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Diffusion Possibilities of Mechanical Rice Transplanters

UMAR FAROOQ, A.D. SHEIKH, MUHAMMAD IQBAL†, ARSHED BASHIR AND ZUBAIR ANWAR‡
Agricultural Economics Research Unit (PARC), AARI, Faisalabad–Pakistan; †Social Sciences Division, PARC, Islamabad–Pakistan; ‡Social Sciences Institute, National Agricultural Research Centre, Park Road, Islamabad–Pakistan

ABSTRACT

The evaluation of diffusion possibilities of mechanical transplanting method revealed that on economic grounds, although this method is more expensive as compared with the conventional method, however, the yield benefits due to higher population stand makes it profitable to adopt. The introducing farmers showed some reservations regarding the spread of this technology in the area. The danger of massive displacement of farm labour cannot be ruled out. However, the big industrial set-up already present in the area may not allow this problem to become more severe.

Key Words: Diffusion possibilities; Mechanical rice transplanters; Farmers

INTRODUCTION

Basmati rice is mainly grown in the northern part of the irrigated Punjab i.e. mainly Sialkot, Gujranwala, Sheikhupura, Hafizabad and Gujrat districts. In rice production, nursery raising and its transplantation is one of the most laborious and one of the major variable cost item. It takes place during June-July, the hottest months of the year. Because of the good off-farm employment opportunities available in the area and the prevailing hot season, the persons already engaged in non-farm jobs are generally reluctant to perform rice transplantation. Therefore, frequent shortage of labour always has been reported during the season. The other common problems associated with the rice transplantation by hired labour are lower plant population per unit area, improper fixation of nursery plants in the soil, a higher percentage of missing plantation and un-even transplantation in paddy fields, i.e. dense and thin planted patches in the field.

Rice researchers regarded lower plant population as one of the major constraints in enhancing rice production in the area. In order to solve this problem and increasing plant population in rice fields, the Agricultural Department of the Punjab and Farm Machinery Institute of Pakistan Agricultural Research Council are trying to popularising the use of mechanical rice transplanters in this zone. Presently, this program is at the stage of experiments on farmers' fields. A team of social scientists from the Agricultural Economics Research Units at Faisalabad and Islamabad has made informal discussion with the farmers whose fields were used for testing mechanical transplantation. This paper describes the diffusion possibilities of this technology on economic, technical and other grounds.

History of mechanical rice transplanting in Punjab. In order to overcome the above mentioned problems, farm machinery experts at Rice Research Institute (RRI), Kala Shah Kaku, Farm Machinery Institute at NARC, Islamabad and private companies have been trying hard to popularising mechanical paddy transplanting in the Punjab. However, most of the emphasis of their work was confined to the testing of imported transplanters and incorporating modifications in the imported ones in order to devise an appropriate machine best suited to our local conditions. In 1976, Government of Pakistan has imported two units of 10 row power operated paddy transplanters from China. Under local conditions, the performance of these transplanters was found unsatisfactory. Later on, this machine was modified by Chinese and Pakistani experts and again tested in 1978 but no success was achieved. In 1976, Democratic Peoples Republic of Korea has given a gift of 50 units of engine powered paddy transplanters to Pakistan. A three member Korean team also came in Pakistan during 1976 for assistance in technical trials. Due to severe nature of many problems[1], it was concluded that this machine should not be introduced as such. In 1978, some modifications were made in the machine and was tested again. Although the results were broadly satisfactory but a large amount of time and labour was needed for trimming and washing the seedlings. Precise levelling and uniform depths of water in the field were other main obstacles perceived (Mufti & Khan, 1995).

In 1977, manual operated transplanter (Chinese version) imported from Philippines was tested and its performance was found satisfactory. It was advised to test its performance extensively. In 1977, using the idea of Chinese transplanter, RRI has developed an animal drawn

[1] For instance, from researchers' point of view, poor anchoring of seedlings in the soil, uprooting of seedlings by the wave action produced due to the movement of the machine, poor metering of seedlings ranging from 3 to 11 seedlings per hole, 35-55% missing plantation were the major problems diagnosed. From farmers' perspectives, it was difficult for them to maintain 2-4 inches water depth in the field, farmers' fields are also not precisely leveled and they do not like seedling preparation operation as it was time consuming and laborious (IRRI-PAK Agricultural Machinery Program, 1978; Khan *et al.*, 1979).

paddy transplanter in collaboration with a private firm. Because of non-uniform walking speed of the animals, the performance of this machine was found un-satisfactory (Mufti & Khan, 1995).

