Handling Farmer Stock Peanuts at Warehouses with Potato Equipment[1]

P.D. Blankenship* and M.C. Lamb[2]

ABSTRACT

An alternative system for handling farmer stock peanuts in and out of warehouse storage was evaluated and compared to conventional handling systems. The potato handling system provided significantly less mechanical damage and improved peanut value than conventional handling methods. Loose shelled kernels and sound splits were decreased by 1.83 and 4.00%, respectively, by more gentle handling of the peanuts (P≤0.05). Thus, the potential for aflatoxin contamination during storage was reduced. Economic analysis revealed that investment costs of the potato and conventional handling systems were similar. The analysis revealed that the net value of peanuts from a 3629-t capacity warehouse could be increased by $23,758/yr by investing in potato handling equipment instead of conventional handling equipment when constructing a new warehouse. However, it is probably not economically feasible to convert the handling equipment of an existing conventional warehouse to the potato handling system.

Key Words: Separation, *Arachis hypogaea* L., potato, handling.

Quality maintenance is a major objective during storage of farmer stock peanuts. Subsequent processing and product manufacture rely heavily upon the quality of peanuts after storage. Conventional handling systems for moving peanuts into and out of storage warehouses present varying risks of mechanical damage to peanuts. A typical handling system for moving peanuts into a warehouse includes a dump pit, bucket elevator, and belt conveyor mounted inside the top length of the warehouse near the roof vertex. Peanut discharge is adjustable along the length of the warehouse with the conveyor. Loading peanuts through the elevator and subsequently dropping the peanuts from the belt conveyor to the warehouse floor or peanut pile mechanically damages peanuts by increasing splitting during shelling and the percentage of loose shelled kernels (LSK) (2,3). Increasing LSK elevates risks of insect damage during storage (1). Dirt in the incoming peanuts generally falls directly under the belt conveyor discharge and is thus concentrated into the center of the warehouse along the length of the peanut pile. The concentration of dirt prohibits normal airflow through the peanut mass which is required for moisture equalization in the peanuts (1). The lack of moisture equalization causes quality loss by maintaining pockets of excessive moisture from vegetative foreign materials or immature peanuts and contributes to risks of aflatoxin contamination during storage (4).

Peanuts are usually removed from warehouses by scooping up the peanuts with the bucket of a front-end loader and transferring them to a mobile belt conveyor for movement onto a vehicle for transportation to a shelling plant. The design and operation of front-end loaders offer considerable potential for mechanical damage. Peanuts are often crushed or damaged by the bucket or loader tires during warehouse unloading. Peanut quality after storage would be improved with more gentle handling systems than generally in current use.

A mechanical system for moving potatoes into and out of storage has been developed which appears to offer more gentle product handling than conventional peanut handling systems. The potato handling system consists of a group of mobile, fixed length, mechanically interlocked belt conveyors which allow altering the total length of the conveying system. In addition to variable length, the discharge of the system is horizontally and vertically manipulable. Loading attachments are provided to move potatoes onto the system for unloading or loading potatoes to storage. The system provides gentle handling of potatoes into and out of storage without excessive risks of handling damage. The design of the system appears to offer adaptation for use in peanuts with only limited modification. The mobility of the

[1]This research was carried out under a Cooperative Research and Development Agreement between ARS, National Peanut Research Laboratory and Spudnik Equipment Co., Blackfoot, ID. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA or Auburn Univ. and does not imply its approval to the exclusion of other products that may also be available.

[2]Agric. Eng., USDA, ARS, Nat. Peanut Res. Lab., Dawson, GA 31742 and Res. Fellow, Dept. of Agric. Economics and Rural Sociology, Auburn Univ., Auburn, AL 36849.

*Corresponding author.

intake and discharge should reduce mechanical damage to peanuts from excessive dropping heights and eliminate dirt and other foreign material concentration in the center of the peanut pile during warehouse loading, thereby reducing risks of aflatoxin contamination.

The purpose of this research was to evaluate the adaptability and economic feasibility of the potato handling system for use in peanuts and to compare peanut quality deterioration associated with warehouse loading and unloading using the potato handling system with conventional warehouse equipment.

