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# FINAL TECHNICAL REPORT

**PROJECT TITLE:**

Design and Fabrication of Multipurpose Self propelled Low Cost Reaper by the University of Agriculture, Faisalabad.

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The author is indebted also to Dr.M.Aslam, Director Research Khawaja Khalid Pervez, Dean, Faculty of Agricultural Engineering and Technology and Manzoor Hussain, Deputy Registrar (P&D) for their unfailing interest and administrative help to complete this work.

My thanks are equally due to M/s.Malbro International for their collaboration to develop the design of this machine at large scale.

Finally the author is grateful to all the staff members of the Workshops of the Department of Farm Machinery and Power who were directly or indirectly engaged in this work and helped me in achieving the target successfully.

( A.D.CHAUDHRY )
Principal Investigator

SELF PROPELLED LOW COST REAPER BY THE
UNIVERSITY OF AGRICULTURE, FAISALABAD .

by

A.D. CHAUDHRY*

## ABSTRACT

Harvesting of wheat conventionally with sickle is the most labour intensive operation in the production of grain. The socio-economic and agro-climate conditions of the country have prevented the adoption of western type mowers and combines for harvesting grain crop. Careful investigations into the agricultural practices with special reference to average farm size in Pakistan led to the development of multipurpose, multicrop and self-propelled University Reaper. This is a very cheap unit and it can cut one ha of wheat, rice and forage crops with in 2.5 hours with an expenditure of rupees 75/ha. All the parts of this machine except 6-7 h.p. gasoline engine have been fabricated from locally available material and this machine is being produced commercially by a Pakistani firm Malbro International Collaborator of an Australian firm Toft.

## INTRODUCTION

Wheat is the most important crop in Pakistan when measured in terms of acreage or tonnage. This crop is harvested conventionally with sickle. The labourer squats, and he grasps a bundle of grain stems in his left hand while the " Dranti " a surrated sickle, is used with the right hand to cut the stacks with a pulling stroke. When a reasonable sized bundle, 7 to 8 cm in diameter, is in the left hand, the right hand is used to wrap a few stalks aroung the bundle, securing it tightly, Additional small bundles are held, cut and tied, until the

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group of bundles in about 15 cm in diameter. An alternative method used in larger fields is to cut the stalks by the handful and to lay them in pile. When the pile is of bundle size it is gathered up and tied with a few stalks. The bundles are then stacked and allowed to dry before threshing. Usually serveral people move through the field together, which gives both companion-ship and a competitive spirit to the harvesting. This whole operation of wheat harvesting is completed within four weeks time.

## JUSTIFICATION

Harvesting is the most labour intensive operation in the production of grain. One strong man will work from 8 to 13 days to cut one ha of grain. The high labour requirement has three distinct adverse effects.

1. Over the past two years, the available labour has not been sufficient to harvest the entire wheat crop, with the result that some of the grain has remained in the fields. What percentage of the crop was lost is not known, but it is large enough that the Agriculture Department officials refer to it as a significant problem.

2. The labour that is available at harvest time recognises that it is in high demand, and therefore, charges the farmer an exhorbitant amount of Rs:250/- per ha .

3. Because of the high wages paid for the harvest labour, many people not normally involved in agriculture take leave from their regular jobs to earn money in the grain harvest.

The first two of these effects work a hardship on the farmer. The first and last are detrimental to the entire community, because the total labour supply is reduced and absenteeism hampers other community activities.

In mechanising labour intensive activities, one should bear in mind the technological unemployment that may result. The labour whose employment will be replaced by machine is temporary or seasonal

labour that gains its normal income from other sources. Approximately 50 percent of the harvest labour is not normally occupied in agriculture so that if the harvest labour is reduced to 50 percent, it need not effect the income of those who are normally farm labourers. The present labour force used in harvesting is insufficient for the size of the crop and therefore, the general economy as well as the farmers lose the value of that portion of the crop not harvested.

The counter balancing factors of total harvest, lower cost, and multiple croping in this case appear to outweigh any temporary labour displacement which may occure for mechanization. For this reason it is not considered that technological unemployment is a valid reason for continuing hand harvesting of grain in Pakistan. Therefore, if a machine could be developed that would reduce the amount of time and labour required to harvest grain it would be of immediate benefit to the society of this country.

