

Full Length Research Paper

Production, consumption, processing and marketing of the baobab fruit (*Adansonia digitata* L.) in Kenya

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Received November 12, 2022; Accepted February 10, 2023

Parts of the baobab tree (*Adansonia digitata* L.) have been considered vital in addressing various nutritional needs and augmenting household incomes. However, limited utilization, processing, and marketing exist in developing countries like Kenya, despite the fruit pulp gaining mass interest overseas as a natural ingredient in various formulations. This study therefore aimed at assessing the status of production, consumption, processing, and marketing of baobab fruit pulp by small holder farmers in selected growing regions. A cross-sectional design was used to carry out the study and purposive sampling was done to identify 250 study cohorts in addition to five focus group discussions and ten key informant interviews. Data was expressed in frequency, percentages and cross tabulation. The findings of the study indicated that the fruit pulp was abundantly consumed by 72% of the respondents while all other parts were consumed to a limited extent. Pulp/seed sweets (*mabuyu*) were largely known and vended by women in the study area. Despite marketing and processing activities being limited, multiple uses of baobab during lean season at the household level were reported. Training on value addition and promotion of value-added baobab products, is necessary for income diversification and increased utilization of the baobab products.

Key words: Baobab products, utilization, superfood, food security, supplement.

INTRODUCTION

Non timber forest products play a significant role in fulfilling several requirements of rural livelihoods, ultimately resulting in reduced vulnerability during lean seasons (Meinhold et al., 2022; Shackleton et al., 2011). Non timber forest products are often vital sources of nutrition and capable of improving dietary diversity in vulnerable poor households (Meinhold and Darr, 2019).

Various communities living in dryer parts of Africa rely on such products as alternative sources of food, during lean seasons often characterized by crop failures and livestock losses (Wanjeri et al., 2020). The baobab tree (*Adansonia digitata* L.), endemic to the semi-arid regions of Africa is a non-timber forest products often depended upon to supplement local diets, nutrition, and a buffer

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during such times of scarcity (Muriungi et al., 2021; Venter and Witkowski, 2013). Further, the baobab tree (*A. digitata* L.) has long been revered for its multiple applications and traditionally considered essential as a source of food, fodder, medicine, shelter, and commercial handicrafts (Buchmann et al., 2010; Gebauer et al., 2016). The nutritional profile of parts of the baobab tree in the supply of essential nutrients is reportedly better than staple food crops (Stadlmayr et al., 2020). This has resulted to appreciation of the baobab tree in international markets thereby putting pressure on baobab pulp exportation to European Union and United States (USA) markets (Fischer et al., 2020). Rapid development of the baobab fruit pulp market has been triggered by the declaration of the fruit pulp as a novel food, by the European Commission (Meinhold et al., 2022), consequently resulting to its promotion as a superfood and its application as a natural ingredient in over 300 formulations (Gebauer et al., 2014). The baobab tree is well appreciated in West African countries, whereby the fruit pulp is incorporated traditionally into diverse cereal gruels or consumed in its fresh state as a snack (Buchmann et al., 2010). Despite the baobab tree gaining mass interest in other countries, there is limited utilization of baobab products in countries such as Kenya. This is largely attributed to increased attention towards the production of staple foods with minimum efforts being directed towards high ecological tolerance indigenous foods (Mc Mullin and Kehlenbeck, 2015) resulting in limited production of innovative high value nutritious products from baobab. When consumed, baobab fruit pulp can provide 54 to 100% of the recommended dietary intake of vitamin C (Asogwa et al., 2021) while consumption of dry or fresh baobab leaves contributes to high calcium and protein intake (Wanjeri et al., 2020). This is a clear indication that baobab products can boost the nutrient uptake and prevent nutritional deficiencies (Momanyi et al., 2019) in rural communities where malnutrition is prevalent. Baobab products are particularly useful during lean seasons in the rural poor communities where they reportedly act as hunger survival strategies (Darr et al., 2020; Legwaila et al., 2011). Formal processing of baobab products is rare in Kenya, with most of the existing baobab products being informally processed and sold on a limited scale (Kaimba et al., 2020; Muriungi et al., 2021). The product largely processed and vended is pulp/seed sweets (*mabuyu*), a candy prepared from the seeds embedded in the pulp (McMullin and Kehlenbeck, 2015) often perceived as food for kids (Kinuthia, 2018). Scarcity in research and innovation on superior processing techniques has largely resulted to a gap in development and commercialization of substantial high quality baobab products for consumption by the general population (Omotayo and Aremu, 2020). Considering minimal employment in the rural areas, commercialization activities of baobab fruit is a worthwhile venture in ensuring the improvement of rural

livelihoods (Meinhold et al., 2022). Parts of the baobab tree (*A. digitata* L.) offer an array of economic benefits as they can be utilized as raw materials for many useful items (Kamatou et al., 2011). The bark of the tree possesses robust fibers that have been successfully exploited in the manufacture of ropes, baskets, and clothing (Chadare, 2010). Such commercial value offers an opportunity for income diversification which contributes to household sustenance since in countries like Sudan, baobab trading activities generates more than half of the annual income of small holder farmers (Adam et al., 2013). However limited knowledge in marketing of baobab products in Kenya due to weak entrepreneurial spirits among the rural communities has impeded successful realization of the full potential of the baobab sector in Kenya (Kaimba et al., 2020). This could be attributed to, inferior processing techniques resulting in poor quality products and socio-cultural factors which contribute to negative consumer attitudes (Jäckering et al., 2019), whereas well-developed baobab products can foster economic prosperity while promoting better nutrition among the rural poor. Hence, there is a need to determine the contribution of baobab products to the diet and in the overall household income towards poverty alleviation (Wanjeri et al., 2020). This study was therefore conducted among different rural communities in Makueni county, Kenya to assess the status of production, consumption, processing, and marketing of the baobab fruit pulp.

MATERIALS AND METHODS

Study design

The study involved a cross-sectional survey of randomly selected small holder farmers, traders, Micro Small Medium Enterprises, and households that were actively involved in utilization of the baobab fruit since in the baobab sector there are interlinkages between and within the value chain (Figure 1).