Materials and Methods

This study was conducted during the 1994 harvest and storage season. Spudnik Equipment Company, Blackfoot, ID, and Birdsong Peanuts, Southeast Division, Dawson, GA, were cooperators in the research. The potato handling equipment evaluated was a Spudnik Potato Scooper and accompanying potato conveyors (Fig. 1). Conventional handling equipment used for comparison included a dump pit, a bucket elevator, and a belt conveyor along the vertex of a warehouse roof. A front-end loader and belt conveyor were used to unload the warehouse with the conventional loading equipment.

Fig. 1. Spudnik Potato Scooper with accompanying potato conveyors.

After being harvested by farmers and transported to a buying point located 13 km from Statesboro, GA, farmer stock peanuts were sampled with a pneumatic sampler, graded, and purchased. The peanuts of each farmer lot were unloaded into a dump pit, elevated with a bucket elevator, and dropped into a discharge pipe. The pipe contained a flow switching valve which allowed discharge of the peanuts into either of two holding bins. Peanuts of each farmer lot were divided into the two bins. Because flow rate of peanuts through the elevator had been previously calibrated, division was accomplished by estimating an appropriate elevator operation time required to lift one-half of the peanuts in the lot and then changing the switching valve at the appropriate time. First or second halves of the farmer lots were alternated between the holding bins. Peanuts were then loaded into separate transport trailers, sampled for grading, and transported to either a commercial warehouse located in Statesboro, GA, (herein warehouse 1) or to a warehouse located in Richland, GA (approximately 400 km from Statesboro) (herein warehouse 2). The peanuts were unloaded into the warehouses, stored for approximately 1 mo, removed from the warehouses in transport trailer lots, hauled to a shelling plant, and sampled for grading before shelling. The peanuts from warehouse 1 were transported to a shelling plant located in Sylvania, GA (37 km from Statesboro) for processing. The peanuts in warehouse 2 were transported to a shelling plant in Blakely, GA (90 km from Richland). The potato handling system was used to load and unload peanuts at the warehouse 1. Conventional handling equipment was used at warehouse 2.

The following official grade samples were extracted from the peanuts with pneumatic samplers for comparisons of the handling systems: (a) as marketed by farmers for use in the tests at the buying point (Farmer-Market), (b) for warehouse loading with potato handling equipment at the buying point (Potato-Load), (c) for warehouse loading with conventional handling equipment at the buying point (Normal-Load), (d) as unloaded with potato handling equipment at Sylvania shelling plant (Potato-Unload), and (e) as unloaded with conventional handling equipment at the Blakely shelling plant (Normal-Unload). Values obtained for official grade factors were used for measures of handling damage and quality comparisons.

Investment costs and value-added considerations will dictate the economic feasibility and industry acceptance of the potato handling system as compared to conventional handling systems. Two scenarios were analyzed to determine the economic feasibility of each system. The first scenario focused on the construction of a new peanut warehouse with a 3629-t capacity. Comparisons made were a warehouse with a conventional handling system (Normal-Load:Normal-Unload) and a warehouse in which the potato handling system was used to load and unload the warehouse (Potato-Load:Potato-Unload). Spot checks with industry personnel were conducted to obtain cost estimates of conventional warehouse equipment and potato handling equipment. The cost of warehouse construction was assumed constant for both handling systems. Useful life of warehouse equipment (dump pit, elevators, catwalk, and installation) and potato handling equipment is assumed to be 15-yr with a 7-yr payoff. Estimates for yearly repair and maintenance cost are included. A 10% rate of interest was applied.

The second scenario assumed an existing warehouse with a 3629-t capacity and a conventional handling system. Comparisons made were to determine if converting an existing conventional warehouse to the potato handling system was economically feasible. Again, the comparisons were Normal-Load:Normal-Unload and Potato-Load:Potato-Unload. In this analysis, conventional warehouse loading equipment exists, and only the cost of unloading the warehouse is considered. The cost of equipment for Normal-Unload and Potato-Unload was obtained and estimated similar to scenario one. The 1994 quota support price was used to calculate the change in value of the stored peanuts based on the grade factors at warehouse unloading.

