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IRRI-PAK
AGRICULTURAL MACHINERY PROGRAM

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POST BOX 1237 ISLAMABAD (PAKISTAN)

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

S_U_M_M_A_R_Y

A collaborative project was carried out by IRRI-PAK Agricultural Machinery Program with the University of Agriculture, Faisalabad, and Rice Research Institute, Kala Shah Kaku to adapt the six-row Korean Paddy transplanter to Pakistani conditions. Korean experts also assisted in this project. Based on experimental findings, recommendations alongwith modified parts drawings were forwarded to Pakistan Tractor Corporation.

The two IRRI-PAK threshers i.e. Standard and the Mini Axial Flow Threshers were extensively field tested and a number of modifications were incorporated to improve performance for threshing wheat and paddy. Based on these modifications, drawings for Standard Axial Flow Thresher were finalized and distributed to various manufacturers in Pakistan, India, Bangladesh, Afghanistan, Egypt, Indonesia etc. Certain modifications are also being incorporated in the design of mini axial flow thresher. A number of manufacturers are producing standard axial flow thresher commercially in Pakistan. Assistance is being provided to the firms in the fabrication of the prototype units of this thresher. Program staff also assisted the cooperating manufacturers in fabricating and in improving their machines.

A prototype unit of the smaller version of the PTO driven thresher with a 0.75 tons/hr. capacity was fabricated and tested on Basmati varieties of rice at Mardan. The work is now underway on the design and development of a larger 45 hp. tractor PTO driven thresher which is expected to thresh 1.5 to 2 tons of wheat/hr.

A four wheel tractor was imported from Thailand. This tractor is equipped with a 16 hp. diesel engine, and has a mechanical tool lift. The tractor also has two front and ~~three~~ one rear speeds. Some work is underway to test the performance of this tractor under local conditions. Provided the test results are positive, local production of this unit will be encouraged.

Two engineers from our cooperating manufacturers in Pakistan participated in a two-week machinery training program in the Philippines.

MACHINERY DESIGN & DEVELOPMENT

1. Standard Axial Flow Thresher

This thresher was extensively tested on wheat and paddy crops during 1978 (See Appendix A). Some problems were encountered in the threshing, screening and aspirating systems and following modifications were made in the machine.

Threshing:

While threshing wheat, it was observed that some partially threshed panicles were passing through at the feed end of the concave. The partially threshed panicles were clogging the upper screen and the machine had to be stopped periodically for cleaning it. To overcome this problem, the spacing between the concave bars in the feed portion was reduced from ¼" to 3/16". This helped in reducing passage of partially threshed panicles through the concave.

Aspiration System:

The aspiration system which was originally developed during 1977 wheat harvesting season was improved by increasing the width of the aspirator fan housing from 4" to 5" and increasing the number of fan blades from 3 to 4. This modification provided increased air flow which resulted in better cleaning performance. Frequent clogging was observed in the square aspiration duct hence this was replaced by a round 5" diameter duct to attain smoother flow of material.

Oscillating Screen:

Movement of the threshed material on the oscillating tray was slow and this often resulted in piling up of straw on the tray. This problem was found to be due to an

excessive angle (62° to 63°) of the tray links with the horizontal when the tray was in the most forward position. Different tray link angles, ranging from 55° to 61°, were tried. A satisfactory straw movement was observed with 55° angle and at 340 oscillations per minute of the tray. A side slope of 3° was also given to the oscillating tray towards the blowers. This helped in uniformally spreading the grain which is pushed by air to one side of the tray, on the lower screen.

Transport of Machine:

Originally, the machine had two rear wheels and a front parking stand. With this arrangement too many persons were required at the front end to manually lift and pull the machine. A steering front wheel (Fig. 1) with a handle was installed in place of the parking stand to facilitate movement of the machine. A screw jack was incorporated with the front adjustable wheel in order to facilitate raising the machine when suspending it on the two rear parking stands and adjustable front wheel for threshing operation.

2. Mini Axial Flow Thresher:

During 1978, the mini thresher (Fig.2) was tested on wheat, paddy, soyabean and saf flower crops (See Appendix B) Some of the design changes made during this period are described below:

Threshing:

In threshing wheat, frequent clogging of the upper screen was encountered due to passage of long straw pieces and partially threshed panicles through the feed end of the concave. The following changes were incorporated to solve this problem.

