

ECONOMIC IMPACT ASSESSMENT OF PULSES AND OILSEED INTERCROPS ON YIELD AND QUALITY PARAMETERS OF SUGARCANE

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ABSTRACT: Background: Climate change and food security is a challenge that world is currently facing. Intercropping being an alternate management approaches in sugarcane field is an excellent practice to increase yield, net return, farm land use efficiency and soil health. Intercrops provide interim economic return to small farmers in interim period.

Objectives: The objective of the experiment is to calculate the economics of various inter cropping systems, useful for the prosperity of small sugarcane growers.

Methodology: For this purpose, a research experiment was designed during the crop season 2017-18 and 2018-19 at Sugarcane Research Institute, Faisalabad, Pakistan. The plot size was 10 m × 9.6 m. The experiment was laid out in a randomized complete block design with five replications. The treatments included four intercrops viz. one and two lines of Mung, Mash, Sunflower and canola with Sugarcane (CPF-249) alone.

Results: It was concluded from the study that higher cane yield (103.3 t ha⁻¹), sugar yield (13.12 t ha⁻¹) and more economic advantage of Rs. 345210/- ha⁻¹ were obtained when intercropped with two lines of Canola. After canola, economic advantage of Rs. 264700/- ha⁻¹ was obtained when intercropped with two lines of Mash. It is also suggested that a canola and Mash as intercrop will be more profitable for sugarcane growers to fetch short term benefit.

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INTRODUCTION

Intercropping aids diversification of crop production. Which fulfill varied needs of farmer community (Singh *et al.* 2017). It is an effective planting practice of growing one crop alongside another and increase yield, reduces pest (Maluleke *et al.* 2005), weeds. There are many intercropping model being practiced in Pakistan, including, wheat, maize, canola, pulses, soybean, onion, garlic, potato, lentil, gram etc. These Intercropping models showed many advantages like, higher yield, improving the soil health (Tetteh *et al.* 2019) higher light interception (Zhi XY *et al.* 2019) and higher utilization rate of inputs, soil and farm resources, enhancing nitrogen nutrition (Chen *et al.*, 2019), phytoremediation of heavy metal contaminated soils (De Conti *et al.* 2019) and availability of Phosphorus (Lian *et al.* 2019).

Sugarcane grow slowly in initial growth stage and can accommodate easily the short-duration crops. Sugarcane crop takes early 120 days for canopy development in autumn plantation (Hossain *et al.*

2019). Companion and multiple cropping produces and opportunity to best utilize the available space of 2-2.5 feet between cane rows. Cane growers may raise numerous short duration crops like cereals, pulses, vegetables, Oilseed crops and spices as intercrops to get interim return. Small sugarcane growers cannot wait until the harvest of the sole crop after 16 months to obtain financial benefits (Zarekar *et al.* 2017).

Organic matter and soil fertility have become foremost concerns for sustainable agriculture and crop production. Pulse crops like lentil, gram etc have the opportunities to improve the crop productivity in sugarcane cropping system. It reduce the cost of production and improve soil fertility level on sustainable basis (Shukla *et al.* 2019).

In Pakistani agriculture, great potential exit in wider use of multiple cropping to increase crop production, more financial returns per unit land area and to improve resource use efficiency in the early slow crop growth period. Legume intercrops in cropping systems enrich soil fertility through the

emission and release of amino acids into the rhizosphere of sugarcane. The legume intercrops fixed the nitrogen and makes it available to the associated sugarcane crop. Further, addition of the crop residues in soil with improve level of organic matter and soil fertility. Nitrogen doze required by sugarcane crop may possibly be decreased planting of legume intercrops (Shen *et al.* 2019).

Intercropping improves the land use efficiency and boosts microbial activities in soil. Among three intercropping systems viz. sugarcane alone, peanut, soybean intercrops, bacterial communities were found correlated positively with soil pH and enzyme protease. The availability of Phosphorus in the soil of intercrops in better quantity showed a resilient link between uptake of soil nutrients and microbes activities. (Solanki *et al.* 2020).