In 1980, Farm Machinery Institute (FMI) at NARC, Islamabad tested a "tractor rear mounted seven row rice transplanter". Seven labourers were required for working on the machine. The machine was declared un-suitable due to less number of hills transplanted (Akhtar, 1981). In 1984, a six-row mat-type self-propelled, ridding type Japanese paddy transplanter was tested at RRI, Kala Shah Kaku. The machine required seedlings raised in plastic trays. Although the performance of this machine was excellent and farmers have appreciated it but the transplanting cost per acre was very high as compared with the conventional method. In 1990 and 1991, another imported transplanter named 'Yanmar paddy transplanter' was tested in paddy fields around Lahore. It was found that machine adjustments are easy to understand, number of missing hills is also very low (5%), labour requirements and operational costs of raising nursery are also low and variation in the number of seedlings planted is quite uniform. However, the machine itself is somewhat complex and requires practical training for successful operation in the field. Moreover, the price of machine is very high and majority of the farmers cannot afford to buy. Local manufacturing of the machinery may bring down the total cost of paddy transplantation (Mufti & Khan, 1995).

Village and farmers' socio-economic environment. Small farmers (70%) dominate this belt; whereas, the medium and large farming groups constitute 28 and 2% of the farming population[2]. Regarding the chances of off-farm employment in the area, fairly good opportunities for off-farm employment are present in the area. Industries such as fans, sports goods especially footballs' stitching, surgical goods, cutlery items, ceramics, tubewell and tractor implement manufacturing are located here. A major road (GT Road) and newly constructed Motor Way (M-2) also passes through this zone. Moreover, this tract is also at 2 - 4 hours distance from Lahore and Faisalabad, the two largest cities and economic centres of Pakistan after Karachi. A large number of labourers daily commute between Lahore and various districts/tehsils of this zone. In villages, the average number of persons per acre of agricultural land is 2.51 persons/acre with significant differences among tehsils and more than 65% of the households are farming households with a significant variation in proportion among districts. Overall, about 0.35 persons per village household are engaged in non-agricultural employment, for example in the army, the police, teaching, clerical work, other government services, grain and livestock trading, working abroad, industry (commuting daily) and milk distribution in the cities. In Daska and Gujranwala tehsils, almost one person in every second household is working outside the village. This may be attributed to the factors such as the distance to industrial estates, the higher number of persons per acre and the relatively larger proportion of small farmers in the villages (Farooq, 1997[3]).

As far as the socio-economic characteristics of rice-wheat growing households are concerned, Farooq (1997) estimated average age of household heads as about 47 years and their mean farming experience was more than 25 years. The mean number of years of formal education was estimated as 4.67 and literacy ratio as 58%. The average family size in this area was estimated as 9.29 persons per household, comprising 2.97 adult males, 2.70 adult females and 3.62 children. In other words, about 32% of family members constitute earning members in this area. In terms of persons employed, on average, 1.5 person per farm household are absorbed on the farm (crop + livestock) and one person is working off-farm. Education is generally considered one of the pre-requisites for getting employment in the cities. In the area, overall, about three children per household are students, but with significant differences between tehsils. The average maximum education among male children was 9.19, implying that the eldest son had 4.52 years more education than his father. Classifying families having children educated higher than the education level of household head as the 'literacy-improved' families, overall, about 58% of the households fall under this category (Farooq, 1997).