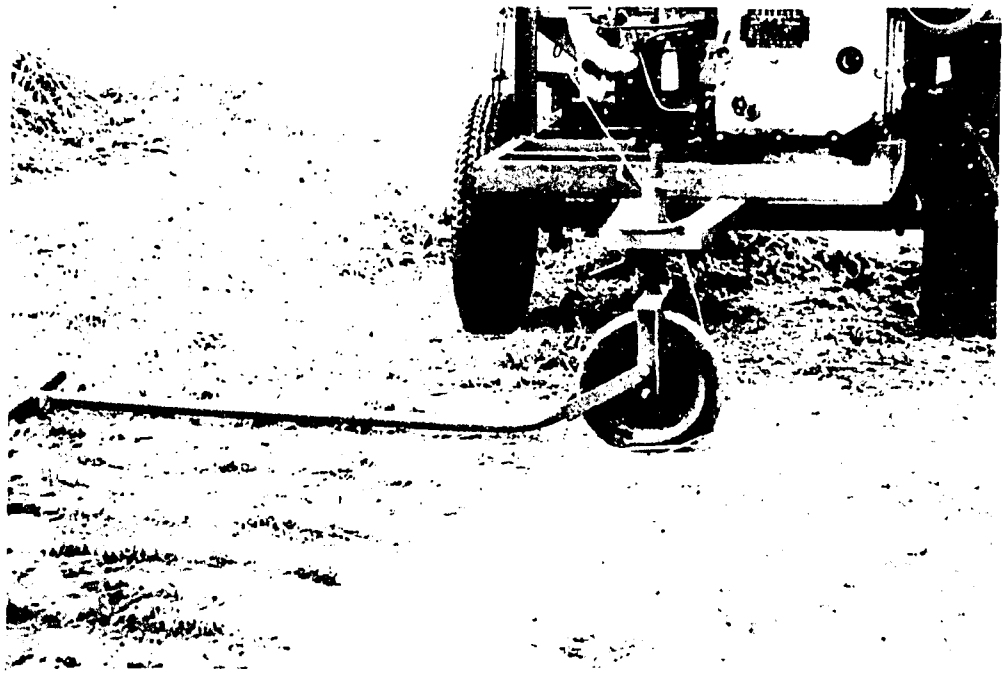

Fig. 1 A View of the Standard Axial Flow Thresher Equipped with the Steered Third Front Wheel.

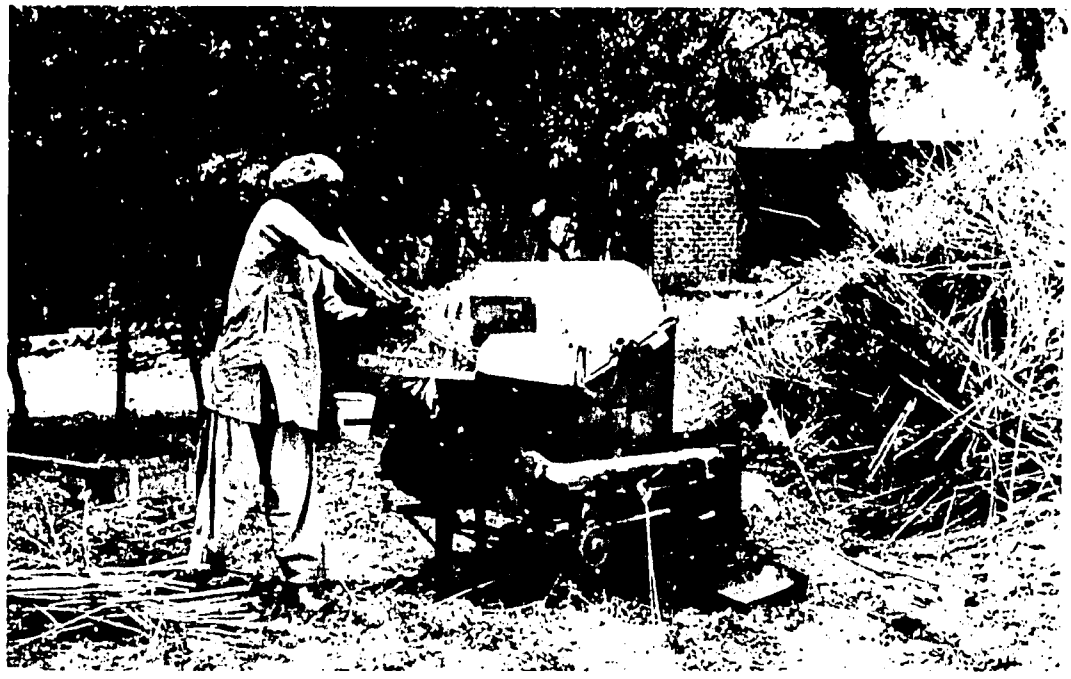

Fig. 2 Mini Thresher being Tested on Saf-Flower.

