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Performance of rice (*Oryza sativa*) and maize (*Zea mays*)-based cropping systems under mid-hills of Mizoram

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ABSTRACT

A field experiment was conducted during 2001–2002 at Mizoram Centre, ICAR Research Complex, Kolasib, to assess the productivity and economics of different rice (*Oryza sativa* L.) and maize (*Zea mays* L.)–based cropping systems under mid-hill conditions of Mizoram. The highest maize-equivalent yield (60.64 q/ha) was obtained with maize + groundnut (*Arachis hypogaea* L.)–mustard [*Brassica juncea* (L.) Czernj. & Cosson] crop sequence with highest net returns (Rs 1,6476/ha) and benefit : cost ratio (2.19). Intercropping legumes with cereals was found to be highly productive and profitable inclusion of groundnut as an intercrop with rice and maize not only enhanced crop yields and highest net returns but also had positive effect on soil fertility build up. Sole cropping of maize–mustard was found to be very exhaustive and unremunerative, while inclusion of groundnut as an intercrop was highly stable and profitable.

Key words: Rice, Maize, Cropping systems, Productivity, Economics, Soil fertility

The importance of highly intensive crop sequence is well recognized to meet the growing demands of ever-increasing population of the region. An intensive cropping system, which is not only highly productive and profitable but also stable over time and maintains soil fertility, is of great importance in present condtions (Alok Kumar *et al.*, 2001). Cultivable jhum lands of Mizoram possess the problems of severe soil erosion, low water and nutrient availablity, steep sloppiness and undulating topography and low cropping intensity which leads to lower crop productivity (Laxminarayana, 2000). Rice and maize are the major food crops in the state which are mostly grown under mid-altitude regions. Most of the land remains fallow in the winter (rabi) season due to lack of irrigation sources and insufficient in-situ moisture status resulting in lower cropping intensity (102%) in the state. It is well recognized that the basic requirement for stabilizing the crop productivity lies in the betterment of soil fertility. In this context, the present investigation was carried out to study the performance of rice- and maize-based cropping systems and their relative effect on soil fertility status.

MATERIALS AND METHODS

The field experiment was conducted at ICAR Mizoram Centre, Kolasib, Mizoram, in the upland terraces for 2 years (2001 and 2002). The experimental soil was a Typic Hapludult, acidic (pH 5.4), non-saline (EC 0.68 dS/m), medium in organic carbon (0.69%), low in available N (276 kg/ha) and P_2O_5 (18.60 kg/ha) and high in K_2O (402.9 kg/ha). The experiment consisted of 8 treatments of various cropping systems (T_1, sole rice; T_2, sole maize; T_3, sole groundnut; T_4, sole soybean [*Glycine max* (L.) Merr.]; T_5, rice + groundnut, 4:2 rows; T_6, rice + soybean, 4:2 rows; T_7, maize + groundnut, paired rows; and T_8, maize + soybean, paired rows) in rainy season (*kharif*) and a uniform crop of mustard in the winter season. The cultivars of 'RCPL 1-27', 'RCM 1-3', 'ICGS-65', 'JS 335' and 'Peelasona' were taken for rice, maize, groundnut, soybean and mustard respectively. The experiment was laid out in randomized block design with 3 replications.

The doses of fertilizers applied were, rice : 80-60-40; maize : 120, 60, 40; groundnut: 30-60-40; soybean: 30-60-40; mustard: 60, 40, 40 kg N, P_2O_5 and K_2O/ha respectively. All the cultural practices were followed as per the recommended schedule for different crops. The crops were harvested at maturity and yield parameters were recorded. Soil samples were collected after harverst of the crops from each treatment and analysed for physico-chemical properties (Jackson, 1973). Maize-equivalent yield (MEY) was calculated based on the average yield data for the 2 cropping seasons. The monetary values of crops were estimated depending upon the prevailing market prices.

