Awarenessof farmers on effect of harvest to mill gap duration on quality of sugarcane(*Saccharum officinarum*)

Abstract

Aims: The aim of doing this research wasto assess farmer's understanding on the impact of time interval from harvest to mill on sugarcane qualityas the basic raw material for sugar production.
Study design:A cross-sectional research design was used
Place and Duration of Study: The study was carried out on July from 19th to 25th 2023 in Kilombero Valley located in the eastern part of Tanzania, between latitude 7 0 42'42'S and longitude 37 0 00'00'E.
Methodology: The study involved two districts Kilombero and Kilosa of which three wards in Kilosa district and one ward in Kilombero were selected, two villages were selected from each ward to form a total of eight villages. A purposeful sampling technique was used to select eighty farmers from 8 villages and 10 employees of Kilombero Sugar Company, forming a total of ninety respondents. A constructed closed and open questionnaire were used to collect information from respondents. The questions were formulated, translated into Swahili and pre-tested and presented to the respondents. The data collected was then coded and analyzed using the Statistical Package for Social Science (SPSS).

Results: The results revealed thatinterviewed respondents about 52.5% were aware of the delay of cutting burnt sugarcane that was between 12 and 30 hours.The majority of farmers, around 70%, reported delays in transportation due to poor infrastructures as well as truck breakdown. The time to transport harvested) sugarcane was between 12and 72 hours. Farmers perception on factors affecting sugarcane quality rated delays in processing and delays in transportation were considered as very important factors, delay in cutting burnt sugarcane rated as important factor and large distance and burning of sugarcane were rated as slightly important factor affecting quality of sugarcane. The impact of these series of delays, respondent explained, that affect sugarcane quality particularly sucrose losses, weight losses, and consequently affect their income Sucrose was mentioned by respondents as quality criteria for selling sugarcane. About 68.8% of the interviewed respondents, described that percentage of sucrose measured from their harvested sugarcane was between 9 and 11%, and the minority 2% obtained sucrose levels was between 12and 14%.
Conclusion: Farmer's understanding on impact of harvest to mill gap is crucial need as supplier of raw sugarcane has to be improved through regular training on factors affecting quality characteristics of sugarcane. The government has to put more emphasize onauthorities. responsible for providing extension service which include, Agriculture officer employed by district council,Sugar Tanzania Sugar Board, Kilombero Sugar Company and National Sugar Institute have been given responsibility of providing extension service to farmers

Key words: *Farmer's awareness, Sugarcane, Harvest to mill, Deterioration, Burning*, postharvest sugarcane

1.0 INTRODUCTION

The sugarcane plant is said to have originated in Papua New Guinea and spread to various parts of the world, including India, China, Europe, the Caribbean, Australia, New Zealand, South and North America, and Africa. Sugarcane is a long perennial grass that thrives in tropical and subtropical climates, reaching heights of 5 to 6 metres. Sugarcane plants are divided into four primary sections based on their morphology: roots, stalks, leaves, and efflorescence.They have multiple stems, which branch at the base to form tillers. As sugarcane matures and increases, the concentrations of sucrose and reducing sugar fluctuate, with sucrose increasing while reducing sugar decreasing.(Dafalla Elfadil, 2015)

Sugarcane has multiple uses, some of which include: utilised as a food for humans that includes sucrose, fructose, and glucose; used as fodder for animals that includes its green leaves, particularly the top portion; applied as fertiliser such as mud cake; used as fuel; and molasses is used in the production of alcohol (Dotaniya et al., 2016) .

According to (Figueroa-Rodríguez et al., 2019), Sugarcane is the world's 12th most significant crop, accounting for 21.1% of total worldwide output by volume. Brazil is the greatest sugarcane producer, accounting for 41% of world output, followed by India at 16%, China at 6%, Thailand at 6%, and the remaining percent split among 100 other countries, including African nations. In Africa, half of the continent's countries plant sugarcane for sugar production. The continent's leading sugar producers are South Africa and Egypt, with Morocco, Uganda, Sudan, Kenya and others.

