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Comparative economic analysis of sugarcane cultivation in Shivalik foothills of Haryana

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Abstract
The present study was carried out with the objectives to work out costs and returns in cultivation of sugarcane in Shivalik foothills of Haryana during 2022-23. The study was based on primary data. Panchkula and Yamunanagar districts were consciously selected. From both districts, four village from each district) were selected purposively i.e., Bagwala, Golpura, Tharwa and Bhagpur from Panchkula district and Jhiwerher, Uncha chandna, Sabri and Marwa Khurd from Yamunanagar district. Finally, 75 farmers were selected randomly from all the selected eight villages were interviewed to gather all the desired information. The per hectare cost of sugarcane cultivation was found to be Rs. 282441 and Rs. 301497 in Panchkula and Yamunanagar district, respectively. On an average, the per hectare yield, gross returns and net returns obtained from the cultivation of sugarcane in Panchkula district were 803.6 quintals, Rs. 303507 and Rs. 21066, respectively. The corresponding figures for Yamunanagar district were worked out to be 801.7 quintals, Rs. 310600 and Rs. 9103, respectively. The B:C ratio and B:C ratio over variable cost of sugarcane cultivation was worked out to be 1:1.07 and 1:1.03, 1:2.01 and 1:1.98 respectively for Panchkula & Yamunanagar district which found to be comparatively lower in Yamunanagar district, high cost of labour and rental value of land was the major reason for this.

Keywords: Cost, returns, cultivation, B-C ratio, B-C ratio over variable cost

Introduction
Sugarcane is an important commercial crop of the world and the cultivation of sugarcane, in India dates back to Pre-Vedic period (2000B.C.). India is one of the principal centers of the origin of the sugarcane. Sugarcane cultivation in India is broadly classified into two agro-climatic regions i.e. sub-tropical and tropical. The sub-tropical zone includes four states i.e. Uttar Pradesh (2.16 million ha), Bihar (0.24 million ha), Punjab (0.09 million ha) and Haryana (0.10 million ha) while tropical zone consists of five states i.e. Maharashtra (0.63 million ha), Andhra Pradesh (0.10 million ha), Tamil Nadu (0.21 million ha), Gujarat (0.17 million ha) and Karnataka (0.35 million ha). The tropical region has about 45% of area and contributed 55% of the total sugarcane production in the country. Thus, sub-tropical region accounted for 55% of area and shared 45% of total production of sugarcane. The production scenario in India indicated that Uttar Pradesh, Maharashtra, Karnataka and Tamil Nadu are the major sugarcane states of India (Brar and Kataria, 2015) [1]. In Northern region, Sugarcane is planted in the months of January-February and October for spring and autumn seasons, respectively. The sugarcane requires 10-18 months for maturity in India but on an average 12 month crop duration is most prevalent. In sub-tropical region, planting seasons are autumn (October), spring (February–March) and summer (April-May). In peninsular region of country, planting is done in the months of January-February. Spring planted crop is also known as Suru in Maharashtra and Eksali in Gujarat and Andhra Pradesh. Autumn Planting in peninsular zone is done during October-November. Autumn planting is also known as pre-seasonal planting in Maharashtra and Gujarat. Sugarcane cultivation and development of sugar industry runs parallel to the growth of human civilization and is as old as agriculture. The importance and use of sugarcane and sugar in the country's socio-economic milieu is deep rooted and immense. In the current day rural economy set up sugarcane cultivation and sugar industry has been focal point for socio economic development in rural areas by mobilizing rural resources, generating employment and higher income, transport and communication facilities.

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Sugarcane (*Saccharum* spp.) is an important commercial crop in India and plays a pivotal role in agricultural and industrial economy of our country. Sugarcane is an important commercial crop of the world and more than 100 Countries produce sugar, at present Brazil, Cuba, Mexico, India and Thailand are the leading producers of sugarcane. Currently 69% of the world's sugar is consumed in the country of region. Globally, sugarcane is cultivated over an area of 20.10 million hectares with a production of 1,318.10 million tones and productivity of 65.5 tonnes per hectare. Sugarcane area and productivity differ widely from country to country. Brazil has the highest area (5.34 million hectares) while Australia has the highest productivity (85.1 tonnes per hectare) India ranks second among the sugarcane growing countries of the world in the both area and production after Brazil with an area under sugarcane cultivation of 4.94 million hectares with an average yield is 68.6 tons per hectare.

