Eco. Env. & Cons. 29 (May Suppl. Issue) : 2023; pp. (S309-S313)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i03s.056

Productivity and profitability of fodder-maize legume mixtures under rainfed temperate condition of Kashmir

Moneesa Bashir[1]*, Syed Ansarul-Haq[2], Waseem Raja[3], A A Saad[1], Tsultim Palmo[1], Tanveer Ahmad Ahngar[1], Haziq Shabir[4], Gulzar Ah. Bhat[4], Raheeba Tun Nisa[5] and Idrees Mohammad[1]

[1] Agronomy, FoA, Wadura, Sopore, SKUAST-K, J&K, India
[2]MLRI, Manasbal, SKUAST-K, J & K, India
[3]MRCFC, SKUAST-K, Khudwani, J & K, India
[4]Soil Science and Agriculture Chemistry, SKUAST-J, J&K, India
[5]Pathology, FoA, Wadura, Sopore, SKUAST-K, J&K, India

(Received 20 December, 2022; Accepted 19 February, 2023)

ABSTRACT

A field experiment was conducted during *kharif* 2018 to study the effect of different fodder maize-legume mixtures on productivity and profitability. The experiment comprised of 10 treatments of fodder maize and fodder legumes with three sole treatments of maize, cowpea and soybean, four intercropped treatments of maize-cowpea and maize-soybean in ratios of 1:1 and 2:1 and three mixed cropped treatments of maize-cowpea, maize-soybean (70% and 30%) and maize, cowpea and soybean (70%, 15%, 15%). Results revealed that system productivity and benefit-cost ratio of sole fodder maize were comparable to the intercropping of fodder maize with soybean in 2:1 row ratio.

Key words : *Economics, Forage, Intercropping, Yield*

Introduction

Cereal- legume intercropping systems are common as they ensure higher productivity besides land utilization, resource conservation and enhancing soil health. Cereal forages are the most lucrative forages because they generate more biomass per unit area, allowing farmers to receive more profit through enhanced milk and meat output (Addo *et al*., 2011). Livestock accounting for maximum share towards the agricultural GDP (NAS, 2019), indicating great demands for quality fodder and forages. The livestock feed including fodder and forages supply in India seem to be short accounting 35.6% green fodder, 10.95% dry crop left overs and 44% concentrate (IGFRI Vision, 2050). Demand for fodder and forages is expected to rise higher in future as a result of changing feeding practices and a great reliance on livestock and its products (Kumar *et al*., 2012). Green fodder demand in Jammu and Kashmir is at 13.21 million tonnes (mt), while supply is around 5.11mt, resulting in a 63% shortfall, and dry feed demand is around 8.52 mt, whereas availability was around 4.55mt, resulting in 37% shortfall (Uzma *et al*., 2016). Furthermore, shrinking agricultural land area attributable to anthropogenic settlements, insufficient ir-

([1] Ph.D., [2]Associate Prof., [3]Associate Prof., [4] Prof. cum Chief Scientist, [5]Ph.D., [6]Ph.D., [7]M.Sc.)

rigation sources for agricultural production, and farmers' propensity in high-revenue generating cash crops have all attributed to drop in fodder production (Ahmad *et al*., 2007).

