Parachute Rice Transplanting Technology

An economical alternative to a traditional practice

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Introduction

The Indo-Gangetic Plains (IGP) is the cradle of rice-wheat production systems in South Asia. These systems have been the main source of food and livelihood security of millions of people in the region for over a thousand year. At present more than 30% of rice and 42% of wheat in the region is grown in the IGP of India, Pakistan, Bangladesh and is Nepal, covering about 13.5 million hectares (Mha).In Pakistan, rice is cultivated in > 2 Mha. and is an important source of foreign exchange. Its production during 2000-01 was more than 6.7 million metric tones (Mt), which is 1.4% of the total rice production (592.8 Mt). Pakistan ranks 13th among 112 rice-producing countries of the world and holds 5th position in exports. This is an encouraging scenario but still there is a great scope for increasing rice production in the country considerably.

Traditional rice cultivation

Traditionally rice is grown in puddled soils by transplanting 25-45 day-old seedlings from wet rice nurseries. Though this method has been practiced for long, it has limitations of poor water management practices in unleveled fields, paucity of irrigation water supplies and provision of drainage facilities. In Pakistan it generally requires 9450 liters of water to produce one kg of rice whereas India and China produce 2 and 5 kg of rice respectively from the same quantity of water.

Fig. 1. Traditional transplantation by contractual laborers has often resulted into low plant population in Pakistan.

Transplanting of rice seedlings in puddled fields is a laborious operation. Normally it requires 7-8 men or 8-10 women workers for two days to transplant rice seedlings in one hectare during hot and humid summers. Because of labour-intensive operations, most farmers face great difficulty in completing rice planting operation well in time. The current trend among farmers is to engage hired labour for rice transplanting. Unfortunately, contractual workers are usually more interested in area coverage rather than planting in rows and maintaining good plant population since more area coverage means more money to them. This tendency very often leads to low plant populations resulting in poor crop productivity.

Disadvantages of traditional manual transplantation

- Low plant population
- Inefficient input management
- Improper seed bed preparation
- Late transplanting
- Labor shortage during peak transplanting time
- Inadequate post-harvest practices

Transplanting of rice seedlings in puddled soil layers more than 5 cm deep delays crop establishment and reduces tillering. On the other hand, shallow planting of a single or two healthy seedlings encourages tillering, enhances yield and reduces seed requirement. As the labor is paid for the rice transplantation according to the area planted rather than by the quality of work, often the plant population remains lower than optimum (2,50,000-3,30,000/ha). It has been observed that contractual labor transplant around 200,000±10% seedlings/ha. In order to attain higher production, it is imperative that the plant population should not be less than recommended spacing of seedlings.

In peak rice transplanting season there is an acute shortage of labor. Late transplanting of rice invariably results in delayed sowing of wheat. In the past, mechanical rice transplanter were developed but the machine transplanting could not become popular with the farmers due to cost and special nursery raising practices. Therefore, alternate methods of establishing rice that require less labor and water without sacrificing productivity are needed. Parachute rice transplanting technique adapted to Pakistan is currently gaining popularity among the farmers and scientists for its many advantages

Parachute rice transplantation technology

Chinese farmers have been practicing 'parachute rice transplanting' technology for many years in puddled and unpuddled soils. To assess its potential for wider adoption by farming community of rice-wheat tract of Pakistan, Rice-Wheat Consortium (RWC) arranged a study tour to the Sichuan Academy of Agricultural Research Chendu, Sichuan Province of China in 2000. During this tour, participants from consortium countries studied 'parachute transplanting technology' for its adaptation and wider introduction in respective countries. Through earnest efforts of national scientists and private entrepreneurs, designs of the polyethylene bubbled sheets for raising rice seedlings in small plastic cups were prepared and appropriate agronomic practices developed by involving all stakeholders in Punjab, Pakistan. One reason for the quick adoption of this technology by farmers in Pakistan, more than by any other IGP-countries, might be because transplanting operations are done by hired labor in the absence of landholders resulting in low plant populations and therefore lower yields. In parachute transplanting, rice seedlings grown in soil-filled cupped-plastic trays are removed and broadcasted in a projectile manner into puddled or unpuddled irrigated fields. Seedlings having a small pallet of soil adhered to the roots when tossed into air in a projectile manner enable seedlings to land in watered fields in upright position. The trajectory of the broadcasted rice seedlings resembles that of a badminton shuttlecock. Here, the weight of the soil plug determines the path of the flight and enables the seedlings to land upright (Fig. 2).

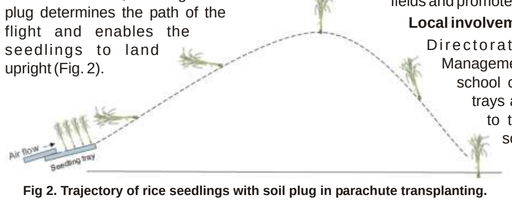

Fig 2. Trajectory of rice seedlings with soil plug in parachute transplanting.

