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Impact of various establishment methods on yield of rice under rainfed condition

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Abstract
The water crisis is threatening the sustainability of the irrigated rice system and food security in Asia. Our challenge is to develop novel technologies and production systems that allow rice production to be maintained or increased in the face of declining water availability. Water shortage is becoming severe in many rice-growing areas in the world, prompting the introduction of water-saving aerobic rice, which is direct-seeded in non-puddled, nonflooded aerobic soil, aerobic rice systems can reduce water use in rice production by as much as 50% 'Aerobic rice' and 'upland rice' are both grown under aerobic conditions. This paper introduces principles that govern technologies and systems for reducing water inputs and increasing productivity. We concluded that, Sanda technology mainly knows as double transplanting increases yield up to 8-10%.

Keywords: Rice, puddled, un-puddled, Sanda technology

Introduction
Food security depends on the ability to increase production with decreasing availability of water to grow crops. Rice, as a submerged crop, is a prime target for water conservation because it is the most widely grown of all crops under irrigation. To produce 1 kg of grain, farmers have to supply 2–3 times more water in rice fields than other cereals. In Asia, more than 80% of the developed freshwater resources are used for irrigation purposes; about half of which is used for rice production. Rapidly depleting water resources threaten the sustainability of the irrigated rice and hence the food security and livelihood of rice producers and consumers. In Asia, 17 million hectare (Mha) of irrigated rice areas may experience physical water scarcity and 22 Mha may have economic water scarcity by 2025. There is also much evidence that water scarcity already prevails in rice-growing areas, where rice farmers need technologies to cope with water shortage and ways must be sought to grow rice with lesser amount of available water. Traditional farming consists of technologies developed by farmers over decades of adjusting farming systems to local agro climatic and social conditions (Venkata Ramaiah and Rama Raju, 2004) [8]. Double step transplanting referred as kaiam is followed in Siddharth Nagar for establishment of crop of the traditional tall scented rice cultivar Kalanamak in rainfed lowland areas. Singh *et al.*, (2005) [6] enumerated potential benefits of the practice over normal transplanting as saving of seeds, staggered use of labor, protection from lodging, increased number of grains per panicle, larger panicles and about ten days of advanced maturity. Farmers practice a system of double transplanting of rice, locally known as Sanda to avoid crop failure from submergence. One-month old seedlings are transferred to another field with dense transplanting, and then re-transplanted to the main after the risk of flash flood is over. Scientists argue that the system would have lower yield and higher costs; This practice helps in producing healthy and taller seedlings that can easily overcome the adverse situation like high water depth at the time of transplanting (Rautaray, 2007; Ashim *et al.*, 2010) [4, 1]. In some flood-prone areas, farmers practice double transplanting (even triple transplanting) to produce taller seedlings for transplanting in standing water at the beginning of the season (India and Bangladesh) or to rejuvenate seedlings while waiting for the floodwater to recede to levels that can allow transplanting in the main field, proper management of seedlings in nurseries or after transplanting in the field (Ram *et al.*, 2010) [3]. It is also said that double transplanted rice produce more yield than normal transplanting with same aged seedlings (Ziagua, 2000; Satapathy, 2015) [9, 5].

Materials and Methods

Experiment were conducted during WS 2020-21 at Instructional farm, A.N.D.U.A&T, Kumarganj, Ayodhya, which is situated at 26.470N (latitude), 82.12 °E (longitude) and 113 m (altitude). The soil is sandy loam low in organic carbon. It is rich in potassium, medium in phosphorus and possesses good water holding capacity. The rice variety Sahbhagi dhan was used as test variety. The nursery of Sahbhagi dhan was sown in 4th week of May every year. After 25 days, seedlings from primary nursery were uprooted and closely transplanted (8cm × 8 cm) in bunches of 8 to 10 seedlings/hill in the secondary nursery for double transplanting. The seedlings from secondary and normal nursery were up rooted at age of 25 and 60 days, respectively, and transplanted in the field with one seedlings at a spacing of 15 cm × 15 cm in last week of July. The second time transplanted rice is cared for in the same manner of normal transplanting, in 3 replication in 20m2 plot size, variety specific agronomic practices were raise the crop. Recommended dose of fertilizer 120:60:60: 25 kg N: P: K: and ZnSO4/ha. Half of the dose of N and full dose of P: K and ZnSO4 were applied basal, while remaining N was top-dressed in 2 equal splits–at tillering and panicle initiation stage. Data were recorded at different crop-growth stages and statistically analyzed. The data recorded on days to 50% flowering, days to physiological maturity, number of tillers per meter^{-2}, number of panicles per meter^{-2}, total number of grains panicle^{-1}, number of fertile grains panicle^{-1}, number of sterile grains panicle^{-1}, total biomass per meter^{-2} (g), 100 seed weight, panicle length (cm), yield (qha^{-1}).

Results and Discussion

Data (table-1) revealed that 50% flowering and days to physiological maturity is more in M4 establishment method (73.66 days and 103.66 days) respectively as compare to others establishment methods. Yield and yield attributing parameters (table-2) *viz.* No. of tillers^{-m2} (325.5), No. of panicles^{-m2} (282.2), Panicle length (25.6cm), Test weight (22.52 gm) in M4 (Sanda technology) respectively, were recorded significantly superior with other establishment methods. However, as per yield production M4 produced (16.6%) more yield as compare to M1, M2 and M3 (-20.03%), (-9.20%) and (-5.50%) respectively. Maximum yield loss was observed in M1 (Dry/Wet DSR) as compare to sanda technology (M4) under rainfed condition.

Table 1: Effect of different transplanting methods on days to 50% flowering, days to physiological maturity of Shahbhagi Dhan

Establishment methods	Days to 50% flowering	Days to physiological maturity
M 1	74.66	102.00
M 2	70.66	101.66
M 3	71.00	99.00
M 4	73.66	103.66
S.Em±	0.68	0.76
CD at 5%	2.31	NS

***Note:** Establishment methods **(**M1: Dry/wet DSR, M2: Puddled transplanting, M3: Un-puddled transplanting, M4: Sanda cultivation (1st transplanting was done on 18.06.20 and 2nd transplanting was done on 10.07.20)

Table 2: Effect of different transplanting methods on number of tillers^{-m2}, number of panicles^{-m2}, panicle length (cm), total grains panicle^{-1}, number of fertile grain, number of sterile grain, total biomass^{-m2}(gm), test weight (gm) of Shahbhagi Dhan

Establishment methods	No. of tillers^{-m2}	No. of panicles^{-m2}	Panicle length	Total number of grains panicle^{-1}	No. of fertile grain	No. of sterile grain	Total biomass^{-m2}	Test weight	Yield (q/ha)
M 1	300.4	247.2	22.5	141.6	82.6	59.00	372.7	20.77	19.47
M 2	309.4	265.7	24.8	152.3	92.8	59.50	425.8	21.27	21.40
M 3	310.2	270.2	24.9	160.6	85.8	80.20	425.4	22.09	22.15
M 4	325.5	282.2	25.6	178.3	103.00	75.30	426.3	22.52	23.37
S.Em±	2.25	2.63	0.75	2.05	1.95	2.01	1.74	0.33	1.65
CD at 5%	7.90	8.97	2.60	6.96	6.70	6.96	6.02	2.6	5.59

***Note:** Establishment methods **(**M1: Dry/wet DSR, M2: Puddled transplanting, M3: Un- puddled transplanting, M4: Sanda cultivation (1st transplanting was done on 18.06.20 and 2nd transplanting was done on 10.07.20)

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