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Short Note

Spatial and Temporal Variations in Water Productivity of Rice in Tamil Nadu

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A study was conducted towards assessing the impact of seasonal and agro-climatological variations on water productivity of rice in Tamil Nadu. The average rice yields in response to seasonal evapotranspiration in various districts of Tamil Nadu were used as the input data. Over the entire state kuruvai (June 12th to September 27th) season registered the highest average water productivity at the rate of 0.48 kg/m^3 evapotranspiration, followed by *navarai* (December 22nd to April 21st) at the rate of 0.44 kg/m^3 and Samba (August 10th to December 23rd) at the rate of 0.41 kg/m^3. Erode district recorded maximum rice water productivity at the rate of 0.65 kg/m^3 followed by Salem at the rate of 0.54 kg/m^3 and Namakkal at the rate of 0.53 kg/m^3. In seven distinct agro climatic zones of Tamil Nadu, the North Western Zone has registered higher levels of rice water productivity in the range of 0.52 to 0.62 kg/m^3.

Key words: Rice, Water Productivity, Season and Agro-climatic zone

The agricultural water productivity of any region gets inflicted when the available quantum of water in that particular region needs to be shared for other usages like industrial and domestic. However, viable strategies shall have to be worked out for sustaining the crop water productivity level even as other competitive water usage domains continue to draw water from the available resources. Rice farming remains the gross consumer of water compared to any other crop farming or industrial or domestic usages. It has been reckoned that a minimum of 1000 mm of water needs to be consumed by a rice farming territory over its growing season, for an average farmstead yield of 5 tonnes/ha as prevailing in Tamil Nadu State. The potential maximum rice production at global level has been established as 12 tonnes/ha (with the reference of dominant rice producing countries like China, Japan and Thailand). In general, farmers prepare rice farming followed by banana, sugarcane or any other lucrative plantation crops when water supply is assured. Even as scientific advancements in agriculture have culminated into a lot of paradigm shifts in multi-various fields of application such as water management, nutrient management, plant protection, value addition and precision farming, motivating the farmers on scientific water management, is still not fully achieved.

In order to take stock of where we stand in our rice productivity levels compared to other countries / locations, a comprehensive physical quantification of rice water productivity both with reference to spatial and temporal parameters is a sine quo non. With this objective, the study was taken up to workout the rice water productivity level in accordance with the seven predominant agro-climatological regions of state and three distinct seasons of rice production during 2003-04.

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Materials and Methods

As a part of the ongoing research project at Centre for Agricultural and Rural Development Studies (CARDS), Tamil Nadu Agricultural University, Coimbatore this study was undertaken to work out the rice water productivity as influenced by seasonal and agro-climatic regional variations in Tamil Nadu. The primary data required for physical quantification of rice water productivity are

1. District wise and season wise average rice yields,
2. District wise daily mean evaporation data.

The rice water productivity has been physically quantified in kg per hectare per m^3 of water consumed (Seckler *et al.* 1998). In simple mathematical terms,

$$WP = \frac{Y}{Cu}$$

Where,

WP is Water productivity

Y is the average yield (in kg for particular district)

Cu is the consumptive use of rice obtained by conversion from the evaporation data (ET0) available as,

Cu = ET0 X Kc

Where, Kc is crop coefficient, Kc = 1.05 for early stage, 1.20 for mid stage and 0.75 for late stage. (FAO, 2005)

The data related to State average yield of rice was picked up from season and crop reports, 2004 Government of Tamil Nadu. The evaporation data was taken from the local meteorological observatories of individual districts. In as much as the district wise rice area consumptive use was worked out from the daily mean values of evaporation. In case of defining the seasons for this study the information was taken from season crop reports and three distinct equivalent seasons viz., *kuruvai* (June 12th to September 27th), *samba* (August 10th to December 23rd) and *navarai* (December 22nd to April 21st) were used for the study.

Results and Discussion

Rice water productivity is chiefly a function of the net quantum of water consumed per unit area over the entire season. The agro-climatology of rice farming belt is a complementary factor in altering the rice yields even if the same quantum of water is applied irrespective of the agro-climatic position of the rice belt. The present study was tailored to suit the spatial variations of water productivity in accordance with the agro-climatological position of the rice belt and temporal variations in line with the predominant rice growing seasons in Tamil Nadu.

