P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 7; Issue 11; November 2024; Page No. 194-202

Received: 17-09-2024
Accepted: 21-10-2024

Indexed Journal
Peer Reviewed Journal

Economic assessment of sugarcane (*Saccharum officinarum* L.) through intercropping systems for doubling farmer's income in Yamunanagar district of Haryana

[1]Jinkle, [2]Veer Sain and [3]Jitender Kumar Bhatia

[1]M.Sc. Research Scholar,

[2]Assistant Professor COA, Kaul, and

[3]Assistant Director, DHRMS, Chaudhary Charan Singh Haryana Agricultural University, Hisar

DOI: https://doi.org/10.33545/26180723.2024.v7.i11c.1316

Corresponding Author: Veer Sain

Abstract

This study was conducted in the Yamunanagar district of Haryana, specifically in the Jagadhari and Radaur blocks, which were selected purposively on basis of highest area and production under sugarcane based intercropping systems. A total of 60 farmers were involved, with 12 farmers selected from each cropping system. The study aimed to analyze the costs and returns of different sugarcane-based cropping systems, with a focus on intercropping. The findings showed that intercropping systems, such as sugarcane + garlic (CS-IV-a) and sugarcane + onion (CS-IV-b), performed significantly better than the sole sugarcane cropping system (CS-I) in terms of gross return, net return, return over variable cost, and benefit-cost ratios. Sugarcane + garlic intercropping (CS-IV-a), emerged as the most profitable system, generating the highest gross return, net return, return over variable cost, and benefit-cost ratio. The sugarcane + onion intercropping (CS-IV-b) also displayed strong performance in terms of gross return and net return. When considering net return, the intercropping systems also showed better results. In terms of net return, the intercropping systems *viz.* CS-II, CS-III, CS-IV-a and CS-IV-b were ₹62,064, ₹38,789, ₹ 1,64,345 and ₹1,37,877 respectively, surpassing the net return of the sugarcane sole crop (CS-I) was ₹ 22,488. Similarly, the benefit-cost (B:C) ratio was higher in intercropping systems. The B:C ratio of different intercropping systems, *viz.* CS-II, CS-III, and CS-IV-a had B:C ratios of 1.18, 1.12, and 1.40, respectively, higher than the B:C ratio of the Sugarcane sole crop (CS-I) was 1.07.

Keywords: Net return, gross return, B: C ratio and intercropping system

Introduction

Sugarcane (*Saccharum officinarum* L.) is an important cash crop that plays a significant role in Indian agriculture and the national economy. It contributes to 79% of global sugar production, with approximately 70% of that coming from *Saccharum officinarum* and its hybrids. In India, sugarcane is a key crop, with both its production and productivity being crucial for the country's agricultural sector and economy. In 2021, sugarcane was cultivated on about 5.15 million hectares in India, with a productivity of around 78.5 tons per hectare (FAO, 2021). The country produced approximately 30.56 million tonnes of sugar, making it the second-largest producer globally, after Brazil (Shukla *et al*., 2022) [5]. The major sugarcane-producing states in India include Uttar Pradesh, Maharashtra, Karnataka, Bihar, Haryana, and Punjab. Uttar Pradesh leads the nation, cultivating sugarcane on 2.18 million hectares with a production of 177.43 million tonnes. In Haryana, sugarcane is grown on 0.11 million hectares, accounting for 2.09% of India's total sugarcane area, with an average productivity of 81 tons per hectare (Ministry of Agriculture & Farmers Welfare, 2021-22). The leading sugarcane-producing districts in Haryana—Yamunanagar, Kurukshetra, Ambala, Sonipat, and Karnal—contribute approximately 60 percent of the state's sugarcane production. A study by Vishwanatha *et al*. (2020) [6] conducted field trials during two consecutive kharif seasons (2010-11 and 2011-12) at the University of Agricultural Sciences, Dharwad, to assess tropical sugar beet cultivars (Cauvery, Shubhra, Magnolia, and Calixta) with various row proportions (1:1, 1:2, and 1:3) in intercropping with sugarcane. The results, based on pooled data from two years, revealed that intercropping sugarcane with sugar beet in 1:2 and 1:3 row proportions (regardless of the sugar beet variety) significantly increased net returns, ranging from ₹1,96,845 to ₹2,08,766/ha in 1:2 RP and ₹1,84,429 to ₹1,97,398/ha in 1:3 RP. However, the benefit-cost (B:C) ratio was higher in the 1:1 RP, ranging from 3.25 to 3.29. Intercropping also provided yield advantages, with sugarcane + sugar beet in 1:2 and 1:3 RP achieving significantly higher sugarcane equivalent yields. Intercropping with sugarcane not only improves soil fertility but also creates a more favorable environment for the further growth of sugarcane. However, due to competition with crops like food grains, fiber, oilseeds, and pulses, expanding the area under sugarcane cultivation is challenging. The focus now lies in increasing sugarcane and

sugar production through better agronomic practices. In recent years, there has been a shift from sole cropping to intercropping, which has proven to be more productive, economically viable, and sustainable. Crop diversification through intercropping offers farmers an opportunity to maximize profits by using the otherwise unutilized space between sugarcane rows, especially in the first 90-120 days when sugarcane grows slowly. During this period, farmers can grow short-duration crops like cereals, pulses, vegetables, and spices as intercrops, ensuring additional interim returns. Keeping in view the importance of various sugarcane-based intercropping and their vast potential in enhancing the farm income and diversification of the existing cropping system, the present study has been undertaken with the following objectives:

