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Sustainable Rice Production through Integrated Farming System Approach

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Abstract

Rice crop suffers from different biotic and abiotic constraints. Diversification of agricultural activities and linking farm based enterprises with the rice cultivation, would help the rice growing farmers to get more income and generate additional employment. Farming system approach was observed to be a resource management strategy for achieving economic and sustainable agricultural production to meet the diverse requirement of farm house hold while preserving the resource base and maintaining high environmental quality. Integration of lotus culture has been reported to offer the opportunity of an ideal biological weed control. Further, integration of fish and poultry components has been reported to be detrimental to weed control in rice and other crops. This could be attributed to a substantial expression of diverse benefits, resulting from integration of lotus with fish and poultry in rice, *viz.*, nutrient supplement, complementary pest control and enhanced fertility and productivity status of system. Hence integrated farming system approach could be a holistic approach, that may help in efficient and sustainable production in rice crop, with substantial improvement in income and livelihood of te small and marginal rice growing farmers.

Key words: Resource management strategy, farming system, sustainable agriculture, rice production, income and Employment.

Introduction

The integrated farming system approach is considered to be the most powerful tool for enhancing profitability of farming systems. These integrated farming system required to be planned, designed, implemented and analyzed for increasing productivity and profitability. These systems also need to be socially acceptable, viable and eco-friendly. Integration of enterprises lead to greater dividends than single enterprise based farming, especially for small and marginal farmers. It also leads to improvement in nutritional quality of daily diet of farmers. The population living in rural areas are facing malnutrition and they need large nutrient supplement along with employment and sustained income.

Fish culture could play a share strongly towards solving these decisive problems and the same is possible in low land rice, as rice is grown with standing water throughout the crop duration with the integration of fish component in rice field. The rural poor farmers would benefit economically and nutritionally by adopting rice-fish integrated culture system (Kumar and Quisumbing, 2011).

Similarly, another important farming system component integrated with rice in poultry. The poultry sector in India has undergone major shift in structure and operation from a mere backyard activity into a major commercial activity with the presence of large integrated players and successful implementation of contract poultry farming on a large scale. Globally, Poultry sector in India is valued at about Rs. 80,000 crore (2015-16) broadly divided into two sub-sectors – one with a highly organized commercial sector with about 80% of the total market share (say, Rs. 64,000 crore) and the other being unorganized with about 20% of the total market share of Rs. 16,000 Crore. The unorganized sector also referred to as backyard poultry plays a key role in supplementary income generation and family nutrition to the poorest of the poor (NAPEP, 2022). It is estimated that with a poultry population of 851.81 million, small and medium farmers are mostly engaged in contract farming system under larger integrators and there are around 30 million farmers engaged in backyard poultry as per 20th Livestock Census (DAH&D, 2022). The domestic poultry market size is estimated at more than Rs. 47,000 crores and the assessment based on the industry feedback indicates that the demand is expected to grow at around 15-18 per cent over medium to long term. This is attributed to rising purchasing power, changing food habit and increasing urbanization (Edwin, 2013).

Further Lotus (*Nelumbo nucifera* G.) is the National Flower of India and all the parts of Lotus are useful. Lotus seeds have immense medicinal, nutritional and commercial Values. However, it is yet to find a cultivation status in India (Ranchana *et al*., 2023). Lotus plants come up in shallow water, and is well suitable for culturing along with poultry and fish components in rice. This would double the farmer's income, impart climate resilience, water reuse and organic mode leading to sustainability along with poultry rearing and fish culture in same field. Hence, an innovative approach of integrating Rice + Fish + Poultry + Lotus was designed for the study in order to address the multiple dimensions of achieving productivity in a sustainable way. Considering the above facts in view, the present investigation was taken up to trace the impact of integrated farming system on rice production.

Materials and Methods

Field investigations were carried out during *samba* (August-January) season of 2018-19 and 2019-20 with rice var. BPT (5204) to trace the impact of integrated farming system on rice production. The experiments were taken up in a randomized block design with three replications. The treatments comprised of rice + fish (T_2), rice + poultry (T_3), rice + lotus (T_4), rice + fish + poultry (T_5), rice + fish + lotus (T_6), rice + poultry + lotus (T_7) and rice + fish + poultry + lotus (T_8) were compared with rice alone (T_1). The field unit consisted of individual plot size of 10m × 20m (200 m^2) in all the treatments. For treatments with fish and lotus, trenches of 20 x 1 x1 m dimension were excavated covering 10 per cent area of the treatment plot. Further, for the treatment with lotus (*Nelumbo nucifera* G.) component, the rhizomes were collected from lotus ponds were planted with a spacing of 60 x 60 cm in trenches. In the treatment with fishes, fingerlings of catla, rohu, mrigal, silver carp, common carp and grass carp as polyculturewere released @ 100 $trench^{-1}$. In treatment involving poultry component, the poultry sheds of dimension 6×4×3 feet have been installed in respective plots, supported by concrete poles of 8 feet length, of which 4 feet which were buried into the soil and half of the length protruding above the soil. The vencob broiler birds were reared @ 20 $birds\ cage^{-1}$. Further the rice cultivar BPT (5204) was transplanted using 21 days old seedlings at a spacing 20×15 cm and gap filling was done at 7 DAT. The fertilizers @150:50:50 kg N, P_2O_5 and K_2O ha^{-1} were applied as per the recommendations, wherein the full dose of Nitrogen, Phosphorus and Potassium were applied basally.