1) The spacing between the concave bars at the feed end was decreased from ¼" to 3/16". The clearance between the pegteeth and the concave bars was also decreased from 5/16" to 1/8" in this portion.

2) Three knives were added to the front bank of 9 knives to improve chopping of straw.

3) The thickness of the drum sheet was increased from 1/16" to 1/8" to eliminate bending at the pegteeth base.

4) Original 96 pegs were mounted on the threshing drum in 8 straight rows. These were replaced with 28 pegs in its first part for threshing and 52 knives in the second part for threshing and chopping of straw. The pegs and knives on the drum were arranged in eight spiral rows.

5) The drum speed for threshing wheat was increased from 660-700 rpm. to reduce unthreshed grains.

6) In order to improve axial movement of material, the number of louvers in the drum cover were increased from 5 to 6.

Seperation and Cleaning:

During tests, it was observed that too many straw pieces were going into the grain delivery spout. The spout often clogged due to excessive grain flow. Also the movement of material over the screen was too fast which resulted in higher screen losses. To solve these problems, following modifications were made in the machine.

1) The length of the lower screen was increased from 26 to 38", to permit dropping of bhoosa away from the grain spout.

2) The length of upper screen was increased 1" beyond the lower screen so that straw would fall clear off the lower screen.

3) A screen with 5/8" perforation was installed for the upper screen in place of the screen with 7/16" perforations.

4) The lower screen with 5/16" perforations was also replaced by a 3/8" perforated screen to reduce sieve losses in soyabeans.
5) The oscillating screen tray speed was decreased from 350 to 320 strokes per minute to minimise bouncing of grain and to reduce screen loss.
6) The angle of spout was increased to 8° to permit greater flow of paddy grain.

Aspiration System:

The original aspiration system which utilized the suction from the blower intake was not found to be satisfactory since it picked considerable grain alongwith chaff and throttling it down was affecting separation of straw and grain. The aspiration duct also clogged often due to its rectangular cross section. A new aspiration system was designed with a separate 10" dia 4 blade fan mounted on the blower shaft. A 4" dia circular duct was used for picking impurities from the grain outlet. The aspirator fan outlet was directed towards the bottom of the upper screen. With these changes, impurities are satisfactorily picked from the delivery spout and were thrown against the bottom of the upper screen. Any grain being picked by the aspirator fan was recycled through the lower screen thus reducing aspiration loss. The drawings of the thresher are under preparation and will be distributed to cooperating manufacturers on finalization.

PTO Thresher

Work is underway on the development of a tractor PTO driven axial flow thresher (Fig. 3). This new thresher is being developed for threshing the wheat and paddy varieties popularly grown in Pakistan. This PTO thresher has an axial flow threshing drum similar to the other IRRI threshers, however, it has a new screen and aspiration system for grain separation and cleaning. The design is

rather simple and compact. It is being developed for 1.5 to 2 ton per hour threshing output. A smaller version of the tractor PTO driven prototype unit was tried on Basmati paddy varieties at Mardan, NWFP. Further development work is also in progress on this project since last November.

Improvements of the Korean Paddy Transplanter

A collaborative project was organized by the IRRI-PAK Program with the University of Agriculture, Faisalabad and The Rice Research Institute, Kala Shah Kaku, to test and modify the six-row Korean paddy transplanter (Fig.4) that have been imported from North Korea. A team of North Korean experts assisted this project in improving these machines. The two main problems encountered with these machines were:

1) The machines were only able to transplant seedlings at shallow depth of upto 2". In Pakistan, preferred depth of transplanting is generally 4 to 6".

2) The machines were planting excessive number of seedlings (3-11) per hill and there were too many missing hills (above 18%).

The problem of 4-6" deep transplanting was successfully solved. The number of seedling per hill and the number of missing hills were also relatively solved. A report on the transplanter improvement project in English and a Transplanter Instruction Manual in Urdu were published by the Program.

Four Wheel Thai Tractor

A simple 4-wheel tractor has been imported from Thailand. This is a simple tractor which is locally produced in Thailand by many small metal working shops. It has a 16 hp. diesel engine. Power is transmitted from the engine to the transmission box with a triple V-belt

Fig. 3 Tractor PTO Multicrop Thresher being Developed by IRRI-PAK Agri. Machinery Program.