Planting nursery by mechanical rice transplanters. The rice transplanting machines introduced in the study area are imported from two countries, i.e. China and Japan. In Japanese transplanting machines, trays of nursery are used whereas in Chinese machines, no such trays are required. At the time of transplantation, five persons are needed with their duties as: one driver; two caring for proper transplantation, feeding the nursery into the machine and solving other problems during plantation; and remaining two for regular transport of nursery trays to the persons working on the machine. Farmers reported that it takes about two hours to sow an acre of land provided that no disturbance takes place during transplantation. The number of plants per hole could be adjusted with the machine, however, the varying thickness of nursery plants sometimes create problem. That is, if the transplanter is set at two plants per hole, it may plant three seedlings per hole if the nursery is consisted of thin plants. Apart from saving labour time and higher plant population per acre (about 60

[2] The farmers having operational holding below 12.5 acres are called small farmers, farming having > 12.5 acres to 25 acres were classified under medium farmers category whereas farmers with more than 25 acres of land were terms as large farmers.

[3] Farooq (1997) had collected data from Daska, Gujranwala and Sheikhupura tehsils of rice-wheat zone.

thousands/acre using transplanter and 40-45 thousands/acre when manually transplanted), the main advantage of the mechanical transplanting reported the farmers was that the nursery plants are firmly pegged into the soil, provided that the field is precisely or laser levelled. In case of poor levelling, uniform transplantation is not possible. So, good transplantation requires; very precisely levelled paddy fields, 8-9 inches long nursery plants or at least 25 days old nursery, roots of the nursery plants should be free from pebbles and also not very bushy, and the paddy field should not be too much puddled and it should not be heavily irrigated on transplanting day.

Nursery raising for mechanical transplanting. For mechanical transplanting, like conventional method, nursery is not raised in plots or fields. A special nursery bed is prepared on a flat piece of land using polythene sheets. For planting one acre of rice, the following is required; about 10 kilogram rice seed, a 10' x 5' polythene sheet, one 10' x 5' wooden/iron frame with the sides 3-4 inches high, and very fine pebbles free soil with sufficient organic matter for covering the volume of 10' x 5' x 4". First the pebbles free fine soil is prepared by using large size sieve and fine farm yard manure is mixed with it. This soil is evenly spread in the frame on polythene sheets and rice seed is evenly broadcasted on this bed. The seed is covered with a very thin layer of fine soil. Then water is sprinkled on this bed till it is sufficiently soaked. Regular sprinkling of water is required twice a day for at least 25 days. Fertilizers, pesticides and weedicides can also be applied when needed. After 25 days, when the nursery is ready for transplantation, it should be cut into sheets/patches according to the size of the trays of the machine.

Problems reported by respondent farmers. The problems noted were: 1. Nursery raising is labour intensive and cumbersome job because special levelled place, soil preparation and regular irrigation by sprinkling are needed. The presence of pebbles in the roots of the nursery often damages the plants and breaks the pegging needles of the machine, 2. Cutting nursery according to the size of feeding trays and its transportation is a tough job, 3. Raising nursery for a very large paddy area is very costly, 4. Precise or Laser levelling paddy fields is an additional cost to the farmer, 5. In highly puddled paddy fields, transplanting is difficult. The outer rows are damaged due to slipping out of earth. This problem is more severe in Chinese transplanters, 6. The machine does not cover the corners of the paddy fields which later to be planted manually, 7. After transplanting, the water is need to be drained out from the field to make it a little dry which destroys its water retention ability. Therefore, mechanically transplanted fields require more irrigation water as compared to manually transplanted paddy fields, 8. The nursery raised for rice transplanters could not be used for manual transplantation because the roots of this nursery are very delicate, compactly inter-woven and shorter as compared with the nursery raised in fields, 9. There is also 10-15% missing transplantation with

Table I. The per acre cost comparison of raising nursery and paddy transplantation by transplanters and the conventional manual methods

