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Economic Impact of Root Grub Infestation in Sugarcane - A Study in Vijayapura District of Karnataka

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ABSTRACT

Holotrichia serrata (Fabricius) has become a major pest affecting sugarcane, especially in the irrigated regions of Northern Karnataka. This study estimates the economic losses caused by root grub infestation in Vijayapura district during 2021-22, using primary data. The total GCA is 21.03 acres, with a net cropped area of 9.42 acres and a cropping intensity of 223.17 per cent. The root grub management requires 2.50 men and 0.90 pair-days of bullock labours in cultural method, 2.00 men labours in mechanical method, for chemical method 2.50 men labours and biological method required 2.81 men labours/ha. The findings reveal that the cost of cultivating sugarcane was lower before the root grub infestation compared to after infestation. However, there was a significant decline in crop yield following the infestation. Gross returns and returns per rupee of expenditure were also drastically reduced. The infestation had a considerable impact on labour requirements, yield and net returns. Partial budgeting analysis showed that sugarcane farmers in the study area suffered on an average net loss of Rs.45,150.67 due to root grub infestation. This highlights the urgent need for agricultural scientists to focus on developing and recommending effective preventive measures for control of root grub infestation in the study region.

Keywords : Economic impact, Partial budgeting, Returns, Root grub, Sugarcane

SUGARCANE, scientifically known as (*Saccharum officinarum*), is a perennial grass belonging to the Poaceae family. In India, sugarcane is the sole contributor to sugar production. Major sugarcane producing countries includes Brazil, India, Cuba, the USA, Philippines and China (Sagar and Gaddi, 2021). On a worldwide scale, India ranks second in both sugarcane area and production with the cultivated area of 5.18 million hectares, an annual production of 439.42 million tonnes and the productivity was 84.90 tonnes per hectare.

Being an important commercial crop in Northern Karnataka, primarily cultivated in the districts of Belagavi, Bagalkote and Vijayapur, which collectively accounts for 71.73 per cent of entire state's sugarcane area. In Karnataka, Belagavi district stood first with an area of 2.71 lakh hectares, productivity of 96 metric tons per hectare and production of 260.86 lakh metric tons. It is followed by Bagalkote, which has an area of 1.07 lakh hectares, productivity of 86 metric tons per hectare and production of 92.16 lakh metric tons and Vijayapura with an area of 0.78 lakh hectares, productivity of 101 metric tons per hectare and production of 78.81 lakh metric tons (Anonymous, 2022).

Sugarcane, like other crops, is highly susceptible to various pests, which pose a significant threat by impacting both yield and sugar production. Common

pests in sugarcane cultivation include the sugarcane aphid (*Melanaphis sacchari*), root grub (*Holotrichia serrata*), early shoot borer (*Chilo infuscatellus*), internode borer *(Chilo sacchariphagus*) and the red rot pathogen (*Colletotrichum falcatum*). These pests can cause considerable damage by feeding on plant tissues, boring into stalks and spreading diseases (Lalitha *et al.,* 2023).

Among these, *Holotrichia serrata* (Fabricius) has become particularly significant pest, especially in the irrigated areas of northern Karnataka. It is responsible for substantial losses, reducing sugarcane yields by 30 to 40 per cent. Moreover, the infestation of *Holotrichia serrata* has extended beyond sugarcane, affecting both *kharif* and rabi crops in the region. This species has emerged as a highly destructive pest, causing serious economic concerns for Belagavi and the surrounding districts in Northern Karnataka (Tippannanavar, 2013). Given this context, the present study aims to assess the economic losses caused by this pest and to suggest appropriate control measures.

METHODOLOGY

Research Methods and Sources of Data

The present study employed a mixed-method sampling approach, with Vijayapur district in Northern Karnataka being selected purposively based on the recommendations of the Field Supervisors and Field Investigators from the Cost of Cultivation Scheme at the University of Agricultural Sciences, Bengaluru. This district was chosen due to the severe impact of root grub infestation during 2021-22.

