Influence of Scale of Operation and Farmers' Risk Aversion on Sugarcane Productivity in Nandi County, Kenya

Joseph Kipkorir Cheruiyot[1*] and Nelly Sang[1]

[1]*School of Agriculture and Biotechnology, University of Kabianga, Kenya.*

Authors' contributions

This work was carried out in collaboration between both authors. Author JKC designed the study, carried out statistical analysis and managed the data collection process. Author NS managed literature review and drafting of the manuscript. Both authors read, edited and approved the final manuscript.

Original Research Article

ABSTRACT

Aims: Sugarcane ranks among top ten commercial crops grown in Kenya, but its productivity has been on the decline. This study investigated influence of scale of farm operation and farmers' risk aversion on productivity. Risk aversion was based on farmers' perceived risks associated with new high yielding, early maturing varieties.
Study Design: The survey study adopted an ex post facto research design.
Place and Duration of Study: The study was carried out in Nandi County, Western parts of Kenya along a sugarcane growing belt. Data was collected between April and September, 2019.
Methodology: An enumerator-administered questionnaire was used to collect data from a sample of 198 respondents. Purposive and stratified random sampling techniques were used to select participants. Data was analyzed with the aid of SPSS Version 20. Chi square test and its related measure of strength of association; Cramer's V, were utilized to estimate relationships between variables. Welch's ANOVA (W-test) was run to test for yield differences between groups. Significant differences were subjected to post hoc tests using Games-Howell test to separate the means.

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*Corresponding author: E-mail: cheruiyotjoseph@gmail.com;

Results: There was a significant association between farmers scale of operation and productivity; χ^2 (2, N = 198) = 14.11, *P* = .001, V = .267. Farmers scale of operation significantly influenced productivity based on W-test (P = .001). Medium scale farms were significantly more productive per unit of land than both small and large scale. Risk aversion as measured by perceived risks of changing to new varieties was associated with sugarcane productivity; χ^2 (2, N = 198) = 9.25, *P* = .01, V = .216. Those who perceived high risks associated with new varieties recorded significantly lower yields compared to low risks (*P* = .001).
Conclusion: Small scale and large scale farmers experienced low sugarcane productivity compared to medium scale. Risk aversion among the farmers appeared to negatively influence sugarcane productivity. Capacity building of the farmers on crop management best practices and risk management strategies is recommended.

Keywords: Farm size; perceived risks; new sugarcane varieties; productivity.

ABBREVIATIONS

AFA   : Agriculture and Food Authority, Kenya
ANOVA   : Analysis of Variance
MOA   : Ministry of Agriculture, Kenya
KESREF : Kenya Sugar Research Foundation

1. INTRODUCTION

Sugarcane is an important crop worldwide. It is a major source of sugar for human consumption, for industrial products such as ethanol and by-products such molasses which are used as livestock feed among other uses. Globally, it was grown in an estimated area of 26.2 million hectares, yielding 1.907 Billion tonnes in 2018 [1]. Africa produced 94.9 million tonnes in 2018 while Eastern Africa produced 36.2 million tonnes out of which 5.26 million was produced in Kenya [1] .The sugar industry in Kenya supports over 6 million Kenyans and employs over 500,000 [2]. There were about 250,000 smallholder sugarcane farmers in Kenya in 2018 most of them in the sugarcane growing Counties of Kisumu, Migori, Kakamega, Busia and Nandi [3]. The country produced about 517,000 metric tons of sugar in 2004, rising to 600,000 metric tons in 2016 [4]. Despite this growth in production, the average productivity per unit of land has been on the decline, dropping from 74 tons/ha in 2004 to 61 tons/ha in 2014 [4]. There has been a further decline in productivity to a low average of 55 tons/ha in 2018 [2]. The continued drop in sugarcane productivity is of concern to stakeholders in the sector since sugarcane is among the top six commercial crops grown in Kenya. The crop ranks sixth as a commercial crop after tea, vegetables, cut-flowers, coffee and maize [3].

