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FEEDER DESIGN TO ELIMINATE HAND INJURIES ON PEANUT GRADING EQUIPMENT

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ABSTRACT. *The current feeding device for the farmers' stock grade sample cleaner and pod sizer causes numerous hand injuries. An improved feeder that eliminates injuries without decreasing equipment performance was designed. Tests showed feed rates greater than 1 min 29 s for the pod sizer and slower than 1 min 20 s for the sample cleaner resulted in sizing and cleaning performance similar to present equipment. The feeder was approved by the Federal-State Inspection Service and is now installed on all new cleaners and sizers. No injuries or inspector complaints related to the improved feeder have been reported.* ***Keywords.*** *Peanuts, Safety, Cleaners, Cleaning efficiency, Inspection, Grading.*

Concerns for inspector safety prompted the Federal-State Inspection Service (FSIS) to request the Agricultural Research Service (ARS) develop an improved feeding device for the grade sample cleaner and pod sizer. The current finger-wheel feeder used on both the sample cleaner and pod sizer caused 5.5 injuries/1,000 workers and accounted for about 38% of all injuries and 67% of the total value of claims paid by FSIS over a two-year period (FSIS, 1992). There was an average of 15 injuries/year and the average total claim paid per year for these injuries was $27,000. Injuries occur when the inspector attempts to retrieve or dislodge material from the feeder (figs. 1 and 2). The metal fingers on the feeder rotate and wedge against the inspectors' fingers at a pinch point causing cuts, crushing, or complete removal of fingers. No OSHA standards directly apply to this equipment.

About 2,000 FSIS personnel annually inspect approximately 600,000 lots of peanuts at over 500 locations throughout the peanut growing area. Samples from lots of farmer marketed in-shell peanuts are inspected to determine the percentage of foreign material (FM), edible kernels, and inedible kernels (USDA, 1990). The inspection process includes cleaning approximately 1500 g (3.3 lb) samples by separating out FM, loose shelled kernels (LSK), and pods (in-shell peanuts) using a sample cleaner (fig. 1). Five hundred g (1.1 lb) of the cleaned pods are then sized into three categories using parallel stepped rollers (fig. 2). The pod size determines which of three sheller compartments the pods are placed in. The sheller separates hulls from the kernels by rubbing pods over perforated grates. Each sheller compartment has a successively smaller grate perforations. After the shelling operation, the shelled kernels are sized using slotted screens. Kernels riding the screen are considered edible grade if they meet FSIS damage specifications. Kernels falling through the screen are used only for nonfood products. Value of the lot is determined from the percentage of FM, edible kernels, and inedible kernels.

The equipment addressed in this research includes only the sample cleaner and pod sizer (figs. 1 and 2). The feeder on the sample cleaner (fig. 1) conveys the 1500-g (3.3-lb) sample to parallel rotating rollers. Small material, such as light trash and LSK, fall through the rollers. This small material is conveyed across a perforated screen which removes dirt. A negative air aspirator floats off light