Results and Discussion

Effect of integrated farming systems on growth and yield characters of rice

All the treatments were significantly influenced by the treatments compared. Among the treatments compared, integrated rice + fish + poultry + lotus showed significantly higher crop-growth attributes (Table 1) of rice with highest plant height (78.37 cm), tillers m^{-2}(337.69), leaf area index of 4.23 and crop dry matter production of 12.52) with the highest yield attributes by recording 325.32 number of panicle m^{-2}, 117.96 filled grains $panicle^{-1}$,grain yield of 5.69 t ha^{-1} and straw yield of 7.09 presented in Table 2.

Integrating fish, poultry and lotus along with rice increased the growth and yield performance of rice compared to the sole cropping of rice revealing the ultimate cumulative benefit of the crop and synergistic effect of poultry, fish and lotus combination. This is due to the fact that, better weed and insect-pest control offering a perfect environment for the crop to use the extended nutrient supplement from poultry voiding contributed and sustained recycling of organic waste. This resulted in increased fertility status of the soil and its ability to support on excellent growth of the crop in both the seasons.

The poultry droppings have also reduced the weed competition by virtue of their acidic nature, and in combination with fish and lotus culture might have further increased the growth attributes of rice. These cumulative effect resulted in better crop performance as reflected on both grain and straw yields in both the years. These results are in conformity with the reports of Kathiresan and Vishnudevi (2021).

Effect of Integration of Rice + Fish + Poultry + Lotus on Rice Equivalent Yield (REY)

As regards the Rice-equivalent yield (REY) (Fig. 1), the treatment comprising lotus culture along with fish and poultry rice recorded the highest Rice-equivalent yield. This is because of the fish meat, poultry meat output and lotus yield in the integrated farming systems, fetched higher returns among the treatments compared. This could be attributed to a tangible expression of multifarious benefits, resulting from integration of lotus with fish and poultry in rice, *viz*., nutrient supplement, complementary pest control and enhanced fertility and productivity status of system. Fishes feed on weeds and pest, lotus reduces the water loss and also contribute for control weeds and pest to some extent, with these the addition of nutrients by poultry manure in a slow and sustained manner increased the biological productivity of the system in total. This lead to a substantial increase in the grain and

straw yield of rice. Even after losing ten per cent of the area for the trenches to accommodate fish and lotus, rice in these integrated farming treatments yielded higher than that under sole cropping of rice. These results are in conformity with the reports of Kathiresan and Vishnudevi (2021).

Conclusion

Considering the above results, it could be concluded that inclusion of Lotus with Fish and Poultry components in rice farming contributed for sustainable rice production. Further it substantially improved the improved the income and livelihood of the small and marginal rice growing farmers.

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Table 1. Growth parameters of rice (Pooled data of two years)

Treatments	Plant height (cm)	Tillers (m^{-2})	Leaf area index	Crop dry matter production (t ha^{-1})
T_2- Rice + Fish	60.45	277.81	3.17	8.70
T_3-Rice + Poultry	72.34	316.30	3.75	10.80
T_4-Rice + Lotus	75.28	330.45	3.89	11.03
T_5- Rice + Fish + Poultry	67.18	290.90	3.57	11.34
T_6- Rice + Fish + Lotus	81.47	362.625	4.34	12.21
T_7- Rice + Poultry + Lotus	78.41	343.21	4.32	12.28
T_8- Rice + Fish + Poultry + Lotus	78.37	337.69	4.23	12.52
S.Ed	**3.26**	**14.32**	**0.17**	**0.50**
CD(p=0.05)	**7.21**	**30.72**	**0.37**	**1.07**

Table 2. Yield parameters of rice (Pooled data of two years)