1. To work out the cost and return of major sugarcane based intercropping systems

Methodology

The present study was based on primary as well as secondary data. In order to achieve the above objectives related of the study of various sugarcane based cropping systems in Yamunanagar district. The two blocks (Jagadhri and Radaur) in Yamunanagar district, were purposively selected as they had the highest area under sugarcane cultivation during 2022-23. A total of 60 farmers were randomly selected, with 30 farmers from each block. Four sugarcane-based cropping systems were considered under study: Sugarcane sole crop (CS-I), Sugarcane + Wheat (CS-II), Sugarcane + Mustard (CS-III), and Sugarcane + Vegetables (CS-IV). The (CS-IV) category was further divided into two prominent intercropping systems: Sugarcane + Garlic (CS-IV-a) and Sugarcane + Onion (CS-IV-b) cropping systems, which were prominent in the study area. Twelve farmers were selected from each cropping system, with an equal distribution from both blocks. For evaluating the specific objectives of the study, primary data were collected through personal interviews with the selected farmers using a pre-tested questionnaire. On the basis of the nature of the data, budgeting technique and various economic tools were used for estimation of cost of cultivation for different intercropping systems.

Results and Discussion

Cost of cultivation of sugarcane sole crop (CS-I) in Yamunanagar district

The Cost of cultivation in sugarcane sole crop (CS-I) in Yamunanagar is presented in Table 1. Among various items, maximum share of 11.77 per cent of total expenses incurred was shared by harvesting of sugarcane in cultivation of sugarcane as a sole crop followed by setts (8.93%), FYM and fertilizers investment (5.57%), sowing (3.28%), preparatory tillage (3.23%) *etc*. in sugarcane sole crop (CS-I). The share of total variable cost was 49.52 per cent and the share of total fixed cost was 50.48 per cent.

Table 1: Cost of cultivation of sugarcane sole crop (CS-I) in Yamunanagar district

Particulars	Quantity	Value in (₹/ha)
Preparatory tillage	6.50	10427 (3.23)
Pre-sowing irrigation		906 (0.28)
Sowing		10580 (3.28)
Ridging		1153 (0.36)
Seed (setts)(qtls)	79.66	28836 (8.93)
Seed treatment		1348 (0.42)
FYM (qtls)	102.92	4117 (1.28)
Fertilizer nutrients		
a) Nitrogen	287.88	3714 (1.15)
b) Phosphatic	89.95	4826 (1.49)
c) Potassic	77.19	4373 (1.35)
d) Zinc Sulphate	3.07	797 (0.25)
e) Sulphur	2.78	161 (0.05)
Total fertilizer investment		13871 (4.30)
Fertilizer application charges		947 (0.29)
Total FYM+ Fertilizer		17987 (5.57)
Irrigation charges	9.16	7451 (2.31)
Hoeing/weeding		
a) Chemical		3437 (1.06)
b) Manual		5660 (1.75)
Total Weeding		9098 (2.82)
Plant Protection	4.75	7636 (2.37)
Plant Protection chemical application		2820 (0.87)
Tying up	2.50	8851 (2.74)
Earthing up		2635 (0.82)
Harvesting		38009 (11.77)
Miscellaneous		741 (0.23)
Total		149425 (46.28)
Interest on working capital (@7%)		10460 (3.24)
Total Variable cost		159885 (49.52)
Transportation charges		20069 (6.22)
Rental value of land		110944 (34.36)
Management charges		15988 (4.95)
Risk factor		15988 (4.95)
Total Fixed cost		162989 (50.48)
Total cost		322874 (100.00)

Note: n = 12

The interest on working capital, calculated at a rate of 7%, amounted to ₹10,460. The largest expense was the rental value of the land, which accounted for 34.36% of the total cost. Transportation costs for cultivating sugarcane as a sole crop were ₹20,069, making up 6.22% of the total. Management and risk charges were ₹15,988, representing 4.95% of the expenses. Overall, the total cost of cultivation per hectare came to ₹3,22,874.

Cost and return of sugarcane sole crop (CS-I) in Yamunanagar district

Table 2 presents the costs and returns from cultivating sugarcane as a sole crop. The gross return from sugarcane was calculated at ₹3,45,362, with a yield of 954 quintals per hectare, equating to the same monetary value. With the total cost of cultivation per hectare amounting to ₹3,22,874, the net return was ₹22,488. The return over variable costs was ₹1,85,477. The benefit-cost (B:C) ratio was 1.07, and the

B:C ratio over variable costs was 2.16. Sugarcane by-products were sold to private agencies, usually at little to no price, as farmers exchanged them mainly for the convenience of managing the leftover materials, resulting in neither profit nor loss.

