Popularising Direct Seeded Rice: Issues and Extension Strategies

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Abstract

Direct Seeded Rice (DSR) is the technology which is water, labour and energy efficient along with eco-friendly characteristics. Flooded rice is a major source of methane emission, while the use of nitrogen fertilizers produces nitrous oxide; both are greenhouse gases linked to global warming. The dominant method of rice establishment is transplanting in the rice-wheat growing areas of the Indo-Gangetic Plains (IGP). However, rising labour costs for establishing a nursery, puddling fields, and transplanting have increased costs for transplanting in the region. Direct seeding of rice was a common practice before green revolution in India and is becoming popular once again because of its potential to save water and labour. However, high weed infestation is the major bottleneck in DSR, especially in dry field conditions and, availability of several nutrients including N, P, S and micronutrients such as Zn and Fe, is likely to be a constraint.

Extension activities can play very important role in popularisation of DSR, which includes training, demonstration of DSR in farmer's field, on farm trial related to various potential problems faced by farmers and exposure visit of farmers to field. Coordination is also required within the different disciplines/specializations, between institutions and departments as well as functional areas like research, extension and training along with people's participation and new thrust on participatory research and development to bring farmers in the framework of interactions at all levels.

With the increase in prices of inputs and low rice prices, rice production does not provide farmers with high income. Rice food security needs clear national policy that allows right investment in all phases of rice development. There must be right policies on input availability, output marketing and prices. The following paper tries to look into the issues affecting DSR adoption and suggests extension strategies to popularise it.

Key Words: Direct seeded rice, Extension strategies, Climate change,

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Rice the most prominent crop of India, is the staple food of the eastern and southern parts of the country. The term 'rice is life' is most appropriate in Indian context as this crop plays vital role in country's food security and is the backbone of livelihood for millions of rural households. By 2010, rice production had reached 151 Mt, which was second to China (FAO, 2010) only. In Asia, more than 2.8 billion people derive 35 to 60 per cent of their calories from rice (Swaminathan, 1989). India occupies an important position both in acreage and production of rice. It has the largest area (42.9 million hectares) that accounts for about 27.1 per cent of the total rice growing area of the world.

Since 1950 the increase has been about 4 times. Most of this increase was as a result of an increase in yields as the area increased was only 40 per cent during this period. In India the demand for rice will increase because of population growth and an expected diet change (Joshi et al., 2009). This increase in rice production has to come from higher yield because land area under rice is declining. Eastern India has great potential in increasing the rice production and productivity. Therefore, the sustainability of rice eco-systems and the ability to increase production in pace with population growth with reduced water and labour use are major concerns.

What is Direct Seeded Rice (DSR)?

Direct Seeded Rice (DSR) is the technology which is water, labour and energy efficient along with eco-friendly characteristics and can be a potential alternative to CT-TPR (conventional puddled transplanted rice) (Kumar and Ladha, 2011). Excellent progress has been made in the development of baseline information required for the successful establishment of direct seeded rice (DSR) as a productive and sustainable alternative to conventional hand-transplanted system. Several field sites were established across states of Haryana, Punjab and Bihar. These states geographically provide an excellent cross section of the Indo-Gangetic plains in terms of climatic and productivity status (Joshi, et al., 2013).

Rationale for Direct Seeded Rice

Flooded rice is a major source of methane emission, while the use of nitrogen fertilizers produces nitrous oxide; both are greenhouse gases linked to global warming. On the other hand, temperature increase, variability in rainfall and its distribution, and rise in ocean water potentially have important effect on rice production. High atmospheric temperature could reduce rice yield in tropical climate areas, while variability in rainfall and its distribution could lead to more frequent and severe floods and droughts. Rising ocean water could expand substantially rice area influenced by tidal waves in low-lying flood plains and deltas of rivers where rainfed lowland, irrigated lowland and deepwater/floating rice are widely cultivated, especially in East Asia, Southeast Asia and South Asia. In addition to the above mentioned-technologies, generations of new rice varieties would most likely be needed for sustainable rice production under climate change.

One problem commonly encountered is degradation of soil structures, caused by excessive tillage and puddling of water for rice production. No-till systems for wheat, developed and introduced in past research, have opened the way for no-till rice cropping. Preliminary research suggests no-till rice can also be grown, substantially boosting the benefits of no-till wheat that are often subsumed by tillage and puddling in rice cultivation. Improving the productivity of direct seeded rice, including by weed, nutrient and crop management improvements, will be undertaken to minimise the yield gap between wheat and rice.

