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Influence of Field Practice on Sugarcane Production in Webuye East Sub-County in Bungoma County, Kenya

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Abstract

Sugarcane production in Kenya has declined, leading to the importation of sugar to meet the country's demand. Webuye East Sub-County (WES) has witnessed dwindling production in sugarcane which has been attributed to the reduced land due to the increasing population. Little focus has been made on unravelling the effects of field crop practices on sugarcane production in WES. Therefore, this study looks at field crop practices influencing sugarcane production in WES. The study was anchored on Cobb Douglas's production theory. A descriptive survey research design was used. A sample of ninety-six (96) respondents was systematically sampled from the target population of 6135 registered sugarcane farmers. In addition, five field officers and eight weighbridge workers in WES were purposively sampled to provide essential information for the study. Questionnaires, interviews, observations, and documentary analyses were data collection tools. Data were analysed using SPSS and Chi-square analysis. The study found that a farmer could achieve, on average, 23.1% more tonnage of sugarcane in an acre of land when essential agronomic practices were practised, in which field crop practices gave 29.2%. There was a significant positive relationship between critical agronomic practices and sugarcane production at 0.05 significance. Field crop production practices significantly influenced cane production in WES and this call for stakeholders to put in place intervention measures that can help achieve maximum cane yield. It is recommended that public meetings for sugarcane farmers be held regularly in every ward in the sub-county and loan services be offered to farmers.

Introduction

In 2012, the Food and Agricultural Organization of the United Nations [FAO] ranked sugarcane as the world's most significant crop production by quantity (FAO, 2015). Africa grows about 5% of world production, 30% of which comes from East Africa (Girei & Giroh, 2012). Kenya is one of the major sugarcane producers in Africa and East Africa. Sugarcane is the second largest contributor to Kenya's agricultural growth after tea (FAOSTAT, 2013). In Kenya, the area under cane is 123,622 hectares, of which smallholders and 12,433 cultivate 111,189 hectares under nucleus estates. This means that 88% of the total area under sugar cane in Kenya is under small-scale farmers. The sector comprises over 250,000 smallholder farmers, who supply over 92% of the sugar cane processed by sugar companies, while the remainder is supplied by factory-owned nucleus estates (Kenya Sugar Board [KSB], 2010). Kenya's annual production ranges from 450,000 - 550,000 metric tons, which does not meet the country's annual demand; consequently, sugar is imported.

The sugar sub-sector plays an essential role in the country's economy. It generates an estimated KES 12 billion annually, provides about 500,000 jobs and supports the livelihood of about six million people (KSI, 2009). Odenya *et al.* (2007) indicate that an estimated 25 per cent of the country's population depends directly or indirectly on the sugar industry for their livelihood. They further indicate that establishing sugar mills in the growing areas has contributed to industrial developments and towns in the growing areas, such as Muhoroni, Awendo, and Mumias. It has also provided raw materials for other industrial Plants, such as those manufacturing industrial spirits.

There has been a decline in sugarcane production per given unit area, affecting approximately 6 million people who depend mainly on sugarcane farming directly or indirectly (KSB, 2008). The sugarcane yield in Kenya stands at 65 tons of cane per hectare, which is way below the potential yield of 100 tons per hectare under rain-fed conditions (Kenya Sugar Research Foundation [KESREF], 2009). Potential reasons for this reduction in productivity include the widespread use of low-quality sugarcane varieties, poor agricultural and land management practices and delayed harvesting of mature sugarcane (KSB, 2010). Moreover, most farmers grow cane varieties susceptible to major diseases such as smut, mosaic, and ratoon stunting disease. These factors, coupled with poor crop management practices, lead to low yields. Like in other parts of Kenya, the sugarcane yields among the farmers of WES have declined while the cost of producing sugarcane is rising. Webuye East Sub-County falls within the area under Nzoia Sugar Company and West Kenya Sugar Company and relies on sugarcane from this area. Since the cane produced in the region is not enough, the region has become a battle zone for sugarcane between West Kenya and Nzoia sugar companies.