From the district, two tahsils were further selected in consultation with the Field Investigators, focusing on areas where the infestation was most prevalent. In the next stage, one village was selected from each tahsil. To identify respondents, the snowball sampling method was used, as there was no prior list of farmers whose sugarcane fields were affected by root grubs. As a result, 45 sample respondents were selected from each village, leading to a total sample size of 90.

To estimate the economic loss caused by the pest, data were collected from the same farmers during both the pre-infestation period (2020-21) and the post-infestation period (2021-22). In this study, data regarding the costs and returns involved in sugarcane cultivation during the pre-infestation period were collected based on the recall information provided by the sample farmers. The data were gathered using a pre-tested and well-structured interview schedule during both the pre-infestation and post-infestation periods.

Analytical Techniques

Descriptive Statistics techniques were employed to present the data on socio-economic profile as well as costs and returns analysis to assess the economic impact of root grub infestation. The components of variable costs comprised of expenditure on sugarcane sets, Farm yard manure, bio fertilizers, bio pesticides chemical fertilizers, micronutrients and pesticides, human labour, bullock labour, machine labour charges, harvesting and transportation cost, irrigation charges and interest on working capital. Fixed costs components include land revenue and taxes, rental value of land depreciation and Interest on fixed capital (Chandakavate *et al.,* 2013).

To analyze the mean differences before and after the root grub infestation, a two-sample t-test was conducted. This test was used to determine if there were statistically significant differences in the costs and returns between the pre-infestation and post-infestation periods. Additionally, the partial budgeting technique was employed to compare the costs and returns before and after the infestation. This approach provided insights into the quantitative differences between the two periods, highlighting the economic impact of the infestation on sugarcane cultivation.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Sample Respondents

A comprehensive overview of the demographic and socioeconomic characteristics of households in the study area is presented in Table 1. It categorizes households into five key considerations: Age of

Table 1

Socio-economic characteristics of sample respondents

Particulars	Frequency (n=90)	Percentage (%)
Age of head of the family(years)		
Below 40	42	46.67
40-50	31	34.45
Above 50	17	18.88
Average age	42.78	100
Level of Education (No.)		
Illiterate	20	22.22
Primary school	26	28.89
Secondary school	26	28.89
PUC	15	16.67
Undergraduate and above	3	3.33
Family Types (No..)		
Nuclear family	60	66.67
Joint family	30	33.33
Occupation (No.)		
Farming/Agriculture	90	100
Government employed	4	4.44
Self employed	10	11.11
Distribution of respondents based on land Holding (No.)		
Small (d" 2.5 ac)	16	17.78
Medium (2.5-5 ac)	34	37.78
Large (> 5 ac)	40	44.44
Details about land holding		
Total land holding (acre)	847.50	-
Average size of holding (acre)	9.42	-
Total area under sugarcane (acre)	363.50	42.89%

household members, level of education, family types, occupation and land holdings. The majority of head of the family belongs to the below 40 years (46.67%) followed by 40-60 age group (34.45%) and more than 60 age group (18.88%). The education level revealed that majority of households had education up to primary schooling (28.89%) and secondary schooling (28.89%). 'Illiterate' households constitute 22.22 per cent. The distribution of family types in the study area showed that nuclear families (66.67%) were dominated in the study area followed by joint families (33.33%). In terms of land holdings, 'Large' land holdings (>5 acres) constitute the largest category (44.44%), followed by 'Medium' at 37.78 per cent and 'Small' at 17.78 per cent.