Despite the important position of sugarcane production in Kenya, the sugar industry is faced with many challenges, a key one of which is low productivity at the producer node in the value chain [5]. The challenges faced by the sugar sub-sector start right from the farm to the factory level. Previous studies have suggested challenges associated with low inputs use; including technological inputs, in weed control, transport and other agronomic practices such as the management of soil fertility [5]. Owing to these challenges, sugar production in Kenya has been prone to fluctuations; fueled by many other factors at play [6]. Previous surveys conducted in Kenya suggest that low farm level productivity is one factor that has contributed to unstable production over the years. A survey conducted by Jamoza et al. [7] reported an average cane yield of 64 tons/ha against a potential of a minimum of 100 tons/ha under rain-fed conditions in the Western Kenya region. This observation suggests a low productivity at farm level. The author had argued that poor utilization of fertilizers; poor weed management and non adoption of superior cane varieties were responsible for the low productivity.

Agriculture and Food Authority, [2] reported a concern that Kenya had relied for a long time on late maturing sugarcane varieties such as CO421 and CO945 whereas other countries such as Brazil have embraced early maturing, high yielding varieties. AFA [2] attributes sugar deficit in Kenya partly to non-adoption of varieties that mature early; after one year, such as KEN83-737. According to Mati and Thomas [3], sugarcane production in Kenya today is far below the milling capacities of the existing processing factories partly due to low productivity at farm level.

Another study conducted by Owino et al. [8] suggested that low productivity of sugarcane in the Western Kenya region was attributed to poor

land preparation, fertilizer application, weeding and weed control, seed cane and planting costs. The author reported significant positive effects from the four factors on cane productivity at farm level. The study which was carried out in the Nyando sugar belt also reported a significant influence of gender on cane output. The study also investigated possible effect of education levels of the farmer; however, the study did not find any association between farmer education levels and cane output. Similarly [9] reported non-significant relationship between education and cane production, but on gender effects, the author reported higher cane outputs for males than females. The findings by Owino et al. [8] were at variance with those reported elsewhere by Mangasini et al. (2013) as cited by Owino et al. [8] who reported no effect from gender.

A number of studies conducted in Kenya suggest that lack of adherence to crop management best practices such as weed control, land preparation and soil fertility management are largely to blame for low sugarcane productivity [7,8]. In addition to these, demographic factors such as gender and education levels have also been associated with productivity levels in conflicting studies [9,8]. The studies, however, do not reveal underlying farm and farmer attributes such as risk aversion among smallholder farmers that may be contributing to the non-adherence of best crop management practices. Studies on effect of farm size also reveal conflicting results. Some studies have reported negative relationship between farm size and productivity (Ali & Denninnger, 2015 as cited by Paul and Wa [10], others suggest a positive relationship between farm size and farm productivity [11].

1.1 Purpose and Objectives

The purpose of the current study was to investigate the influence of farm size or farmers' scale of operation and farmers' risk aversion towards new sugarcane varieties on sugarcane productivity in Nandi County, Kenya. The study was guided by two specific objectives, namely; to determine the influence of scale of operation or farm size on sugarcane productivity and the influence of farmers' aversion to risks of planting new sugarcane varieties on sugarcane productivity.

The scale of operation in the current study is based on farm size. It is a categorical variable ranging from small (less than 1ha), to medium (over 1 to 3ha) and to large (Over 3ha). Risk aversion on the other hand is a qualitative variable measured by the unwillingness of the farmer to take risks on new varieties of sugarcane. The variable is measured on three levels from high to moderate and to low risk aversion. High risk aversion individuals are expected to perceive new varieties as being highly risky to adopt, while low risk aversion individuals are expected to perceive risks associated with new sugarcane varieties as being low. Consequently the concept of risk aversion was measured based on perceived risks associated with new sugarcane varieties. The perceived risks are measured on an ordinal scale, namely; low, medium and high.

2. METHODOLOGY

2.1 Study Site

The study was carried out in Nandi County located in the Rift Valley Region of Kenya. Nandi County has six Sub-counties, one of which; Tinderet is located in the sugar belt. It was purposively carried out in a sugarcane growing zone of Tinderet in Nandi County. Nandi county is located in the Western Parts of Kenya at longitude 35º38' E and latitude 0º10' North and covers an area of 2884 Km² [12]. Tinderet sub-county is pre-dominantly a lower midland zone where sugarcane has a good yield potential [13]. It has bimodal rainfall distribution; first rain season starts indistinctly towards end of August. The mean annual rainfall ranges from 1400 to 1800 mm, fairly well distributed except for the months of December and January which are normally dry periods [14]. The temperature ranges from 15ºC to 32ºC with a moderate mean of 21ºC [14].