Sugarcane is cultivated in 25.98 million ha of land with cane production of 1.84 billion tonnes and productivity of 70.89 tonnes ha-1 in the world in 2017 (FAO, 2019). It is cultivated in 10.02 million ha (38.57%) of area in the whole Asia with total production of 685.78 million tonnes (37.24%) and about 68.41 tonnes ha-1 of productivity. Sugarcane is considered as the crop for the future because of its contribution to production of sugar, jaggery, khandsari and many by products like molasses, bagasses and press mud and also certain renewable sources of green energy in the form of bioethanol and many bio-based products (Upreti & Singh, 2017) [2]. The major sugarcane growing countries are Brazil, India, China, Thailand, Pakistan, Mexico and Colombia. All these seven countries contributed about 76.42% of total area and 78.52% of total production in the world. Brazil ranked first in the world and contributed about 39.18 and 41.19% of the total area and production in the world, respectively. About 80% of the total world sugar requirement came from sugarcane while 20% came from sugar beet.

Haryana has shown a tremendous progress in the sugarcane cultivation during the last few years mainly due to expanded irrigation facilities. Haryana state is sharing 2.33% of the total area and contributing 2.84% of total production of sugarcane in India. Sugarcane alone cultivated on 1.14 lakh ha accounting 2.48% of total cropped area with production of 8.71 million tonnes in the state during 2018. It is an important annual cash crop grown on fertile and irrigated areas of the state. Sugarcane is mainly grown on large farm holdings and it is water guzzling crop having less risk as compared to other crops. However, sugarcane is resource exhaustive crop requiring huge quantity of inputs such as human labour, machine labour, fertilizers, irrigation, capital and management practices etc. for better crop stand and to harness higher productivity. The use of various inputs in sugarcane cultivation varied in both planted and ratoon conditions in Haryana. These variations in use of different combinations of resources affect the production and yield of sugarcane. Further more, there is wide yield gap between farmer's field and experimental field indicating the sub optimal use of resources (Ahmad *et al*. 2018) [3]. The expenses incurred on the use of inputs largely depend upon mechanization of farm operations like hoeing/weeding, harvesting as well as labour wages. Sugarcane is heavy feeder of nutrients and requires frequent irrigation to get more productivity. The crop sown with proper spacing and stand for longer period of time. Therefore, this research work aim is to understand the private and social costs on subsidy provided for fertilizers and drip irrigation system in sugarcane cultivation and their impact on resource use efficiency. Keeping in view the above discussion of the sugarcane cultivation, the present study was an attempt to find out the cost and return of sugarcane under various method of irrigation in the study area.

Sugarcane (*Saccharum officinarum*) is one of the major commercial crops grown in the world. It is the most important source of sucrose or sugar. It is indigenous to tropical South and Southeast Asia. Different species have different origins, with Saccharum barberi originated in India while Saccharum edule and Saccharum officinarum are indigenous to New Guinea. Sugarcane was first domesticated as a crop in New Guinea around 6000 BC.

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Methodology
Panchkula and Yamuna Nagar District which comes under the Shivalik foothills of Haryana were selected for the present study. Yamuna Nagar and Panchkula District having largest area under wheat, rice & sugarcane cropping pattern were selected randomly. Four villages from each district from plains were selected at random. Ten (10) farmers from each village were selected for the study from Yamunanagar. Thirty (35) farmer from Panchkula and Forty (40) farmers from Yamunanagar district were selected. Thus, a total of 75 sugarcane farmers from 8 villages were taken for the study. Multistage random sampling technique was used for selection of farmers. The primary data for 2022-23 was collected using survey method by conducting personal interviews of the selected farmers with the help of pre-tested schedule.

Selection of study area
The present study was conducted in Haryana state to achieve well-defined objectives for sugarcane crop. Haryana state carved out from Punjab state in 1966 having geographical area 44,212 sq. km. The gross area sown in the state was 150 thousand hectare during 1966-67 and during 2022-23 it was observed to be 107.75 thousand hectare which showed an decrease 42.25 thousand hectare from 1966-67 to 2022-23.

