Indian Journal of Animal Sciences **89**(3): 276–280, March 2019/Article
https://doi.org/10.56093/ijans.v89i3.88041

Nutritional portfolio of maize and cowpea fodder under various intercropping ratio and balanced nitrogen fertilization

AKANKSHA TAMTA[1], RAKESH KUMAR[2], HARDEV RAM[3], R K MEENA[4], UTTAM KUMAR[5], M R YADAV[6], D J SUBRAHMANYA[7] and ADRASH KUMAR PANDEY[8]

ICAR-National Dairy Research Institute, Karnal, Haryana 13201 India

Received: 5 April 2018; Accepted: 26 October 2018

ABSTRACT

Cereal–legume mixture may be a viable option to improve forage yield and quality. Furthermore, nitrogen requirement may also varying according to proportion of legume component. Therefore, the present study was carried out to evaluate the effect of different intercropping ratios and nitrogen levels on productivity and nutritional quality of fodder maize (*Zea mays* L.) and Cowpea (*Vigna unguiculata* L.). The experiment was laid out in split plot arrangement with three intercropping row ratios of maize: cowpea (1:1, 2:1 and 1:2, respectively) in main plot and five nitrogen levels (0, 30, 60, 90 and 120 kg N/ha) in sub plot. Highest total green fodder, protein and ash yield in 2:1 ratio whereas maximum ether yield was reported in 1:2 intercropping ratio of maize and cowpea. However, the maximum crude protein, ether extract, ash content and lowest NDF, ADF and ADL of maize and cowpea, respectively were obtained under 1:2 intercropping ratio of maize and cowpea. Among N levels, highest total green fodder, crude protein, ether and ash yield and as well as their content in green forage of maize and cowpea were recorded with the use of 120 kg N/ha. However, cowpea responded significantly upto 60 kg N/ha only. The lowest NDF, ADF and ADL of maize and cowpea were found when these crops fertilized with 120 Kg N/ha. A significant interaction between intercropping ratios and N levels was reported in terms of yield. Thus, it can be concluded that nitrogen rates 90, 120 and 60 kg/ha found suitable to achieve maximum fodder yield in 1:1, 2:1 and 1:2 (maize: cowpea) ratios, respectively.

Key words: Cowpea fodder, Forage Quality, Intercropping, Maize, Nitrogen

India being rich in livestock's cultivation and agro-climatic conditions sustaining around 17% of the world livestock population. From the economic and livelihood viewpoint, livestock constitute the bulk of cash income in the arid and semi-arid region of the country (Kumar *et al.* 2017b). The profitability of livestock farming is directly dependent on the sources of feed and fodder, as feeding accounting 65–70% of the total cost (Kumar *et al.* 2016b). Thus, cultivation of fodder crops to supply green fodder to the animals is quite necessary in order to reduce the cost of milk and to increase the profit of the livestock farmers (Kumar *et al.* 2017a). However, the green fodder production of our country is not sufficient to meet the present demand and also the forages offered to animal are mostly of poor quality (Kumar *et al.* 2016a). Thus, any attempt towards enhancing fodder availability would results in higher profits to livestock owners.

Intercropping is a type of mixed cropping and defined as agricultural practice of cultivating two or more crops in the same space at the same time. Fodder quality of legume and cereal crops mixture will be ideal as legumes are rich in protein and cereals are rich in carbohydrates and fibres. Maize is one of the most important cultivated fodder crops due to its high production potential, wider adaptability, quick growing nature, succulence, palatability, excellent fodder quality (Yadav *et al.* 2017b). Cowpea is an important fodder crop of *kharif* and summer season in India due to its short duration, high yield and quick growth along with high protein content and palatability particularly to small ruminants (Kumar *et al.* 2016a).

Nitrogen fertilization influences dry matter yield (DMY) by influencing growth and photosynthetic efficiency in sole as well under intercropping (Yadav *et al.* 2017a). Therefore, standardization of optimum dose of nitrogen fertilizer is required to get maximum forage yield and with better quality traits. Optimum rate of fertilizer depends on numerous variable factors such as environmental conditions, management practices and crop combinations (Yadav *et al.* 2016). Therefore, the present study was carried out to evaluate the effect of different intercropping ratios and nitrogen application rates on nutritive yields and quality of fodder maize and cowpea.