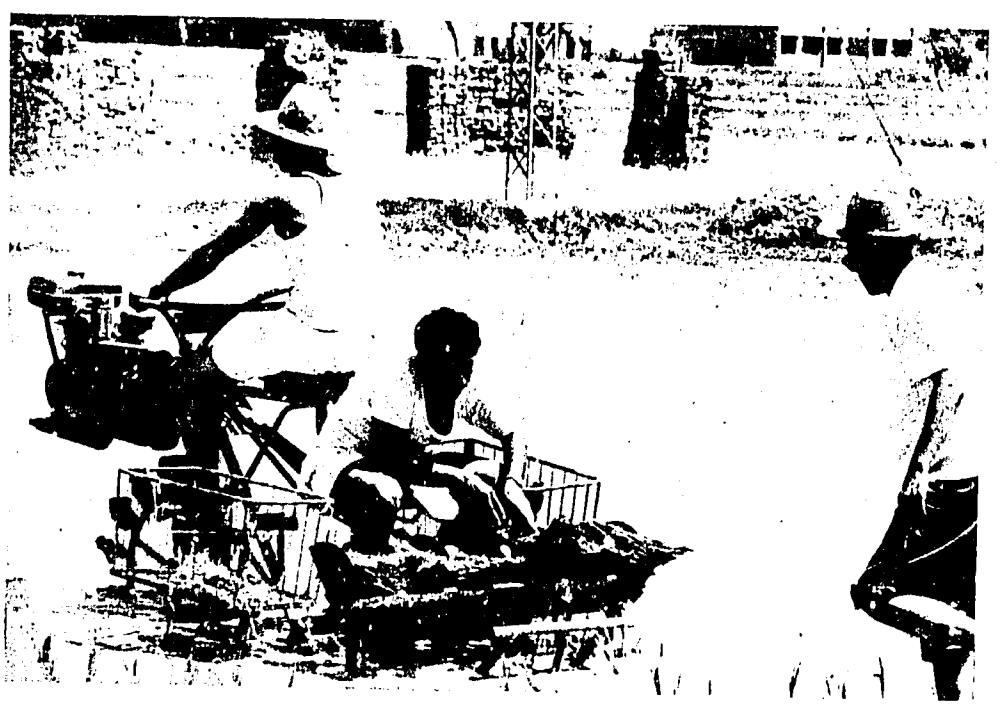

Fig. 4 Six-Row Korean Paddy Transplanter being Tested by Korean & Pakistani Experts.

and an idler clutch arrangement. The transmission box has a combination of automotive truck gears and chain sprockets which are generally available in most developing countries. The tractor has a tool bar with a simple mechanical lift for hitching implements. Appropriate implements are now being developed for this tractor to suit local farming requirements. If the performance of this simple tractor is found satisfactory, local production would be encouraged.

MANUFACTURING DEVELOPMENTS

Standard Axial Flow Thresher:

A total of 20 machines were fabricated by our cooperating manufacturers in Pakistan during the year. These manufacturers are making these machines in Pakistan commercially. Diesel or gasoline/kerosene engines of 7-12 hp. size can be used for powering this machine although there is a general preference for diesel engines in Pakistan. Four companies M/s Roomi Industries, M/s Master Engineering Works, M/s Javed Engineering Co., M/s Northern Motors (Fazal Engineering Co.) are now manufacturing this thresher for commercial sale during the on-coming wheat season.

Mini Axial Flow Thresher:

A total of 6 threshers were fabricated by four firms during the year. A 3-5 hp. air cooled gasoline engine is available in the market and can be satisfactorily used as a prime mover. M/s Javed Engineering Co., Gujranwala, M/s Master Engineering Works, Faisalabad and M/s Roomi Industries, Mian Channu have started production of this thresher for sale in the on-coming wheat season.

REGIONAL INDUSTRIAL EXTENSION

Pakistan:

The Project staff paid over 70 visits to cooperating manufacturers and assisted them in improving and testing the threshers fabricated by these firms. The Project also participated in four Fairs at Chakwal , Kala Shah Kaku, Gujranwala and Rawalpindi where the IRRI-PAK machines were demonstrated. Field demonstrations were also held at various locations for threshing wheat, paddy and soyabean.

