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Pokkali Rice Cultivation System of Kerala: An Economic Analysis

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Abstract

Pokkali rice-prawn is a unique system of rice cultivation found only in the coastal areas of Central Kerala, India where water column height of the fields increases more than 100 cm during the South-West monsoon. After the harvest of Pokkali rice- prawn stockings were introduced to these fields. It received the Geographical Indication tag in the year 2007. This research was an attempt to address production economics, efficiencies, environmental aspects etc. of this system. This study was conducted among the traditional Pokkali-prawn farmers in Ernakulum and Alappuzha districts of Kerala constituting 80 sample respondents from eight villages. Data Envelopment Analysis was used to estimate Technical (TE), Allocative (AE) and Economic Efficiencies (EE) and the Resource Use Efficiencies (RUEs) of inputs were estimated using Cobb-Douglas production function approach. The net return for the system was estimated at ₹ 281015 with Benefit-Cost ratio of 2.17. Pokkali system accounted higher efficiency measures with TE, AE and EE at 0.91, 0.97 and 0.91, respectively. The estimated RUEs of Pokkali- prawn system indicated that seeding material and labour force were over-utilized during production. Presence of NO_2-N in the water samples collected from Pokkali fields indicated oxidized condition prevailed in the fields throughout the production period which reduced the methane production to minimal level. The results of the study indicated that practicing this unique production system is important from the ecosystem perspective as well as the environmental sustainability view also.

Introduction

Rice (*Oryza sativa*) is a most widely consumed cereal grain as the staple food for a large part of the world's human population, especially in the Asian continent. There are 23 species of genus Oryza is known to the world of which 21 are wild species and only two viz., Oryza sativa and Oryza glaberrima are cultivated. Oryza sativa is grown in almost all rice growing areas around the world, but Oryza glaberrima is confined to the West Africa only. The major rice producing countries in the world include China, India, Indonesia, Bangladesh, Thailand, Vietnam, Burma, Philippines, Cambodia and Pakistan. These countries also have another interesting feature to share in common, the tradition of practicing agriculture-aquaculture integrated farming systems in which freshwater prawns have been grown as a part of rice-fish integrated farming systems either in the same season or in the consecutive seasons (Halwart and Gupta, 2004). Kerala holds 18th position in terms of production of paddy in India. But a particular type of rice production system is exclusively found in the coastal areas of the central Kerala commonly referred as the “Pokkali Rice cultivation System”.

Pokkali rice is a unique system of cultivation found only in the Central Kerala coastal line. It received the Geographical Indication (GI) tag in the year 2007. Pokkali fields are prepared for paddy cultivation from the auspicious Malayalam New Year Day-Vishu (April 14th or 15th) every year. During the monsoon, the water height in the Pokkali fields raise up to 100 to 110 cm and the Pokkali rice grows above the water height throughout the season and floats over it (Basheer, 2008). It grows up to a height of 130 to 140 cm by the time of flowering. During the low tide condition, the excess water is let out through the sluice openings and during high tide condition the backwater is allowed to enter the field. Droppings of the previous prawn culture, dead and decayed prawns etc. add to the nutrient contents in the Pokkali fields for the next Pokkali rice cultivation (Das and Stigter, 2005). Water from the backwaters supply the additional nutrients required for the growth of Pokkali rice. By mid-September, the crop will come to harvest. The rice is harvested by cutting the panicle at a height of 30 to 35 cm from the top and the remaining plant part is left in the water column for decomposition. This will act as the feed for prawn cultivation (Nambiar & Raveendran, 2009). After the harvest of Pokkali rice, the

field is kept idle for the proper decomposition of the leftover of the Pokkali rice. By the month of October-November, the local prawn varieties like Naran, Choodan etc. will gravitate towards the field along with the brackish water from the sea during high tides through the "Sluice Gate Openings" (Thomas, 2002 and Paimpillil, 2007). Many of the Pokkali farmers cultivate tiger prawn and crab along with the local prawn varieties in the same field (Pillai et al., 2003) by letting out fingerlings. Prawns in Pokkali field subsist on the organic matter from decayed stubbles, drying water weeds etc. and in turn, the field is enriched in manure and the excreta of organic wastes from fish and prawn. By the second fortnight of March prawn and crab will mature enough and we can go for harvesting process using "Bag net" placed on the sluice gates. When the water leaves from the field prawns will move in the direction of the water flow and it will get trapped in the bag net. As Pokkali rice variety is cultivated using organic farming methods, it has high export potential and medicinal value. And it is farmed for its special taste and high protein content as well.