Operations	Mechanical Transplanting			Conventional Manual Transplanting		
	Quantity	Price (Rs/unit)	Cost/Acre (Rs.)	Quantity	Price (Rs/unit)	Cost/Acre (Rs.)
Nursery Raising:						
Seed[1]	10 Kg	15.00	150.00	4 Kg	15.00	60.00
Plastic Sheet	10' x 5'	-	100.00	-	-	-
Ploughing[2]	-	-	-	6 Nos.	80.00	12.00
Planking[2]	-	-	-	4 Nos.	40.00	4.00
Soil Preparation[3]	2 MH	10.00	20.00	-	-	-
FYM, Fertilizer, Pesticide, Irrigation	-	-	30.00	-	-	30.00
Watering[4]	6 MH	10.00	60.00	-	-	-
Cutting/Uprooting Nursery	4 MH	10.00	40.00	-	100.00	100.00
Sub Total-I			400.00			206.00
Transplanting:						
Nursery Uprooting	-	-	-	-	100.00	100.00
Laser Levelling	3 TH	150.00	450.00	-	-	-
Nursery Transport and Transplantation	10 MH	10.00	100.00	-	500.00	500.00
Missing Plantations	5 MH	10.00	50.00	-	-	-
Sub Total-II			600.00			600.00
Trasplanter Hiring Rate[5]	1 Acre	300.00	300.00	-	-	-
Grand Total			1300.00			806.00

MH = Man Hours; TH = Tractor Hours

[1] Farmers reported that the nursery of about 4 Kg. of seed sufficient for transplanting one acre paddy field; also Bashir, *et al.*, 1995; [2] The ploughing and planking prices are in terms of per acre per turn; [3] Farmers reported that 4 man-days are required for preparing the soil of 20 acres; [4] One man can easily sprinkle water on 10 acres nursery in one hour, therefore, 2 hours/day are required for irrigating 10 acres nursery; [5] This rate is estimated using the tractor hiring rate (i.e. Rs. 150/hour, calculated on the basis of ploughing time and ploughing price in the area) and the transplanting time.

mechanical transplanters but the higher plant population compensates it during tillering, and 10. The price of mechanical transplanter is higher than the price of tractor whereas its services are required in only for two months in a year, i.e. June-July.

Economic viability of mechanical rice transplanter and its rental price. The material and labour costs involved in nursery raising for mechanical transplanting and actual transplanting are compared with the conventional method in Table I. It was found that the cost of raising nursery for mechanical transplanters is almost double as compared with conventional method whereas the nursery transplanting expenses are same, if the transplanters are provided free of cost by the government. In other words, if the government takes the responsibility of providing the transplanters free of cost, farmers will have to spend about Rs. 200 per acre more for achieving 25-33% higher plant population. However, including the rental price of transplanter inflates the total cost by more than 60%.

Regarding the yield comparison by transplantation methods, the innovator farmers reported that mechanically transplanted fields yielded 200-240 kg acre^{-1} higher as compared with the manually transplanted fields at similar inputs use level. This implies that farmers can still earn Rs. 1706 per acre more as compared with the conventional method, even after paying the transplanter's rental charges (Table II). This implies that a significant increase in paddy production can take place by wide spread adoption of mechanical transplanters in the area.

Table II. Partial costs and returns analysis of mechanical rice transplanting

Costs/Returns Items	Values
Yield premium over manually transplanted fields (kg acre^{-1})	220
Basmati paddy price (Rs./40 Kg)	400.00
Total returns premium (Rs/acre)	2200.00
Extra costs of nursery raising and transplantation (rice transplanter rental charges included)	494.00
Partial net-benefits of mechanical transplantation (Rs/acre)	1706.00

Social implications and other researchable issues. It is evident from the discussion in previous section that mechanical transplanting is clearly more remunerating as compared with the conventional method. However, the wide spread adoption of mechanical transplantation has some social implication such as massive labour displacement at transplanting times. Some of the displaced labour may be absorbed by the owners of transplanters, nursery transporting labour etc. However, the presence of big industrial infrastructure may play some role in absorbing this labour. There are also many researchable issues regarding the spread of mechanical transplanting in the area, such as: 1. There is a need to estimate the extent of plant population and yield trade-offs between transplanting at laser levelled and just levelled paddy fields, 2. It is also needed to search for alterations in the machine to deal with the problem of pebbles in the soil.

CONCLUSIONS

The partial economic analysis clearly revealed the profitability of mechanical rice transplanter's technique, however, the introducing farmers has some reservations about this transplantation method. Keeping in view the small average farm sizes and labour available (from farming and landless households) in the area, massive displacement of farm labour could be easily envisaged. The big industrial set-up already present in the area may dampen the severity of this problem.

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