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Reshu Bhardwaj
Research scholar, Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

MK Singh
Ex-University Professor cum Chief Scientist, Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

AK Singh
Assistant professor cum Junior Scientist, Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

AK Tiwary
Assistant professor cum Junior Scientist, Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

Correspondence
Reshu Bhardwaj
Research scholar, Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

Soil health, weed density and economics of rice as affected by crop establishment methods – a review

Reshu Bhardwaj, MK Singh, AK Singh and AK Tiwary

Abstract
Rice is one of the most important food crop of South East Asia, particularly India, where more than 60% of the population consume rice as staple food crop. In Jharkhand, rice is conventionally grown by transplanting method. Direct seeding of rice is practiced in limited areas where water scarcity and labour shortage are limiting factors. When transplanting method of rice establishment was compared with broadcasted rice, transplanted rice showed better results in nutrient utilization, weed dynamics and economics due to optimum spacing and judicial utilization of inputs by the crops, however, among direct seeding methods, rice established through drum seeding, where inter spacing is maintained, had an edge over broadcasting of sprouted or dry seeds and was at par with conventional and mechanically established rice. This technique aids in reducing labour needs, investments on inputs, avoids drudgery, saves time by escaping the nursery operation resulting in timely sowing of crop and achieving desirable yield. The crop is also harvested 8-10 days earlier than transplanted rice. The present paper discusses the advantages and disadvantages of transplanting and direct seeding methods.

Keywords: Soil health, weed density, economics of rice

Introduction
Rice (*Oryza sativa* L.), a starchy cereal, belonging to Gramineae family is consumed as a staple food crop by more than half of the world's population. In south east Asia, farmers grow rice on large scale by transplanting method. This technique involves different agricultural operations like nursery raising, uprooting of seedlings and transferring it to main field for transplantation which makes it quite complex and labour intensive as compared to direct seeding method. A sharp decline in water table has been observed due to excessive pumping of ground water to meet the water requirement of transplanted rice. However, transplanted paddy utilizes the soil nutrients more efficiently from the eco-rhizosphere and also reports less weed infestation on account of optimum spacing, thereby resulting in higher yield. On the other hand direct seeded rice offers the advantage of faster and easier planting, ensure proper plant population, reduce labour and hence less drudgery, 10-12 days earlier crop maturity, more efficient water use and higher tolerance to water-deficit, and often high profit in areas with assured water **supply (De Datta, 1986).**

Effect of different crop establishment methods on soil health
Gangwar *et al.* (2008) while studying the effect of different rice establishment methods on soil properties, found that lowest (1.46 Mg m^{-3}) and highest (1.49 Mg m^{-3}) values of bulk density were found in direct seeding (dry bed) and mechanical transplanting (puddled), respectively.
The soil organic carbon in 0-15 cm increased by 4% in mechanical transplanting (puddled) while it decreased by 3.40% under direct seeding (dry bed) (Gangwar *et al.* 2009).
Uptake of nutrients (N, P and K) by crop is a function of the nutrient content in the plant and the dry matter accumulation per unit area (Kanthi *et al*. 2014). Chander and Pandey (1997) observed that N (112.8 kg ha^{-1}), P (17.0 kg ha^{-1}) and K (172.3 kg ha^{-1}) uptake by rice were significantly higher under transplanting than direct seeded rice under puddled condition. Similarly, Shashi kumar, (1990) and Anbumani *et al*. (2004) found that line transplanted rice registered significantly higher nutrient uptake than direct seeded rice. This is attributed to the submerged conditions in transplanted rice that facilitate availability of more mineralized form of N, P and K and therefore its uptake in transplanted rice is higher than that of direct sowing which encouraged tiller production in addition contributed to higher dry matter production and grain yield. Similar findings were observed by Shashi kumar (1990).
Transplanting method recorded significantly higher nitrogen uptake in grain(49.68 and 43.45 kg/ha) and straw (31.67 and 29.84 kg/ha) followed by broadcasting of sprouted seeds under puddled condition recording (44.20 and 40.00 kg/ha) in grain and (28.53 and 28.10 kg/ha) in