Table 2: Cost and return of sugarcane sole crop (CS-I)in Yamunanagar district

Particulars	Quantity	Value (₹/ha)
Total Variable cost		159885
Total Fixed cost		162989
Total cost		322874
Production (qtls.)		
a) Main(Sugarcane)	954.04	345362
b) By-product(Sugarcane)	_	_
Gross return		345362
Net return		22488
Return over variable cost		185477
B-C ratio		1.07
B-C ratio over variable cost		2.16

Note: n = 12

Cost of cultivation of sugarcane + wheat intercropping system (CS-II) in Yamunanagar district

The cost of cultivating sugarcane and wheat intercropping system (CS-II) in Yamunanagar district is shown in Table 3. The largest expense, making up 9.55% of the total, was for harvesting sugarcane. This was followed by the cost of sugarcane setts at 5.75%, investments in FYM and fertilizers at 5.53%, and wheat harvesting at 3.42%. Other notable costs included preparatory tillage at 3.04% and sowing of sugarcane at 2.94%. Overall, variable costs accounted for 51.68% of the total, while fixed costs made up 48.32%.

Table 3: Cost of cultivation of sugarcane + wheat intercropping system (CS-II) in Yamunanagar district

Particulars	Quantity	Value (₹/ha)
Preparatory tillage	6.67	10703 (3.04)
Pre-sowing irrigation		1039 (0.29)
Sowing a) Sugarcane		10374 (2.94)
b) Intercrop-Wheat		1214 (0.34)
Ridging		2861 (0.81)
Seed		
a) Sugarcane (qtls.)	55.99	20267 (5.75)
b) Intercrop-Wheat (Kgs)	92.21	3458 (0.98)
Seed treatment		823 (0.23)
FYM (qtls)	119.38	4775 (1.35)
Fertilizer nutrients		
a) Nitrogen	287.88	3714 (1.05)
b) Phosphatic	104.15	5588 (1.59)
c) Potassic	77.19	4373 (1.24)
d) Zinc Sulphate	3.01	787 (0.22)
e) Sulphur	4.63	268 (0.08)
Total fertilizer investment		14730 (4.18)
Fertilizer application charges		1039 (0.29)
Total FYM+ Fertilizer		19505 (5.53)
Irrigation charges	9.25	7966 (2.26)
Hoeing/weeding		
a) Chemical		3479 (0.99)
b) Manual		6998 (1.99)
Total Weeding		10477 (2.97)
Plant Protection	4.85	9839 (2.79)
Plant Protection chemical application		3520 (1.00)
Tying up	2.25	8233 (2.34)
Earthing up		3046 (0.86)
Harvesting a) Sugarcane		33670 (9.55)
b) Intercrop		12041 (3.42)
Threshing (Intercrop-Wheat)		9365 (2.66)
Miscellaneous		834 (0.24)
Total		170274 (48.30)
Interest on working capital (@7%)		11919 (3.38)
Total Variable cost		182193 (51.68)
Transportation charges		19823 (5.62)

a) Sugarcane		
b) Intercrop (Wheat)		1275 (0.36)
Rental value of land		112797 (32.00)
Management charges		18219 (5.17)
Risk factor		18219 (5.17)
Total Fixed cost		170333 (48.32)
Total cost		352526 (100.00)

Note: n = 12

The Interest on working capital at the rate of 7 per cent was worked out to be ₹ 11,919. Maximum cost was incurred on the rental value of land alone contributed 32.00 per cent of total cost. A total transportation charge at 5.98 per cent was worked out to be ₹ 21,098. Both management and risk charges at 5.17 per cent were worked out to be ₹ 18,219. Finally, total cost of cultivation on per hectare basis worked out was ₹ 3,52,526.

Cost and return of sugarcane + wheat intercropping system (CS-II) in Yamunanagar district

Table 4 shows the costs and returns from cultivating sugarcane + wheat intercropping system (CS-II). The gross return from this system was calculated at ₹4,14,591. The main crop, sugarcane, yielded 852 quintals per hectare, valued at ₹3,08,478. For the intercrop, wheat, the main yield was 41 quintals per hectare, worth ₹83,779, and the by-product yield was 45 quintals per hectare, valued at ₹22,333. With a total cultivation cost of ₹3,52,526 per hectare, the net return was ₹62,064. The return over variable costs was ₹2,32,397. The benefit-cost (B:C) ratio was 1.18, and over variable costs, it was 2.28.