Cereal forages have a high energy content but low crude protein (CP) level. They also include fibre, which aids healthy digestion in forage eating animals. Legumes have long been known as rich source of crude protein. Legumes have the potential to produce a high dry matter in a short period of time and also being more digestible for livestock. The shift from calorie-based diets to produce rich diets of the burgeoning population will give impetus to grass based livestock in few decades. The dry matter content and nutritional value of forage crops have been greatly reduced as a result of the negative effects of climate change (Chapman *et al*., 2012). Increasing carbon to nitrogen ratios (C:N) in plants and increased dominance of palatable plant species are primarily responsible for the decrease in nutritional quality of fodder caused by elevated CO_2 concentration in atmosphere. Additionally, in remote regions, there is no standard approach for forage or fodder cultivation, and cattle are supplemented with low-quality protein, minerals that include a grasses, bushes and weeds grown on non agricultural sites. Feed supply through crop residues have insufficient nutritional value to enable high milk production (Pathan *et al*., 2012). Intercropping systems having cereals and legumes have been acknowledged as a profitable crop per unit area per unit time besides quality fodder and improved soil fertility by fixing atmospheric nitrogen. The paucity of high quality feed and forages has indeed been cited as a significant stumbling block to India's livestock industry reaching its full potential, but legumes, as a rich source of crude protein when intercropped with cereal, can improve forage quality. Intercropping fodder crops also give a supplement to the farmer's dairy cattle diet (Balde *et al.,* 2020). Globally, cereal legume cropping system based forage cultivation mitigates the impact of greenhouse gases through reduced use of inorganic nitrogen application and enhancing soil carbon stocks (Marer *et al.*, 2007), reducing runoff loses (Tamta *et al*., 2019), drought resilience (Reddy and Palled, 2016) and improving livelihood and profitability (Kumar *et al.*, 2017). Maize (*Zea mays L.*) is a notable twin crop farmed substantially for grain and fodder during the *kharif* season in the most parts of the country and is renowed as the "King of Fodder".

Cowpea (*Vignaunguiculata L.*) and soybean (*Glycine max L.*) are gaining importance as a fodder legume crop and are grown during summer and *kharif* seasons. For forage based ration both the crops are important as they provide considerable amount of protein and crude fibre besides having good palatability, succulent and quality fodder (Bisht *et al*., 2001).

Keeping in view the above facts, it becomes imperative to enhance the productivity of forages for the sustainable livestock production. As a result, the current study aimed to assess the yield and economics of fodder under intercropping systems.

Materials and Methods

The research was carried out under rainfed conditions during the *kharif* season of 2018 at the Regional Research Station's research farm in Wadura, Sopore, Jammu and Kashmir 34°172N and 74°332E at an altitude of 1524m above mean sea level. The experimental soil had a neutral reaction, was high in organic carbon, medium in nitrogen, phosphorus and potassium. The experiment was laid out in a randomized block design with 10 treatments replicated thrice and having a net plot size of 5.1m x 4.0m. The experimental treatments comprised of sole maize in 30 cm apart rows, sole cowpea in 30cm apart rows, sole soybean in 30 cm apart rows, maize intercropped with cowpea in replacement series of 1:1 and 2:1 row ratio, maize intercropped with soybean in replacement series of 1:1 and 2:1 row ratio, maize (70%) mixed with cowpea in (30%) and soybean (30%) independently and maize (70%) mixed with cowpea (15%) and soybean (15). 'African Tall', 'Shalimar Cowpea-1' and 'Shalimar Soybean-1'were the fodder maize, fodder cowpea and fodder soybean varities respectively. All other agronomic procedures were kept regular and uniform for all treatments except those under study.Chemical fertilizers like urea, DAP and MOP were employed as sources of nitrogen, phosphorus and potassium respectively. The half of nitrogen, as well as the full doses of phosphorus and potassium were administered as basal at the time of sowing, and the remaining half of nitrogen was split into two. Forage equivalent yield of maize (Equation 1), cowpea (Equation 2) and Soybean (Equation 3) were computed as follows:

$$\text{Forage equivalent maize, FEY maize} = \frac{Ymi}{price\ of\ maize}\ \text{price of maize} \quad 1$$

where, ymi= yield of maize in intercropping

$$\text{FEY cowpea} = \frac{Yci}{\text{price of maize}}\ \text{price of cowpea} \quad 2$$

where, Yci= yield of cowpea in intercropping

$$\text{FEY soybean} = \frac{Ysi}{\text{price of maize}}\ \text{price of soybean} \quad 3$$