straw, however, the lowest nitrogen uptake was found in direct seeding method (40.89 and 37.06 kg/ha) in grain and (26.63 and 25.38 kg/ha) in straw and the increase in total N-uptake was 11.9 and 19.7% over broadcasting of sprouted seeds under puddled condition and 7.6 and 17.4% over direct seeding during the 1st and 2nd year of experiment, respectively. This might be due to higher grain and straw yield under transplanting, though the N content did not vary with planting methods as observed by Jaiswal and Singh (2001). Singh and Singh (2010), however, revealed that the nutrient uptake by the crop was significantly influenced by different rice establishment methods in which drum seeding of rice under puddled condition recorded highest uptake of N (82.04 kg ha^{-1}), P (20.02 kg ha^{-1}) and K (112.2 kg ha^{-1}) followed by wet seeding i.e. broadcasting of sprouted seeds under puddled condition having nutrient uptake of N (71.62 kg ha^{-1}), P (17.54 kg ha^{-1}) and K (99.0 kg ha^{-1}) and dry seeding having nutrient uptake of N (63.71 kg ha^{-1}), P (15.28 kg ha^{-1}) and K (92.1 kg ha^{-1}). Perceptible differences were observed with regard to nutrient uptake among the crop establishment techniques tried. Nitrogen (60.8 and 26.9kg ha^{-1}), phosphorus (20.3 and 14.7 kg ha^{-1}) and potassium (30.6 and 113.0 kg ha^{-1}) uptake by grain and straw, respectively was found to be the maximum with transplanting method. While, the lowest uptake (46 and 20.7 kg N, 14.2 and 11.5 kg P_2O_5, 19.4 and 92.9 kg K_2O ha^{-1} in grain and straw, respectively) was associated with broadcasting of sprouted seeds, which was however, statistically at par with drum seeding of sprouted seeds (48.4 and 22.1 kg N, 15 and 11.5 kg P_2O_5, 21.4 and 96.2 kg K_2O ha^{-1} in grain and straw, respectively) at harvesting. Better environment available around the eco-rhizosphere as a result of thorough pulverization of soil under a film of water and transplanting of rice seedlings aged about 25 days in such an ideal environment might have enabled the crop to absorb native as well as applied nutrients incessantly to give an early lead to the growth of individual plants as well as higher nutrient content that resulted in higher nutrient uptake as stated by Kanthi et al. (2014). Varied levels of absorption of nutrients under different methods of crop establishment had also been reported by Singh *et al.* (2007c); Singh *et al.* (2008a). The nutrient uptake by rice grain at harvest indicated that nitrogen, phosphorus and potassium (62.84 and 65.44 N kg ha^{-1}, 12.40 and 12.92 P kg ha^{-1}, 12.13 and 12.65 K kg ha^{-1}) in transplanting method was significantly higher compared to direct seeded rice (sprouted seeds) under puddled condition (54.27 and 56.77 N kg ha^{-1}, 10.19 and 10.66 P kg ha^{-1} and 10.01 and 10.48 K kg ha^{-1}) in the year 2010 and 2011, respectively. The decreased weed competition in transplanted rice might have augmented the uptake of applied nutrients as well as soil nutrients. Similar effects were reported earlier by Chander and Pandey (1997). Significantly higher nutrient uptake (42.94 and 44.71N kg ha^{-1}, 7.31 and 7.62 P kg ha^{-1} and 48.53 and 50.55 K kg ha^{-1}) by rice straw was observed with transplanted rice whereas the lowest uptake of nutrients (36.51 and 39.10 N kg ha^{-1}, 5.55 and 5.95 P kg ha^{-1} and 42.15 and 45.15K kg ha^{-1}) was registered with direct seeded (sprouted seeds) rice under puddled condition in the year 2010 and 2011, respectively (Prarameshwari and Srinivas, 2014).

Effect of different rice establishment methods on weed dynamics

On sandy loam soils, Chander and Pandey, (2001) registered significantly lower weed dry weight in transplanted rice than in direct seeded rice at tillering, flowering and maturity stages. The results are in agreement with the findings of Singh *et al*. (2006). Yadhav and Singh, (2006) observed the lowest population of weeds in transplanted rice compared to direct sowing. Singh *et al.* 2007c, comparing transplanting and direct seeded rice concluded that transplanting method of rice establishment recorded reduced number of dicot and monocot weed population i.e. 10.6 m^{-2} and 7.38 m^{-2} respectively while under direct seeded it was 12.7 m^{-2} and 9.36 m^{-2} respectively.