Study area

The study was conducted in Makueni County located in the southeastern part of Kenya in October 2021, during which a lot of baobab fruit had been harvested for sale or processing purposes. The county lies between a latitude of 1° 35' and 32° 0' South, and longitude of 37° 10' and 38° 30' East (CGM, 2018) and covers an area of 8008.7 km² (CGM, 2018). The county is largely arid and semi-arid with the lower regions receiving rainfall ranging from 250 to 400 mm, while high regions receive 800 to 900 mm (CGM, 2018). Most residents rely on rain-fed farming (Gevera et al., 2020). The county is characterized by a rapidly growing population, water scarcity, falling food production, and low resilience to climatic changes and with all these factors combined result to increased food insecurity, environmental degradation, and high poverty levels (Gevera et al., 2020). The county is divided into six sub-counties which are further subdivided into 30 wards and 60 sub-wards (CGM, 2018). Two sub-counties that is Kibwezi East and Kibwezi West were purposively selected from which two wards from each sub-county were randomly selected as study sites. Authority to

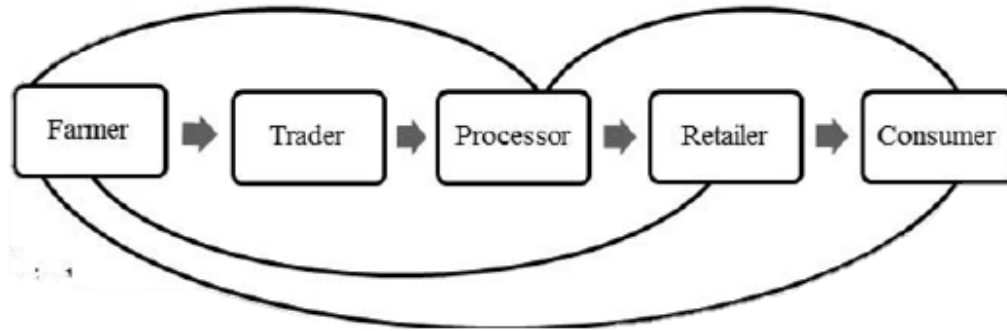


Figure 1. Value chain network of baobab products.
Source: Jäckering et al. (2019).

conduct the survey was obtained from the respective sub-county Agricultural Officers and Head of Wards. The enumerators who participated in data collection process were selected by sub-county agricultural officers.

Sample size

A sample size of 250 respondents was involved in the study to which the semi-structured questionnaire was administered. The sample size was calculated using the method described by Anderson et al. (2016).

$$n = p(1-p)Z^2 / E^2$$

where n is the sample size, p is the proportion of the population involved in the utilization of the baobab fruit, Z is the confidence interval, and E is the marginal error.

Since the proportion of the population involved in the utilization of the baobab fruit was unknown in the study site, the values were then set as $p = 0.5$, $Z = 1.96$, and $E = 0.062$.

Sampling procedure

Purposive sampling was used in getting the sample units in this study. Data was collected from two sub-counties namely Kibwezi East and Kibwezi West, and respondents were further selected from four wards namely Makindu, Mito Andei, Kambu, and Ivingoni/Nzambani. These sub-counties were purposively selected as they represented baobab consumption and processing areas in Kenya since a variety of processed products are known to be available and sold in these areas.

Data collection

A semi-structured questionnaire was validated and used for surveys. Key informant interviews and focus group discussions were also used. The questionnaire was developed by the researchers and loaded in the Open Data Kit (ODK) mobile application to gather information.

Household survey

The survey was carried out in October 2020. Face to face interviews were used to gather information on the socio-demographic and socio-economic characteristics of the study

population as well as the production, consumption patterns, processing, and marketing activities. The questionnaire was written in English, but questions were interpreted into the local dialects of the respondents for ease of communication. Written consents of the respondents were sought once the study objective was fully explained to them before their participation in the study. During the survey, geographical coordinates of the households visited were recorded. The semi-structured questionnaire was validated by pretesting with ten small holder farmers that were not included in the actual study. The necessary adjustments were made and additional questions that arose during the Focus Group Discussion were included in the tool. The questionnaires were administered with the help of field enumerators who were first trained on the operation of the Open Data Kit application, administration of the questionnaire as well as data collection ethics, with each question being explained to the enumerators to ensure that they familiarized themselves with the survey tool.

Focus group discussion

Focus group discussion was used to collect information on the utilization of parts of the baobab tree, processing and marketing of baobab products, and challenges experienced by small holder farmers and small-scale processors and traders. The intention was to bring together small holder farmers, traders, and processors to understand the various ways which parts of the tree are included in the local delicacies, perceptions around the baobab tree and various products processed from the baobab. Five focus group discussions were conducted in Kinyambu and Muuo wa Sombe in Kibwezi West sub-county with each focus group discussion consisting of 11 to 15 participants. The areas were chosen since they were easily accessible by farmers and were part of the baobab processing sites for some women group associations. Key questions were used to guide the focus group discussion, with the facilitator ensuring even participation from all members. Neutrality was maintained while the diverse opinions that were expressed and agreed by all members of the focus group discussions noted.

Key informant interviews

Ten face to face key informant interviews were conducted using formulated key guide questions. The interviews consisted of sub-county agricultural officers, women group leaders in small scale baobab processing facilities, middlemen involved in the sale of baobab fruits and one large scale baobab fruit processor located in Kibwezi. The key informant interviews were conducted in order to provide in depth qualitative information from community experts

Table 1. Socio-demographic characteristics in selected wards of Makueni county.

Variable		Ivingoni Nzambani	Kambu	Makindu	Mtito Andei	Combined (Pooled)
		Percentage				
Gender	Female	43.5	61.9	56.9	44.4	58.3
	Male	56.5	38.1	43.1	55.6	41.7
Marital status	Divorced		1.3	1.5		1.2
	Married	87.0	78.7	70.8	88.9	77.8
	Separated		1.3			0.8
	Single	8.7	8.4	24.6		12.3
	Widowed	4.3	10.3	3.1	11.1	7.9
Level of education	No education	4.3	3.9	7.7		4.8
	Primary	39.1	44.5	23.1	22.2	37.7
	Secondary	56.5	47.1	47.7	44.4	48.0
	Tertiary		3.9	21.5	33.3	9.1

*N = 252, P values = 0.325, 0.123, 0.004, respectively.
Source: Authors

who had knowledge and understanding of the baobab tree, while providing insights on the nature of the problems experienced in processing and other utilization activities.