## CHOICE OF TYPE OF EQUIPMENT

There seems to be two possible ways of overcoming the problem of labour shortage during harvesting season and obtaining timely operation to facilitate the growing of the succeeding crop in the multiple croping sequence. These are namely (a) the use of combine harvester and (b) development of improved simple harvesting machines suitable for the developing countries. There are certain principal factors which have prevented the adoption of western type mowers and combines for harvesting grain crops in this country. Most of the fields are too small for conventional machinery and they are borded by narrow dirt " Bunds ". Bunds are elevated earthen ridges, used to contain irrigation water and serve as paths arround wet fields. These prevent or hinder access to the fields with large equipment. Even though a farmer may own two ha of farm land, his holdings are usually split into several smaller fields. This is due to fractionation through inharitance, the requirement of irrigation practices, and in places, to the relaively steep terrain. The village lanes are usually 2 to 3 meters wide. This limits the width of the machine not

to exceed 5 meters.

Not only the initial cost of the machine is a factor coming in the way of introducing the machine, but also the facilities of repair and servicing by the agricultural machinery dealers. They have the problem of justifying a service specially when they face low density of machine in a particular area, long distances from their head quarters, poor and impassible roads to villages, lack of materials, government restrictions on imports, taxes and lack of trained personnel. Inadequate service facilities is a major factor hinderance to efficient introduction of any machinery. The best solution to such a machinery seems to be to introduce a machine which will require minimum maintenance and service parts which are easily available or preferably locally manufactured.

The harvesting season of wheat remains only for ten to fifteen days and a machine designed only for wheat harvesting will not be prefered by a traditional farmer. Therefore, a multicrop harvesting equipment which could cut wheat, rice and forage crops would be readily acceptable to the farmer, as he will use his equipment for the whole of the year and need not to buy new machines for rice and other such crops.

## DEVELOPMENT OF UNIVERSITY REAPER

Careful investigations on the techno-economic, agro-climatic and other requirements enumirated above with special reference to average farm situations in Pakistan led to the development of University Reaper. The few imported reapers both self propelled and tractor drawn which were tried at different places were not accepted by the farmers due to high cost, difficulty in bundling and poor manoeuvrability. These machines were also found unsuitable in uneven and small fields borded by narrow dirt " Bunds " for irrigation purposes. The machines designed for horses were too heavy for a pair of average size bullocks and were inefficient to harvest when the crop growth were thick.

A multipurpose, multicrop, self-propelled reaper to over come the above mentioned problems was designed and developed at the University of Agriculture, Faisalabad. The Pakistan Science Foundation sponsored this project and the final design of this machine has been purchased by a firm Malbro International collaborator of an Austrialian firm Toft for large scale production.

The main frame of Uni-reaper is supported on two front driving wheels and one rear supporting wheel with pneumatic tyres (Fig.1). P-11 The power for cutting operation and for forward travel of the machine are provided by a 6-7 h.p. light weight gasoline engine fixed to the rear of the machine. A V-belt drive and bevel gear mechanism provided the necessary reduction of the engine speed from 2500 r.p.m. to 350 r.p.m. at the crank wheel to which the pitman head is fixed (Fig.2). P-12 This produces 700 strokes per minute of the cutter bar. A roller chain and spur gear reduction mechanism has been provided to avoid slippage losses and to run the front driving wheel at 30 r.p.m. (Fig.3). P-13

The convential mower cutter bar has been adopted to form the cutting unit. Two dog clutches are provided one on each of the front wheels (Fig.3). These dog clutches work simultaneously to engage or disengage engine power for forward travel. These clutches work independent of each other and help in easy turning of the machine. The expensive differential gear mechanism has been replaced by this simple arrangement. One dog clutch is provided to engage and disengage engine power from cutter bar (Fig.3). The cutter bar is mounted at a distance of 5 cm. at the back of front wheel (Fig.1).