The dominant method of rice establishment is transplanting in the rice-wheat growing areas of the Indo-Gangetic Plains (IGP). However, rising labor costs for establishing a nursery, puddling fields, and transplanting have increased costs for transplanting in the region. Concerns about depleting underground water and increasing costs of irrigation have made transplanting less appealing to farmers. Direct seeding of rice is an alternative method that could reduce the labour and irrigation water requirements for crop establishment (Kumar and Ladha 2011). Direct seeding would also enable farmers to establish rice early, allowing them to harvest early, so that they can start sowing a subsequent crop, which is, wheat, in areas in eastern India, leading to higher yield of the crop (Singh et al 2008).

Transplanting of rice is more water demanding, laborious, cumbersome, time consuming and entails a lot of expenditure on raising nursery, uprooting, and transplanting. Scarcity of labour during peak period of transplanting, uncertain supply of irrigation water, depletion of groundwater and increasing production cost necessitate the search for an alternative to the conventional puddled transplanting of rice. As rice production is intricately linked with land and water, this has unique and profound implications for the environment. Therefore, careful management of the natural functioning of rice ecosystems is critically important for protecting the environment while raising rice productivity to meet growing demand.The rice-wheat cropping system of the Indo-Gangetic Plains (IGP) also showed yield stagnation/ decline in the last two decades (Ladha et al.,2003). The challenge is to integrate productivity and profitability improvement while conserving and enhancing the quality of the environment on which production depends.

Farmers in Asia and Africa have the tradition of transplanting lowland rice. Transplanting uses less seed but requires more labour, time and water. It normally requires about 120 man-hours to transplant a hectare. Direct seeding on dry soils has been used by lowland rice farmers in Asian countries such as Indonesia and Philippines who grow two rice crops within a year in rainfed areas with long rainy season. The adoption of direct seeding onto flooded and saturated soils has increased in Asia due to labour shortage in rural areas. Direct seeding, however, requires large quantities of seed. Also weed competition in direct seeded fields is high. (Jha et al. 2012)

Direct seeding of rice was a common practice before green revolution in India and is becoming popular once again because of its potential to save water and labour. Currently, direct seeded rice in Asia occupies about 29 M ha which is approximately 21% of the total rice area in the region. Countries like USA and Australia extensively practicing direct seeding of rice are with profitable results as it avoids all the penalties entailed in transplanting. Direct seeded rice under no/reduced tillage is an efficient resource conserving technology (RCT) holding good promise in coming days because of the following advantages over transplanting of rice (Pathak et al.2011) :

Relevance of DSR under Climate change situation

Rice production contributes to global climate change through emissions of methane and nitrous oxide and in turn suffers from the consequences. Methane is formed in soil through the metabolic activities of a small but highly specific bacterial group called methanogens. Their activity increases in submerged, anaerobic condition developed in wetland rice fields, which limit the transport of oxygen into the soil, and the microbial activities render the water-saturated soil practically devoid of oxygen. Water management, therefore, plays a major role in methane emission. Altering water management practices, particularly mid-season aeration by short-term drainage as well as alternate wetting and drying can greatly reduce methane emission in rice cultivation. Improving organic matter management by promoting aerobic degradation through composting or incorporating into soil during off-season drain period is another promising technique.

Flooded rice culture with puddling and transplanting is considered one of the major sources of methane (CH4) emissions (Reiner and Aulakh, 2000). Direct-seeded rice is a feasible alternative to conventional puddled transplanted rice having good potential to mitigate and adapt to climate change. Climate change is expected to increase the variability of monsoon rainfall and the risks of early or late-season drought. The DSR increases the capacity of poor farmers to cope with climate induced change by offering a choice of rice establishment methods and by reducing the amount of water required for crop establishment and subsequent crop growth. Further, faced with early drought, farmers can direct seed with minimal soil moisture, rather than wait for sufficient rainfall for transplanting. Crop establishment through DSR reduces the risk of yield loss from late-season drought, and the cost of additional irrigation to prevent such losses.

Weed management in DSR

High weed infestation is the major bottleneck in DSR, especially in dry field conditions (Singh et al., 2009). Estimated losses from weeds in rice are around 10% of total grain yield; however, can be in the range of 30 to 90%, reduces grain quality and enhances the cost of production (Singh et al., 2012). FAO recommends an integrated approach that combines preventive, cultural, and chemical methods that is desirable for effective and sustainable weed control in Dry-DSR. Moreover, weed surveillance may also prove beneficial in selecting suitable herbicides and weed management strategies in a region (Singh and Meena., 2012).