Sugarcane crop alone occupies an area of 107.75 thousand hectare with a total production of 8913.80 thousand tons, having average yield 82726.68 Kg. per hectare in 2022-23 in the state, In Panchkula district sugarcane crop is grown an area of 0.52 thousand hectare with an average yield of 82726.68 Kgs. per hectare having total production of 8913.80 thousand tonnes. (Economics and Statistical Analysis, Department of agriculture and farmers welfare Haryana 2022-23) [4].

Selection of Villages
A total of eight villages were selected randomly from both the districts that is four villages from each district.

Collection of data
The present study was based on the primary data. To work out the cost and returns in cultivation sugarcane to study the economics of sugarcane and to identify production of sugarcane in Panchkula and Yamunanagar district of Haryana for the year 2022-23. The primary data from selected farmers for the year 2022-23 was collected by survey method through personal interview with the help of well-structured interview schedule which include the following aspects.
1. General information of the selected farmers.
2. A detailed information about the per hectare input use pattern, prices of inputs to work out cost of cultivation of sugarcane crop and detailed information about sugarcane seed, total quantity of fertilizer purchased and various charges incurred in production of sugarcane etc.
3. Yield and returns from the crop and from the main and by-products obtained after harvesting of sugarcane.

Analytical Tools
The various statistical tools like Average, Percentage, costs, returns, Benefit-Cost ratio (B:C ratio) etc. were employed to draw valid inferences from the study. Cost and returns in production of Sugarcane
Following tools or formulae were employed to work out the cost and returns in the cultivation of sugarcane:
- Gross return = Main product value + By product value
- Return over variable cost = Gross return – Total variable cost
- Return over total cost (Net return) = Gross return – Total cost
- Benefit-cost ratio = Gross return/ Total cost
- Cost of production per quintal without by-product =

$$\frac{\text{Total cost}}{\text{Main product quantity in quintals}}$$

Cost of production per quintal with by-product =

$$\frac{\text{Reduced Total cost}}{\text{Main product quantity in quintals}}$$

(Reduced Total Cost = Total Cost – Value of by-product).
- Working capital / variable cost = Total preparatory tillage cost + pre sowing irrigation charges + sowing value + FYM value + total fertilizer cost + irrigation value + pesticide cost + herbicide cost + manual weeding charges + Harvesting value + Threshing value + Miscellaneous charges.

- Management charges (10%) = Total variable cost *0.1
- Risk factor (10%) = Total variable cost *0.1
- Total fixed cost = Transportation charges +Rental value of land+ Management charges+ Risk factor.

Results and Discussion
Comparative economic analysis of sugarcane cultivation in Shivalik foothills in selected districts were made on per hectare basis. Result pertaining to cost details of sugarcane in Panchkula and Yamunanagar district is shown in Table 1. The results shows that total cost spent in growing sugarcane in Panchkula district (₹ 282441/ha) is lower than the cost incurred in Yamunanagar district (₹ 301497/ha) due to higher rental value in Yamunanagar as compared to Panchkula district. Total variable cost constituted for 53.2% (₹ 150279/ha) and 51.9% (₹ 156469/ha), in Panchkula and Yamunanagar district respectively, of total cost incurred in the cultivation of sugarcane. The overall average for both the districts for variable cost and total cost observed to be ₹ 153374 and ₹ 291969. Overall average of principal components of variable cost in decreasing order are preparatory tillage, harvesting cost, tying and irrigation charges contributing 3.7, 13.2, 2.8 and 3.3%, respectively of the total cost. While in fixed cost these were rental value of land, management charges, risk factor and transportation charges contributing 29.3, 5.3, 5.3, and 7.6%, respectively. Returns from sugarcane cultivation in Panchkula and Yamunanagar district shown in the table shows that yield of sugarcane obtained to be 803.6 and 801.7 quintal per hectare respectively. Whereas, gross return received in Panchkula district were found to be ₹ 303507 and in Yamunanagar, it was obtained ₹ 310600 per hectare. While, net returns in Panchkula district (₹ 21066/ha) were estimated to be higher compared to Yamunanagar district (₹ 9103/ha). The benefit cost ratio (B:C ratio) for Panchkula and Yamunanagar district were recorded to be 1:1.07 and 1:1.03 respectively.

