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Research Article

Effect of Preceding Crops and Nitrogen Rates on Economic Studies of Winter Hybrid Maize (*Zea mays* L.)

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Abstract

A field experiment was conducted at Agronomy research farm of IAAS, Rampur, chitwan, Nepal during summer and winter season 2010 and 2011 to study the effect of crop sequence and nitrogen rates on hybrid maize. The research finding revealed that maximum gross return (Rs 53660 /ha in 2010 and Rs 60450/ha in 2011) was obtained from maize grown after greengraml while maximum net return (Rs 30170/ha in 2010 and Rs 33440/ha in 2011) was obtained from maize under greengram-maize sequences. Benefit & cost ratio was maximum (1.22 in 2010 and 1.18 in 2011) from maize under greengram-maize sequences while it was minimum (0.50 in 2010 and 0.47 in 2011) under maize–maize sequences. Maximum maize equivalent yield 11516 kg /ha in 2010 and 12710 kg /ha in 2011) was obtained under maize-maize sequences while it was minimum (4310 kg /ha in 2010 and 4624 kg /ha in 2011) under clusterbean-maize sequences. Maize equivalent yield was maximum (10824 kg /ha in 2010 and 11923 kg /ha in 2011) with 200 kg N/ha while it was minimum (7384 kg /ha in 2010 and 8206 kg /ha in 2011) without nitrogen. Grain production efficiency was maximum (32.0 kg /ha/day under greengram– maize sequences in 2010. but in 2011, maximum grain production efficiency (34.8 kg /ha /day) was recorded under maize–maize sequences which was comparable to grain production efficiency under greengram-maize sequence. Maximum grain production efficiency (29.2 kg/ha/day in 2010 and 32.8 kg /ha/day in 2011) was obtained with 200 kg N/ha.

Keywords: Preceding crop; nitrogen rates; summer legumes; inclusion; crop sequence; production efficiency.

Introduction

Winter maize has got highest production potential among the crop plants and due to wide variability in plant morphology; it has extremely wider adaptability also. It is more efficient than rice, wheat, barley. It is a heavy feeder of fertilizer nutrients particularly nitrogen, its effect being manifested quickly on plant growth and productivity. Among cereals, Maize is an important food and feed crops which rank second after rice and then wheat where as in global context it ranks third after wheat and rice. It is the second most important staple food crop both in terms of area and production after rice in Nepal. It is grown in 8, 70,166 hectare of land with an average yield of 2159 kg/ha. It occupies about 28.15% of the total cultivated agricultural land. Winter maize has an important place amongst the winter crops of the country and the other crops are wheat, gram, lentil, pea etc, under upland rainfed condition summer maize, green gram, black gram, cowpea, cluster bean are grown in rainy season and after the harvest of these crops during winter wheat, lentil, gram, mustard and winter maize are grown.

Maize being C_4 plant is called photosynthetically most efficient plant in general among cereal and among three season of maize i.e winter, spring season and rainy season. Winter maize is physiologically, biotic and abiotic point of view is most efficient. Hence, from maximum production point of view winter maize is top most among winter season crops i.e. wheat, barley and others. Although maize is grown in all seasons i.e. spring, rainy and winter season, the productivity of winter maize is much higher than other season maize (Sherchan *et al*., 2004) For many crop plants of temperate zone, optimum temperature for photosynthesis is lower than that for respiration, This has been suggested as one of the reasons for the higher yields of starchy crops

such as maize and potatoes in cool climates as constrained with the yield of these crops in warmer region. Inner terai winter season temperature is favourable for photosynthesis than respiration during period of winter maize. For best growth, mean day temperature is 24 ^{o}C, which is likely to be available for maize in winter season rather than other season i.e. spring and rainy season.

Maize-wheat and Maize-toria is widely adopted crop sequence and more popular under upland conditions. Besides the higher production potential for grain, higher amount of feed and fodder is also obtained under this sequence. But the continuous adoption of this sequence on same piece of land may have adverse effect on physical, chemical and biological properties of soil as continuous cropping of cereals impoverish yield of succeeding crops but inclusion of legumes in the rotation benefits the succeeding crops (Bains 1962).

