Int.J.Curr.Microbiol.App.Sci (2019) *8*(11): 382-387

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 Volume 8 Number 11 (2019)
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.811.048

Effect of Crop Diversification and Fish Integration in Productivity Enhancement of Rice

M.R. Reshma[1*], P. Shalini Pillai[1], Jacob John[2] and K.C. Manorama Thampatti[1]

[1]*College of Agriculture, Kerala Agricultural University, Vellayani, Thiruvananthapuram-695 522, India*
[2]*Integrated Farming System Research Station, Kerala Agricultural University, Karamana, Thiruvananthapuram-695 002, India*

**Corresponding author*

Keywords

Rice, Fish, Farming system

Article Info

Accepted:
04 October 2019
Available Online:
10 November 2019

A B S T R A C T

The field experiment was conducted during *Virippu* season 2016-’17 in the low land rice fields. Seven rice based farming systems *viz.*, T_1: rice succeeding fallow; T_2: rice succeeding amaranthus; T_3: rice succeeding culinary melon; T_4: rice succeeding fodder cowpea; T_5: (rice + fish) succeeding (amaranthus + fish); T_6: (rice + fish) succeeding (culinary melon + fish); T_7: (rice + fish) succeeding (fodder cowpea + fish) were evaluated for assessing the effect of crop diversification and fish integration on the productivity of rice. Diversification of summer rice fallows with different crops resulted in a yield improvement to the tune of 10.22 per cent over the rice succeeding fallow. Whereas, in fish integrated systems, the yield improvement was 15.56 per cent more than the sole crop of rice. The grain yield (6.62 t ha^{-1}) and straw yield (6.84 t ha^{-1}) were significantly higher in rice + fish succeeding fodder cowpea + fish. The productivity of rice grain and straw was less in the rice – rice – fallow system. In general, crop diversification and fish integration resulted in productivity improvement in rice based farming systems.

Introduction

Rice is the single largest food source for the poor and the source of one quarter of global per capita. In India, rice is cultivated in an area of 43 million hectares (GOI, 2016). As far as Kerala is concerned, the major crop rice is an integral part of the wetland ecosystem with specific ecological functions. However, the recent years have witnessed the rapid decline in paddy area. Over the last three decades, area under rice in Kerala declined from 8.5 lakh ha to 1.99 lakh ha (FIB, 2017). According to the long term studies conducted in Asian countries by Pingali *et al.,* (1990) the intensive modern monoculture of rice has resulted in declined yield trends and the rice production systems have become practically unsustainable. Further, it has reduced the environmental quality also.

Degradation of resources including soil and water, severity in pest and disease incidence are also consequences of monoculture. In this scenario sustainable rice based farming system approach, which ensures increased productivity besides conserving the environmental quality and sustainability is gaining much importance.

Rice-rice-fallow was identified as the major rice based cropping system in the southern districts of Kerala (John *et al.,* 2014). The summer rice fallows are major avenues for the cultivation of other remunerative crops like pulses, vegetables, tuber crops and short duration fodder crops.

Instead of keeping the field fallow during summer, going for a cropping system approach can increase cropping intensity, economic returns as well as create diversity in the field.

Judicious integration of rice enhances the income base of farmer as well as sustains rice production (Padmakumar, 2013). Inclusion of animal components in the cropping systems can further improve the system productivity.

Rice-fish integration is one such production system which provides additional food and income by diversifying farm activities and increasing the yield of both.

In this context, a study was undertaken to assess the impact of crop diversification and fish integration in yield enhancement of *Virippu* rice in lowland rice fields of southern Kerala.

Materials and Methods

A field study was carried out in the lowland rice fields of Integrated Farming System Research Station, Karamana, Thiruvananthapuram during *Virippu* 2016-‘17. The soil of the experimental site was clayey in texture, acidic in pH (5.33), high in organic carbon (1.58 per cent), low in available nitrogen (249.20 kg ha^{-1}), medium in available phosphorus (24.70 kg ha^{-1}) and potassium status (154.85 kg ha^{-1}).