A new firm M/s Fazal Engineering Co., signed a Memorandum of Agreement with the Program and has started fabrication of the Standard Axial Flow Thresher for commercial sales in the coming wheat threshing season.

Two project officials Dr. Amir U. Khan and Mr. Abdul Shakoor Khan, participated in two Seminars and presented papers on Small Farm Mechanization and Rural Industrialization in Pakistan.

The Project staff also assisted M/s Engineering Services, Peshawar; M/s Javed Engineering Co., Gujranwala; M/s Master Engineering Works, Faisalabad and M/s Roomi Industries, Mian Channu in fabrication of prototype units of both the Standard and Mini Threshers. The project staff also assisted M/s Javed Engineering Co., Gujranwala; M/s Master Engineering Works, Faisalabad and M/s Engineering Services, Peshawar in demonstrating their machines to farmers and Government officials in their areas. Twenty units of Standard Axial Flow Threshers and six units of the Mini Threshers were sold by our cooperating manufacturers during 1978.

The machines developed by the Program were demonstrated at a Rice Conference, held at Gujranwala, Punjab and at the Annual Fruit Show at Peshawar, NWFP. The Standard and Mini Axial Flow Threshers were also demonstrated to farmers in

districts of Gujranwala and Faisalabad in Punjab, and in Mardan, NWFP. M/s Fazal Engineering Co., Rawalpindi has started production of the Standard Axial Flow Thresher for the coming wheat threshing season.

M/s Ittefaq Bros. Lahore in cooperation with Mr. Habibur Rahman, Asstt. Agri. Engineer, Rice Research Institute, Kala Shah Kaku, has developed a head stripping paddy thresher. The machine is partially based on the Standard IRRI Axial Flow Thresher but has a Japanese paddy thresher type chain feed mechanism to permit hold on type threshing. This thresher permits threshing of paddy crop without damaging the straw. The output of the machine is claimed to be 12-15 maunds of grain per hour at threshing costs of Rs. 1.12 per maund as compared to Rs. 3 with manual threshing. The machine is available from M/s Ittefaq Brothers, Lahore with a 12 hp. diesel engine or a tractor pulley operated version.

Afghanistan:

M/s Jangalak Industries, Kabul, Afghanistan, a nationalized company, were provided with engineering drawings of the Mini Thresher. This company has made a prototype unit and is now fabricating a second unit. This company has also received engineering drawings of the standard axial flow thresher from the IRRI-PAK Program.

India:

Manufacturers interest in the IRRI developed machines has increased substantially during the last year in India. M/s Suri Research Foundation, New Delhi and the Agricultural University, Pantnagar continue to assist IRRI in the industrial extension of IRRI machines in India. The Project Director visited India twice to encourage local production of IRRI machines during 1978.

A number of companies have started production of the multicrop IRRI threshers. Prominent amongst these are M/s Union Tractors Workshop, New Delhi and the American Spring and Pressing Works Ltd., Malad, Bombay. The G.B. Panth University has developed a large Axial Flow Thresher based on the IRRI design. Dr. S.R. Verma of the Punjab Agricultural University, Ludhiana, has been informally assisting the IRRI-PAK Program in introducing the IRRI machines among manufacturers in Punjab. Latest reports indicated that 10 small manufacturers in Ludhiana area have produced 35 IRRI threshers. Engineering drawings of the IRRI-PAK Mini Thresher have been provided to the two sub-contracting organizations and some manufacturers in India.

Production of the IRRI diesel power tiller with steering clutches has also made considerable headway in India. M/s National Engineering Co, Madras have already marketed 40 IRRI power tillers and these have been well received by paddy farmers in southern India. These tillers are powered through a 4.5 hp. Lombardini diesel engine and are sold in India for Rs. 7,900 complete with engine. The company has an ambitious expansion program and is now gearing for a monthly production of 200 power tillers. Westinghouse Saxby Farmer, a company in Calcutta is also producing the IRRI power tillers. M/s Krishi Engines Ltd., Hyderabad, manufacturers of the Krishi power tillers, have also completed their prototype unit of the IRRI power tiller and are planning to start its production.

M/s Sriram Industries, Hyderabad, has recently fabricated a prototype unit of the IRRI motorized cart. This is a three wheeled slow speed vehicle for rural transport that was originally developed at IRRI some years ago. The company is testing this unit for one ton load on rural roads in India. Efforts are also underway at the

IRRI-PAK Program to improve the design of this farm cart in the interest of better suitability and to permit utilization of a diesel engine.