Table 4: Cost and return of sugarcane + wheat intercropping system (CS-II) in Yamunanagar district

Particulars	Quantity	Value (₹/ha)
Total Variable cost		182193
Total Fixed cost		170333
Total cost		352526
Production (qtls.)		
a) Main (Sugarcane)	852.15	308478
b) By-product (Sugarcane)	_	_
c) Intercrop (Wheat)	41.37	83779
d) By-product (Wheat)	44.67	22333
Gross return		414590
Net return		62064
Return over variable cost		232397
B:C ratio		1.18
B:C ratio over variable cost		2.28

Note: n = 12

Cost of cultivation of sugarcane + mustard intercropping system (CS-III) in Yamunanagar district

Cost of cultivation in sugarcane + mustard intercropping system (CS-III) in Yamunanagar district is presented in Table 5. The largest expense, accounting for 9.99 percent of the total, was for harvesting sugarcane. This was followed by the cost of sugarcane setts at (5.96%), investments in FYM and fertilizers at (5.47%), total weeding at (3.53%), plant protection chemicals at 3.31%, sowing of sugarcane at (3.11%), and preparatory tillage at (3.00%). In this system, variable costs made up (50.24%) of the total, while fixed costs accounted for (49.76%).

Table 5: Cost of cultivation of sugarcane + mustard intercropping system (CS-III) in Yamunanagar district

Particulars	Quantity	Value (₹/ha)
Preparatory tillage	6.17	9901 (3.00)
Pre-sowing irrigation		1050 (0.32)
Sowing a) Sugarcane		10271 (3.11)
b) Intercrop-Mustard		947 (0.29)
Ridging		2964 (0.90)
Seed		
a) Sugarcane (qtls.)	54.34	19671 (5.96)
b) Intercrop-Mustard (Kgs)	3.19	2182 (0.66)
Seed treatment		762 (0.23)
FYM (qtls)	100.86	4034 (1.22)
Fertilizer nutrients		
a) Nitrogen	262.87	3391 (1.03)
b) Phosphatic	94.68	5080 (1.54)
c) Potassic	74.10	4199 (1.27)
d) Zinc Sulphate	2.99	822 (0.25)
e) Sulphur	9.63	557 (0.17)
Total fertilizer invest.	444.28	14048 (4.25)
Fertilizer application charges		1009 (0.31)
Total FYM+ Fertilizer		18082 (5.47)
Irrigation charges	8.58	7420 (2.25)
Hoeing/weeding		
a) Chemical		350 (0.11)
b) Manual		11321 (3.43)
Total Weeding		11671 (3.53)
Plant Protection	4.1	10930 (3.31)
Plant Protection chemical application		3335 (1.01)
Tying up	2.08	8028 (2.43)
Earthing up		2758 (0.84)
Harvesting a) Sugarcane		32999 (9.99)
b) Intercrop-Mustard		4631 (1.40)
Threshing (Intercrop-Mustard)		5660 (1.71)
Miscellaneous		792 (0.24)
Total		155064 (46.95)
Interest on working capital (@7%)		10854 (3.29)
Total Variable cost		165918 (50.24)
Transportation charges a) Sugarcane		17600 (5.33)
b) Intercrop (Mustard)		1604 (0.48)
Rental value of land		111973 (33.90)
Management charges		16592 (5.02)
Risk factor		16592 (5.02)
Total Fixed cost		164361 (49.76)
Total cost		330279 (100.00)

Note: n = 12

Interest on working capital at the rate of 7 per cent was worked out to be ₹ 10,854. Maximum cost was incurred on the rental value of land which alone contributed 33.90 per cent of total cost was worked out to be ₹ 1,11,973. Total transportation charges at 5.81 per cent was worked out to be ₹ 19,204. Both management and risk charges came to ₹16,592, representing 5.02% of the costs. In total, the cost of cultivation per hectare was ₹3,30,279.

Cost and return of sugarcane + mustard intercropping system (CS-III) in Yamunanagar district

Table 6 presents the costs and returns from the sugarcane + mustard intercropping system (CS-III). The gross return from this system was calculated at ₹3,69,068. The main crop, sugarcane, yielded 836 quintals per hectare, valued at ₹3,02,517. For the intercrop, mustard, the main yield was 12 quintals per hectare, worth ₹62,887, and the by-product yield was 20 quintals per hectare, valued at ₹3,664. With the total cost of cultivation per hectare being ₹3,30,279, the net return was ₹38,789. The return over variable costs was ₹2,03,150. The benefit-cost (B:C) ratio was 1.12, while the B:C ratio over variable costs was 2.22.

