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Soybean Seed Handling

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SOYBEAN SEED HANDLING

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Introduction and Objective

Improper handling of soybean seed can substantially reduce seed quality. Many commercial conveyors are available for bulk handling of seed. These conveyors were designed for grain and information on the damage caused by these conveyors in seed handling is limited.

The objective of this research was to compare several seed handling systems with respect to their effect upon soybean seed quality. The ultimate goal is to provide the soybean seed producer with information upon which to base the purchase of new system and optimize the operation of those already in hand.

Description of Conveyors

A survey was conducted to determine the types of conveyors being used by approved soybean seed conditioners in Iowa. A total of 74 questionnaires were sent with 66 conditioners responding. This survey indicated that 25.8% of the conditioners use steel-flighting augers, 24.2% use belt conveyors, 19.7% use augers with rubber-flighting intakes, 15.2% use pneumatic conveyors, 10.6% use flight conveyors, 3% use other conveyors and 1.5% do not use any conveyors for bulk handling of soybean seed. Based on the survey information, six conveyors were included in the experimental design. These conveyors were:

1. Steel-flighting Auger: A steel-flighting auger (Figure 1) is the most common device on the farm for bulk handling of seed. It implements a rotating helix inside a tube for lifting of the seed. Because the helix and the tube are made of metal, mechanical damage to seed can occur.

2. Auger with Rubber Intake: The main feature of this auger is a two-foot rubber intake section (Figure 2). Originally a safety feature, the rubber intake offers some protection against seed damage.

3. Pneumatic Conveyor: Seeds in this device are conveyed by a moving air stream. The seeds are conveyed through the intake pipe

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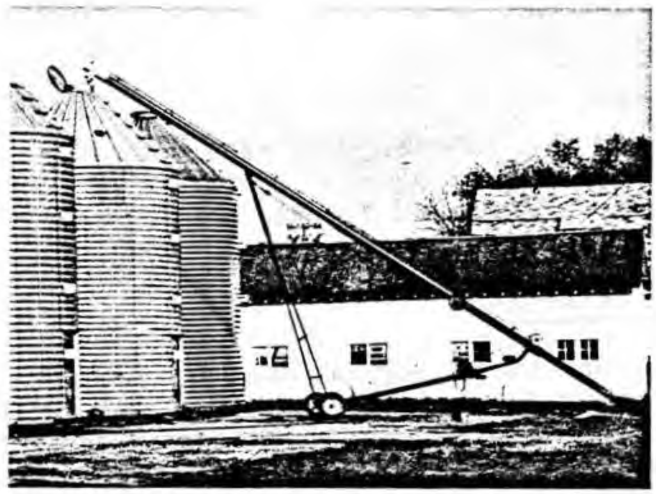

Figure 1. An auger is often used on the farm to fill bulk storage.

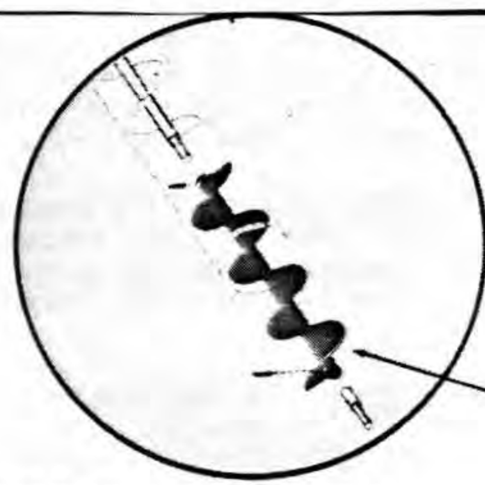

Figure 2. Auger with rubber intake.

(Figure 3) to the separator cyclone and into an airlock. From the airlock, the seeds drop into the discharge pipe and conveyed to the discharge cyclone.

4. The Belt Conveyor: In this conveyor, a rubber belt travelling through a steel tube carries the seeds (Figures 4a and 4b). Since the seeds are carried on the belt, damage to seeds can be minimized.