To avoid swinging of the cutter bar a supporting wheel of 20 cm. dia is provided at the right hand side of the cutter bar (Fig.1) This arrangement helps in easy running of the machine in uneven fields. Four adjustable screws are used for raising and lowering the cutter bar to cut the crop at desired height (Fig.3). For transportation purposes the cutter bar can be lifted up at an angle of 80 degree with the horizontal and tied with the frame of the machine. Thus the machine occupies only one meter space while travelling on a road or

oving from one field to the other. The cutter bar is detachable and the rest of the machine can be used as a small power tiller of 6-7 h.p. for other farm operations as sewing of cereals and spreading fertilizer in the field.

## WORKING OF UNIVERSITY REAPER

Only one operator is required to control and operate this machine in the field. Two control levers accessable to operator, one for cutter bar control and the other for forward travel control, have been provided (Fig.4)[p-14] The operator can walk or sit on the seat provided for this purpose. Two additional workers are necessary for tying bundles of the cut crop or removing it from the field and taking it to threshing centre. One ha of wheat /rice and forage crop can be cut within 2.5 hours with an estimated cost Rs:75-06 per ha. This cost includes fuel, labour and depreciation of the machine. At present to harvest wheat manually one man takes about ten days to cut one ha of wheat working for eight hours a day with an expenditure of Rs:250/- per ha.

With the adjustable cutter bar the crop can be cut at a desired height, maximum up to 30 cm and by detaching the cutter bar from the main assembly the machine is being used as a small power tiller and it can sow one ha of cereal crop with in 25 hours. The farmers are using the engine of this machine on a small thresher of capacity 500 kg/hour of wheat and 800 kg/hour of rice. All the parts of this machine except 6-7 h.p. gasoline engine were manufactured in Pakistan from the locally available materials. The life of this machine has been estimated 8-10 years with care and maintenance. This is a very cheap unit and it can be fabricated with an expenditure of Rs:8000.00 only.

## ACCEPTABILITY OF THE UNIVERSITY REAPER

The simplicity of design and the working of this machine have been appreciated by the farmers, national and international manufacturing agencies and organizations as mentioned below:

A.

| S.No. | Date | Name of Organization/Institution | Remarks |
|---|---|---|---|
| 1. | 12.5.77 | Dr.Amir Mohammad the Vice Chancellor, University of Agriculture, Faisalabad and Advisor of Agricultural Affairs Government of Pakistan inaugrated the demonstration of this machine in the wheat fields of the University (Fig.5,6). P-15,16 | This indigenous unit can be used in farmer's field without much problem. |
| 2. | 7.8.77 | " National News Bulletin " Radio Pakistan. | This is the cheapest unit in the world made form locally available materials. |
| 3. | 18.8.77 | Daily " Imroz ". | This machine can cut wheat and rice efficiently and power mechanism of this unit with little modification can be used for sowing cereals and distributing fertilizer in the field. |
| 4. | 1.3.78 | " Sarsabz Programme " Pakistan Television Corporation. | A film of " Field Demonstration of the University Reaper " was shown. |

B. Pakistan Science Foundation chipped in with a hand some hand out of Rs:25,000/- to help redesign and further improve the device. Some national manufacturing agencies given below approached the University authorities to get rights of production of this machine.

1. M/s. Sadiq and Sons, Lahore.
2. Lahore Engineering Foundary and Workshops, Lahore.
3. M/s. International Commercial Traders, Karachi.
4. M/s. J.T.Steels Narwala Road, Faisalabad.
5. Master Engineering Company Samundary Road, Faisalabad.

But only a reputed Pakistani firm Malbro International Lahore Collaborator of an Australian firm Toft purchased the design of this machine for large scale production (Fig.7). P-17,18 This is the first time in the history of the University that a private Organization has collaborated with the University in the field of Agricultural Engineering. C,16

Some International Manufacturing Agencies have aksed for the details of the design of this machine and have demanded its drawings to develop this unit in their own country. The names and addresses of these organizations are given as under:

| S.No. | Name | Designation | Address |
|---|---|---|---|
| 1. | Ronal R.Down | Manager Sales | Toft Brothers Industries Australia. |
| 2. | Gordon S.Powel | Manager Asia | Toft Brothers Industries Ltd. Australia. |
| 3. | G.E. Thierstein | Agri.Engineer | International Crop Research Institute for the Semi Arid Tropics, Hyderabad, India. |
| 4. | Michael Chapman | Manager | The Daily Leader, stuttgart, Arkansas, USA. |
| 5. | Dr.Abdul Salam A.Gomma | Director | Wheat Research section Field crops Research Institute, Giza, U.A.R. |

Fig.