Table 6: Cost and return of sugarcane + mustard intercropping system (CS-III) in Yamunanagar district

Particulars	Quantity	Value(₹/ha)
Total Variable cost		165918
Total Fixed cost		164361
Total cost		330279
Production (qtls.)		
a) Main (Sugarcane)	835.68	302517
b) By-product (Sugarcane)	_	_
c) Intercrop (Mustard)	12.45	62887
d) By-product (Mustard)	19.97	3664
Gross return		369068
Net return		38789
Return over variable cost		203150
B:C ratio		1.12
B:C ratio over variable cost		2.22

Note: n = 12

Cost of cultivation of sugarcane + vegetables intercropping systems (CS-IV) in Yamunanagar district

1. Cost of cultivation of sugarcane + garlic intercropping system (CS-IV-a) in Yamunanagar district

The cost of cultivating sugarcane + garlic intercropping system (CS-IV-a) are presented in Table 7. The largest expenses were for harvesting the intercrop (garlic), which accounted for (9.19%) of the total costs, and harvesting sugarcane, which made up 8.71 percent. These were followed by the cost of sowing garlic at (6.14%), investments in FYM and fertilizers at (4.95%), sugarcane setts at (4.45%), sowing sugarcane at (2.54%), and preparatory tillage at (2.29%). Overall, variable costs represented 54.74 percent of the total, while fixed costs accounted for 45.26 percent.

Interest on working capital at the rate of 7 per cent was worked out to be ₹ 14,638. Maximum cost was incurred on the rental value of land which alone contributed 28.10 per cent of total cost. Total transportation charges at 6.21 per cent was worked out to be ₹ 25,392. Both management and risk charges at 5.47 per cent were worked out to be ₹ 22,375. Finally, total cost of cultivation on per hectare basis worked out was ₹ 4,08,749.

Table 7: Cost of cultivation of sugarcane + garlic intercropping system (CS-IV-a) in Yamunanagar district

Particulars	Quantity	Value (₹/ha)
Preparatory tillage	5.83	9365 (2.29)
Pre-sowing irrigation		1081 (0.26)
Sowing a) Sugarcane		10374 (2.54)
b) Intercrop-Garlic		25112 (6.14)
Ridging		2326 (0.57)
Seed		
a) Sugarcane(qtls.)	50.22	18181 (4.45)
b) Intercrop-Garlic(qtls.)	5.11	10777 (2.64)
Seed treatment		1400 (0.34)
FYM (qtls.)	109.09	4364 (1.07)
Fertilizer nutrients		
a) Nitrogen	236.53	3051 (0.75)
b) Phosphatic	127.15	6822 (1.67)
c) Potassic	80.28	4548 (1.11)
d) Zinc Sulphate	3.34	857 (0.21)
e) Sulphur	11.49	610 (0.15)
Total fertilizer investment		15889 (3.89)
Fertilizer application charges		648 (0.16)
Total FYM+ Fertilizer		20252 (4.95)
Irrigation charges	8.25	7132 (1.74)
Hoeing/weeding		
a) Chemical		206 (0.05)
b) Manual		8027 (1.96)
Total Weeding		8233 (2.01)
Plant Protection	2.58	6072 (1.49)
Plant Protection chemical application		2367 (0.58)
Tying up	2.25	8336 (2.04)
Earthing up		3190 (0.78)
Harvesting a) Sugarcane		35609 (8.71)
b) Intercrop- Garlic		37546 (9.19)
Miscellaneous		1112 (0.27)
Total		209114 (51.16)
Interest on working capital (@7%)		14638 (3.58)
Total Variable cost		223752 (54.74)
Transportation charges a) Sugarcane		19077 (4.67)
b) Intercrop (Garlic)		6315 (1.54)
Rental value of land		114855 (28.10)
Management charges		22375 (5.47)
Risk factor		22375 (5.47)
Total Fixed cost		184997 (45.26)
Total cost		408749 (100.00)

Note: n = 12

Cost and return of Sugarcane + Garlic intercropping system (CS-IV-a) in Yamunanagar district

The cost and returns from cultivation of sugarcane + garlic intercropping system (CS-IV-a) are presented in Table 8. The gross return from this intercropping system was calculated to be ₹5,71,360 per hectare. The main crop (sugarcane) yielded 926 quintals per hectare, valued at ₹3,35,303, while the intercrop (garlic) produced 103 quintals per hectare, with a monetary value of ₹2,36,058. The total cost of cultivation per hectare was ₹4,07,016, resulting in a net return of ₹1,62,611. The return over variable costs was ₹3,47,608. The benefit-cost (B:C) ratio was calculated at 1.40, and the B:C ratio over variable costs was 2.55. Additionally, farmers who use single bud sets for planting reduce seed material costs by two-thirds and require only 2-3 tonnes of setts per hectare.

Table 8: Cost and return of sugarcane + garlic intercropping system (CS-IV-a) in Yamunanagar district

Particulars	Quantity	Value (₹/ha)
Total Variable cost		223752
Total Fixed cost		184997
Total cost		408749
Production (qtls.)		
a) Main (Sugarcane)	926.25	335303
b) By-product (Sugarcane)	_	_
c) Intercrop (Garlic)	103.12	236058
d) By-product (Garlic)	0.00	0
Gross return		571360
Net return		162611
Return over variable cost		347608
B:C ratio		1.40
B:C ratio over variable cost		2.55

Note: n = 12

2. Cost of cultivation of sugarcane + onion intercropping system (CS-IV-b) in Yamunanagar district

Cost of cultivation in sugarcane + onion intercropping system (CS-IV-b) in Yamunanagar district is presented in Table 9. Among various items, harvesting of intercrop (onion) and sugarcane shared 8.48 and 8.24 per cent, respectively of total expenses incurred in cultivation of sugarcane + onion intercropping system (CS-IV-b) followed by sowing of intercrop i.e. onion (6.47%), FYM and fertilizers investment (4.87%), seed of onion (3.87%), setts of sugarcane (3.73%), sowing of sugarcane (2.43%), preparatory tillage (2.26%) *etc*. in sugarcane + onion intercropping system (CS-IV-b). The share of total variable cost is 54.91 per cent and the share of total fixed cost is 45.09 per cent.