Present address: [1]Research Scholar (akanksha7878 @gmail.com), [2]Principal Scientist (drdudi_rk @rediffmail.com), [3,4]Scientist (devagron@gmail.com, rajeshkumar2793 @gmail.com), [5]Chief Technical Officer (uttamndri@gmail.com), [6,7,8]Research Scholar (raomaluydv@gmail.com, subrahmanyadj @gmail.com, neeruagrian1992@gmail.com).

MATERIALS AND METHODS

The soil of experimental site was sandy clay loam in texture with 7.2 pH, Walkley–Black C (0.54%), EC (0.30 dS/m), $KMnO_4$ oxidizable N (196 kg/ha), 0.5 M $NaHCO_3$ extractable P (18.15 kg/ha) and 1 N NH_4OAC extractable K (256 kg/ha). The experiment was laid out in split plot arrangement with three intercropping ratios of maize and cowpea, i.e. 1:1 (one maize row + one cowpea row), 2:1 (two maize row + one cowpea row), 1:2 (one maize row + two cowpea row) (1:1, 2:1, 1:2) in main plot and five nitrogen levels (0, 30, 60, 90 and 120 kg N/ha) in sub plot with replicated thrice. The experimental field was deep tilled and then levelled before starting the experiment. The fodder maize (Cultivar J-1006) and Cowpea (Cultivar C-152) were sown with seed rate of 50 and 25 kg/ha respectively during 2nd week of April by keeping a row spacing of 30 cm. For accommodating component crops in intercropping treatments replacement series was used.

Both maize and cowpea were harvested manually at 65 DAS about 10 cm above the ground level and fresh forage yield was recorded. Subsamples were collected from each of the experimental plot and dried in hot air oven at 60°C for 48 h thereafter dry fodder yield was recorded. These oven-dried samples of plant were ground to pass through 40 mesh sieve in a Macro-Wiley Mill and used for chemical analysis. Finally milled sample were analyzed for DM, ash, ether extract and Kjeldahl Nitrogen (AOAC 2005). Crude protein was determined by multiplying the N concentration by 6.25. Neutral detergent fiber was analysed by the procedure suggested by Van Soest *et al.* (1991). Acid detergent fiber was analyzed according to AOAC, 2005. Neutral (NDICP) and acid (ADICP) detergent insoluble CP were determined by analysing NDF and ADF residues for Kjeldahl nitrogen (Licitra *et al.* 1996).

All data recorded for different parameters were analysed with the help of analysis of variance (ANOVA) technique (Gomez and Gomez 1984) for split-plot design using IRRISTAT software (IRRI 1999). The least significant difference test was used to decipher the main and interaction effects of treatments at 5% level of significance by using least significant test.

RESULTS AND DISCUSSION

Effect of agronomic management on forage yield: Green fodder yield of the fodder maize and cowpea were significantly influenced by various intercropping ratios and nitrogen application rates (Table 1). The highest total green fodder yield (maize + cowpea) as well as green fodder yield of maize were registered under 2:1 intercropping ratio followed by 1:1 and minimum were under 1:2 ratio. However, the cowpea planted under 1:2 intercropping ratio resulted in highest green fodder yield while minimum was under 2:1. The highest total green fodder yield, green fodder yield of maize and cowpea under 2:1 and 1:2 intercropping ratio may be attributed due to higher proportion of maize and cowpea in respective treatments. Similar results with improved agronomic management were observed by Parihar *et al.* 2017.

Table 1. Effect of intercropping and nitrogen level on green fodder yield.

Treatment	Green fodder yield (q/ha)		
	Maize	Cowpea	Total yield
Intercropping ratio (maize:cowpea)			
1:1	417.52	122.80	538.32
2:1	490.79	90.36	581.15
1:2	363.79	162.44	526.22
SEm ±	4.80	1.55	3.57
CD (P=0.05)	13.32	4.30	9.90
Nitrogen level (kg/ha)			
0	309.38	91.11	400.49
30	418.91	125.74	544.65
60	440.25	134.15	574.40
90	465.78	135.00	600.78
120	485.86	136.65	622.51
SEm ±	3.83	1.90	4.17
CD (P=0.05)	7.72	3.84	8.41

Significantly total green fodder yield and green fodder yield of maize were observed with application of 120 kg N/ha, then at 90 kg N/ha and the minimum were obtained in control. However, in case of cowpea, application of N up to 30 kg/ha significantly increased the green fodder yield and further increase in dose of nitrogen were produced statistically similar fodder yield. The higher availability of N resulted into greater plant growth which may attribute to higher green fodder yield under higher level of N over control. The increase in total green fodder yield in intercropping system might be owing to better utilization of resources such as space and light interception along with nutrient contribution of leguminous fodder to maize. Our results of higher green fodder yield with enhanced level of N are in close agreement with the outcome of Ayub *et al.* 2002.

