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COMPARATIVE COST-BENEFITS ANALYSIS AMONG RAIN-FED AND IRRIGATED SUGARCANE PRODUCTION FARMING SYSTEMS IN BAUCHI STATE, NIGERIA.

ONI B. O., BALOGUN O. S., ADEMOLA T. O AND AARON J.A

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ABSTRACT

Various interventions in agricultural production are aimed at maximizing agricultural revenue, and key enterprises to improve livelihood and reduce poverty. This study assessed cost and benefits of Rain-Fed Farming Systems (RFFS) and Irrigated Farming System (IRFS) of sugarcane production in Bauchi State, Nigeria. Using primary data collected in a three-stage purposive sampling procedure from a total of 231 sugarcane farmers. The data were analyzed using descriptive statistics, farm budgetary techniques, Z-statistics, and Likert scale. The farmers mean age was 43 years with an average of 7 years of formal education. There were significant differences in the level of income with a profitability ratio of 1.14 RFFS and 1.85 IRFS respectively. The major constraints include inadequate capital and access to credit facilities, excessively high labour and transportation costs. The study recommends improved education and extension services to sensitize sugarcane farmers on how to appropriately employ improved technologies to optimize their production outcomes. Also, there should be implementation of policies that improves marketing activities by reducing the transports costs and ensuring better connection between producers and mills. Productivity should be improved by increasing yields with more policies supporting producers directly.

KEY WORDS: Cost-Benefit, Constraint, Irrigation, Rain-Fed, and Bauchi state.

INTRODUCTION.

Equitable and sustainable development cannot ignore basic food commodities, particularly in developing countries such as Nigeria. In fact, most periods economic growth has been highly correlated with agricultural progress. Sugarcane (*Saccharum officinarum*) is one of the most important crops in the world because of its immense usage in the daily life of man and or any nation for industrial uses aimed at nutritional and economic sustenance. Sugarcane contributes about 60% of the total world sugar requirement while the remaining 40%, is from beet (Girei and Giroh, 2012). It is a tropical crop that usually takes between 8 to 12 months to reach its maturity. Mature cane may be green, yellow, and purplish or reddish and considered ripen when sugar content is at maximum.

Sugarcane is widely cultivated in Nigeria; it is a very essential commodity consumed by majority of the Nigerians. The wellbeing of most farmers in Nigeria is tied to the productivity of their crops and livestock (Fanen, and Olalekan, 2014) therefore, as the population increases, several studies revealed that, there is need to increase food output in order to: feed the increasing population and at the same time improve the wellbeing of farmers consequently, at the ongoing pace the production of sugarcane through the conventional methods cannot meet up with the demand of the people. Various attempts have been made in the past to increase sugar production in Nigeria.; earn the needed foreign exchange to import non-food needs; to generate savings for investment; and to preserve and conserve the natural resource base to enhance its productivity (;Tashikalma, *et al*, 2014).

Oni B. O., Department of Vocational Studies. Federal College of Forestry Mechanization, Afaka, Kaduna State, Nigeria

Balogun O. S., Department of Agricultural Extension and Management, Federal College of Forestry Mechanization, Afaka, Kaduna State, Nigeria

Ademola T. O., Department of Agricultural Technology, Federal College of Forestry Mechanization, Afaka, Kaduna State, Nigeria

Aaron J. A., Department of Agricultural Technology, Federal College of Forestry Mechanization, Afaka, Kaduna State, Nigeria

According to Murthy, (2010) an average man's annual food composition is approximately one million calories. The consideration of other numerous direct and indirect products derived from sugarcane gives an even more impressive conception, because apart from its varied uses as food and sweetening agent, it is equally used prominently as a raw material for the production of important chemicals such as refrigerants and drugs.The trends in sugarcane industrial activities suggest that the demand for sugar will continue to rise to the point that demand for sugar in Nigeria will outstrip supply thereby causing a deficit in supply (Lyocks, 2016). It is in this light that this study, seeks to assess sugarcane production under rain-fed and irrigated farming systems in Bauchi State, Nigeria. Hence, the study provided answers to the following research questions: What are the costs and returns of sugarcane production under rain-fed and irrigated farming systems in the study area, are there constraints to sugar cane production in the study area?

