A Screening Attachment for an Amadas Peanut Combine[1]

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Abstract

Some farmers mechanically screen farmer stock (FS) peanuts after combining to remove undesired materials for value and quality improvement. Screening is accomplished with low capacity, portable screens at the field after combining or with high capacity cleaners or screens at buying points. An alternative method for FS peanut screening has been developed cooperatively by Amadas Industries and USDA-ARS, National Peanut Research Laboratory utilizing an experimental combine screening attachment. The attachment is a hydraulically driven, rotating cylindrical screen (trommel) with an axis inclined less than 10° from horizontal during operation. Peanuts are screened with the trommel prior to entering the combine basket, and smaller, unwanted materials are returned to the soil. Thirty-eight lots of FS peanuts averaging 3.27 t/lot were combined throughout all U.S. peanut-producing regions to examine performance. Foreign materials for the screened lots averaged 2.15% less than the unscreened lots (P = 0.05). Hulls were 0.62% less in the screened lots (P = 0.05). None of the other grade factors or market values per hectare were significantly different for runner peanuts. Foreign materials for screened virginia peanuts were 2.44% less than in unscreened (P = 0.01). Loose shelled kernels were 0.44% higher (P = 0.05), hulls 0.67% lower (P = 0.10), and damage 0.56% higher in screened peanuts than in unscreened. None of the other grade factors or market values per hectare were significantly different for virginia peanuts. Although most grade factors and values per hectare were not significantly different for screened and unscreened peanuts tested, foreign materials were reduced significantly providing needed quality improvement. Possible cleaning costs also could be reduced with the attachment.

Key Words: *Arachis hypogaea* L., cleaning, foreign material, loose shelled kernels, LSK separation.

Farmer stock (FS) peanuts are harvested with various compositions of peanut pod sizes, loose shelled kernels (LSK), and foreign materials (FM) (7). At farmer marketing, the value of FS peanuts is determined by a sample extraction and composition analysis procedure (grade) which along with weight determines the lot value (6, 8). Grade factors include percentages for FM, LSK, and various types and sizes of kernels, along with a visual inspection for kernels contaminated with *Aspergillus flavus* (6). Value and quality of peanuts vary directly with kernel size and inversely with damage, LSK, and FM content (1, 3, 8). Visual detection of *A. flavus* requires an inedible classification (Segregation Three) and reduces the value of FS peanuts by approximately 75% (1, 8). Peanuts with *A. flavus* are assumed to contain aflatoxin. Aflatoxin levels in contaminated FS peanuts are inversely related to kernel sizes and directly related to LSK and damage content (2, 9). Therefore, removal of small peanut pods, LSK, and FM from FS peanuts prior to marketing should reduce aflatoxin risks and improve quality and value for the farmer. Damaged kernels may not be removed by screening unless associated with LSK and smaller peanuts.

Some farmers mechanically screen FS peanuts after

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combining to remove FM, LSK, and small pods for value and quality improvement prior to marketing (1, 3). A limited amount of FS peanut screening is done by farmers with low capacity, portable screens at the field before transportation to the drying shed or buying point. This type of screening, although effective, is generally low capacity and increases harvest labor and management requirements substantially. Most buying points offer screening facilities for a fee, and farmers sometimes utilize this option. Recent improvements in commercial, high capacity screening, such as adaptation of orbital screening to peanuts, have enhanced the capabilities of buying points to provide more effective means for farmers to accomplish screening away from the field.

Although increasing, the economic rationale of post harvest screening has not been accepted by all farmers or other U.S. peanut industry segments as advantageous. Current FS peanut program marketing regulations discourage FS peanut screening after harvest, prior to farmer marketing (5). Some farmers and buying point managers are hesitant to screen FS peanuts because the regulations require tracking all peanut material after combining (5). If peanut materials are removed from a lot prior to marketing, the removed materials must be marketed as contract additional, loan additional, or quota (5). Recent increases in combine capacities (two- to fourfold) along with the regulatory requirements for tracking and handling all peanut materials from separations made from screening on an individual farmer basis would generate tremendous bottlenecks at buying points. Some shellers question the value of screening because of differences between purchase costs and comparative shelling out-turn returns from screened and unscreened peanuts. Also, the purchase and installation costs of screening equipment to meet the diminishing time frame of peanut harvest is expensive whether done on the farm or at the peanut buying point.