Raising rice nurseries for parachute transplanting

To ensure that a high percentage of seedlings are planted upright into puddled field by broadcasting, flexible plastic bubble-sheets are used for growing the nursery. Plastic trays, 59 cm in length and 33 cm width, are placed on the raised beds. These trays have 434 plugs (micro-pots of 1.3cm dia. and 1.3 cm depth) with a tiny hole in the bottom to facilitate movement of water and nutrients from the soil below into soil plugs through capillary action. It requires 400 plastic trays to raise seedlings for one hectare. If trays are handled carefully, bubbled plastic sheets can last for three years.

Fig. 3. Plastic bubble-sheet used for raising rice seedlings.

Mechanically two to three seeds are dropped on the surface of each soil plug. But the recommendation is to seed the soil plugs with one or two seeds and cover them with a thin layer of sieved soil. Soil cups are watered with a sprinkler frequently in initial stages. The nursery so grown would take 25-30 days to attain a height of about 20 cm before transplanting. At transplanting, seedling weight including the soil plug is about 6-7 gm. Total weight of each plastic bubbled sheets with seedlings is around 3 kg 25 days after sowing.

Seedlings raised on bubbled plastic sheets have vigorous growth and save nursery area, labor in watering, weeding, uprooting and transplanting of seedlings. Parachute technique gives an early start to young rice seedlings transplanted into main fields and promotes early tillering.

Local involvement

Directorate of On Farm Water Management (OFWM), Punjab involved school children to sow seeds in the trays and then sell the sheets back to the growers. In the process, school children made some money and were happy to undertake seeding into soil plugs. Manual seeding helped save costly seed and it enabled growers to donate additionally to schools for this service.

Fig. 4. Plastic-tray seedbed preparation – a key for successful broadcasting of seedlings.

Fig. 5. Seedlings in plastic trays ready for transplantation.

Main-field preparation

Main-field preparation for broadcast-transplanting of rice seedlings is very much similar to conventional transplanting method. Field should be ploughed twice in dry condition, and irrigated to soften the soil overnight before puddling. Wet planking of puddled fields is necessary to ensure even distribution of water and anchoring of the tossed seedlings. Average water depth in leveled field should not be more than 4-6 cm. For younger seedlings (< 25 days old) depth of standing water may be reduced appropriately.

Manual parachute rice transplantation

In China, parachuting of the young rice seedlings is done both manually and by using mechanical blowers. With manual broadcasting, a labor simply tosses few seedling-plugs up into the air. Compared with conventional transplanting, seedling broadcasting still saves labor. Except for the trajectory, process of seedling distribution is akin to broadcasting of seeds and fertilizers. Manual parachute method is easy to practice and needs no investment on power blower. However, it results in poor distribution of manually broadcasted seedlings and needs some careful redistribution to avoid big gaps. As an alternative to manual broadcasting of the seedlings, modified power air-blower device can also be used.

Mechanical parachute rice transplantation

In the machanical method, a modified power sprayer is used to broadcast rice seedlings raised in plastic trays. A steel tray (43 cm x 31 cm) is attached in front of a Solo Spray machine (1.5 HP) at an angle of 60° to drop seedlings in a projectile way. The equipment weighs about 8 kg. The power sprayer machine can toss up the seedlings to a height of 3-4 m before landing into puddled fields with the roots directed towards the soil. Before actual transplanting is taken up, a threshold-speed of the blower must be set to ensure that the seedlings attain proper height, which also controls their angle of landing on the field. A proper height would ensure more upright landing and hence a successful establishment. This would also help overcome the problem of floating as seedlings anchor properly to the puddle.

Fig 6. A close-up of seedlings arranged in the blower tray.

The machine is capable of transplanting 434 seedlings into the puddled field in 46 seconds or about 3400 seedlings per hour.

Post-transplantation care

Gap filling and turning the slant seedlings upright are the two most important operations in achieving good crop stand with parachute transplanting. As the uniformity of the plant population depends on the skill of the worker in distributing the seedlings, care must be taken to avoid large gaps in the field. Gaps occur sometimes due to 'floats' where seedlings did not make soil contact or were

Fig. 7. Power blower modified for broadcasting seedlings.

average yield of 4.3 t/ha was obtained over three years, which was an indication of the production potential of this technology. The Box 1 shows the clear advantage of the technology over the traditional transplantation. In spite of higher initial cost due to the plastic bubble-trays, the method provided higher net income by 13% due to the savings in other inputs and higher grain yield.

carried away by the water currents. Gap filling should be done within 2 days after transplanting to avoid delayed establishment and suppressed growth of the established plants. Upright landing of seedlings can be ensured at the time of broadcasting either by careful hand broadcasting to a sufficient height or by proper angle of the seedling-tray in the mechanical method.