Direct seeding (dry bed) produced maximum weed population (17.67 m^{-2}) and weed dry matter (3.58 g m^{-2}). Mechanical transplanting (puddled) recorded lower weed population (2.33 m^{-2}) and weed dry matter accumulation (0.87g m^{-2}) as compared to other establishment methods (Gangwar *et al.* 2009). The rice established with drum seeding under puddled condition had minimum density and dry weight of weeds, the maximum density was recorded under dry seeding of rice at 45 and 60 DAS. This might be due to the effect of puddling which placed the seeds, stems, and stolons of weeds into sub-surface, as a result these materials could not get favourable environment for their germination and establishment, thereby lowering the weed population during crop period as reported by Singh and Singh (2010). The weed parameters like total weed density and weed dry matter was significantly influenced by different rice establishment methods. The total weed density and weed dry matter (10.4 m^{-2} and 7.06 g m^{-2}) was higher in drum seeding than transplanting method which recorded weed density and weed dry matter of 9.1 m^{-2} and 6.6 g m^{-2}, respectively at 30 DAS/T due to puddling operation which inhibited the germination of weed seeds and destroyed most of the weeds under anaerobic condition, that might have reduced weeds density under puddled condition (Talla and Jena, 2014). Subbulakshmi and Pandian (2002) have also reported similar results.

Crop establishment methods exerted significant influence on the weed count (m^{-2}) and weed dry weight (g m^{-2}) recorded at 60 DAS. The total weed density and dry weight of weeds were higher (43.49 and 39.47 g m^{-2}) under direct seeded rice (sprouted seeds) under puddled condition compared to transplanting (33.73 and 32.20 g m^{-2}), which might be due to failure to maintain flooded conditions in field and non submergence of crop in the initial stages, as crop and weeds germinate simultaneously so competition exists (Parameshwari and Srinivas, 2014). These results are in conformity with those of Subramanayam *et al.* (2007).

Effect of different crop establishment methods on economics of rice

Economic analysis of the treatments showed relevance to consider the practical adaptability of a particular treatment from the farmers' point of view (Jha *et al.* 2011).

Sanjay *et al*. (2006) stated that line transplanting recorded significantly higher gross income (Rs. 31,158 ha^{-1}) compared to drum seeding (Rs.30,829 ha^{-1}) and broadcasting method (Rs.22,032 ha^{-1}). Sharma *et al.* (2006 b) reported that the transplanting of rice by self propelled transplanter gave maximum net monetary return (Rs.44,559 ha^{-1}) and B:C ratio (1:47) which was at par with manual transplanting (Rs.42,035 ha^{-1}) and proved better than the other methods of rice establishment. The self propelled eight row transplanter gave a net profit of Rs.1146 and Rs.1319 per ha when annual use of machine was 300 h (one season) and 500 h (two seasons), respectively over the manual transplanting (Chaudhary *et al.* 2005). Economic analysis of data showed that drum seeding of rice under puddled condition (24.52 x 10^3 Rs. /ha and 1.76) was more effective than wet seeding i.e. broadcasting of

sprouted seeds under puddled condition (22.40 x 10^3 Rs./ha and 1.63) and dry seeding (18.91 x 10^3 Rs./ha and 1.32) of rice in realizing higher net returns and benefit: cost ratio owing to more grain yield (Singh and Singh, 2010).

