The Capacity and Efficiency of Official Grade Shellers[1]

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ABSTRACT

Some segments of the US peanut industry are interested in raising the allowable peanut grading moisture content (MC) at farmer marketing from 10.49% to 18.49%. Prior to 2004, USDA had not raised the allowed MC maximum because of concern that the sheller used in official grading would not provide appropriate capacity or efficiency to meet time constraints for shelling peanuts at higher MC. A total of 112, 500.9 g subsamples of runner type, farmer stock peanuts with varying moisture contents were shelled to evaluate efficiency of the grade sheller. Kernel MC averaged 16.7% with a range of 7.7% to 37.4% and SD of 7.8%. Peanuts were shelled either with or without pod recycling during shelling. Based on linear regression of unshelled pod count and pod MC, pod MC did not explain the variance in unshelled pods from shelling, regardless of whether recycling was used or not. The R^2 indicated very weak correlations for peanuts shelled with recycling ($R^2 = 0.27$) and without recycling ($R^2 = 0.02$). After shelling pod weight means had comparable trends as pod count means. Comparisons were conducted separating data into shelling with and without pod recycling and into three levels of kernel MC including: MC $\leq$ 10.49% (MC1); 10.49% $>$ MC $\leq$ 18.49% (MC2); and MC $>$ 18.49% (MC3). MC3 level peanuts shelled with pod recycling had an average of 38 pods after shelling which was significantly higher than all other MC levels ($P = 0.05$). Comparing data by MC levels showed that shelling peanuts for four minutes up to 18.49% MC (MC2) would not significantly increase unshelled pod count or weight compared to shelling with MC $\leq$ 10.49% (MC1).

Key Words: Official grade, shelling, *Arachis hypogaea L.*, moisture content.

Peanut grading regulations in the 2002 Food Security and Rural Investment Act required that kernel moisture content (MC) of farmer stock peanuts be less than 10.49% for farmer marketing (Farm Bill 2002; Federal Register 2003). Thus, peanut lots must be identity preserved until grading and marketing is complete. Under current marketing procedures a sample is randomly taken from each farmer stock lot and foreign material (FM) and loose shelled kernels (LSK) are separated, weighed, and removed leaving a cleaned sample for evaluation. A 500-g subsample is used for lot sizes of 10 t or less and a 1000-g pod subsample for lots over 10 t. The pod sample is pre-sized to improve shelling efficiency and shelled. After shelling the kernels are sampled for MC. If the MC is greater than 10.49%, the lot must be dried until MC is 10.49% or less. If the MC is 10.49% or less, the kernels are separated on a vibratory screen shaker resulting in several grade categories consisting of sound mature kernels (SMK), sound splits (SS), other kernels (OK), and oil stock (OS). The categories are visually inspected for A. *flavus* and if detected, the lot is determined to be Segregation 3. Damaged and discolored kernels are also visually separated and weighed (DM). The total value of the farmer stock lot is determined after the grading process is completed from the resulting grade factors and the net lot weight adjusted to 7% MC as mandated by marketing regulations.

Maintaining lot identity through farmer marketing prevents utilization of technology with potential economic benefit for farmers and peanut buying points such as more efficient use of harvesting equipment and improvement of peanut lot handling procedures. Raising the maximum allowable MC would provide opportunities for utilization of drying technology different than currently used such as continuous flow peanut drying. To address the issue, the Peanut Standards Board requested that the USDA raise the MC maximum for farmer marketing of farmer stock peanuts during the 2003 harvest (Federal Register 2003). The request was denied. The industry continued to request that the 10.49% MC maximum be raised to 18.49% to expand opportunities for technology utilization at buying points, since farmer stock grading at higher moistures does not appear to have a negative effect on farmers or peanut buyers. On October 21, 2004, USDA issued a letter to the ''Peanut Standards Board, Peanut Growers, Shellers, and Buying Point Operators'' stating ''In response to request from industry representatives, the Department of Agriculture is implementing a relaxation in incoming peanut

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requirements, effective immediately for the 2004 crop only, inspection of Runner Type peanuts will be permitted with moisture content up to 18.00%."

Previous research has shown that the farmer stock grade, lot weight, and value can be accurately determined at kernel moisture contents greater that 10.49% (Blankenship et al. 2001; Lamb et al. 2003). During 1998 and 1999, 686 runner, virginia, and spanish farmer stock lots were graded and weighed at moisture contents greater than 10.49% (HMC). The peanuts were then cured, graded, and weighed again at moisture contents less than 10.49% (LMC) (Blankenship et al. 2001; Lamb et al. 2003). Results showed that LMC grades, lot weights, and lot values could be predicted accurately from HMC data. Another project was conducted during the 2001 crop year to address the accuracy and variability of HMC grading versus LMC grading. Farmer stock lots (n=34) were sampled and graded six times at HMC utilizing standard grading and value determination procedures. The equations derived from the 1998 and 1999 trials were utilized to predict grades and values that would result after drying to 10.49% MC or less. Each farmer stock lot was then dried to less than 10.49% MC and sampled and graded six times at LMC utilizing the same grading procedures for comparison to the grades and values predicted from HMC. The results showed that the accuracy and variability of farmer stock grades, weights, and values were not affected by grading at HMC as compared to grading at LMC.