5. The Rubber-flight Conveyor: This conveyor has rubber flights molded on a rubber belt (Figure 5) to prevent the roll back of seeds during handling. The flight conveyor can therefore be operated at higher angles of inclination than the belt conveyor without increasing the belt speed.

6. The Steel-core Bristle Auger: This auger uses nylon bristles instead of metal flightings to move the seed (Figure 6). The nylon bristles are attached to a steel core. The steel core provides strength to keep the material moving and the bristles provide a sweeping action to minimize seed damage during handling.

Experimental Procedure

The total experimental design included six conveyors, two angles of inclination (30^{o} and 15^{o}), two volume controls (full capacity and half capacity), two consecutive passes through each conveyor, and two seedlots. Seedlot 1 consisted of 1200 bushels of Pella soybean seed grown in Madrid, Iowa by the University Farm Service. The seeds were harvested in October, 1984 at an average seed moisture of 14.8% and put in 20 bushel plastic lined bulk bags for the handling experiments. Seedlot 2 was a proprietary variety and was a surplus production from the previous year. The seedlot was at 10.7% moisture, was cleaned by the conditioner and stored in 60-pound seed bags. A thousand of these bags were transported to the warehouse for the seed handling experiments.

Two bins, made of wood and angle iron were used for this research (Figure 7). One of the bins was suspended from a forklift to provide the desired angle of inclination. Each bin was equipped with a 4 inch x 16 inch slide gate at the bottom. Prior to the experiments, the slide gates were calibrated to control the volume of seed flow into the conveyor. The conveyor transferred seed from one bin to the other.

The time for each conveying run was recorded using a chronometer. The capacity of each conveyor was calculated by dividing the weight of seeds conveyed by the time recorded.

During conveying, samples were taken from the inlet and exit end of the conveyor. Each sample of approximately 2 kilograms of soybeans was obtained by cutting across the stream of seed flow several times with a container. For the second pass, samples were taken only at the