where, Ysi = yield of soybean in intercropping

Equivalent yield of system = FEY maize + FEY cowpea or soybean

Results and Discussion

Green Fodder Yield

A cursory look at the data (Table 1) revealed that total green fodder yield varied from 185.31q/ha (sole cowpea) to 428.3 q/ha (sole maize). Sole maize alone with 30cm spacing generated much more total green fodder yield than the other treatments, followed by maize + soybean intercropped in row ratio of 2:1. Under the treatment sole cowpea, the total green fodder yield was much lower. All intercropped treatments and maize intercropped with legumes in 2:1 row ratio produced more total green fodder yield as compared with sole ones and maize intercropped with legumes in a row ratio of 1:1 respectively. Also, among all the treatments, statistically green fodder yield of maize was found highest in sole maize (428.3q/ha) followed by maize + soybean intercropped in 2:1 row ratio (338.10q/ha) with lowest being recorded under maize + cowpea in 1:1 row proportion (245.20q/ha). The higher green fodder yield obtained in case of sole maize can be attributed to taller plants and efficient utilization of resources in sole maize compared with other intercropped treatments. These results confirm the findings of of Rahman and Raja, (2020); Tamta *et al*., (2019) and Jan *et al*., (2016). In comparison, the yields of maize fodder and total fodder were higher in intercropped plots than in solitary maize plots, according to Mthembu *et al*., (2018).

Dry Fodder Yield

Data presented in Table 1 revealed that total dry fodder yield varied from 57.7 q/ha (sole cowpea) to 171.2 q/ha (sole maize). Statistically, higher total dry fodder yield was recorded under sole maize (171.2 q/ha) followed by maize + soybean intercropped in 2:1 row proportion (153.8 q/ha) the lowest being recorded in sole cowpea (57.7 q/ha). It was also ascertained that all of the intercropped treatments recorded more dry fodder yield when compared with sole ones. Also, the perusal of the data revealed that among all the treatments, dry fodder yield of maize was found highest in sole maize (171.2q/ha) followed by maize + soybean intercropped in 2:1 row ratio (130.3 /ha) with lowest dry fodder yield being recorded under maize + cowpea

Table 1. Fodder yield of maize- legume mixtures under different cropping systems

Treatment	Fodder Yield							
	Green				Dry			
	Maize	Cowpea	Soybean	Total	Maize	Cowpea	Soybean	Total
Units	q/ha	q/ha	q/ha	q/ha	q/ha	q/ha	q/ha	q/ha
Sole Maize	428.3	-	-	428.30	171.20	-	-	171.20
Sole Cowpea	-	185.31	-	185.31	-	57.71	-	57.71
Sole Soybean	-	-	242.11	242.11	-	-	79.80	79.80
Maize + Cowpea (1:1)	245.20	74.00	-	319.20	100.40	25.20	-	125.60
Maize + Cowpea (2:1)	312.02	57.00	-	369.02	118.31	24.20	-	142.51
Maize + Soybean (1:1)	251.80	-	86.00	337.80	103.80	-	32.60	136.41
Maize + Soybean (2:1)	338.10	-	69.30	407.20	130.31	-	29.51	153.82
Maize (70%) + Cowpea (30%) mixed	297.71	54.00	-	351.71	121.7	15.70	-	137.40
Maize (70%) + Soybean (30%) mixed	316.80	-	61.20	378.00	114.80	-	38.31	153.11
Maize (70%) + Cowpea (15%) + Soybean (15%)	323.71	20.70	32.00	376.41	121.30	9.0	16.90	147.20
SE m±	4.15	-	-	6.59	4.09	-	-	5.67
CD(Pd”0.05)	12.72	-	-	19.60	12.54	-	-	16.98

SE (m)- standard error of mean, CD- critical difference in 1:1 row proportion (100.4q/ha). Higher dry fodder yield in sole maize compared to maize in intercropped system might be due to taller plants and efficient utilization of resources in sole maize as compared to maize in intercropped system. The results confirm the findings of Rehman and Raja, (2020); Tamta *et al*., (2019).

Forage Equivalent Yield

The highest system productivity in terms of forage equivalent yield (FEY) was discovered in sole maize, which was statistically comparable to maize + soybean intercropped in 2:1 row proportion, compared to the rest of the intercropping and sole cropping of cowpea and soybean (Figure 1). This could be due to better green fodder yield of maize in sole maize and higher economic value of the soybean intercrop in maize + soybean intercropped in 2:1 row proportion as forage equivalent yield is a function of economic value of the crop and its yield. Similar results were found by Rehman and Raja, (2020).

