Madras Agric. J. 91 (7-12) : 489-495 July-December 2004
https://doi.org/10.29321/MAJ.10.A00140

Sustainability of Rice Based Farming Systems in the Tambiraparani River Command Area

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Abstract : Though, increasing production and productivity of rice is essential to feed the growing population, considering its poor cost-benefit ratio and negative impact on the environment, alternatives need to be thought off. Based on this issue, a study was conducted in the Tambiraparani river command area of southern Tamil Nadu. It was found that the economic viability and ecological soundness of diversified farms especially that of paddy + banana + dairy systems were higher than the non-diversified systems. Dairy and banana were found to have contributed significantly for the high level of sustainability of the diversified farms. Considering the need to increase the income of farmers and conserve the environment, banana and dairy would serve as an ideal combination with rice crop to boost the sustainability of the Tambiraparani river basin.

Introduction

Irrigated areas in India play an important role in the foodgrain production of the country. As far as South India is concerned, the prevailing agro-climatic conditions favor growth of rice crop and besides being the staple food of many; this crop is grown extensively and intensively in this area wherever surface irrigation is available. To feed the huge population the vast area under the crop is understandable and going by reports on population predictions for the next 20-25 years more rice needs to be produced. However, off late, the rice crop is beginning to cause environmental concerns by posing threats to the sustainability of the irrigated regions, both in economic and ecological terms. It is reported that rice production and productivity are stagnating at current levels. Raj *et al.* (1989) reported that rice output in the last few years has been systematically below the levels projected on the basis of past growth rate. Pingali (1991) has observed that at the International Rice Research Institute (IRRI) and other research stations in the Philippines, the yields of the highest yielding entry rice variety in long term fertility trials fell steadily between 1966 and 1988. This gives a signal that extending the area under irrigation further by more investments to increase the acreage of rice crop would not commensurate the cost of resource creation.

Ecologically, rice crop poses several environmental hazards in irrigated areas such as reduction in biodiversity due to crop specialization; production of methane, an important green house gas, due to continuous stagnation of water in the rice fields, increased use of inorganic fertilizers, leading to soil compaction and pollution of ground water; and indiscriminate application of chemical pesticides, causing resurgence of pests, destruction of natural predators and parasites, and increase in residual effects in food produce. It is for these reasons, Rao (1977) has expressed concern about the sustainability of one of the most productive cropping systems *viz.*, rice- wheat, covering around 10 m ha. Besides, Singh (1989) reported that continuous puddling of rice fields in Punjab has led to the formation of an impervious layer of soil, which not only prevents uptake of water and nutrients from deeper layers but also requires more fertilizer application.

The short-term gains have resulted in long-term negative consequences by growing rice intensively. The solution lies with farm

Table 1. List of Sustainability parameters with Operationalisation and Measures

S.No.	Parameters*	Operationalisation	Value used	Measure
	Economic Viability			
1.	Production Efficiency	yield per acre or output per animal in the farm	absolute values	ratio of farm yield to locality yield
2.	Cultivated Land Utilisation Index	efficiency in utilization of the farmland by growing various crops in a period of one year	absolute values	cropping intensity in terms of crop duration
3.	Net Return	net profit obtained by deducting the variable cost from gross return and expressed in terms of rate of return	absolute values	rate of return (ratio of net return to variable cost)
4.	Technology Use Level	extent of adoption of the recommended technologies for crop and animal enterprises by farmers	scores	ratio of actual extent of adoption score to maximum score
5.	Low-cost Technology Use Level	extent of adoption of low-cost technologies recommended for crop and animal enterprises by farmers	scores	ratio of actual extent of adoption score to maximum score
6.	Employment Generation Capacity	extent of employment generated by the farm in a year	absolute values	ratio of mandays generated in the farm to standard mandays required
7.	Farm Family Employment Level	extent to which the farm family was employed in the farm in a year	absolute values	ratio of mandays of farm family employment in the farm to number of mandays in a year.
8.	Self-reliant Level	extent to which the farmer was self-reliant in terms of capital, labour, inputs and information on agricultural aspects	scores	ratio of actual self-reliant score to maximum score
9.	Self-sufficiency Level	extent to which the farm household was self-sufficient in terms of food, fodder and fuel.	scores	ratio of actual self-sufficiency score to maximum score.
	Ecological Soundness			
10.	Eco-friendly Technology Use Level	extent of adoption of eco-friendly technologies recommended for crop and animal enterprises by farmers	scores	ratio of actual extent of adoption score to maximum score.
11.	Organic Recycling Level	extent to which the farm by-products were recycled in the farm	absolute values	ratio of quantity of farm by-products recycled to quantity of farm by-products produced in the farm.
12.	Low-external Input Use Level	extent of adoption of the external inputs viz., chemical fertilizers and pesticides for crops, and chemical mineral mixtures for dairy animals.	absolute values	ratio of quantity of external input recommended to quantity of external input used.
13.	Soil Health	soundness or the wholesomeness of the soil system in terms of its organic matter content, nutrient content (Nitrogen, Phosphorus and Potassium), electrical conductivity and pH.	absolute values and scores	ratio of actual score of the soil characteristics to maximum score of the soil characteristics

* Each parameter is expressed as a percentage in order to maintain uniformity.

diversification as a suitable alternative to boost the farm income and also to enhance the ecological stability of irrigated areas. Even according to FAO (1991), the benefits of farm diversification are food security by ensuring an appropriate and sustainable balance between self-sufficiency and self-reliance; employment and income generation in rural areas, in particular to eradicate poverty; and natural resource conservation and environment protection. Research has shown that rice based farming systems are economically viable and ecologically sound, and capable of improving the sustainability of the irrigated regions.