Cropping Pattern of Sample Respondents

Data dipicted in Table 2 revealed that the variety of crops grown by sample respondents and provide insight into their agricultural practices and distributions of crops. The agricultural landscape is marked by the cultivation of various crops across different seasons. Sugarcane stands out as the primary crop, with a consistent presence in *kharif, rabi* and *Summer*, covering an average area of 4.04 acres in each season and collectively occupying 12.12 acres, making up 57.03 per cent of the Gross Cropped Area (GCA). The Lemon production follows, with 1.12 acres dedicated to it in each season, contributing to a total GCA of 3.37 acres, representing 16.46 per cent of the total GCA. Pigeon pea is cultivated during *kharif* and occupies 2.00 acres, making up 9.57 per cent of the GCA. Onion, Bengal Gram, Wheat, Jowar, Cotton and Groundnut also find their place in the cropping pattern, although some crops like Jowar and Onion have a limited presence. The total GCA was 21.03 acres, with a net cropped area of 9.42 acres and a cropping intensity of 223.17 per cent.

Labour Utilization Pattern in the Production of Sugarcane

Comparative overview of labour utilization pattern in sugarcane cultivation on per acre basis before and after infestation has been analysed and presented in Table 3. Land preparation required 2.06 pair-days of bullock labour and 2.50 hours of machine labour, while other operations such as FYM application and planting required 2 and 5.15 men labours required for both before and after infestation of root grub, respectively. Chemical fertilizer application demanded 2.17 men and 1.46 women labour, while intercultural operations required 9 women labour and 1.61 machine labour. Weedicide application required 0.50 men labour and irrigation

TABLE 2

Cropping pattern of sample respondents (n=90)

(Area in acres)

Crop	*Kharif*	*Rabi*	Summer	GCA	%
Sugarcane	4.04	4.04	4.04	12.12	57.03
Lemon	1.12	1.12	1.12	3.37	16.46
Pigeon pea	2.00	0.00	0.00	2.00	9.57
Onion	0.33	0.00	0.00	0.33	1.71
Bengal Gram	0.00	0.62	0.00	0.62	2.98
Wheat	0.00	0.56	0.00	0.56	2.59
Jowar	0.00	0.24	0.00	0.24	1.25
Cotton	0.50	0.00	0.00	0.50	2.22
Groundnut	0.00	0.00	1.29	1.29	6.19
Gross cropped area				21.03	100.00
Net cropped area				9.42	0.00
Cropping intensity				223.17	0.00

TABLE 3

Labour utilization pattern in the production of sugarcane

(Per acre)

Operation	Before infestation (n=90)				After infestation (n=90)			
	M	W	BL	ML	M	W	BL	ML
Land preparation	-	-	2.06	2.50	-	-	2.06	2.50
FYM application	2.00	-	-	-	2.00	-	-	-
Planting	5.15	-	-	-	5.15	-	-	-
Chemical fertilizer application	2.17	1.46	-	-	2.17	2.19	-	-
Intercultural operation	-	9.00	-	1.61	-	8.00	-	1.61
Weedicide	0.50	-	-	-	0.75	-	-	-
Irrigation	5.00	-	-	-	5.00	-	-	-
Root Grub Management								
Cultural method	-	-	-	-	2.50	-	0.90	-
Mechanical method	-	-	-	-	2.00	-	-	-
Chemical method	-	-	-	-	2.50	-	-	-
Biological method	-	-	-	-	0.81	-	-	-
Total	14.81	10.46	2.06	4.11	22.90	10.19	2.96	4.11

Note : M = Men labour (Man days), W = Women labour (Man days), BL = Bullock labour (pair days) and ML = Machine labour (hrs.)

demanded 5 men labour in before infestation of root grub and for after infestation of root grub requires 2.19 women and 2.17 men labour for chemical fertilizer application, while intercultural operations required 8 women labour and 1.61 machine labour. Weedicide application required 0.75 men labour and irrigation demanded 5 men labour. The root grub management requires 2.50 men and 0.90 pair-days of bullock labours in cultural method, 2.00 men labours in mechanical method, for chemical method 2.50 men labours and biological method required 2.81 men labours.