An alternative method to remove FM, LSK, and small pods is to increase the screening capability of combines after separation of the pods from vines, allowing return of unwanted materials to the field. Since screening would occur during combining, discharged peanut material would not have to be tracked. Umphlett Brothers Farms, Gates, NC, increased combine screening capability by constructing externally mounted screening devices on two, six-row Amadas combines. The screeners with 1.27 cm (1/2 in.) galvanized hardware cloth screening surfaces operate just prior to peanuts entering the combines baskets. Small FS peanut materials such as dirt, LSK, and small pods are dropped to the field during operation. After a limited field evaluation of these screening devices, USDA-ARS National Peanut Research Laboratory (NPRL) and Amadas Industries entered into a cooperative research and development agreement to modify the Umphlett design, and develop this type of screening technology.

The purpose of this research was to modify and evaluate a FS peanut screening attachment for the peanut combine. The screening attachment was designed for installation and use on current models of Amadas combines.

Materials and Methods

The design of the experimental screening attachment is a rotating cylindrical screen (trommel). The trommel has a 91.44-cm (36 in.) diameter by 304.8-cm (120 in.) long lateral screening surface which operates with the axis inclined less than 10° from horizontal during operation (Fig. 1). The screening surface used for runner-type peanuts during the performance tests had 0.95 × 7.62 cm (22/64 × 3 in.) openings with the 7.62-cm dimension parallel to the trommel axis. The screening surface used for virginia-type peanuts was 1.27-cm (1/2 in.) galvanized hardware cloth. Openings used in the screening surface for the tests were selected to provide a minimum discharge of FS peanut material. The screening surface is divided into three replaceable sections, allowing changing of screen openings. A schematic detailing trommel operation is shown in Fig. 2. FS peanuts enter the trommel from a rerouted, air transportation duct, originally designed to convey peanuts to the holding bin above the combine. Peanuts leave the duct at the lower end of the trommel with adequate velocity to propel the peanuts through the trommel length into the upper end (Fig. 2). After downward deflection by the upper end, the FS peanuts reverse direction and tumble back through the rotating trommel over the screening surface (Fig. 2). The aggressiveness of the tumbling motion was regulated by the rotational speed which varied between 22

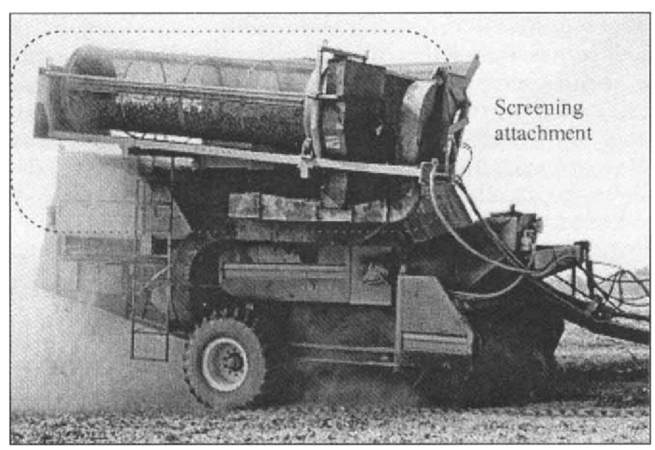

Fig. 1. The screening attachment installed on an Amadas peanut combine.

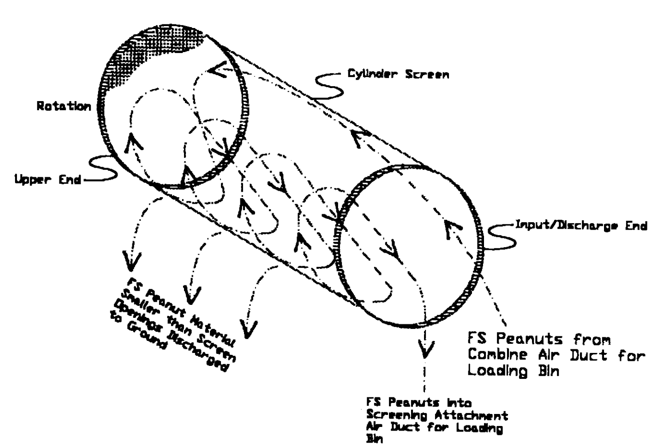

Fig. 2. A schematic of farmer stock peanut material movement during trommel operation.

to 25 rpm. Materials smaller than the openings in the screen passed through and fell to the ground. Screened FS peanuts moving back through the trommel dropped into an air duct for conveyance to the holding bin. FS peanut materials were separated into two size fractions (overs and thrus) as the peanuts moved through the trommel.