Keeping the issue of sustainability of irrigated areas in the country; and the performance of rice and rice based farming systems economically and ecologically, a study was undertaken in the Tambiraparani river command area of Tamil Nadu State with the following objectives.

Objectives

- To assess the sustainability of diversified and non-diversified rice based farming systems.
- To identify the parameters that influence the sustainability of diversified and non-diversified rice based farming systems.

Materials and Methods

The study was carried out in the Tambiraparani river command area of Southern Tamil Nadu. It is one of the important river irrigation systems with an authorized command area of 34,443 hectares, of which about 47% is direct command area and 53% is indirectly fed through tanks. The Tambiraparani command area is characterized by four types of farming systems *viz.*, (i) rice, (ii) rice + banana, (iii) rice + dairy, and (iv) rice + banana + dairy. The first two can be considered as non-diversified systems due to the absence of allied enterprises and the later two are diversified systems with the inclusion of dairy being an allied sector activity.

In order to assess the sustainability of the farming systems, a sustainability index was constructed by considering two dimensions of sustainable agriculture *viz.*, economic viability and ecological soundness. This decision is supported by Costanza (1991) who defined sustainability as a relationship between dynamic economic systems and larger dynamic, but normally slower changing ecological systems. Similarly, Theodore (1996) expressed that sustainability in agriculture will be possible by maintaining the balance between economic output and environmental quality. For the purpose of this study the sustainability index was the simple arithmetic mean of economic viability and ecological soundness, where the economic viability is the simple arithmetic mean of the nine economic parameters operationalized in Table 1. Similarly, the ecological soundness was the simple arithmetic mean of the four economic parameters defined in Table 1. To find out the group of parameters that influence the sustainability of the diversified and non-diversified rice based farming systems, 'Principal Component Analysis' was carried out as per Morrison (1976).

The study was carried out in two districts *viz.* Tirunelveli and Thoothukudi of South Tamil Nadu. To make the study comprehensive, the head, mid and tail reaches of the river basin were covered. From each reach 10 villages were selected at random and therefore for the three reaches 30 villages were selected. From each village four farms each representing one type of farm i.e., paddy, paddy +banana, paddy +dairy, and paddy + banana + dairy, were selected at random. Thus the sample comprised of 120 farms with 60 diversified and 60 non-diversified farms. Interview method was used to collect data.

Results and Discussion

The findings of this study are presented under two heads *viz.*, sustainability of the farming systems and principal component analysis as follows:

Table 2. Economic Viability, Ecological Soundness and Sustainability of the Rice Based Farming Systems

S. No.	System Pairs	Economic Viability			Ecological soundness			Sustainability		
		Mean economic viability(%)	Diff. between means	t value	Mean economic viability(%)	Diff. between means	t value	Mean economic viability(%)	Diff. between means	t value
1.	Rice and Rice + banana	51.3883 62.3547	-10.9664	5.8964**	57.8900 61.4957	-3.6057	1.6779NS	54.6383 61.9253	-7.2870	4.3904**
2.	Rice and Rice + dairy	51.3883 63.1310	-11.7427	6.1044**	57.8900 66.1023	-8.2123	3.7519**	54.6383 64.6173	-9.9790	6.1169**
3.	Rice and Rice + banana + dairy	51.3883 71.7680	-20.3797	11.0889**	57.8900 69.8947	-12.0097	6.1121**	54.6383 70.8337	-16.1954	10.5596**
4.	Rice + banana and Rice + dairy	62.3547 63.1310	-0.7763	0.4097 NS	61.4957 66.1023	-4.6066	2.6858**	61.9253 64.6173	-2.6920	1.9502NS
5.	Rice + banana and Rice + banana + dairy	62.3547 71.7680	-9.4133	5.2079**	61.4957 69.8997	-8.4040	5.9254**	61.9253 70.8337	-8.9084	7.0506**
6.	Rice + dairy and Rice + banana + dairy	63.1310 71.7680	-8.6370	4.6111**	66.1023 69.8997	-3.7974	2.5691*	64.6173 70.8337	-6.2164	5.0706**

* Significant at 0.05 level of probability ; ** Significant at 0.01 level of probability

Table 3. Principal Component Weights of the thirteen Parameters for the four Farming Systems.