Statistical data analysis

Data analysis was performed using statistical package for Social Sciences Software (IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA)). Descriptive statistics for mean, frequency and percentages were used to analyze data for consumption and processing of the baobab fruit while cross tabulations were used to determine the relationship between the different study sites and demographic, socioeconomic characteristics, and the marketing aspect of the baobab fruit and products.

RESULTS

Sociodemographic and economic characteristics of baobab utilizing households in Makueni county

From the study, more females (58.3%) were involved in baobab production and processing activities compared to males (41.7%) (Table 1).

The main income generating activity reported by 29% of the households was crop farming with small holder farmers largely depending on rain-fed agriculture. As a supplement to monthly incomes, at least 13% of the respondents were involved in income generation from baobab. However, majority of these reported to derive low income from sale of the fruit and other products (Figure 2).

The study area was characterized by rising levels of poverty with majority of the respondents (81.7%) earning a monthly income of less than 20000 KES, while 18.3% reportedly earned a monthly income of 20000 KES and

above as shown in Figure 3.

Majority of the respondents (49.6%), reported low supplementary income generation from the baobab fruit and high income reported in only 4.4% of the respondents (Figure 4).

Production of baobab products

All the respondents in the study area reported to know the baobab tree with 84.1% of respondents growing at least one tree in their farms. On average each household had at least 1.02 ± 0.166 baobab tree growing in their farm. These households reported that the baobab trees existed in their farms naturally and had not been cultivated. However, negative effect on crop farming in the presence of baobab trees was reported, which claimed that the roots of the tree suck all the water, allowing no food crop to grow around it. Some respondents had no ownership of baobab trees but reportedly accessed them from either surrounding neighborhood or community lands (Figure 5).

Consumption of baobab plant products

Majority of the respondents (98.4%) reportedly use the baobab tree parts in one way or another in their local diets. Baobab fruit pulp was the most consumed part in the study area (Figure 6) while consumption of all other parts was to a limited extent.

Consumption of baobab fruit pulp

In all interviewed households, 87.3% of the respondents

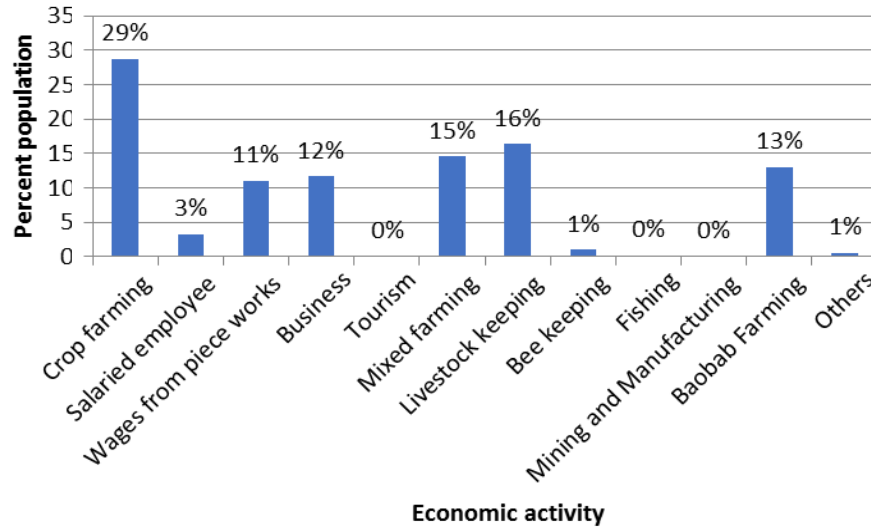


Figure 2. Main economic activities among baobab utilizing households in Makueni county.
Source: Authors

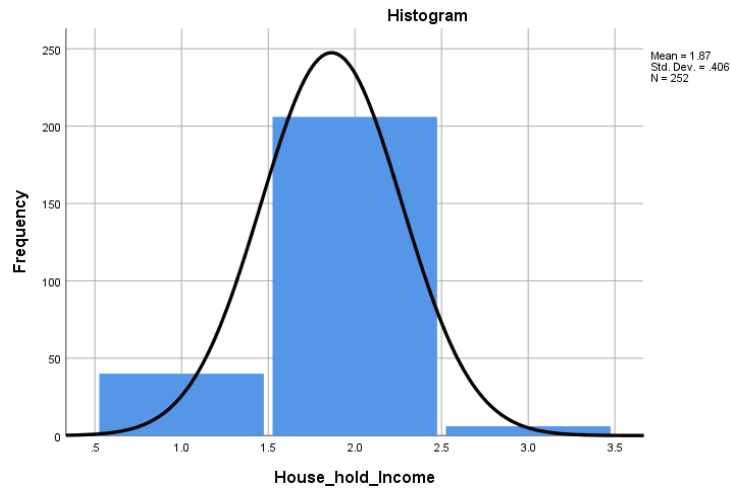


Figure 3. Average household incomes of respondents in Makueni county.
Source: Authors

reported the consumption of the fruit pulp by all family members, 11.1% reported consumption of the fruit pulp by only children (5-12 years) while 1.6% reported consumption by only adults. The frequency of consumption of the baobab fruit pulp is as indicated in Figure 7.

Consumption of baobab leaves

Consumption of the leaves was quite unknown to most of the respondents with 98% considering them as livestock

fodder with only 2% of the respondents reporting the use of the baobab leaves as substitutes for regularly consumed vegetables.