The experiment was laid out in randomised block design with seven treatments, replicated thrice. The treatments comprised seven rice based farming systems *viz.,* T_1: rice succeeding fallow; T_2: rice succeeding amaranthus; T_3: rice succeeding culinary melon; T_4: rice succeeding fodder cowpea; T_5: (rice + fish) succeeding (amaranthus + fish); T_6: (rice + fish) succeeding (culinary melon + fish); T_7: (rice + fish) succeeding (fodder cowpea + fish). The variety of rice was Uma (MO 16). The plot size was 6 m x 6 m. In the treatments where fish was integrated with crops (T_5-T_7), half of the plot was converted into trenches of size 6m x 3m x 1m. The fish species *viz.,* catla (*Catla catla*) and rohu (*Labio rohita*) were reared in the trenches. The crops were raised as per the Kerala Agricultural University Package of Practices Recommendations (KAU, 2016). The fishes were introduced into the trenches after transplanting *Virippu* crop and were harvested after the summer crop. After summer season, the trenches were desilted and the silt was added and incorporated into the respective plots, before raising *Virippu* rice. The trench silt was characterized for quantity, physico-chemical and biological properties. The observations on yield attributes and yield were recorded at the time of harvest of the *Virippu* rice. Observations on the yield attributes (productive tillers m^{-2}, grain weight $panicle^{-1}$, total number of grains $panice^{-1}$, filled grains panicle^{-1}, sterility percentage) were recorded from ten randomly selected hills from the net plot area. Grain yield and straw yield (on dry weight basis) were recorded after harvesting the net plot area and drying the produce to constant weights.

The data generated were statistically analysed using analysis of variance (ANOVA) for Randomized Block Design (Cochran and Cox, 1965). Wherever significant differences among treatments were observed, CD values at 5 per cent level of significance were calculated for comparison of means.

Results and Discussion

The data on the yield attributes and yield of *Virippu* rice are presented in Table 2. The number of productive tillers per m^{-2} did not vary significantly among the treatments. Though non-significant, the productive tiller count was relatively higher in treatments with fish integration. Significantly higher grain weight panicle^{-1} (4.08) was obtained in the system rice + fish succeeding fodder cowpea + fish (T_7) and was on a par with rice + fish succeeding amaranthus + fish (T_5) and rice + fish succeeding culinary melon + fish (T_6). Vromant *et al.*, (2002) observed an increase in the number of grains per panicle which compensated the decrease in the number of panicles m^{-2} in a rice-fish integration system.

Total number of grains panicle^{-1}, filled grains panicle^{-1} and sterility percentage were significantly different among the treatments. The treatment rice + fish succeeding fodder cowpea + fish (T_7) recorded significantly more number of grains (159.80) and filled grains per panicle (144.35). It was at par with rice + fish succeeding amaranthus + fish (T_5) and culinary melon + fish (T_6) combinations. Sole crop of rice succeeding fallow recorded significantly lower number of filled grains panicle^{-1} and it remained at par with rice succeeding amaranthus (T_2), rice succeeding culinary melon (T_3), and rice succeeding fodder cowpea (T_4). Rice succeeding fallow recorded the lower number of grains and filled grains per panicle.

Significantly lower sterility percentage (5.69 per cent) was recorded in T_5 (rice + fish succeeding amaranthus + fish) and it was observed to be on a par with T_6. The highest percentage of chaffy grains (13.18 per cent) was observed in T_2 (rice succeeding amaranthus) which was at par with T_4, T_1 and T_3.

Table.1 Physico-chemical properties of trench silt

Sl. No.	Parameters	Value
1	Texture	Clayey
2	Bulk density (Mg m^{-3})	0.78
3	Water holding capacity (%)	47.38
4	pH	5.41
5	Electrical conductivity(dS m^{-1})	0.51
6	Organic carbon (%)	2.12
7	Available nitrogen (mg kg^{-1})	709.33
8	Available phosphorus (mg kg^{-1})	7.53
9	Available potassium (mg kg^{-1})	204.28