Parameters	Principal Component Weights of each system			
	Paddy	Paddy + Banana	Paddy + Dairy	Paddy + Banana + Dairy
Economic viability				
1. Production efficiency	0.229 (4)	0.661 (3)	0.916 (1)	0.815 (2)
2. Cultivated land utilisation index	0.383 (4)	0.666 (2)	0.779(1)	0.633 (3)
3. Net return	0.409 (4)	0.742 (1)	0.667 (2)	0.591 (3)
4. Technology use level	0.449 (4)	0.933 (2)	0.911(3)	0.968 (1)
5. Low-cost technology use level	0.056 (4)	0.342 (3)	0.561(2)	0.629 (1)
6. Employment generation capacity	0.924 (1)	0.428 (4)	0.488 (3)	0.607 (2)
7. Farm family employment level	0.165 (4)	0.718 (2)	0.360 (3)	0.724 (1)
8. Self-reliant level	0.120 (4)	0.891 (1)	0.882 (2)	0.834 (3)
9. Self-sufficiency level	0.132 (4)	0.830 (1)	0.734 (2)	0.246 (3)
Ecological Soundness				
10. Eco-friendly technology use level	0.382 (4)	0.949 (2)	0.943 (3)	0.957 (1)
11. Organic recycling level	0.125 (4)	0.451 (3)	0.513 (2)	0.516 (1)
12. Low-external input use level	0.629 (4)	0.906 (3)	0.966 (2)	0.975 (1)
13. Soil health	0.148 (4)	0.863 (1)	0.774 (2)	0.663 (3)

Figures in parentheses indicate ranks.

Sustainability of the Farming Systems

The results of the pair-wise comparison of the rice based farming systems with respect to economic viability, ecological soundness and sustainability is presented in Table 2. Among the six pairs the economical viability of the system 'rice + banana + dairy' (71.77%) was found to be the highest. This was followed by an almost equal level of sustainability of the systems "rice + banana' (62.35%) and 'rice + dairy' (63.13%). The least economically viable system was found to be 'rice' (51.39%). Since, the system rice + banana + dairy includes three activities its economic viability was observed to be the highest and with decrease in the number of the activities the economic viability also reduced accordingly.

From the Table 2 it is also evident that the ecological soundness of the system ie., rice + banana + dairy (69.90%) was the highest, followed by the system rice + dairy (66.10%). The system rice + banana (66.49%) and rice (57.89%) were found to have the lowest ecological soundness among the four systems. The results clearly indicate that theological soundness of the farming systems was decided by the presence or absence of dairy activity and accordingly, the systems which included dairy component were found to be more ecologically sound than those systems which lacked the dairy component.

As already mentioned, the sustainability index was the arithmetic mean of economic viability and ecological soundness of the farming systems. Accordingly, in Table 2 it is found that the results of the economic viability and ecological soundness of the four farming systems is clearly reflected in the sustainability level of the four farming systems. The sustainability of the system rice + banana + dairy (70.83%) was observed to be the highest. This was followed by an equal level of sustainability in the systems rice + dairy (63.62%) and rice + banana (61.93%). The least sustainable system was found to be rice (54.64%).

Since, the system rice + banana + dairy had three activities including dairy component, its sustainability level was found to be the highest. The banana component in the rice + banana system contributed for its economic viability and the dairy activity in the rice + dairy system were found to have contributed for its ecological soundness, which led to an almost equal level of sustainability in both these systems. The rice system with only one component resulted in the lowest level of sustainability among the four farming systems.

Principal Component Analysis

The results of the Principal Component Analysis (PCA) is presented in Table 3. The rankings in the Table indicate that the high level of efficiency of the parameters *viz.* technology use level, low cost technology use level, farm family employment level, eco-friendly technology use level, organic recycling level and low-external input use level were mainly responsible for the high level of sustainability of rice + banana + dairy system. It means that these six parameters have performed well in this system than in the rest of the systems. It could also be seen that in the rice system, majority of the parameters have scored fourth rank. This implies that those economic and ecological parameters have not performed well in the rice system and are responsible for the lowest sustainability level among all the four systems.

Conclusion

Though rice forms the staple food of our country still considering the economic and ecological implications new options need be thought off to optimize resource use. It is found through this study that the diversified rice based farming systems with banana and dairy activities are highly sustainable than the non-diversified systems in the Tambiraparani river command area. Therefore, steps need to be taken to increase area under banana and to promote dairy activity in the region. Whereas, farmers have expressed that small land size, lack of adequate capital, paucity of water for irrigation during summer months, damage to crops by wild boars and theft of fruit bunches from the fields as reasons constraining growing banana crop. Similarly, farmers have stated that inadequate space either in the farm or homestead to maintain dairy animals, lack of capital, and non-availability of family labour to maintain the animals as reasons for not diversifying their farms with dairy component. Since, the marginal and small farmers form the most vulnerable group in the command area they require the maximum support to improve their socio-economic status from subsistence farming. They can be encouraged to form self-help groups for starting dairy business collectively in a cooperative manner to supplement their farm income.

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(Received: April 2004; Revised: October 2004)