The study area is endowed with diverse agro-ecological zones, however, the area of focus was the lower midland zone; a traditionally sugarcane producing area. In this zone, sugarcane marketing institutions have emerged and established themselves over the years. Smallholder sugarcane producers sell their produce through farmers' cooperative societies [15].

2.2 Research Design

An ex post facto research design was adopted for the study in order to collect data from events that had already taken place. According to Kumar [16] a research design is meant to explain how to find answers to research questions. The current research question is whether scale of

operation and risk aversion has roles in productivity of sugarcane in Nandi County. In order to examine the linkages between the farm and farmer attributes with sugarcane productivity an ex post facto research design was deemed appropriate. Authors Simon [17] have explained that an ex post facto research is ideal for conducting research when it is not possible to manipulate the characteristics of the participants. It is a substitute for experimental research, but it differs from experimental research in that it studies facts that have already occurred and cannot be manipulated. In the design, treatments cannot be randomly assigned to the subjects [17]. What are the advantages of the design?

The strength of ex post facto design is that it can be used to test hypothesis on cause-and-effect or correlation relationships [17,18]. The ex post facto research can be used to predict possible causes behind an effect that has already occurred. The design is also referred to as causal-comparative research since the researchers goal is to determine whether the independent variables affected the outcome by comparing two or more groups of individuals [19] as in the current study. This design allows individuals selected for study to be placed into categories based on their histories of exposure to the independent variables [20]. The individuals' categories are obtained from the study population as represented by the individuals selected through an appropriate sampling procedure.

2.3 Sample and Sampling Procedures

The main reason for sampling is because the logistical resources of studying the entire population are saved [16], otherwise an entire population would participate at high costs. The sample, however, still has to provide valid information about the entire population; hence the need to sample in a way that minimizes difference between sample statistics and population statistics. The current study adopted purposive sampling to select a sugarcane zone in Nandi County for the study. Purposive sampling was used to select administrative Sub County where sugarcane was widely grown. Stratified random sampling techniques were then used to select sugarcane farmers to participate in the study. Stratification places sampling units of the population into relatively uniform categories before selecting the samples [21]. The sampling units or strata are based on information other than the variable that is being measured for its

influence on another variable of interest. According to FAO [22], populations can be stratified on the basis of income, age, sex, geographical region or possession of a particular commodity. Stratified random sampling is regarded as a more precise sampling procedure than simple random sampling. Stratification has the advantage of increasing precision without increasing the sample size. In the current study, administrative Locations and established farmers' institutions in the form of cooperative societies were found relevant as a criterion for stratification. All the sugarcane farmers market their sugarcane produce through cooperative societies which serve a given geographical area. These cooperatives may influence farmers operations including access to inputs, training and other services. For this reason the cooperative societies were used as a secondary sampling unit.

Nine administrative Locations in the selected area constituted the primary sampling units. One farmers' cooperative society involved in the marketing of sugarcane was randomly selected from each Location to participate in the study. From the 9 selected cooperative societies one third of its members participated in the study as suggested by Mugenda and Mugenda [23]. The one-third of total membership of 594 farmers gave a target sample of 198 farmers. The 198 farmers who participated were drawn from each of the 9 Societies based on their proportional contribution to the total membership. Farmers' registers provided by the cooperative societies were utilized to randomly select the farmers from the individual societies to participate. The outcome from the sampling process was the sample of 198 farmers who participated in the study by providing relevant information and data.

2.4 Data Collection

An enumerator-administered questionnaire was used to gather information and data from the 198 sampled farmers. The questionnaires were designed to make it fairly simple to respond to Kumar [16]. Both structured and unstructured questions were used to elicit in-depth responses. Unstructured items allowed space for respondents to make further comments in order to get the participants views in-depth as pointed out by Gorard [24]. The open-ended questions were included in the questionnaire in to help explain the patterns in the data. The questionnaires were pretested before administering to detect potential ambiguities.

The questionnaire tool was utilized to collect data on the characteristics of the farm and farmers attributes on risk aversion. Self-reported sugarcane data on yields was collected from the farmers who relied on their own records to furnish the data. The data collected on total production was later converted into production in tons per unit area in order to measure productivity based on land resource. This measure was used to compare farm productivity between groups.