Consumption of baobab seeds

Baobab seeds consumption was also reported, with majority of respondents (56%) reporting that after sucking the pulp covering the seed, the outer shell of the seed is cracked and the inner part (kernel) that has a nutty flavor consumed. Other diverse consumption practices of the

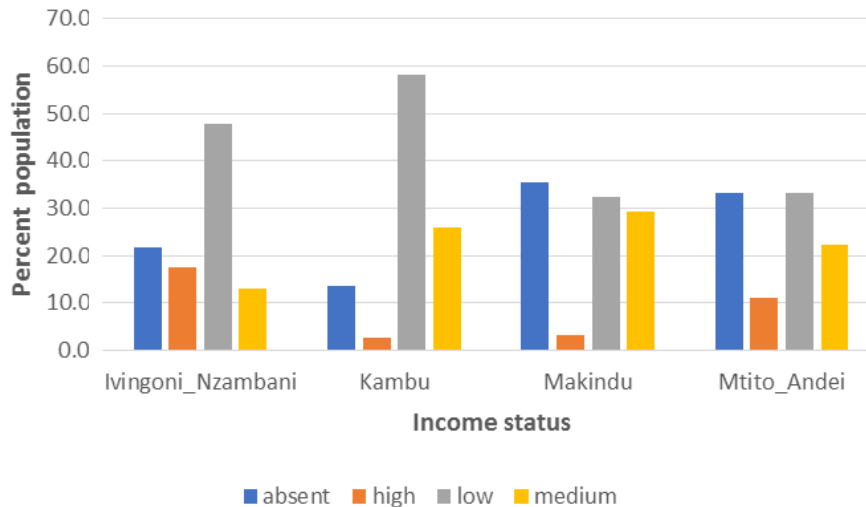


Figure 4. Income generation from baobab products in Makueni county. Source: Authors

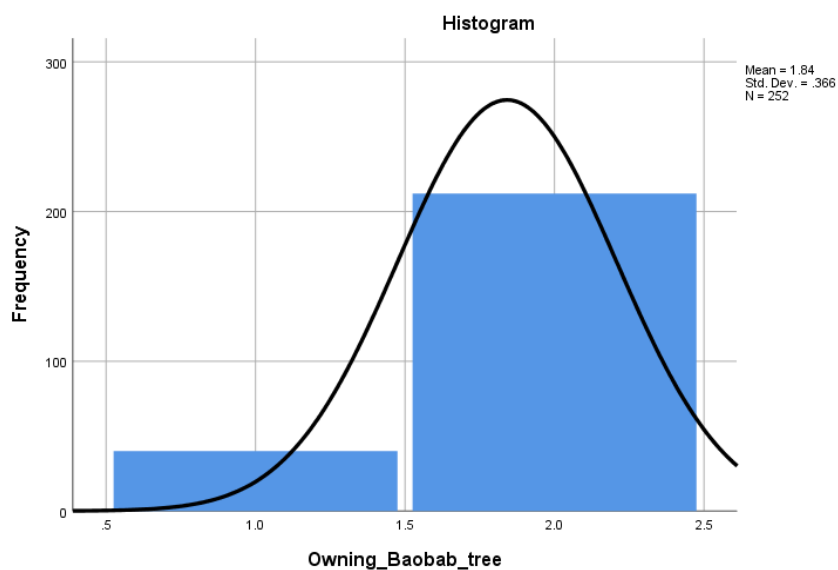


Figure 5. Ownership of baobab trees in Makueni county. Source: Authors

baobab seeds were also reported among the respondents (Figure 8).

Processing of baobab-based products

In the current study, only a small percent (28.2%) were involved in processing products from baobab while the rest were not involved in any form of processing (Figure 9). Baobab seed processing activities are as illustrated in Figure 10.

The baobab fruit pulp was the most processed part in the study area proving useful in manufacture of local brews, baobab jam, baobab juice, pulp/seed sweet (*mabuyu*) and baobab fruit powder as illustrated in Figure 11.

On an annual basis it was established that pulp/seed (*mabuyu*) sweets recorded the highest volume of production (8875 KGS) annually as illustrated in Figure 12, followed by baobab fruit powder (3598 KGS) and the least processed product reported was baobab seed oil since most of the processors lacked the oil pressing equipment and facility.

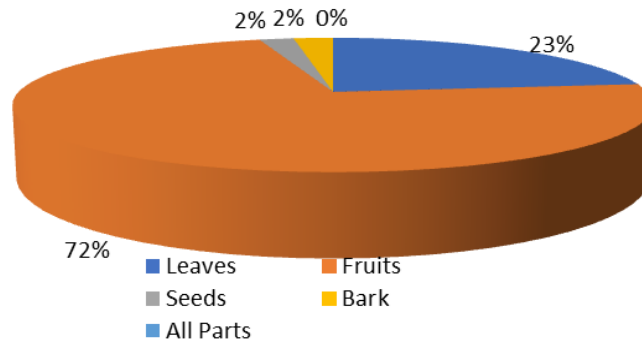


Figure 6. Consumption of baobab tree parts in Makueni county. Source: Authors

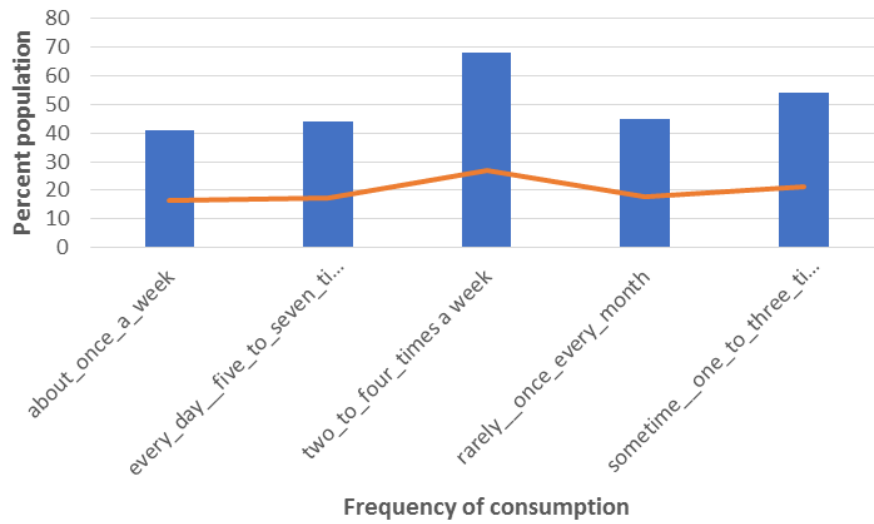


Figure 7. Frequency of consumption of baobab fruit pulp in Makueni county. Source: Authors