The interaction effect between intercropping and nitrogen levels on total green fodder yield was found significant (Fig.1). Among different ratios, 2:1, 1:1 and 1:2 ratio responded significantly up to 120, 90 and 60 kg N/ha. At lower supply of external nitrogen a legume (cowpea) crop may fix higher atmospheric nitrogen through well-developed nodules and fulfil some of the nitrogen

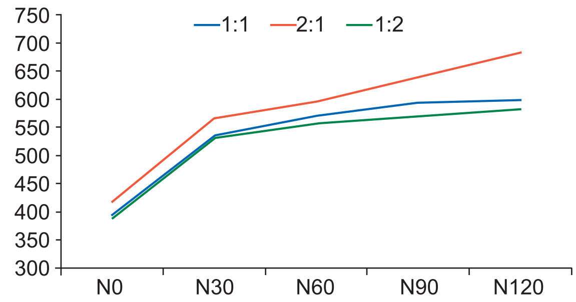

Fig. 1. Interaction effect of intercropping ratios and nitrogen levels on total green fodder yield (q/ha).

requirement of component crop which might be one of the reason that 1:1 and 1:2 intercropped ratio responded up to 90 and 60 kg N/ha. Results are in close agreement with the result of Nadeem *et al.* 2009.

Effect of agronomic management practices on fodder quality: Effect of intercropping ratio on forage quality parameters (crude protein, ether extract and ash content) of maize was found significant (Table 2). The highest CP (%), EE (%) and ash content (%) of maize were found under 1:2 intercropping ratio, respectively. However, in case of cowpea the intercropping ratios were found significant for CP (%) only in which highest CP% reported in 1:2 intercropping ratio. The higher content of aforesaid forage quality parameters under the treatment which contain higher proportion of cowpea (1:2 and 1:1) over 2:1 intercropping ratio might be due the fact that a legume has the ability to fix atmospheric N and recycle the soil P for the component crop. Besides, better soil health with higher proportion of legume in intercropping may enhance uptake of macro and micro nutrient thus nutrients plays a critical role in enhancement of forage quality. These results are in close agreement with the findings of Getachew *et al.* (2013).

Nitrogen fertilization showed significant effect on the chemical composition of the fodder maize and cowpea (Table 2). Maximum CP%, EE% and ash content (%) of maize and cowpea were found with the application of 120 kg N/ha and lowest under control. The higher CP% could be attributed due to fact that optimum levels of nitrogen in plants are known to enhanced nitrogen uptake which might improves protein synthesis. Significant improvement of ash and ether content in fodder might be due to fact the higher availability of nitrogen promote the growth and dry matter accumulating capacity of the plants and synergistic effect of nitrogen on the availability of macro and micro nutrient further add in the enhancement of these quality parameters. These results are in agreement with the findings of Meena and Shivay (2010).

Fiber fractions of maize and cowpea forage (NDF and ADL) were not influenced significantly by intercropping rations (Table 3) except the ADF. The lowest NDF, ADF and ADL of maize and cowpea were found under 1:2 intercropping ratio. The lowest values of various fibber fractions in treatments which having higher proportion of cowpea might be due the fact of higher availability of nutrients and improved soil condition which enhance the growth and reduced the fibre fractions. Similar results were also reported by Khan *et al.* (2013).

NDF, ADF and ADL content of the fodder significantly affected through N fertilization (Table 3) and showed declining trend with increase in N application rates. The maximum NDF, ADF and ADL of maize and cowpea reported with control while lowest with the 120 kg N/ha. The results could be attributed due to the fact that higher nitrogen availability resulted in higher protein synthesis and lowered the soluble carbohydrates which could be responsible for lower content of NDF, ADF and ADL in fodder.