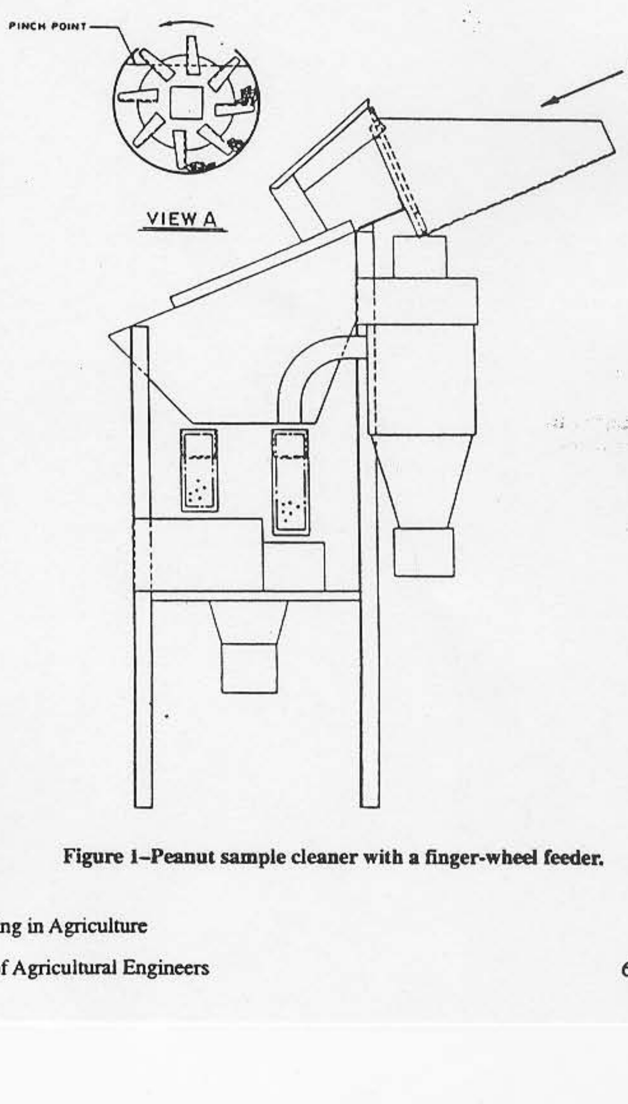

Figure 1–Peanut sample cleaner with a finger-wheel feeder.

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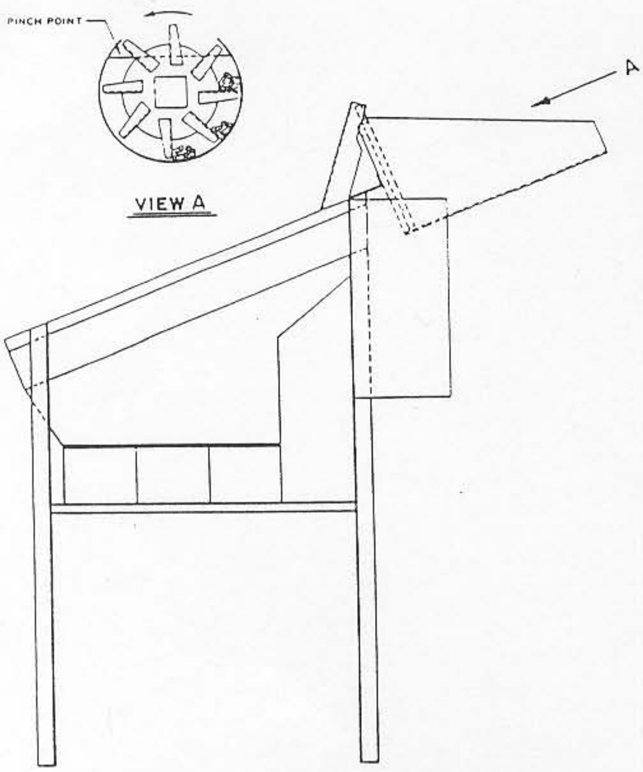

Figure 2–Peanut pod sizer with a finger-wheel feeder.

material then a positive air aspirator drops out rocks, leaving only LSK. The large material riding over the rollers also passes over the positive air aspirator to remove large rocks, leaving only pods. If the cleaner is fed too quickly, the rollers and aspirators overload, causing improper separation of FM and subsequent excessive hand cleaning by inspectors to complete the FM removal.

The feeder on the pod sizer (fig. 2) conveys a 500-g (1.1-lb) sample to parallel counter-rotating rollers. The gap between the upper portion of the rollers allows small pods to fall into a bin. A larger gap at the lower portion of the rollers allows medium size pods to fall into a separate bin. Larger pods carried over the rollers fall into a third bin. If feed rates are excessive, the pods sizer overloads resulting in small pods falling into bins intended for larger pods.

The feeders for the cleaner and pod sizer utilize metal fingers rotating in a vertical plane (view A, figs. 1 and 2). This finger-wheel feeder is chain or belt driven at a constant speed. The safety hazard posed to inspectors by this feeder dictated improved feeders for sample and pod sizing equipment, however, the improved feeders must be compatible with the existing system sample processing capacity to prevent improper cleaning or sizing. Thus, the objective of this research was to develop a safe feeding device capable of feeding materials at optimum feed rates.