Although economic theory suggests that the relative importance of agriculture declines as the economy grows, agriculture is still critical for such transformations to occur. The neglect of sugarcane-related practices by the farmer has contributed to the low productivity and profitability of the sugar industry in Kenya (Obange, 2018). This affirms the need for the farmers to implement production-promoting practices on the farm. Also, through the stakeholders, the government of Kenya needs to increase sugarcane production so that the country can become a net exporter of sugar, as stated in the country's development plan. As far as research is concerned, existing studies have focused on the socio-economic and physical factors affecting production. However, agronomic practices have been identified as essential drivers of crop production (GoK, 2008), sugarcane being included. This inspired research on agronomic factors influencing sugarcane production in WES.

Research Methodology

This study drew on the descriptive survey research design to elicit data from the study participants. The study targeted a population of

6135 farmers (Maraka ward 1250 farmers, Ndivisi 1355 and Mihuu 3530) (GOK, 2019), five field officers and eight weighbridge workers of West Kenya Sugarcane Company in WES. A systematic sampling design was utilised to select the study sample. The sample size was 96 sugarcane farmers and was calculated based on the Kothari (2004) formulae. The sample size for each ward was derived proportionately. In addition, ten farmers were purposively selected for an in-depth interview to gain deeper insight into their experiences with agronomic practices and their influence on sugarcane production. Data were collected during the year 2020 using in-depth interview schedules and questionnaires. Questionnaires were administered to the 96 sugarcane farmers in person at their homes, and follow in-depth interviews done later with the ten purposively selected farmers. Key informants, which included field officers and weighbridge workers, were first contacted over the phone to arrange for the interviews at a place of their convenience and time. The interviews lasted between 20 to 30 minutes. Data were analysed using the Statistical Package for Social Science (SPSS) software which generated both descriptive statistics (frequency and percentage) and inferential statistics (chi-square)

Results and Discussion

Weeding, ratooning, and pest and disease control were field crop production practices on sugarcane production that were assessed. The study looked at weeds present in sugarcane farms, how the weeds were controlled, how weeding affected sugarcane yield, a pest that was commonly found in a sugarcane field, diseases that affected the sugarcane crop, how pests and diseases were controlled in the sugarcane farm and how pests and diseases affected the sugarcane production. The researcher also looked at ratoon cropping in terms of whether the farmers practice ratoon cropping, the number of times the ratoon cropping was practised before the sugarcane plant was uprooted and how ratoon cropping affected the production of sugarcane crop and the reasons that motivated farmers within Webuye East sub-county to practice ratoon cropping.

Control of weeds by farmers

Weeds observed in the sugarcane farm included oxalis, pigweed, leave me not, wandering jew, Mexican marigold, couch grass and blackjack. Although these weeds were present in sugarcane farms, the blackjack and couch grass were the most observed weeds in the sugarcane fields. Contrary to the findings of this research, Linda (2005), in her study on *'weed control'* in Louisiana, found that the major weeds in the sugarcane field were Johnson grass and Bermuda grass. This means that significant types of weeds in sugarcane farms vary with region. The study's findings in Table 1 show that most farmers (51.0%) controlled weeds by spraying and hoeing; this was followed by hoeing alone (46.8%), and only 2.1% used spraying alone. This information was supported by one of the field officers at Ndivisi ward, who indicated that most farmers used both hoeing and spraying because spraying completely eradicated the weeds that could have survived after hoeing. He also explained that spraying reduced the number of times of hoeing before the sugarcane plant attained maturity.

One of the field officers based at the Mihuu ward opined that farmers who used hoeing alone could not afford the purchase of chemicals because hoeing involved the use of family labour and hence was free (M. Simiyu, Personal communication, 2020). He added that some of these farmers intercropped sugarcane with beans, and spraying could interfere with the survival of beans. Another field officer based at Maraka ward added that those farmers who used spraying alone considered the method appropriate because of the scarce and expensive human labour. He said that spraying was a faster and easier way of weed control (T. Wasike, Personal communication, 2020).