Input Use Pattern in Sugarcane Cultivation

Input utilization pattern in sugarcane cultivation on per acre basis has been analysed and presented in Table 4. Before infestation, human labour amounted to 20.56 man-days, while bullock labour and machine labour were 2.06 pair-days and 4.11 hours per acre, respectively. The use of sets and farm yard manure remained constant at 2.83 tonnes and 3 tonnes per acre, respectively. Regarding chemical fertilizers, the input quantities for nitrogen, phosphorus and potassium were 113.42, 81.52 and 106.33 kg per acre, respectively, before infestation. Weedicide, specifically Atrazine, required 0.75 kg per acre. Additionally, mechanical control components in the form of traps were used, totalling to the 2.38 traps per acre (Fig. 1).

Table 4

Input utilization pattern in sugarcane cultivation

(Per acre)

Inputs	Units	Before infestation (n=90)	After infestation (n=90)
Human labour	Mandays	20.56	28.35
Bullock labour	Pair days	2.06	2.96
Machine labour	hrs	4.11	4.11
Sets	t	2.83	2.83
Farm yard manure	t	3.00	3.5
Chemical Fertilizers			
N	kg	113.42	121.34
P	kg	81.52	87.21
K	kg	106.33	113.76
Weedicides			
Atrazine	kg	0.75	0.75
Mechanical control components			
Traps	nos.	-	2.38
Bio pesticides			
Metarizhium anisopliae	kg	-	4
Plant protection chemicals			
Chloropyriphos	ltrs	-	2.5
Phorate 10G	kg	-	3.61
Irrigation	acre inch	160	180

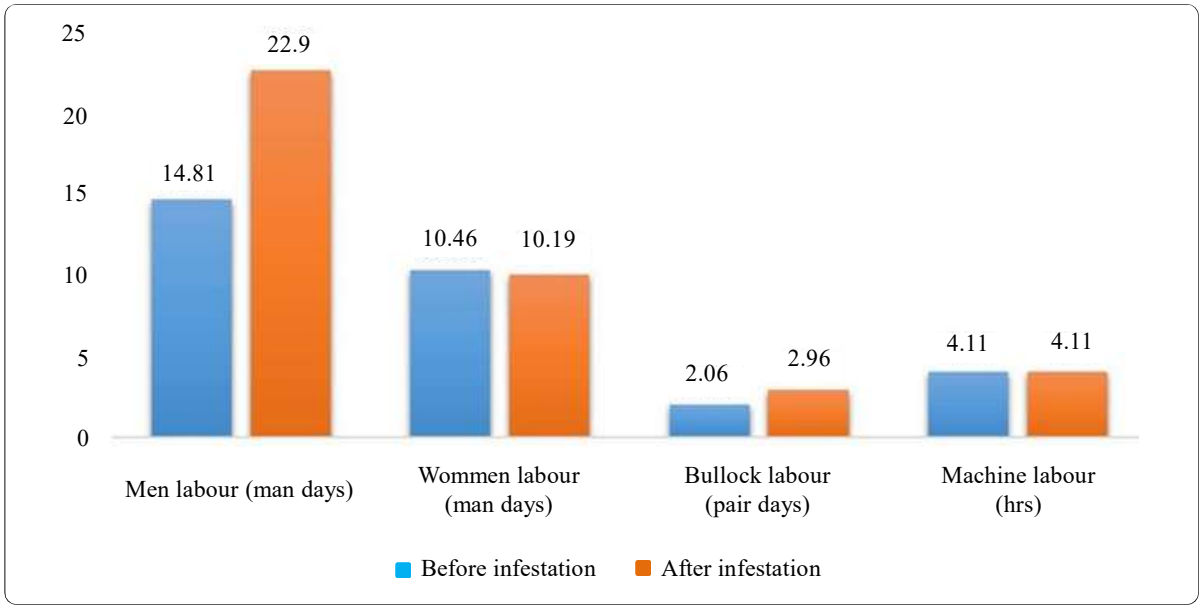

Fig. 1 : Labour use pattern in before and after infestation of sugarcane cultivation