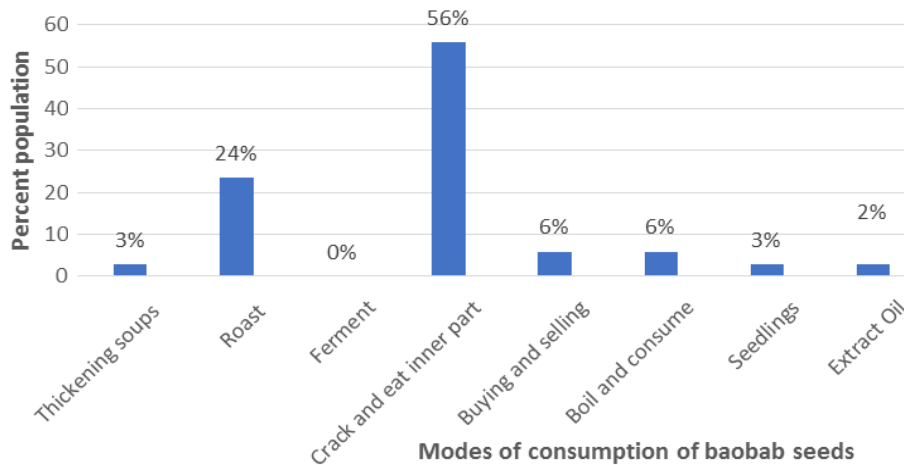


Figure 8. Modes of baobab seeds consumption in Makueni county. Source: Authors

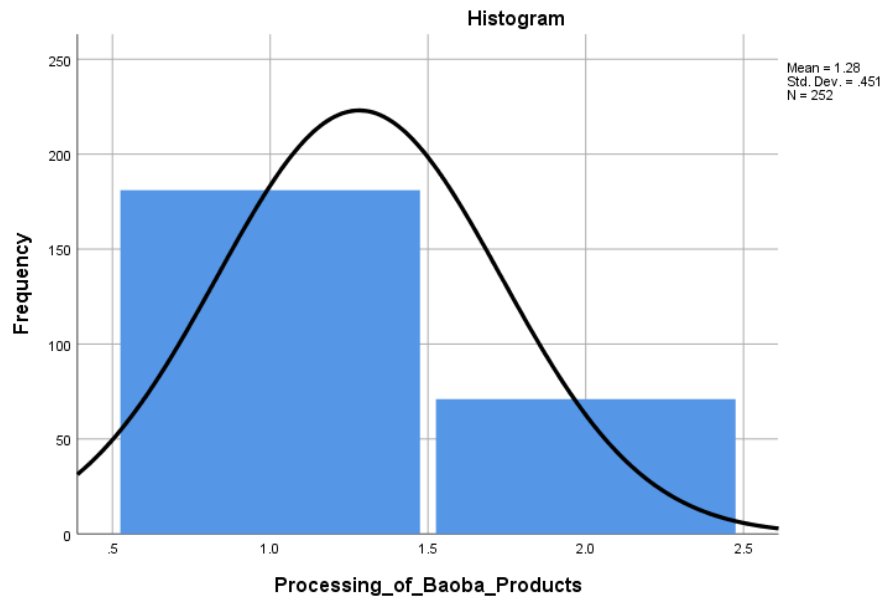


Figure 9. Status of processing of baobab products in Makueni county. Source: Authors

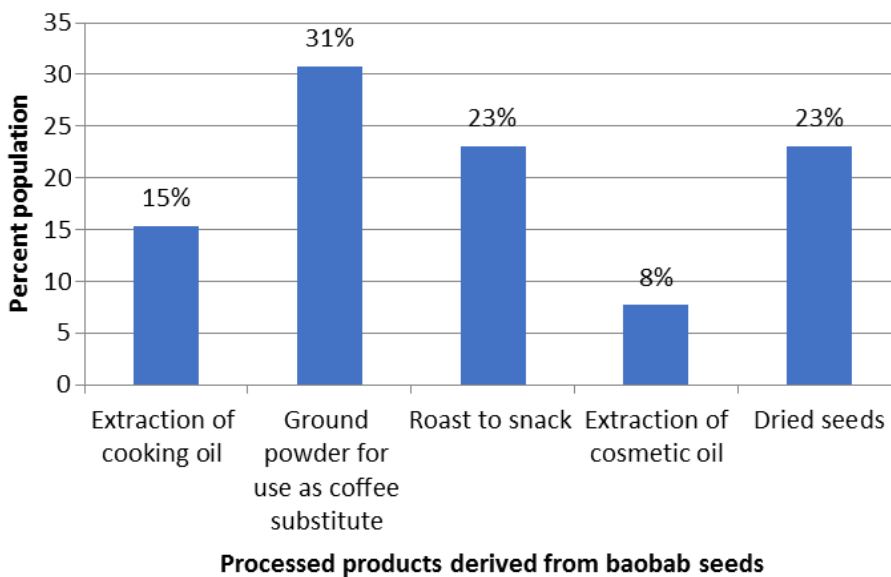


Figure 10. Processing of baobab seeds in Makueni county. Source: Authors

Marketing potential of the baobab fruit

Income generation from the baobab processed products in various study sites within Makueni county is as indicated in Figure 13.

In the current survey, 29.8% of the respondents reported involvement in marketing baobab products with pulp/seed (*mabuyu*) sweets being the most vended

product in packages that cost KES 20. The study area consisted of organized community women groups who besides the sale of pulp/seed (*mabuyu*) sweets were also involved in the sale of baobab jam sold at KES 400/50 g and baobab fruit powder sold at KES 1000/1 kg. The sale of baobab processed products was quite a new venture among majority of the respondents who were reportedly involved in the business for less than five years with an