Table 1: Methods of Weed Control

Weed control methods	Freq.	Percent	Cumulative Percent
Hoeing	45	46.8%	46.8%
Spraying and hoeing	49	51.0%	97.8%
Spraying	2	2.1%	99.9%
Total	96	100%	

Source: *Survey data 2020*

As indicated by farmers, these weeds had been controlled mechanically by hoeing and chemically by spraying in some sugarcane fields. These findings compare favourably with those of SRI (2015), indicating that sugarcane farmers controlled weeds mechanically by hoeing and chemically by spraying glyphosate. However, SRI (2015) also found that apart from these two methods, farmers also used other methods like intercropping, crop rotation and mulching. In addition, Linda (2005) explained that Louisiana's weeds were controlled by following and planting early maturing resistant soybeans on sugarcane farms.

Concerning the effect of weeds on sugarcane yield, most of the farmers (81.0%) in WES strongly agreed that weeds should be controlled for cane production to be high, and few (18%) agreed that weeds should be controlled for cane yield to be high and very few (1%) of farmers disagreed that weed control determined cane production. The proportion of farmers who agreed that weeds should be controlled for cane yield to be high was large compared to the farmers who disagreed with the same statement. An in-depth interview with one of the field officers indicated that weed control highly increases sugarcane yield. He observed that: "Farmers who failed to control weeds ended up harvesting one trailer of sugarcane in an acre of land whose weight does not exceed eight tones while farmers who partially control weeds would harvest cane that does not exceed a total weight of 18 tones in an acre of land."

This agreed with one key informant who said that sugarcane farmers who controlled weeds in their sugarcane fields harvested cane whose average tonnage was 55 tones in an acre of sugarcane plot (Ikapel J. Personal communication, August 30, 2020). This implied that farmers who failed to control weeds in sugarcane fields incurred huge losses during harvesting.

In addition, 82% of farmers in WES indicated that they have ever experienced variation in cane output based on the level at which weeds were controlled. 44% of farmers who have experienced unsuccessful weed control had an average yield of 18 tones in an acre of sugarcane farm. In comparison, 51% of farmers with successful weed control had an average yield of 50 tons in an acre of a cane field. Farmers (5%) who did not control the weeds had an average yield of 8 tones in one acre of cane plot, as illustrated in Table 2. This implies that farmers who successfully controlled weeds harvested 58.2% more tonnage than those who unsuccessfully controlled weeds and 76.4% more than those who did not. These findings concur with that of Linda (2005), who notes that the competition for light, space, water and nutrients between the crop and weeds can lower sugarcane stalk population and yield. She adds that weeds emerging with the crop may lower cane tillering and hinder growth, resulting in low harvest yields. Nazir *et al.* (2013) also indicates that weeds restrict moisture, nutrients, and light and serve as alternative hosts for insect pests in sugarcane crop.

Table 2: Effect of weed control on sugarcane yield

Level of control	Freq.	Percent of farmers	Amount of yield
Successful control	49	51%	50%
Unsuccessful control of weeds	42	44%	18%
Did not control	5	5%	8%

Source: Survey data 2022

Control of Pests and Diseases

Farmers indicated that pests such as sugarcane borers, yellow sugarcane Aphids, Wireworms, Ants, Moles, Armyworms, Termites, and rodents are found in sugarcane fields within Webuye East Sub County, the most common being Sugarcane borers, yellow sugarcane Aphids, moles and termites. This finding was in contrast with the conclusion made by Santo *et al.* (2000) in their study on sugarcane, where only three insects, yellow sugarcane aphid, New Guinea sugarcane weevil and the lesser cornstalk borer were identified by sugarcane farmers in Hawaii as the most common pests.

Diseases that were identified to affect sugarcane production in WES included smut, ratoon stunting and yellow-orange leave. Smut and ratoon stunting diseases were observed to be the most common diseases that negatively affected sugarcane production within WES, as indicated in Table 3. Ratoon stunting disease was because of mismanagement of the first and subsequent ratoons, while smut disease was a viral disease, as explained by one of the field officers.

Table 3: Diseases that affect cane yield in WES

Disease	Freq.	Percent.	Cumulative percent
Ratoon stunting	45	46.9	46.9
Smut	38	39.6	86.5
Yellow orange leave	13	13.5	100.0

Source: Survey data 2020

The study sought to find out how pests and diseases were controlled in WES, and the findings showed that 19.7% controlled pests and diseases by use of chemicals, 17.8% controlled the pest and diseases culturally, 1.0% controlled pests and diseases biologically and 61.5% controlled pest and diseases mechanically as indicated in Table 4. This agreed with the sentiments by one of the field officers who said that most farmers controlled pests mechanically though these pests still need to be fully managed. The field officer added that moles had been identified as notorious pests in sugarcane crop, especially in the Mihuu ward. The field officers further indicated that moles attacked the cane crop from the roots, causing drying up and, subsequently, death of the cane crop. He added that moles had been controlled mechanically by trapping and killing them.