The specific objectives of the study are to: determine the costs and returns of sugarcane production under rain-fed and irrigated farming systems in the study area and identify the constraints to sugar cane production in the study area.

Working Hypothesis:

$H0_1$: There is no significant difference between the income of RFFS and IRFS in the study area.

MATERIALS AND METHODS

The study Area

Bauchi State, Nigeria. is in the North-East agro ecological zone of the country between Latitudes 9°30' and 12°30' North of the equator, and Longitudes 8°45' and 11°0' East of the Greenwich meridian. Situated in the North-East geopolitical zone of Nigeria, the state is bordered by Jigawa to the north, Yobe to the northeast, Gombe to the east, Taraba and Plateau to the south, Kaduna to the west and Kano to the northwest. It comprised of 20 Local Government Areas (LGAs), namely; Alkaleri, Bauchi Bogoro, Dambam, Darazo, Dass, Gamawa, Ganjuwa, Giade, Itas Gadau, Katagum, Kirfi, Jama'are, Missau, Ningi, Shira, Tafawa-Balewa, Toro, Warji and Zaki. The State covers Tashikalma land area of about 49,259 Km^2 with a projected population of about 6,216,486 in 2018 at 2.8% growth rate per annum (National Bureau of Statistics (NBS), 2016).

Bauchi state is heterogeneous in terms of ethnicity, with predominant tribes like Hausa, Fulani, Jarawa, Tangale, Waja, Balewa, Sayawa and Tarewa. The residents of the area are engaged in agriculture with trading activities. Common crops cultivated includes millet, sugarcane, maize, guinea corn, and groundnut and Livestock rearing. (Bauchi State Agricultural Development Project (BSADP), 2019.

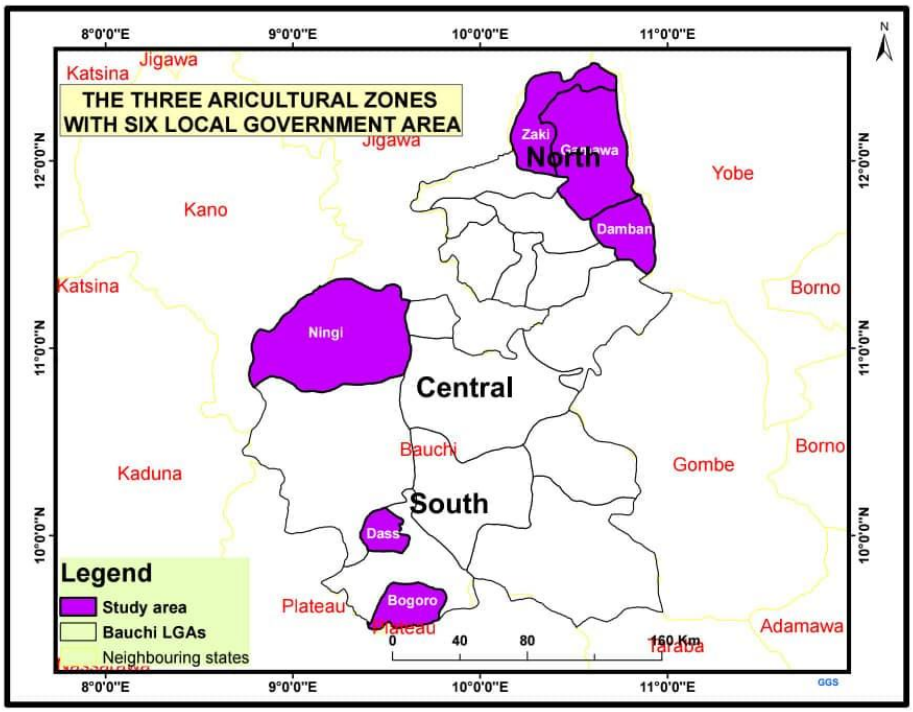

Figure 1 Showing The three Agricultural zones and six Local Government Areas of the study.

Sampling Procedure and Sample Size

Three-stage sampling procedure was used for this study. The first stage involved the purposive selection of two (2) LGAs each from the three (3) agricultural Zones in the state to make a total of six (6) LGAs selected. The second stage involved purposive selection of two (2) villages from each of the selected LGAs to make up a total of twelve (12) villages considered for this study. In the final stage, Taro Yamane's formula at 5% precision level was used to select a sample size of farmers resulting to a total of 231 farmers. The sample outlay of the respondents is presented in Table 2. Taro Yamane's formula is given as:

$$n = \frac{N}{1 + N e^2} \quad (1)$$

Where n = Sample size, N = Finite population, and e = limit of tolerable error (5% precision level).