Sugarcane is an essential commercial crop in Tanzania. It is the primary source of sugar produced for domestic use. Sugar processing companies and contract farmers own the farms where sugarcane is grown. Its production is concentrated in the Morogoro, Kagera, Kilimanjaro, and Pwani areas. Sugar produced is consumed locally and remains inadequate.Tanzania experience yearly sugar shortfall exceeds 300,000 tonnes, mostly due to a small number of sugar industries and insufficient sugarcane area with low productivity(Mourice, 2020), (Andreoni et al., 2020). According to(Sulle, 2017a), (Mourice, 2020),(Kangile et al., 2022). companies producing sugar in Tanzania include Kilombero Sugar Company (KSCL), Mtibwa Sugar Estates, Tanganyika Planting Company (TPC), Kagera Sugar, Bagamoyo Sugar Limited,Mkulazi Holding Company Limited and Zanzibar Sugar Factory Limited (ZSFL) Mahonda, Zanzibar.

Kilombero Sugar Company Limited (KSCL) is Tanzania's largest sugar company. It generates 45 percent of the country's total sugar production (Sulle, 2017). Sugarcane cultivation is regarded as the most significant cash crop generating income in Kilombero valley, where more than 5500 farmers have engaged in sugarcane growing, selling 600,000 tonnes of sugarcane to the company and earning 65 billion/- annually(By Stuff Reporter, 2021)

1.1 Sugarcane postharvest losses

Sugarcane is among perishable crop that requires immediate processing after being harvested. A delay in processing causes sucrose to be converted to reducing sugars. Immediately after harvesting, sugar canes have to be processed to reduce sucrose losses(Xu et al., 2021). Postharvest sugarcane loss is a problem facing farmers and sugarcane millers. Sugarcane quality decline when farmers leave the harvested sugarcane in the farm for a few days or when it takes a long time to transport it to the factory. The longer the time between harvest and milling, the more decline in quality of sugarcane as the raw material for sugar production. This affects sugar recovery and income of farmers and millers(Misra et al., 2022) .The postharvest deterioration process of sugarcane starts from the burning and advances as cut sugarcane is delayed in milling. Post-harvest deterioration causes changes in sugarcane composition. Weight, reducing sugar, and sucrose concertation have been described as properties of sugarcane that are affected, with weight loss ranging from 7-15% because of drying, reducing sugars increasing, and sucrose content decreasing. At the field and factory level, variables leading to postharvest losses include crop maturity, pre-harvest measures such as burning, delay in transporting harvested sugarcane, delay in processing supplied sugarcane, and restricted capacity of the crushing company, among others (Jain et al., 2017).

1.2 Harvesting and Transportation of harvested sugarcane

Post-harvest activities in sugarcane production include pre-harvest burning, cutting burnt sugarcane, transporting and crushing sugarcane. These operations are carried out in sequence starting from pre-harvest burning, cutting, transportation and finally crushing. Harvesting of sugarcane is done by either burning the sugarcane stalk or by green harvesting. Burning sugarcane before harvest aims to remove unnecessary dry leaves (Massawe & Mhoro, 2017). Thetwo types of sugarcane harvesting methods are manual and mechanized. When harvesting by hand, ordinary workers called cane cutters select and take 4 or 5 stalks at a time and then use a machete to cut the stem. Mechanical harvesting involves the use of machines called cane harvesters (Braunbeck & Neto, 2014).The harvesting and transportation operations of a sugarcane face many difficulties and are greatly affected by the condition of infrastructure, weather conditions and machinery breakdown, these factors affect implementation of the planned harvest and transportation plan(Mcrae, 2012) .