Cost of Cultivation of Sugarcane

The cost involved in the cultivation of Sugarcane was estimated during both pre and post infestation of root grub and is given in Table 5. Perusal of the results revealed that, the expenditure on usage of human labour was increased significantly after infestation, rising from Rs.9,254 to Rs.12,759 per acre, representing a 37.87 per cent increase. Even bullock labour costs also experienced a substantial increase, from Rs.1,954 to Rs.2,808, reflecting a 43.75 per cent increase. On the contrary, machine labour and set costs remained unchanged *i.e.* Rs.2,055 and Rs.7,652, respectively. Farmyard manure cost rose from Rs.3,450 to Rs.4,025, indicating a 16.67 per cent increase. Similarly, chemical fertilizer cost increased from Rs.4,445 to Rs.5,104, representing an increase of 14.83 per cent. After infestation the farmers incurred some expenditure towards the control of root grub. Farmers spent Rs.286, Rs.494 and Rs.1530 for mechanical control, biological control and chemical control, respectively. Irrigation charges increased from Rs.5,120 to Rs.5,760, showing a 12.50 per cent increase. However, harvesting and transportation costs decreased significantly from Rs.23,179 to Rs.16,605, marking a substantial decrease of 28.36 per cent. Harvesting and transportation costs has been decreased after the root grub infestation due to lesser yield after the infestation of root grub infestation in the study area. Interest on working

TABLE 5

Cost of cultivation of sugarcane

(Rs. /acre)

Particulars	Before infestation (n=90)	Per cent	After infestation (n=90)	Per cent	Per cent change
Variable Cost					
Human labour	9254	11.97	12759	15.89	37.87
Bullock labour	1954	2.53	2808	3.50	43.75
Machine labour	2055	2.66	2055	2.56	0.00
Setts	7652	9.89	7652	9.53	0.00
Farm yard manure	3450	4.46	4025	5.01	16.67
Chemical Fertilizers	4445	5.75	5104	6.36	14.83
Weedicides	420	0.54	420	0.52	0.00
Mechanical control components	0	0.00	286	0.36	100.00
Bio pesticides	0	0.00	494	0.62	100.00
Plant protection chemicals	0	0.00	1530	1.90	100.00
Irrigation charge	5120	6.62	5760	7.17	12.50
Harvesting and Transportation	23179	29.97	16605	20.68	-28.36
Interest on working capital @ 7%	4027	5.21	4222	5.26	4.83
Total variable cost (A)	61556	79.59	64530	80.35	4.83
Fixed cost					
Land revenue	12	0.02	12	0.01	0.00
Depreciation	1267	1.64	1267	1.58	0.00
Rental Value of Land	12810	16.56	12810	15.95	0.00
Interest on fixed capital @ 12%	1691	2.19	1691	2.11	0.00
Total fixed cost (B)	15780	20.40	15780	19.65	0.00
Total cost of cultivation (A+B)	77336	100.00	80310	100.00	3.70