Resource Use Pattern
The use of inputs and adoption of various cultural practices in the cultivation of sugarcane crop in Panchkula and Yamunanagar district has been given in the table 2.
The field preparation for sugarcane sowing in Northern Haryana starts in February month. On an average, 6.3 preparatory tillage operations in Panchkula district and 6.3 in Yamunanagar district were done to prepare the fields. Fields were prepared with the help of tractors. The per hectare seed rate used was 78.2 Qtls, in Panchkula district the corresponding figures for Yamunanagar district were 76.7 Qtls respectively. The quantity of FYM applied to the field in Panchkula district was 64.3 and 46.2 quintal per hectare FYM was used in Yamunanagar district respectively. Quantity of Nitrogen fertilizer used in Panchkula and Yamunanagar district was 250.5 and 248 kg per hectare. Quantity of Phosphate fertilizer used in Panchkula and Yamunanagar district was 82.0 and 87.86 kg per hectare respectively. The Potassic feritilizer was used 56.7 and 53 kg per hectare in both district respectively. The Zinc sulphate was used 10 and 9.5 kg per hectare in both the district respectively. On an average, 11 irrigations were given to the sugarcane crop in Panchkula district and 10.7 irrigations were given in Yamunanagar district by sample farmers.

Table 1: Comparative economics of sugarcane crop grown in Shivalik foothills of Haryana (₹/ha)

Sr. No.	Item	Panchkula			Yamunanagar			Overall Average		
		Qty.	Value	Percent	Qty.	Value	Percent	Qty.	Value	Percent
1.	Preparatory tillage	6.3	10850	3.8	6.3	10875	3.6	6.3	10863	3.7
2.	Pre-sowing Irrigation		1039	0.4		1019	0.3		1029	0.4
3.	Sowing		11779	4.2		11775	3.9		11777	4.0
4.	Ridiging		545	0.2		495	0.2		520	0.2
5.	Seed (qtl.)	78.2	28314	10.0	76.7	28417	9.4	77.5	28365	9.7
6.	Seed Treament		1154	0.4		1344	0.4		1249	0.4
7.	FYM (qtl)	64.3	2571	0.9	46.2	1913	0.6	55.3	2242	0.8
8.	Fertilizer nutrients									
9.	(a) Nitrogen	250.5	3266	1.2	248.0	3313	1.1	249.2	3290	1.1
10.	(b) Phosphatic	82.0	4393	1.6	87.86	4757	1.6	84.9	4575	1.6
11.	(c) Potassic	56.7	3308	1.2	53.0	3109	1.0	54.9	3209	1.1
12.	(d) Zinc Sulphate	10.0	1000	0.4	9.5	970	0.3	9.8	985	0.3
13.	Total Ferti. Invest		11967	4.2		12150	4.0		12058	4.1
14.	Fertilizer Application		813	0.3		820	0.3		816	0.3
15.	Irrigation	11.0	9625	3.4	10.7	9528	3.2	10.9	9577	3.3
16.	Hoeing /Weeding			0.0			0.0			0.0
17.	(a) Chemical		4800	1.7		5131	1.7		4966	1.7
18.	(b) Manual			0.0			0.0			0.0
19.	Plant Protection		8657	3.1		8731	2.9		8694	3.0
20.	Harvesting		36161	12.8		41094	13.6		38627	13.2
21.	Threshing/ winnowing/Tying		8007	2.8		8550	2.8		8279	2.8
22.	Miscellaneous		723	0.3		736	0.2		730	0.2
23.	Total (1to 15)		145197	51.4		151178	50.1		148187	50.8
24.	Interest on working Capital		5082	1.8		5291	1.8		5187	1.8
25.	Variable cost		150279	53.2		156469	51.9		153374	52.5
26.	Management charges		15028	5.3		15647	5.2		15337	5.3
27.	Risk factor		15028	5.3		15647	5.2		15337	5.3
28.	Transportation		24107	8.5		20547	6.8		22327	7.6
29.	Rentalvalue of land		78000	27.6		93188	30.9		85594	29.3
30.	Total Cost		282441	100.0		301497	100.0		291969	100.0
31.	Production(qtl.)									
32.	(a) Main	803.6	298929		801.7	305738		802.7	302333	
33.	(b) By Product		4579			4863			4721	
34.	Gross return		303507			310600			307054	
35.	Return over variable cost		153229			154131			153680	
36.	Net return		21066			9103			15084	
37.	Cost of Production/(qtl.)									
38.	(a) Without by Product		1035			1180			1107	
39.	(b) With by Product		840			913			877	
40.	B:C Ratio	1:1.07			1:1.03			1:1.05		
41.	Number of farmers	35			40			75		
42.	Area(acre)	108			132			240		
43.	Labour									
44.	(a) Human Days	215.4			211.3			213.4		
45.	(b) Bullock days									
46.	(c) Tractor hours	40.0			39.56			39.8		