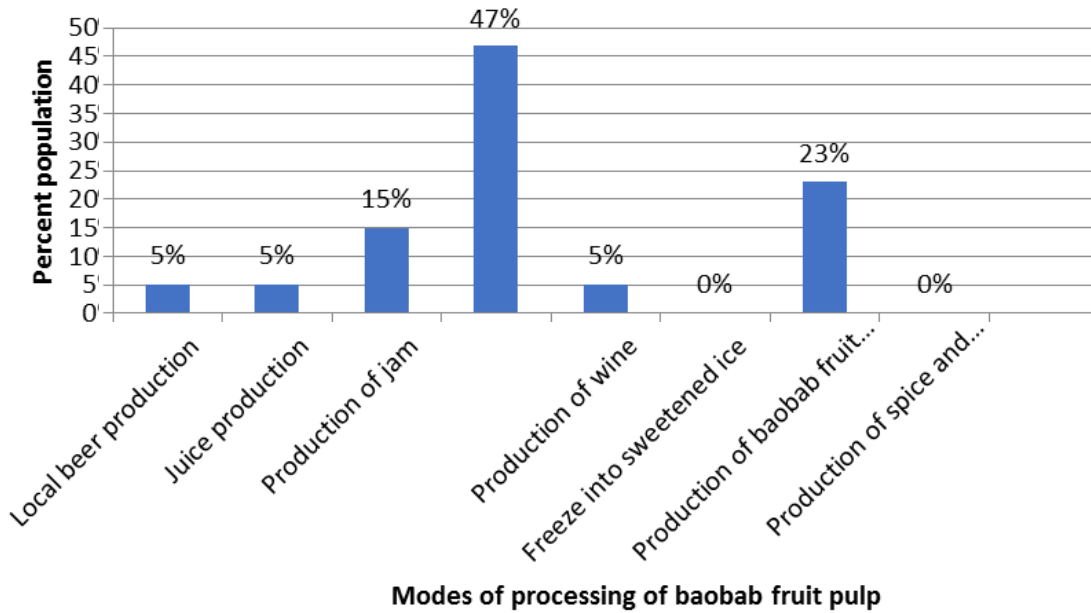


Figure 11. Various products processed from the baobab fruit pulp in Makueni county.
Source: Authors

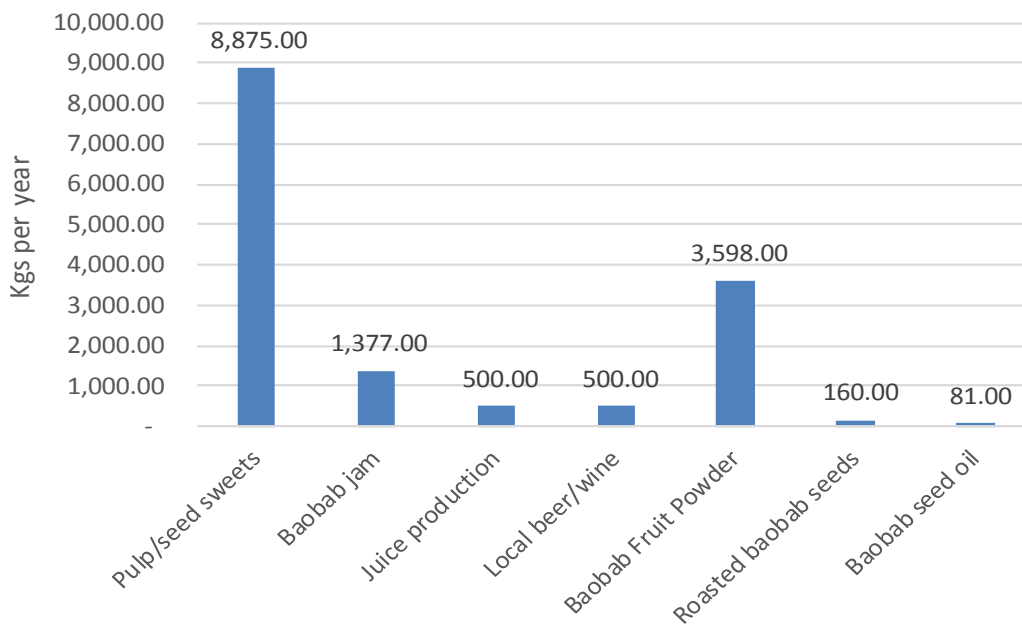


Figure 12. Volume of production in KGS per year of various baobab processed products in Makueni county.
Source: Authors

aim of generating supplementary income. Majority of the respondents (52%) derived meagre profits of less than KES 5000 from the sale of baobab processed while only 5% of the respondents earned profits more than KES 10000 (Table 2).

Various sale avenues of baobab processed products were also reported as illustrated in Figure 14. The importance of the sales of baobab products in the contribution of the overall household income was reported to be less than 20% in 58% of the respondents,

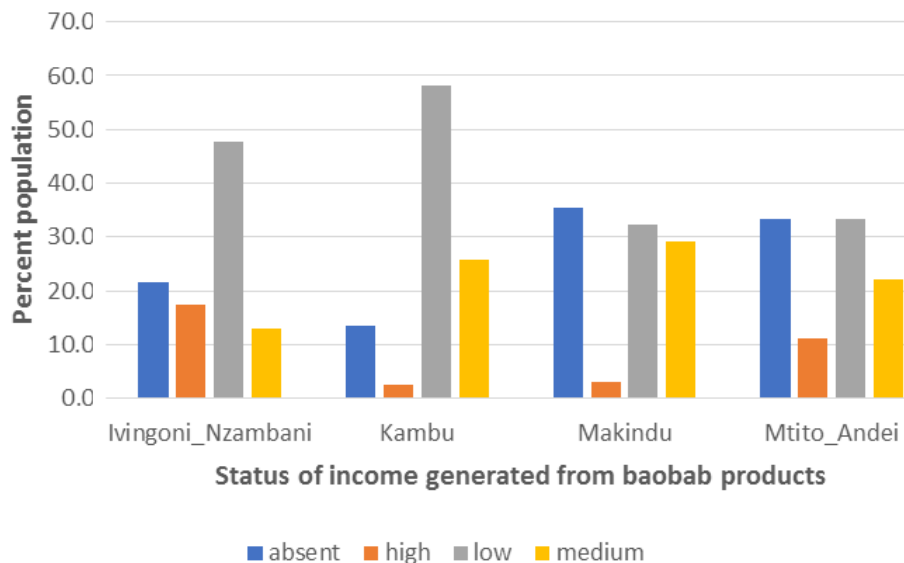


Figure 13. Income generation from the baobab products in Makueni county.
Source: Authors

between 40 to 49% in 28%, between 60 to 79% in 10% and more than 80% in 4% of the respondents.

Challenges faced by baobab processors in the study area

Rural marketers of baobab products face several challenges with 40% of the small holders encountering financial constraints in running their enterprises, 25% reported few customers, 12% reported limited market space while 23% reported limited market returns. Minimum substantial capital developments acquired from the sale of baobab products was reported whereby 70% utilized profits in expansion of businesses, 2% built houses while 28% bought livestock.