Among intercropping ratio's NDICP (CP%) and ADICP (CP%) of maize significantly lowest value was registered at 1:2 ratio (Table 4). Nitrogen application also influenced NDICP (CP%) and ADICP (CP%) of maize significantly. NDICP (CP%) of maize decreased up to the last dose of nitrogen fertilizer. Whereas ADICP (CP%) of maize reduced significantly up to 90 kg N/ha after that difference were statistically at par. The minimum value of NDICP and ADICP of cowpea was found in 1:2 intercropping proportion. Increase in N application reduces the NDICP (CP%) and ADICP (CP%) of cowpea significantly up to 60 kg N/ha.

Effect of agronomic management on nutrient yield: Nutrient yields of fodder maize and cowpea were influenced significantly by intercropping ratios (Table 5). The highest CP, EE and ash yield of maize and cowpea were reported under 2:1 and 1:2 intercropping ratio, respectively. However, the total (maize + cowpea) CP, EE and ash yield

Table 2. Effect of intercropping and nitrogen application on CP, EE and ash content

Treatment	CP (%)		Ether extract (%)		Ash%	
	Maize	Cowpea	Maize	Cowpea	Maize	Cowpea
Intercropping ratio (maize:cowpea)						
1:1	9.58	17.08	1.45	2.81	8.22	11.17
2:1	9.40	17.02	1.26	2.79	7.65	11.14
1:2	9.88	17.19	1.98	2.87	8.72	11.19
SEm ±	0.03	0.04	0.02	0.04	0.11	0.04
CD (P=0.05)	0.07	0.11	0.06	NS	0.30	NS
Nitrogen level (kg/ha)						
0	7.05	3.11	1.43	2.30	7.62	10.60
30	9.68	4.34	1.50	2.84	7.89	11.17
60	10.47	4.74	1.57	2.95	8.18	11.30
90	11.21	4.76	1.63	3.01	8.50	11.38
120	12.26	4.77	1.70	3.03	8.79	11.39
SEm ±	0.12	0.07	0.02	0.05	0.12	0.05
CD (P=0.05)	0.24	0.14	0.05	0.09	0.25	0.10

Table 3. Effect of intercropping and nitrogen application on NDF, ADF and ADL content

Treatment	NDF (%)		ADF (%)		ADL (%)	
	Maize	Cowpea	Maize	Cowpea	Maize	Cowpea
Intercropping ratio (maize:cowpea)						
1:1						
1:1	63.39	46.48	34.41	30.74	4.60	8.16
2:1	63.66	46.74	34.45	31.12	4.62	8.18
1:2	60.92	45.29	32.95	29.94	4.43	7.99
SEm ±	0.98	0.51	0.44	0.31	0.06	0.07
CD (P=0.05)	NS	NS	1.24	0.85	NS	NS
Nitrogen level (kg/ha)						
0	66.66	47.90	35.61	31.87	4.87	8.39
30	64.60	46.95	34.56	31.02	4.72	8.22
60	62.72	45.75	33.85	30.20	4.58	8.05
90	60.85	45.20	33.20	30.00	4.42	7.96
120	58.45	45.05	32.45	29.89	4.16	7.94
SEm ±	0.91	0.39	0.55	0.37	0.06	0.07
CD (P=0.05)	1.84	0.78	1.11	0.75	0.13	0.15

Table 4. Effect of intercropping and nitrogen application on NDICP and ADICP

Treatment	Maize				Cowpea			
	NDICP		ADICP		NDICP		ADICP	
	DM%	CP%	DM%	CP%	DM%	CP%	DM%	CP%
Intercropping ratio (maize:cowpea)								
1:1	3.06	32.21	1.31	14.86	7.88	44.80	2.63	15.86
2:1	3.06	33.84	1.38	15.40	7.94	44.20	2.75	16.63
1:2	2.74	30.93	1.19	12.61	7.75	44.58	2.38	14.17
SEm ±	0.15	0.33	0.04	0.18	0.04	0.16	0.07	0.09
CD (P=0.05)	NS	0.92	0.10	0.50	0.10	0.44	0.20	0.52
Nitrogen level (kg/ha)								
0	3.20	34.56	1.47	16.54	8.03	45.94	2.94	17.53
30	3.13	33.06	1.41	15.33	7.97	44.76	2.81	16.29
60	3.03	32.35	1.30	13.64	7.86	44.25	2.60	15.05
90	2.74	31.57	1.27	12.41	7.83	44.00	2.53	14.61
120	2.67	30.09	1.02	12.20	7.79	43.69	2.03	14.28
SEm ±	0.22	0.35	0.05	0.48	0.05	0.17	0.10	0.58
CD (P=0.05)	NS	0.71	0.10	0.96	0.10	0.34	0.20	1.17