Table 9: Cost of cultivation of sugarcane + onion intercropping system (CS-IV-b) in Yamunanagar district

Particulars	Quantity/Number (s)	Value (₹/ha)
Preparatory tillage	5.92	9499 (2.26)
Pre-sowing irrigation		1019 (0.24)
Sowing a) Sugarcane		10209 (2.43)
b) Intercrop-Onion		27170 (6.47)
Ridging		1400 (0.33)
Seed		
a) Sugarcane (qtls.)	43.23	15647 (3.73)
b) Intercrop-Onion (Kgs.)	8.13	16253 (3.87)
Seed treatment		1750 (0.42)
FYM (qtls)	111.15	4446 (1.06)
Fertilizer nutrients		
a) Nitrogen	235.97	3044 (0.73)
b) Phosphatic	129.21	6932 (1.65)
c) Potassic	77.19	4374 (1.04)
d) Zinc Sulphate	3.47	892 (0.21)
e) Sulphur	13.15	760 (0.18)
Total fertilizer invest.		16002 (3.81)
Fertilizer application charges		762 (0.18)
Total FYM+ Fertilizer		20448 (4.87)
Irrigation charges	8.42	7089 (1.69)
Hoeing/weeding		
a) Chemical		494 (0.12)
b) Manual		8261 (1.99)
Total Weeding		8755 (2.09)
Plant Protection	4.44	9108 (2.17)
Plant Protection chemical application		3017 (0.72)
Tying up	2.33	8799 (2.10)
Earthing up		3088 (0.74)
Harvesting a) Sugarcane		34580 (8.24)
b) Intercrop- Onion		35583 (8.48)
Miscellaneous		1095 (0.26)
Total		215345 (51.31)
Interest on working capital (@7%)		15074 (3.59)
Total Variable cost		230419 (54.91)
Transportation charges a) Sugarcane		19942 (4.75)
b) Intercrop (Onion)		8772 (2.09)
Rental value of land		114443 (27.27)
Management charges		23042 (5.49)
Risk factor		23042 (5.49)
Total Fixed cost		189241 (45.09)
Total cost		419660 (100.00)

Note: n = 12

Interest on working capital at the rate of 7 per cent was worked out to be ₹ 15,074. Maximum cost was incurred on rental value of land alone which contributed 27.27 per cent of total cost. Total transportation charges at 6.84 per cent was worked out to be ₹ 28,714. Both management and risk charges at 5.49 per cent were worked out to be ₹ 23,042. Finally, total cost of cultivation on per hectare basis worked out was ₹ 4,19660.

Cost and return of sugarcane + onion intercropping system (CS-IV-b) in Yamunanagar district

Cost and return from cultivation of sugarcane + onion intercropping system (CS-IV-b) are depicted in Table 10. The gross return from sugarcane +onion intercropping system (CS-IV-b) computed was to be ₹ 5,57,537. The yield of main crop (sugarcane) and intercrop (onion) attained were 852 and 205 qtls/ha with monetary value of ₹ 3,08,478 and ₹ 2,49,058, respectively. With the per hectare total cost of cultivation being ₹ 4,18,762, the net return worked out was ₹ 1,37,877. The return over variable cost was worked out to be ₹ 3,27,118. The B:C ratio was worked out to be 1.33. The B:C ratio over variable cost was worked out to be 2.42.

Table 10: Cost and return of sugarcane + onion intercropping system (CS-IV-b) in Yamunanagar district

Particulars	Quantity	Value (₹/ha)
Total Variable cost		230419
Total Fixed cost		189241
Total cost		419660
Production (qtls.)		
a) Main (Sugarcane)	852.15	308478
b) By-product (Sugarcane)	_	_
c) Intercrop (Onion)	204.8	249058
d) By-product (Onion)	0	0
Gross return		557537
Net return		137877
Return over variable cost		327118
B:C ratio		1.33
B:C ratio over variable cost		2.42

Note: n = 12

Comparative economics of sugarcane based intercropping systems in the Yamunanagar district

Comparative analysis of various sugarcane based intercropping system was done by analyzing and comparing cost and return of various sugarcane based intercropping systems. (Table 11)

Table 11: Comparative economics of sugarcane based intercropping systems in Yamunanagar district