1.3 Sugarcane farmers in Kilombero and their challenges

Sugarcane farmers in Kilombero like other farmers producing cash crops faces different problems Various studies have been done indicating challenges faced by farmers. Among issues addressed by researchers are complaints from farmers on low quality of sugarcane. Sugarcane quality is an important parameter used to determine sugar recovery. It is determined based on its sugar content or commonly known as sucrose. Research done by (Sulle et al.,2014) and (Sulle, 2017)at Kilombero valley have indicated that farmers regularly complain on low quality of their delivered sugarcaneas it affects their income. Farmers complain that their measured quality of sugarcane is low below the benchmarking ten percent sucrose. None of researches has attempted to assess on farmers understanding on factors affecting quality of sugarcane as is affected by multiple factors.

1.4 Research objective

The objective of this research was to assess farmers awareness on series of delays from preharvest burning to harvest, from harvest to transportation and from transportation to milling on the quality attributes of sugarcane.as raw material for sugar production

1.5Problem statement and justification

A number of studies have been conducted on the challenges facing sugarcane farmers, especially issues related to sugarcane harvesting, transportation, production, infrastructures, marketing and lack of effective extension services, as well as a poor regulatory framework to monitor weight and measurement of sucrose levels when sugarcane is delivered to the mill(Machimu & Kayunze, 2019), (Sulle, 2017a), (Saenko, 2019). A limited number of studies have been conducted to gauge the extent of farmers' understanding on the impact of harvest-to-mill gaps on sugarcane quality. Conducting this research is important to the scientific community, agricultural communities as well as policy makers. Understanding how the time between harvest and milling affects sugarcane quality attributes is critical and requires a joint effort to understand the factors that affect sugarcane postharvest losses and find scientific solutions that the agricultural community and policy makers can implement to minimize postharvest losses of sugarcane to minimum level.n

2.0 METHOD AND MATERIALS

2.1 Study design and sampling procedure

A cross-sectional study design was chosen because the research aimed at collecting data from many different individuals at a single point in time.The study was conducted between sugarcane growers and employees of Kilombero Sugar Ltd. for data collection in Kilombero and Kilosa districts, of which three wards in Kilosa district and one ward in Kilombero were selected. Then, two villages were selected from each ward to form a total of eight villages. Purposive sampling technique was used because the target was to selectrespondents that are most likely to yield appropriate and useful information **and thus** 80 farmers was selectedfrom 8 villages and 10 employees of Kilombero Sugar

Ltd, forming a total of 90 respondents. Both closed and open questionnaires were used to collect information from respondents. The questions were formulated, translated into Swahili and pre-tested and presented to the respondents. The questionnaires were developed to collect information on respondents' perceptions of the influence of the time interval between harvesting and milling on sugarcane quality.

2.2 Statistical data analysis

Data from the respondents' questionnaires were processed through coding and analyzed using the statistical software package for the social sciences (IBM SPSS version 25.2017). Descriptive statistics was used to summarize data. The data were then presented as frequencies and percentages.

3.0 RESULT AND DISCUSSION

3.1 Demographic information

The demographic information of sugarcane farmers and key informant summarized in the Table 1 and Table 2 below:

Table 1: Demographic characteristic of the sugarcane farmers

Variable	Respondent /category	Frequency	Percent
Gender	Male	55	68.8
	Female	25	31.3
Age	Age below 30	5	6.3
	30-40	30	37.5
	41-50	26	32.5
	Age above 50	19	23.8
Education	Informal education	9	11.3
	Primary education	45	56.3
	Secondary education	14	17.5
	Higher education	12	15.0
Occupation	Farmer	67	83.8
	Agricultural officer	7	8.8
	Representatives from sugar cooperatives	4	5.0
	Employed private /government	2	2.5
Ward	Ruhembe	39	48.8
	Kidatu	14	17.5
	Kidodi	12	15.0
	Sanje	15	18.8
District	Kilosa	51	63.7
	Kilombero	29	36.3

Source: Author

Table2: Demographic characteristic of the key informant

Variable	Respondent /category	Frequency	Percent
Gender	Male	6	60
	Female	4	40
Age	Age below 30	3	30

