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Integrated farming system in enhancing the productivity of marginal rice (*Oryza sativa*) holdings in Goa

B.L. MANJUNATH[1] AND C.J. ITNAL[2]

ICAR Research Complex for Goa, Old Goa 403 402

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ABSTRACT

A field experiment was conducted at the ICAR Research Complex for Goa, Old Goa, during 1999–2000 and 2000–2001 to assess the productivity of rice (*Oryza sativa* L.)-based cropping sequences, viz. rice–brinjal (*Solanum melongena* L.), rice–cowpea [*Vigna unguiculata* (L.) Walp.], rice–groundnut (*Arachis hypogaea* L.)–rice–sunnhemp (*Crotalaria juncea* L.) and sole rice–integrated with poultry and mushroom production. The highest system productivity (21,487 kg/ha/year) of rice-grain-equivalent yield was recorded with rice–brinjal (*Solanum melongena* L.) system integrated with mushroom and poultry, followed by rice–cowpea (18,027 kg/ha/year) and rice–groundnut system (16,922 kg/ha/year). The contribution of crops towards the system productivity ranged from 33 to 52%, while the share of poultry and mushroom production was 28 to 39% and 20 to 28% respectively.

Key words : Integrated farming, Productivity, Rice-grain equivalent yield

Goa, a small state in the West coast of India, has a geographical area of 370,100 ha, with 34,112 land holdings, of which more than 80% are below 1 ha (NABARD, 2001). These marginal land holdings are further characterized by undulating terrain with diverse soil conditions. Increased cost of cultivation with incompatible scale economics and lower value for the produce are threatening rice cultivation, as evident by the increased fallow lands over years. Earlier studies have confirmed the selection of cropping system in sustaining the profitability of rice crop (Manjunath *et al.,* 1997). Integrated farming systems (IFS) seems to be the possible solution to meet the continuous increase in demand for food, stability of income and diverse requirements of foodgrains, vegetables, milk, egg, meat etc., thereby improving nutrition of the small-scale farmers with limited resources. Integration of different agriculturally related enterprises with crops provides ways to recycle products and by-products of one component as input through another linked component and reduce the cost of production and thus raises the total income of the farm. Further, farming system approach helps sustain crop productivity with increased profitability. The present study was conducted to evolve suitable farming system options for achieving sustainable income in the marginal land holdings.

MATERIALS AND METHODS

A field experiment was conducted during 1999–2000 and 2000–2001 at the ICAR Research Complex for Goa, Old Goa. The soil was sandy loam, acidic (5.99), having 292 kg/ha available N, 37.9 kg/ha available P_2O_5 and 264 kg/ha available K_2O. The experiment was conducted in split-plot design with 3 replications. Main plot tretaments comprised recycled manures from allied agro-enterprises and rice, viz. farmyard manure (FYM), poultry manure, paddy straw with mushroom-spent substrate along with a control (no recycled manure). All the recycled manures were applied to rice and the quantity of recycled manures applied to each treatment was based on the potential quantity available within the system. Recommended fertilizers of rice were given to all the treatments uniformly. Rice-based cropping systems suited to the location, viz. rice–groundnut ('DH 3-30'), rice–cowpea ('V118'), rice–brinjal ('Local'), rice–sunnhemp and rice–fallow (control), constituted the sub-treatments. The recommended fertilizers were applied to the crops. All the rice-based crops were raised under residual moisture situations except brinjal which was raised under protective irrigated conditions as per the local practice. The rice-grain-equivalent yield was worked out as per the method suggested by Jayanthi (1995). Mushroom production was integrated with crop components using paddy straw, while broken rice and rice bran formed the ingredients of a formulated feed for the integrated poultry unit. Commercially available poultry feed formed the control.

Present address : [1]Divison of Agronomy; [2]University of Agricultural Sciences, Dharwad, Karnataka 580 005

RESULTS AND DISCUSSION

Performance of cropping systems

Rice-grain-equivalent yield differed significantly due to cropping systems in both the years and their pooled mean, although recycled manures did not influence the yield significantly (Table 1). The highest rice-grain-equivalent yield was obtained with rice–brinjal, followed by rice–cowpea system. The increase in yield with rice–brinjal system was 158, 70, 45 and 123% over rice–fallow, rice–groundnut, rice–cowpea and rice–sunnhemp systems respectively. The enhanced productivity was the consequence of higher yield of brinjal (average weight of more than 250 g/fruit) and more fruits/plant than yield attributes of other rice-based crops. Balusamy (1994) also inferred that inclusion of a vegetable in the rice-based sequence recorded the highest yield with maximum production efficiency. Among the recycled manures, higher grain yield was recorded in recycled rice straw with mushroom-spent substrate and was followed by recycled poultry manure.