Treatments	No. of Panicles (m^{-2})	Filled grains $panicle^{-1}$	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1- Rice alone	222.25	73.98	3.41	4.96
T_2- Rice + Fish	253.04	85.67	4.30	5.98
T_3-Rice + Poultry	264.36	84.29	4.49	5.97
T_4-Rice + Lotus	232.72	86.46	4.57	5.76
T_5- Rice + Fish + Poultry	290.10	108.90	4.82	6.41
T_6- Rice + Fish + Lotus	274.60	106.71	4.63	6.24
T_7- Rice + Poultry + Lotus	270.15	105.77	4.63	6.29
T_8- Rice + Fish + Poultry + Lotus	325.32	117.96	5.69	7.09
S.Ed	**11.46**	**4.14**	**0.19**	**0.26**
CD(p=0.05)	**24.58**	**8.89**	**0.42**	**0.55**

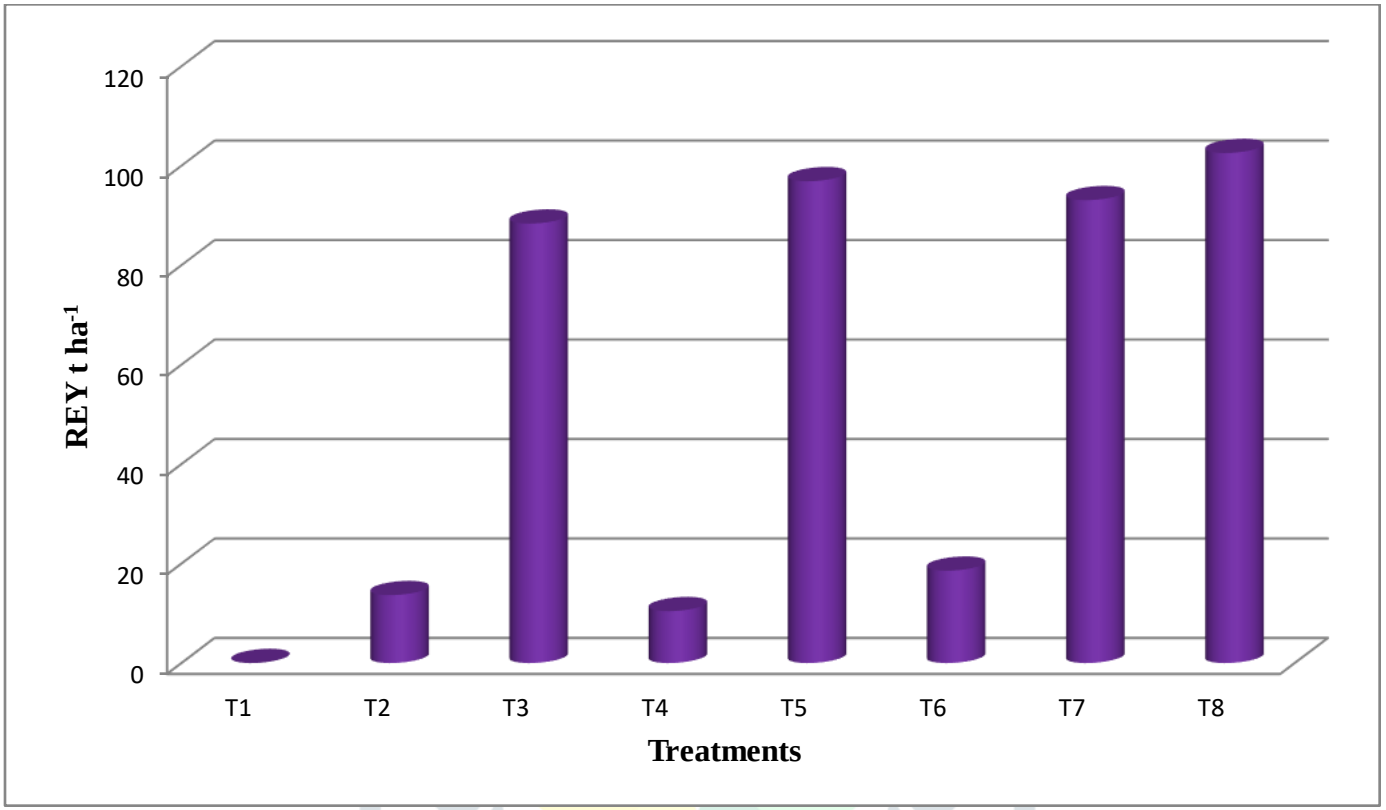

Figure 1. Rice Equivalent Yield (REY) (t ha^{-1}) (Pooled data of two years)

T_1-Rice, T_2- Rice+ Fish, T_3-Rice+ Poultry, T_4-Rice+ Lotus, T_5- Rice + Fish + Poultry, T_6- Rice+Fish+Lotus,T_7- Rice+ Poultry+Lotus,T_8- Rice + Fish + Poultry + Lotus