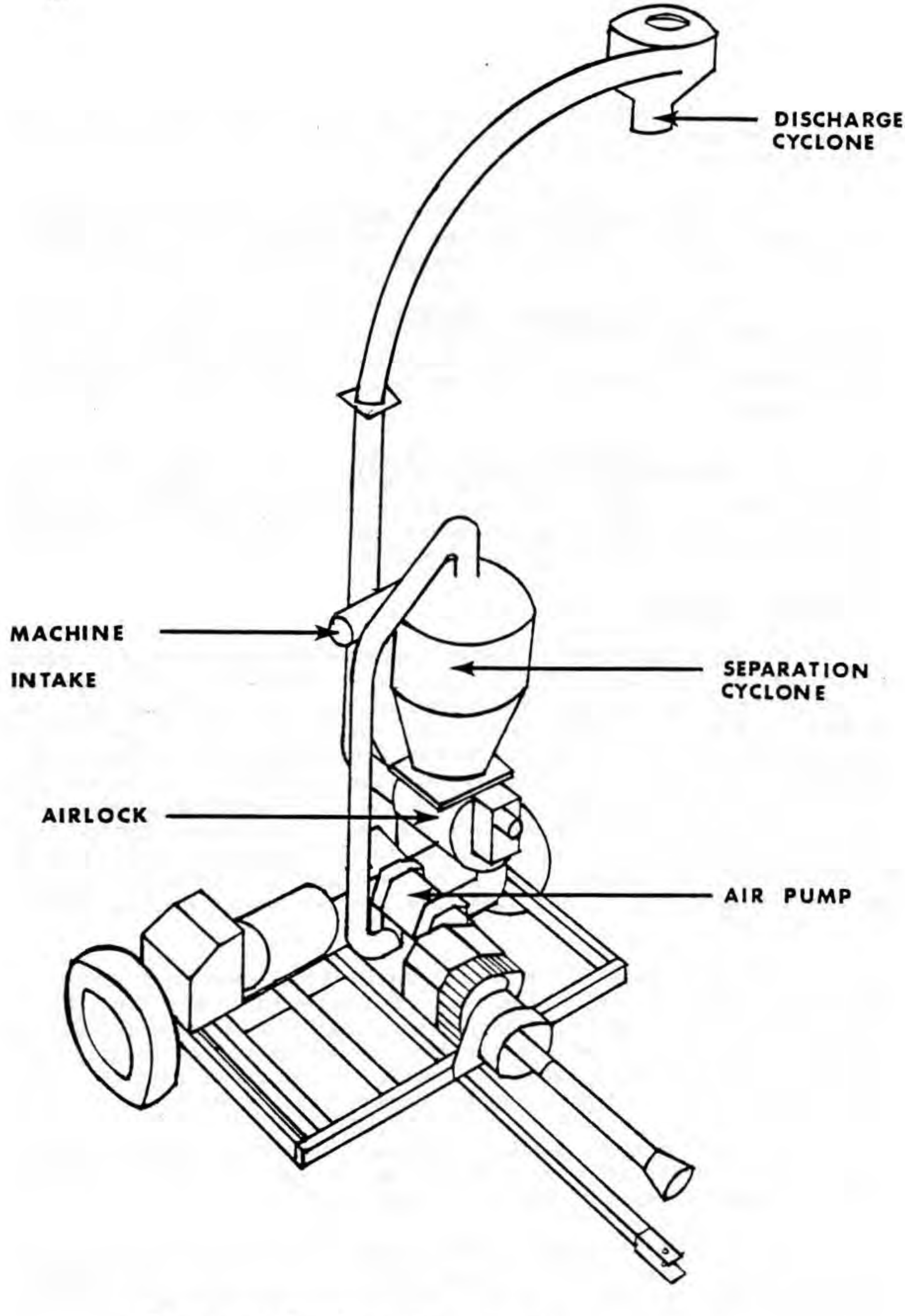

Figure 3. The Pneumatic Conveyor

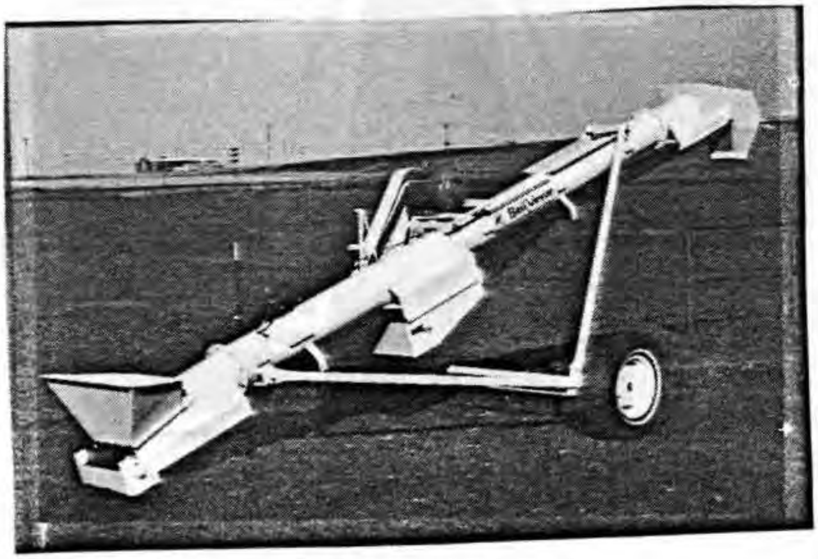

Figure 4(a). The Belt Conveyor

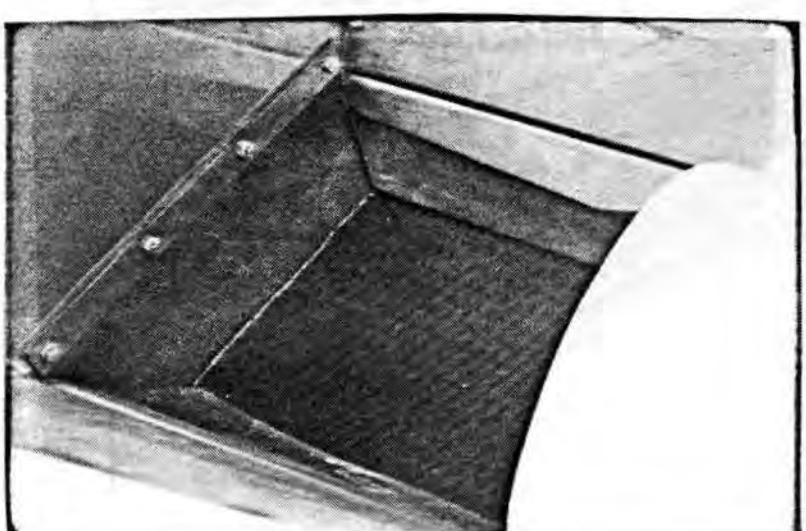

Figure 4(b). Close-up of the belt in the tube of the Belt Conveyor