Results and Discussion

Two hundred fourteen lots of farmer stock peanuts, averaging 4.4 t, were officially graded from 11 Oct. through 12 Nov. and used in the test. The peanuts were divided into 44 transport trailer lots averaging 21.4 t (22 lots for each of the warehouses). Peanuts were removed from warehouse 1 and serviced by the potato handling equipment from 2-7 Dec. Peanuts were removed from warehouse 2 and serviced by the conventional equipment during 15-21 Dec.

A summary of means and standard errors of official grade factors for the peanut samples are presented in Table 1. The data summarized in Table 1 were used in comparisons of differences between means for each grade factor to determine the propensity of the two handling systems toward mechanical damage from moving peanuts into and out of storage.

A comparison of the differences in LSK means for the various sample extractions is presented in Table 2. Some mechanical damage was generated by the divider system used to generate the lots of peanuts for the two handling systems. Of the total averages in LSK at warehouse loading, the divider system increased LSK an average of 1.77% for the Potato-Load lots and 1.85% for the Normal-Load lots. The values were not significantly different, indicating a suitable division of the Farmer-Market lots for the experiment. The potato handling system increased LSK 1.13% ($P \leq 0.05$) into and out of storage; whereas, the conventional system increased LSK 2.96% ($P \leq 0.001$) (Table 2). The 1.83% difference in mean LSK values or pods shelled comparing the handling systems indicates that the potato system provided more gentle handling (or produced less mechanical damage) than the conventional system.

Differences in sound mature kernels (SMK) percentages (Table 1) remained relatively low (≤0.35%) for the different sample extractions, except from peanuts after warehouse unloading with conventional equipment. Comparing Normal-Unload and Potato-Unload, SMK had an average decrease of 3% ($P \leq 0.05$) for the conventional handling system (Table 3). The increase in average LSK through the conventional system provided some explanation for this change (Table 2). The decrease in SMK for handling with the conventional equipment supports the premise stated above that the potato handling system provided less mechanical damage to peanuts than the conventional handling system.

Sound splits (SS) increased 4% more with the conven-

Table 1. Comparison of means and standard errors (S.E.) of official grade factors from samples extracted and graded during the tests at (a) Farmer-Market, (b) Potato-Load, (c) Normal-Load, (d) Potato-Unload, and (e) Normal-Unload.

	Official grade sample extraction									
	Farmer-Market		Potato-Load		Normal-Load		Potato-Unload		Normal-Unload	
Grade factor	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
	%									
Loose shelled kernels	3.13	0.67	4.90	0.34	4.98	0.34	6.03	0.35	7.94	0.37
Sound mature kernels (SMK)	62.61	1.01	62.89	0.52	62.96	0.53	62.63	0.52	59.61	0.56
Sound splits (SS)	4.47	0.46	4.70	0.24	4.37	0.24	5.14	0.24	9.14	0.26
SMK + SS	67.09	1.09	67.60	0.56	67.33	0.57	67.78	0.56	68.75	0.60
Other kernels	7.00	0.59	6.92	0.30	6.74	0.31	7.02	0.30	5.99	0.33
Total kernels	74.75	0.64	75.61	0.33	75.49	0.33	75.77	0.33	75.95	0.35
Hulls	25.42	0.61	24.07	0.31	24.33	0.31	24.27	0.31	23.76	0.34
Total kernels & hulls	100.17	0.20	99.68	0.10	99.85	0.10	100.04	0.10	99.72	0.11
Damage	0.67	0.20	1.10	0.10	1.21	0.10	0.97	0.10	1.19	0.11
Concealed damage	0.00	0.02	0.04	0.01	0.04	0.01	0.00	0.01	0.00	0.01
Moisture content	8.72	0.16	6.90	0.08	6.98	0.08	7.38	0.08	7.77	0.09
Foreign material	4.55	0.53	5.25	0.27	5.08	0.27	5.54	0.28	9.09	0.30

Table 2. Comparison of differences in loose shelled kernel means from official grades of peanuts sampled at (a) Farmer-Market, (b) Potato-Load, (c) Normal-Load, (d) Potato-Unload, and (e) Normal-Unload.