were reported with 2:1 intercropping ratio. The highest nutrient yields, of maize and cowpea under 2:1 and 1:2 intercropping ratio may be attributed due to higher proportion of maize and cowpea in respective treatments. Results are in close agreement with the findings of Kumar *et al.* 2005.

Nitrogen fertilization also had significant effect on various nutrient yields. The application of N @ 120 kg/ha were accountable for 42.51, 21.01, 14.62 and 8.58% higher CP, 42.78, 19.29, 12.43 and 5.78% higher EE and 40.82, 18.03, 11.81 and 5.12% higher ash yields of forage maize over 0, 30, 60 and 90 kg N/ha, respectively. However, the cowpea responded significantly to the N application up to 60 kg N/ha only. Further increase in N application rates were produced similar nutrient yields of cowpea (CP, EE and ash yield). The application of N @ 120 kg/ha were accountable for 40.39, 17.67, 10.71 and 6.25% higher total CP (maize + cowpea), 44.30, 17.03, 9.54 and 4.30% higher EE and 39.73, 15.67, 9.29 and 3.97% higher ash yields over 0, 30, 60 and 90 kg N/ha, respectively. The nutrient yields is a function of dry matter yield and nutrient content in fodder, partly could be due to favorable effect of N application on growth parameters, i.e. plant height, number of leaves, leaf length and leaf width, which increased dry matter yield of the fodder and higher nutrient uptake with successive increase in the level of nitrogen, particularly in case of maize (Kumar *et al.* 2005).

Present study demonstrated that planting of maize and cowpea in 1:1, 2:1 and 1:2 ratios responded differentially to application rate of nitrogen. To obtain maximum production in best quality of maize and cowpea in 1:1, 2:1 and 1:2 ratios use of 90, 120 and 60 kg N/ha, respectively is quite helpful. Use of these recommended doses will help in saving of N cost, which will further strengthen and sustain the performance of livestock in terms of health and milk production.

Table 5. Effect of intercropping and nitrogen application on nutrient yields (q/ha)

Treatment	CP yield			Ether yield			Ash yield		
	Maize	Cowpea	Total	Maize	Cowpea	Total	Maize	Cowpea	Total
Intercropping ratios (maize:cowpea)									
1:1	9.72	4.18	13.90	1.50	0.69	2.20	8.48	2.74	11.21
2:1	11.85	3.13	14.98	1.57	0.52	2.09	9.48	2.05	11.53
1:2	8.83	5.72	14.55	1.77	0.96	2.73	7.78	3.73	11.51
SEm ±	0.11	0.06	0.07	0.03	0.01	0.03	0.19	0.04	0.17
CD (P=0.05)	0.31	0.17	0.18	0.09	0.04	0.08	0.54	0.11	NS
Nitrogen level (kg/ha)									
0	7.05	3.11	10.15	1.10	0.43	1.53	5.98	1.99	7.98
30	9.68	4.34	14.02	1.55	0.73	2.28	8.29	2.87	11.16
60	10.47	4.74	15.21	1.68	0.81	2.49	8.92	3.09	12.01
90	11.21	4.76	15.97	1.81	0.82	2.64	9.59	3.12	12.71
120	12.26	4.77	17.03	1.92	0.83	2.75	10.11	3.12	13.23
SEm ±	0.12	0.07	0.15	0.03	0.02	0.04	0.16	0.05	0.18
CD (P=0.05)	0.24	0.14	0.29	0.06	0.04	0.08	0.32	0.09	0.37

REFERENCES

AOAC. 2005. *Official Methods of Analysis.* 18th edn. Association of Official Analytical Chemists, Arlington, Virginia, USA.

Ayub M, Nadeem M A, Sharar M S and Mahmood N. 2002. Response of maize (*Zea mays* L.) fodder to different levels of nitrogen and phosphorus. *Asian Journal of Plant Sciences* **1**: 352–54.