DISCUSSION

Production of baobab products

Makueni county has a high density of mature baobab trees (Musyoki et al., 2022). The trees are easily accessible facilitating consumption among the rural poor and encouraging business ventures into various baobab products (Vinceti et al., 2013). However, felling of baobab trees is common since it is believed where the tree exists crop cultivation cannot prevail (Musyoki et al., 2022). Notwithstanding indigenous foods are often considered inferior, they can be exploited in the production of premium specialty products vended in urban markets therefore improving income generation among these vulnerable populations (Darr et al., 2020) consequently

promoting domestication of the trees.

Consumption of baobab products (leaves, pulp, and seeds)

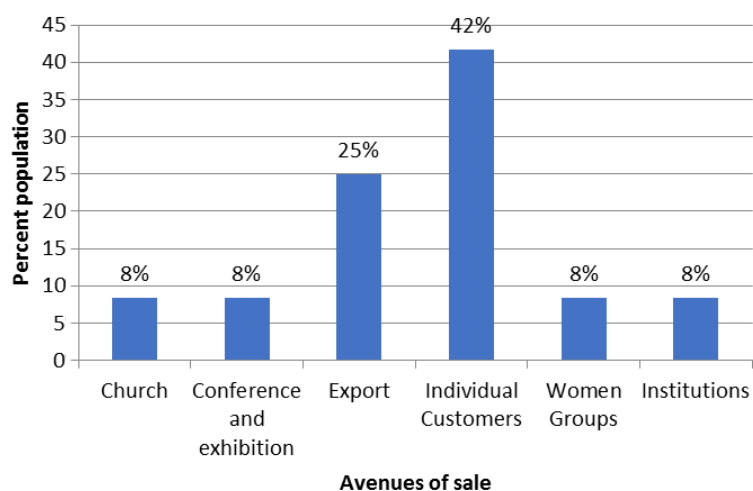
This study corroborates with findings of Wanjeri et al. (2020) who established that households in Kilifi and Kitui counties often consume baobab fruit pulp in its fresh state. Besides baobab fruit pulp being consumed in fresh state, the pulp is incorporated into cereal gruels, soups, ice cream and used in the manufacture of *mabuyu* sweets. Consumption of the pulp comes in handy in the provision of nutrients when the rural poor cannot afford the acquisition of fruits from markets/farms or during pre-harvest periods of the rural staples (Wanjeri et al., 2020). This study and another conducted in Taita Taveta and Kitui counties indicate that consumption of leaves is unknown to people living along Kenyan baobab growing regions (Fischer et al., 2020). This reveals that there is a need for sensitization of communities living along the baobab growing regions on the utilization of baobab leaves as an alternative source of food during periods of food scarcity (Wanjeri et al., 2020) as well as their engagement in baobab leaves value addition activities as part of income generation. Consumption of baobab leaves is a common practice in West African countries, preferably used in local soups and stews to impart a desirable slimy like consistency (Zahra'u et al., 2014). A review by Asogwa et al. (2021) indicates that baobab kernels can be roasted or eaten raw agreeing with the findings of this study. Similar to findings of this study other communities, roast the seeds, grind and utilize the powder as a coffee substitute (Tembo, 2016) or used in,

Table 2. Sales and marketing of baobab processed products in Makueni county.

Characteristic	Response	Ivingoni	Kambu	Makindu	Mtito andei	Pooled
		Nzambani				
		Percent (%)				
Involvement in processed baobab products marketing	No	73.9	83.9	35.4	77.8	70.2
	Yes	26.1	16.1	64.6	22.2	29.8
Frequency of sale of baobab products	2-3 times a week	8.7	13.5	12.3	11.1	12.7
	Everyday	39.1	12.3	36.9	11.1	21.0
	Not involved	26.1	34.2	35.4	44.4	34.1
	Once a week	26.1	40.0	15.4	33.3	32.1
Period involved in income generation	>20 years	0.0	6.5	0.0	0.0	4.0
	<5 years	47.8	24.5	53.8	33.3	34.5
	10-20 years	8.7	6.5		11.1	5.2
	5-9 years	17.4	27.7	10.8		21.4
Main reason for engaging in sale of baobab products	Not involved	26.1	34.8	35.4	44.4	34.5
	Generate major source of income	47.8	12.9	3.1	0.0	13.1
	Generate supplementary income	26.1	52.3	61.5	55.6	52.4
Demand of baobab products	Decreasing	4.3	2.6	1.5	0.0	2.4
	Fluctuating	13.0	20.6	27.7	22.2	21.8
	Not changed	4.3	8.4	27.7	22.2	13.5
	Increasing	56.5	34.8	7.7	11.1	29.0
	Not involved	21.7	33.5	35.4	44.4	33.3
Ability to meet demand	No	52.2	85.8	89.2	88.9	83.7
	Yes	47.8	14.2	10.8	11.1	16.3
Profits	5000-10000 kshs	34.8	38.1	16.9	33.3	32.1
	<5000 kshs	39.1	23.9	47.7	22.2	31.3
	>10000 kshs	4.3	3.2	0.0	0.0	2.4
	Not involved	21.7	34.8	35.4	44.4	34.1

*N = 252; P value = 0.004.

Source: Authors

**Figure 14.** Various sale avenues of baobab products in Makueni county.
Source: Authors

thickening soups (Braca et al., 2018). The kind of utilization of baobab seeds revealed in the study was an indicator of a coping mechanism among the rural poor when calamities strike or during food shortages (Fanzo et al., 2013; Wanjeri et al., 2020).

