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IRRI-PAK
AGRICULTURAL MACHINERY PROGRAM

73-A, SATELLITE TOWN, RAWALPINDI (PAKISTAN)

A collaborative Program of the Pakistan Agricultural Research Council and the International Rice Research Institute

S U M M A R Y

During the reported period, greater emphasis of the Program activities was on testing and improvement of the IRRI-PAK designed machines. Special attention was paid to the improvement of the single shaft axial flow threshers that are being developed by the Program. There are two versions of these threshers, one which is operated by a 10-16 hp. engine and the other operated from the tractor PTO drive. These threshers combine the axial flow threshing principle of the IRRI threshers and a single aspirator type grain separating and cleaning system. These are much more simpler and easier to manufacture than the previous standard axial flow thresher.

Following an increased demand in the agricultural sector, the program has also concentrated its efforts to develop appropriate crop harvesters. Various models available in the country were tested and evaluated. Information gleaned from these tests has been used to develop a crop harvester in the program. This project is yet in the initial stages and further developments are being carried out.

Other machines tested by the program include an IRRI designed TK-6 paddy thresher which was imported from the Philippines, an animal drawn three row grain seeder and the three wheel farm cart. Improvements are being incorporated in these machines following extensive tests.

DESIGN, DEVELOPMENT & TESTING OF MACHINES

a) Single shaft axial flow threshers:

The standard IRRI-PAK axial flow thresher that was developed in 1977 in Pakistan has been found to be rather complex to fabricate. Its power transmission system was also prone to field problems as it had too many belts. The machine delivers the threshed straw at many locations which is not preferred by farmers. To overcome these problems, the IRRI-PAK Agricultural Machinery Program has been experimenting with a new multicrop thresher design over the last two years. The new design combines the well proven axial flow threshing principle of the IRRI threshers with a simple aspirator type grain separating and cleaning system that is popularly used on wheat threshers in India. The single shaft design eliminates the two side mounted blowers, the aspiration fan and many other affiliated components of the older machines.

In this new design, the threshing drum and the radial aspiration fan are mounted on the same shaft. The machine has a triple screen oscillating straw-grain separator. Threshed straw is picked up from the top two screens by two aspiration ducts at the rear end of the machine. A third suction duct removes any light impurities from the grain at the grain spout. Straw and chaff are blown out together to one point from the drum thrower and fan outlets. A fly wheel is installed on the threshing drum shaft to take care of the rapidly fluctuating threshing load. Two different models of the

single shaft threshers were developed, one powered by a 10-16 hp. diesel engine and the otherfrom a tractor PTO shaft.

i) Engine operated single shaft thresher:

This thresher has been developed as an improved model of the earlier IRRI PAK standard thresher. Like the older machine, it is also designed for powering with a 12 hp. diesel engine that is mounted on the frame. The thresher use the same threshing drum and concave as the older IRRI-PAK machine. This thresher has been tested and improved during the 1979 and 1980 wheat and 1979 paddy seasons. Initially, the machine exhibited fairly high grain loss. Two openings were cut on the side of the suction ducts and sliding gates were provided to control air movement at the suction spouts. Various settings of these gates were tried to achieve desirable cleaning efficiency with minimum grain losses. The machine has consistantly exhibited a superior performance than the earlier IRRI machines and is not as prone to field problems. Test results during the last two seasons are briefly described in Appendix I.

ii) Tractor PTO operated thresher.

In view of the substantial population of agricultural tractors in Pakistan and India, this thresher has been designed for powering from Tractor PTO shafts. The design of this thresher is similar to the engine driven axial flow thresher but it has a larger dia $20\frac{3}{8}$" threshing drum and 34" aspiration fan. The tractor PTO is connected with an in-line shaft with two universal joints to the thresher counter shaft. This eliminates the need for special PTO pulley attachment on tractors that are normally used for powering belt driven wheat threshers in Pakistan. Three bsection V-belts are used to transmit power from the counter shaft to the threshing drum shaft.

The PTO thresher was field tested at Mardan, NWFP during the 1979 paddy harvesting season on Basmati 370 paddy variety with 1:2.7 grain straw ratio at 16% moisture level. Detailed tests results are included in Appendix II and the main findings are summarized below:

a) Output: A maximum output of 498 kg./hr. was obtained during the tests and an average output of 338 kg./hr. was obtained on the fairly tall basmati paddy varieties. Since no dwarf paddy varieties were available at Mardan, output on such varieties could not be determined.

b) Aspiration fan losses: The least total grain loss was 1.05% which was picked up by the three suction ducts and blown with the straw. In some cases, however, losses were found to be quite high due to grain being picked up from the upper sieve by the front suction duct. The front suction hole on the fan housing was therefore reduced to 12" diameter from the original 13" dia to reduce air flow in the front suction duct. This helped in reducing grain loss.

c) Thrower Loss: Grain loss from the straw thrower outlet was determined for three different angles of the deflecting louvers in side drum cover. The least loss was found to be 0.6% with an average of 1.2% at the 65 louver angle with respect to the drum axis.

d) Cleaning Efficiency: The average cleaning efficiency was 94.4% with a maximum of 96% and a minimum of 86%.