Cropping System	Total Variable Cost (₹/ha)	Total Fixed Cost (₹/ha)	Total Cost (₹/ha)	Gross Return (₹/ha)	Net Return (₹/ha)	Return over Variable Cost (₹/ha)	B:C Ratio	B:C Ratio over Variable Cost
Sugarcane Sole Crop (CS-I)	1,59,885	1,62,989	3,22,874	3,45,362	22,488	1,85,477	1.07	2.16
Sugarcane + Wheat (CS-II)	1,82,193	1,70,333	3,52,526	4,14,591	62,064	2,32,397	1.18	2.28
Sugarcane + Mustard (CS-III)	1,65,918	1,64,361	3,30,279	3,69,068	38,789	2,03,150	1.12	2.22
Sugarcane + Garlic (CS-IV-a)	2,23,752	1,84,997	4,08,749	5,71,360	1,62,611	3,47,608	1.40	2.55
Sugarcane + Onion (CS-IV-b)	2,30,419	1,89,241	4,19,660	5,57,537	1,37,877	3,27,118	1.33	2.42

Note: n = 12

The comparative economics of various sugarcane-based intercropping systems were analyzed, including sugarcane as a sole crop (CS-I), sugarcane + wheat (CS-II), sugarcane + mustard (CS-III), sugarcane + garlic (CS-IV-a), and sugarcane + onion (CS-IV-b). Among these, the sugarcane + garlic intercropping system (CS-IV-a) had the highest gross return, net return, return over variable cost, and B:C ratio. This was followed by sugarcane + onion (CS-IV-b), sugarcane + wheat (CS-II), sugarcane + mustard (CS-III), and lastly, the sugarcane sole crop (CS-I).

In terms of gross return, the sugarcane + garlic intercropping system (CS-IV-a) generated the highest return at ₹5,71,360, with the sugarcane + onion system (CS-IV-b) close behind at ₹5,57,537. The sugarcane sole crop (CS-I), on the other hand, produced the lowest gross return at ₹3,45,362.

Similarly, when evaluating net returns, the intercropping systems performed better than the sole crop. Net returns were ₹62,064 for CS-II, ₹38,789 for CS-III, ₹1,64,345 for CS-IV-a, and ₹1,37,877 for CS-IV-b, all surpassing the sole crop system's net return of ₹22,488.

From Table 11, it is clear that CS-IV(b) was most economic sugarcane based intercropping systems followed by CS-IV(a), CS-II and CS-III respectively. However, B:C ratio also gives clear indication about the onion and garlic intercropping systems as most economic among all cropping systems analyzed but these are labour intensive cultivation and in time availability of labour for both crops becomes a severe problem in the study also.

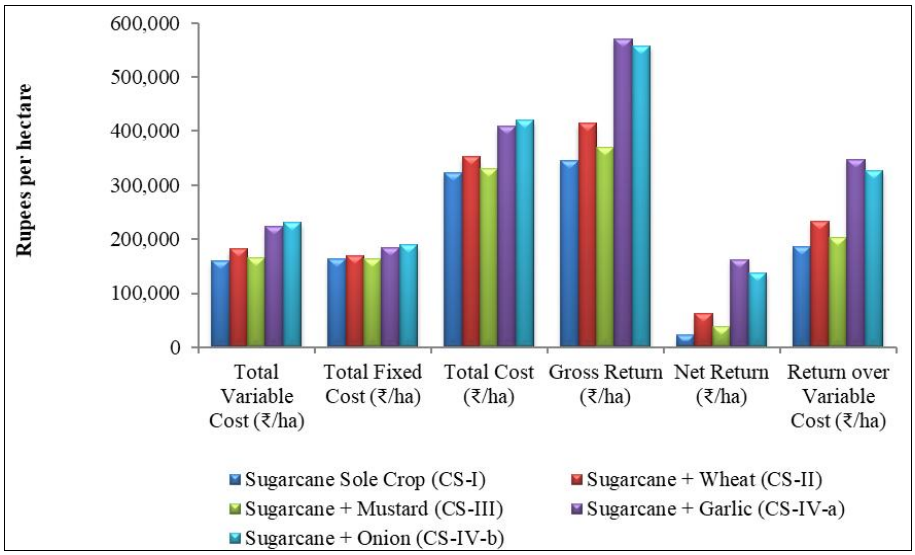

Fig 1: Comparative economics of sugarcane based intercropping systems in Yamunanagar district

Cost and return of various sugarcane based intercropping systems under study

The study analyzed the costs and returns of different sugarcane intercropping systems in the Yamunanagar district, including sugarcane as a sole crop (CS-I), sugarcane + wheat (CS-II), sugarcane + mustard (CS-III), sugarcane + garlic (CS-IV-a), and sugarcane + onion (CS-IV-b). Among these, the sugarcane + garlic intercropping system (CS-IV-a) had the highest gross return, net return, return over variable cost, and B:C ratio, followed by sugarcane + onion (CS-IV-b), sugarcane + wheat (CS-II), sugarcane + mustard (CS-III), and lastly, the sugarcane sole crop (CS-I). In terms of gross return, the sugarcane + garlic system (CS-IV-a) generated the highest amount at ₹5,71,360, with the sugarcane + onion system (CS-IV-b) close behind at ₹5,57,537. On the other hand, the sugarcane sole crop (CS-I) had the lowest gross return, amounting to ₹3,45,362. These findings highlight the significant increase in net return when sugarcane is intercropped, as compared to being grown alone. Similar results were reported by Shahana *et al.* (2020) [3] at Telangana State Agricultural University in their study on the benefits of intercropping in autumn-planted sugarcane.