Getachew B, Ketema B and Sharma J J. 2013. System productivity of forage legumes intercropped with maize and performance of the component crops in Kombolcha, eastern Ethiopia. *East African Journal of Sciences* **7**: 99–108.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*. John Willey and Sons, Singapore. 680 p.

Khan M A, Kakar S, Marwat K B and Khan I A. 2013. Differential response of *Zea mays* L. in relation to weed control and different macronutrient combinations. *Sains Malaysiana* **42**(10): 1395–1401.

Kumar R, Rathore D K, Singh M, Kumar P and Khippal A. 2016a. Effect of phosphorus and zinc nutrition on growth and yield of fodder cowpea. *Legume Research-An International Journal* **39**(2): 262–67.

Kumar R, Singh M, Tomar S K, Meena B S and Rathore D K. 2016b. Productivity and nutritive parameters of fodder maize under varying plant density and fertility levels for improved animal productivity. *Indian Journal of Animal Research* **50**(2): 199–202.

Kumar R, Singh M, Meena B S, Kumar S, Yadav M R, Parihar C M, Ram H, Meena R K, Meena V K and Kumar U. 2017a. Quality characteristics and nutrient yield of fodder maize (*Zea mays*) as influenced by seeding density and nutrient levels in Indo-Gangetic Plains. *Indian Journal of Agricultural Sciences* **87**(9): 1203–08.

Kumar R, Singh M, Meena B S, Ram H, Parihar C M, Kumar S, Yadav M R, Meena R K, Kumar U and Meena V K. 2017b. Zinc Management effects on Quality and Nutrient Yield of Fodder Maize (*Zea mays* L.). *Indian Journal of Agricultural Sciences* **87**(8): 1013–17.

Kumar S, Rawat C R and Melkania N P. 2005. Fodder production potential and economics of maize (*Zea mays*) and cowpea (*Vigna unguiculata*) intercropping under rainfed conditions. *Indian Journal of Agronomy* **50**: 184–86.

Licitra G, Hernandez T M and Van Soest P J. 1996. Standardization of procedures for nitrogen fractionation of ruminant feeds. *Animal Feed Science and Technology* **57**(4): 347–58.

Meena H N and Shivay Y. 2010. Productivity of short-duration summer forage crops and their effect on succeeding aromatic rice in conjunction with gypsum-enriched urea. *Indian Journal of Agronomy* **55**(1): 11–15.

Nadeem M A, Iqbal Z, Ayub M, Mubeen K and Ibrahim M. 2009. Effect of nitrogen application on forage yield and quality of maize sown alone and in mixture with legumes. *Pakistan Journal of Life Social Science* **7**: 161–67.

Parihar C M, Yadav M R, Jat S L, Singh A K, Kumar B, Pooniya V, Pradhan S, Verma R K, Jat M L, Jat R K and Saharawat Y S. 2017. Long Term Conservation Agriculture and Intensified Cropping Systems: Effect on Growth, Yield, Water and Energy-use Efficiency of Maize in North-Western India. *Pedosphere* DOI:10.1016/S1002-0160(17)60468-5.

Van Soest P J, Robertson J B and Lewis B A. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of dairy sciences* **74**(10): 3583–97.

Yadav M R, Kumar R, Parihar C M, Yadav R K, Jat S L, Ram H, Meena R K, Singh M, Birbal, Verma A P, Kumar U, Ghosh A and Jat M L. 2017b. Strategies for improving nitrogen use efficiency: A review. *Agricultural Reviews* **38**(1): 29–41.

Yadav M R, Parihar C M, Jat S L, Singh A K, Kumar D, Pooniya V, Parihar M D, Saveipune D, Parmar H and Jat M L. 2016. Effect of long-term tillage and diversified crop rotations on nutrient uptake, profitability and energetics of maize (*Zea mays*) in north-western India. *Indian Journal of Agricultural Sciences* **86**(6): 743–49.

Yadav M R, Parihar C M, Jat S L, Singh A K, Kumar R, Yadav R K, Kuri B R, Parihar M D, Verma A P and Jat M L. 2017a. Long term effect of legume intensified crop rotations and tillage practices on productivity and profitability of maize vis-a-vis soil fertility in North-Western Indo-Gangetic Plains of India. *Legume Research* **40**(2): 282–90.