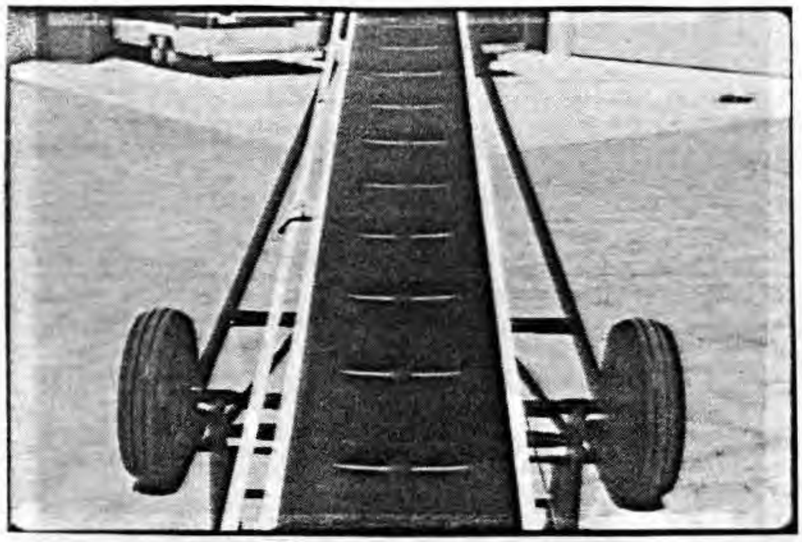

Figure 5. The Rubber-flight Conveyor

Figure 6. The Steel-core Bristle Auger

2 SEEDLOTS WITH DIFFERENT MOISTURE CONTENT

6 CONVEYORS - STEEL FLIGHTING AUGER
RUBBER INTAKE AUGER
PNEUMATIC CONVEYOR
BELT CONVEYOR
NYLON BRUSH CONVEYOR
FLIGHT CONVEYOR