Table 4: Methods of Pests and Disease Control

Pests and disease control methods	Freq.	Percent.	Cumulative Percent
Chemical	19	19.7%	19.7%
Cultural	17	17.8%	37.5%
Biological	1	1.0%	38.5%
Mechanical	59	61.5%	100%
Total	96	100%	

Source: *Survey data 2020*

Another field officer from Maraka ward added that chemical control of pests in WES involved the use of synthetic chemicals to manage pest population and diseases Wasike (2020). This method was highly effective and gave quick results though non-targeted species were affected, and its continued use made pests develop resistance. Cultural control of pests involved the use of timings and a combination of agronomic practices which made the environment less favourable for development of pests and diseases. Cultural pest and disease control in WES included, crop rotation, destruction of sugarcane crop residue, use of CO-421 variety, which was a resistant variety, earthing up of sugarcane that checked up emergence of borers and thrush mulching. Though this method was effective for single pests only, no extra cost was incurred. Mechanical control of pests and diseases in WES involved manual killing or hand picking the pests such as ants and moles. These methods of controlling pests and diseases were in line with the findings by Santo *et al.* (2000) in Hawaii, where pests and diseases were controlled through modification of cultural practices, selection of the insect tolerant cultivars and biocontrol of the insect pests. However, the chemical control method contrasted with his conclusion that insecticides were not used

because of the potential harm to the beneficial insects. Although different pest and disease control methods were employed in WES, the cultural method was the best though more involving and partially used. In contrast, mechanical control of pests and disease was not involved and was widely used by farmers in the sub-county, as indicated in Table 5 above.

The field officers explained that pests negatively affected sugarcane in terms of weight and quality. One of the field officers based at Maraka ward explained that termites were controlled chemically using chemicals supplied to farmers on credit by the Nzoia Sugar Company in the WES and mechanically by removing the queen and killing it. He added that Moles were controlled mechanically by digging and applying plenty of water in the path of the mole, which choked it and forced it to come out (D. Musombi, Personal communication, August 14, 2020).

Another field officer indicated that rust disease was controlled by planting a resistant variety of CO-421 in WES. He also added that sugarcane borers were controlled by detrashing the cane and trash mulching to promote the growth of beneficial organisms. However, some farmers burned sugarcane crop residue after harvesting and practised crop rotation. Another field officer added that although sugarcane farmers controlled pests and diseases, it was not a hundred per cent managed because the methods that were mostly applied were mechanical, which overwhelmed farmers. He added that farmers in WES should incorporate detrashing, trash mulching and chemicals to control the menace caused by pests and diseases to achieve a maximum yield of 55tonnes per acre of sugarcane plot Ikapel (2020).

When asked whether control of pests and diseases affected sugarcane yield, 50% of farmers in WES strongly agreed that control of pests and diseases resulted in high cane production, 47.9% agreed, 1% disagreed and 1% strongly disagreed with the statement as illustrated in Table 5. This finding compares with that of DAFF, (2014) in South Africa where it was found that pests such as Edana borer cause severe loss in cane quality and reduce cane weight whereas diseases such as eye spot, brown spot, Pokkahboeng, gumming, red rot, rust, leaf scald, mosaic, smut and ratoon stunting attack sugarcane and reduce yield.

Table 5: Response rate on control of pests and diseases on cane yield

Response rate	Freq.	Percent	Cumulative Percent
Strongly agree	48	50%	50%
Agree	46	47.9%	97.9%
Disagree	1	1%	98.9%
Strongly disagree	1	1%	100%
Total	96	100%	

Source: *Survey data 2020*

To add on, 38% of farmers who had successful pests and disease control in their sugarcane farm had an average tonnage of 36 tonnes in an acre of sugarcane field as opposed to a maximum yield of 55 tones in an acre. In comparison, 62% of farmers who did not control pests successfully had an average sugarcane yield of 28 tones in an acre of land. This implied that farmers who controlled pests and diseases successfully harvested 14.5% more tonnage than those who controlled diseases and pests unsuccessfully in their sugarcane plot. Though farmers who controlled pests successfully harvested more, these farmers did not attain the maximum yield of 55 tonnes per acre because of failure to practice successfully other agronomic practices as explained by one of the field officers.