Table.2 Yield attributes and yield of rice

Treatments	Productive tillers m^{-2}	Grain weight $panicle^{-1}$ (g)	Total number of grains $panicle^{-1}$	Filled grains $panicle^{-1}$	Sterility percentage	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Grain: straw ratio
T_1: Rice succeeding fallow	426.62	3.61	126.35	112.02	12.77	4.89	5.19	0.94
T_2: Rice succeeding amaranthus	442.17	3.33	135.00	117.73	13.18	5.37	5.86	0.92
T_3: Rice succeeding culinary melon	452.17	3.22	129.56	114.07	11.93	5.31	5.76	0.93
T_4: Rice succeeding fodder cowpea	468.84	3.40	136.48	123.37	13.03	5.50	5.95	0.92
T_5: Rice + fish succeeding amaranthus+fish	482.17	4.02	153.30	137.84	5.69	5.87	6.14	0.96
T_6: Rice + fish succeeding culinary melon+fish	486.61	3.91	148.35	137.67	7.21	5.77	5.99	0.96
T_7: Rice + fish succeeding fodder cowpea+fish	557.72	4.08	159.80	144.35	7.86	6.62	6.84	0.97
CD (0.05)	-	0.532	18.985	17.338	1.628	0.960	0.770	-

Sterility percentage was found to decrease in treatments integrated with fish. The treatments with fish integration had higher biomass production which might have contributed to better grain filling as suggested by Peng *et al.,* (1999). Fish integration meant incorporation of trench silt also. The trench silt was rich in N and K (Table 1). The higher nitrogen content of trench silt might have improved photosynthesis and consequently increased the amount of photosynthates available for grain filling in the crop (Moridani and Amiri, 2014). While N is important in the production of assimilates, K is the key nutrient that determines the source-sink relationship that favors better grain filling (Hayashi *et al.,* 2013).

The grain yield was significantly higher (6.62 t ha^{-1}) in the rice + fish succeeding fodder cowpea + fish. Straw yield was significantly higher and remained at par with the systems of rice + fish succeeding fodder cowpea + fish (6.84 t ha^{-1}) and rice + fish succeeding amaranthus + fish (6.14 t ha^{-1}). Similar increase in yield with fish integration has been recorded by Mohanty *et al.,* (2010). The productivity of rice grain and straw was less in the rice – rice – fallow system. The grain : straw ratio was found non-significant among treatments.

Yield is a function of yield attributes. Significantly higher grain weight per panicle, total number of grains and filled grains per panicle might have contributed to increased grain yield of *Virippu* rice in the system rice + fish succeeding fodder cowpea + fish. The increased yield attributes and yield realised with fish integration could also be due to the addition and incorporation of the nutrient rich trench silt (Table 2). Further, being an experiment in vogue for the past four years, trench silt addition might have also improved the soil physical conditions. Mohanty (2003) observed a similar increase in yield attributes and yield of rice with fish integration and attributed this to the improvement in soil fertility and consumption of planktons, weeds, insects and bacteria by fish. The positive effect of fish sediments in improving soil structure and soil fertility by enhancing soil aeration, water and nutrient holding capacities, root penetration by crops and thereby increasing crop growth and yield have also been reported by Ihejirika *et al.,* (2012).

The specific yield increase recorded by rice + fish succeeding fodder cow pea + fish may be due to the legume effect. Legumes can be considered as small nitrogen factories in the field. Legumes also help to solubilize insoluble soil P, improve the soil physical conditions and increase the soil microbial activity (Ghosh *et al.,* 2007). The residual effect of fodder cowpea raised during summer might have contributed to improving the yield attributes of the succeeding *Virippu* rice. Prabhakaran and Janardhana (1997) reported that the grain yield of *Kharif* rice increased from 4.7 t ha^{-1} to 5.4 t ha^{-1} in rice – groundnut – cowpea system while a decline in grain yield was observed from (4.5 t ha^{-1} to 4.1 t ha^{-1}) in rice – rice sequential cropping system.

The present study revealed that, crop diversification increased the productivity of *Virippu* rice. In general, diversification of summer rice fallows with component crops resulted in an yield increase of 10.22 per cent over the rice succeeding fallow. Rice succeeding amaranthus, culinary melon and fodder cowpea recorded 9.82 per cent, 8.59 per cent and12.47 per cent increase in productivity respectively as compared to rice succeeding fallow. Integrating fish in rice based farming systems enhanced the yield of *Virippu* rice by 15.56 per cent.