Nutrient management in DSR

Since direct seeding follows aerobic cultivation of paddy, it usually results in different nutrient dynamics than the TPR. In direct seeding, availability of several nutrients including N, P, S and micronutrients such as Zn and Fe, is likely to be a constraint. The general recommendation is to apply a full dose of P and K and one-third N as basal at the time of sowing. Split applications of N are necessary to maximize grain yield and to reduce N losses. The remaining two-third dose of N should be applied in splits and top-dressed in equal parts at active tillering and panicle initiation stages.

Extension strategies for DSR

Extension activities can play very important role in popularisation of DSR, which includes training, demonstration of DSR in farmer's field, on farm trial related to various potential problems faced by farmers and exposure visit of farmers to field.

Agricultural extension and advisory services both public and private thus have a major role to play in providing farmers with information, technologies and education on how to spread the DSR technology and face problems related to it in field condition. Extension traditionally has played a role in providing information and promoting new technologies or new ways of managing crops and farms. Extension agencies links farmers to researchers and other players in the technology transfer system.

Farmers, extension agents and researchers must work together on farmers' fields to prioritize, test and promote this technique. Extension agencies can provide information using flyers, radio messages as well as field demonstrations in addition to innovative activities like adult education and experimental learning approaches utilized in Farmer field schools as well as multimedia campaign. Another role is acting as important and honest broker in bringing together all actors in this field by linking farmers to transport agents markets and input supplier among others.

Coordination is also required within the different disciplines/specializations, between institutions and departments as well as functional areas like research, extension and training along with people's participation and new thrust on participatory research and development to bring farmers in the framework of interactions at all levels. More allied agencies have to be brought together to serve the farmers on the line of farming systems approach. More specifically, the following measures are needed to popularise DSR:

1. Effective field-level organization allowing extension personnel to work with farmers, both individually and collectively;
2. Existence of sufficient number of trained personnel of different backgrounds capable to carry out the program from the planning stage to practical implementation on the farmer's holdings;
3. Program of effective in-service training for existing personnel, and initial training for new recruits joining the service;
4. Sufficient budgetary resources to cover program expenses;
5. Close collaboration with the agencies concerned with agricultural research, seed production, quality control, agricultural credit, and marketing.
6. Production and Dissemination of Rice Seed
7. Production of basic and certified seeds;
8. Strengthening rice seed distribution network in the country;
9. Supporting on-farm seed production;
10. Creating awareness and provision of up to date information on availability seeds to farmers;
11. Strengthening the capacity of public and private seed companies

Constraints

Agronomic constraints

The major agronomic constraints in rice production are identified to be weeds, pest, diseases, and lack of their control methods. Poor land preparation techniques are reported to be the third most important rice production constraint. Method and date of planting that is developed taking the rainfall patterns, soil type, and rice varieties into consideration is lacking. Problems associated with fertilizer use are viewed relatively less important mainly due to the limited utilization of chemical fertilizer.

Pre and post harvest handling

According to the priority of rice production input constraints, post harvest handling particularly availability and access of equipments. Availability of efficient de-hulling and milling equipments are reported to be the major constraints in rice production. Produce is stored in jute bags at home or in traditional storage bins. Hence, these storage practices are in capable maintaining the quality of the produce for a long period, and grain losses are high. Harvesting and threshing is done manually and by trampling of animals. Delayed harvesting and shattering are also serious problems that have to be reckoned with. Extension Packages

A step-wise approach of integrating new technological options into production systems with full farmer participation is essential to close the large gaps between actual farmers' yields and attainable yields under better management.

Gaps and challenges

Technologies

1. Lack of recommended transplanting technique;
2. Lack of information on ratoon management; and
3. Lack of recommendations on agronomic and cropping systems management
4. Lack of information on parboiling techniques

Capacity

1. Limited skill of extension personnel; and
2. Lack of experts specialized on rice and the knowledge gap.

The main challenges are related to inputs, agronomic practices, irrigation and water management, pre and post harvest technologies, markets, product utilization, investment, the limited human and institutional capacity, and to some extent policy.

Scaling up of DSR Technologies

Experience shows that incomplete stakeholders' participation in promotion of technologies has limited effectiveness, sustainability, and outputs. The technology promotion and/or demonstration using volunteer farmer's fields have been undertaken with dual objectives availing of technologies; and availing of seed on revolving scheme that enhances the exchange of the seed within and between localities.

Technology adoption

The experience with FRG (Farmer Research Group) approach encouraged member farmers to practice improved rice production management, which received wider acceptance not only among FRG member farmers but also farmers in the surrounding areas.