Relative Economics

Research findings revealed that sole maize had the highest benefit:cost ratio (1.58) followed by treatment maize + soybean intercropped in 2:1 row proportion (1.51) with the lowest benefit:cost ratio in sole cowpea (0.36) (Table 3). In addition, maize + cowpea and maize + soybean in proportion of 2:1 had a higher B:C ratio than maize + cowpea and

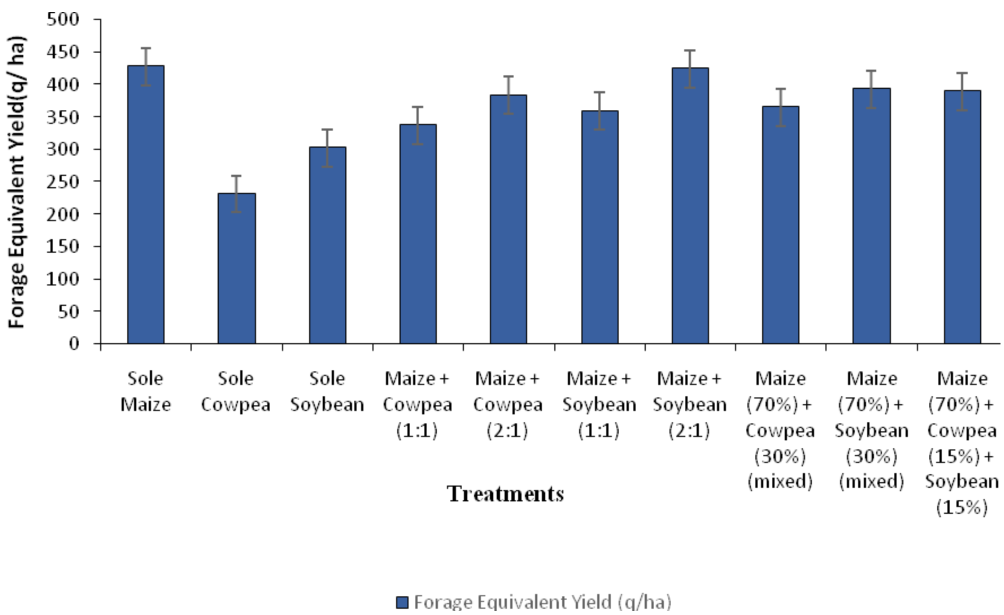

Fig. 1. Forage Equivalent yield of different cropping systems

Table 3. Relative Economics of maize legume mixtures under different cropping systems (Rs/ha)

Treatment	Cost of cultivation	Gross returns	Net Returns	B:C
Units	Rs/ha	Rs/ha	Rs/ha	Rs/ha
Sole Maize	33142	85660	52518	1.58
Sole Cowpea	33962	46325	12363	0.36
Sole Soybean	35062	60525	25463	0.72
Maize + Cowpea (1:1)	33552	67540	33988	1.01
Maize + Cowpea (2:1)	33446	76690	43243	1.29
Maize + Soybean (1:1)	34102	71860	37758	1.10
Maize + Soybean (2:1)	33820	84945	51124	1.51
Maize (70%) + Cowpea (30%) mixed	33388	73040	39652	1.18
Maize (70%) + Soybean (30%) mixed	33718	78660	44942	1.33
Maize (70%) + Cowpea (15%) + Soybean (15%) mixed	33553	77915	44362	1.32

maize + soybean in row ratio of 1:1.These findings corroborate those of Rehman and Raja, (2020) and Ginwal *et al.* (2019).

Conclusion

According to the result of the research, the sole maize yielded more green and dry fodder than the other cropping systems. It was also revealed that sole maize was economically sustainable. As a result, it can be inferred that sole maize cropping system can be used for improved fodder production and efficiency.