Method of Data Analysis

Descriptive statistics, Farm budgeting technique, Likert type scale rating, T-statistics and Kendall's coefficient of concordance were used to analyse the data.

Model Specification

Farm budgetary technique. Farm budgeting technique was used to estimate the profitability of sugarcane production under systems Net Farm Income (NFI), Gross Margin (GM) and Returns on Investment (ROI).

$$NFI = TR - TC \quad (1)$$

$$GM = \sum Y_i P_i - C_i (i = 1, 2, K \ldots . n) \quad (2)$$

$$ROI = GM/TC \quad (3)$$

Where

NFI = Net Farm Income (₦/ha), GM = Gross Margin (₦), ROI = Returns on Investment (₦), TR = Total Revenue (₦), TC = Total Cost (₦), TVC = Total variable cost (₦)

TFC = Total fixed cost (₦).

P*i* = the market price of the *i*th crop (₦ /unit) in the enterprise, Y*i* = the annual yield of the *i*th crop (unit/ha) and C*j* = the inputted variable cost of producing the *i*th crop (₦/ha).

Kendall's coefficient of concordance

The Kendall's coefficient was also used to examine the constraints hindering sugarcane production under irrigated farming system. Kendall's coefficient of concordance (W) is given by the relation:

$$W = \frac{12S}{P^2 (n^3 - n)} - P^T \quad (5)$$

Where

W = Kendall's coefficient of concordance; P = number of respondents ranking the constraints,

n = number of quality perceptions; T = correction factor for tied ranks, S = sum of squares statistics over the row sum of ranks (Ri) ; The sum of square statistics (S) is given as:

$$S = \sum_{i-1}^{n} (Ri - R)^2 \quad (6)$$

Where: R_i = row sums of rank; R = mean of R_i

The correction factor for tied ranks (T) is given as:

$$T = \sum_{k-1}^{m} (t_k^3 - t_k) \quad (7)$$

The test of significance of Kendall's coefficient of concordance will be done using the chi-square statistic which is computed using the formula:

$$X^2 = P (n - 1) W \quad (8)$$

Where

n = number of constraints, P = number of respondents, and W = Kendall's coefficient of concordance.

Hypothesis Testing: Hypothesis was tested using the Z-test statistics.

The Z-test statistics or model is

$$Z = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad (9)$$

Where

For hypothesis

Z = Calculated Z value

$\bar{X}_1$= Mean income of farmers under irrigation farming system, $\bar{X}_2$ = Mean income of farmers under rain fed farming system, S_1^2 = Standard deviation of farmers under irrigation farming system, S_2^2 = Standard deviation of farmers under rain fed farming system, n_1 = Sample size of farmers under irrigation farming system, n_2 = Sample size of farmers under rain fed farming system.

RESULTS AND DISCUSSION

Mean income from sugarcane by the respondents

Table 1. shows that the mean income of mean income of ₦1,081,356 with a minimum of ₦25,000 and maximum of ₦2,904,000 for all respondents (pooled). Comparing the RFFS and IRFS, the IRFS had higher income from sugarcane production. Higher income is desirable for sustainable livelihood and wellbeing of the farmers. Ajayi *et al.* (2016) who noted that the ability of smallholder farmers to meet up households' needs can only possible from higher income generated from their farm produce

Table 1: Mean respondents' income from sugarcane production in Naira

Output	Minimum (Kg)	Maximum (Kg)	Mean (Kg)
Rain-fed	43,500	2,500,000	777,946
Irrigated	25,000	2,904,000	1,426,906.94
Pooled	25,000	2,904,000	1,081,356.00

Source: Field Survey, 2019Respondents' Level of Income

Table 2 reveals the distribution of respondents according to level of income from sugarcane production in the study area. The pathern of distribution clearly show that farmers practicing the irrigation system were better off in terms of Gross income. The table shows that about 32% of IRFS farmers made between 1.5 Million – 2 Million Naira compared to 1.6% among the RFFS. Furthermore, about 63% of farmers under the rain fed made between 500000- 1000000 Naira per production cycle. This findings is in consonance with similar comparative study of Rainfed and irrigated food crops in Adamawa state by Tashikalma *et al.* (2014), where farmers practicing IRRFS were reported to earn higher income than rain-fed farmers possibly because of dry and wet season production advantage.