TRAINING

The International Rice Research Institute organizes a two-week machinery training workshop at its headquarters in the Philippines for engineers working with cooperating IRRI manufacturers worldwide. Candidates undergo a familiarization program in the full range of IRRI developed machines and visit leading manufacturers of IRRI machines in the Philippines. Mr. Naveed Saeed of Engineering Services, Peshawar and Mr. Iftikhar Aziz of Climax Engineering Co., G.T. Road, Gujranwala participated in the last two-week workshop held in October, 1978 in the Philippines. The next IRRI machinery program is scheduled to be held in March, 1979.

Mr. Mohammad Ilyas, Agri. Engineering with the IRRI-PAK Program was awarded an IRRI scholarship for M.S. degree in Agri. Engineering. He is completing his course work at the Agri. Engg. Deptt of the University of Philippines and intends to return to the IRRI-PAK Program to conduct his dissertation research.

APPENDIX A

STANDARD AXIAL FLOW THRESHER

The axial flow thresher was further improved for threshing wheat during 1978. Later, it was also tested during the paddy harvesting season for threshing paddy. The thresher was tested at Faisalabad, Gujranwala and Rawalpindi districts of Punjab and Mardan and Peshawar districts of NWFP. During the field tests, some manufacturing defects were observed which were rectified and a few additional modifications were incorporated.

A. Grain straw seperation at concave

In threshing paddy, almost all grain is seperated from straw at the concave and the seperated straw is thrown out at the straw outlet. The machine tested on wheat threshing during 1978 had 10° louver angles which was kept to increase crop retention time in the threshing cylinder to reduce thrower losses. Compared to wheat, paddy crop has more moisture content at the time of threshing, therefore, crop retention time had to be reduced in order to avoid drum clogging. The following louver angles were found satisfactory for threshing paddy.

1st 6 louvers.	13°
7th louver	17°
8th louver.	17° in first portion and 22° in rest portion.

B. Oscillating Screen

Originally the oscillating tray was horizontal. In the new prototype unit, a side slope of 3° has been given to the oscillating tray towards the blower. This helped in uniformly spreading the grain on the lower screen. Previously, the grain was pushed by air to one side of the tray.

The machine was tested for capacity, performance, efficiency and durability. The following operating conditions were maintained during the tests.

1. The threshing drum speed was maintained at 550 rpm.
2. The oscillating tray speed was maintained at 350 rpm.
3. Only one bank of concave knives was used to test tall basmati variety whereas no concave knives were used in case of IRRI varieties.
4. Blower shutter was adjusted at such a position at which grain loss was minimum and grain cleaning was good.
5. Feed rate was kept uniform and continuous.
6. Test duration was kept 3 to 5 minutes and each test was replicated two to three times on each variety of paddy.

TEST RESULTS

Grain output and losses on different varieties of paddy crop.

Crop Variety	IRRI-6	PK-377 Tedy Basmati	Sehla Basmati
Grain straw ratio	1.67	0.88	0.681
Av.output kg/hr.	353	253	222
Thrower Loss (%)	0.61	0.17	0.07
Blower loss (%)	0.11	0.09	0.10
Sieve Loss (%)	0.65	1.26	0.20
Grain purity (%)	98	97.7	99
Grain breakage (%)	0.0	0.0	0.0

APPENDIX-B

MINI THRESHER

The new prototype unit was tried for threshing paddy and soyabean. Testing was conducted in Punjab(Faisalabad, Gujranwala and Rawalpindi Districts) and NWFP (Mardan district). Two modes of feeding were tried for different varieties of paddy.

A. Throw-in type:

Operator feeds the crop with the panicles away from himself into the threshing drum through the half opened feed gate (Fig. I).

B. Hold-on type:

In this case, feed gate is opened fully (Fig.II) and front cutters are removed. The operator having a bundle of crop in his hands feeds only the panicles and moves the bundle side ways along the axis of threshing drum. When the panicles are removed he places the bundle of straw on one side of machine and takes another bundle of crop for threshing. When hold-on type feeding is done, the rear thrower opening is closed and bottom thrower opening is opened so that material should fall directly over top screen.

For paddy, teddy basmati and IRRI varieties, throw-in type feeding is found the best for more threshing efficiency. Whereas for long basmati when throw-in type feeding was done, drum clogging occurred due to straw wrappage on drum. Therefore, hold-on type is considered best for threshing long basmati.

Component Speeds:

Paddy Threshing:

Threshing drum speeds from 540 to 550 rpm. are found satisfactory for paddy thredshing. Oscillating tray speeds from 320 to 330 rpm are found satisfactory.