METHODS

The feeder specifications given to ARS by FSIS include: to reduce worker compensation costs, the feeder must reduce hand injuries; the grading process must not be slowed down, thus feed rate cannot be reduced; previous samples cannot contaminate subsequent samples, thus the feeder must be self cleaning; retrofitting costs must be kept to a minimum, therefore, installation of the feeder must not require modification of the cleaner and pod sizer, except for removal of the existing feeder; to minimize sample spillage and allow for possible future increases in sample size, the bin must hold twice the current sample size; and to provide easy accessibility by inspectors, the height of the feeder must not be greater than the present feeder height of 155 cm (61 in.). Numerous bins, mounting brackets, and feeders were tested. The same design was tested on the pod sizer and cleaner. After FSIS approved the final laboratory prototype, the improved pod sizer feeder and a cleaner feeder were field tested at one location in Texas, two locations in Georgia, and one location in North Carolina during the 1992 harvest season. The test locations contained two complete sets of grading equipment to obtain inspector feedback on the reliability and ease-of-use of the improved feeders as compared to the finger-wheel feeders. In 1993, approximately 250 units were installed on equipment throughout the peanut producing areas. Feedback was informal and was conveyed to ARS through inspector supervisors. Approximately 1,000 samples were graded at each of these locations in 1992 and 1993.

Separate tests to study effects of feed rate on machine performance utilized 10 replicated samples run over each feeder type. Ten 1500 g (3.3 lb) samples were cleaned using the finger-wheel feeder, then these 10 samples were cleaned using 3 different feed rates of the improved feeder. Similarly, ten 500 g (1.1 lb) samples of pods were sized using the finger-wheel feeder, then these 10 samples were sized using 3 different feed rates of the improved feeder. All results were compared using standard least-significant-difference (LSD) statistical procedures.

RESULTS

The final bin design utilized tapered sides to reduce bin height to allow inspectors to easily pour samples into the bin and inspect the bin for remaining material (figs. 3, 4, and 5). The bin and trough were fabricated from 16-gauge sheet metal and the frame fabricated from 0.5 mm (0.02 in.) × 3.8 mm (0.15 in.) metal. The bin height is 16.3 cm (6.4 in.) and tapers from 50 cm (20 in.) × 30 cm (12 in.) down to 10 cm (4 in.) × 10 cm (4 in.). The trough is 10 cm (4 in.) wide × 20 cm (8 in.) long. An adjustable gate at the front of the bin controls the flow rate when different varieties of pods are cleaned or sized. Runner- and Spanish-type peanuts require a gate opening of about 4 cm (1.6 in.), whereas Virginia-type peanuts require an opening of about 5 cm (2 in.). Most locations inspect only one peanut type, thus the gate is set once and left in that position throughout the harvest season.

An electromagnetic vibratory feeder was selected for its compactness, safety, and variable speed capabilities. The specific feeder used was a Syntron FTOC with a 110-Volts controller. The feeder delivers a stroke of about 0.13 cm (0.05) with a frequency of about 4000 V/min. Other feeders with similar specifications may suffice.

No inspector complaints, equipment failures, or injuries were recorded during field testing of any of the final prototypes. The locations of test equipment throughout the peanut producing areas provided extreme variations in crop conditions. There was no affect of crop variation between years or within years on feeder performance or inspector

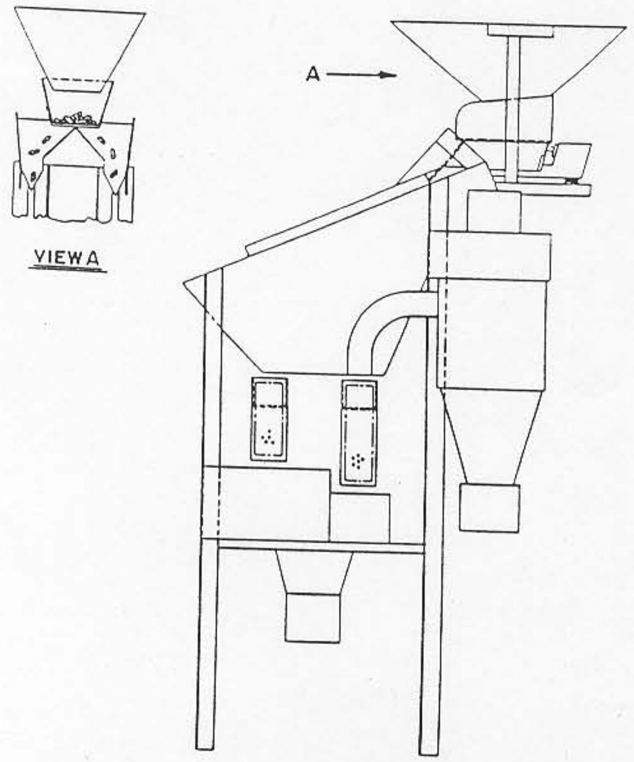

Figure 3–Peanut sample cleaner with a vibratory feeder.