The drum seeding of sprouted seed in puddled condition gave higher net monetary returns and maximum benefit: cost ratio (Rs.47 373ha^{-1} and 3.2:1) followed by mechanical transplanting by self propelled transplanter (Rs.44 325 ha^{-1} and 3.1:1).This was ascribed to higher grain yield and minimum cost of production. However, manually transplanted rice fetched the minimum net monetary returns (Rs.41 364 ha^{-1}) and the lowest benefit: cost ratio (2.1:1) mainly due to higher cost of cultivation involved with it primarily for the employment of huge manpower (Jha *et al.* 2007). Among the different sowing methods, the highest gross monetary returns was observed in mechanical transplanting (Rs. 68 772 ha^{-1}) that was statistically similar to drum seeding of sprouted seed in puddled condition (Rs.68 703 ha^{-1}) followed by manually transplanted rice (Rs. 64 563 ha^{-1}) (Jha *et al.* 2011). Benefit cost ratio of mechanical transplanting and manually transplanting was 2.38:1 and 1.77:1, respectively, therefore mechanical transplanted rice gave higher B:C ratio of 34.46 per cent as compared to hand transplanted rice (Mohanty and Barik, 2010). In Bangladesh, Rana *et al.* (2014) while analyzing the economical data reported that the highest net return (23362.00 BDT ha^{-1}) and cost benefit ratio (1:1.49) was noted in direct seeding of sprouted seeds that may be due to high yield and labour charges beared for seedling raising and transplanting in the field, which was followed by direct seeding of dry seeds which recorded (13814.00 BDT ha^{-1} and 1:1.30) and transplanting method, (8139.00 BDT ha^{-1} and 1:1.14) net return and cost benefit ratio, respectively. However, the highest gross return was also observed in direct seeding of sprouted seeds (71056 BDT ha^{-1}) followed by transplanting method (67433 BDT ha^{-1}) and direct seeding of dry seeds (60608.00 BDT ha^{-1}) (Rana *et al.* 2014). The cost of cultivation for mechanically transplanted rice through SPT was (Rs. 21,252 ha^{-1}) and gave maximum benefit: cost ratio (2.86), net income (Rs.39,491 ha^{-1}), and gross return (Rs.60,743 ha^{-1}), hence proved more remunerative than other methods of crop establishment. This was ascribed to higher grain yield and minimum cost of production under SPT. The next best treatment with cost of cultivation (Rs. 23,483 ha^{-1}) was hand transplanted rice in terms of benefit: cost ratio (2.58), and was on par in respect to net income (Rs.37,108 ha^{-1}) and gross return (Rs. 60,591 ha^{-1}) with mechanical transplanting. However, minimum benefit: cost ratio (2.51), net income (Rs.31,990 ha^{-1}), and gross return (Rs.53,182 ha^{-1}) was observed in direct seeding of sprouted seeds by drum seeder with Rs. 21,192 ha^{-1} cost of cultivation (Bohra and Kumar, 2015). These results are in close conformity with the findings of Singh *et al.* (2005 b) and Bohra *et al*. (2006).

Conclusion

On comparing the efficacy of different rice establishment methods on soil health, weed dynamics and economics,it was found that transplanted rice showed better results due to optimum spacing and judicial utilization of inputs by the crops, however, among direct seeding methods, rice established through drum seeding, where inter spacing is maintained, had an edge over broadcasting of sprouted or dry seeds and was at par with conventional and mechanically established rice. This technique aids in reducing labour needs, investments on inputs, avoids drudgery, saves time by escaping the nursery operation resulting in timely sowing of crop and achieving desirable yield. The crop is also harvested 8-10 days earlier than transplanted rice. Therefore, transplanting can be replaced by direct seeding under puddled condition where water and labour scarcity exists.

References

1. Anbumani S, Chandrasekharan B, Kuppuswamy G. Evaluation of establishment methods and NPK levels in rice and their impact on succeeding crops. Agri. Sci. Digest. 2004; 24(3):190-193.
2. Bohra JS, Verma KR, Singh RP, Singh JP, Singh Y. Crop establishment options in rice *(Oryza sativa*)-wheat (*Triticum aestivum*) system under irrigated conditions of Varanasi. (In) National Symposium on Conservation Agriculture and Environment, 26-28 October, 2006, Indian Society of Agronomy, BHU, Varanasi, India. 2006, 48-49.
3. Bohra JS, Kumar Rakesh. Effect of crop establishment methods on productivity, profitability and energetics of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) system. Indian Journal of Agricultural Sciences. 2015; 85(2):217-23.
4. Chander S, Pandey J. Nutrient removal by scented basmati rice (*Oryza sativa*) and associated weeds as affected by nitrogen and herbicides under different rice cultures. Indian Journal of Agronomy. 1997; 42(2):256-260.
5. Chander S, Pandey. Effect of rice culture, nitrogen and weed control on nitrogen competition between scented rice and weeds. Indian Journal of Agronomy. 2001; 46(1): 68-74.
6. Chaudhary VP, Varshney BP, Kalra MS. Self propelled rice transplanter – A better alternative than manual transplanting. Agricul Engin Today 2005; 29(5-6):32-37.
7. De Datta SK. Technology development and the spread of direct-seeded flooded rice in South-East Asia. Exp. Agri. 1986; 22:417-26.
8. Gangwar KS, Chaudhary VP, Gangwar B, Pandey DK. Effect of crop establishment and tillage practices in rice (*Oryza sativa*)-based cropping systems. Indian Journal of Agricultural Sciences. 2009; 79(5):334-9.
9. Gangwar KS, Tomar OK, Pandey DK. Productivity and economics of transplanted and direct-seeded rice (*Oryza sativa*) – based cropping systems in Indo-Gangetic plains. Indian Journal of Agricultural Sciences. 2008; 78(8):655-8.
10. Jaiswal VP, Singh GR. Effect of planting methods, source and level of nitrogen on the growth and yield of rice *(Oryza sativa)* and on succeeding wheat *(Triticum aestivum).* Indian Journal of Agronomy. 2001; 46(1):5-11.
11. Jha AK, Kewat ML, Upadhyay VB, Vishwakarma SK. Effect of tillage and sowing methods on productivity, economics and energetic of rice (*oryza sativa* L.)- wheat *(Triticum aestivum)* cropping system. Indian Journal of Agronomy. 2011; 56(1):35-40.
12. Jha AK, Sharma RS, Vishwakarma SK. Development of resource conservation techniques for tillage and sowing management in rice-wheat cropping system under irrigated production system of Kymore Plateau and Satpura hill zone of Madhya Pradesh. JNKVV Research Journal. 2007; 41(1):26-31.
13. Kanthi M, Sandhya Ramana AV, Murthy KV. Ramana. Effect of different crop establishment techniques and nutrient doses on nutrient uptake and yield of rice (*Oryza*