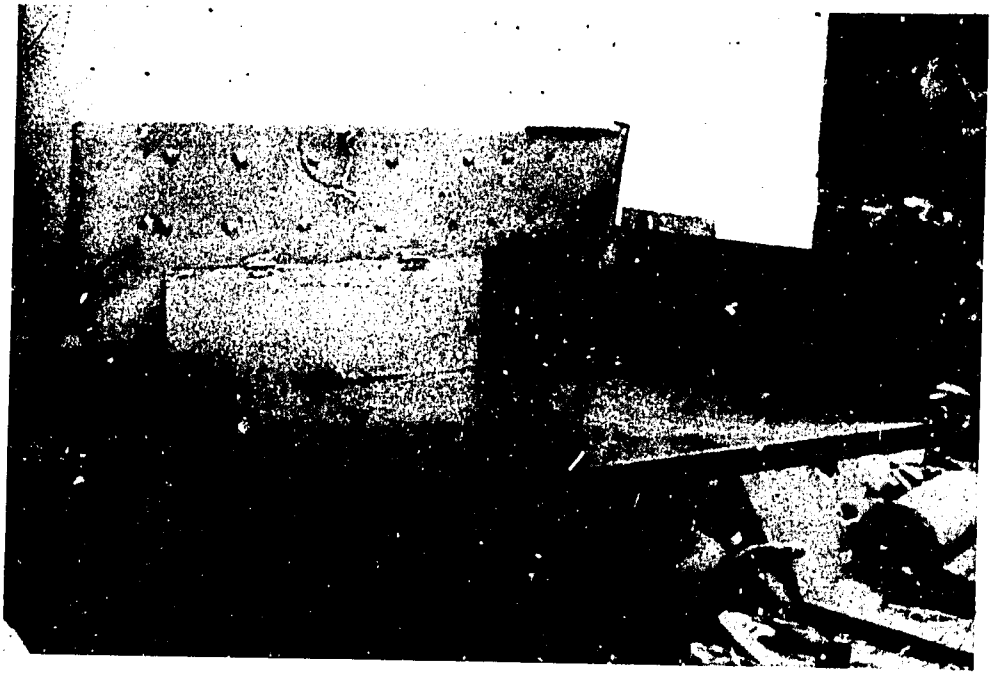

Fig. I A View of the Mini Thresher Illustrating Half Opened Feed Gate.

Fig. II A Fully Opened Feed Gate of Mini Thresher.

Soyabean Threshing:

Threshing drum speeds from 500 to 530 rpm are found satisfactory for soyabean threshing. Oscillating tray speeds from 340 to 350 rpm are found satisfactory. Oscillating tray speeds are high because pneumatic seperation of straw from grain is impossible due to heavy straw than grain. Therefore, for good mechanical cleaning, speeds of oscillating tray are higher than paddy or wheat crops.

Feed Pusher:

In throw-in system of paddy threshing straw wrapping on drum shaft usually occured which put trouble in drum rotation. Two feed pushers are installed to overcome the problem. The performance of feed pushers was found satisfactory.

Grain Cleaning:

A double screen oscillating mechanism (Fig.III) already installed for mechanical seperation of straw and grain during wheat threshing was not suitable in case of paddy and soyabean threshing because sieve losses were too high. To reduce sieve losses upper screen having ½" dia holes is changed with a screen of 5/8" perforations and lower screen having ¼" dia holes is changed with a screen of 3/8" perforations. A third screen over grain delivery spout attached with lower tray is removed because material was gathered over tray from time to time. Due to coarser structure of paddy grains, material movement in grain delivery spout was not good, therefore, the grain delivery spout angle with horizontal was increased from 5° to 8°. Air velocity at duct inlet of aspirating system was higher than the terminal velocity of paddy and wheat grains, therefore, the grains were sucked initially and once they entered into the larger dia horizontal pipe, they did not move due to less air velocity than grain terminal velocity so the grain piled in the pipe from time to time. To overcome this difficulty cross-sectional area of duct at inlet is

increased which in turn reduced the air velocity below the terminal velocity of paddy and wheat grain.

In case of soyabean threshing tough straw passing through the concave portion clogs the upper screen. In order to avoid this problem, it is recommended that a solid sheet metal screen (about the width of the concave) should be fastened on top of the upper screen for smoother flow of material . Tray supporting links angle with horizontal along the direction of motion was 62.5^{o} which is decreased to 55°. This is done to give more vertical drop to the material over screen for best mechanical and pneumatic seperation of straw and grain. For pneumatic cleaning of grain, air discharge from blower is controlled by blower shutters (Fig. III).