Acknowledgments

The authors express the deepest appreciation to the teachers and technical staff of Division of Agronomy. Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura, Sopore-193201, India for providing all the necessary facilities, suggestions, help, cooperation, and praise to complete the research.

Conflict of Interest

Authors have no conflict of interest

References

Addo, Q.A., Darkwaand, A. and Ocloo, G.K. 2011. *Growth analysis of component crops in a growth, yield and quality of summer maize + cowpea fodder.* M. Sc. (Agriculture), N. D. University of Agriculture, Faizabad, India.

Ahmad, A.H., Ahmad, R. and Mahmood, N. 2007. Production potential and quality of mixed sorghum forage under different intercropping systems and planting patterns. *Pakistan Journal of Agricultural Sciences.* 44: 87-93.

Balde, A.B., Scopel, E., Affholder, F., Silva, F.A. M.D., Wery, J. and Corbeels, M. 2020. Maize relay intercropping with fodder crops for small scale farmers in central Brazil. *Experimental Agriculture.* 1-13.

Bisht, J.K., Chandra, S., Singh, R.D. and Mani, V.P. 2001. Effect of cutting days on the forage yield and quality of cowpea (*Vigna unguiculata*) and gahat (*Macrotylomauniflorum*). *Forage Research.* 27(3): 171-176.

Chapman, S.C., Chakarborty, S., Dreccer, M.F.and Howden, M.S. 2012. Plant adaptation to climate change: opportunities and priorities in breeding. *Crop Pasture Science.* 63 : 251-268.

IGFRI Vision, 2050. Indian Grassland and Fodder Research Institute, Jhansi (UP).

Jan, R., Saxena, A., Jan, R. and Aga, F.A. 2016. Intercropping patterns of maize and cowpea impact on nodulation and maize yielding ability. *Indian Journal of Ecology.* 43(1): 151-153.

Kumar, K., Stephen, H., Anderson, Ranjith, U.P. and Robert, L.K. 2012. Water infiltration influenced by agroforestry and grass buffers for a grazed pasture system. *Agroforestry Systems.* 325-335.

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. 2017. Zinc management effects on quality andnutrient yield of fodder maize (*Zea mays*). *Indian Journal of Agricultural Sciences.* 87: 29-33.

Marer, S.B.E., Lingaraju, B.S. and Shashidhara, G.B. 2007. Productivity and economics of maize and pigeon pea intercropping under rainfed Northern transitional zone of Karnataka. *Karnataka Journal of Agricultural Sciences.* 20: 1-3.

Mthembu, B.E. and Everson, T.M. 2018. Intercropping maize (*Zea mays L.*) with lablab (*Lablabpureus L.*) for sustainable fodder production and quality in smallholder rural farming systems in South Africa. *Agroecology and Sustainable Food System.* 42: 362-382.

NAS, National Account Statistics. 2019. Central Statistical Organization. Available online: http://mospi.nic.in/publication/national-accounts-statistics-2020.

Pathan, S.H., Tumbare, A.D. and Kamble, A.B. 2012. Impact of planting material, cutting management and fertilizer levels on nutritional quality of Bajra X Napier hybrid. *Forage Research*. 38 : 74-79.

Reddy, S.A. and Palled, Y.B. 2016. Effect of intercropped fodder cowpea on maize and system productivity in maize + fodder cowpea intercropping systems. *Journal of Farm Sciences.* 29 : 265-267.

Rehman, U. and Raja, W. 2020. Performance of fodder sorghum with different forage legumes combination under temperate conditions of Kashmir. *Forage Research.* 46 : 248-253.

Tamta, A., Kumar, R., Ram, H., Meena, R.K., Meena, V.K., Yadav, M.R. and Subrahmanya, D. J. 2019. Productiviy and profitability of legume-cereal forages under different planting ratio and nitrogen fertilization. *Legume Research.* 42: 102-107.

Uzma, M., Mushtaq, A., Ishfaq, A. and Shikari, A.B. 2016. Participatory varietal selection on fodder oats under temperate conditions of Kashmir valley. *Indian Journal of Genetics and Plant Breeding.* 76: 217-220.