2 ANGLES OF INCLINATION - 30°
15°

2 VOLUME CONTROLS - FULL CAPACITY
HALF CAPACITY

2 CONSECUTIVE PASSES THROUGH EACH CONVEYOR

2 REPLICATIONS

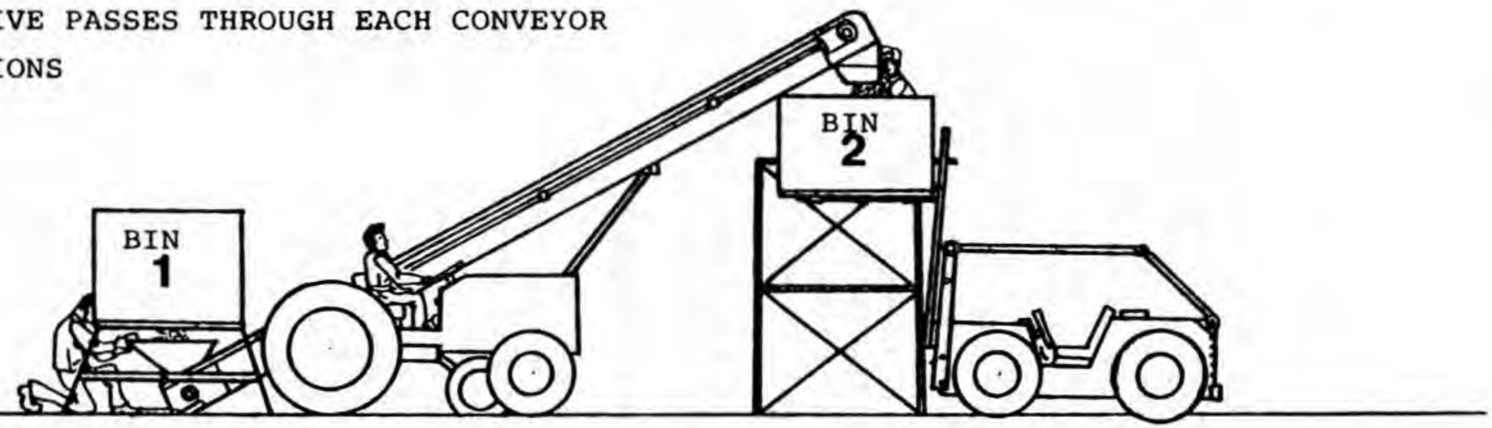

Figure 7. The Experimental Set-up

exit end of the conveyor, since the sample at the inlet for the second pass is the same sample as collected at the exit end during the first pass.

The seed quality of the samples was evaluated in terms of germination, seedcoat damage, and splits. The germination tests were conducted by the Iowa State Seed Laboratory according to the "Rules for Testing Seeds" of the Association of Official Seed Analysts. Four replications of 100 seeds were planted in a kimpak substrate, germinated at 25°C for 7 days, and the percentage normal seedlings recorded. The sodium hypochlorite soak procedure was used to determine seedcoat damage. In this procedure, two replications of 100 seeds were soaked in a 1% sodium hypochlorite solution for ten minutes. The seeds with seed coat damage swelled visibly and were counted. Splits were obtained by passing the sample through a 10/64-in. slotted hand sieve. The material that fell through the sieve often contained weed seeds and small undamaged seeds in addition to splits. These materials (other than splits) were removed by hand and the percentage of splits was calculated on the basis of weight of actual splits.

Data analysis was made by the Statistical Analysis System using a Completely Randomized Block experimental design.

Results and Discussion

Significant differences in capacity (maximum delivery) were found for various types of conveyors and angles of inclination (Figure 8). The flight conveyor, on the average, had the highest capacity (2373 Bu/hr) followed in order by the belt conveyor (2255 Bu/hr), the steel flighting auger (2166 Bu/hr), the pneumatic conveyor (2092 Bu/hr), the steel-flighting auger with rubber intake (2053 Bu/hr), and the nylon bristle auger (1883 Bu/hr). For all conveyors, the capacities declined at 30° angle of inclination compared to 15° angle of inclination. The capacity of the belt conveyor was reduced by 46% when the belt conveyor was operated at 30° angle of inclination. The pneumatic conveyor capacity was reduced only 3% by increasing the angle of inclination from 15° to 30°.