Table 2: Resource use pattern in sugarcane in Panchkula a n d Yamunanagar district, during 2022-23. (per hectare)

	Panchkula	Yamunanagar	Overall average
Preparatory tillage (No.)	6.3	6.3	6.3
Seed (qtls)	78.2	76.7	77.5
Fertilizer nutrients (Kg)			
(a) Nitrogen	250.5	248.0	249.2
(b) Phosphatic	82.0	87.86	84.9
(c) Potassic	56.7	53.0	54.9
(d) Zinc Sulphate	10.0	9.5	9.8
FYM (qt)	64.3	46.2	55.3
Irrigation (No.)	11.0	10.7	10.9

Resource Use Pattern

The use of inputs and adoption of various cultural practices in the cultivation of sugarcane crop in Panchkula and Yamunanagar district has been given in the table 2.

The field preparation for sugarcane sowing in Northern Haryana starts in February month. On an average, 6.3 preparatory tillage operations in Panchkula district and 6.3 in Yamunanagar district were done to prepare the fields. Fields were prepared with the help of tractors. The per hectare seed rate used was 78.2 Qtls, in Panchkula district the corresponding figures for Yamunanagar district were 76.7 Qtls respectively. The quantity of FYM applied to the field in

Panchkula district was 64.3 and 46.2 quintal per hectare FYM was used in Yamunanagar district respectively. Quantity of Nitrogen fertilizer used in Panchkula and Yamunanagar district was 250.5 and 248 kg per hectare. Quantity of Phosphate fertilizer used in Panchkula and Yamunanagar district was 82.0 and 87.86 kg per hectare respectively. The Potassic feritilizer was used 56.7 and 53 kg per hectare in both district respectively. The Zinc sulphate was used 10 and 9.5 kg per hectare in both the district. On an average, 11 irrigations were given to the sugarcane crop in Panchkula district and 10.7 irrigations were given in Yamunanagar district by sample farmers.

Conclusion
It is concluded that sugarcane grown in Shivalik foothills of the study area. The gross returns from cultivation of sugarcane were worked out to be Rs. 303507 and Rs. 310600 in Panchkula and Yamunanagar district, respectively. The net returns per hectare worked out were Rs.21066 and Rs. 9103 with total cost of cultivation of Rs. 282441 and Rs. 301497 in Panchkula and Yamunanagar district, respectively. The per hectare return over variable cost and net returns from sugarcane crop was found to be ₹ 153229 and ₹ 21066 respectively in the Panchkula district and it was ₹ 154131 and ₹ 9103 in the Yamunanagar district. Among various variable cost items harvesting, seed, fertilizer preparatory tillage and irrigation of sugarcane have maximum share i.e., 12.8, 10.0, 4.2, 3.8 and 3.4% of total expenses incurred in cultivation of sugarcane in Panchkula district. While corresponding figures for Yamunanagar district were observed to be 13.6, 9.4,4.0,3.6 and 3.2% of total expenses incurred. Total fixed cost components, the rental value of land have maximum share i.e., 27.6 and 30.9% of total cost incurred in cultivation of sugarcane in Panchkula and Yamunanagar district, respectively. The B:C ratio was found to be 1:1.07 and 1:1.03 in Panchkula and Yamunanagar district, respectively. The study also revealed that Benefit Cost ratio is greater than one in both the districts which indicates that sugarcane grown in the Shivalik foothills to be economically viable. So, it is suggested that this crop should be promoted as much as possible in the region.

Competing Interest
Authors have declared that no competing interests exist.

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