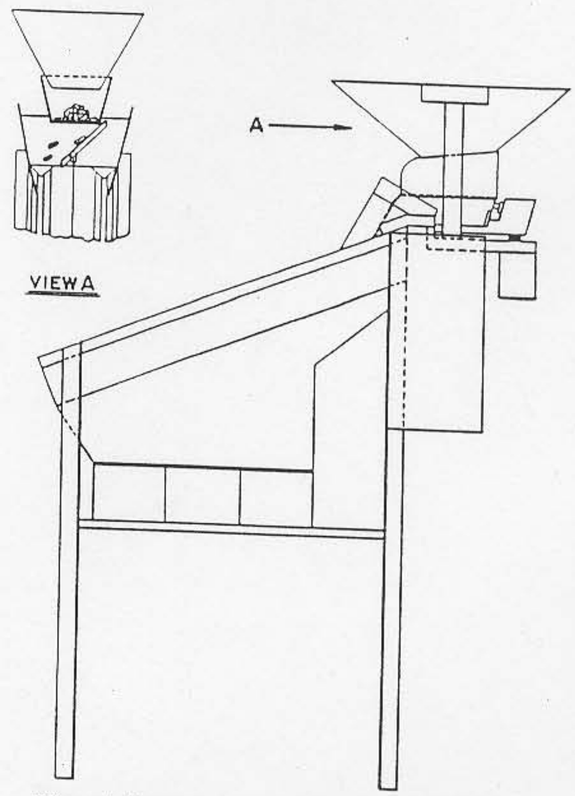

Figure 4–Peanut pod sizer with a vibratory feeder.

safety. The feeders resulted in a reduction of injury rates due to feeder injuries from 5.5 injuries/1,000 workers to 0 injuries/1,000 workers.

Table 1 shows the effect of speed and feeder type on the performance of the pod sizer. The two faster vibratory feed rates resulted in pod sizing similar to the finger-wheel feed rate. However, it is interesting to note that the slowest feed rate resulted in significantly fewer pods in the large pod bin than the fast feed rate. Thus, more pods fell into the correct bins at the slower feed rate. The slower feed rate allowed pods to fall through the proper size gap. Higher feed rates overloaded the sizer and caused small pods to fall into the large pod bin. These improperly sized small pods are placed in shelling compartment designed for larger pods. Thus, the small pods fall through the sheller grate and must