2.5 Data Analysis

The data collected on farmers' and farm characteristics were analyzed using SPSS version 20 for windows. Test for associations were carried out using chi square method and its related coefficient of correlation; Cramer's V. One-way analysis of variance using Welch's ANOVA was conducted to establish whether there were significant differences in sugarcane productivity among the categories when other factors were held constant [25]. Post hoc tests to separate the means were conducted using Games-Howell tests. The test is appropriate even for situations where there is non-uniformity in variances between samples [25].

Welch's ANOVA or W-test is an appropriate test for differences between group means when the groups have unequal variances and unequal sample sizes [26]. In the current study, the sample sizes were unequal since categories were created after the data collection, making them naturally unequal. The W-test has been recommended as a robust test where there are doubts about homogeneity of variances and thus the standard F-test cannot be used [27]. Games-Howell post hoc test was used to separate the means where Welch's test showed significant differences among categories. Games-Howell post hoc test, like Welch's analysis of variance, does not require the groups to have equal standard deviations. Conversely, Tukey's method which is commonly used requires equal standard deviations [28] and therefore could not be used for the current study.

3. RESULTS AND DISCUSSION

The study participants were composed of 31% Females and 69% Males. 18% of the respondents were youths aged 35 years and below. A majority of them were aged between 36 and 55 years. 36% were aged 36-45, 21% aged 46-55 years and 25% were aged over 55 years.

In education levels, majority of the respondents had Primary school level of education (60%), secondary level education constituted 20% of the respondents. A few of the respondents did not have any formal education (7%) while 14% had post-Secondary school education.

3.1 Scale of Operation and Farm Productivity

The data collected on the farm sizes were categorized into three groups based on farm size on which sugar cane was grown. Farm sizes less than 1 hectare were treated as small scale, over 1 ha to 3 hectares were treated as medium size and more than 3 hectares were regarded as large scale. Based on the three categories the respondents were grouped accordingly. Among the respondents, there were 49.5% small scale farmers, 29.3% medium scale and 21.2% large scale farms as illustrated in Table 1.

The quantitative data collected on yields in tons per hectare was categorized into low (less than 100 tons per ha) and high (Over 100 tons per ha) for purposes of testing for possible association between scale of operation and productivity levels. The scales of operation of small, medium and large were disaggregated based on their yield levels as captured in Table 2. The frequencies for each category are as indicated in Table 2. A chi square test between scale of operation and productivity levels suggest a significant association between the two variables; χ^2 (2, N =198) = 14.11, *P*=.001, V =.267. The effect size of scale of operation as measured by Cramer's V coefficient was of moderate strength [29]. This finding suggests a strong association between scale of operation and sugarcane productivity.

Further analysis to investigate the significance of the influence of scale of operation on sugarcane productivity was carried out using Welch's Analysis of Variance techniques. Welch's ANOVA was run to establish the influence of scale of operation on sugarcane productivity using the quantitative data collected on yields per hectare. Welch's Analysis of Variance (W-test) on sugarcane productivity indicated statistically significant differences (*P* = .001) in the productivity between the three categories of small, medium and large scale farmers. A separation of the means using Games-Howell post hoc analysis revealed a significant difference in productivity between small scale and medium scale at 5% significance level. There was also a significant difference between

medium and large scale, but there was no significant difference between small-scale and large scale farms as illustrated in Table 3. The mean difference in yields between small scale and medium scale category was negative 20.13 tons per hectare suggesting that the medium scale category produced an average of 20 tons per hectare above the small scale producers. The medium scale also recorded a significantly higher mean yield compared to large scale (Table 3).

The productivity as measured in mean yields per hectare were significantly higher for medium scale farmers compared to both small scale and large scale as presented in Fig. 1. The observations suggest that small-scale farms suffer low productivity compared to medium scale. This observation may be attributed to the limited resources at the disposal of the small scale farmers. Previous studies suggest that small-scale farmers have poor access to inputs such as fertilizers and poor access to information for productivity improvement [11]. On the other hand, the results indicate that large scale farms equally suffer low productivity. This observation is probably due to diseconomies of scale suffered by large farms. Author Henderson [30] asserts that an inverse relationship between farm size and productivity is a well established empirical regularity in agriculture systems of developing countries. The findings from the present study disagree with this position since small scale farms did not report an inverse productivity outcome, nor did the large scale farms. The current study suggests an increase in productivity between small and medium and a decline between medium and large.