After two consecutive passes, the steel-flighting auger produced the highest increase in splits (0.56%) followed in order by the rubber intake auger (0.24%) and the pneumatic conveyor (0.2%) (Table 1). The nylon brush conveyor produced only a very small increase in splits (0.02%) and the remaining two conveyors, i.e. the belt conveyor and the flight conveyor did not produce any increase in splits in two consecutive passes. The steel flighting auger also produced the highest seed coat damage (4.3%) in two consecutive passes. The rubber intake auger and the pneumatic conveyor inflicted about equal seed coat damage (2.8%) in two consecutive passes. The corresponding seed coat damage for the nylon brush conveyor, the flight conveyor and the belt conveyor were 1.59%, 0.66% and 0.38%, respectively. The steel flighting auger, the

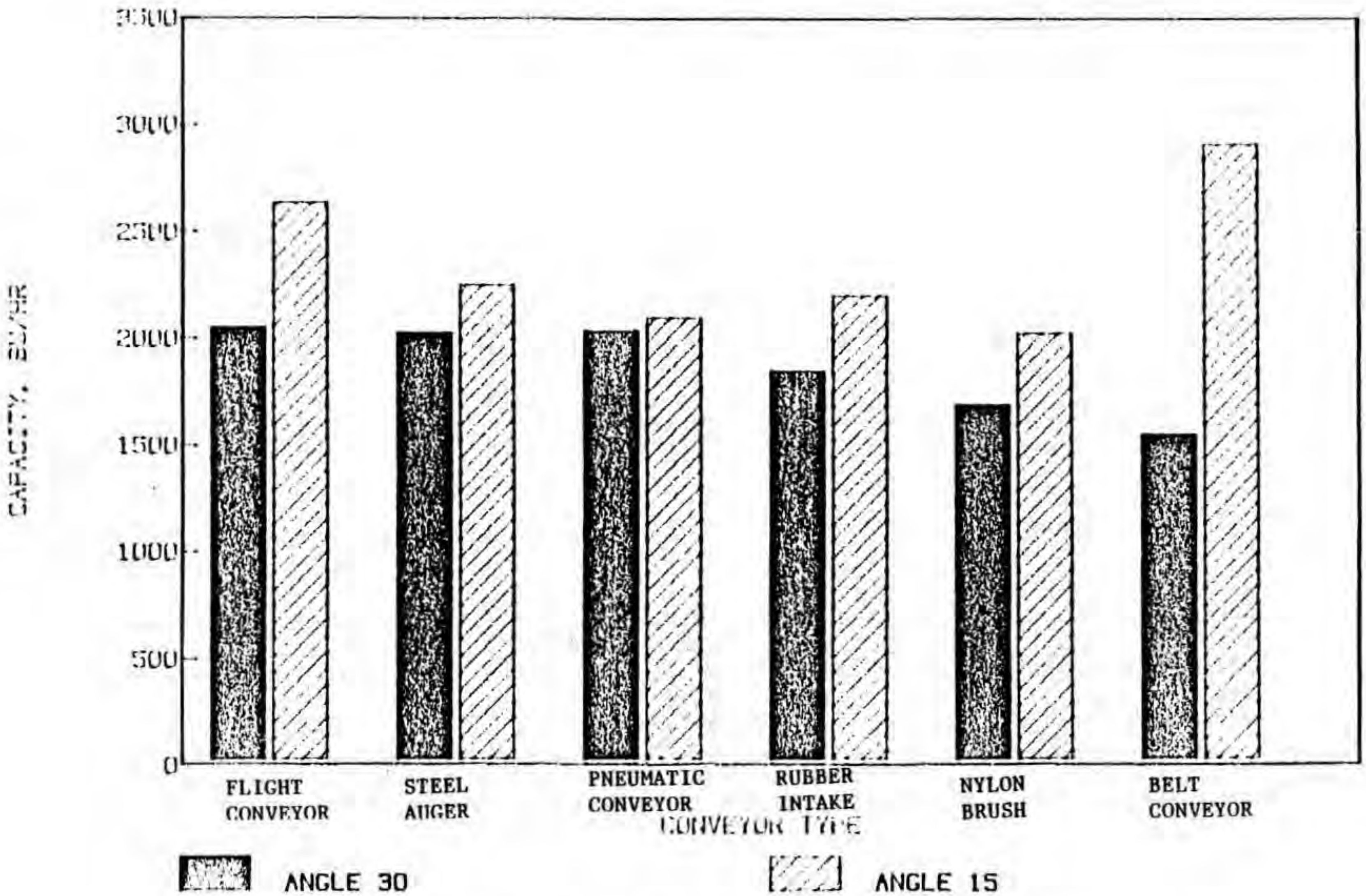

Figure 8. Effect of conveyor type and angle of inclination on capacity.