Table 2: Distribution of Respondents according to level of income

	Rain-fed		**Irrigated**		**Pooled**	
Income (₦)	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
< 500,001	32	26.1	40	37.0	72	31.2
500,001 – 1,000,000	63	51.2	24	22.2	87	37.7
1,000,001 – 1,500,000	26	21.1	12	11.1	38	16.4
1,500,001 – 2,000,000	1	0.8	6	5.6	7	3.0
> 2,000,000	1	0.8	26	24.1	27	11.7
Total	**123**	**100.0**	**108**	**100.0**	**231**	**100.0**
Mean	**₦777,946.30**		**₦1,426,906.90**		**₦1,081,356.00**	

Source: Field Survey, 2019

Costs and Returns of Sugarcane production under rain-fed and irrigated farming

The costs and returns analysis are presented in Tables 3. An average sugarcane producer spends an estimated ₦361,301.76 on variable items per hectare. This constitute about 95.24 per cent of the total costs while the total fixed cost of sugarcane production was ₦18,051.62representing 4.76 percent of the total cost for production. The total revenue generated per production cycle in the study area (pooled) result was ₦1,081,356.00; with gross margin of ₦720,054.24 and a net farm income of ₦702,002.62. The profitability ratio recorded was ₦1.85 kobo implying that for every ₦1.00 invested in sugarcane production, ₦1.85 kobo was realized. Implying that sugarcane production in the study area is a profitable enterprise. IRFS's and RFFS's recorded an estimated ₦347,907.48 and ₦479,209.67 variable costs respectively. This constituted about 95.68 and 95.79 percent of total costs of production cost per hectare. the total fixed cost for RFFS and IRFS were ₦15,696.57 and ₦21,058.84, representing 4.32 and 4.21 percent of the total cost per hectare in the study area.

Meanwhile, the trend in percentage cost for both systems were same except for transportation cost which was slightly higher (26.89%) for RFFS compared to (18.99%) for IRFS. The of highest variable cost incurred by the RFFS was transportation cost (₦97,791.17; 26.89%) and it is followed by cost of labour (₦95,234.47; 26.19%) and fertilizer/manure (₦78,480.84; 21.58%) comparatively, labour constituted the highest cost (₦187,073.38; 37.39%) under the IRFS followed by cost of transportation (₦94,986.74; 18.99%) and fertilizer/manure (₦82,662.00; 16.22%). Coincidentally, the pooled result revealed the same trend with transportation constituting the highest cost (₦96,923.61; 25.55%), followed by labour (₦90,250.06; 23.79%) and fertilizer/manure (₦80,287.35; 21.16%). This implies that labour and transportation costs were the highest expenses

incurred on sugarcane production under rain-fed and irrigated farming system as over half of
the expenses incurred from sugarcane production in the study area were from labour usage and transportation. Labour is one of essential factor of crop production, while transportation services are vital factor in moving farm produce from the farms or the mills places to consumers. Yadav *et al*. (2018) in their studies on cost of labour and the machinery used in sugarcane production, observed that cultural practices are very tedious most especially planting, plant protection and harvesting processes; hence modern technologies (machines) and labour saving devices reduced cost of sugarcane cultivation.

The total revenue generated RFFS and IRFS were found to be ₦777,946.30 and ₦1,426,906.90, respectively. The gross margin being ₦430,038.82 RFFS and ₦947,697.23 with a net farm income of ₦414,342.25 and ₦926,638.339, for RFFS and IRFS respectively. Sugarcane production is a profitable enterprise in the study area however, all profitability indicators shows that IRFS higher returns compared with RFFS

Table 3: Costs and Returns Analysis of Sugarcane Production under Rain-fed and Irrigated Farming System.