Nitrogen is the most limiting nutrient for maize production. Maize is an exhaustive crop and requires high quantities of nitrogen. The practice of fertilizer recommendation on the basis of individual crop is becoming less relevant because individual crop is a component of cropping system and cannot be grown in isolation. Therefore, fertilizer recommendation should be made by giving due considerations to nature of preceding crops or in other words the cropping system as a whole besides the soil condition. To analyze the benefit cost ratio of maize crop sequence with various nitrogen fixing legumes and their economic return rates from maize using nitrogen supplement is the main objective of this research.

Materials and Methods

Field experiment under upland ecosystem was conducted in split plot design with three replications at Institute of Agriculture and Animal Science (IAAS) Agronomical research farm Rampur, Chitwan during 2010 and 2011, keeping crop sequence in main plots and nitrogen rates to maize in sub plots. The main plots treatments consisted six crop sequence i.e. fallow-maize, Maize-maize, green gram-maize, cowpea -maize, black gram-maize, cluster bean-maize. The sub-plot treatment consisted five nitrogen rates to maize i.e. 0, 50, 100, 150 and 200 kg N/ha. Experiment was laid down in a split plot deign with thirty treatment and three replications. The soil of the experimental field was free from any kind of salinity/sodicity hazards. Soil was suitable to variety of crops of tropical and subtropical regions. Soil was loamy sandy soil with neutral pH (7.0). The climate of the experimental farm was characterized as subtropical humid. Economics studies of different summer legumes crops was studied along with Rajkumar, Indian hybrid maize, variety sown at row to row distance 60 cm and plant to plant 20 cm, popularly grown in Chitwan and terai region of Nepal which is a semi-dent and orange flint type possess relatively longer ear with high disease resistant and responsive to fertilizer and water.

After harvest economic return studies was done i.e. gross return from maize, net return, benefit: cost ratio, gross return, net return and benefit: cost ratio from different crop sequences, productivity of different crop sequences and grain production efficiency was calculated and statistical analysis was done. Cost of cultivation was calculated on the basis of available local charges for different agro-inputs viz., price of seed, labor wages, fertilizer, machines, chemicals and other necessary materials.

Result and Discussion

Economic studies

Gross return from maize

Different crop sequences brought significant variation in gross return obtained from maize during both the years. (Table1). Maximum gross return was obtained under greengram- maize sequences during both the years and it was significantly higher than under all other crop sequence. In 2010, gross return under cowpea- maize, blackgram-maize and clusterbean- maize sequences was significantly more than under fallow- maize and maize-maize. Further gross return under fallow- maize sequences was significantly higher than under maize- maize sequences.

In 2011, gross return obtained under cowpea- maize, blackgram- maize sequences was significantly more than under cluster bean- maize, fallow- maize and maize-maize. However, gross return under clusterbean –maize, fallow-maize was significantly more than under maize- maize sequence.

Nitrogen rate resulted significant increase in gross return obtained from maize during both the years. (Tale 1). Maximum gross return rupees 63250 and rupees 72800 /ha was obtained with 200 kg N/ha in 2010 and 2011 respectively.

Successive increase in nitrogen rate from 0 to 200 kg N/ha caused significant increase in gross return during both the years. However gross return under 150 kg N and 200 kg N were statistically at par.

Net Return from Maize

Various preceding crops caused significant variation in net return from maize during both the years (Table 1). Maximum net return was obtained under greengrain- maize sequences which was significantly more than other crop sequences except cowpea- maize, blackgram- maize sequence during both the years. In 2010, net return under cowpea-maize, blackgram-maize, clusterbean-maize sequence was significantly more than under fallow- maize and maize-maize sequence. Further net return under fallow-maize sequence was also significantly more than under maize- maize In 2011 net return under cowpea- maize, blackgram-maize sequence was significantly more than under clusterbean-maize, fallow-maize and maize-maize sequences.

Table 1. Effects of crop sequences and nitrogen rates on economic return from maize.