Table 1. Average splits, germination and seedcoat damage for various types of conveyors; averaged across seedlots, angles of inclination and volume flow.

Types of conveyor	Splits Initial (%)	Splits After 1st pass (%)	Splits After 2nd pass (%)	Germination Initial (%)	Germination After 1st pass (%)	Germination After 2nd pass (%)	Seed Coat Damage Initial (%)	Seed Coat Damage After 1st pass (%)	Seed Coat Damage After 2nd pass (%)
Steel flighting auger	0.147_a	0.418_a	0.704_a	$93.1_{a,b}$	91.9_b	$90.6_{b,c,d}$	6.53_a	$9.13_{a,b}$	10.8_a
Rubber-intake auger	0.157_a	0.281_b	0.397_b	90.9_c	$90.1_{b,c}$	88.5_d	7.28_a	$9.00_{a,b,c}$	$10.1_{a,b}$
Pneumatic conveyor	0.140_a	0.246_b	0.340_b	$91.1_{c,b}$	89.6_c	$88.5_{c,d}$	7.84_a	9.71_a	$10.7_{a,b}$
Belt conveyor	0.117_a	0.117_c	0.116_c	$92.0_{c,b}$	91.8_b	$91.1_{b,c}$	7.50_a	7.25_d	7.88_c
Nylon brush conveyor	0.136_a	0.151_c	0.159_c	$92.1_{c,b}$	$91.2_{b,c}$	$92.3_{a,b}$	7.63_a	$8.19_{b,c,d}$	$9.22_{b,c}$
Flight conveyor	0.141_a	0.146_c	0.142_c	94.7_a	94.2_a	94.3_a	7.12_a	$7.78_{c,d}$	8.03_c

*Means with the same letters within columns do not differ significantly at the 5 percent level.

rubber intake auger and the pneumatic conveyor reduced the germination by very similar amounts (2.5%) in two consecutive passes. The remaining three conveyors, i.e. the nylon brush conveyor, the belt conveyor, and the flight conveyor, induced no significant decrease in germination during conveying (Table 1).

A significant interaction of conveyor type and angle of inclination was found for splits produced during conveyance of seedlot 2 (Table 2). At steeper angle of inclination for seedlot 2, the steel flighting auger produced 1.49% splits in two consecutive passes which is very undesirable and must be avoided. The rubber intake auger also produced more splits (0.66%) at steeper angle compared to 15° angle of inclination (0.4%). The pneumatic conveyor showed a reverse trend, which can not be fully explained. A possible explanation may be that the seeds were slowed down in the exit cyclone due to the additional length of pipe needed for increasing the height of discharge. The three remaining conveyors i.e. the belt conveyor, the nylon brush conveyor and the flight conveyor did not produce any appreciable amount of breakage to soybeans in any angle of inclination.

The interaction of conveyor type with volume flow is shown in Table 3. For seedlot 2 the steel flighting auger produced a substantial increase in splits (1.225%) in half volume flow condition. The rubber intake auger and the pneumatic conveyor also produced more splits when operated at half volume capacity as compared to full volume flow condition. The remaining three conveyors i.e. the belt conveyor, the nylon brush conveyor and the flight conveyor were not influenced by the volume flow in term of breakage. The pneumatic conveyor caused a significant decrease in germination in the half volume condition for seedlot 2 (Table 3). The seedlot, after two consecutive passes, had a germination of 82.9%. Further analysis indicated this decrease occurred in both angles of inclination. Further research is recommended to confirm this aspect of pneumatic conveying because of its significance in recommending proper operational procedure to the producer for maintaining seed quality.