The present era of organic agriculture is gaining societal, political and scientific recognition for its contribution to sustainable agriculture. Enhancing rice production from a naturally organic production system like Pokkali rice tract, which is an abiotic stress prone area, is imperative to achieve the evergreen revolution in rice. Rice cultivation alone not profitable under the organic farming, but the overall Pokkali farming system is made highly profitable by including prawn cultivation in the succeeding season (Sudhan and Mogalekar, 2016). Combining organic rice with organic freshwater prawn production in paddy fields as rotational crops achieved 20 per cent more net revenue than the combination of conventional rice-conventional prawn production. This is an important outcome and demonstrates the potential for adapting rotational rice-prawn farming practices to organic farming (C.M. Nair et al., 2013).

Even though many attempts were made to study the Pokkali rice prawn system of cultivation till date, studies regarding economic aspects, efficiency measures and resource use efficiencies were very few in number. So, this study was an attempt to bridge these gaps by providing the economics of production of Pokkali-prawn system and to estimate its technical, allocative and economic efficiencies and resource use efficiencies. An attempt was done to address the environmental implications associated with Pokkali-prawn system of cultivation as well. This study mainly focused on following specific objectives; i) to analyzing the production economics of *Pokkali* rice-fish farming system and ii) to estimating the resource use efficiency of all the three farming systems along with estimation of technical, allocative and economic efficiencies had given equal priority in this study. Studying the environmental issues related to this system and policy implications were addressed to some extent but detailed analysis was not possible due to so many constraints.

Materials and Method

Ernakulum and Alappuzha districts of Kerala, are presently practicing *Pokkali* rice growing districts in Kerala presently. Based on the maximum Pokkali rice area Ernakulum district was selected for this study. Three taluks viz., North Paravur, Kochi and Kanayannur Taluks from Ernakulum district were selected. From the selected taluks, two to three villages were randomly selected based on maximum cultivation area and from these villages, 10 farmers were selected randomly, making a total sample size of 80 *Pokkali* farmers. Both primary and secondary data were collected for the study. The primary data required for the study was collected through personal interview method using well-structured pre-tested interview schedule.

The percentages and averages analysis were used to work out the demographic and agro-socio-economic characteristics of *Pokkali* farmers. Usually Frontier production function analysis is used for estimating the Technical efficiencies of different agricultural production systems. But in this study multiple outputs are produced in the production system so frontier production function analysis could not be used because it accounts only single output and multiple inputs relationship. So, in the study, the Technical, Allocative and Economic efficiencies were estimated using Data Envelopment Analysis (DEA) which is able to account more than one output in the production system under consideration. Cobb-Douglas production function is used to estimate the resource use efficiency for different components of the production system using elasticity of production and inputs prices as follows (Nimoh, Tham and Nyarko, 2012):

The marginal physical product (MPP) is given by,

$$MPP_i = b_i \times APP_i$$

Where b_i is the elasticity of the various inputs,

$$APP_i = \frac{\overline{Y}}{\overline{X}_i}$$

Where $\overline{Y}$ is the mean of outputs and $\overline{X}_i$ is the mean of factor inputs,

Using the above specifications and the output and input prices, the marginal value products (MVPs) and Resource Use Efficiencies (RUE) were computed as follows

$$MVP_i = APP_i \times P_y$$

$$RUE_i = \frac{MVP_i}{MFC_i}$$

Where, P_y and MFC_i are the unit prices of output and factor input respectively. The resources are said to be used efficiently only if the value of RUE equals unity. A value less than one indicates over utilization of resource and value more than one indicates underutilization of resource.