Linkages and participation

Farmers, agricultural experts, multidisciplinary research teams and other relevant stakeholders have actively participated and worked together during the research process. As a result, strong linkage is formed among key stakeholders that would have a considerable impact for technology dissemination in sustainable manner. During the process, farmers had an opportunity to run their own experiment and get access to apply their local knowledge, skill, and experience. To strengthen farmers' participation in the research and exploit their indigenous knowledge, a deliberate effort was made to enable them take part starting from problem identification and later suggest solutions for the problems faced. So the process was participatory from beginning to end.

Awareness creation

FRG members and development agents have acquired the skill and knowledge on improved rice production and FRG concepts during the training, field trials, experience sharing, meeting and field visits. The attitude of farmers has changed and they have showed strong desire to produce rice at a wider scale. The recognition on the importance of using improved varieties with appropriate agronomic practices has also significantly improved among the farmers. Not only farmers but also researchers have benefited from the farmers' indigenous knowledge and experience.

Policy and Institutional Environment

The majority of rice farmers are poor and caught in the endless cycle of poverty and food deficit, but national policies in countries, where rice is the staple food crop, usually favour the rice consumers, not the farmers; by limiting the prices of rice in the market. With the increase in prices of inputs and low rice prices, rice production does not provide farmers with high income. Rice food security needs clear national policy that allows right investment in all phases of rice development. There must be right policies on input availability, output marketing and prices The rice Green Revolution in the 1970s and 1980s was possible thanks to the investment in research and extension services to build capacity and expertise in rice production. The success of rice Green Revolution has led to reduction in public investment in rice research and extension in general. Policy must be readjusted to provide more support to the development and transfer improved technologies for sustainable rice production.

At *Policy level* DSR can be popularised through following measures:

Providing a special fund for DSR rice research with special focus on Eastern India suitable under DSR,

1. Constituting a task force to oversee the progress on DSR,
2. Creating conducive environment to boost seed production both by public and private sector suitable under DSR, and
3. Procurement of DSR suitable rice varieties by FCI and other agencies.

At *Technical level* intensive research needed to solve the problem on water, nutrient and weed management arising at local level.

At *Extension level*- exposure visit of farmers to on-farm and on-station trials on DSR to expose the potential and performance of DSR in order to increase awareness about DSR technology. Facilitate interaction among different stake holders involved in studies related to DSR. Identify constraints associated with DSR, identify the future research needs.Summarize technological package on DSR for an area.

Village-level integration in the context of DSR should aim to, educate and improve farmers' decision-making abilities to develop and incorporate DSR within their own farming systems; enhance the adoption of DSR in their environment, and ensure increased productivity of the farming community. The economic component of the technology, through increased productivity or reduced costs, is essential. Five closely linked activities should be implemented:

1. Participatory problem analysis and finding solutions through focus group discussions and participatory resource appraisal.
2. Capacity enhancement through farmer's field schools.
3. Experiential learning in the on-farm participatory technology development trials.
4. Communication support through information materials such as newsletters, posters, and radio and TV if appropriate, and
5. Technology synthesis where the new and traditional knowledge of farmers blend together to form an adapted IWM-DSR technology.

Linkages and networking for popularisation

The two-way interaction between farmers and extension officers and between farmers and research scientists of Krishi Vigyan Kendra, State Agricultural University and Zonal Research Stations can play a very important role in transfer of technology.

Some of the steps that can be taken to improve such linkages can be organization of joint workshops, meetings and training programs. Farmers could take their problems and queries to extension workers who themselves provided the solution or forwarded them to research system and get the solution that can be communicated back to the farmers. This would enrich the capacity of the researchers in responding quickly to the needs of the farmers and developing location-specific technologies. Besides, active participation of farmer's and close coordination between extension and research systems reduces the cost of technology dissemination and time lag in adoption of DSR technologies.

Conclusions

As the 21st century unfolds, global rice production has showed signs that it may no longer be stable in the future. On the other hand the global population continues to increase, although with lower growth rate, while the resources for rice production are diminishing.

There are many constraints and challenges to reduce rice food shortage, lessening rural hunger and poverty within the rice-based systems. Fortunately, there are technical opportunities to address the constraints and challenges. Rice is the staple food crop of more than half of the world population. It is hoped that the above information and analysis would contribute to the formulation of appropriate policy and strategy for the promotion of sustainable rice production intensification.

In view of water and labour scarcity as well as to mitigate GHG emission, the DSR technology holds very good promise. It is becoming more popular among rice farmer as it is more economical than conventional transplanting. If properly managed, the yields are also comparable with transplanted rice. The system has been proved cost effective and farmers friendly but require further improvement in technological approach to realize greater benefits. Direct seeding is a viable alternative to puddled transplanting to overcome the problem of labour and water shortage. Large scale adoption of DSR is possible but prioritizing resources and public - private -partnership (PPP) holds the key.

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