Processing baobab products

With regards to processing of baobab products, there is a clear indication of how underutilized the baobab tree is in Kenya. Products processed from the baobab leaves were not available in the study area yet, in other countries like Mali and Benin the fresh leaves are sundried and ground into leaf powder for sale (Venter and Witkowski, 2013). Extraction of cooking oil from the baobab seeds was however reported. Baobab seed oil contains a high fatty acid composition with a low degree of unsaturation making it a promising source of vegetable oils (Abubakar et al., 2015). Baobab fruit pulp was the prevalent raw material in majority of processed products. The most actively commercialized products included pulp/seed sweets and baobab jam. The pulp/seed sweets were produced by covering the pulp powder embedded on the baobab seed with sugar and artificial food grade coloring (Jäckering et al., 2019). All these products were being processed by women group associations, confirming the findings of a study conducted by Jäckering et al. (2019) on the main value chain actors being predominantly women. Other additional baobab processed products from the fruit reported in Key Informant Interviews included baobab toffees and biscuits enriched with baobab fruit pulp. Processing of pulp/seed (*mabuyu*) sweets was reported to be done by first cracking the outer shell of the fruit with a hammer or stone, separating the fibers from the pulp covering the seed after which artificial coloring and sugar is boiled in water to form a thick paste in which the seed containing the pulp is added. A small amount of the pulp powder is added, allowed to cool, and packaged in polythene bags or plastic containers in small quantities. The current findings on the processing of *mabuyu* sweets agree with a similar study by Jäckering et al. (2019). Baobab jam on the other hand involved soaking of the fruit pulp for approximately 1 h in water to form a thick paste and sieving to separate the fibers. Afterwards, sugar in the ratio of three quarters the amount of baobab fruit pulp is dissolved in approximately 1 L of warm water. The mixture is then put over high heat while stirring to prevent caramelization and a golden-brown color change serves as an indication of achievement of the correct brix. The high level of pectin in baobab imparts a high gelling capacity in jam and has been utilized as a substitute for commercial pectin (Ndabikunze et al., 2011) forming part of the reason why it is possible to produce jam using the baobab fruit. All these baobab fruit products were processed informally on a small-scale basis using informal equipment such as sufurias, cooking sticks,

energy generated from firewood and measurement estimation using cups and spoons. The least processed product was baobab seed oil due to the lack of proper facilities for carrying out subsequent extraction processes.

Marketing of baobab products

Marketing of baobab-based products is considered to provide an opportune buffer during times of scarcity (Venter and Witkowski, 2013) and serve to alleviate poverty (Venter and Witkowski, 2013). Further to that, since constant drought in the arid and semi-arid lands leads to livestock losses and crop failures, households have delved in alternative sources of food and income (Mwema et al., 2013) such as the sale of non-timber forest foods like the baobab fruit. However, the baobab fruit pulp market in Kenya is still at an infancy stage (Meinhold and Darr, 2019) with most of the baobab products occupying a small market share and being traded by a small number of actors compared to tropical fruits (Kiprotich et al., 2019). The successful commercialization of underutilized indigenous fruits is impeded by the lack of financial resources and lack of entrepreneurial capabilities by the rural processors (Meinhold and Darr, 2019) resulting to minimum returns. Further to that, the lack of interest and acceptance of indigenous fruits plays a big part in derailing the successful innovation and commercialization of indigenous based products (Bvenura and Sivakumar, 2017). This explains why majority of the respondents reported no increase in demand of baobab fruit products with most of the products being sold to individual customers than retailers. The demand for *mabuyu* sweets in particular, is high during school events such as sports or during county events such as agricultural shown as earlier stated by the respondents. In a study conducted by Jäckering et al. (2019), the demand for *mabuyu* sweets is reportedly high during festive seasons such as Ramadan. In the same study rural processors were involved in transportation of *mabuyu* sweets to urban centers like Nairobi (Eastleigh) and Mombasa (Kongowea market) with consumption being largely appreciated by the Muslim population. Some respondents reported an increase in demand of baobab fruit products, particularly the fruit powder as it was considered by most of their clients important in boosting immunity following the rising COVID-19 cases. This is attributed to the substantial Vitamin C levels in the baobab fruit pulp. Vitamin C is an essential micronutrient that contributes to the immune defense and its supplementation can prevent and treat various respiratory and systemic infections (Carr and Maggini, 2017).

Challenges faced in the baobab processing sector

Limited knowledge on the potential health benefits of the

baobab fruit due to inadequate research, thwarts baobab commercialization activities in East African countries such as Kenya (Gebauer et al., 2016). Furthermore, baobab fruit pulp is regarded as a snack or poor man food and not an essential part of the diet (Jäckering et al., 2019), thereby impeding its success in the market. Owing to the fact that local value chains provide low incomes to traders compared to global value chains (Mwema et al., 2013; Shackleton et al., 2007), minimum capital developments are derived from the sale of baobab products. Regulatory frameworks in sub-Saharan Africa do not actively promote development of small enterprises as laws are bureaucratically or weakly enforced (Meinhold and Darr, 2019). In addition, small processors face various challenges in their small-scale manufacture of products such as: lack of proper processing facilities, lack of proper equipment which has consequently derailed the certification of their products and lack of proper training on processing of diverse baobab products that would enable them to earn more income. The lack of financial muscle to facilitate all these activities results in limited value addition and low economic impact (Meinhold and Darr, 2019).

Conclusion

Consumption of the baobab fruit pulp was well appreciated in the area with multiple uses being reported particularly during the recurrent drought seasons. However, compared to West African countries baobab utilization in Kenya is limited, since parts of the tree are not regarded important in the daily diets of the local communities. Processing and marketing activities of various baobab processed products was carried out to a limited scale, but it cannot be ignored that women in the study area have actively taken part in the processing and trading activities of baobab products. Through the conglomeration of women into community groups, they can earn additional income while others depend solely on the baobab processing activities. Finally, action is needed to expand markets for the rural baobab processors since most of them are not able to access the right markets for their products causing them not to reap immense benefits from the baobab products.

RECOMMENDATION

Research organizations should consider creating awareness on the nutritional benefits of various parts of the tree to promote incorporation of parts of the baobab tree (leaves, seeds, and fruit pulp) into the local diets of communities living along baobab growing regions. For instance, sensitization of such communities on consumption of the baobab leaves will lead to appreciation of the leaves as an alternative source of food and income when all other crops have failed and

subsequently promoting food security. Empowerment of community groups through adequate training will serve to improve their knowledge on baobab processing operations. Capacity building through equipping small holders with sufficient resources necessary for production of high-quality products with a higher market value will ultimately result to better income. In return, this will result to improved standards of living among them noting that in the rural areas women have a role in supplementing household incomes and even being bread winners. Provision of credit services, market space and empowering the women associations involved in processing will serve as a major driver towards promoting the consumption, processing, and marketing of baobab products.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors greatly appreciate the field enumerators, sub-county officers and farmers who participated in the study. This work was financially supported by The European Union through ESSA (Earth Observation and Environmental Sensing for Climate-smart Sustainable Agro-pastoral Ecosystem Transformation in East Africa) a project under DeSIRA (Development of Smart Innovation Through Research in Agriculture).

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