Treatments	Gross return (Rs/ha)		Net return (Rs/ha)		Benefit: cost ratio	
	2010	2011	2010	2011	2010	2011
Crop sequences						
Maize -maize	35880	40700	12390	13700	0.500	0.470
Fallow- maize	41310	50270	17820	23270	0.700	0.800
Greengram- maize	53660	60450	30170	33440	1.220	1.1800
Cowpea-maize	52620	60050	29130	33050	1.170	1.170
Blackgram-maize	49710	59320	26220	32320	1.070	1.140
Clusterbeam -maize	48930	53740	25430	26740	1.030	0.930
S.Em.+-	1330	1410	1330	1410	0.050	0.040
C.D at 5%	4190	4440	4190	4440	0.160	0.150
Nitrogen rates (kg/ha)						
0	26720	30280	8680	9670	0.470	0.460
50	45330	52110	22560	25790	0.980	0.970
100	53430	62670	28010	33400	1.090	1.130
150	62590	71300	34850	39490	1.250	1.230
200	63250	72800	35850	40490	1.280	1.250
S.Em+-	1230	960	1230	960	0.050	0.030
C.D at 5%	3530	2270	3530	2770	0.140	0.090

Net return under cluster bean-maize, fallow-maize was significantly more than maize-maize. Nitrogen rates had significant effect on net return during both the years. (Table 1). Maximum net return rupees 35850 in 2010 and rupees 40490 in 2011 was obtained with 200 kg N/ha. Significant increase in net return with successive increase in nitrogen rate from 0 to 200 kg N/ha was noted during both the year.

Benefit: Cost Ratio of Maize

Benefit: Cost ratio of maize was affected significantly due to various crop sequences during both the year. (Table 1) Maximum benefit cost ratio was obtained under greengram-maize sequence and it was significantly higher than under all the other sequences during both the years.

In 2010, benefit cost ratio under cowpea-maize, blackgram-maize, clusterbean-maize was significantly higher than under fallow-maize and maize-maize sequences. Further benefit cost ratio under fallow-maize was significantly more than maize-maize sequences.

In 2011, benefit cost ratio under cowpea-maize and blackgram-maize was significantly more than under clusterbean-maize, fallow-maize and maize-maize sequences. But benefit: cost ratio under clusterbean-maize and fallow-maize was significantly more than under maize-maize sequence.

Rate of nitrogen application had significant effect on benefit: cost ratio during both the years.(Table 1). Maximum benefit cost ratio during both the years. Maximum benefit cost ratio 1.28 in 2010 and 1.25 in 2011 was recorded with 200 kg N/ha. The increase in rate of nitrogen from 0 to 50, 50 to 100, 100 to 150 and 150 to 200 kg N/ha resulted consistence and significant increase in the benefit: cost ratio during both the years.

Gross Return from Different Crop Sequences

Total number of crop sequences as a whole varied significantly under different crop sequences during both the years.(Table 2) Maximum gross return was obtained under maize -maize and it was significantly higher than other crop sequences during both the years. In 2010, gross return obtained under greengram -maize and cowpea- maize sequences was significantly more than under fallow- maize, blackgram- maize, clusterbean -maize sequences .

Gross return under fallow- maize sequences was significantly more than under black gram- maize, clusterbean -maize sequences. Further gross return under blackgram - maize was also significantly higher than under clusterbean -maize sequences.

Table 2: Gross return, net return and benefit: cost ratio under different crop sequences and nitrogen rates

Treatments	Gross return (Rs/ha)		Net return (Rs/ha)		Benefit : cost ratio	
	2010	2011	2010	2011	2010	2011
Crop sequences						
Maize -maize	71760	81400	24780	27400	0.5	0.47
Fallow- maize	82620	100540	35640	46540	0.7	0.8
Greengram- maize	105320	120900	60340	66880	1.22	1.18
Cowpea-maize	105240	120100	42260	66100	1.17	1.17
Blackgram-maize	99420	118640	52440	64640	1.07	1.14
Clusterbeam -maize	97860	107480	50860	53480	1.03	0.93
S.Em.±	2660	2820	2660	2820	0.05	0.04
C.D at 5%	8380	8880	8380	8880	0.16	0.15
Nitrogen rates (kg/ha)						
0	53440	60560	17360	19340	0.47	0.46
50	90660	104220	45120	51580	0.98	0.97
100	106860	125340	56020	66800	1.09	1.13
150	125180	142600	69700	78980	1.25	1.23
200	126500	145600	71700	80980	1.28	1.25
S.Em±	2460	1920	2460	1920	0.05	0.03
C.D at 5%	7060	4540	7060	5540	0.14	0.09