6. The abstract relating to field study of the University Reaper has been published in the following National and International News Letters/Bulletins.

| S.No. | Name of Bulletins | Name of Organization | Year/Volume |
|---|---|---|---|
| 1. | " Science News " | National Science Council Pakistan. | 1976 Vol-II,No.3-4 |
| 2. | " Vistas " | University of Agriculture Faisalabad,Pakistan. Monthly Edition. | August,1977 No.2050 |
| 3. | " Vistas " | -do- | March,1978 Vol-I (9) |
| 4. | Annual Research Report | -do- | 1976-1977 |
| 5. | "General Information Bulletin." | -do- | 1977-1978 |
| 6. | Welcome Address to the President of Pakistan by Dr.Amir Mohammad, the Vice Chancellor of the University and Advisor of Agricultural Affairs, Government of Pakistan. | On 4th Convocation of the University of Agriculture, Faisalabad. | March,1978 |
| 7. | " The Versities " | University Grant Commission. | Sept.-October, 1977 |

The above mentioned acceptability report indicates that a multipurpose machine is more acceptable to the farmers of Pakistan than a machine designed only for one operation.

## CONCLUSION

The following conclusion has been drawn from the study of the manufacturing processes and the field study of the University Reaper.

1. This indigenous unit is suitable to socio-economic and agro-climatic conditions of Pakistan.

2. The farmers of this country like simple, low cost, multi-purpose and multicrop machines made from locally available materials.

3. The manufacturing agencies of Pakistan prefer indigenous machines for large scale production provided these machines have been properly designed and evaluated.

4. There are highly qualified personnel in the field of Agricultural Engineering and Agriculture in the University and if a centralised Research Centre for the Development of Agricultural Machinery is established in this Institution then local manufacturing organisations and foreign firms would collaborate in the research activities to develop agricultural machinery.

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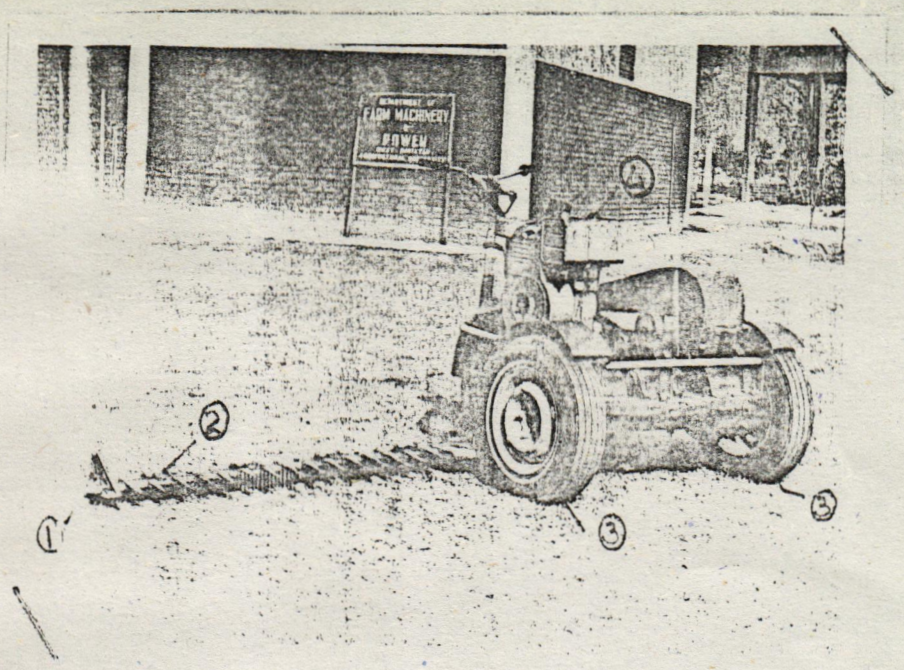
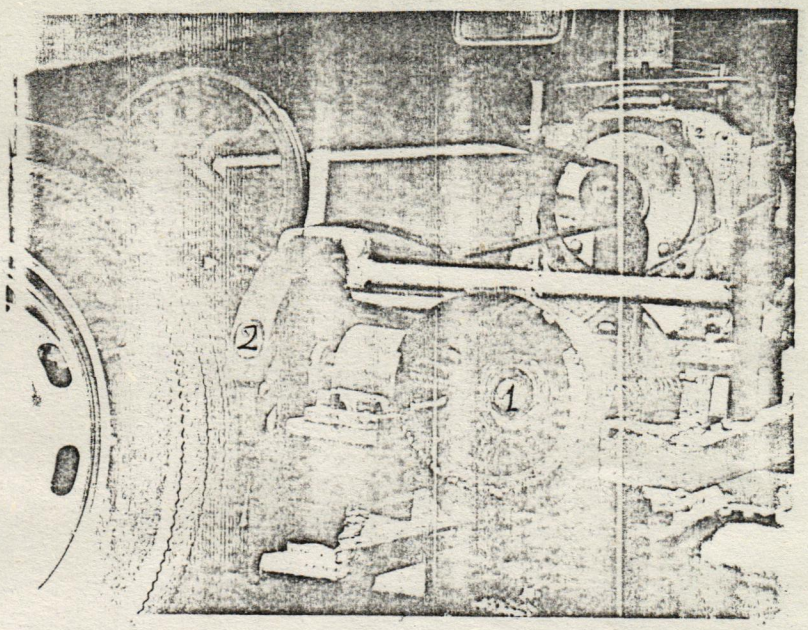