Soybean is also experimented for ten years as a sugarcane intercrop in china with low input of Nitrogen and it was find out that soybean intercrop improved the sugarcane productivity with 17.8%–39.4% higher energy yield and 3.2%–30.4% lower carbon footprint value in field. Sugarcane / soybean crop best perform at reduced 300 kg N than 500 kg N ha⁻¹ (Wang *et al.* 2020).

In some research trials, it was found that Garlic, linseed, oilseed and Methi intercropping not only add organic matters and increase soil fertility but also reduces the population of subterranean termites in agroecosystem of sugarcane (Ahmed *et al.* 2008). Weed oppressing was seen higher (36.3%) in cowpea intercrop while high benefit cost ratio was observed in soybean intercrop than sugarcane mono-cropping system (Geetha *et al.* 2018).

Consecutively two years, in acidic soil, effects of silicon application in peanut sugarcane intercropping was worked out. The height, diameter, fresh weight, cane yield, brix, pol% and sucrose contents were increased and reducing sugars and fiber contents were decreased (Shen *et al.* 2019). The legumes intercropping increases not only organic matter in soil but also improves the accessibility of NPK and micro nutrients to plant (Cong *et al.* 2015). Intercropping of beneficial short duration crops in sugarcane give way forward to sustainable sugarcane production with better utilization of scarce farm resources and provision of interim return to marginal and small farmers (Akbar *et al.* 2011).

The conventional method of planting cane does not permit the intercrops to grow well due to shading and competition effect (Rehman *et al.* 2014). The use of leguminous intercrops in wider spaces sugarcane can help naturally to increase the available nitrogen in the soil, thereby reducing the use of inorganic fertilizers (Tosti and Guiducci 2010).The

intercrops were also used in the South African sugarcane industry to manage nematodes on small scale grower farms (Berry *et al.* 2009).

Intercropping is the farm management technique in which the available space between cane rows are utilized to enhance interim return to farmer. In this view a field experiment was planned to optimize the intercropping system best suited for sugarcane growers.

MATERIALS AND METHODS

The experiment was piloted at research and farm area of Sugarcane Research Institute, Faisalabad, Pakistan during autumn of the crop season 2017-18 and 2018-19 to work out the feasibility and scope of suitable intercrop for sugarcane for increasing the cropping intensity and profitability and to determine the effect of different associated pulses and Oilseed crops on growth, yield and quality of autumn planted sugarcane. The net plot size was 10 m × 9.6 m a randomized complete block design with five replications. The four crops viz. Mung, Mash, Sunflower and Canola were selected as inter crops comprised with sugarcane alone as check. The sugarcane clone CPF-249 was used and seed was planted in September each year at the rate of 50,000 triple budded setts per hectare, on four feet apart double row strips. The treatments includes:

- T1: sugarcane alone
- T2: Sugarcane + 1 row of mong
- T3: Sugarcane + 2 rows of mong
- T4: Sugarcane + 1 row of mash
- T5: Sugarcane + 2 rows of mash
- T6: sugarcane + 1 row of sunflower
- T7: sugarcane + 2 rows of sunflower
- T8: sugarcane +1 line of canola
- T9: sugarcane +2 line of canola

Half seed rate of intercrops was used viz. Mash 20 kg, Mung 20 kg, Sunflower 5 kg and Canola 5 kg per hectare respectively. One / two lines of intercrops were sown on ridges as per treatments. Intercrops were harvested at maturity while the sugarcane crop was harvested in the month of December each year. NPK Fertilizer was applied at the rate of 169, 112 and 112 kg per hectare respectively in the form of urea, DAP, SOP. Fifteen irrigations were applied at different intervals according to the crop need and weather conditions.

Data recording

Germination % and tillers were calculated at 45 and 90 days after sowing of experiment respectively. Number of canes was counted from the whole plot at crop harvesting and converted to number

of canes per hectare. Crop was harvested at maturity from each plot and cane yield per hectare was valued.

Net return was worked out by deducting the total cost of production from the gross income of each treatment (CIMMYT 1988).

Net income = Gross income – Cost of production

The data were put to Fisher's analysis of variance and treatment means were compared to find the differences by using LSD test at 0.05% probability (Steel and Torrie 1984).