Table 1. Effect of recycled manures on rice-grain-equivalent yield (kg/ha) in different cropping systems

Cropping system	Recycled manure				
	M_0	M_1	M_2	M_3	Mean
Rice–fallow	4,216	4,171	4,169	4,688	4,311
Rice–groundnut	5,761	6,707	7,125	6,638	6,558
Rice–cowpea	7,455	7,584	8,146	7,461	7,661
Rice–brinjal	11,183	10,696	10,008	12,600	11,122
Rice–sunnhemp	4,724	5,520	4,681	5,046	4,993
Mean	6,668	6,936	6,826	7,276	
	Recycled manure		*Cropping system*		*Interaction*
CD (P=0.05)	NS		901.7		NS

M_0, No recycled manure + recommended NPK; M_1, recycled FYM+recommended NPK; M_2, recycled poultry manure + recommended NPK; M_3, recycled mushroom-spent substrate + recycled paddy straw + recommended NPK

Rice–cowpea system yielded 78% more rice-equivalent-grain yield over rice–fallow system. Early duration coupled with compact branching of the cowpea ('V 118') provided scope to accommodate an optimum plant population per unit area. Better root establishment (17 cm) in the early stages of the crop resulted in gradual depletion of soil moisture from the surface layers (1.78 cm/30 cm depth of soil). Further, extraction of more moisture from subsurface soil as compared to groundnut and sunnhemp in the sequence, resulted in increased productivity. Padhi (1993) opined that inclusion of summer cowpea not only enhanced the production of following crops but also contributed for higher total production.

Performance of integrated enterprises

The average production of mushroom was 493 kg/1,000 bags of 1 kg capacity (on wet-weight basis). The production was spread over the year with storing of rice straw obtained from the system.

The requirement of feed for poultry formulated using the ingredients obtained from rice production system was nearly the same (2.35 kg/bird) compared with the control feed (2.47 kg/bird) (Table 2). The feed conversion efficiency in terms of feed required to produce a unit gain in weight was better with formulated feed (2.14 g feed/g grain) than the control feed. The average weight of the birds at the age of marketing was slightly higher with formulated feed (1.21 kg), with better livability (94.4%) and dressing (77.3%) than the control feed. Although poultry manure production was higher with the control feed (673 g/bird), the overall feed efficiency was better with formulated feed. Further, there was a substantial reduction in the feed cost (Rs 6.36/kg formulated as against Rs 8.10 kg control feed). The better performance of integrated mushroom and poultry units indicated that these enterprises are complimentary with rice production. The cost of maintenance of mushroom was lower (only 38.8% of poultry), owing to the low priced raw materials for its cultivation. Jayanthi (1995) inferred that integration of cropping with mushroom and poultry resulted in higher production than cropping alone.

Table 2. Performance of broiler chicks reared with formulated feed

Variables	Formulated feed	Control feed
Total feed requirement for 72 birds (kg)	169.0	177.8
Feed consumption (g/bird)	2,350	2,470
Feed conversion (g feed/g grain)	2.14	2.17
Livability	94.4	91.7
Average weight of birds at 42 days (g)	1,207	1,186
Weight gain (g/bird)	1,161	1,140
Dressing (%)	77.3	76.2
Poultry waste production (g/bird)	667	673
Total poultry manure production (including coir waste litter) for 72 birds (kg)	140.4	140.9
Feed cost (Rs/kg)	6.36	8.10

Productivity of the integrated systems

The system productivity as measured in terms of rice-grain-equivalent yield is presented in Table 3. The contribution of crops towards the system productivity ranged from 33 to 52%, while poultry and mushroom contributed 28 to 39% and 20 to 28% respectively.

The highest system productivity of 21,487 kg/ha/year of rice-grain-equivalent yield was recorded with rice–brinjal system integrated with mushroom and poultry pro-

Table 3. Productivity of integrated farming systems (mean data over 2 years)

Farming system	Component productivity (kg/ha)			Rice-grain-equivalent yield (kg/ha)
	Crop	Poultry	Mushroom	
Rice cropping alone	4,311			4,311
Rice–groundnut + mushroom + poultry	6,557 (39)	6,060 (36)	4,305 (25)	16,922
Rice–cowpea + mushroom + poultry	7,662 (43)	6,060 (34)	4,305 (23)	18,027
Rice–brinjal + mushroom + poultry	11,122 (52)	6,060 (28)	4,305 (20)	21,487
Rice–sunnhemp + mushroom + poultry	4,993 (33)	6,060 (39)	4,305 (28)	15,358

Figures in parentheses indicate per cent contribution to the total system productivity

duction. This was followed by rice–cowpea (18,027 kg/ha/year) and rice–groundnut system (16,922 kg/ha/year) integrated with mushroom and poultry production. Rice–brinjal with mushroom and poultry system recorded nearly 400% more productivity, of which 240% was contributed by allied enterprises, viz. mushroom (100%) and poultry (140%). Similarly, rice–cowpea sequence cropping integrated with mushroom and poultry resulted in 318% more productivity over rice alone.

Poultry and mushroom production when maintained with recycled by-products of rice production system such as rice straw, rice bran and broken rice, the dependence and cost incurred on externally purchased inputs was greatly reduced. A better market for the products, viz. mushroom, poultry etc. resulted in substantial benefits to the system. Chandrashekaran *et al.* (1994) working in Cauvery Delta area and North-western zone of Tamil Nadu opined that integrated farming systems are better over existing cropping systems.

Thus integration of poultry and mushroom production with recycling of by-products obtained from rice system and adoption of improved cropping system enhanced the productivity of marginal rice lands substantially.

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