Table 1. Spatial and temporal variations in water productivity of rice in Tamil Nadu

Name of District	Water Productivity (kg/m^3 crop evapotranspiration)			
	Kuruvai	Samba	Navarai	Mean
Kancheepuram	0.44	0.51	0.39	0.44
Thiruvallur	0.48	0.37	0.41	0.42
Cuddalore	0.51	0.49	0.54	0.51
Villupuram	0.44	0.51	0.61	0.52
Vellore	0.43	0.55	0.49	0.49
Thiruvannamalai	0.35	0.45	0.40	0.40
Salem	0.62	0.51	0.49	0.54
Namakkal	0.63	0.54	0.43	0.53
Dharmapuri	0.50	0.42	0.32	0.41
Coimbatore	0.57	0.49	0.43	0.50
Erode	0.67	0.70	0.60	0.65
Tiruchirapalli	0.51	0.42	0.35	0.43
Karur	0.43	0.38	0.41	0.41
Perambalur	0.37	0.35	0.33	0.35
Pudukottai	0.42	0.27	0.40	0.36
Thanjavur	0.47	0.41	0.41	0.43
Thiruvarur	0.36	0.20	0.40	0.32
Nagapattinam	0.39	0.26	0.41	0.35
Madurai	0.36	0.40	0.39	0.38
Theni	0.49	0.58	0.45	0.51
Dindigul	0.39	0.42	0.41	0.41
Ramanathapuram	0.00	0.03	0.00	0.03
Virudhunagar	0.00	0.26	0.41	0.34
Sivagangai	0.00	0.10	0.00	0.10
Tirunelveli	0.41	0.48	0.41	0.43
Thoothukudi	0.41	0.50	0.65	0.52
The Nilgiris	0.77	0.00	0.00	0.77
Kanyakumari	0.47	0.58	0.00	0.52
State	0.48	0.41	0.44	0.44

Spatial variations in rice water productivity

Variations in the seasonal water productivity of rice in various districts of Tamil Nadu falling within the seven defined agro-climatological regions are furnished in Tables 1 and 2. Among the various districts where rice is being predominantly produced in three seasons, Erode district recorded the maximum water productivity of rice (0.65 kg of rice/m^3), followed by Salem (0.54 kg of rice/m^3) and Namakkal (0.53 kg of rice/m^3) districts. Villupuram, Thoothukudi and Kanyakumari districts had the water productivity of 0.52 kg of rice/m^3. The Nilgris district showed higher water productivity during *kuruvai* season due to less crop evapotranspiration, but the rice area is much less in the district. The predominant rice growing districts, Thiruvarur and Nagapattinam have registered the minimum water productivity.

A clear variation in water productivity of rice was noticed under different agro-climatic regions of Tamil Nadu. High altitude zone has produced the maximum water productivity, but the rice is being grown in only one season. North western zone has recorded higher productivity of rice. Yoshida (1978) reported that yield variation in rice to an extent of 65% was attributed to changing environments.

Temporal variations in rice water productivity

With respect to seasonal variations, higher average water productivity has been noticed during *kuruvai* season (0.48 kg of rice/m^3), followed by *navarai* (0.44 kg of rice / m^3) and *samba* (0.41 kg of rice / m^3). Occurrence of bright sunshine, high temperature and low rainfall for better photosynthesis and low pest and disease incidence during *kuruvai* season have obviously resulted in higher grain yield that led to increased water productivity. Krishnakumar and Soundarajan (1964) reported earlier that during *kuruvai* season the weather conditions were conducive for the better performance of rice crop were hotter and brighter days, lesser rainfall, long day length, greater difference between maximum and minimum temperature etc. The minimum water productivity

Table 2. Spatial and temporal variations in water productivity of rice in Tamil Nadu

Agro-climatic zones	Water Productivity (kg/m^3 crop evapotranspiration)		
	Kuruvai	Samba	Navarai
North Eastern Zone	0.44	0.48	0.47
North Western Zone	0.62	0.59	0.52
Western Zone	0.58	0.49	0.41
Cauvery Delta Zone	0.42	0.33	0.39
Southern Zone	0.41	0.35	0.39
High Rainfall Zone	0.47	0.58	0.00
High Altitude Zone	0.77	0.00	0.00

was observed during *samba* season mainly due to higher rainfall coupled with less sunshine hours caused low crop evapotranspiration demand in the atmosphere during flowering and maturity stages. Due to low crop evapotranspiration demand, the crop physiology *viz.*, water and nutrient movement and photosynthesis may get altered adversely. These reasons might be collectively responsible for poor grain yield during *samba* season than other seasons. Krishnakumar (1986) reported that low temperature prevailed during north east monsoon might have lowered the uptake of nutrients. Low solar radiation during ripening phase reduced the grain yield considerably because of a decrease in the percentage of filled grains.

Thus, from the foregoing analysis of water productivity in rice, it could be suggested that area under rice cultivation could be altered favourably where higher water productivity has been recorded viz., North western zone, keeping in mind the future water demand. In rice cultivation, general consensus is that higher the quantum of water delivered to the rice fields more would be the rice yield. However, this fallacy needs to be eradicated from the farmers' mind setup and awareness should be created on controlled and correct usage of water without resulting in the water application losses by runoff or deep percolation. Also the potential for rice cultivation during *kuruvai* season should be fully exploited by making use of the available water sources. However, the operation of the reservoir system and tank filling pattern may be positive constraints. Water productivity of a rice belt can be improvised upon by way of following scientific rice production technologies.

The basic premise of this study is confined only to the dependability of rice water productivity on evapotranspiration influence. However, the practical dependability of rice WP by and large would depend on variations in cultivar used, quality of irrigation water and total inputs used etc.

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