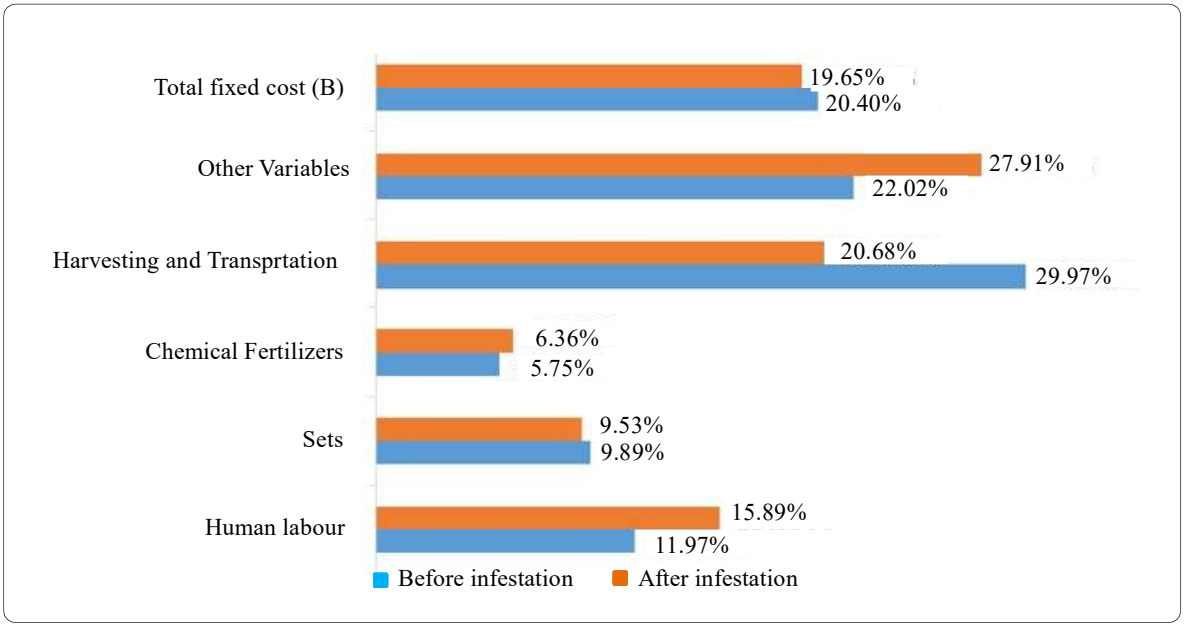

Fig. 2 : Component wise cost incurred in sugarcane cultivation before and after root grub infestation

capital at 7 per cent increased slightly from Rs.4,027 to Rs.4,222, with a 4.83 per cent increase. The total variable cost went from Rs.61,556 to Rs.64,530, reflecting a 4.83 per cent increase after infestation. These results are in line with that of Zalucki *et al.* (2012) (Fig. 2).

On the other hand, the fixed costs remained constant for land revenue, depreciation, rental value of land, and interest on fixed capital at 12 per cent, staying at Rs.12, Rs.1,267, Rs.12,810 and Rs.1,691, respectively. The total fixed cost) before and after infestation remained unchanged at Rs.15,780.

Yield and Returns from Sugarcane Cultivation

Further in continuation with the estimation of cost, the study analysed the yield loss due to the infestation and the results are presented in Table 6. It could be seen from the table that, before infestation, the yield of sugarcane stood at 51.51 ton per acre, but after infestation, it dropped significantly to 36.90 tons per acre, marking a substantial decrease of 28.36 per cent. The procurement price of the factory remained constant at Rs.2,950.00 per ton, showing no change. Gross returns were dropped from Rs.1,51,952.80 to Rs.1,08,855.73 per acre after infestation reflecting a 28.36 per cent decrease in gross return.

TABLE 6

Yield and returns from sugarcane cultivation

(per acre)

Particulars	Before infestation (n=90)	After infestation (n=90)	Per cent change
Yield of sugarcane (t)	51.51	36.9	-28.36
Procurement price of factory (Rs.)	2950	2950	0
Gross returns (Rs.)	151953	108856	-28.36
Cost of cultivation (Rs.)	77336	80310	3.85
Net returns (Rs.)	74617	28546	-61.74
Net Returns over variable cost (Rs.)	90397	44326	-50.96
Returns per rupee of expenditure	1.96	1.36	-31.02
Cost of production (Rs. /t)	1501	2176	44.96

Simultaneously, the cost of cultivation increased from Rs.77,336 per acre to Rs.80,310 per acre after infestation, representing a 3.85 per cent increase in cultivation costs. Consequently, the net returns decreased from Rs.74,617 per acre to Rs.28,546 per acre after infestation, indicating 61.74 per cent decrease in net returns. Furthermore, the returns per rupee of expenditure dropped from 1.96 to 1.36, reflecting a 31.02 per cent reduction in efficiency after infestation. While cost of production per ton of