Box 1. Comparative performance of mechanical parachute and conventional transplanting methods (Average of three years)

Parameter	Conventional method	Mechanical parachute method	Advantage (%)
Water for transplantation (cm)	21	5.5	57
Age of seedlings (days)	40	26	35
Time for transplanting (hr/ha)	15	5	67
Cost of transplanting (Rs/ha)	2,300	6,900	-200*
Average height of seedlings at transplantation (cm)	45	18	60
Plant population per square meter	15	23	53
Productive tillers per square meter	292	428	47
Panicle length (cm)	25	25	0
Plant height at harvest (cm)	102	102	0
1000 grain weight (g)	21	22	5
Yield (kg/ha)	3,400	4,300	27
Net income (Rs/ha)	31,900	36,000	13

* Higher initial cost due to sprayer modifications and plastic bubble-sheets.

Comparison of conventional vs. parachute transplanted rice

Sheikhupura and Bhalwal village clusters shown in the map were selected to test the technology (Fig. 8). Positive results were observed during the first year. To improve the performance of the machinery, some necessary modifications were made in 2001-02. The technology was tested once again. Keeping in view the outcome of the trial, the experimental area was extended subsequently. Among many parameters studied, the method proved cost-effective due to the savings in water and labour; and enabled early transplanting by fourteen days. An

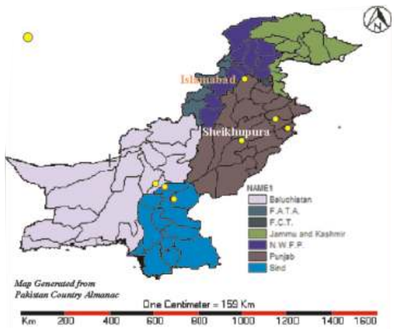

Fig. 8. Map showing the Sheikhupura and nearby villages where the technology was tested.

Advantages of parachute transplanting

- Three to four persons can broadcast seedlings in one hectare in 6-7 hrs. In conventional method, 10-11 persons usually transplant 12 ha in one month, whereas, the same can be accomplished in one week by adopting parachute transplanting technology. Hence, this technology is quick and economical for the farmers owning large land holdings.
- Only 2.5 liters of diesel is consumed for one hectare, which is very economical as compared to other conventional methods.
- Considerable quantity of water (60%) is saved, as 4-5 cm of water in fresh puddled field is enough for promising results.
- There is a saving of 60–70% in labor costs as compared to the conventional method.
- Uprooting of nursery from the plugs on plastic trays is very easy.
- Results in higher crop yields and net income as compared with the traditional method.

Important Precautions

- Avoid using clayey soil to cover the seed in the plastic trays.
- Place plastic trays on 6-7cm raised beds, leveled properly.
- Apply light irrigation at proper intervals over the nursery.
- Protect nursery area from birds and animals.
- Stop irrigation a day before removing the seedling with soil plug.
- Seedlings should not be entangled with each other and must have some soil adhered to the roots.
- Place uprooted seedlings on steel tray attached to Solo Sprayer machine.
- Seedlings placed in tray should have roots towards the air blower pipe.
- Transplanting operation must be started from one corner of the field.
- Avoid transplanting against the wind direction.
- Keep a 4-6 cm water depth at transplanting to avoid seedling floatation.
- Adopt laser land leveling technology before crop cultivation.

Status of parachute transplanting in Pakistan

During 2003, demonstrations of parachute transplanting were laid out on a much larger scale in Punjab, Pakistan. A program has been planned to demonstrate parachute transplanted rice in each *Thana* (smallest local unit of governance) in Punjab by the government of Pakistan in 2004. A private firm is manufacturing the trays and selling them to the farmers. An Urdu pamphlet has been produced to further disseminate the technology among farmers in other provinces. The OFWM used informal participatory training for operation of equipment and seeding of trays with the growers. Over the past three years, more than 2,000 men and women farmers, school children, and staff have been trained. Grower rallies, workshops, and TV programs have been utilized to publicise this technology widely.

Rice-Wheat Consortium for the Indo-Gangetic Plains

The Consortium is an Ecoregional Program of the Consultative Group on International Agricultural Research (CGIAR), managed by CIMMYT, involving the National Agricultural Research Systems, the International Agricultural Research Centers, and the Advanced Research Institutions. Its main objective is to promote research on issues that are fundamental to enhance the productivity and sustainability of rice-wheat cropping systems in South Asia.

These objectives are achieved through:

- Setting priorities for focused research on problems affecting many farmers.
- Promoting linkages among rice-wheat research specialists and other branches of research and extension.
- Encouraging interdisciplinary team approach to understand field problems and to find solutions.
- Fostering quality work and excellence among scientists.
- Enhancing the transfer of improved technologies to farmers through established institutional linkages.

Financial support for the Consortium's research agenda currently comes from many sources, including the Governments of Netherlands, New Zealand, Australia and the Department for International Development (DFID), the International Fund for Agricultural Development (IFAD), the United States Agency for International Development (USAID), the World Bank and the Asian Development Bank (ADB).

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