	30-40	2	20
	41-50	4	40
	Age above 50	1	10
Education	Advanced secondary education	0	0
	Diploma	2	20
	Bachelor	7	70
	Master	1	10
Occupation	Processing engineer	2	20
	Agricultural officer	6	60
	Production supervisor	1	10
	Laboratory supervisor	1	10
Ward	Ruhembe	1	10
	Kidatu	3	30
	Kidodi	1	10
	Ruaha	5	50
District	Kilosa	6	60
	Kilombero	4	40

Source: Author

Respondents were classified into two groups, farmers and key informants. Ten (10) experts were interviewed, including six (06) men and four (4) women. The average age of the experts interviewed ranged from 30 to 50 years old. Their education levels vary from diploma to master's level. Farmers interviewed were eighty (80), of which 68.8% were male and 31.3% were female, their age ranged from 30 to 50 years old. The percent of men famers interviewed was high as compared to women, this can be due system of landownership leading to majority of sugarcane farms owned by men, furthermore, most of the sugarcane production activities are labor-intensive carried out by men. Similar results were reported by(von Maltitz et al., 2019) . Their educational attainment ranges from non-formal education to higher education, but the majority of respondents were literate, which may be due to adoption of a free education policy for primary and secondary education. and increased enrollment rates for high school education. The resultis parallel with(Munisi & Namusonge, 2018), who reported an increased student enrolment in secondary education leading to overcrowded classrooms, shortage of teachers, insufficient teaching and learning materials as an outcome of free education policy.

3.2 Criteria for harvesting sugarcane.

Table 3: Awareness of farmers on maturity duration for sugarcane

Variable	Duration in month	Frequency	Percent
Time (month) taken for sugarcane to mature	7-8	5	6.3
	9-10	13	16.3
	11-12	38	47.5
	13-14	24	30.0
	Total	80	100.0

Knowing the harvesting criteria is an important quality aspect affecting sugarcane production. Interviewees indicated that age, brix, pol (sucrose content) and leaf dryness were used to assess sugarcane maturity (Yesuf et al., 2016). Respondents explained that the age of sugarcane ripening must be from nine (09) month or more. Improper harvesting time adversely affects sugarcane production. This affects the quality and yield of sugarcane, which in turn affects the income of farmers

and millers. Similar results were also reported by (Luel Mengistu, 2014), (Urgesa & Keyata, 2021). Brix (total dissolved solids) and pol (sucrose) ratios of sugarcane are essential criteria to evaluate ripe sugarcane quality. and have a significant impact on sugar production. Respondent described that mature sugarcane should have a brix and pol ratio of more than 18%, similar to the (South Africa Association of Sugar Technologist, 2009)which recommends that brix of sugarcane must be between 18 and 23%. while pol% of sugarcane should be between 14 and 21%.

3.3 Awareness of farmers on effect time interval from harvesting to milling on quality of sugarcane

The information on awareness of farmers on effect of time gap between harvestingand milling are summarized by Table 4 and 5 below

Table 4: Awareness of farmers on time delays from harvesting to milling

Variable	Category	Frequency	Percent
Time delay in Cutting burnt cane	12-18 hours	17	21.3
	19-24 hours	10	12.5
	25-30 hours	11	13.8
	More than 30 hours	4	5.0
	Delay in cutting is not important factor	38	47.5
Time delay in transporting cut cane	12-24 hours	20	25.0
	25-48 hours	18	22.5
	49-72 hours	17	21.3
	More than 72 hours	1	1.3
	Delay in transportation is not important factor	24	30.0
Truck on factory site Waiting time for delivering cane to the mill	Below 3 hours	4	5.0
	3-6 hours	26	32.5
	7-9 hours	5	6.3
	More than 9 hours	7	8.8
	Truck waiting time is not important factor	38	47.5

Source: Author

Table 5: Awareness of farmers on time interval as the factor affecting quality of sugarcane