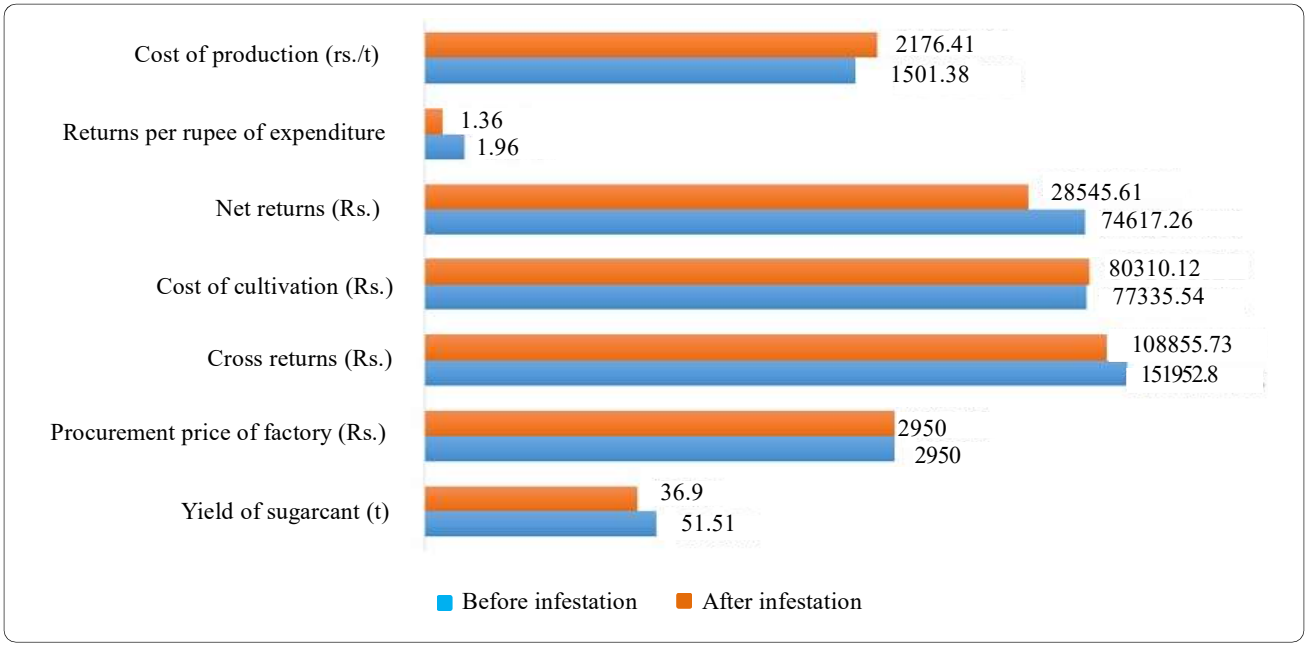

Fig. 3 : Yield and returns from sugarcane cultivation

sugarcane increased from Rs.1,501 to Rs.2,176, marking a substantial increase of 44.96 per cent.

The current results are in line with the study conducted by Lamani *et al*. (2017) wherein study revealed that Input used was more in case of infested sugarcane field as compared to non-infested sugarcane field and yield realized by the infested sugarcane field was lesser as compared to non-infested sugarcane field. Net return by the infested sugarcane field found to be less than the non-infested sugarcane field. Net loss realized was due to the root grub infestation (Fig. 3).