While the previous research was conclusive, a primary concern of HMC grading and marketing has been that the capacity and efficiency of the sheller used in official grading may prohibit official graders from meeting time requirements of the harvest rush. Data on the capacity and efficiency of the sheller used in grading are not available for currently grown commercial varieties. Thus, an exploratory evaluation of the capacity and efficiency of the official grade sheller was conducted. The objective of this research was to compare the shelling efficiency (defined as number of unshelled pods) at varying MC.

Materials and Methods

During fall of 2003, samples of FS runner peanuts were harvested at five farms located within a 30 mile radius of Dawson, Georgia and at one located in Trenton, FL. Peanut varieties consisted of Georgia Green for the five harvests in Georgia and Virugard for the Florida location. Harvested peanuts were placed into 0.03 m^3 plywood boxes for artificial drying. Three, four, or five samples were harvested and placed individually into the boxes for artificial drying. Boxes had perforated metal bottoms and no top. During drying, boxes were placed on a 1.3 m $\times$ 1.3 m $\times$ 0.6 m plenum with openings that accommodated up to four boxes for forced air drying. Air was supplied to the plenum with a dryer equipped with a backward inclined fan and a gas-fired burner. Drying air temperature was thermostatically controlled and maintained at or below 37.8 C. Before drying was initiated, a subsample was randomly extracted from peanuts in each box for initial shelling. The dryer was started and peanuts were artificially dried. During drying, four or five subsamples were extracted randomly for shelling at lower moistures at intermittent periods. The official grade shelling evaluation procedure included first cleaning and separating the peanuts into three diameters ($>$ 11.5 mm; $<$ 11.5 mm, $>$ 9.9 mm; $<$ 9.9 mm) with the official grade sizer. Peanuts were then placed by diameter into three appropriate sheller compartments and shelled. The sheller was equipped with screens for runner type peanuts including: 19.1 mm $\times$ 10.3 mm for the largest size pods; 19.1 mm $\times$ 8.7 mm for the middle size; and 19.1 mm $\times$ 7.5 mm for the smallest size. For the first 20 subsamples, the sheller was operated for five minutes during shelling of each subsample. It became evident that five minutes was too long because shelling was being completed in less than four minutes for these samples. Shelling time was shortened to four minutes for the remainder of the samples. Initially, subsamples were shelled without recycling pods back through the sheller, which fell into the catch pan during shelling. Usually during shelling, Federal State Inspection Service graders recycle pods falling into the sheller catch pan initially through the compartment for middle sized pods and later through the compartment for the smallest sized pods to reduce hand shelling. Therefore, during shelling of some subsamples, pods falling into the sheller catch pan were recycled through the middle and small compartments during the shelling period. On average, for the first 2 minutes of shelling, pods falling into the catch pan were recovered and placed into the middle size compartment for shelling during the next 0.5 minutes. Pods collected during this time were then placed into the smallest size compartment for the remaining 1.5 minutes of shelling time. At the end of shelling, pods in the sheller and in the catch pan were counted and weighted. Following shelling, the MC of the kernels was determined by drying in an oven for the time and temperature prescribed by ASAE Standard S410.1 (ASAE

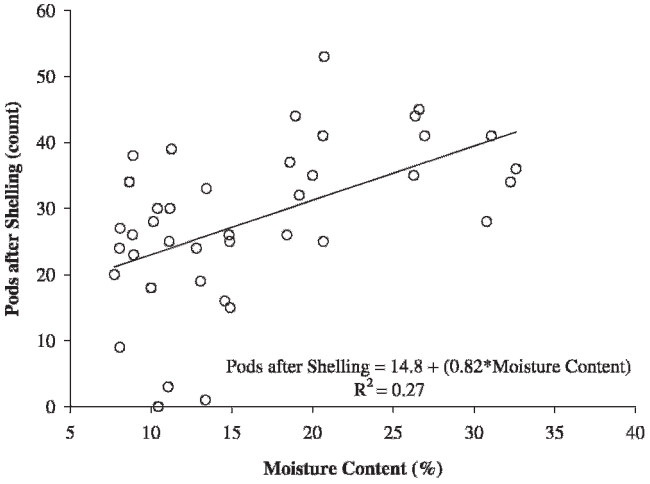

Fig. 1. Comparison of moisture content and unshelled pod count for shelling with the grade sheller with pod recycling.