RESULTS AND DISCUSSION

The data of experiment was abridged in Table-1, and found that all intercrops and sugarcane alone has no significant effects on crop germination. However the highest germination of 52 % was achieved in one row of Mash and one row of Sunflower intercrop which was followed that of 51 % in one row of Mung intercrop and 50% in two rows of sunflower and sugarcane alone. The lowest germination of 48 % was observed in two rows of mash and one line of canola. Because intercrops occupied the space between cane rows and suppress the weeds during critical period of competition. Sain, *et al.* (2003) presents the same results and germination of sugarcane crop was not affected by sowing of intercrops.

The number of tillers per plant counted at cane harvesting and found that higher number of tillers per stool (2.25) was formed in the plots where two rows of mash was used as intercropped followed by 2.20 tillers per plant in one row of Mung. The number of tillers plant⁻¹ of sugarcane with intercrops varied statistically non-significantly. The data clearly presents that intercrops have competitive effects on sugarcane. Mash enhanced more tillers per plant. One row of Mash and two rows of canola produced 1.95 and 1.98 number of tillers per plant respectively and these are the lowest numbers of tillers per plant among all treatments. These results are oppose with of Sain, *et al.* (2003) who reported smothering and competitive effects of intercrops lowered the tillers per plant.

Regarding the cane count it was observed that the highest cane count of 150 thousand ha⁻¹ was recorded in one line of Mung intercrop. Two rows of Mash, one line of canola and two rows of canola produced 125, 120 and 115 thousand ha⁻¹ number of millable canes respectively. This may be due to more tillers per plant in Mung intercropping in Sugarcane. The lowest numbers of cane count 67 thousand ha⁻¹ was recorded in Sugarcane + two rows of sunflower and these results are same as of Shen *et al.* (2019) because sunflower crop is an exhaustive crop and competes with main crops of nutrients.

The statistical data in table-1 presents that Sugarcane mono-cropping and various inter crops in Sugarcane had highly significant effect on sugarcane yield. Two lines of canola produced the highest cane yield with the quantity of 103.3 t ha⁻¹ when intercropped in sugarcane followed by 92 and 91 t ha⁻¹ in one row of Mung and two rows of Mung respectively. This may be due to higher number of canes per ha and tillers per plant in one row of Mung and two lines of canola. The availability of sufficient soil nutrients especially Nitrogen by Mung crop being leguminous and restorative crop, improves the soil fertility and organic matter. The lowest crop yield of 45 t ha⁻¹ was attained when two lines of sunflower was sown in sugarcane. These results are similar to Sain *et al.*, (2003). Legume crops excreted large amount of amino acids into the rhizosphere. A further possibility of soil fertility improvement is through addition of crop residues, which on decomposition adds to the fertility of the soil and increased the organic matter in soil from 1.12% to 1.62% as presented in table-3. The nitrogen fixed by nitrogen fixing bacteria on the root nodules of lentil makes available to allied sugarcane crop and ultimately has positive impacts of yield contributing parameters (Shen *et al.* 2019). But sunflower crop competes with major crop and lowers yield.

The means of sugar yield was also varied among all the treatments. The two lines of canola intercropped in sugarcane model out yielded in sugar quantity (13.12 t ha⁻¹) and then one row of Mung and two rows of Mung sugarcane crop system produce sugar quantity of 11.46 t ha⁻¹ and 11.11 t ha⁻¹ respectively. Two lines of canola also out yielded others in cane yield which ultimately leads to higher sugar yield. On the other hand, two rows sunflower-sugarcane model produced lowest sugar of 5.73 t ha⁻¹. This may leads to the support the recommendation that two lines of canola as intercrop in sugarcane will be better for the farmers to get maximum cane and sugar yield (Rehman *et al.* 2014). Intercrops did not affect significantly sugarcane recovery. Maximum sugarcane recovery of 12.75% and 12.70% was achieved in one lines of canola and two rows of canola respectively. This highest sugarcane recovery in canola intercrops leads to maximum sugar yield.

