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Productivity and economics of different maize *(Zea mays)*-based crop sequences under dryland conditions

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ABSTRACT

A field experiment was conducted during 1993–97 at Rakh Dhiansar, Bari-Brahamana, Jammu, to study the productivity and economics of diffferent maize (*Zea mays* L.)-based cropping systems. Among the cropping sequences tried, the productivity and net returns were the highest in maize–wheat (*Triticum aestivum* L. emend. Fiori & Paol.) sequence, followed by green fodder–*toria* [*Brassica campestris* L. ssp. *oleifera* (metzger) sinsk. var. *toria*]+*gobhi sarson* (*B. napus* L. ssp. *oleifera* DC. var *annua* L.). Maize–*toria*–wheat and greengram–(*Phaseolus radiatus* L.) *toria*–wheat achieved the highest land-utilization efficiency. However, the production efficiency was the highest in green fodder–*toria*+*gobhi sarson* sequence, followed by maize–wheat sequence.

Key words : Maize-based crop sequences, Equivalent yield, Economics, Net returns, Production efficiency

As the scope of increasing irrigation potential in the near future seems to be very limited in our country, the development of feasible cropping systems for the rainfed areas is the need of the hour. Maize, being a short-duration, moderately drought-tolerant and comparatively high yielding, is the major rainy (*kharif*)-season crop of the rainfed areas of Jammu region. Apart from the production potential and the land utilization, there is a need to evaluate crop sequences on the basis of their nutrient requirement and stability of production. The need for inclusion of oilseeds and pulses for sustainable crop production has also been recognized now. Therefore an investigation was carried out to study the production potential, land utilization and economics of maize-based crop sequences for 5 years.

MATERIALS AND METHODS

A field experiment was conducted from 1993–94 to 1997–98 at Dryland Agriculture Research Sub-Station, Rakh Dhiansar, Bari-Brahamana, Jammu, to study the feasibility of promising maize- based crop sequences. The treatments comprising 8 crop sequences, viz. maize–wheat (CS_1), green manuring (GM)–*toria*–wheat (CS_2), greengram–*toria*–wheat (CS_3), green-manuring–wheat (CS_4), maize–*toria*–gram (CS_5), maize–*toria+gobhi sarson* (CS_6) maize–*toria*–wheat (CS_7) and green fodder–*toria+gobhi sarson* (CS_8), laid out in randomized block design with replications in plots of 105 m^2. The soil of the experimental site was sandy loam in texture, having pH 6.8, organic carbon 0.32%, available nitrogen, phosphorus and potash 165, 16 and 95 kg/ha respectively. The recommended fertilizer doses were applied in all the crops. The rainy-season crops were sown with the onset of monsoon and harvested at the physiological maturity stage to conserve the residual soil moisture. The harvesting of green fodder was done in August and thereafter the soil moisture was conserved by ploughing followed by planking. *Gobhi sarson* and *toria* were sown in late September and the sowing of gram was done in the second week of October every year. Plant-protection measures were adopted as per the need of the crops.

For comparison between crop sequences, the yields of all the crops were converted into maize equivalent on price basis (Verma and Modgal, 1983). The land-use efficiency was worked out by taking total duration of crops in individual crop sequence divided by 365 and production-efficiency values were obtained by total production in a sequence divided by total duration of crops in that sequence (Tomar and Tiwari, 1990).

RESULTS AND DISCUSSION

Maize-equivalent yield

Maize–wheat sequence was found most productive crop sequence with respect to maize-equivalent yield, followed by green fodder–*toria+gobhi sarson* and maize–*toria* wheat (Table 1).

However, these crop sequences were at par with each other in this respect. Maize-equivalent yield recorded from greengram–*toria*–wheat sequence was significantly higher than green manure–*toria*–wheat and maize–*toria*+gram. It was significantly lower than that recorded in maize–wheat and green fodder–*toria+gobhi sarson* crop sequences. This was due to low yield of wheat after *toria* in case of green manure–*toria*–wheat and *toria* and gram after maize in maize–*toria* + gram crop sequence. Maize–*toria+gobhi sarson*, green manure–wheat, green manure–wheat and maize–*toria*+gram crop sequences were statistically at par with each other in this respect.