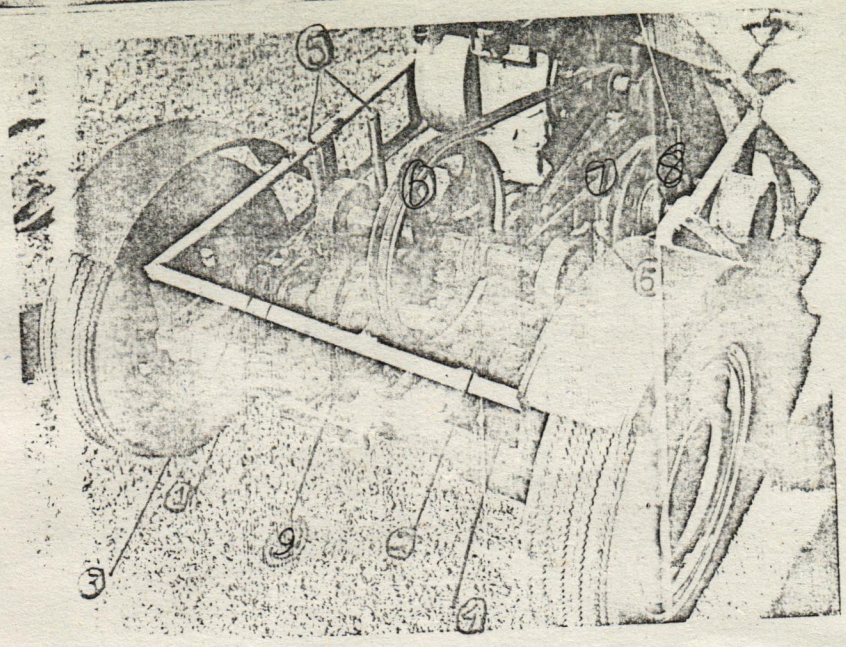

1. Supporting Wheel for Cutting Blade.
2. Cutting Blade Assembly.
3. Front Pneumatic Tyres.
4. Engine.

Fig. 1. Assembly of the improved model of the University Reaper.