Acknowledgement

The authors are grateful to the Kerala Agricultural University, Integrated Farming System Research Station of KAU and the Indian Institute of Farm Systems Research (ICAR) for the research grant and facilities provided for undertaking the study.

References

Cochran, W. G. and Cox, G. M. 1965. *Experimental design*. John Wiley and Sons. Inc., New York, 225p.

FIB [Farm Information Bureau]. 2017. *Farm Guide 2017*. Farm Information Bureau, Thiruvananthapuram 456 p.

Ghosh, P. K., Bandyopadhyay, K. K., Wanjari, R. H., Manna, M. C., Misra, A. K., Mohanty, M., and Rao, A. S. 2007. Legume effect for enhancing productivity and nutrient use efficiency in major cropping systems- an Indian perspective: a review. *J. Sustainable Agric*. 30(1): 59-86.

GOI [Government of India]. 2016. State of Indian Agriculture 2015-16. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare. Ministry of Agriculture and Farmers Welfare, New Delhi. 280p.

Hayashi, M., Hayashi, T., Kuno, C., Chikako, K., Toshio, T., Ikuma, E., Atsushi, H., Mana, N. K., and Akira, Y. 2013. Enhanced nitrogen uptake and photosynthesis of rice grown with deep and permanent irrigation method: possible mechanism for chalky grain reduction. *Plant Prod. Sci.* 16 (4): 309-316.

Ihejirika, C. E., Onwudike, S. U., Nwaogu, L. A. Emereibeole, E. I., Ebe, T. E., and Ejiogu, C. C. 2012. Assessment of aquaculture sediment for agricultural fertilizer supplement and soil conditioner in Owerri Urban, Nigeria. *J. Res. Agric.*1: 34-38.

John, J., Rajasekharan, P., Rajasree, G., and Bindu, P. 2014. *Cropping Systems in Kerala*. State Planning Board, Thiruvananthapuram, Kerala, 46p.

KAU [Kerala Agricultural University] 2016. *Package of Practices Recommendations: Crops* (15th Ed.). Kerala Agricultural University, Thrissur, 393 p.

Mohanty, R. K. 2003. Feed intake pattern and growth performance of Indian major carps and fresh water prawn in a rice-fish integration system. *J. Asian Fisheries Sci*. 16: 307-316.

Mohanty, R. K., Takur, A. K., Ghosh, S., and patil, D. U. 2010. Impact of rice-fish-prawn culture on rice field ecology and productivity. *Indian J. Agric. Sci*. 80(6): 597-602.

Moridani, M. J. and Amiri, E. 2014. Effect of nitrogen and potassium on yield and yield components of rice cultivar “Hashemi”. *Indian J. Fundamental Applied Life Sci*. 4(4): 417-424.

Padmakumar, K. G. 2013. Aquaculture integration ensures resilience in integrated farming system. In: *Integrated Farming System - Towards a Strategy for Agriculture Development in Kerala*. Kerala State Planning Board, Thiruvananthapuram, pp. 130-150.

Peng, S., Cassman, K. G., Virmani, S. S. Sheehy, J., and Khush, G. S. 1999.Yield potential trends of tropical rice since release of IR8 and the challenge of increasing rice yield potential. *Crop Sci.* 39: 1552-1559.

Pingali, P. L., Moya, P. F., and Velasco, L. E., 1990. The post-green revolution blues in Asian rice production-the diminished gap between experiment station and farmer yields. Paper No. 90-01, IRRI Social Science Division, International Rice Research Institute, Manila, Philippines.

Prabhakaran, T. K. and Janardhana, N. A. 1997. Performance of rice based farming system in coastal Karnataka. *Indian J. Agron*. 42(1): 5-8.

Vromant, N., Duong, L. T., and Ollevier, F. Effect of fish on the yield and yield components of rice in integrated concurrent rice-fish systems. *J. Agric. Sci*. 138 (1): 63-71.

How to cite this article:

Reshma, M.R., P. Shalini Pillai, Jacob John and Manorama Thampatti, K.C. 2019. Effect of Crop Diversification and Fish Integration in Productivity Enhancement of Rice. *Int.J.Curr.Microbiol.App.Sci.* 8(11): 382-387. doi: https://doi.org/10.20546/ijcmas.2019.811.048