.2	4690.1	-22.6	4504.2	-19.6
LK26/Deckboat	Runner	1.0	2.0	25.6	3732.7	4826.2	-22.7	4682.4	-20.4
LK42/Deckboat	Runner	1.0	2.0	24.6	3603.6	4826.2	-25.3	4682.4	-23.2
Total					19417.2	24784.2	-21.7	23948.2	-18.9
2012									
SK14/Huckabee	Spanish	3.0	1.0	9.0	9081.8	9697.8	-6.4	9407.1	-3.5
LK1/Huckabee	Spanish	3.0	1.0	10.4	9081.8	9697.8	-6.4	9407.1	-3.5
SK6/N. Barger	Spanish	4.0	1.0	21.6	4738.2	4635.7	2.2	4450.2	6.5
LK3/N. Barger	Spanish	5.0	1.0	24.4	4830.3	4672.0	3.4	4438.4	8.8
LK50/Suter	Spanish	2.0	1.0	13.8	4558.2	3991.6	14.2	3911.8	16.5
SK9/Suter	Spanish	2.0	1.0	12.8	5419.5	4826.2	11.3	4729.6	14.6
LK6/Hughes	Spanish	2.0	1.0	11.1	4207.8	4771.8	-11.8	4676.5	-10.0
LK48/Hughes	Spanish	2.0	1.0	15.6	4786.3	4490.6	6.6	4400.8	8.8
Total					46703.9	46783.5	-0.2	45421.5	2.8
LK45/N. Barger 2	Runner	1.0	1.0	15.8	4540.0	4372.6	3.8	4286.0	5.9
SK13/N. Barger 2	Runner	1.0	1.0	20.6	4530.4	4254.7	6.5	4169.9	8.6
LK27/Butler Endura	Runner	1.0	1.0	12.3	4612.1	4073.3	13.2	3992.1	15.5
LK42/Butler Endura	Runner	2.0	1.0	11.0	4726.0	4472.4	5.7	4295.5	10.0
Total					18408.5	17173.0	7.2	16743.5	9.9
All OK Data Total					112894.1	119231.2	-5.3	114655.9	-1.5

[a]Peanut grade data reported from the local peanut buy point.
[b]Moisture content was calculated by weighing oven drying and weighing field samples.
[c]Yield monitor weight as estimated by the yield monitor field computer.
[d]Field weight of the sample collected from the peanut wagon by using truck scales in the field.
[e]Trailer weight as reported by the peanut buy point after moisture content and foreign material correction.

yield monitor weights are based on this number. The AgLeader calibration number is a proprietary number provided by the monitor for the end user to utilize in different calibration scenarios. It is not directly related to load weights or loads used for the calibration. The error for spanish type peanuts in 2011 ranged from -5.4 to 3.0 %. It should be noted that the -5.4 % error was on a load not used for calibration. The errors for the runner type of peanuts ranged from -23.2 to -16.3 %. The greater errors were a result of not being included in the calibration. Performing the calibration with all 15 loads resulted in a calibration number of 4165. The errors ranged from -15.8 to 12.9 % with this calibration. Including both peanut types in the same calibration resulted in a compromised calibration that was unacceptable for both types of peanut. This was the case because the two types of peanut are different in shape, size, and moisture content during harvest.

Moisture content at harvest ranged from 8.99 to 25.6 % but was generally related to the type of peanuts with runners being higher moisture than the spanish during 2011. The runners were harvested last and are generally later maturing which led to higher harvest moisture. The yield monitor weights were based on a calibration number of 3767 using net weight from the first five loads in Table 1. Error was calculated from the net and gross weights obtained at the buy point.

Table 2. Summary data for the 15 Mississippi loads utilized for calibrating and verifying accuracy for the Ag Leader Yield Monitor collected during 2012 and 2013.