In 2011, gross return under greengram- maize, cowpea-maize and fallow- maize was significantly more than under blackgram -maize and clusterbean -maize sequences.

Further gross return under blackgram- maize was significantly more than under clusterbean - maize sequences like first years.

Gross return obtained from crop sequences as a whole significantly influenced due to nitrogen rates during both the years (Table 2). Successive increase in nitrogen rates up to 200 kg N/ha resulted significant increase in gross return.

Net Return from Different Crop Sequences

Net return from crop sequences as a whole was influenced significantly due to different crop sequences (Table 2). During both the years, net return under greengram- maize sequences was maximum (Rs. 60340/ha in 2010 and Rs 66880/ha in 2011) and significantly higher than under other crop sequences. Net return under cowpea- maize sequences was significantly higher than under maize- maize, fallow -maize, blackgram- maize and cluster bean- maize sequences. Net return under maize- maize and fallow maize was significantly more than under blackgram -maize and clusterbean -maize. Similarly net return under blackgram-maize was significantly more than under clusterbean -maize sequences.

Net return obtained from crop sequences as a whole was significantly influenced due to nitrogen rates during both the years (Table 2). Maximum net return (Rs 71700/ha in 2010 and Rs 80980/ha in 2011) was obtained with 200 kg N/ha. Net return increased significantly with successive increase in nitrogen rates from 0 to 200 kg N/ha.

Benefits: Cost Ratio of Different Crop Sequences

Benefit: cost ratio of crop sequences as a whole differed significantly due to different crop sequences during both the years.(Table 2). Maximum benefit cost ratio was obtained under greengram -maize sequences (1.28 in 2010 and 1.25 in 2011) and it was significantly more than under all other crop sequences during both the years. Benefit cost ratio under cowpea -maize was significantly more than under clusterbean- maize, fallow- maize, maize -maize and blackgram -maize sequences. In 2010 significantly higher benefit cost ratio was noted under clusterbean- maize than fallow- maize, maize- maize and blackgram- maize sequences.

Further significantly more benefit: cost ratio was recorded under fallow -maize than maize -maize and black gram-maize sequences. In 2011 benefits: cost ratio under fallow-maize and cluster bean- maize sequences was significantly more than blackgram -maize , maize - maize sequences . Further blackgram -maize sequence was significantly

superior to maize -maize sequences. Nitrogen rates brought significant variation in benefit cost ratio of crop sequences as a whole during both the years (Table 2). In 2010 significant increase in benefits: cost ratio was noted as a result of successive increase in nitrogen rate up-to 100 kg N/ha but in 2011 successive increase in benefit: cost ratio upto 200 kg N/ha.

Productivity of Different Crop Sequences

Maize equivalent yield varied significantly due to different crop sequences during both the years.(Table 3). Maize equivalent yield under maize-maize and greengram –maize sequence was significantly more than all the other crop sequences in 2010 and then under fallow- maize, blackgram-maize and clusterbean – maize sequences during 2011. Maize equivalent yield noted under cowpea-maize sequences was significantly more than under fallow-maize, black gram-maize, and cluster bean –maize sequences during both the years. Significantly more maize equivalent yield was obtained under fallow-maize sequences than black gram-maize and clusterbean- maize and under blackgram-maize sequence than under cluster bean –maize.