Sample	Sample extraction			
extraction	Farmer-Market	Potato-Load	Normal-Load	Potato-Unload
	%			
Potato-Load	1.77*			
Normal-Load	1.85*	0.08		
Potato-Unload	2.90***	1.13*	1.05*	
Normal-Unload	4.80***	3.03***	2.96***	1.90***

*,***Indicate significant difference between means at the P=0.05 and 0.001 levels, respectively.

Table 3. Comparison of differences in sound mature kernel means from official grades of peanuts sampled at (a) Farmer-Market, (b) Potato-Load, (c) Normal-Load, (d) Potato-Unload, and (e) Normal-Unload.

Sample	Sample extraction			
extraction	Farmer-Market	Potato-Load	Normal-Load	Potato-Unload
	%			
Potato-Load	0.28			
Normal-Load	0.35	0.07		
Potato-Unload	0.02	-0.26	-0.33	
Normal-Unload	-3.00*	-3.28***	-3.35***	-3.02***

*,***Indicate significant difference between means at the P=0.05 and 0.001 levels, respectively.

tional system than the potato handling system (Table 4). The changes in SS also indicate that the potato system handles peanuts more gently than the conventional equipment. Other kernels (OK) observed in the conventional system were 1.03% (P≤0.05) higher than the potato system after warehouse unloading (Table 5). This difference can probably be attributed to changes in LSK and SMK discussed above in conjunction with methods used in calculation of official grade percentages. Total kernels and hulls (TKH) means were 0.32% (P≤0.05) higher at Potato-Unload than Normal-Unload (Table 6) providing a further indication that the potato handling system caused less mechanical damage than the conventional system. Other grade parameters were not significantly different when comparing peanuts moved into and out of storage with the two handling systems except for foreign material (FM). FM averages were within about 1% for all sample extractions, except from peanuts after handling with the conventional equipment which showed an increase of 3.55% (P≤0.001) as compared to the potato handling system (Table 7). Slight increases in FM should have occurred to correspond with the increase in LSK (or possibly some variation in observations could be attributed to sample extraction variability). However, no clear explanation for the magnitude of change in FM for these peanuts is evident.

Investment costs for warehouse equipment and potato handling equipment were similar. Excluding the cost of warehouse construction, equipment cost (including installation) for a conventional warehouse is estimated to be $83,934. With a 15-yr depreciable life and a 10% salvage value, the yearly equipment cost is $9932. The yearly repair and maintenance cost of the warehouse equipment is estimated at $1986. Conventional warehouse loading equipment totals $11,918/yr which equates to $3.28/t/yr. The cost of unloading a warehouse by conventional means must be included also. These costs (including bucket loader, incline conveyer, utilities, and labor) were estimated to be $6364/yr and $1.75/t/yr. Thus, conventional handling methods for a 3629-t capacity warehouse are estimated to be $18,282/yr or $5.04/t/yr.

Potato handling equipment cost, provided by the manufacturer, was $86,795. With a 15-yr depreciable life and a 10% salvage value, the yearly cost of the potato handling equipment is $10,270. The repair and maintenance cost is estimated at $2054/yr. The mobility of the potato handling equipment allows warehouse unloading without additional investment in equipment. However, similar utility and labor costs for unloading are incurred. Thus, loading and unloading a 3629-t capacity warehouse is estimated to be $14,724/yr or $4.06/t/yr.

Generally, the official grade factors indicated that the potato handling system caused less mechanical damage

Table 4. Comparison of differences in sound splits means from official grades of peanuts sampled at (a) Farmer-Market, (b) Potato-Load, (c) Normal-Load, (d) Potato-Unload, and (e) Normal-Unload.

Sample extraction	Sample extraction: Farmer-Market	Potato-Load	Normal-Load	Potato-Unload
	%			
Potato-Load	0.23			
Normal-Load	-0.11	-0.34		
Potato-Unload	0.67	0.44	0.78	
Normal-Unload	4.66***	4.43***	4.77***	4.00***

***Indicates significant difference between means at the P=0.001 level.

Table 5. Comparison of differences in other kernels means from official grades of peanuts sampled at (a) Farmer-Market, (b) Potato-Load, (c) Normal-Load, (d) Potato-Unload, and (e) Normal-Unload.