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Table 1. Grain yield (q/ha) of individual crop components, economics and changes in soil fertility status under different rice- and maize- based cropping systems (mean data of 2 years)

Cropping system	Rainy-season crop yield	Mustard yield	Maize-equivalent yield (q/ha)	Gross returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	Benefit: cost ratio	Organic carbon (%)	Available nutrient (kg/ha)		
									N	P_2O_5	K_2O
Rice–mustard	24.98	4.40	35.54	17,770	12,725	5,045	1.40	0.61	267	20.60	366
Maize–mustard	44.83	3.27	52.67	26,339	14,050	12,289	1.87	0.57	248	19.25	355
Groundnut–mustard	17.84	3.77	57.22	28,608	13,450	15,678	2.13	0.62	283	22.07	381
Soybean–mustard	9.07	3.70	44.27	22,127	13,050	9,077	1.69	0.59	278	21.57	373
Rice+groundnut–mustard	16.49+9.67	3.43	50.85	25,416	13,350	12,066	1.90	0.58	275	21.20	372
Rice+soybean–mustard	15.47+6.53	3.07	48.29	24,153	12,950	11,203	1.87	0.57	271	20.12	368
Maize+groundnut–mustard	30.72+8.09	3.37	60.64	30,326	13,850	16,476	2.19	0.61	265	21.85	361
Maize+soybean–mustard	29.33+4.87	2.92	55.34	27,666	14,150	13,516	1.96	0.58	260	20.57	359
Initial value								0.69	276	22.40	403
CD (P=0.05)			6.65					0.03	4	1.11	6

Prevailing market price (Rs/q): Rice, 500; maize, 500; groundnut, 1,350; soybean, 1,950; mustard, 1,200

RESULTS AND DISCUSSION

Performance of cropping systems

The highest grain yield in terms of maize-equivalent yield (60.64 q/ha) was obtained by maize + grondnut–mustard cropping system (Table 1), followed by groundnut–mustard (57.22 q/ha) and maize + soybean–mustard (55.34 q/ha). However, lowest maize-equivalent yield (35.54 q/ha) was recorded with rice–mustard sole cropping.

The highest maize-equvalent yield in maize-based cropping systems was owing to high market price and highest yield of the crop in both the years. It was observed that the seed yield of mustard was lower in the maize-based cropping systems than rice-based cropping systems, probably due to the fact that maize is a heavy feeder of different nutrients and show considerable effect on crop yields of the successive crop. Inclusion of groundnut as an intercrop in both rice and maize proved stable for increasing productivity. Soybean also showed significant effect on crop yields as an intercrop in maize than in rice. Positive effect of legume crops on soil fertility was observed, which in turn increased the crop yields either as sole or intercropping with different cereals. The results confirm the findings of Munda *et al.* (1999) and Nanda *et al.* (1999).

Economics

The pooled analysis of results for 2 years on grain yield in terms of maize eqivalent yield (Table 1) revealed that maize + groundnut – mustard cropping system recorded highest net returns (Rs 16476/ha) with highest benefit: cost ratio (2.19), followed by groundnut–mustard (2.13) and maize + soybean–mustard (1.96). The maize-based cropping systems though recorded highest cost of cultivation, provided maximum net returns than the rice-based systems, which might because of high maize-equivalent yield and high local market price of grondnut and maize. Inclusion of grondnut as an inter-crop with both the rice- and maize-based cropping systems is more profitable and stable in comparison to other sequences. However, cultivation of soybean with rice or maize showed lower net returns and benefit : cost ratio due to lower productivity and higher input cost. These results are in agreement with the earlier findings of Mudna *et al.* (1999).

Soil fertility status

Changes in soil fertility status over 2 years (Table 1) revealed that there was a significant reduction in organic carbon, available N, P and K under different cropping sequences, except available N in groundnut – mustard crop sequence. Maximum reduction of soil fertility was observed in maize- - mustard cropping sequence because

maize was a heavy feeder of different essential nutrients as a sole crop than inter copped with groundnut of soybean. However, inclusion of legume crops in both rice-and maize-based cropping systems showed slight improvement in the soil fertility than the sole cropping of cereals. Similar results were also reported by Alok Kumar *et al.* (2001). Among all the crop sequences, groundnut sole cropping showed a significant increase in available N over the initial status followed by soybean–mustard sequence. From these findings, it appears that inclusion legume crops may help in stabilizing the crop yields by improving soil fertility in long term (Ghosh, 1987).

It can be concluded that cultivation of maize as a sole crop is inferior in terms of soil fertility and it should be grown with inter crops like groundnut or soybean for obtaining higher and sustainable crop yields besides maintaining the soil fertility in the highly eroded hilly terrains of Mizoram. Similarly, upland rice in mixed stand with legume crops provides more crop yields and improves fertility status of the soil than rice as a sole crop. Increasing cropping intensity with suitable high-yielding varieties in the crop sequences was found to be more productive and remunerative that sole cropping with cereals.

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