Ratooning

It was found that most (91.7%) sugarcane farmers in the sub-county practised ratooning while few (8.3%) indicated that they did not practice ratooning, as illustrated in Table 6. 91.7% of sugarcane farmers indicated that they practised ratooning two to three times before the sugarcane plant crop was uprooted.

Table 6: Farmers who practice ratooning

Whether ratooning is practiced or not	Freq	Percent	Cumulative percent
Yes	88	91.7%	91.7%
No	8	8.3%	100%
Total	96	100%	

Source: *Survey data 2020*

One of the weigh bridge workers also indicated that some sugarcane farmers went up to five times of cutting sugarcane before uprooting their plant crop. Information from another field officer indicated that cane variety CO-421 could go up to 9 ratoons before the cane crop was uprooted. However, most ratoons went up to 3 times of cutting before the crop was uprooted. However, the number of times that sugarcane crop was cut before uprooted depended on how the farmers maintained their cane crop in the field. On the other hand, it was observed by the researcher that the plant crop was healthier than the ratoon crop. One field officer added, "The production of ratoon crop was lower than the plant crop, but farmers considered practising ratooning."

The reason the field officers cited ratooning was practised in the WES was that the ratoon crop was easy to maintain and matured faster than the plant crop. Also, the planting material was inadequate. The farmer had to save on the initial costs of establishing the new sugarcane plant because of the lease agreement of harvesting cane three times before uprooting the crop. Ratooning was highly practised within WES by cane farmers though the yield of the cane crop decreased with the subsequent ratoon, as indicated by 77% of farmers who agreed. Aamer *et al*. (2017) noted the same in the productivity of the ratoon crop in Faisalabad, Pakistan. As indicated by farmers, the major reason for ratoon cropping was to reduce costs that could have been incurred during replanting and ease management. This was in line with Shukla *et al.* (2013) in India, who argued that ratooning in sugarcane saved seedbed preparation costs and planting operations. Out of 96 responses on whether cane production decreased with the increase in the number of ratoons, 43.0% of the farmers strongly agreed that cane production went down with the increase in the number of ratoons, 34.0% agreed, and 23.0% disagreed. The number of farmers who agreed that cane yield decreases with the number of ratoons was higher (77%) than the number of farmers who disagreed (23%). This finding implied that sugarcane tonnage decreased when the number of ratoons increased.

Farmers also indicated that, on average, sugarcane plant crop gave 35 tonnes in an acre, the first ratoon had an average yield of 41 tones in an acre, and the second ratoon had 30 tones. The third ratoon yielded 21 tonnes in an acre of land, as indicated in Figure 1. First, ratoon gave a higher yield than the plant crop. The first ratoon had 14.9% more tonnage than the plant crop. Though the second and third ratoon had less tonnage than the plant crop, farmers did not incur extra costs of preparing the land, seed cane and planting. This finding compares with Aamer *et al.* (2017), who note that the productivity of ratoon is 10 to 30 per cent below the sugarcane plant crop, which can be attributed to the low and differential ratooning capabilities of cultivars and sub-optimal crop management. Malaza and Myeni (2009) also found an inverse relationship between the age of the ratoon and the crop yield.

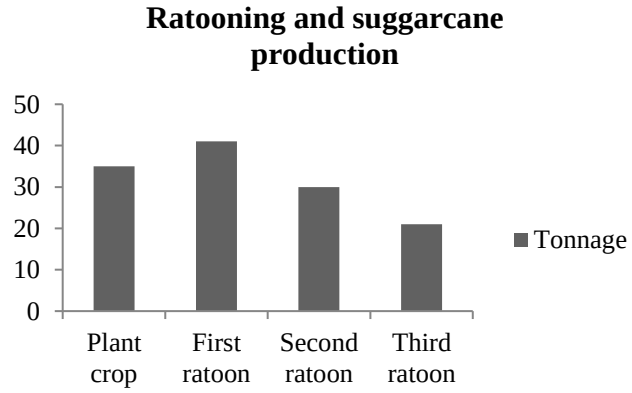

Figure 1: Effects of ratooning on sugarcane production

Source: Survey data 2020

One of the weigh bridge workers indicated that:

"The production of the plant crop was normally higher than the ratoon crop though in some cases, the production of the first ratoon could be higher when compared to plant crop" (Weigh Bridge Worker 1). Another weigh bridge worker added that the production of the first ratoon was higher than the subsequent ratoons though the returns for ratoon crops were higher than the plant crop because there were no planting costs. As explained by one of the field officers, variations in the output of ratoon crops were attributed to soil degeneration because of mono-cropping and continuous cropping, and sub-optimal ratoon sugarcane crop management. In general, field crop production practices impact sugarcane production in WES, where farmers who adequately practised field crop production practices had, on average, 29.2% more tonnage of the total expected production in an acre of sugarcane farm than those farmers who partially observed these practices.

Analysis of the Results by Chi-Square

Control of weeds and sugarcane production

Table 7 shows the amount of tonnage harvested concerning how weeds were controlled on the sugarcane farm. The results were subjected to chi-square analysis, as indicated below. It was found that the critical X^2 value was 5.99 at a 0.05 level of significance and 2 degrees of freedom which was less than the calculated chi-square value of 65.5. This implied a positive significant relationship between the control of weeds and sugarcane production. Therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted.

Table 7: Control of weeds and sugarcane production

Variable	Observed tonnage	Expected tonnage
Successful control weeds	50	55
Unsuccessful control of weeds	18	55
Did not control	08	55

Source: Survey data 2020

Control of pests and diseases and sugarcane production

Table 8 indicates the amount of tonnage harvested concerning how pests and diseases were controlled on the sugarcane farm. The results were subjected to chi-square analysis as indicated below.

Table 8: Control of pests and diseases and sugarcane production

Variable	Observed tonnage	Expected tonnage
Successful pest and disease control	36	55
Unsuccessful pest and disease control	28	55

Source: Survey data 2020

The chi-square results showed that the critical X^2 value was 3.84 at a 0.05 level of significance and 1 degree of freedom lower than the calculated chi-square value of 19.9. This showed that control of pests and diseases significantly affected cane production, so the null hypothesis was rejected, and the alternative hypothesis was accepted.

Ratooning and sugarcane production

Results on ratooning and sugarcane production are presented in Table 9, and chi-square analysis was performed as illustrated.

Table 9: Ratooning and sugarcane production

Variable	Observed tonnage	Expected tonnage
Plant crop	35	55
First ratoon	41	55
Second ratoon	30	55
Third ratoon	21	55

Source: Survey data 2020

The chi-square results showed that the critical X^2 value was 7.81 at a 0.05 level of significance and 3 degrees of freedom. The calculated chi-square value was 43.3, which was higher than the required or theoretical value of the chi-square. This indicated that ratooning positively influenced cane production; hence alternative hypothesis is accepted, and the null hypothesis is rejected.

Conclusion

Field crop production practices such as weeding, pests, disease control, and ratooning influenced sugarcane production in WES. Farmers who adequately used these practices had, on average, 29.2% more tonnage of the total expected output in an acre of sugarcane farm. Farmers who observed agronomic practices on their sugarcane farm had an average increased sugarcane yield of 23.1% per acre of cane crop. Although these agronomic practices affected cane yield in WES, they were partially practised by most of the farmers in the sub-county due to inadequate information and poverty.

To augment the productivity of sugarcane crops within Webuye East Sub County and the country at large, the government and other related stakeholders should help sugarcane farmers solve the problems of growers, such as poverty, inadequate information and inadequate extension services that hinder agronomic practices within the sugarcane field to produce more sugarcane and earn a higher net return. These problems can be solved through sugarcane companies offering extension services such as information on technology on good cane husbandry. This can be done by holding sugarcane farmers' public meetings. The West Kenya Sugar Company and Nzoia Sugar Company should offer loan services to farmers. These initiatives are essential for the country's quality and quantity of cane production and satisfactory returns to all stakeholders.

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