The machine was extensively tested during the 1980 wheat threshing season in the barani area. A maximum output of 400 kg./hr. of wheat was obtained with losses ranging from .6% to 1.7%.

The following major modifications have been made on this machine to reduce grain loss and improve performance. The distance between drum and the oscillating screen has been increased by 3" to permit installation of a sloping shield under the straw thrower section of the concave. This deflects grain falling from the concave some distance away from the front suction spout and helps in reducing grain losses. To further reduce grain losses, the fan blades length was reduced by 2" which reduced air velocity at the suction ducts.

The suction spouts were redesigned into a diverging shape thereby increasing the cross-sectional area at the mouth to reduce air suction velocity. Originally, the two intake holes on the fan housing were of 13" diameter.

b) Crop Harvester

Due to seasonal labor shortages, farmers in Pakistan are now beginning to face increasing problems in harvesting their crops. During the last two wheat harvesting seasons, two different makes of Italian reaper binders were introduced in the country by two companies. These machines have received favourable comments from farmers but the high cost of binding twine, which is not locally produced, has been a serious problem in their introduction. Many farmers have indicated that binding is not an essential function and a machine which could harvest and lay crop in neat bundles would be quite satisfactory.

The IRRI-PAK Agricultural Machinery Program has initiated a project to develop a simple harvester which could

harvest and drop the crop in heaps without tying in bundles. A commercially available tractor PTO powered cutter bar was used for experimenting with a simple crop collecting and dropping mechanism. A crop deflecting reel, a folding crop collecting board with an on-the-go tipping mechanisms were added to the cutter bar. Preliminary tests were conducted on harvesting wheat. The machine can harvest and drop the harvested crop in heaps but unloading of crop from the board is somewhat slow resulting in some degree of scatter in the harvested crop. Also the machine does not function well on lodged crops. Further development work is continued on this project.

c) IRRI TH-6 Rice Thresher:

A double oscillating screen paddy thresher, that has recently been developed by IRRI in the Philippines was imported into Pakistan. This is a high capacity axial flow thresher which is a rather compact machine. It has a light weight skeleton type open threshing drum and a high capacity double oscillating screen for grain-straw separation. This machine was tested at Gujranwala during the 1979 paddy threshing season. The machine performed well on the dwarf IRRI paddy varieties with a maximum output of upto 522 kg./hr. With local paddy varieties which are much taller, wrappage of straw on the drum was a serious problem in its operation. Since dwarf paddy varieties are widely grown in Sind, the machine has been sent to PASSCO, Jacobabad Sind for testing during the next paddy season. Two manufacturers from Karachi have shown interest in manufacturing this machine and this machine will be loaned to these firms on completion of the planned tests. For test details see Appendix III.

d) Standard Axial Flow Thresher:

M/s Hashtnagar Industries, Peshawar, fabricated eleven machines during the last wheat threshing season. The Government of NWFP had placed a larger order for these machines with the firm but due to the shortage of time only six machines could be supplied by the firm during the wheat season. The machines were checked by the IRRI-PAK staff and had to be substantially reworked to bring these to the IRRI-PAK specifications. These threshers will be used for contract hire and demonstration purposes in the NWFP.

The IRRI_PAK threshers are also beginning to receive favourable response in Punjab and Sind. The firms M/s Javed Engineering Co., Gujranwala, M/s Fazal Engineering, Rawalpindi and M/s Rehman Industries, Hyderabad, have also marketed their machines during the last wheat threshing seasons. Two machines manufactured by M/s Rehman Industries, Hyderabad were provided to the Rice Research Institute, Dokri and the Agriculture University, Tandojam, Hyderabad, Sind.

e) IRRI-PAK Seeder:

The simple three row animal drawn seeder that was reported earlier was tested at the National Agricultural Research Center, Rawalpindi in November, 1979. Based on these tests, the following modifications were incorporated:

1. The weight of the seeder caused excessive penetration of the tynes into the ground and made it difficult to handle on turns. Two supporting wheels were installed on the seeders to limit the ground penetration problems. The dual handle problem was found to be inconvenient for handling the machine specially during turns. This problem was rectified by installing a single central handle.

2. The exceed seed collecting tray was too large and interfered with the operations when walking behind the machine. The tray was repositioned at higher point which minimized the problem.

3. The excess width (6.5 ") of the three original cultivation tynes produced very wide furrows in which soil could not properly fall back in to cover the dropped seeds. Narrower tynes of 1.2" width were used and these gave satisfactory results.