Paul and Wa [10] Have argued that smallholder farms face a lower labour cost and in turn apply more labour leading to higher productivity. This explanation appears to contrast with the findings of the current study. Studies in China, Rwanda and India have reported negative correlation between land size and yields (Ali & Denninnger, 2015 as cited by Paul and Wa [10]. The current study suggests that medium sized sugarcane farms in the study area were more productive per unit of land compared to both small scale and large scale. This may suggest that small scale farms suffer from low physical and technological inputs for improved productivity to be realized. Large scale farms on the other hand may be requiring owners to have higher management skills, more labour and even mechanization for improved productivity. The low productivity in large scale farms may be attributed to inadequate management capacity of the farmer as the scale of operation increases. In such situations, best management practices, especially agronomic, may become compromised leading to low productivity.

Table 1. Categories of respondents based on their scale of operation

		Frequency	Percent
Scale	Small	98	49.5
	Medium	58	29.3
	Large	42	21.2
	Total	198	100.0

Source: Field data 2019

Table 2. Scale of operation and productivity level categories

		Yield level		Total
		Low	High	
Scale of Operation	Small	62	36	98
	Medium	27	31	58
	Large	35	7	42
Total		124	74	198

Source: Field data 2019

Table 3. Games-Howell mean differences in productivity per ha between groups based on scale of operation

	Small	Medium	Large
Small		-20.13[*]	5.45
Medium	20.13[*]		25.58[*]
Large	-5.45	-25.58[*]	

(Means were separated by Games-Howell test at 5% significance level) Significant at 5% significance level, Source: Field data 2019*
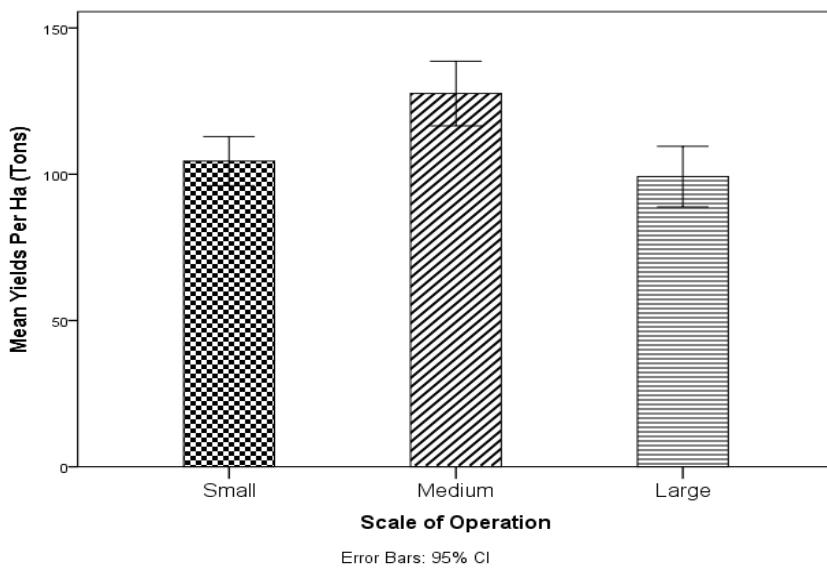
Fig. 1. Sugarcane mean yields based on scale of farm operation
Source: Field data 2019

Table 4. Adoption of new sugarcane varieties among the respondents

		Frequency	Percent
Category	Non Adopters	148	74.7
	Adopters	50	25.3
	Total	198	100.0

Source: Field data 2019

3.2 Adoption of New Sugarcane Varieties

Participants in the study were asked to provide the identities of the varieties of sugarcane they had established in their farms. The variety names were captured as responses to a non-structured question so that the respondents could list all the varieties in their farm. The respondents were later grouped into two categories; adopters of new sugarcane varieties and non-adopters based on the varieties reported. Those who grew traditional varieties only such as CO617 and CO421 were regarded as non-adopters of the new sugarcane varieties. The respondents who reported inclusion of new varieties such as; CB38-22, KEN 82, KEN 83 and EAK in their farms were treated as adopters. An analysis of the data collected showed that 74.7% of the respondents had not adopted the new varieties, while 25.3% were adopters of the new varieties (Table 4).

The high frequency of non adopters suggests the presence of underlying factors that need to be investigated further. Such factors could include

farmers' attributes such as risk aversion; a second objective of the current study.