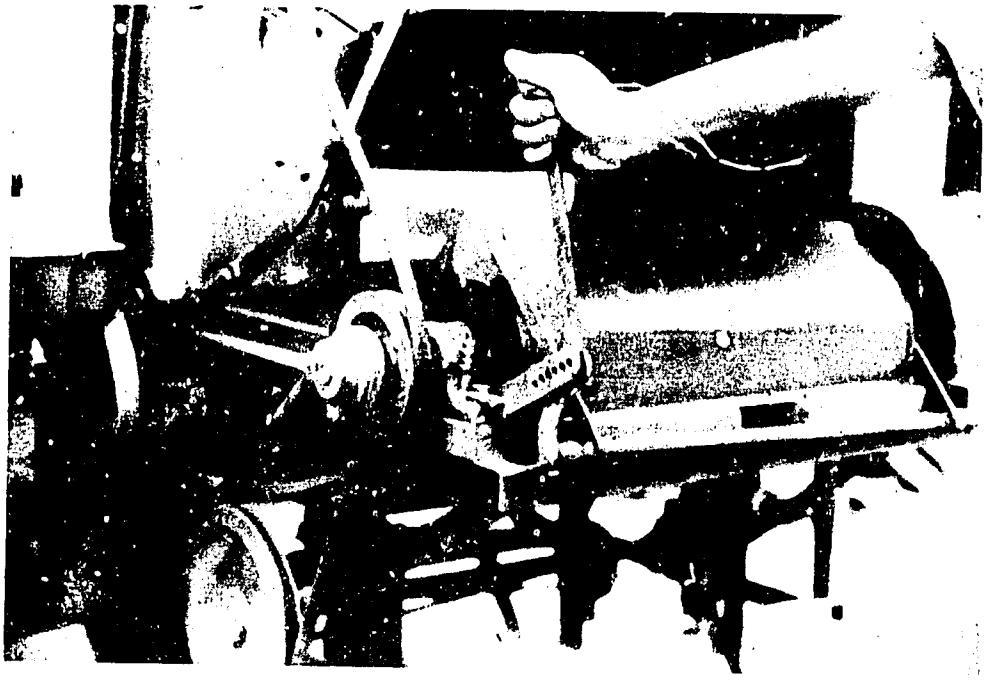

Fig. III Blower Shutter Control for Air Discharge from Mini Thresher Blower.

MINI THRESHER

Grain output losses on soyabean*

Test No.	1	2	3	4	5
Duration (Min.)	5	3.7	30	30	30
Drum speed rpm.	513	530	500	500	500
Blower rpm.	1100	1120	1050	1050	1050
Osc. Tray rpm.	325	342	350	350	350
Grain output/kg/hr.	62.4	58.4	52	60	56
Thrower & Sieves % Loss.	13.12	15.3	13	14	16
Breakage %	Nil	Nil	Nil	Nil	Nil
Grain purity %	96.15	97.22	96	97	97.5
Feed gate open. .	Half	Full	Full	Full	Full

*Soyabean, Mitchel variety.

MINI THRESHER

Grain output and losses on paddy*

Test No.	1	2
Test duration(min.)	5	5
Output (kg.)	4.55	5.78
Thrower Loss(%)	0.09	0.534
Sieves Loss (%)	Nil	Nil
Grain breakage (%)	Nil	Nil
Grain purity (%)	97.0	96.94
Threshing system.	Hold on	Throw in

*Crop variety IRRI-6

Grain moisture content % 15.45

Component speeds.

i) Threshing drum. 540 rpm.
ii) Blower. 1085 rpm.
iii) Osc. Tray. 330 rpm.

MINI THRESHER

Grain output and losses on paddy*

Test No.	1	2
Test duration(min.	5	5
Output (kg.)	13.50	14.00
Thrower Loss (%)	1.08	0.54
Sieve Loss (%)	0.45	0.04
Grain breakage %	Nil	Nil
Grain purity (%)	97	93
Threshing system	Hold on	Hold on

* Crop variety	Long Basmati
Stalk length.	72 inches.
Grain moisture content.	14.74%
Component speeds.	
1) Threshing drum.	550 rpm.
2) Blower	1110 rpm.
3) Oscillating tray.	320 rpm.