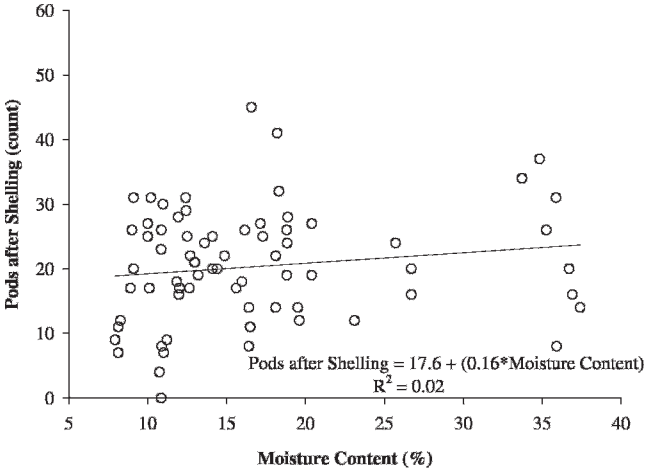

Fig. 2. Comparison moisture content and unshelled pod count for shelling with the grade sheller without pod recycling.

Standards 2003). Data collected were analyzed statistically comparing shelling with and without pod recycling.

Results and Discussion

A total of 112 subsamples from 28 samples of runner type farmer stock peanuts were evaluated. Subsample size averaged 500.9 g. During shelling of the first 72 subsamples (18 samples, four harvest dates) pods falling into the sheller catch pan were not recycled through the sheller. Average kernel MC for peanuts in these subsamples was 16.9% and ranged from 7.9% to 37.4% with a SD of 8.0%. For the next 40 subsamples, pods falling into the catch pan during shelling were recycled through the sheller (10 samples, two harvest dates). Average kernel MC was 16.4% and ranged from 7.7% to 32.6% with a SD of 7.6%. Average moisture contents for peanuts shelled with or without pod recycling were not significantly different according to Duncan's New Multiple Range Test (P = 0. 05) (SAS, 2003).

Linear regression equation ($R^2 = 0.27$) indicates that variance in pod count is not explained by MC (Fig. 1). Similarly, a comparison of pods after shelling without pod recycling and MC is presented in Fig. 2. According to linear regression ($R^2 = 0.02$), variance in pod count is explained less by MC than with shelling and pod recycling. These data show that MC has little effect on unshelled pods falling into the sheller catch pan during shelling within the MC range evaluated. Further comparisons were conducted separating the data into shelling with and without pod recycling and into three levels of kernel MC including: MC $\leq$ 10.49% (MC1); 10.49% $>$ MC $\leq$ 18.49% (MC2); and MC $>$ 18.49% (MC3).

A comparison of average pod counts and pod weights after shelling are presented in Table 1. Means are presented with and without pod recycling and by MC levels (Table 1). Moisture contents for MC1 level peanuts shelled with and without recycling averaged 9.0% and 9.1% and were not significantly different (P = 0.05) (Table 1). MC for peanuts for MC2 and MC3 levels shelled with and without recycling were not significantly different (P = 0.05) (Table 1). Average moisture contents of peanuts for MC1, MC2, and MC3 levels were significantly different (P = 0.05) for both with and without pod recycling during shelling. Comparisons of pod counts and weight within and between MC levels were conducted. Peanut samples in MC3 with recycling averaged 15 more unshelled pods than those from MC1. This was the only significant difference in unshelled pods with recycling (P=0.05). In samples shelled without recycling, peanuts from MC1 averaged 19 unshelled pods compared to 20 in MC2 and 21 in MC3. The mean pods without recycling were not significant different. After shelling pod weight means had comparable trends as pod count means (Table 1). Comparing data by moisture levels showed that shelling peanuts up to 18.49% MC would not significantly increase after shelling pod count or weight compared to shelling with MC $\leq$ 10.49%.

Summary and Conclusions

These data show that the maximum MC for grading runner type, farmer stock peanuts can be raised to 18.49% without significantly effecting unshelled pod count or weight after shelling if the

Table 1. Comparison of average pod count and weight after shelling versus moisture content level.

Moisture Content Level	n	Mean[a] Moisture content	Pods after shelling	Pod weight after shelling
		%	count	g
With recycle shelling				
MC1: (MC ≤ 10.49%)	12	9.0 a	23.1 a	10.7 a
MC2: (10.49% < MC ≤ 18.49%)	13	13.5 b	21.7 a	10.9 a
MC3: (MC > 18.49%)	15	24.8 c	38.1 b	22.4 b
Without recycle shelling				
MC1: (MC ≤ 10.49%)	12	9.1 a	19.4 a	12.4 a
MC2: (10.49% < MC ≤ 18.49%)	40	14.0 b	20.1 a	11.7 a
MC3: (MC > 18.49%)	20	27.2 c	21.4 a	14.7 a

[a]Means in a column followed by the same letter are not significantly different (P = 0.05)

grade sheller is operated for four minutes for each sample shelled. Efficiently staging samples through the sheller should allow shelling 10–12 samples per hour per sheller for this time period. Shelling, with or without recycling pods, with kernel moisture ≤ 18.49 had no significant effect on unshelled pod count or weight after shelling. Linear regression analysis showed that MC has no significant effect on the variance of pod counts and pod weights after shelling. These evaluations were conducted on runner type peanuts only, but the authors feel similar results would occur with other types of peanuts.

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