Garrett's ranking technique was used to rank the constraints in the production and problems faced by farmers in the *Pokkali*-prawn production system.

The main objective the study is to estimate the resource use efficiency, AE, TE and EE of the production system while giving some emphasis on environmental impacts due to its cultivation practice as well. This study was conducted in Ernakulum district of Kerala covering 80 *Pokkali* farmers. Keeping the objectives of the study in view, data collected were subjected to statistical analysis and the results are presented and discussed in the following sections.

Results and Discussion

The data collected from the sample respondents were subjected to statistical analysis. The results obtained from those analyses were discussed below in brief (Table 1). Every farming decision is influenced by several factors, of which farm size is one of the major factors that influence decision making regarding crop selection and adoption of new technology. The farm size is also more correlated to the farm owning assets and their progressiveness. The sample farmers were classified based on their land holding as Marginal (Less than 1 ha), Small (1 to 2 ha) and Large (More than 2 ha) farmers. More than 70 per cent of the total farmers were either marginal or small farmers indicating constrained production in general. Even the average farm size of these farmers accounted lowest values. Average farm size of *Pokkali* farmers were only 1.65 ha. The average farm income of *Pokkali* farmers were around `3.9 lakhs from each hectare of *Pokkali*-prawn cultivation.

Table 1: Farm Characteristics of *Pokkali*-prawn system

Sl. No	**Farm Size**	***Pokkali*-prawn system**		
		Per cent	**Farm Size (**Hectares**)**	**Farm Income (**lakh ₹/ha**)**
1.	Marginal	42.50	0.51	3.30
2.	Small	30.00	1.38	4.18
3.	Large	27.50	3.71	4.39
	Total	100	1.65	3.87

The main objectives of this study were estimation of Technical (TE), Allocative (AE) and Economic (EE) efficiencies of this production systems and the estimation of resource use efficiencies (RUEs) for the inputs used in this production systems. Table 2 gives the summery of different efficiency estimates and Table 3 summarizes the Resource Use Efficiencies of different resources used in this system. Using Data Envelopment Analysis (DEA) the TE, AE and EE were estimated accounting multiple inputs and outputs. The technical efficiency of *Pokkali* system was estimated at 0.91 while the allocative efficiency was 0.97 and the economic efficiency was 0.91. Minimum number of farm operations and minimum input usage were the reasons for higher values of TE and AE in this production system. Between Sowing/stocking to harvesting of *Pokkali*/ prawn no cultural practices are carried out

and minimal human interference occurs during this stage, which reduces the chances of inefficient use of resources.

Table 2: Efficiency measures of *Pokkali*-prawn system

Sl. No	Efficiencies	***Pokkali*-prawn system**
1.	Technical Efficiency	0.91
2.	Allocative Efficiency	0.97
3.	Economic Efficiency	0.91

When the Resources Use Efficiency, results were analyzed it could be observed that in *Pokkali* system most of the inputs were over utilized. Only the crab seed material found to be underutilized in this production system. Even though it yielded higher income for the farmers, the cost of production can be further reduced by reducing the excess input utilization.

Table 3: Resource use efficiencies of Pokkali-prawn system

Sl. No.	Input	***Pokkali*-prawn system**	
		Pokkali rice system	Prawn production system
1.	Labour	0.131	- 1.549
2.	*Pokkali* seed	- 0.275	-----
3.	Prawn Seed	-----	- 2.047
4.	Crab seed	-----	1.871

The net return for *Pokkali* rice cultivation alone indicated a loss of `62864 per hectare. But it was compensated through cultivating prawn in the next season, which generated a net return of around ` 343879 from each hectare put under prawn cultivation. Total cultivation cost for the entire production system was 239505 and the gross income was `520521. BCR is a common measure used to analyze the profitability of a production system. *Pokkali*-prawn system was able to double the investment made in it. Every rupee invested in *Pokkali*-prawn system yielded back 2.17 rupees to the farmer.