Land use and production efficiency

Maize–*toria*–wheat and greengram–*toria*–wheat crop sequences achieved the highest land-use efficiency of 82% (Table 1), followed by maize–wheat, maize–*toria*+gram, maize–*toria+gobhi sarson* and green fodder–*toria+gobhi sarson*. The lowest land-use efficiency was recorded in green manuring–wheat sequences, as the land was occupied by the crops for a short period in this sequence in comparison with other crop sequences studied. Production efficiency was the highest in green fodder–*toria+gobhi sarson*, followed by maize–wheat, greengram–*toria*–wheat and maize–*toria*–wheat. Green manuring–*toria*–wheat and maize–*toria+gobhi sarson* accrued more or less the similar production

Table 1. Grain yield and economics of different maize-based crop sequences (pooled over 5 years)

Crop sequence	Grain yield (kg/ha)	Land-use efficiency (%)	Production efficiency (kg/ha/day)	Gross returns (Rs/ha/year)	Net returns (Rs/ha/year)	Benefit: cost ratio
Maize	2,520	73.9	18.70	26,375	14,175	1.16
Wheat	2,700					
Maize equivalent	5,051*(270)					
Green manuring		60.3	12.35	12,534	3,234	0.34
Toria	624.5					
Wheat	1,592.0					
Maize equivalent	2,728.0 (220)					
Greengram	366.5	82.0	16.87	15,100	4,875	0.47
Toria	208.0					
Wheat	2,491.5					
Maize equivalent	3,740.0 (300)					
Green manuring		49.3	10.17	14,070	3,345	0.31
Wheat	3,257					
Maize equivalent	3,053.0 (180)					
Maize	1,873.50	71.2	10.48	11,980	2,650	0.28
Toria	160.5					
Gram	214.0					
Maize equivalent	2,726.0 (260)					
Maize	1,973.0	82.0	14.18	14,240	3,415	0.31
Toria	250.0					
Wheat	1,908.0					
Maize equivalent	4,256.0 (300)					
Maize	1,833.50	71.0	12.66	16,352	3,227	0.28
Toria	155.0					
Gobhi sarson	527.0					
Maize equivalent	2,393.0 (260)					
Green fodder	29,410.0	65.7	20.39	17,908	12,058	2.06
Toria	281.0					
Gobhi sarson	583.0					
Maize equivalent	4,894.0 (240)					
CD (P=0.05 for Maize equivalent	888.0					

Figures in parentheses indicate duration of crops in that sequence efficiency. All other crop sequences had more or less the similar production efficiency. It was the lowest in green manuring–wheat and maize–*toria*+gram. This was due to less production in these crop sequences spread over a long duration compared with other cropping systems.

Economics

Maize–wheat crop sequence accrued the highest gross returns as well as the net returns followed by green fodder–*toria*+*gobhi sarson*. Green manuring–*toria*+wheat, maize–*toria*+wheat and maize–*toria*+*gobhi sarson* accrued more or less the same net returns per unit area, though the crop sequences having green manuring were the most beneficial ones with regard to sustainability and soil health. The lowest net returns was recorded in maize–*toria*+gram sequence. This was mainly due to realization of low yields of *toria* and gram, after maize crop. Green fodder–*toria*+*gobhi sarson* recorded the highest benefit : cost ratio, followed by maize–wheat, greengram–*toria*+wheat. This was possibly due to the realization of high yields of green fodder, *toria* and *gobhi sarson* in this sequence and the cost involved in the production of these crops.

The intercropping or mixed cropping is considered ideal under limited soil-moisture conditions. The growth of *gobhi sarson* in the early stages is very slow and it remains suppressed temperarily, whereas the *toria* being a short-duration crop grows normally by using the available resources. Being slow in establishment and late in maturity, *gobhi sarson* combined well with early-maturing toria which helped in the efficient use of above- and below-ground resources by the component crops and subsequently increased the productivity, monetary returns and benefit : cost ratio. These results corroborate the findings of Jadhav *et al.* (1991), Mulik *et al.* (1996) and Verma and Warsi (1999).

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