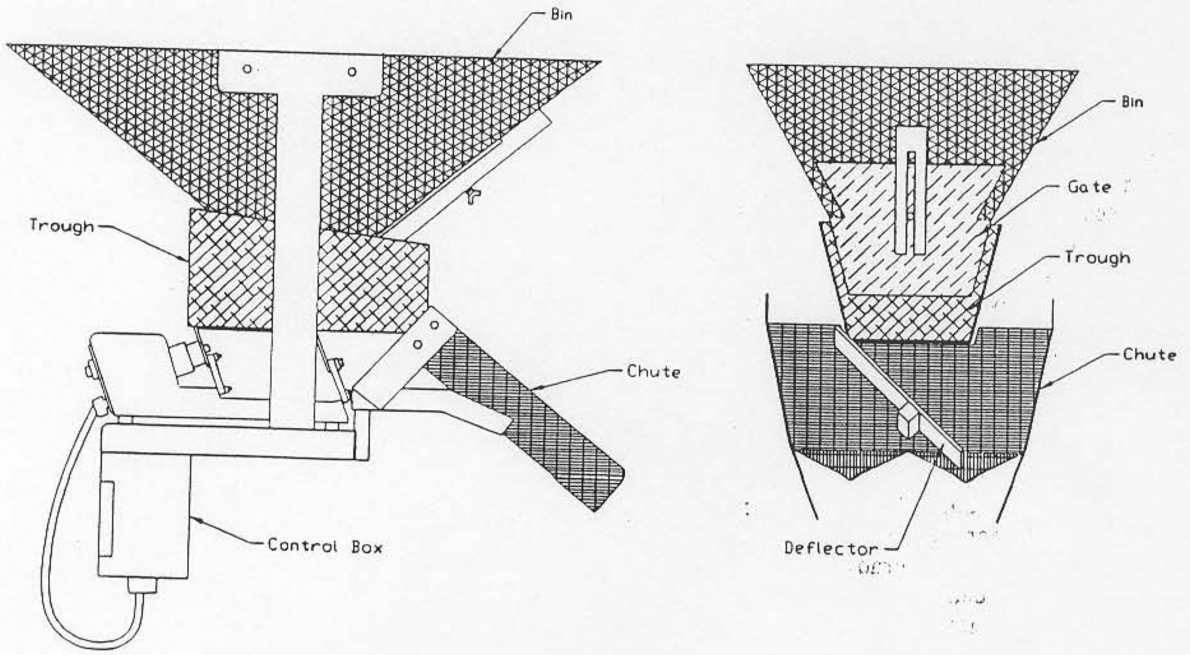

Figure 5–Vibratory feeder designed to eliminate hand injuries.

Table 1. The effect of feeder type and time to feed 500 g (1.1 lb) of pods on the weight of pods placed in the large, medium, and small pod bins*

Feeder Type	Feed Time	Large Pod Bin (g)	Med. Pod Bin (g)	Small Pod Bin (g)
Wheel	53 s	360.3 ab†	119.9 a	19.9 a
Vibratory	43 s	370.4 a	111.4 a	17.7 a
Vibratory	1 min 29 s	357.4 ab	120.9 a	21.4 a
Vibratory	3 min 24 s	351.3 b	122.9 a	21.6 a

* Values are averages of 10 samples.
† Means in columns followed by the same letter are not significantly different at P = 0.05.

Table 2. The effect of feeder type and time to feed 1500 g (3.3 lb) of material on the separation of pods, loose shelled kernels (LSK), light trash, and dirt into the correct respective bin*

Feeder Type	Feed Time	Pod Bin (g)	LSK Bin (g)	Light Trash Bin (g)	Dirt Bin (g)
Wheel	2 min 46 s	1348.6 a†	68.5 a	17.1 a	0.20 a
Vibratory	2 min 09 s	1355.9 a	48.3 b	15.3 a	0.19 a
Vibratory	1 min 20 s	1355.6 a	47.4 b	15.9 a	0.16 a
Vibratory	39 s	1324.2 b	48.9 b	12.3 b	0.18 a

* Values are averages of 10 samples. Only material correctly separated into proper bins were included in this table, thus rows do not sum to 1500 g.
† Means in columns followed by the same letter are not significantly different at P = 0.05.

be hand shelled. Slowing the sizing process reduces shelling labor by accurately sizing pods, thereby reducing hand shelling. The FSIS requested the vibratory feeder perform similar to the finger-wheel feeder, thus the two faster feed rates should be used. However, if FSIS wishes to reduce hand shelling, the slower feed rate which sizes pods more accurately should be used.

Table 2 shows the effect of feeder type and feed rate on cleaning efficiency. The pod, light trash, and dirt separating efficiency of the two slower feeding rates were not significantly different than the finger-wheel feeder. However, the vibratory feeder had significantly fewer LSK than the finger-wheel feeder. The angle of the feeding tray probably caused LSK to roll too quickly down the rollers, thus not allowing ample time to fall through into the LSK bin. Either of the two slower feed rates give similar pod, light trash, and dirt separation as the finger-wheel feeder. A decrease in the angle of the feed tray should improve the LSK separation.

Summary and Current Project Status

The vibratory feeder met all requirements of safety, speed, and installation requirements and the technology transfer to FSIS is complete. Feed rates faster than 1 min 29 s for the pod sizer and slower than 1 min 20 s for the sample cleaner resulted in sizing and cleaning performance similar to that of the finger-wheel feeder. The FSIS reported no inspector complaints or injuries related to the vibratory feeder. The FSIS currently contracts with a local equipment manufacturer to produce the vibratory feeding units. The FSIS replaces existing finger-wheel feeders as they wear out and is installing the vibratory feeder on all new pod sizers and sample cleaners. Cost of the vibratory feeder is similar to the finger-wheel feeder. Approximately 250 units are now being used in the field.

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