Mean Differences Before and After Infestation of Root Grub

In Table 7, the mean differences before and after the infestation of root grub in sugarcane crop in the study area, are given for the four key variables *viz.,* Labour, Fertiliser, Yield and Net Returns. Firstly, the mean value of labour input increased significantly from 20.56 mandays before infestation to 28.00 mandays after infestation, with a corresponding t-value of 2.99, indicating a statistically significant difference. This suggests that the infestation had a notable impact on the amount of labour required. On

TABLE 7

Mean differences before and after infestation of root grub

Variable	Before infestation (n=90)	After infestation (n=90)	t-value	
Labour (mandays)	20.56	28.00	2.99	***
Fertiliser (Rs.)	4444.50	5103.84	0.98	NS
Yield (t)	51.50	36.90	2.89	***
Net Returns (Rs.)	74617.26	28545.60	7.05	***

*** Significant at 1 per cent

the other hand, fertiliser usage revealed no significant difference between the two conditions, with means of Rs.4444.50 and Rs.5103.84 before and after infestation, respectively (t-value = 0.98). This implies that the infestation did not significantly influence fertiliser application. Furthermore, the mean yield exhibited a significant decrease from 51.50 tonne before infestation to 36.90 tonne after infestation, with a t-value of 2.89. This indicates a substantial impact on crop yield due to the infestation. Lastly, the mean net returns showed a pronounced decline, declining from Rs.74,617.26 before infestation to

TABLE 8

Partial budget to analyse economic loss due to root grub infestation

Debit		Credit	
Added costs due to root grub infestation	*Amount (Rs.)*	*Added revenue*	*Amount (Rs.)*
Chemical fertilizers	659.33	-	-
Mechanical control components	285.89		
Biopesticides	494.36		
PPC	1529.55		
Irrigation charges	640.00		
Labour charges (HL+ML+BL)	4359.24		
Farm yard manure	659.33		
Total increased costs	8627.70	Total added revenue	-
Reduced revenue due to root grub infestation	*Amount (Rs.)*	*Reduced costs due to root grub infestation*	*Amount (Rs.)*
Revenue lost	43097.07	Harvesting and Transportation	6574.10
Total revenue reduced	43097.07	Total reduced costs	6574.10
Total Debit	51724.77	Total Credit	6574.10
Net Loss	45150.67		

Rs.28,545.60 after infestation. This decline is statistically significant, with a t-value of 7.05, highlighting the significant financial implications of the infestation. These findings underscore the varied effects of root grub infestation on these agricultural variables, with implications for agricultural management and decision-making.

Partial Budgeting to Analyse Economic Loss Due to Root Grub Infestation

A partial budget for the production of sugarcane before and after the root grub infestation is showed in Table 8.

Partial budgeting technique was used to estimate the relative benefit/loss due to root grub infestation in sugarcane cultivation. It is evident from Table 6 that, the sugarcane growing farmers have realised a net loss of Rs.45,150.67 due to root grub infestation in the study area. The result clearly indicated the economic loss faced by sugarcane growers post the root grub infestation. The additional cost of Rs.8,627.70 per acre was incurred to take control measures to reduce root grub infestation. The per acre revenue lost in the form of decreased yield levels due to root grub infestation was estimated to be Rs.43,097.07. The results are in line with study conducted by Lamani *et al*. (2017) wherein they revealed that added cost due to infestation of white grub was found to be Rs.11,529 per ha while reduced returns was Rs.62,938.19 per ha.

The increased human labour was mainly due to higher labour usage for the control of root grub in sugarcane crop after the infestation. The higher cost of cultivation after infestation was mainly due to usage of different management practices to control root grub. Gross returns dropped from Rs.151,953.00 to Rs.108,856.00 per acre after infestation reflecting a 28.36 per cent decrease in gross returns. Returns per rupee of expenditure dropped from 1.96 to 1.36, reflecting a 31.02 per cent reduction in efficiency after infestation. The infestation had a significant impact on the amount of labour required, yield and net returns, whereas fertilizer was found to be non-significant. Partial budgeting indicated that, the sugarcane growing farmers have realised a net loss of

Rs.45,150.67 due to root grub infestation in the study area. The findings of the study highlight the decrease in returns and increase in cost of cultivation of sugarcane due to root grub infestation. Farmers need to be educated through trainings regarding preventive measures and early detection by government agencies, agricultural universities and farmers' associations to create a robust support network for knowledge-sharing and resource access. So as to reduce the economic losses due to root grub infestation.

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