An apparatus was provided to allow the trommel to be operated or not operated so that performance could be compared without combine variability. Also, the support frame of the trommel was fitted with a canvas underneath to capture samples of materials passing through the screen (thrus). Two individually controlled, hydraulic motors provided power for the screening attachment. One motor was used to rotate the trommel and the other for rotating a fan supplying air for the transportation duct at the trommel discharge. Hydraulic fluid for the two motors was supplied through two, remote hydraulic outlets on the tractor pulling the combine.

During the initial 5 wk of 1997 harvest in south Georgia, the screening attachment was evaluated and modified. Next, the performance of screening attachment was evaluated with field tests on cooperating farms in all three U.S. producing areas. Runner-type peanuts were harvested in Georgia and Texas; virginia types in North Carolina and Virginia. Subsequently, performance data for the screening attachment were collected with combines operating with and without the attachment during daily experiments. For each day's experiment, a block of adjacent windrows was selected in a field ready for combining. The combine was first operated excluding the screening attachment, and one or two unscreened lots were combined from randomly selected windrows within the selected block of windrows. After the unscreened lot or lots were harvested, the combine air transportation duct was rerouted from the bin to the screening attachment, and one to four lots were combined.

During combining of the screened lots, thrus were collected from a measured length of windrow to allow estimation of the total material discharged from the lot and to provide a sample for grade analysis. Each sample of thrus was weighed and a subsample obtained by riffle dividing. Row widths and lengths of windrow were measured to allow yield computations. Yield data, farmer stock grade data (unscreened and screened lots), and grade data for the thrus were used to evaluate the performance of the screening attachment.

Results and Discussion

During performance testing, the screening attachment operated satisfactorily on five different combines for a total of 14 d. Thirty-eight lots of FS peanuts with an average weight of 3.27 t per lot were harvested. Lots combined allowed for 22 paired comparisons of unscreened versus screened data (13 for runner and nine for virginia-type peanuts). Unscreened lots were combined from an average area of 0.77 ha and screened lots from 0.84 ha. Average yield for areas combined (FM included) was 4.40 t/ha and ranged from 2.83 to 6.04 t/ha. Thrus were discharged from the screened lots at a mean rate of 255.31 kg/ha and varied from 50.93 to 691.31 kg/ha. As a percentage of weight of material being combined, the mean discharge rate of thrus was 5.82%, varying from 1.35 to 17.67%.

FM was the major component of thrus. The average composition of the thrus included 80.87% FM (206.73 kg/ha), 6.15% LSK (13.29 kg/ha), and 12.98% peanut pods (35.29 kg/ha). The average composition of thrus pods was 23.61% SMK (6.67 kg/ha), 34.86% other kernels (12.92 kg/ha), 0.47% damaged kernels (0.45 kg/ha), and 41.06% hulls (15.25 kg/ha). The mean composition of FM in the thrus is presented in Table 1. The SD's for the components indicate that compositions of FM in thrus varied widely. Various factors appeared to affect FM compositions including peanut and soil types, windrow conditions, and environmental conditions at harvest. Also, different screen openings would have varied the amount and composition of thrus as well. Based on average discharge rate and composition, the estimated mean value of thrus was $11.20/ha, varying from $2.55 to $29.43/ha. From the farmer's perspective, the loss in value of thrus must be justified by a net increase in value of FS peanuts screened (grade improvement) or by a reduction of the risk of *A. flavus* detection during grading.

At farmer marketing of peanut lots combined from these tests, some grade factor means for unscreened and screened lots were significantly different; however, the differences were less than 1%, except for FM. Comparisons of means and mean differences for grade factors of unscreened and screened lots are presented in Tables 2

Table 1. Means, maximums, minimums and standard deviations of the components of foreign materials in thrus from lots screened during the tests.

Material	Mean	Max.	Min.	Standard deviation
	%	%	%	%
Dirt	38.62	55.42	19.44	10.62
Hulls	22.15	48.11	3.12	14.32
Rocks	20.96	43.54	1.71	13.32
Sticks	12.36	41.83	0.59	11.98
Stems	4.81	11.16	0.73	3.76
Miscellaneous foreign materials	1.10	9.46	0	2.49

Table 2. Comparison of screened and unscreened official grade factor means and mean differences for runner-type peanut lots combined during the field evaluation tests.

Grade factor	Screened	Unscreened	Difference[a]
	%	%	%
Foreign material	3.62	5.77	-2.15**
Loose shelled kernels	1.77	2.15	-0.38
Sound mature kernels (SMK)	66.92	67.15	-0.23
Sound splits (SS)	6.85	6.62	0.23
SMK+ SS	73.77	73.77	0
Other kernels	4.46	4.15	0.31
Damage	0.31	0.15	0.15
Hulls	21.38	22.00	-0.62**
Moisture content	9.31	9.15	0.15

[a]Difference = screened - unscreened.

