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Production potential and economic analysis of various cropping systems for Central Plains Zone of Uttar Pradesh

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ABSTRACT

A field experiment with 9 crop sequences was conducted during 1997–2001 at Kanpur, Uttar Pradesh. All these cropping sequences were evaluated for their production potential, calorific value, production efficiencies, land-use efficiency and economics. Rice (*Oryza sativa* L.)-equivalent yield was recorded maximum (155.9 q/ha) through maize (*Zea mays* L.)–potato (*Solanum tuberosum* L.)–wheat (*Triticum aestivum* L. emend. Fiori & Paol.) sequential cropping, while high calorific value (46,857 k. cal) and production efficiency (65.96 kg/ha/day) were with maize–potato–sunflower (*Helianthus annuus* L.) and highest land-use efficiency (91.2%) was measured with rice–wheat–green manuring cropping systems. Economic analysis revealed that the maximum net profit (Rs 30,617/ha), production efficiency (109.36 Rs/ha/day) and benefit : cost ratio (1.95) were recorded in rice–wheat crop sequence over other cropping systems. Hence maize–potato–wheat and rice–wheat sequences in the zone remained identified as the most biologically efficient and profitable cropping systems respectively.

Key words : Production potential, Economic analysis, Production efficiency, cropping systems

The Central Plains Zone of Uttar Pradesh is the largest zone having highly productive alluvial soils with intensive irrigation and increased cropping intensity. The rice and maize crops are the most common crops utilized as base crop for different sequential cropping systems. Rice–wheat is the prominent cropping system of irrigated areas of Central Plains Zone of Uttar Pradesh. This system needs high input resources for higher production which results in increase of cost per unit of area and time. The demand for continuous increase in per hectare yields and income in rice–wheat system requires high amount of input resources than used at present. The present levels of fertilizer availability and economic conditions of large number of farmers do not permit applying them in quantities adequate enough to meet the total plant nutrient needs at the desired level of productivity. In view of this it would be advantageous if a more profitable and economically viable sequence could be introduced under such a situation for long-term productivity and sustainability to the system.

MATERIALS AND METHODS

A field experiment was undertaken during 1997–2001 at Students' Instructional Farm of the University, Kanpur, under All-India Co-ordinated Research Project on Cropping Systems, to identify biologically most efficient and profitable cropping systems for Central Plains Zone of Uttar Pradesh. The soil was neutral to slightly alkaline of alluvial type having pH 7.8 and organic carbon 0.38%. It was low in available phosphorus (12.5 kg/ha), medium in available potash (175 kg/ha) and low in nitrogen (125 kg/ha). The experiment was laid out in balanced incomplete block design with 4 replications on a fixed site. There were 9 crop rotations tested, out of these 5 were rice-based, 3 were maize-based and 1 crop rotation was soybean-based cropping system (Table 1). In rainy season, 'Pant Dhan 12', Azad Uttam' and 'Gaurav' varieties were used for rice, maize and soybean respectively. In winter (*rabi*), 'PBW 343' (wheat), 'Azad Uttam' maize, 'Azad P 1' vegetable pea, 'Kufri Badshah' Potato and 'Varuna' mustard were tested. In summer, 'Morden' sunflower and 'K 851'greengram were sown.

To compare crop sequences, the yield of all crops were converted into rice equivalent on price basis (Verma and Mudgal, 1983). Production-efficiency values in terms of kg/ha/day were worked out by total production in a crop rotation divided by total duration of crop in that rotation. Land-use efficiency was obtained by taking total duration of crop in individual crop rotation divided by 365 days. The production efficiency values in terms of Rs/ha/day were calculated by net monetary returns of the rotation divided by total duration of the crop in that rotation

(Tomar and Tiwari, 1990). The calculation of calories was done on the basis of calories found in a particular crop on per gram basis.

RESULTS AND DISCUSSION

System productivity

The mean seed yield of 4 years revealed that the maximum yield of rice in rice–wheat–green manuring, where green manuring was taken in summer after wheat followed by rice–mustard–sunflower sequence (Table 1). It was owing to beneficial effect of green manuring on the soil health. In maize-based crop sequences, maximum yield was obtained with maize–vegetable–sunflower compared to maize–potato–wheat and maize–potato–sunflower cropping systems. On the basis of rice equivalent yield, significantly highest yield (155.9 q/ha) was recorded through maize–potato–wheat rotation followed by maize–potato–sunflower in comparision to rice–wheat–green manure crop sequence amongst all 9 crop rotations.