Table 4: Cost and return summary of Pokkali-prawn system

Sl. No.	Particulars (₹/ha)	***Pokkali*-prawn System**	
		Pokkali	Fish
1.	Total cost	127525	111980
2.	Return	64661	455859
3.	Net return	- 62864	343879
4.	Gross Income for the system	520521	
5.	Total Cost of Cultivation for the system	239505	
6.	BCR	2.17	

When the problems faced by the farmers during production and marketing were analyzed using Garrett's ranking technique, most of the farmers were agreed that labour shortage and higher labour wage rates were the major constraints in production process. Constraints in mechanization of farm operations were also raised as a serious problem of this cultivation system. Perishability of the prawn and price fluctuations in the market were the main constraints they faced during marketing of their product.

The cultivation practice of *Pokkali* rice-prawn system is significantly different from normal wetland paddy cultivation. Gravitating water in and out of the fields during high tide and low tide conditions respectively is considered as the major difference between the systems. Water parameters are affected by this water exchanging process. Presence of NO_2-N in the water sample taken from the *Pokkali* field occurs only when an oxidized condition is maintained in the system (K. K. Krishnani et. al., 2003). Continuous exchange of water during high tides and low tides throughout the production period helps to maintain sufficient amount of oxygen in the fields and it helps to create an oxidized condition in the production system rather than a reduced condition. Because of continues mixing of water, perfect reduced condition is not attained unlike in normal wetland paddy ecosystems, where continuous stagnation of water will create a perfect reduced condition for methane production. So, through practicing this *Pokkali*-prawn system, the farmers are reducing the load of methane gas emission, thus reducing the contribution of GHG from these areas.

Discontinuing the *Pokkali* cultivation will greatly affect the prawn farming. The juvenile prawn lacks the high protein supplement from the decaying stubbles and vulnerable to many diseases. Without *Pokkali* farming, the flooded land becomes more acidic less oxygen availability, which is in turn detrimental to prawn farming (Das and Stigter, 2005). Another threat of monoculture of prawn without practicing *Pokkali* rice cultivation will lead to loss of lively hood of many rural women, who work in the paddy fields (Ranga, 2006). Discontinuation of *Pokkali* and monoculture of prawn and shrimp will lead to serious social and environmental implications. The ecological balance in the *Pokkali* rice fields get disturbed leading to loss of biodiversity. Monoculture of prawn will give higher income in the initial years but eventually the yield will start to decline so the income as well (Krishna, 2006). So, practicing this unique production system is important not only from the ecosystem perspective but from the environmental sustainability view also.

Conclusions

This study mainly focused in the economic aspects of production systems and to some extends regarding the environmental implications also. When the data was analyzed following conclusions could be formulated from the results obtained. The general characteristics of sample farmers were important to know the level of adoption of technologies and marketing practices. All the sample respondents were literate. Marginal farmers exceeded in number than other farmer categories.

There is much difference in terms of cost and returns in the cultivation system. The total cultivation cost was `239505 while the gross return for the same was estimated at `520521. *Pokkali* system was able to achieve a BCR of 2.17. *Pokkali* farms were technically, allocatively as well as economically efficient in their farming. *Pokkali* system accounted a technical efficiency of 0.91, allocative efficiency of 0.97 and economic efficiency of 0.91. Analyzing the RUEs, it could be observed that in *Pokkali* system most of the inputs were found over utilized. Even though it yields higher income, the cost of production can be further reduced by reducing the excess input utilization. When the environmental related issues are analyzed, Presence of NO_2-N in the water samples from *Pokkali* fields indicated that oxidized condition prevailed in the system due to continuous exchange of water during high tides and low tides throughout the production period which reduce the methane production to minimal level.

The TE, AE, EE and RUEs indicated that *Pokkali*-prawn system was more efficient in coastal Kerala rice production system. Even with lesser number of inputs it could able to realize higher production parameters which indicate that practicing this unique production system is important from the ecosystem perspective as well as the environmental sustainability view also.

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