4. The angle of the beam was also changed by drilling additional holes in the beam to mount the cross beam. This allowed greater angle variation of the beam and implement which helped in achieving optimum implement penetration.

f) Three wheel farm cart:

Tests were conducted in January, 1980 on the motorized farm cart at the National Agricultural Research Centre, Rawal Dam, Islamabad. The main results of the tests and the recommendations for design modifications are described below.

1. The cart can transport 1000 kg. load on roads with upto 8.75% slope. The cart was, however, not able to transport this load over rough roads with greater than 8.75% slopes. The maximum forward speed of 17.5% km./hr. seemed too high, both for the point of view of vehicle control on rough roads and for adequate traction for carrying the designed load on 15% slopes.

2. Steering the cart was difficult and somewhat unmanageable. The following recommendations were made to improve steeribility.

   a) Install thrust bearings at the steering linkage pin.

   b) Moving the engine as close to the pivot points as possible.

   c) Install the steering pin in a vertical position.

3. The center of gravity of the cart was still too high. This could be lowered by about 6" by modifying the rear axle and the front hitch arrangement.

4. The frictional drum reversing mechanism did not perform satisfactorily. The lining on the friction drum wore rapidly and kept coming off. It was suggested that an alternate arrangement be worked.

5. The braking capacity of the single front wheel was not adequate under fully loaded conditions. Normal braking distance was found to be 33 ft. when travelling at maximum speed and in case of emergency stopping the distance was 17 ft.

6. Excessive engine vibrations were transmitted to the steering handles.

7. The accelerator linkage was not so smooth and required great deal of exertion on the part of the operator.

8. Traction problems were encountered on muddy roads with automotive type front tyre. Tractor tyre V-traction lug type or type traction must be installed to improve traction.

Staff Changes:

Mr. Abdul Shakoor Khan, Deputy Agricultural Engineer, who worked with the IRRI-PAK Program for a period of 2 years, left for graduate studies toward an M.S degree in Agricultural Engineering from the OHIO State University, Columbus, OHIO.

Mr. Khalid H. Uqaili, Design Engineer, proceeded for graduate studies leading to a M.S. degree program in Agricultural Engineering for the Asian Institute of Technology, Bangkok.

Mr. M. Shafiq Malik, Administrative Associate of the IRRI-PAK Program joined the ARAMCO in Saudi Arabia as a Statistician. Mr. Mohammad Mobin has joined the IRRI-PAK Program as the Administrative Associate.

Two Agri. Engineers, Mr. Basharat Javed and Mr. P.M.Moshabbir joined the Program during the reported period as Research Officers in the Agri. Engineering Cell of Pakistan Agri. Research Council.

APPENDIX I

TEST RESULTS(THRESHER)

		1	2	3	Average
Capacity	(Kg.)	5.25	4.8	5.1	
	(Kg./hr.)	315	288	306	303
Thrower Loss	(Kg.)	0.034	0.036	0.020	
	(%)	0.65	0.76	0.39	0.6
Blower Loss	(kg.)	0.045	0.024	0.023	
	(%)	0.85	0.50	0.45	0.6
Unthreshed Grains	(%)	Nil	Nil	Nil	-
Grain Breakage	(%)	-	-	-	-
Purity.	(%)	97.8	98.2	98.6	98.2
Test Duration	(Min.)	1	1	1	

Crop Paddy.
Crop Variety: IRRI-6
Grain Moisture. 15.7
Date Harvested: 3.12.1979
Date threshed: 5.12.1979.
Cut crop length: 27 inches.
Straw-grain ratio: 0.87

Model: Engine operated unishaft thresher
Manufacturer/Maker: JECO Engineering Co.
Drum speed. 550 rpm.
Screen speed. 350 rpm.
Length of threshing drum. 48 inches.
No. of louvers/inclination:
others:

Remarks:

APPENDIX I (contd.)

TEST RESULTS (THRESHER)

		1	2	3	4
Front duct shutter position		Fully closed	3" opened	3" opened	3" opened
Rear duct shutter position		Fully closed	Fully closed	1" opened	2" opened
Capacity	(kg.)	5.23	3.40	3.10	3.45
	(kg./hr.)	313.8	204.0	186.0	207.3
Blower Loss	(kg.)	0.056	0.065	0.015	0.008
	(%)	1.07	1.91	0.48	0.23
Unthreshed grains (%)		Nil	Nil	Nil	Nil
Grain Breakage (%)		Nil	Nil	Nil	Nil
Purity	(%)	98.1	97.8	96.4	96.2
Test duration	(Min.)	1	1	1	1

