<u>***Original Research Article***</u>

Maximization of productivity and water saving through Alternate Wetting and Drying Irrigation (AWDI) in Rice under TN IAMP Aliyar sub basin farmers of Tamil Nadu

ABSTRACT

TN IAMP-II Aliyar sub basin scheme operated by Agricultural College and Research Institute (TNAU), Vazhavachanur, Tiruvannamalai, Tamil Nadu state has conducted large scale front line demonstrations on alternate wetting and drying (AWD) practice in transplanted paddy growing in 11 villages of Tiruvannamalai district at 100 farmer's holdings during *kharif* season of 2019-20 and 2020-21. The data on productivity, economics and water saving in demonstrated plots were compared with farmer's practice (Continuous flooding method). The demonstrated plots was 24.3 per cent higher grain yield than farmer's practices. The extension gap, technology gap and technology index were 12.6 q ha^{-1}, 5.8 q ha^{-1} and 8.29 per cent, respectively. The higher gross return (Rs. 1,28,443 ha^{-1}), higher net return (Rs. 74,319 ha^{-1}) and B:C (2.38) was observed in demonstrated plot as compared to farmers practice of continuous flooding. Higher yield and returns due to reduced cost of cultivation, higher grain yield, higher net returns and higher water saving (24.7%) in the demo plot over the farmer's practice created greater awareness and motivated the other farmers to adopt AWD practices in TN IAMP Phase II Aliyar sub basin farmers of Tiruvannamalai district.

Key words: TNIAMP, Paddy, Field Water Tube, Water Saving, Economics

INTRODUCTION

Rice (*Oryza sativa* L.) is a major staple crop with more than 50 kg of rice being consumed per capita per year worldwide (FAOSTAT, 2016). Globally, over 478 million tons of milled rice was produced in 2014-15 of which over 90% was used directly for human consumption (USDA, 2016). India is producing 22.1 per cent of it (105 million tonnes of rice), in an area of 44 million hectares (Anon, 2020). Water resources, both surface and underground are shrinking and water has become a limiting factor in rice production (Farooq *et al*., 2009). Estimate by IRRI, Philippines, 2009 says that being one of the least water use efficient crop, rice needs about 5000 liters of water for producing 1 kg of unmilled rice. The traditional water management *viz*., continuous flooding system makes the production of rice as a less efficient in water use. Considerable quantity of water savings with higher paddy yields by following alternate wetting and drying method of irrigation leads to average 35 per cent reduction in irrigation water consumption per hectare (Jagannath *et al*., 2013), While rice is essential for ensuring global food security, traditional rice cultivation, practiced in flooded paddy soils, demands higher water inputs than other cereal crops (Pimentel *et al*., 2004). With the increasing threat of water scarcity currently affecting 4 billion people around the globe (Mekonnen and Hoekstra, 2016), it is crucial to develop agronomic practices with the potential to reduce water use while maintaining or increasing yields to support a growing population. One practice that has been shown to reduce water use in rice systems is an irrigation management practice referred to as Alternate Wetting and Drying (AWD) (Linquist *et al*., 2014; Lampayan *et al*., 2015). Under AWD, fields are subjected to intermittent flooding (alternate cycles of saturated and unsaturated conditions) where irrigation is interrupted and water is allowed to subside until the soil reaches a certain moisture level, after which the field is reflooded. AWD has been reported to reduce water inputs by 23% (Bouman and Tuong, 2001) compared to continuously flooded rice systems. Recent estimates indicate that there would be acute water shortage in the coming decades. Here is a need to develop an alternative system of rice cultivation to save the water and other inputs. Alternate Wetting and Drying (AWD) is a water saving technology that farmers can apply to reduce their irrigation water consumption in rice fields without decreasing its yield. It is an irrigation practice of introduction of unsaturated soil conditions during the growing period that can reduce water inputs in rice without compromising yields. Tuong (2007) recorded the successful usage of field water tube in AWD management regime to monitor the water depth and capable to indicate the right time of irrigation and saved water, without any yield penalty and using of field water tube in AWD was safe to limit the water use to 25 per cent was reported by Suresh Kulkarni, 2011.

In Tiruvannamalai district, more than 40,000 hectares of land is under paddy cultivation during kharif season. Major problem identified were indiscriminately use of irrigation water to the paddy crop by continues flooding and farmers were lack of awareness about Alternate Wetting and Drying (AWD) through Pani Pipe. By considering the above present demonstration was carried out to create awareness to transplanted paddy farmers of Tamil Nadu Irrigated Agriculture Modernization Project Phase-II, Aliyar sub basin of Tiruvannamalai district about judicious use of irrigation water by using Pani Pipe. A climate-smart practice that presents both mitigation and adaptation benefits is critical to addressing climate change in rice production.

MATERIALS AND METHODS

Tamil Nadu Irrigated Agriculture Modernization Project (TNIAMP) Phase-II, Aliyar sub basin by Agricultural College and Research Institute, Vazhavachanur, Tiruvannamalai was conducted large scale frontline demonstrations in irrigated lowlands and followed alternate wetting and drying (AWD) practices by using field water tube for two consecutive years during *kharif* seasons of 2019-20 and 2020-21 at farmer's fields of Agarampallipattu, Thenmudiyanur, Radhapuram, Sathanur, Nedungavadi, Kanakkandal, Veeranam villages of Thandrampet block and Vinnavanur, Kannagurukai, Uchimalaikuppam villages of Chengam block of Tiruvannamalai district. There were two treatments T1: Farmers practice (Continues ponding of water at 5 cm depth) and T2: AWD (irrigation water was applied when water level has dropped to about 5 cm below the surface of the soil). A practical way to implement AWD safely is by using a 'field water tube' ('pani pipe') to monitor the water depth on the field. After irrigation, the water depth will gradually decrease. When the water level has dropped to about 5 cm below the surface of the soil, irrigation was applied to re-flood the field to a depth of about 5 cm. From one week after transplanting to week before flowering and during flowering the field was kept flooded, topping up to a depth of 5 cm as needed. After flowering, during grain filling and ripening, the water level was allowed to drop again to 5 cm below the soil surface before re-irrigation.

A field tube in flooded field: The field water tube was made of 30 cm long plastic pipe, having a diameter of 10"15 cm so that the water table is easily visible, and it is easy to remove soil inside. Perforate the tube with many holes at 2 cm distance on all sides, so that water can flow readily in and out of the tube. The tube was hammered into the soil so that 15 cm protrudes above the soil surface. The soil from inside the tube was removed so that the bottom of the tube is visible. AWD was started a few weeks (1"2 weeks) after transplanting. When many weeds are present, AWD was postponed for 2"3 weeks to assist suppression of the weeds by the ponded water and improve the efficacy of herbicide. Fertilizer recommendations as for flooded rice was followed. N was applied on the dry soil just before irrigation. All the package of practices was followed as per Tamil Nadu Agricultural University recommendations.

The large scale demonstration was conducted to study the technology gap between the potential yield and demonstrated yield, extension gap between demonstrated yield and yield under existing practice and technology index. The yield data were collected from both the demonstration and farmers practice by random crop cutting method. Qualitative data was converted into quantitative form and expressed in terms of per cent increase in yield. (Narasimha Rao *et al*., 2007). The data was further analyzed by using simple statistical tools. The technology gap, extension gap and technological index were calculated (Samui *et al*., 2000) as given below.

Technology gap = Potential yield - Demonstrated yield

Extension gap = Demonstrated yield - Yield under existing practice

Technology index = Potential yield - Demonstrated yield x 100

Potential yield

RESULTS AND DISCUSSIONS

Grain Yield

The supervision of the Agricultural College and Research Institute, Vazhavachanur, Tiruvannamalai TNIAMP Phase II Aliyar sub basin scientist crop yield was harvested accordingly. The grain yield from both the plots i.e., demonstration and farmers' practices were compared and it was evident that an average yield of demonstrated plots was 24.3 per cent higher than that of farmer's practices (Table 1). The grain yield under demonstrated plots were 64.5 and 63.9 q ha^{-1} with an average of 64.2 q ha^{-1} from the year 2019-20 and 2020-21, respectively. However, it was 51.8 and 51.5 q ha-1 with an average of 51.7 q ha^{-1} under farmer's practice. The reasons behind the increase of yield under demonstrated plots might be due to AWD improves the aeration in the root zone, their by more number of tillers per meter square and which ultimately increased the yield. The similar results were reported by Santheepan and Ramanathan, (2016).

Extension Gap

An extension gap between demonstrated technology and farmers practices was calculated and on an average basis, the extension gap of 12.6 q ha^{-1} was calculated (Table 2). This gap might be attributed to the adoption of alternate wetting and drying technology in demonstrated plots which resulted in higher grain yield than the farmer's practices. On the basis of the extension gap, the farmers were motivated to adopt the alternate wetting and drying technique to reduce the extension gap and to increase their grain yield. The similar results were reported by Raju *et al* (2012).

Technology Gap

The technology gap was calculated by deducting the demonstrated plot yield from the potential yield of the paddy crop. The recorded technology gap was 5.5 and 6.1 q ha^{-1} during 2019-20 and 2020-21, respectively. The average technology gap was found 5.8 q ha^{-1}. Higher technology index reflected the inadequate proven technology for transferring to farmers and insufficient extension services for transfer of technology.

Economic Analysis

The demonstrated technology was observed higher gross return (Rs. 128443 ha-1), higher net return (Rs. 74319 ha^{-1}) and higher benefit cost ratio (2.38) on overage of both the years as compared to farmers practices (Table 2). Higher net returns which might be due to proper management practices resulted in higher yield and which ultimately higher returns. The similar results were also reported by (Daniela *et al*., 2017)

Water Saving through AWD

The demonstrated technology was observed less number of irrigation (20.5) and average per cent of water saving (24.7%) to complete the life cycle of paddy as compared to farmer's practices.

Farmer's feedback

Less number of irrigations was given and hence water was saved by AWD through Pani Pipe technology will increase the production area. More number of tillers were produced which leads to higher yield, less pest and disease incidence were occurred due to AWD practice. Pani Pipe will be easily manufactured by farmers themselves, simple method to follow. It reduce the cost per acre

CONCLUSION

Alternate wetting and drying is a promising management practice through pani pipe with respect to judicious application of irrigation water, increases the paddy yield to the tune of 24.3 per cent and besides higher water saving per cent (24.7).

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Table1. Productivity, Extension gap, Technology gap and Technology index of paddy as grown under large scale AWDI demonstration and existing package of practices.

Year	Area (ha)	No. of farmer's	Potential yield (q ha^{-1})	Average Yield (q ha^{-1})		% increase over FP	Extension gap (q ha^{-1})	Technology gap (q ha^{-1})	Technology index (%)
				AWDI	FP				
2019-20	40	40	70.0	64.5	51.8	24.5	12.7	5.5	7.86
2020-21	60	60	70.0	63.9	51.5	24.0	12.4	6.1	8.71
Total/Mean	**100**	**100**	**70.0**	**64.2**	**51.7**	**24.3**	**12.6**	**5.80**	**8.29**

Table 2. Economic analysis of Alternate Wetting and Drying Irrigation (AWDI) and farmer practices of paddy as grown under large scale cluster demonstration under TN IAMP-II Aliyar sub basin of Tiruvannamalai District

Year	Cost of cultivation (Rs./ha)		Gross Return (Rs./ha)		Net Return (Rs./ha)		Benefit Cost Ratio		No. of Irrigation (No.)		Irrigation water saved (%)
	AWDI	FP	AWDI	FP	AWDI	FP	AWDI	FP	AWDI	FP	
2019-20	54078	52274	129001	103771	74923	51497	2.39	1.98	21	25	20.0
2020-21	54171	52285	127885	103116	73714	50831	2.36	1.97	20	26	29.4
Average	**54125**	**52280**	**128443**	**103444**	**74319**	**51164**	**2.38**	**1.98**	**20.5**	**25.5**	**24.7**