sativa L.). Karnataka J Agric. Sci. 2014; 27(3):293-295
14. Mohanty DK, Barik KC. Comparitive performance of eight row self-propelled rice transplanter and manual transplanting ar farmer's field. Agricul Engin Today. 2010; 34(4):87-92.
15. Parameswari YS, Srinivas A. Influence of weed management practices on nutrient uptake and productivity of rice under different methods of crop establishment. Journal of Rice Research. 2014, 7(1&2).
16. Rana Md, Masud Mamun Md, Abdullah Al, Zahan Afruz Ahmed Md, Nayeem Mridha Md, Abdul Jalil. Effect of Planting Methods on the Yield and Yield Attributes of Short Duration Aman Rice. American Journal of Plant Sciences. 2014; 5:251-255.
17. Sanjay MT, Setty TK, Nanjappa HV. Enhancing productivity of rice under different crop establishment methods through weed management practices. Crop Research. 2006; 31(2):192-197.
18. Sharma RP, Raman KR, Jha RN, Chattopadhyaya Nb. Effect of crop establishment methods and tillage practices on crop productivity, profitability and soil health of rice – wheat cropping system. Journal Farming Systems Research and Development. 2006; 12(1&2):42-46.
19. Shashikumar G. Effect of age seedlings and nitrogen levels on growth and yield of rice varieties under late planting condition. M.Sc. (Ag) Thesis, ANGRAU, 1990.
20. Singh KK, Jat AS, Sharma SK. b. Improving productivity and profitability of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system through tillage and planting management. Indian Journal of Agricultural Sciences. 2005; 75(7):396-9.
21. Singh Mandhata, Singh RP. Influence of crop establishment methods and weed management practices on yield and economics of direct-seeded rice (*oryza sativa* L.). Indian Journal of Agronomy. 2010; 55(3):224-229.
22. Singh P, Singh P, Singh SS. c. Response of aromatic rice (Pusa Basumati 1) to establishment methods, fertility levels and weed management practices. Indian Journal of Weed Science. 2007; 39(1&2):32-35.
23. Singh SP, Sreedevi B, Kumar RM, Subbaiah SV. Grain yield and economics of wet direct sown rice under different establishment methods and nitrogen schedules. *Oryza*. 2008a; 41(3&4):120-124.
24. Singh VP, Singh G, Singh RK, Singh SP, Kumar A, Sharma G. et al. Effect of weed management and crop establishment methods on weed dynamics and grain yield of rice. Indian Jounal of Weed Science. 2006; 38(1&2):20-24.
25. Subbulakshmi S, Pandian BJ. Effect of water management practices and crop establishment techniques on weed growth and productivity of rice. Indian Journal of Weed Science. 2002; 34(3-4):275-277.
26. Subramanyam D, Raghava Reddy C, Srinivasulu Reddy. Influence of puddling intensity and water management practices on weed dynamics and yield of transplanted rice (Oryza sativa L.). Indian Journal of Agronomy. 2007; 52(3):225-330.
27. Talla Arunbabu, Jena Satya Nanda. Efficacy of different establishment methods and weed management practices on weed density, weed dry matter, weed control efficiency and yield under rainfed lowland rice. International Journal of Plant, Animal and Environmental Sciences. 2014; 4(3):188-191.
28. Yadav V, Singh B. Effect of crop establishment method and weed–management practice on rice (*Oryza sativa)* and associated weeds. Indian Journal of Agronomy. 2006; 51(4):301-303.