3.3 Risk Aversion and Sugarcane Productivity

Two questions were used to measure the construct of risk aversion on an ordinal scale. One question was on rating of risks associated with new sugarcane varieties and another was on the extent to which risks associated with changing over to new varieties influenced the respondents' decision on the varieties to grow. The responses from these two questions were subjected to spearman's rank correlation analysis to establish their ability to measure the same risk aversion concept. There was a significant relationship between the datasets with a correlation coefficient of .768 (76.8%). A test for agreement between the two datasets using Kendall's coefficient of concordance also indicated a strong relationship between the two variables (W = .745). These observations indicated a strong relationship between the two measures of risk aversion suggesting reliability of

the indicators in the measurement of the concept of risk. The third question on the subject of risk sought to establish what the respondents regarded as risks associated with new sugarcane varieties. This was an open-ended question in which the respondents were required to enumerate in their own words their perceived risks associated with the new sugarcane varieties.

3.3.1 Risks associated with new sugarcane varieties as perceived by respondents

In order to solicit responses on the perceived risks associated with new sugarcane varieties, the study participants were asked if there were any risks associated with the new sugarcane varieties. Those who responded in the affirmative were asked to rate the risk based on an ordinal scale provided in the data collection instrument, namely; low risk, medium level risk and high risk. Analysis of the data showed that all the respondents indicated there were some risks. 52% of the respondents rated the risks associated with new varieties as low, 40.4% as medium level risks and 7.6% perceived risks associated with new varieties as being high (Table 5).

A Welch's Analysis of Variance was carried out to establish whether there were any differences between productivity levels among the different categories. The analysis revealed significant differences (P = .001) between the group means as depicted in Fig. 2. Separation of the means using Games-Howell post hoc test at 5% significance level showed that 'low risk' perception respondents had significantly higher sugarcane yields compared to the group that perceived 'high' risks to be associated with the

new sugarcane varieties (Table 6). Detailed differences and their significance are as illustrated in Table 6.

3.3.2 Risk of changing over to new varieties

The respondents had been asked to rate the extent to which the risks associated with new varieties played a role in their decision on what variety to grow. 35.9% of the respondents indicated that the associated risks did not affect their decision at all, 49% indicated it slightly did so and 15.2% indicated it strongly influenced their decisions on the variety to grow (Table 7).

Risk aversion as measured by perceived risks associated with adopting new sugarcane varieties were significantly related to sugarcane productivity as measured by yields per unit of land; χ^2 (2, N = 198) = 9.25, P = .01, V = .216. Further analysis to ascertain differences between the three groups of respondents in sugarcane productivity was done using Welch's Analysis of Variance. This was an appropriate test to use since the standard ANOVA could not be used as the sample sizes and variances were not homogeneous [27]. Welch's ANOVA revealed a significant (P = 0.001) productivity difference among the groups. The respondents who indicated that there were 'no risks at all' did not differ in sugarcane productivity with those who indicated 'slight risk'. In contrast there was a significant difference at 5% level of significance between 'no risk at all' with 'strong risk' categories as illustrated in Fig. 3. There was also a significant difference between the '*slight risk*' and the '*strong risk*' category. However, there was no significant difference between the 'no risks at all' with the 'slight risk' category on the sugarcane productivity.

Table 5. Perceived risks associated with new sugarcane varieties as reported by respondents

Risk level		Frequency	Percent
	Low	103	52
	Medium	80	40.4
	High	15	7.6
	Total	198	100.0

Source: Field data 2019

Table 6. Games-Howell mean differences in sugarcane productivity between categories based on perceived risks on new varieties

	Low	Medium	High
Low		9.9671	31.1421[*]
Medium	-9.9671[*]		21.1750[*]
High	-31.1421[*]	-21.1750[*]	