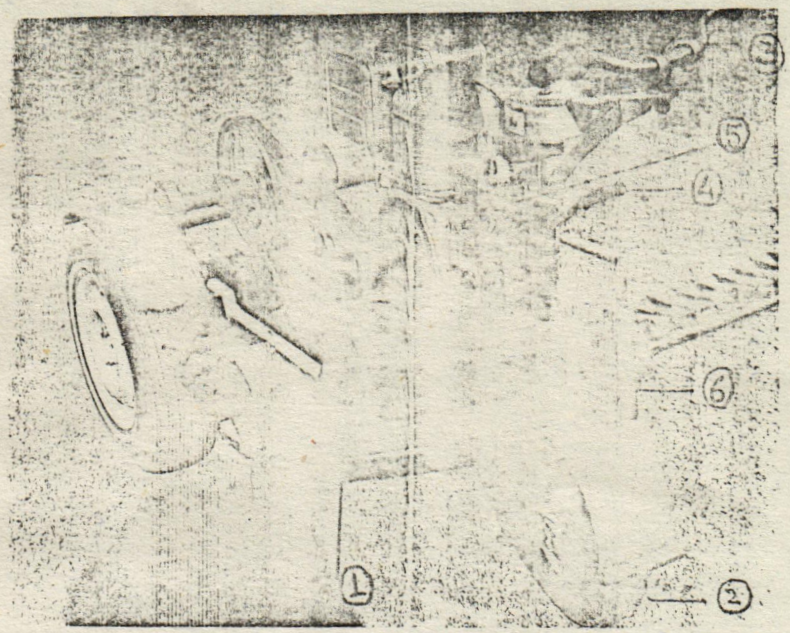

1. Bevel gear.
2. Power Transmission to pitmanshaft.

Fig. 2. Bevel gear and power Transmission to the pitman shaft of the University Reaper.




1-2. Dog clutches for forward travel control.
3-4. Final speed reduction gears for forward travel.
5. Cutting Blade height adjusting screws.
6. First speed reduction.
7. Second speed reduction.
8. Dog clutch to control cutting Blade operation.
9. Roller Chain.

Fig. 3: Inside details of the University Reaper.




1. Dog clutch to control cutting Blade operation.
2. Rear supporting wheel.
3. Steering.
4. Control lever for forward travel of the machine.
5. Control lever for cutting Blade operation.
6. Provision for attaching a seat with the machine.

Fig.4: Details of the Rear section of the University Reaper.