Various nitrogen rate resulted significant variation in maize equivalent yield during both the years. (Table3) Maximum maize equivalent yield (10824 kg/ha in 2010 and 11932 kg/ha in 2011) was recorded with 200 kg N/ha to maize. Successive increase in nitrogen rate from 0 to 200 kg N/ha brought significant and simultaneous improvement in maize equivalent yield during both the years.

Maize equivalent yield was influenced significantly due to the interaction effects of crop- sequences and nitrogen rages during 2010- 2011 only (Table 4). Maximum maize equivalent yield (14514 kg /ha) was obtained under maize– maize sequence at 200 kg N/ha which was significantly more than under all the sequence at all the nitrogen rates except greengram– maize and cowpea – maize sequences at 200 kg N/ha. At 0 , 50 , 100, 150 and 200 kg N/ha maize equivalent yield obtained under maize– maize , greengram – maize and cowpea – maize sequences was significantly more than under fallow– maize , blackgram– maze and clusterbean – maize sequences . Similarly, maize equivalent yield under fallow – maize sequences was significantly higher than under blackgram- maize and clusterbean – maize sequences. Further maize equivalent yield under blackgram- maize sequences significantly more than under clusterbean– maize sequences. Under maize – maize and clusterbean- maize sequences, successive increase in nitrogen rate resulted simultaneous and significant increase in maize equivalent yield. Under fallow – maize and blackgram- maize sequences maize equivalent yield obtained at 100, 150 and 200 kg N/ha was significantly more than at no nitrogen and 50 kg N/ha and at 50 kg N/ha than at no nitrogen treatments.

Table 3: Productivity (maize equivalents) and grain production efficiency under different crop sequences and nitrogen rates

Treatments	**Productivity (Kg/ha)**		**Grain production efficiency (Kg/ha/day)**	
	2010	**2011**	**2010**	**2011**
Crop sequences				
Maize -maize	11516	12710	31.6	34.8
Fallow- maize	9910	11112	27.2	30.4
Green gram- maize	11696	12504	32	34.2
Cowpea-maize	11044	12428	30.2	34
Blackgram-maize	11490	8794	20.6	24
Clusterbeam -maize	4310	4624	11.8	12.6
S.Em.+-	146	132	0.4	0.4
C.D at 5%	462	420	1.2	1.2
Nitrogen rates (kg/ha)				
0	7384	8206	20.2	22.4
50	9146	10204	25	28
100	9992	11148	27.4	30.6
150	10788	11894	29.6	32.6
200	10824	11932	29.2	32.8
S.Em+-	132	90	0.4	0.2
C.D at 5%	382	258	1	0.8

Table 4: Interaction effects between crop sequences and nitrogen rates on productivity (maize equivalents) and grain production efficiency during 2010-2011

Treatments	Productivity (kg/ha)					Grain production efficiency (kg/ha/day)				
	2010					2011				
	Nitrogen rates (kg/ha)					Nitrogen rates (kg/ha)				
	0	50	100	150	200	0	50	100	150	200
Crop sequences										
Maize- maize	11144	12400	13080	14214	14214	30.4	33.8	35.8	38.8	39.6
Fallow-maize	9060	10436	12320	12634	12634	24.8	28.4	33.6	34.6	35.2
Greengram-maize	9920	12844	13146	14108	14108	27	35	36	38.6	39
Cowpea- maize	10282	12652	13150	13632	13632	28	34.6	36	37.2	37.6
Black gram -maize	6298	8738	9890	10254	10254	17.2	23.8	27	28	29.2
Clusterbean- maize	2528	4152	5300	6518	6518	6.8	11.2	14.4	17.8	18.2

	S.Em±	C.D at 5%	S.Em±	C.D at 5%
For comparing crop sequences at same or different levels of nitrogen	232	690	0.6	1.8
For comparing nitrogen rates under same crop sequences	220	632	0.6	1.6

Under greengram – maize sequences maize equivalent yield obtained at 200 kg N/ha was significantly more than at all other nitrogen rates. Further maize equivalent yield at 100 and 50 kg N/ha was significantly more than at no nitrogen level. Under cowpea– maize sequences maize equivalent yield obtained at 100, 150 and 200 kg N/ha was significantly more than at no nitrogen and at 50 and 100 kg N/ha than no nitrogen treatment.