(Mean separation using Games-Howell test at 5% significance level) Significant at 5% significance level, Source: Field data 2019*
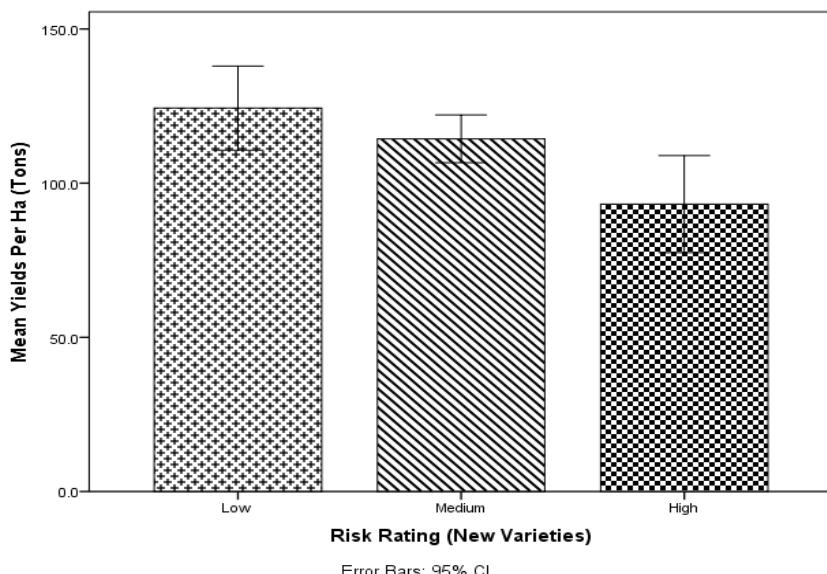
Fig. 2. Sugarcane yields per category based on risks associated with new varieties
Source: Field data 2019

Table 7. Reported risk levels associated with changing over to new sugarcane varieties

	Frequency	Percent
Not at all	71	35.9
Slightly	97	49.0
Strongly	30	15.2
Total	198	100.0

Source: Field data 2019
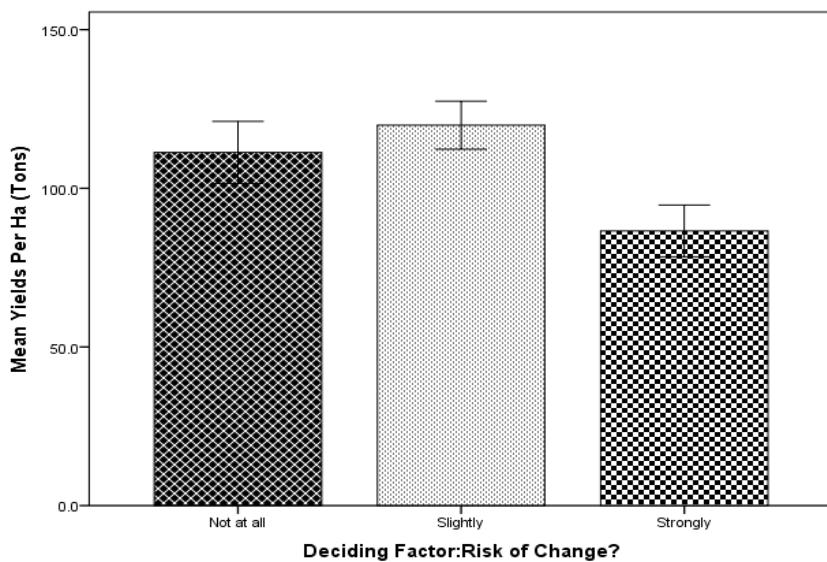
Fig. 3. Productivity per respondents' perceived risks of changing to new varieties
Source: Field data 2019

A post hoc analysis using Games-Howell test at 5% significance level revealed a significantly lower yield from those who viewed risks associated with new sugarcane varieties as being 'strong" (Table 8). This observation suggests that those who associated new sugar cane varieties with "strong risks" may have been more risk averse and probably lost out on the productivity associated with new technologies including new high yielding varieties.

3.3.3 Risks associated with new sugarcane varieties reported by respondents

What did the respondents consider as risks associated with new sugarcane varieties? In order to investigate risks that farmers perceived were associated with the new sugarcane varieties, an unstructured question was posed to them to indicate the risks they thought were associated with the new sugarcane varieties. An adequate writing space was provided for the responses to ensure clarity in the responses. The responses given were analyzed for content. The analysis grouped the responses into six categories. According to the analyzed data,

majority of the respondents appeared skeptical about the ability of the new varieties to tolerate drought (30%) and its ability to form good ratoons (26%). The other areas of concern to the respondents were proneness to weather fluctuation, pests and diseases, floods and low long-term yields as illustrated in Fig. 4.