Variable (factor)	Category	Frequency	Percent
Delay in Cut Burnt Cane	Very important factor	16	20.0
	Fairly important factor	27	33.8
	Important factor	28	35.0
	Slightly important factor	7	8.8
	Not important at all	2	2.5
Delay in processing cane	Very important factor	26	32.5
	Fairly important factor	16	20.0
	Important factor	25	31.3
	Slightly important factor	8	10.0
	Not important at all	5	6.3
Large distance farm-	Fairly important factor	14	17.5

industry	Important factor	6	7.5
	Slightly important factor	35	43.8
	Not important at all	25	31.3
	Fairly important factor	14	17.5
Delay in transportation cut cane	Very important factor	35	43.8
	Fairly important factor	21	26.3
	Important factor	15	18.8
	Slightly important factor	8	10.0
	Not important at all	1	1.3
Effect of burning	Very important factor	2	2.5
	Fairly important factor	4	5.0
	Important factor	5	6.3
	Slightly important factor	22	27.5
	Not important at all	47	58.8

Source: Author

3.4 Time delay in cutting, transportationand processing of burnt sugarcane

The majority of farmers (about 52.5%) reported that there was a delay in cutting burnt sugarcane. Cutting time for burnt sugarcane ranges from 12 to 30 hours after burning Sugarcane like other perishable crop deteriorates as it is detached from the ground where it loses its machinery ability of sucrose formation and become easily attacked by microorganism that destroy the quality of sugarcane. According to(Davies,1998) , it is recommended to cut, transport and crush sugarcane 16 hours after burning, because the act of burning sugarcane stalkdestroy and breaks the protective wax layer, facilitating the invasion of sugarcane stalk by bacteria and yeast that cause sucrose inversion

Farmers who were interviewed between 1.3 and 25 % making a total of 70%, reported delays in transportation. The time to transport harvested sugarcane to the millwas about 12 to 72 hours. Delay in transporting harvested sugarcane to the mill was contributed by truck breakdown, poor infrastructures,fire accident and harvesting too much sugarcane exceeding the given daily ratable delivery (DRD), DRD this is the amount of harvested sugarcane that the contractor is assigned to deliver to the mill per day This delay has a detrimental effect on the quality of the sugarcane.According to(Misra et al., 2022) , reported that transporting sugarcane to the mill for several days resulted in a significant loss of sucrose.

According to(Dafalla Elfadil, 2015) found that the quality of sugarcane is significantly compromised by a 1 to 6day delay in the transport or crushing process. A significant amount of brix lost 0.6-9.8%, sugar content 0.7-9.9%, purity decreased 0.03% - 0.19%, fiber content increased from 0.22% to 1.11% and glucose increased from 1.54. % in 8.66. On a 5-point Likert scale, farmers were asked to rate the factors that affect sugarcane quality, with processing and transportation delays being of great importance, delay in cutting burnt sugar cane, and long distance and burning being slightly important factors. Similar results from farmers in Ndwedwe, South Africa described those delays in cutting, harvesting and transportation are common problems for sugarcane farmers. The sugar industry recommends 24 hours interval from burningto cutting (harvesting) to prevent sucrose depletion. Each one-day delay results in a sucrose loss of 2.2% per day(Zulu et al., 2019). According to(Peng et al., 2021) , in many countries, harvested sugarcane lies in the field without being transported to the factory for 3-5 days due to transportation difficulties, while the sugarcane stays in the factory's warehouse for 1-3 days waiting to be milled. This leads to severe sucrose inversion due to microbialand enzyme activity.

3.5 Impact of time interval from harvesting to milling on the quality of sugarcane

Information on farmers' perceptions of the impact of time between harvesting and milling on

sugarcane quality is summarized in Table 6 below.