	Rain-fed (n = 123)		Irrigated (n = 108)	
Items	**(₦)/hectare**	**% Cost**	**(₦)/hectare**	**% Cost**
Variable costs				
Cost of planting material	33,328.50	9.17	53,806.90	10.76
Cost of labour	95,234.47	26.19	187,073.38	37.39
Cost of fertilizer/manure	78,480.84	21.58	82,662.00	16.52
Cost of agro-chemical	6,873.03	1.89	17,953.00	3.59
Cost of transportation	97,791.17	26.89	94,986.74	18.99
Cost of storage	14,625.00	4.02	20,000.00	4.00
Commission fees/levies	21,574.47	5.93	22,727.65	4.54
Total Variable Cost (TVC)	**347,907.48**	**95.68**	**479,209.67**	**95.79**
Fixed cost				
Depreciation of fixed assets (Cutlass, hoe, sickle, sprayer, water pump, etc)	15,696.57	4.32	21,058.84	4.21
Total Fixed Cost (TFC)	**15,696.57**	**4.32**	**21,058.84**	**4.21**
Total cost	**363,604.05**	**100.00**	**500,268.51**	**100.00**
Returns				
Revenue	777,946.30		1,426,906.90	
Gross Margin (GM) =TR – TVC	430,038.82		947,697.23	
Net Farm Income (NFI) = GM – TFC	414,342.25		926,638.39	
Profitability Ratio (PR) = NFI/TC	1.14		1.85	

Field Survey, 2021

Hypothesis testing.

The result of the hypothesis testing is as presented in table 4. The result revealed a significant t – statistic value of 4.28 at 1% level of probability implying that there was significant difference in the mean income of the farmers in the two systems.

Table 4: T-test estimate for null hypothesis I

	Mean (₦)	Std deviation.	t – value	Decision
Irrigated sugarcane output	1426907	1634997	4.2809**	Reject
Rain-fed sugarcane output	777946.3	368886.7		
Mean difference	1081356			

Source: Field survey, 2019 * = significant at 1% probability level**

Constraints associated with Sugarcane Production Systems

As presented in Table 5, the pooled result of perceived constraints associated with sugarcane production in the study area, revealed inadequate capital and access to credit facilities ($\bar{X}$= 2.58), inadequate extension services ($\bar{X}$= 2.45), high cost of farm inputs ($\bar{X}$= 2.32) and poor access to training on sugarcane production ($\bar{X}$= 2.32) ranked 1st, 2nd and 3rd, 4threspectively, For the RFFS the major perceived severe constraints were inadequate capital and access to credit facilities ($\bar{X}$= 2.74), inadequate extension services ($\bar{X}$= 2.63) and high cost of farm inputs ($\bar{X}$= 2.44). Under IRFS includes inadequate capital and access to credit facilities ($\bar{X}$= 2.41), poor access to training on sugarcane production ($\bar{X}$= 2.31) and inadequate extension services ($\bar{X}$= 2.24) ranked 1st, 2nd and 3rd. These findings agreed with that of Sulaiman *et al.* (2015) who reported that inadequate funding or credit facilities in sugarcane farmers' perception, challenges and response to climate change in Kaduna State, Nigeria as major constraints.

In the same vein, Oravee (2015) noted that lack of funding in the river basin and rural development lead to ineffectiveness of the scheme. In extension services, Mgbenka *et al.* (2015) identified access to credit and extension contact to be paramount among other factors in maximizing productivity.

It is important to note that the identified constraints lowers productivity consequently translate to small earning by the farmers and hence high poverty level. Ikeme (2009) observed that Problem of pests and diseases infestation in most places in Nigeria is responsible for declining agricultural production.

Table 5: Respondents' Constraints to Sugarcane Production under different Production Systems