The current study establishes that drought is a major risk as perceived by sugarcane farmers. Weather fluctuations and floods reported by the respondents suggest that climate related risks are viewed by the farmers as a potential source of harm to the sugarcane enterprises. Kumar and Singh [31] in a study conducted in India found that drought and excess rain were a major source of uncertainty in agriculture. The author suggested that soil type and climate determined productivity risks at farm level. Risks in crop farming can emanate from business risks resulting from variability in crop prices and revenues [31]. Productivity risk is another form of risk. The author suggests that productivity risks are dependent on weather and other external factors, while business risks are associated with market prices as affected by supply and demand.

Table 8. Games-Howell comparison of mean yields among different risk categories of respondents

	Not at all	Slightly	Strongly
Not at all		-9.7314	24.7432[*]
Slightly	9.7314		34.4746[*]
Strongly	-24.7432[*]	-34.4746[*]	

Mean separation by Games-Howell at 5% significance level Significant at 5% significance level,*
*Source: Field data 2019*
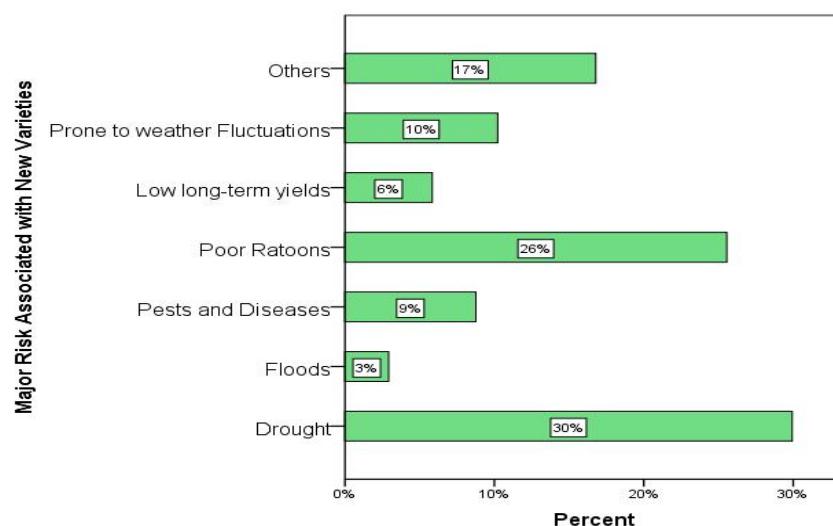
Fig. 4. Risks associated with new sugarcane varieties as perceived by respondents
Source: Field data 2019

Ahsan [32] has explained that risk perception is a subjective evaluation of the probability of a negative outcome. The author explains that an individual risk perception has significant influence on risk taking behavior. In the current study, it is argued that in the absence of risk taking behavior, adoption of new more productive technologies would be adversely affected. On the basis of the significance of farm productivity differences between the categories, it is suggested that unwillingness to take risks could be contributing to low enterprise productivity. According to Winsen et al. [33], individual perception of risks differs from one person to another and is subjective in nature. From a realist perspective real risk can be measured and is therefore objective. Perceived risks therefore differ from real risks as the perceived risk depends largely on the attitude of the farmer towards the risk [32]. According to KESREF [34] the new sugarcane varieties were developed partly to enhance resistance to diseases. The current finding where some farmers perceive that the new varieties may be prone to pests and diseases suggests some discordance between technical information and the farmers' perceptions.

4. CONCLUSION AND RECOMMENDA-TIONS

The study concludes that the scale of farm operation had a significant influence on sugarcane productivity. Small scale farmers and large scale farmers experienced significantly lower yields compared to medium scale farmers. Adopters of new sugarcane varieties benefited from the early maturity exhibited by the varieties as expressed through farmers general comments. Risk aversion negatively influenced sugarcane productivity. Those who perceived that strong risks were associated with new sugarcane varieties recorded significantly lower yields.

The current study is of importance to agricultural extension agents and policy makers. It is recommended that agricultural extension agents invest energy and other resources in training farmers. There is need to increase awareness on productive technologies such as use of improved varieties, crop management practices and risk management strategies in the sugarcane growing zones. At the policy level, there is a need for support of the smallholders in form of inputs; physical inputs in form of credits,

knowledge and skills development for improved productivity.

CONSENT

Individual consent was sought from the respondents prior to administration of the data collection tools.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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