Table 6: Awareness of farmers on sucrose percent and its affecting factors

Variable	Category	Frequency	Percent
Sucrose content	6-8 %	19	23.8
	9-11 %	55	68.8
	12-14 %	2	2.5
	More than 14 %	4	5.0
Factor affecting sucrose	Delay in cutting burnt cane	9	11.3
	Effect of burning cane	2	2.5
	Large distance from farm to industry	3	3.8
	Delay in transporting cut cane	48	60.0
	Delay in processing delivered cane	18	22.5

Source: Author

One of the most important quality criteria for the sale of sugarcane known to Kilombero farmers is the sucrose content of the sugarcane. High sucrose content per ton of sugarcane is associated with high income per ton of cane delivered. The sugarcane delivered to the mill must be weighed and measured for sucrose content, as an important quality indicator in evaluating the price per ton, to determine payment against the provisional price offered by the company at the beginning of the harvest based on the market(Sulle Emmanuel, 2015) .

The results indicates that, about 68.8% of those interviewed, showed that the percentage of sucrose obtained by farmers was between 9and 11% and the minority 2% obtained sucrose levels was between 12and 14%. Regardingto factorsaffecting sucrose content, 60% of farmers interviewed said delay in transporting harvested sugarcane to the mill is the most important factor, and the remaining describes that delay in processing, delay in cutting burnt sugarcane, distance from farm to mill and burning of sugarcane contribute in affecting sucrose levels. The result is parallel with (Larrahondo, 2006), who described that sucrose losses are due to pre-harvest burning and the interval between harvesting and crushing of the sugarcane,that result into losing of 0.06-0.15% sucrose for every hour the sugarcane has stayed on the farm or on the truck and an average of 40 hours after burning, cutting and crushing, 1.2 units of sucrose islost

3.6 Interval from burn to crush

The key informant results show that, according to Kilombero Sugar Company, the set interval from burnto crush should not exceed five days (120 hours), exceeding five days will result into rejecting sugarcane due to excessive spoilage. The findings from experts are parallel with research done by(Solomon, 2009) and (Yusof et al., 2000) indicated that the interval between harvesting and crushing should be 3 to 5 days, which is common in most sugar industries. The deterioration of harvested sugarcane varies from place to place depending on storage condition,cut to crush interval, sugarcanevariety and its maturity, mechanical or manual harvesting and exposure to microbes(Peng et al., 2021).

3.7 Farmers' harvesting challenges

Improper harvesting practices, poor infrastructures, climate condition, fire accident,immaturesugarcane are among the problems that sugarcane growers face. Lack of assurance to harvest forces farmers to harvest immature sugarcane. The results of the farmer interview (47.5%) indicated that the maturity period of sugarcane varies from 11 to 12 months. According to (Luel Mengistu, 2014), suitable sugarcane harvest time varies among varieties, ranging from 10 to 16 months depending on early, medium or late ripening varieties. Poor infrastructure, damaged trucks and fires accident were mentioned by interviewees as serious problems faced by

sugarcane growers. Although farmers contribute financially to maintain the infrastructures particularly roads, some infrastructures are still not in good condition. The trucks used to transport sugarcane after harvest arewere worn out demanding regular repair. According to(Isager et al., 2018) , fires accident is a common problem, but intentionally caused by farmers themself. When a fire occurs, large areas are burned, disrupting the normal harvesting process

4. Conclusion and recommendation

The findings show that farmers' understanding of the various factors influencing sugarcane quality from harvest to milling varies depending on the variable. Farmers' awareness ranges from low to high, some have a broad understanding, while others have little understanding on the effects of time gap between harvesting and milling on the quality of sugarcane as raw materials for sugar production. It is recommended that farmers' understanding on variables influencing sugarcane quality need to be increased through frequent training. The government must place a greater emphasis on the authorities in charge for providing extension services to farmers, which include district council agriculture officers, Tanzania Sugar Board, Kilombero Sugar Company, and the National Sugar Institute.

ACKNOWLEDGEMENT

The authors are grateful for the financial support provided by Ministry of Agriculture, Tanzania

REFERENCE

Andreoni, A., Mushi, D., & Therkildsen, O. (2020). *The political economy of "scarcity" in East Africa: a case study of sugar production, smuggling and trade in Tanzania*.