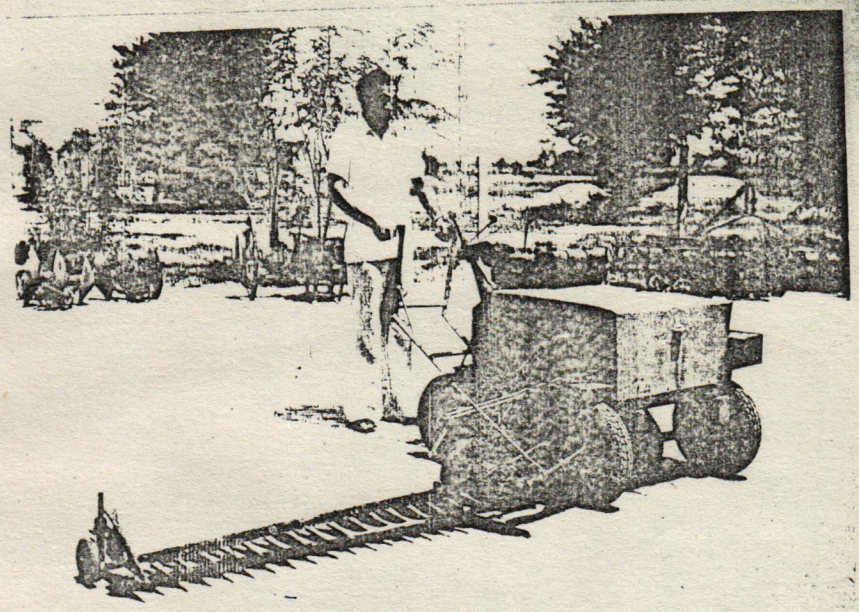
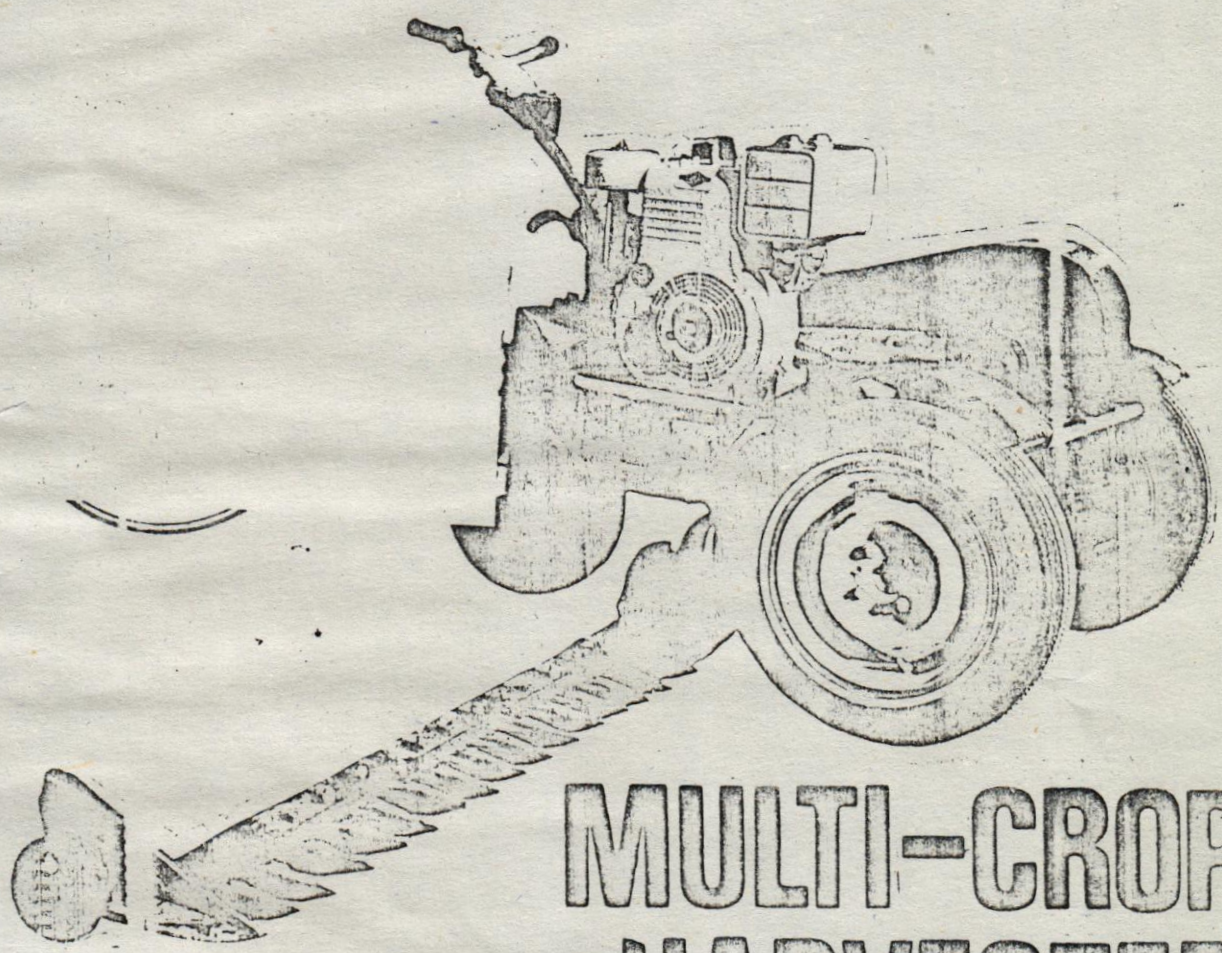


Fig. 5: The first prototype designed and fabricated By A.D. CHAUDHRY in the workshops of the dept. of Farm Machinery & Power University of Agriculture, Faisalabad.

Fig. 6: The demonstration of the first prototype of the University Reaper on 13-5-1977 in the wheat fields of the University of Agriculture, Faisalabad.
The Vice-Chancellor Dr.Amir Mohammad is handling the devics.

Fig 79, 17

# Malbro and Agriculture University, Faisalabad join hands to introduce



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