Energetic value

Maximum calorific value was found in maize–potato–sunflower crop sequence, followed by maize–potato–wheat and rice–wheat–green manuring (Table 1). This indicates that maize–potato–sunflower crop sequence have high value, high quality produce with highest biological efficient crop sequence, followed by maize–potato–wheat and rice–wheat–green manure crop sequences.

Land-use efficiency and production efficiency

Land-use efficiency of all 9 crop sequences revealed that highest land-utilization efficiency was observed in rice-based cropping systems, i.e. rice–wheat–green manuring, followed by rice–maize–green manuring than maize-based cropping system, i.e. maize–potato–wheat (Table 1).

Highest production efficiency was obtained through maize potato–sunflower cropping sequence, followed by maize–potato–wheat and the minimum in rice–maize–green manuring (Table 1).

Economic analysis

Among all 9 crop sequences, the highest gross returns (Rs 84,200/ha) were recorded with maize–potato–wheat, followed by maize–potato–sunflower (Rs 81,923/ha). It was owing to higher system productivity in all 9 crop sequences. Rice–wheat sequence fetched the highest net monitory return (Rs 30,617/ha), followed by rice–wheat–green manuring crop sequence (Rs 29,262/ha) and soybean–wheat (Rs 22,619/ha). The higher net return from rice-based crop sequences were more merely because of low cost of cultivation of these sequences (Singh and Verma, 1998). The benefit : cost ratio also showed the

Table 1. Yield, rice-equivalent yield, total calories, land-use efficiency and production efficiency of different crop sequences (mean data of 4 years)

Crop rotation	Yield (q/ha)						Rice-equivalent yield (q/ha)	Total calories (K×1,000)	Land-use efficiency (%)	Production efficiency (kg/ha/day)	Net return (Rs/ha)	Benefit : cost ratio	Production efficiency (Rs/ha/day)
	Rainy season		Winter season		Summer								
	Grain	Straw	Grain	Straw	Grain	Straw							
Rice–wheat–sesbania (GM)	42.50	61.23	46.17	70.34			119.9	34,514	91.2	36.01	29,262	1.82	87.87
Rice–mustard–sunflower	40.38	59.82	16.67		13.14		118.9	27,872	75.6	43.09	17,717	1.38	64.19
Rice–mustard–greengram	36.54	56.38	17.04		9.32		100.3	25,809	75.6	36.35	12,683	1.31	45.95
Rice–maize–sesbania (GM)	38.54	55.89	35.44	119.83			84.3	25,615	87.1	26.52	10,046	1.28	31.59
Maize–potato–sunflower	31.90	135.77	214.71		14.27		151.7	46,857	63.0	65.96	12,923	1.19	56.19
Maize–potato–wheat	32.23	139.04	160.50				155.9	39,878	83.3	51.29	13,200	1.18	43.42
Maize–vegetable–sunflower	32.73	139.90	23.71	35.81	13.57		119.5	23,215	69.0	47.43	19,545	1.45	77.56
Soybean–wheat	11.34	30.51	48.18	76.82			94.6	25,127	75.9	35.06	22,619	1.79	83.77
Rice–wheat	40.09	57.43	45.29	69.80			115.9	32,606	76.7	41.41	30,617	1.95	109.36
CD (P=0.05)							2.3						

GM, Green manuring

same trend, i.e. more in rice–wheat or soybean–wheat sequences and low in maize-based crop rotations. It showed that the rice- or soybean-based crop rotation are input responsive crop rotations resulted with higher return/ha. Further, production efficiency in terms of Rs/ha/day was also maximum (109.3) in rice–wheat crop sequence, followed by rice–wheat–green manuring (87.5) and soybean–wheat (83.7).

Thus the maize–potato–sunflower and maize–potato–wheat crop sequences are more biologically efficient crop sequences having more calorific value and cash ensuring crops, but rice–wheat, rice–wheat–green manuring and soybean–wheat crop sequences are more input responsive and highly profitable crop sequences and fetch more return per unit of area and time, as also reported by Raskar *et al.* (2000). However, the farmers still prefer rice–wheat sequence because of better stability and assured government procurement policy with greater remunerative profit margins than other less assured crop sequences in the Central Plains Zone of Uttar Pradesh.

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