Sample extraction	Sample extraction: Farmer-Market	Potato-Load	Normal-Load	Potato-Unload
	%			
Potato-Load	-0.08			
Normal-Load	-0.26	-0.19		
Potato-Unload	0.02	0.10	0.28	
Normal-Unload	-1.01	-0.93*	-0.74	-1.03*

*Indicates significant difference between means at the P=0.05 level.

Table 6. Comparison of differences in total kernels and hulls means from official grades of peanuts sampled at (a) Farmer-Market, (b) Potato-Load, (c) Normal-Load, (d) Potato-Unload, and (e) Normal-Unload.

Sample extraction	Sample extraction: Farmer-Market	Potato-Load	Normal-Load	Potato-Unload
	%			
Potato-Load	-0.49			
Normal-Load	-0.33	0.17		
Potato-Unload	-0.14	0.36*	0.19	
Normal-Unload	-0.46*	0.04	-0.13	-0.32*

*Indicates significant difference between means at the P=0.05 level.

Table 7. Comparison of differences in foreign material means from official grades of peanuts sampled at (a) Farmer-Market, (b) Potato-Load, (c) Normal-Load, (d) Potato-Unload, and (e) Normal-Unload.

Sample extraction	Sample extraction: Farmer-Market	Potato-Load	Normal-Load	Potato-Unload
	%			
Potato-Load	0.70			
Normal-Load	0.53	-0.17		
Potato-Unload	0.99	0.29	0.46	
Normal-Unload	4.54***	3.84***	4.01***	3.55***

***Indicates significant difference between means at the P=0.001 level.

to peanuts than a conventional system in loading and unloading a warehouse. However, the potato handling system used will not allow piling peanuts as high as normally required to fill conventional warehouses (6.1 to 7.6-m lower than normal peanut pile). Using the potato system for loading conventional warehouses would only allow filling the warehouse to about two-thirds full. Factoring the reduced capacity with peanut value indicates that it is not economically warranted to replace existing conventional systems with potato handling systems in existing peanut warehouses. The potato system is fully adaptable for unloading conventional warehouses and would probably yield less mechanical damage than is usually caused by front-end loaders scooping up and/or running over peanuts in warehouse unloading. Although experimental design did not allow comparison of Normal-Load:Normal-Unload with Normal-Load:Potato-Unload, the grade and cost data indicate that unloading conventionally loaded warehouses with the potato handling could be an economically feasible alternative to conventional unloading methods.

The potato handling system provides an economically feasible alternative when constructing new peanut warehouses or for utilizing existing buildings other than conventional warehouses for peanut storage. The gross value of peanuts, based on grade factors at warehouse unload in a 3629-t capacity is increased by $20,200. Including the difference in per year cost of the two handling systems indicates that the potato handling system could increase returns by $23,758 compared to conventional handling methods. Also, since the potato system is portable, it offers the capability for use in more than one storage building during peanut harvest and for unloading warehouses. The potato system certainly provides an alternate handling system which should be considered in making additions or changes in peanut warehousing capacity or replacement of handling equipment for storage.

Literature Cited

1. Davidson, J. I. Jr., T. B. Whitaker, and J. W. Dickens. 1982. Grading, cleaning, storage, shelling, and marketing of peanuts in the United States, pp. 571-623. *In* H. E. Pattee and C. T. Young (eds.) Peanut Science and Technology. Amer. Peanut Res. Educ. Soc., Inc., Yoakum, TX.
2. Slay, W. O. 1976. Damage to peanuts from free-fall impact. ARS-S-123.
3. Slay, W. O., and R. S. Hutchison. 1973. Handling peanuts with bucket elevators. ARS-S-17.
4. Smith, J. S., Jr., and J. I. Davidson, Jr. 1982. Psychometrics and kernel moisture content as related to peanut storage. Trans. Amer. Soc. Agric. Eng. 25:231-236.

Accepted 8 February 1996