The economics of the treatments were also calculated (table 2) were compared with the sugarcane mono-cropping system. The data discovered that h economic advantage of Rs. 345210/- ha⁻¹ with benefit cost ratio of 1.93 was high and found in the treatments where two lines of canola sugarcane intercropping model was adopted because this intercrop maximizes the tonnage of sugarcane crop. Then economic advantage of Rs. 264700/- ha⁻¹ was received in two

rows of Mung Intercrop- Sugarcane model with BCR of 1.47. The lowest benefit of Rs. 80386/- ha⁻¹ was produced where two lines of sunflower was sown as intercrop with minimum BCR of 0.44. These results are in line with Rehman *et al.*, (2014) who stated that exhaustive inter crops decline cane yield and net benefit.

CONCLUSION

It was concluded from the study that higher cane yield (103.3 t ha⁻¹), sugar yield (13.12 t ha⁻¹) and more economic advantage of Rs. 345210/- ha⁻¹ were obtained when intercropped with two lines of Canola. After canola, economic advantage of Rs. 264700/- ha⁻¹ was obtained when intercropped with two lines of Mash. It is also suggested that a canola and Mash as intercrop will be more profitable for sugarcane growers to fetch short term benefit.

Table 1. Effect of Pulses and Oilseeds Inter crops on Sugarcane Yield and quality.

Sr.no	Treatment	Germination (%)	Tillers/plant	Cane account (000/ha)	Cane yield (t/ha)	Sugar recovery (%)	Sugar yield (t/ha)
1	T1 sugarcane alone	50	2.10	129 B	84 B	12.42	10.43 AB
2	T2 Sugarcane + 1 row of mong	51	2.20	150 A	92 A	12.47	11.48 A
3	T3 Sugarcane + 2 rows of mong	49	2.00	86 D	91 A	12.31	11.11 A
4	T4 Sugarcane + 1 row of mash	52	1.95	92 D	72 D	12.26	9.63 B
5	T5 Sugarcane + 2 rows of mash	48	2.25	125 B	79 BC	12.13	9.58 B
6	T6 Sugarcane + 1 row of sunflower	52	2.08	100 C	74 CD	12.52	9.28 B
7	T7 sugarcane +2 rows of sunflower	50	2.05	67 E	45 E	12.74	5.73 C
8	T8 sugarcane +1 line of canola	48	2.00	120 B	79.4	12.75	10.12 B
9	T9 sugarcane +2 line of canola	49	1.98	115 B	103.3 A	12.70	13.12 A
	LSD 0.05	N.S	N.S	7.8989	5.8425	N.S	1.2789

Treatments	Sugarcane yield (t / ha)	Intercrop yield (kg / ha)	sugarcane Income Rs.	Intercrop Income Rs.	Total income Rs.	Cost of production of sugarcane Rs.	Cost of protection of Intercrop Rs.	Total cost Rs.	Net income Rs.	BCR
T1 Sugarcane alone	84	-	378000	-	378000	175000	-	175000	203000	1.16
T2 Sugarcane + 1 row of mong	92	234	414000	20592	434592	175000	5000	180000	254592	1.41
T3 Sugarcane + 2 rows of mong	91	400	409500	35200	444700	175000	5000	180000	264700	1.47
T4 Sugarcane + 1 row of mash	72	267	324000	24831	3488310	175000	5500	180500	168331	0.93
T5 Sugarcane + 2 rows of mash	79	400	355500	52000	407500	175000	5500	180500	227000	1.26
T6 sugarcane + 1 row of sunflower	74	1000	333000	57000	390000	175000	6000	181000	209000	1.15
T7 sugarcane + 2 rows of sunflower	45	1033	202500	58881	361381	175000	6000	181000	80386	0.44
T8 sugarcane +1 line of canola	79	1.05	357300	59360	416660	175000	4000	179000	237660	1.33
T9 sugarcane +2 line of canola	103	1.05	464850	59360	524210	175000	4000	179000	345210	1.93

Table 2. Economic Impacts of Pulses and Oilseeds Inter crops on Sugarcane Yield and quality.

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