**Indicates significance at the P = 0.05 level of probability.

and 3. T-tests were used to determine if the mean differences shown were significantly different from zero (4). Mean differences found significantly different from zero indicate that average grade factors for unscreened and screened lots were significantly different. The mean difference shown for FM in runner-type peanuts (Table 2) indicated that FM in unscreened lots averaged 2.15% more than FM in screened lots (P = 0.05). Hulls in unscreened lots of runner peanuts were 0.6% more than hulls in screened lots (P = 0.05) (Table 2). Other grade factors for runner-type peanuts were not significantly different.

FM in unscreened lots of virginia-type peanuts averaged 2.4% more than in screened lots (P = 0.001) (Table 3). Virginia-type LSKs were 0.4% less in unscreened than in screened lots (P = 0.05). This result was not expected and the authors offer no speculation for explanation. Damaged kernels in unscreened lots of virginia peanuts were 0.6% less (P = 0.05) than damaged kernels in screened lots (Table 3). Virginia hulls were 0.7% more in unscreened lots than in screened (P = 0.10) (Table 3). Other grade factors for virginia-type peanuts were not significantly different. The limited effect of screening on grade factors minimized value changes in the FS peanuts screened.

Comparisons of means and mean differences for value/t for the unscreened and screened FS peanuts tested are presented in Table 4. Although the value/t for the screened runner peanuts averaged slightly more than unscreened the difference was not significantly different. For virginia-type peanuts screening improved the value/t an average of $13.61 (P = 0.05). While value/t is a good indicator of screening benefit, farmers must consider net return based on a value/ha to justify screening and/or possible reduction in risk of *A. flavus* detection during grading. Comparisons of means and mean differences for value/ha for the unscreened and screened FS peanuts tested are presented in Table 4. On the

Table 3. Comparison of screened and unscreened official grade factor means and mean differences for virginia-type peanut lots combined during the field evaluation tests.

Grade factor	Screened	Unscreened	Difference[a]
	%	%	%
Foreign material (FM)	3.11	5.56	-2.44***
Loose shelled kernels (LSK)	1.44	1.00	0.44**
Sound mature kernels (SMK)	61.22	60.78	0.44
Sound splits (SS)	2.11	2.22	-0.11
SMK+ SS	63.33	63.00	0.33
Other kernels (OK)	4.56	4.78	-0.22
Extra large kernels (ELK)	38.78	38.67	0.11
Fancy pods (FP)	80.00	77.11	2.89
Damage	0.67	0.11	0.56**
Hulls	31.22	31.89	-0.67*
Moisture content	9.00	8.89	0.11

[a]Difference = screened - unscreened.

*,**,***Indicate significance at the P = 0.10, 0.05, and 0.01 levels of probability, respectively.

Table 4. Comparison of screened and unscreened value/t and value/ha means and mean differences for peanut lots combined during the field evaluation tests (assuming quota value).

Peanut type	Value	Screened	Unscreened	Difference[a]
		$	$	$
Runner	Value/t	569.76	568.26	1.50
	Value/ha	2964.28	2985.27	-20.99
Virginia	Value/t	489.35	475.74	13.61**
	Value/ha	2123.20	2146.57	-23.37

[a]Difference = screened - unscreened.

**Indicates significance at the = 0.05 level of probability.

average, screening offered no direct economic benefit in these tests. Unscreened peanuts combined during these tests had low mean LSK, indicating little opportunity for value increase through removal and replacement with higher value pods (Tables 2 and 3). Likewise, FM averaged less than 6% (Tables 2 and 3), offering only a $1.10/t reduction from excess FM.

Even though improved grade factors are major considerations in determining the economic rationale for screening, other factors to be considered include the thrus discharge rate, physical properties, and values. Screening is a technically feasible method for improving quality and value of FS peanuts. Screening offers a method to reduce risks of *A. flavus* detection during FS grading by removing peanut components with higher risks of contamination. Aflatoxin risks are subsequently lowered. However, many factors must be considered on a field by field basis to establish the economic feasibility of screening prior to farmer marketing. For instance, screening increased the value/ha for peanuts from one of the farms $80.85/ha ($32.72/ac), whereas screening decreased value/ha $183.51/ha ($74.26/ac) on another.

Although average economic benefits from screening were not demonstrated in these tests, quality improvement trends were apparent. Economic justification of FS peanut screening is an individual farmer marketing decision, which must be made based on particular circumstances. The combine screening attachment reported herein provides a usable method for accomplishing FS peanut screening prior to farmer marketing and is compliant with current peanut program regulations.

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