Grain Production Efficiency

Grain production efficiency varied significantly due to different crop sequences (Table 3) during both the years. Grain production efficiency under maize– maize and greengram– maize sequences was significantly more than all the other crop sequences in 2010 and than under fallow– maize, blackgram - maize and clusterbean– maize in 2011. Significantly more grain production efficiency was noted under cowpea – maize sequences than under fallow-maize, blackgram – maize and clusterbean – maize during both the years. Grain production efficiency under fallow– maize sequences was significantly more than under blackgram-maize and clusterbean – maize sequences. Further grain production efficiency under blackgram- maize was significantly more than clusterbean– maize.

Rate of nitrogen application significantly influenced grain production efficiency during both the years (Table 4). Maximum grain production efficiency (39 .6 kg /ha /day in 2010 and 38.8 kg /ha/day in 2011) was recorded with 200 kg N/ha to maize. Successive increased grain production efficiency significantly during both the years.

Effect of interaction between crop sequences and nitrogen rates on grain production efficiency was found significant in 2010 only (Table 4). Maximum grain production efficiency (34.8 kg /ha / day) was obtained under maize–maize sequences which was significantly higher than under all the sequences at all the nitrogen rate except under greengram– maize and cowpea– maize sequence at 200 kg N/ha.

At no nitrogen, grain production efficiency under maize–maize sequence was significantly more than under all other sequences. But grain production efficiency under greengram – maize and cowpea – maize sequences was significantly more than under fallow – maize, blackgram – maize and clusterbean– maize sequences was significantly more than under blackgram- maize and clusterbean–maize sequences. Further grain production efficiency under blackgram – maize sequences was significantly more than under clusterbean – maize sequences.

At 50, 100, 150 and 200 kg N/ha grain production efficiency under maize-maize greengram-maize and cowpea-maize sequences was significantly more than under all other sequences, Grain production efficiency under fallow-maize was significantly morethan under blackgram-maize and clusterbean-maize sequences. While grain production efficiency under blackgram-maize sequence was significantly more than under clusterbean-maize sequence.

Under maize–maize and clusterbean– maize sequences grain production efficiency obtained at 200 kg N/ha was significantly more than at all the other nitrogen rates. But

grain production efficiency at 100 kg N/ha was significantly more than at 50 kg N/ha and no nitrogen, while grain production efficiency at 50 kg N/ha was significantly more than at no nitrogen level.

Under fallow– maize and blackgram – maize sequences grain production efficiency obtained at 100, 150 and 200 kg N/ha was significantly more than at no nitrogen and 50 kg N/ha. While grain production efficiency at 50 kg N/ha was significantly more than no nitrogen level. Under greengram – maize sequences grain production efficiency at 200 kg N/ha was significantly more than at all other nitrogen rates. While grain production efficiency at 100 and 50 kg N/ha was significantly more than at no nitrogen treatments.

Under cowpea-maize sequence grain production efficiency at 200 kg N/ha was significantly more than at no nitrogen and 50 kg N/ha. While grain production efficiency at 50 and 100 kg N/ha was significantly more than at no nitrogen treatment.

Economic consideration is one of the best criteria to choose the most appropriate cropping system for an area. Singh *et al*. (1967) reported that inclusion of legumes in rotation on Sandy soils low in nitrogen proved most profitable and the gross income was in the order of cowpea – maize – wheat, guar – maize – wheat, fallow – maize – wheat, bajra – maize – wheat, jowar – maize – wheat. Khybri *et al.* (1973) reported that in Doon valley, out of several double cropping systems, highest net profit (Rs. 1622/ha) was obtained from maize- pea rotation fallowed by maize- wheat rotation.

Faroda and Singh (1983) reported that among the crop rotations, i.e. blackgram – wheat, greengram – wheat, cowpea – wheat, pigeonpea- wheat, pearlmillet fertilized with 60 kg N/ha. Wheat and pearlmillet fertilized with 90 kg N/ha – wheat, the rotation blackgram – wheat gave maximum net return (Rs. 7662.79 /ha) where as pearlmillet fertilized with 60 kg N/ha) – wheat gave minimum net return.