Wagon Label/Field	Type	Foreign Material (%) [a]	Least Shelled Kernels (%) [a]	Moisture Content (%) [b]	Monitor Estimated Weight (lbs) [c]	Gross Weight (lbs)[d]	% Error	Net Weight (lbs)[e]	% Error
2012									
NE MS 1	Runner	4.0	2.1	18.2	3121.0	3421.0	-9.6	3218.0	-3.0
NE MS 2	Runner	2.0	1.6	21.3	3183.0	2850.0	10.5	2737.0	16.3
NE MS 3	Runner	2.0	1.5	21.7	2949.0	2759.0	6.4	2650.0	11.3
NE MS 4	Runner	0.8	0.5	23.0	3371.0	3060.0	9.2	2975.0	13.3
NE MS 5	Runner	12.5	0.7	23.0	3016.0	2746.0	9.0	2355.0	28.1
Total					15640.0	14836.0	5.4	13935.0	12.2
CE MS 1	Runner		-	-	3898.0	3584.0	8.8	-	-
CE MS 2	Runner		-	-	3736.0	3899.0	-4.2	-	-
CE MS 3	Runner		-	-	3761.0	3851.0	-2.3	-	-
CE MS 4	Runner		-	-	3846.0	3918.0	-1.8	-	-
CE MS 5	Runner		-	-	3225.0	3323.0	-3	-	-
Total					18466.0	18575.0	-0.6	-	-
2013									
CE MS 1	Runner	2	12	11.5	3140.0	3526.0	-10.9	3282.0	-4.3
CE MS 2	Runner	2	8	12.1	3036.0	3132.0	-3.1	2916.0	4.1
CE MS 3	Runner	1	3	11.5	1698.0	1635.0	3.8	1538.0	10.4
CE MS 4	Runner	3	7	12.1	5157.0	4926.0	4.7	4539.0	13.6
CE MS 5	Runner	4	3	11.5	2369.0	2688.0	-11.9	2451.0	-3.3
Total					15400.0	15907.0	-3.2	14726.0	4.6
All MS Data Total					49506.0	49318.0	0.4	28661.0	8.3

[a]Peanut grade data reported from the local peanut buy point.
[b]Moisture content was calculated by weighing oven drying and weighing field samples.
[c]Yield monitor weight as estimated by the yield monitor field computer.
[d]Field weight of the sample collected from the peanut wagon by using truck scales in the field.
[e]Trailer weight as reported by the peanut buy point after moisture content and foreign material correction.

In the AgLeader® system, each peanut type should be entered as an individual crop to have develop a separate calibration for peanut type (i.e. spanish peanuts or runner peanuts in this case). Similar results were not observed from the 2012 data. A pronounced difference between peanut types did not appear when the calibration from the 2011 season was used. Thus, the difference that was prevalent in 2011 should be further investigated to determine the source of the difference.

However, the moisture versus peanut type correlation was not present during the 2012 harvest season. The non-correlating moisture trends in 2012 was attributed to several factors including various rain events just after the peanuts had been dug, however, no data is available on the exact digging events and rainfall, thus this is only speculation based on information gathered from the producer operating the peanut digger and combine.

Since the yield monitor does not include a moisture sensor like grain yield monitors, there is some cause for concern. Further studies across a wider range of moisture content are needed for the three main types of peanuts (runner, spanish, virginia) before conclusions between moisture content, peanut type and yield monitor estimation can be drawn.

Mississippi. Data from the 15 loads collected in MS can be seen in Table 2. The 2012 growing season was particularly challenging for Mississippi growers due to extreme shifts from hard, dry soil to rainfall saturated soils. Many producers were forced to dig peanuts from wet soil. Peanuts dug from wet soil, anecdotally, exhibited greater soil adherence than if they were removed from drier soil. Additionally, some growers chose to mechanically lift peanut vines to encourage drying and to remove excess adhered soil. Conditions during the 2013 harvest season were more typical for local conditions. Thus, data collected during 2012 had more foreign material introduced during harvest.

At the Northeast Mississippi location, error between the yield monitor and the gross field weight ranged from -9.6% to 10.5% (Table 2). These errors are within the bounds reported in other studies (Porter, 2012). Net weight error was, generally, larger than gross weight error. Most notably was the 28.1% error, which also had the largest amount of FM. Not enough data were collected to allow for strong correlation analysis. A high rate of non-peanut material being observed by the mass flow sensor should increase net weight error. These results suggested that changes in soil type or in temporary soil conditions can influence the quality of data being collected for yield analysis. Choosing representative calibrations loads will be important to the success of collecting quality data for all conditions, but particularly if a large quantity of FM is expected. Analysis of the 2012 Central Mississippi site was limited due to missing data; however, error between gross weight and monitor estimated weight was well within and even below the expected range of ± 10%. Of note is the total of all loads which has less than 1% error. The 2013 harvest season resulted in MC within a tight range (11.5 – 12.1% MCwb). The Mississippi data included five calibration loads collected from Northeast Mississippi and five from Central Mississippi in 2012 and five loads collected from Central Mississippi in 2013 with associated grade, estimated and measured weight.

As in the previously discussed data, the error is greater for net weight than gross weight in the Mississippi data. This error may be driven by the legally defined calculation for net weight. The traditional method for calculating net weight from gross weight and grade samples may introduce errors when compared back to field estimated mass and mass flow. If these errors could be reduced the utilization of buy point net weight for calibration has many advantages, including not needing in-field scales and creating yield analyses referenced to the weight upon which a producer is paid. This allows both yield performance and profitability comparisons.