Braunbeck, O. A., & Neto, E. A. (2014). TRANSPORT LOGISTICS OF RAW MATERIAL AND WASTE OF SUGARCANE. In *Sugarcane bioethanol — R&D for Productivity and Sustainability* (pp. 487–504). Editora Edgard Blücher. https://doi.org/10.5151/blucheroa-sugarcane-sugarcanebioethanol_45

By Stuff Reporter. (2021, November 30). Kilombero Sugar ,Tanzania to double its production. *FARMERSREVIEW AFRICA*.

Dafalla Elfadil, A. (2015). *Effect of dry-off period and crushing and extracting delays on sugarcane quality and productivity*. https://www.researchgate.net/publication/280620976

Davies, J. (1998). *The causes and consequences of cane burning in Fiji's sugar belt*.

Dotaniya, M. L., Datta, S. C., Biswas, D. R., Dotaniya, C. K., Meena, B. L., Rajendiran, S., Regar, K. L., & Lata, M. (2016). Use of sugarcane industrial by-products for improving sugarcane productivity and soil health. In

International Journal of Recycling of Organic Waste in Agriculture (Vol. 5, Issue 3, pp. 185–194). Springer Berlin Heidelberg. https://doi.org/10.1007/s40093-016-0132-8

Figueroa-Rodríguez, K. A., Hernández-Rosas, F., Figueroa-Sandoval, B., Velasco-Velasco, J., & Rivera, N. A. (2019). What has been the focus of sugarcane research? A bibliometric overview. In *International Journal of Environmental Research and Public Health* (Vol. 16, Issue 18). MDPI AG. https://doi.org/10.3390/ijerph16183326

Isager, L., Fold, N., & Nsindagi, T. (2018). The Post-Privatization Role of Out-growers' Associations in Rural Capital Accumulation: Contract Farming of Sugar Cane in Kilombero, Tanzania. *Journal of Agrarian Change*, *18*(1), 196–213. https://doi.org/10.1111/joac.12197

Jain, R., Chandra, A., & Solomon, S. (2017). Post-harvest Handling of Sugarcane for high sugar recovery. In *Indian Farming* (Vol. 67, Issue 02).

Kangile, J. R., Mpenda, Z. T., Kadigi, R. M. J., & Mgeni, C. P. (2022). The Effects of Trade Governance on Sugar Trade and Its Landscape of Policy Practices in Tanzania. *SAGE Open*, *12*(3). https://doi.org/10.1177/21582440221121603

Larrahondo, J. E. , B. C. O. , R. M. , and P. M. (2006). An assessment of after harvest sucrose losses from sugarcane field to factory. Sugar Tech. *Sugar Tech*.

Luel Mengistu, H. H. (2014). Determining Optimum Harvest Age of Sugarcane Varieties on the Newly Establishing Sugar Project in the Tropical Areas of Tendaho, Ethiopia. *Advances in Crop Science and Technology*, *02*(05). https://doi.org/10.4172/2329-8863.1000156

Machimu, G. M., & Kayunze, K. A. (2019). *IMPACT OF SUGARCANE CONTRACT FARMING ARRANGEMENTS ON SMALLHOLDER FARMERS' LIVELIHOOD OUTCOMES IN KILOMBERO VALLEY, TANZANIA*. www.mocu.ac.tz

Massawe, B. H. J., & Mhoro, L. (2017). *THE UNITED REPUBLIC OF TANZANIA Ministry of Agriculture Feasibility Study of Green Harvest Technology in the Sugarcane Farming in Tanzania, under the Accompanying Measures Sugar Protocol (2011-13) REPORT*.