	Rain-fed System (n = 123)				Irrigated System (n = 108)			
Constraints	**WS**	**WM**	**Rank**	**Remark**	**WS**	**WM**	**Rank**	**Remark**
Inadequate capital and access to credit facilities	337	2.74	1st	Severe	260	2.41	1st	Severe
Inadequate extension services	324	2.63	2nd	Severe	242	2.24	3rd	Severe
High cost of farm inputs	300	2.44	3rd	Severe	235	2.18	5th	Severe
Unavailability of improved sugarcane seedlings	296	2.41	4th	Severe	219	2.03	7th	Severe
Poor market policies and linkages	290	2.36	5th	Severe	216	2.00	8th	Severe
Inadequate and high prizes of labour	289	2.35	6th	Severe	206	1.91	11th	Not Severe
Poor access to training on sugarcane production	287	2.33	7th	Severe	250	2.31	2nd	Severe
Poor road networks from farms to market	283	2.30	8th	Severe	211	1.95	10th	Not Severe
Inadequate storage facilities for sugarcane	281	2.28	9th	Severe	186	1.72	14th	Not Severe
Inadequate or poor access to farm inputs	280	2.28	9th	Severe	237	2.19	4th	Severe
Lack of standardized means of measurement	267	2.17	11th	Severe	178	1.65	16th	Not Severe
Poor value addition for sugarcane production	256	2.08	12th	Severe	196	1.81	12th	Not Severe
Problems of pests and diseases infestation	247	2.01	13th	Severe	228	2.11	6th	Severe
Shortage of land for sugarcane farming	206	1.67	14th	Not Severe	170	1.57	17th	Not Severe
Low demand for sugarcane by consumers	206	1.67	14th	Not Severe	216	2.00	8th	Severe
Problem of drought	200	1.63	16th	Not Severe	194	1.80	13th	Not Severe
Insufficiency of irrigation water	186	1.51	17th	Not Severe	185	1.71	15th	Not Severe

Source: Field Survey, 2019

Note: VS= VerySevere (3), S= Severe (2), NS = Not Severe (1), WM = Weighted Mean and WS = Weighted Sum. The bench means score
Value is 2.0.

The result of the Kendall coefficient of concordance as presented in Table 6. It revealed that the sum of mean rank of the constraints under rain-fed was 153.00 which is lower than chi-square value of 395.67 at 1% level of probability with Kendall *W* value of 0.201. More so, sum of mean rank of the constraints under irrigated was 150.01 which is lower that the chi-square value of 286.52 at 1% level of probability with Kendall *W* value of 0.166. The result on constraint pooled revealed sum of mean rank of 143.32 which is lower than the chi-square value of 574.08 at 1% level of probability with Kendall *W* value of 0.155. This implies that there was a general agreement among the respondents with respect to constraints associated with sugarcane production in the study area.

Table 6: Kendal Coefficient estimates of the constraints to Sugarcane Production

Constraints	Rain-fed Mean Rank (n=123)	Irrigation Mean Rank (n=108)
Inadequate capital and access to credit facilities	12.33	11.70
Inadequate extension services	11.55	10.65
High cost of farm inputs	10.53	10.32
Unavailability of improved sugarcane seedlings	10.43	9.43
Poor market policies and linkages	10.20	9.11
Inadequate and high prizes of labour	9.95	8.57
Poor access to training on sugarcane production	9.84	11.09
Poor road networks from farms to market	9.72	8.88
Inadequate storage facilities for sugarcane	9.65	7.52
Inadequate or poor access to farm inputs	9.61	10.42
Lack of standardized means of measurement	9.00	6.92
Poor value addition for sugarcane production	8.32	8.13
Problems of pests and diseases infestation	8.08	9.86
Low demand for sugarcane by consumers	6.37	9.15
Shortage of land for sugarcane farming	6.17	5.89
Problem of drought	5.92	7.99
Insufficiency of irrigation water	5.33	7.38
Sum of mean rank	153.00	150.01
Kendall *W*	0.201	0.166
Chi-square	395.67***	286.52***

Source: Field Survey, 2019

CONCLUSION

About, 56.1% of the farmers in RFFS utilized light texture soil with good drainage, 69.9% raised sugarcane nursery during land preparation, 71.5% utilized Autumn planting of 76.4% utilized weeding by hoe; 31.7% applied NPK fertilizer at 112kg(N), 25kg(P), 48kg(K) rate/acre; and 64.2% utilized manual harvesting. comparatively, 62.0% of farmers in IRFS utilized ploughing depth of 30cm during land preparation, 59.3% utilized combination of cultural and chemical methods of weeding. The farmers had enough education for adoption of new technologies. The net farm income of ₦414,342.25 for RFFS compared with ₦926,638.339 for IRFS and a profitability ratio of 1.14 RFFS and 1.85 IRFS implied that sugarcane enterprise is profitable in the study area however, IRFS is more profitable. The major constraints include inadequate capital and access to credit facilities. The study, recommends more education and sensitization for sugarcane farmers on how to appropriately employ improved technologies to optimize their production outcomes.

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