Conclusions

The conclusions derived from the first year of research are:

1. The flight conveyor had the highest capacity followed, in order, by the belt conveyor, the steel flighting auger, the pneumatic conveyor, the rubber intake auger, and the nylon brush auger.

2. The capacity of each conveyor decreased at a steeper angle of inclination. This decrease was most pronounced in the belt conveyor and least noticeable for the pneumatic conveyor.

Table 2. Effect of conveyor type and angle of inclination on splits and germination of soybean seed.

		Splits (%)				Germination (%)			
		Seedlot 1		Seedlot 2		Seedlot 1		Seedlot 2	
Type of conveyor	Angle of inclination (Degrees)	After 1st pass	After 2nd pass	After 1st pass	After 2nd pass	After 1st pass	After 2nd pass	After 1st pass	After 2nd pass
Steel flighting auger	15	0.001	0.050	0.427	0.73	94.4	92.7	92.1	92.1
	30	0.012	0.097	0.783	1.49	89.3	87.8	90.8	88.7
Rubber intake auger	15	0.017	0.015	0.230	0.397	88.9	87.4	89.4	87.6
	30	0.031	0.026	0.357	0.660	93.5	92.4	89.9	89.1
Pneumatic conveyor	15	0.074	0.137	0.200	0.353	93.6	93.5	86.9	86.2
	30	0.098	0.146	0.285	91.0	91.8	88.0	84.0	
Belt conveyor	15	-0.032	-0.010	0.061	0.058	92.6	93.5	93.0	92.3
	30	0.043	0.021	0.065	0.068	92.1	90.9	89.3	87.8
Nylon brush conveyor	15	0.007	-0.004	0.092	0.019	93.4	93.8	90.2	91.7
	30	0.012	0.023	0.095	0.108	91.6	93.2	899.5	90.4
Flight conveyor	15	0.004	0.003	0.071	0.062	96.7	94.6	90.7	91.0
	30	-0.025	-0.014	0.078	0.061	94.3	95.8	93.6	93.7

Table 3. Effect of conveyor type and volume of flow on splits and germination of soybean seed.

		Splits (%)				Germination (%)			
		Seedlot 1		Seedlot 2		Seedlot 1		Seedlot 2	
Type of conveyor	Volume flow	After 1st pass	After 2nd pass	After 1st pass	After 2nd pass	After 1st pass	After 2nd pass	After 1st pass	After 2nd pass
Steel flighting auger	Full	- .021	0.012	0.516	0.995	91.2	89.8	92.2	90.9
	Half	0.034	0.135	0.694	1.225	92.5	90.6	90.6	89.9
Rubber intake auger	Full	0.042	0.032	0.256	0.486	92.3	92.3	88.5	87.3
	Half	0.006	0.009	0.331	0.571	90.1	87.5	90.8	88.4
Pneumatic conveyor	Full	0.074	0.099	0.144	0.259	92.2	92.3	90.9	87.3
	Half	0.109	0.184	0.221	0.379	92.3	93.1	84.0	82.9
Belt conveyor	Full	0.019	0.022	0.079	0.080	92.6	94.1	91.2	90.4
	Half	-0.008	-0.011	0.069	0.072	92.1	90.3	91.2	89.6
Nylon brush conveyor	Full	0.020	0.032	0.102	0.111	91.8	94.0	89.1	90.5
	Half	-0.001	-0.011	0.085	0.106	93.3	93.0	90.6	91.5
Flight conveyor	Full	-0.016	- .008	0.067	0.059	95.9	94.5	92.3	92.9
	Half	-0.002	0	0.082	0.065	95.1	95.8	92.0	91.9

3. The belt conveyor, the flight conveyor and the nylon brush auger did not cause significant damage to seed during conveying.

4. The steel flighting auger, the rubber intake auger and the pneumatic conveyor produced significant seed damage during conveying if:

    a. the conveyor was not kept full,

    b. the angle of inclination was steep,

    c. the seed moisture was not ideal,

    d. a combination of a, b and c.