Ramshe and Patil (1987) obtained maximum net return from groundnut – wheat rotation which had given an additional profit in order of Rs. 1924, Rs 2470, Rs 2008 and Rs. 1268 over moong - wheat, bengalgram – wheat and bajra – wheat and cowpea – wheat respectively. Singh and Faroda (1987) reported that pigeonpea + moong – wheat rotation had given an additional return Rs. 1758/ha as compared to pigeonpea – wheat rotation. Sharma and Thakur (1988) found maximum gross return (Rs 26610/ha) and net return (Rs.16325/ha) with a economic efficiency of Rs, 77.67 /day /ha in terms of gross return and Rs 47.33/day /ha in terms of net return under maize –pea (grain pod) – wheat – moong system. But maize + pigeonpea – wheat – greengram sequences had stability in production and economics over maize – pea (pods) – wheat – greengram sequence. Deka *et al.* (1984) observed maximum net return of Rs. 6345 / ha from rice – wheat – maize + cowpea (fodder) sequences, closely followed by rice – berseem (Rs. 5426/ha) and it was lowest (2919/ha) from rice- lentil sequence. Ramteke *et al.* (1986) reported highest net profit from berseem – maize sequence followed by legume (pea, lentil) - maize sequence and lowest in wheat – maize sequences.

Summary and Conclusion

Maximum gross return (Rs 53660 /ha in 2010 and Rs 60450/ha in 2011) was obtained from maize grown after greengram while it was minimum (Rs 35880/ha in 2010 and Rs 40700/ha in 2011) when grown after maize. Gross return was maximum (Rs 63250/ha in 2010 and Rs 72800/ha in 2011) from maize with 200 kg N/ha and it was minimum (Rs 26720/ha in 2010 and Rs 30280/ha in 2011) with no nitrogen.

Maximum net return (Rs 30170/ha in 2010 and Rs 33440/ha in 2011) was obtained from maize under greengram – maize sequences and it was minimum (Rs 12390/ha in 2010 and Rs 13700/ha in 2011) under maize– maize sequences. Net return was maximum (35850/ha in 2010 and Rs 40490 /ha in 2011) from maize with 200 kg N/ha and it was minimum (Rs 8680/ha in 2010 and Rs 9670/ha in 2011) with no nitrogen.

Benefit: cost ratio was maximum (1.22 in 2010 and 1.18 in 2011) from maize under greengram – maize sequences while it was minimum (0.50 in 2010 and 0.47 2011) under maize– maize sequences. Maximum benefit: cost ratio (1.28 in 2010 and 1.25 in 2011) from maize was obtained with 200 kg N/ha and it was minimum (0.47 in 2010 and 0.46 in 2011) with no nitrogen.

Maximum maize equivalent yield 11516 kg /ha in 2010 and 12710 kg /ha in 2011) was obtained under maize – maize sequences while it was minimum (4310 kg /ha in 2010 and 4624 kg /ha in 2011) under clusterbean – maize sequences. Maize equivalent yield was maximum (10824 kg /ha in 2010 and 11923 kg /ha in 2011) with 200 kg N/ha while it was minimum (7384 kg /ha in 2010 and 8206 kg /ha in 2011) with no nitrogen.

Grain production efficiency was maximum (32.0 kg /ha / day under greengram– maize sequences in 2010. but in 2011 , maximum grain production efficiency (34.8 kg /ha /day) was recorded under maize– maize sequences which was comparable to grain production efficiency under greengram – maize sequence. While grain production efficiency was minimum (11.18 kg /ha /day in 2010 and 12.6 kg /ha /day in 2011) under clusterbean – maize sequences. Maximum grain production efficiency (29.2 kg /ha /day in 2010 and 32.8 kg /ha /day in 2011) was obtained with 200 kg N/ha while it was minimum (20.2 kg /ha /day in 2010 and 34.8 kg /ha/day in 2011) with no nitrogen application.

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