The results indicate that the sugarcane + vegetable intercropping system (CS-IV) offers higher profitability after accounting for cultivation costs, while the sugarcane sole crop (CS-I) shows the lowest profitability and benefits among the systems. These findings align with Kiran *et al.* (2016) [1], who also reported higher gross return, net return, and return over variable costs in intercropping systems compared to sole cropping in their study on groundnut-based cropping systems in Tumkur, Karnataka.

The sugarcane + garlic intercropping system (CS-IV-a) was the most profitable, with a net return of ₹1,62,611, while the sugarcane sole crop (CS-I) had the lowest net return at ₹22,488. In terms of return over variable costs, the sugarcane + garlic system also performed best, yielding ₹3,47,608, while the sole crop (CS-I) had the lowest return in this category. Among all the systems, the sugarcane + garlic system (CS-IV-a) proved to be the most cost-effective and profitable, with a benefit-cost (B:C) ratio of 1.40, compared to the lowest B:C ratio of 1.07 in the sole crop (CS-I). These results are consistent with the findings of Singh *et al.* (2016) [2], who reported a higher economic return and B:C ratio for sugarcane + garlic intercropping in Faridkot district, Punjab, compared to sole sugarcane cropping. Intercropping systems showed better net returns overall. The net returns for CS-II, CS-III, CS-IV-a, and CS-IV-b were ₹62,064, ₹38,789, ₹1,62,611, and ₹1,37,877, respectively, all of which outperformed the net return from the sole crop (CS-I), which was ₹22,488.

Similarly, the return over variable costs was higher in all intercropping systems compared to the sole crop system. The values were ₹2,32,397 for CS-II, ₹2,03,150 for CS-III, ₹3,47,608 for CS-IV-a, and ₹3,27,118 for CS-IV-b, while the sole crop (CS-I) recorded ₹1,85,477. In terms of the benefit-cost ratio (B:C), the intercropping systems also outperformed the sole crop. CS-II, CS-III, and CS-IV-a had B:C ratios of 1.18, 1.12, and 1.40, respectively, while the sole crop (CS-I) had a B:C ratio of 1.07.

Overall, the analysis demonstrated that intercropping systems provided higher gross returns, net returns, returns over variable costs, and B:C ratios, making them more profitable and cost-effective compared to the sugarcane sole crop. These findings align with those of Shinde *et al.* (2009) [4], who reported higher gross returns from sugarcane intercropping systems compared to sole sugarcane cropping in their study on profitability in Belgaum district, Karnataka.

Conclusion

In this study, the findings indicate that the sugarcane + garlic intercropping system (CS-IV-a) demonstrated the highest gross return, net return, return over variable cost, and benefit-cost ratio, suggesting its potential for better profitability, resource utilization, and cost-effectiveness compared to other systems. Similarly, the sugarcane + onion intercropping system (CS-IV-b) also showed favorable results across these parameters.

Acknowledgements

Authors are thankful to Department of Agricultural Economics, Chaudhary Charan Singh Haryana Agricultural University, Hisar, 123005.

References

1. Kiran R, Sivakumar SD, Tej MK, Mathialagan M. The cost and return structures of major groundnut-based cropping systems in Pavagada Taluk of Tumkur district in Karnataka. Int J Agric Sci. 2016;8(56):3070-3073.
2. Singh K, Brar AS, Singh K, Kaur R. Investigations on competition in sugarcane-garlic intercropping systems. Agric Res J. 2016;53(3):323-327.
3. Shahana F, Reddy TP, Bharati Y, Pallavi M. Assessment of monetary advantage of intercropping in autumn planted sugarcane. IJCS. 2020;8(3):556-558.
4. Shinde N, Patil BL, Murthy C, Mamledesai NR. Profitability analysis of sugarcane-based intercropping systems in Belgaum district of Karnataka. Karnataka J Agric Sci. 2009;22(4):820-823.
5. Shukla SK, Sharma L, Jaiswal VP, Dwivedi AP, Yadav SK, Pathak AD. Diversification options in sugarcane-based cropping systems for doubling farmer's income in subtropical India. Sugar Tech. 2022;24:1212-1229.
6. Vishwanatha S, Shwetha BN, Koppalkar BG, Kavya BM, Hiremath SM, Patil PL. Yield advantages of sugarcane and sugarbeet intercropping system in Northern Karnataka. J Pharmacogn Phytochem. 2020;6:339-343.