Crop: Wheat
Crop Variety: LY-73
Model: Engine operated unishaft thresher.
Manufacturer/Maker: IRRI-PAK
Drum speed: 700 rpm.
Screen speed: 350 rpm.
Length of threshing drum: 48"

TEST RESULTS(THRESHER)

APPENDIX II

		1	2	3	Average
Capacity	(kg.)	4.4	8.3	6.44	--
	(kg./hr.)	263	498	386.4	382.5
Thrower Loss	(kg.)	0.100	0.058	0.255	
	(%)	2.1	0.7	3.3	2.03
Blower Loss	(kg.)	0.210	0.533	0.940	
	(%)	4.5	6.0	12.3	7.6
Unthreshed Grains (%)		Nil	Nil	Nil	-
Grain Breakage (%)		Nil	Nil	Nil	--
Purity (%)		98.4	97.3	z90.8	98.2
Test Duration (Min.)		1	1	1	-

Crop: Paddy.
Carop Variety: Basmati.
Grain Moisture. 18.3
Date Harvested: 5.12.1979.
Date threshed: 18.12.1979.
Cut crop length: 38"
Straw-grain ratio: 4.9:1
Model. ,PTO
Manufacturer/ Maker IRRI-PAK
Drum speed : 425 rpm.
Screen speed: 350 rpm.
Blower speed: -
Length of threshing drum. 48"
No. of louvers/inclination. 8/5°
Others:

Remarks:

APPENDIX III

TEST RESULTS (THRESHER)

		1	2	3	Average
Capacity	(kg.)	26.13	22.06	23.20	
	(Kg./hr.)	522.6	441.2	464.0	475.9
Thrower Loss	(kg.)	0.220	0.071	0.150	
	(%)	0.83	0.32	0.64	0.60
Blower Loss+ Sieve Loss.	(kg.)	0.270	0.246	0.234	
	(%)	1.01	1.10	0.99	1.03
Sieve Loss	(kg.)				
	(%)				
Unthreshed Grains (%)		-	-	-	
Grain Breakage	(%)	Nil	Nil	Nil	
Purity	(%)	97.1	96.8	97.2	97.0
Test Duration	(min.)	3	3	3	

Crop: Paddy
Crop Variety: IRRI-6
Grain Moisture: 16.0
Date Harvested: 3.12.1979
Date threshed: 6.12.1979
Cut crop length: 26.5 inches.
Straw-grain ratio: 0.87

Model: TH-8
Manufacturer/maker: IRRI
Drum speed: 660 rpm
Screen speed: 360 rpm.
Blower speed: 670 rpm.
Length of threshing drum:
No. of louvers/inclination:
Others:

Remarks:

TEST RESULTS (THRESHER)

		1	2	3	Average
Capacity	(Kg.)	3.24	3.60	3.64	
	(kg./hr.)	64.8	72.0	72.8	69.9
Thrower Loss	(kg.)	0.040	0.051	0.046	
	(%)	1.20	1.38	1.23	1.27
Blower Loss+ Sieve Loss	(kg.)	0.004	0.030	0.038	
	(%)	0.80	1.02	0.92	0.91
Unthreshed Grains (%)		-	-	-	
Grain Breakage (%)		Nil	Nil	Nil	
Purity (%)		97.4	97.8	97.1	97.4
Test duration (min.)		3	3	3	

Crop: Paddy.
Crop Variety: Basmati 370
Grain L Moisture 16.0
Date Harvested: 5.12.1979.
Date threshed. 15.12.1979
Cut crop length: 37 inches.
Straw grain ratio: 2.7

Model: TH-6
Manufacturer/Maker: IRRI
Drum speed. 660 rpm
Screen speed: 370 rpm
Blower speed: 870 rpm.
Length of threshing drum:
No. of louvers/inclination:
Others:

Remarks:

APPENDIX IV

EFFECT OF LOUVER ANGLE ON THROWER LOSS

		1	2	3	Average
Louver angle w.r.t threshing drum axis.		85°	77°	65°	-
Capacity	(kg.)	5.8	6.2	4.36	
	(kg./hr.)	348	372	261.6	327.2
Thrower Loss	(kg.)	0.010	0.016	0.046	
	(%)	0.17	0.26	1.01	
Unthreshed Grains	(%)	Nil	Nil	Nil	-
Grain Breakage	(%)	Nil	Nil	Nil	-
Purity	(%)	98.1	98.0	98.8	-
Test Duration	(Min.)	1	1	1	

Crop. Wheat
Crop Variety. N.U.W.Y.T.3
Grain Moisture: -
Date Harvested 15.6.1980
Date threshed: 7.7.1980
Cut crop length: 36"

Model: PTO
Manufacturer/Maker: IRRI-PAK
Drum speed. 610 rpm.
Screen speed: 340 rpm.
Length of threshing drum: 48"
No. of louvers/inclination: 8
Others:

Remarks: