E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
www.agronomyjournals.com
2024; SP-7(6): 506-509
Received: 28-04-2024
Accepted: 30-05-2024

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Alternate wetting and drying (AWD) a promising water saving technology in rice production system for farmers of Telangana, India

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i6Sg.935

Abstract
Farmers can employ the water-saving technique known as alternate wetting and drying (AWD) to reduce the irrigation water used in rice fields while maintaining crop yields. This irrigation method decreases water usage in rice cultivation by allowing periods of unsaturated soil during the growing season without compromising productivity. During the Kharif seasons of 2018 and 2019, 15 frontline demonstrations were conducted on farmers' fields. This advanced technique resulted in grain yields averaging 4.5% higher (6031 kg/ha) compared to traditional methods (5772 kg/ha). It also led to increased net returns (Rs. 55,552/-) and gross returns (Rs. 102,819/-). Using the AWD method, a B:C ratio of 2.2 was achieved, saving Rs. 1,900/- per hectare compared to traditional practices (GR: 98,585/-, NR: 49,437/-, B:C 1.9).

Keywords: Alternate wetting and drying, water saving technology, rice production system, farmers

Introduction

Food security is increasingly becoming a critical concern as natural resources, such as land and water, are depleting while global food consumption rises due to population growth (Li, H., and Li, M., 2010; Lampayan *et al*., 2015a) [7, 5]. Recent projections indicate severe water shortages in the coming decades. To conserve water and other inputs, an alternative rice cultivation system must be developed. By allowing periods of non-submerged conditions for several days during the growth season, water inputs can be minimized, and water productivity increased unless fissures appear through the plough sole (Belder *et al*., 2004) [9]. Farmers can adopt the water-saving technique known as Alternate Wetting and Drying (AWD) to reduce irrigation water use in rice fields without compromising yields (Lampayan *et al*., 2015b) [6]. This method lowers water usage in rice cultivation by introducing unsaturated soil conditions during the growth season. According to Suresh Kulkarni (2011) [2], using a field water tube in AWD is safe if water use is limited to 25%. Tuong (2007) [3] documented the successful use of field water tubes in AWD management to monitor water depth, indicate the optimal time for irrigation, and save water without affecting yields. The aim of the current front-line demonstrations was to highlight the benefits of the AWD technique in rice production to farmers in the Rangareddy, Vikarabad, and Medchal districts of Telangana State, India. Addressing climate change in rice production requires a climate-smart strategy that provides advantages for both adaptation and mitigation.

Methodology

The demonstrations on farmers' fields were conducted in irrigated lowlands and adhered to alternate wetting and drying (AWD) procedures using a field water tube during the Kharif seasons of 2018 and 2019. Two treatments were tested: T1 (AWD - irrigation was applied when the water level dropped to about 5 cm below the soil surface) and T2 (Farmer's practice - continuous ponding of water at a 5 cm depth). A hands-on method to implement AWD safely involves using a 'field water tube' ('pani pipe') to monitor the water depth in the field. After irrigation, the water depth gradually decreases. Irrigation was used to replenish the field with water when it decreased to a depth of around 5 cm below the soil's surface. The field was kept flooded for one week following transplanting, one week prior to blooming and one week during flowering, with additional water added as needed to reach a depth of 5 cm. Prior to re-irrigation, the water level was once again allowed to fall to 5 cm below the soil's surface throughout the grain filling and ripening stages after blooming.

A field tube in a flooded field: The field water tube was constructed from a 30-cm-long plastic pipe with a 7–10 cm diameter. This allowed for easy dirt removal inside the tube and allowed for easy visibility of the water table. Water could easily enter and exit the tube since it was perforated on all sides with many holes spaced two centimetres apart. Ten centimetres of the tube were exposed above the soil's surface after it was driven into the ground. The bottom of the tube was exposed by clearing away the dirt within. AWD was started one or two weeks following transplantation. The flooded rice fertiliser recommendations were adhered to, with nitrogen being supplied to dry soil just before to irrigation. Every procedure followed the guidelines set forth by the PJTSAU.

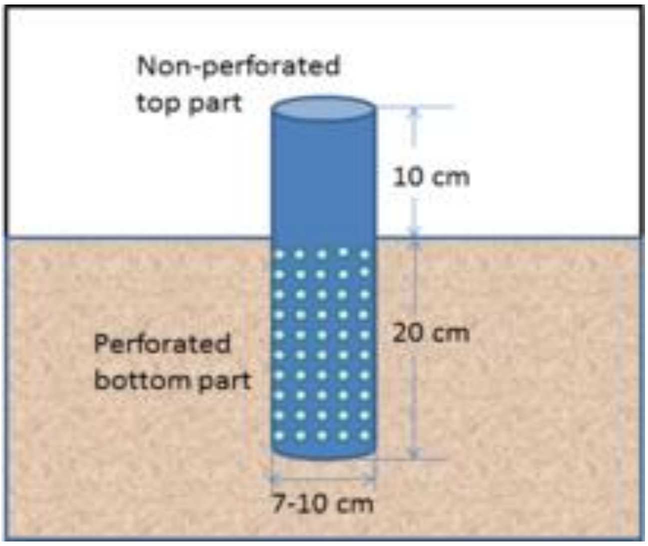

Fig 1: AWD pipe hammered in the field

Results and Discussions

Based on the frontline demonstrations conducted during Kharif 2018 and 2019, it was observed that this improved technology resulted in an average grain yield that was 4.5% higher (6031 kg/ha) compared to farmers' traditional practices (5772 kg/ha). The AWD practice also recorded higher gross returns (Rs. 102,819/-), net returns (Rs. 55,552/-), and a B: C ratio (2.2), with a cost saving of Rs. 1,900/- per hectare. In comparison, the traditional practices resulted in gross returns of Rs. 98,585/-, net returns of Rs. 49,437/-, and a B: C ratio of 2.0. The superior performance of AWD over traditional practices can be attributed to several factors: AWD increases the proportion of productive tillers, reduces the angle of the uppermost leaves (thereby allowing more light to penetrate the canopy), and modifies shoot and root activity, including altered root-to-shoot signaling of phytohormones such as Abscisic Acid and cytokinins (Yang and Zhang, 2009) [4]. Additionally, the remobilization of carbohydrates from stems to grains is another crucial mechanism for improving grain filling under AWD treatments. Avil Kumar *et al*. (2006) [1] recorded that grain and straw yield were significantly influenced by different irrigation schedules on red sandy loam soils. The AWD method of irrigation reduced both irrigation costs and overall production costs while yielding higher gross returns and margins compared to conventional practices, as reported by Rahman (2016) [8].

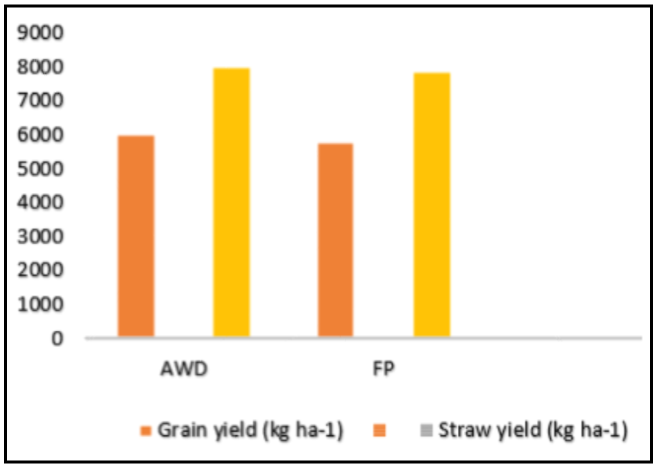

Fig 2: Grain and straw yield of rice as influenced by AWD and FP

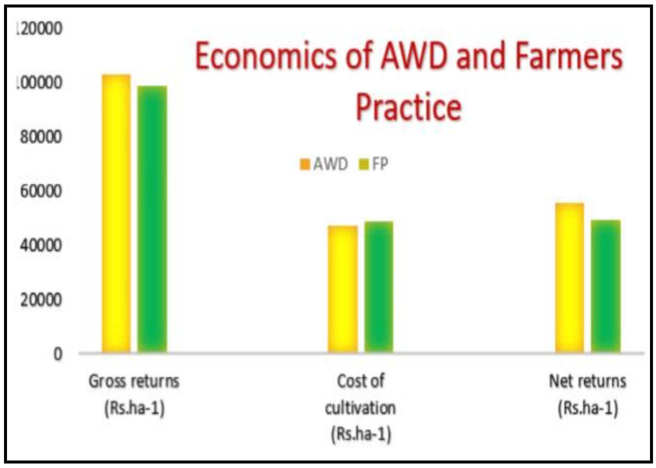

Fig 3: Economics of rice as influenced by AWD and FP

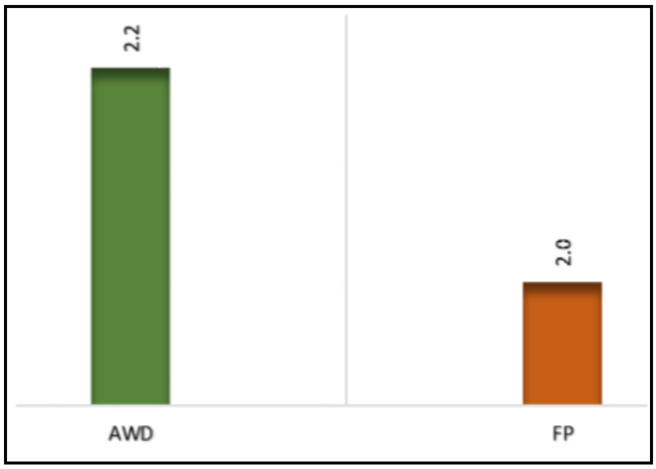

Fig 4: Economics of rice as influenced by AWD and FP

a. Inserting Field water Tube, b. Measuring water level in the tube, c. Field day celebration d. Crop at grain filling

Fig 5: A farmers' field in the Rangareddy area of Telangana, India, serves as a front-line demonstration of Alternate Wetting and Drying (AWD) in rice

Table 1: Farmer wise grain and straw yield of rice and economics as influenced by AWD and FP during *kharif* 2018

S. No.	Yield & Economics	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Gross returns (Rs. ha^{-1})		Cost of Cultivation (Rs. ha^{-1})		Net returns (Rs. ha^{-1})		B: C ratio	
	Farmer's name	AWD	FP	AWD	FP	AWD	FP	AWD	FP	AWD	FP	AWD	FP
1	Srideep Reddy	7125	6687	7261	7867	121125	113679	49525	51620	71600	62059	2.45	2.20
2	Srinivas Reddy	6825	6488	8267	8564	116025	110288	47850	49385	68175	60903	2.42	2.23
3	Ragupathy Reddy	7225	6813	8742	8993	122825	115813	43900	45615	78925	70198	2.80	2.54
4	Ravi Reddy	5638	5250	7554	7088	95838	89250	48250	50150	47588	39100	1.99	1.78
5	K. Narsimulu	5188	4832	7366	6958	88188	82144	47525	48950	40663	33194	1.86	1.68
6	S.K. Khan	6713	6234	9532	8977	114113	105978	46060	47870	68053	58108	2.48	2.21
7	M. Jangaiag	6813	6542	8584	7392	115813	111214	48525	50350	67288	60864	2.39	2.21
8	D. Anjaiah	5634	5231	8073	8167	95778	88927	48650	50125	47128	38802	1.97	1.77
9	D. Ramulu	5874	5512	7942	7276	99858	93704	46900	48180	52958	45524	2.13	1.94
10	P. Praveen	5540	5320	6703	7022	94180	90440	48250	50780	45930	39660	1.95	1.78
11	Indala Bal Reddy	5900	5534	7906	7471	100300	94078	45675	47350	54625	46728	2.20	1.99
12	K. Pentaiah	6163	5663	8751	8154	104763	96263	47850	49250	56913	47013	2.19	1.95
13	B. Laxmaiah	5400	5088	7908	7918	91800	86488	46925	48220	44875	38268	1.96	1.79
14	T. Venkat Ramireddy	7188	6613	10299	10324	122188	112413	48325	49856	73863	62557	2.53	2.25
15	Ch. Bal Reddy	6088	5732	7361	7008	103488	97444	47425	48885	56063	48559	2.18	1.99
	Average	6221	5836	8150	7945	105752	99208	47442	49106	58310	50102	2.2	2.0

Note:	PJTSAU: Professor Jayashankar State Agriculture University AWD: alternate wettng and drying FP: Farmers Practice	NR: Net Returns B:C ration Benefit cost ratio GR: Gross Returns

Table 2: Farmer wise grain and straw yield of rice and economics as influenced by AWD and FP during *kharif* 2019

Yield & Economics		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Gross returns (Rs. ha^{-1})		Cost of Cultivation (Rs. ha^{-1})		Net returns (Rs. ha^{-1})		B: C ratio	
S. No.	**Farmer's name**	**AWD**	**FP**	**AWD**	**FP**	**AWD**	**FP**	**AWD**	**FP**	**AWD**	**FP**	**AWD**	**FP**
1	Anjaiah	6160	6035	8236	8345	109155	106940	44875	47275	64280	59665	2.43	2.26
2	B. Srideep Reddy	5742	5634	7845	7725	101748	99834	47125	49125	54623	50709	2.16	2.03
3	M. Ravindhar Reddy	5680	5400	7748	7605	100650	95688	45575	47775	55075	47913	2.21	2.10
4	M. Venkat Reddy	5435	5380	7582	7536	109155	95334	49700	52000	59455	43334	2.2	1.83
5	Rajendhar Reddy	5532	5465	7685	7532	97916	96731	47650	49650	50266	47081	2.05	1.95
6	Madhusudhan Reddy	6240	5950	8532	8354	93600	89250	48300	50300	45300	38950	1.94	1.77
7	K. Venkat Reddy	5832	5780	7855	7736	87480	102306	45875	47875	41605	54431	1.91	2.14
8	K. Linga Reddy	5736	5642	7834	7745	101527	99976	48640	50800	52887	49176	2.09	1.97
9	K. Rama Krishna	5795	5661	7536	7732	86919	84911	46130	48200	52936	48907	2.12	1.99
10	K. Raghavendra	6255	6132	7873	7812	110714	108659	45500	47700	51519	47563	2.08	1.96
11	B. Pullaiah	6552	6435	8236	8146	104176.8	102317	40125	41115	64051	61202	2.60	2.49
12	P. Rangaiah	6650	6650	8536	8642	105735	105735	42525	43750	63210	61985	2.49	2.42
13	M. Thariya	6245	6126	8574	8542	99296	97403	48305	50300	50990	47103	2.06	1.94
14	S. Gopal	4500	4250	6100	5845	71550	67575	42054	43100	29496	24475	1.70	1.57
15	Rambabu	6542	6432	8126	8234	104018	102269	38245	39700	65772	62569	2.72	2.58
	Average	5840.7	5707.9	7872.6	7812.2	99886.4	97962.9	46937	49070	52794.6	48772.9	2.11	1.99

Table 3: Year wise yield & economics of rice as influenced by AWD and FP

	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Gross returns (Rs. ha^{-1})		Cost of cultivation (Rs. ha^{-1})		Net returns (Rs. ha^{-1})		B: C ratio	
	AWD	**FP**	**AWD**	**FP**	**AWD**	**FP**	**AWD**	**FP**	**AWD**	**FP**	**AWD**	**FP**
2018	6221	5836	8150	7945	105752	99208	47442	49106	58310	50102	2.2	2
2019	5840	5707	7872	7812	99886	97962	46937	49070	52794	48772	2.11	1.99
Average	6030	5771	8011	7878	102819	98585	47189	49088	55552	49437	2.15	1.99

Conclusion

Alternate Wetting and Drying (AWD) irrigation, as demonstrated during Kharif 2018 and 2019, resulted in a 4.5% higher average grain yield (6031 kg/ha) compared to traditional practices (5772 kg/ha). AWD also delivered superior economic outcomes with higher gross returns, net returns, and a favorable cost-saving per hectare. This success is attributed to its ability to enhance productive tillers, optimize light penetration, and modify plant physiology, thereby offering a sustainable approach to improve agricultural productivity and profitability.

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