Mcrae, S. (2012). *Sugarcane harvest and transport management: A proven whole-of-systems approach that delivers least cost and maximum productivity*. https://www.researchgate.net/publication/283234978

Misra, V., Mall, A. K., Solomon, S., & Ansari, M. I. (2022). Post-harvest biology and recent advances of storage technologies in sugarcane. In *Biotechnology Reports* (Vol. 33). Elsevier B.V. https://doi.org/10.1016/j.btre.2022.e00705

Mourice, S. K. (2020). Climate Change Will Intensify Drought Risk at the Newly Established Mkulazi II Sugar Estate, Mvomero District, Tanzania. *Sugar Tech*, *22*(1), 157–170. https://doi.org/10.1007/s12355-019-00748-3

Munisi, I. S., & Namusonge, G. S. (2018). *ASSESSMENT OF FREE SECONDARY EDUCATION POLICY ON QUALITY OF SECONDARY EDUCATION IN TANZANIA A CASE STUDY OF MERU DISTRICT COUNCIL*. http://www.ijssit.com

Sulle, E., Smalley, R., & Malale, L. (2014).*Opportunities and Challenges in Tanzania's Sugar Industry: Lessons for SAGCOT and the New Alliance Executive summary*. www.future-agricultures.org

Peng, N., Yao, Z., Wang, Z., Huang, J., Khan, M. T., Chen, B., & Zhang, M. (2021). Fungal deterioration of the bagasse storage from the harvested sugarcane. *Biotechnology for Biofuels*, *14*(1). https://doi.org/10.1186/s13068-021-02004-x

Saenko, V. and S. J. K. (2019). *Main Issues of the Contract Farming Structure in Sugar Cane Farming Perspective of Small Holder Farmers in Kilombero Region Tanzania. Sharing Society g*.

Solomon, S. (2009). *Post-harvest deterioration of sugarcane* (Vol. 11, Issue 2).

South Africa Association of Sugar Technologist. (2009). *South Africa Association of Sugar Technologist (SASTA), Laboratory Manual ,in SASTA Method*.

Sulle, E. (2017a). Social differentiation and the politics of land: Sugar cane outgrowing in Kilombero, Tanzania. *Journal of Southern African Studies*, *43*(3), 517–533. https://doi.org/10.1080/03057070.2016.1215171

Sulle, E. (2017b). Social differentiation and the politics of land: Sugar cane outgrowing in Kilombero, Tanzania. *Journal of Southern African Studies*, *43*(3), 517–533. https://doi.org/10.1080/03057070.2016.1215171

Sulle Emmanuel. (2015). Study of Sugarcane Outgrowing at Kilombero. *Http://Www.Plaas.Org.Za/Plaas-Publication/Tanzania-Ksugar-FAC*.

Urgesa, G. D., & Keyata, E. O. (2021). Effect of Harvesting Ages on Yield and Yield Components of Sugar Cane Varieties Cultivated at Finchaa Sugar Factory, Oromia, Ethiopia. *International Journal of Food Science*, *2021*. https://doi.org/10.1155/2021/2702095

von Maltitz, G. P., Henley, G., Ogg, M., Samboko, P. C., Gasparatos, A., Read, M., Engelbrecht, F., & Ahmed, A. (2019). Institutional arrangements of outgrower sugarcane production in Southern Africa. *Development Southern Africa*, *36*(2), 175–197. https://doi.org/10.1080/0376835X.2018.1527215

Xu, F., Wang, Z., Lu, G., Zeng, R., & Que, Y. (2021). Sugarcane ratooning ability: Research status, shortcomings, and prospects. In *Biology* (Vol. 10, Issue 10). MDPI. https://doi.org/10.3390/biology10101052

Yesuf, E., Wolde, Z., Getaneh, A., & Negi, T. (2016). Journal of Resources Development and Management www.iiste.org ISSN. In *An International Peer-reviewed Journal* (Vol. 25). www.iiste.org

Yusof, S., Shian, L. S., & Osman, A. (2000). *Changes in quality of sugar-cane juice upon delayed extraction and storage*. www.elsevier.com/locate/foodchem

Zulu, N. S., Sibanda, M., & Tlali, B. S. (2019). Factors affecting sugarcane production by small-scale growers in ndwedwe local unicipality, South Africa. *Agriculture (Switzerland)*, *9*(8). https://doi.org/10.3390/agriculture9080170