Based on this study and previous research, some best practices have been identified to utilize an optical cotton yield monitor for estimating peanut yield. As with all yield monitoring systems, caution is advised to ensure that the most accurate data are available. As can be seen in Table 1, peanut type can have an impact on estimated yield due to their varied size and shape. Buy point-measured MC did not have an obvious impact on yield estimation. There was a wide range of moisture contents for a single peanut type and the errors from both the gross and net weights did not follow an observable trend by moisture. It can be seen by the data between the Oklahoma and Mississippi study that if significant changes in soil condition or type are seen then a different calibration should be applied. Some soil types and conditions can result in higher amounts of foreign material that can be counted by

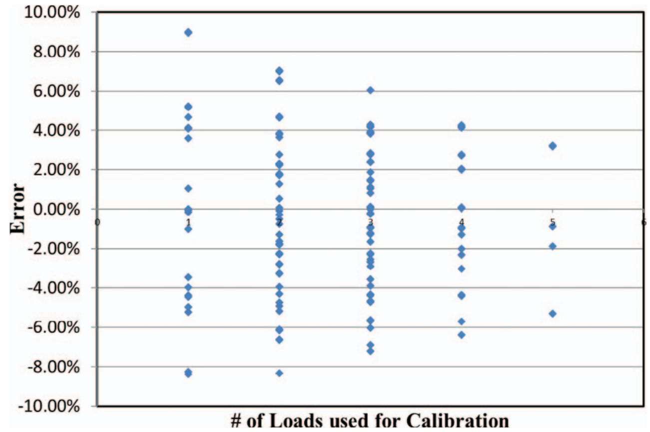

Fig. 5. The graphical representation of the total error and the number of calibration loads applied to the yield monitor, the more calibration loads that were used the total error was reduced.

the yield monitor and in some cases, unfortunately, by the infield scales if not removed by the combine. Thus, in these cases the net weight may have a higher percentage error but is still the closest to the actual peanut weight and should be utilized for calibration.

The most important factor in utilizing optical yield monitoring system for peanuts is the number of calibration loads which should be implemented for each of the above listed conditions. As can be seen in Figure 5, a greater number of loads utilized for calibration lowers the overall error. When using only one load for calibration the total error ranged from -9% to 9% or a total error of 18%, which is not within an acceptable range. It is highly recommended, based on this study, that at least five loads be utilized for calibration. No additional benefit was seen in error reduction for utilizing more than five loads. These calibration procedures should be implemented specifically as noted above when peanut type is changed or a difference in soil condition is present. A calibration process may seem cumbersome but can be an easier process if net weight from the buy point is used. The data have shown that the net weight is a valid data set for calibration of the AgLeader® Cotton Yield Monitor to accurately estimate peanut yields.

Conclusions

This study supports previous research demonstrating the feasibility of using an optical cotton yield monitor to measure peanut yield within acceptable error limits of approximately ± 10% per load. Similar to other crops, calibrations are essential when using a yield monitor with a peanut crop. This and previous studies suggest that accuracy of the system is brought within acceptable limits after five calibration loads. Choosing representative calibration loads will continue to be important to successful peanut yield monitor implementation. Data from Oklahoma in which a previous year's calibration settings were applied to the next year's data did not identify any clear trends which suggest that local calibrations for each field may be necessary for highest data quality. Even without clear trends the overall errors were within an acceptable error range of $\pm$ 10% per load with a total error across all loads of 2%, which may provide enough information for limited management decisions – if harvest conditions were similar and the same peanut type were harvested. These data suggested that peanut type has an effect on predicted yield suggesting calibration is required for each peanut type, variety appeared less important to calibration. Data from Mississippi indicated that soil texture can influence calibration accuracy, especially if that soil were adhered to the peanut. Lighter soil texture exhibited lower error total error than heavier soils.

Soil content, FM, MC, LSK and have potential to influence net weight error, further information is needed to conclusively define the relationships. While inconclusive, moisture may be a critical factor in estimating net or buy point weights for peanuts. Further research should be conducted to investigate methods of on-the-go moisture measurement for peanut combines, to be used in correcting predictions, such as those currently being investigated for use in grading. As an alternative, it may be possible to identify other quantifiable variables that can help explain the error demonstrated here in predicting net weights. With such developments, a producer may be able to calibrate a cotton yield monitor more accurately for the net weight obtained from a buy point.

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