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Exploring the Potentiality of Producing Sustainable Gum Arabic: Case of Sheikan Locality, North Kordofan State, Sudan

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ABSTRACT

Gum Arabic is a critical source of livelihood in rural areas of Sudan and a key economic commodity. This study investigates the potential for sustainable gum Arabic production in Sheikan locality, North Kordofan, Sudan. Using participatory Rural Appraisal (PRA), structured questionnaires with 302 households, and focus group discussions, the research assesses household participation, gum resource potential, and production challenges. Results indicate that 93% of the respondents own gum gardens with gum contributes 38% to household income. Additionally, from targeted respondents 37% of the respondents have less than 10 years experiences in gum Arabic activities. Based on respondents' perception the average gum production of tree/season was (2.79 kg). However, limited participation by youth, inadequate infrastructure, and environmental constrains hinder gum production sustainability. The study recommends that integrating indigenous knowledge with modern practices, expanding youth involvement, and enhancing policy support to secure a sustainable supply of gum Arabic.

Keyword: *Acacia senegal*, livelihood, North Kordofan, Gum Arabic, Sheikan,Subsistence.

1. Introduction

Gum Arabic belt is one of the most important forest types in Sudan [1], it spans the traditional rain-fed agricultural areas of Western and Central Sudan that include Great Kordofan covering about 49.3% [2]. Gum

Arabic tree is a multipurpose tree that generates income, provides household wood energy, building materials, fodder and enrich soil fertility through biological nitrogen fixation [3, 4]. Gum Arabic in Sudan produce from *Acacia senegal* [5, 6] and other numerous trees species in the region that also produce gum such as *Acacia seyal* (Talh*), A. mellifera, B. papyrifera* and other [7, 8], but gum from these trees are less valuable compared to *A. senegal* [8]. Gum production is a mast of family economy in rural areas of Sudan belt [9] and contributes 10-50% to rural household income compared with other income sources [2, 10]. Additionally, about 60% of total gum production in Sudan come from Kordofan region compared to other regions in the country [8], and in total contributes about 95% of the world production [5, 11], as well as control 80% of world market [12].

Gum is obtained from the stem and branches of *A. senegal* and *A. seyal* [5, 13] by tapping using sunki and traditional axe during October/November of each year [12]. Consequently, a study by [5] recommended that sonki is most appropriate tool for tapping *A. senegal* compared to other traditional tools, while gum production maybe tapped when the tree attains the age of 3 years, and gum yield and quality become consistent when the tree reached 5 years old [12]. Even though gum production is affected by numerous factors such tapping tools, direction and tapping position [12], but gum yields positively correlated with tapping intensity [14]. These challenges include declining productivity, limited market access, and monopolization of trade by middlemen [11, 15]. The great potential for gum production and marketing implies that the implementation of appropriate policy and resource management measures could enhance the socio-economic and ecological gains from the subsector. Consecutive drought years were negatively affected by tree cover and gum producing trees in the gum belt [16, 17], in addition to climate change, fluctuations in rainfall intensity, fire, overgrazing, and agriculture expansion are main drivers reducing gum belt area and gum yield [18], while negatively impact small-farmers and local traders in rural areas [12]. As observed in some areas gum tree areas recovered, but in other trees were cut down for competing land use as well as for firewood, building materials for own use or selling [4].

Despite Sudan contributing significantly to global gum Arabic supply [11], sustainable production is increasingly threatened by land use change, decline youth involvement, and inadequate policy support. While previous studies addressed economic contributions, tapping tools [10-12, 17, 19), gum value chain [13, 17, 18, 20], gum uses [21-23], tapping methods and direction [5, 24, 25], only few have focused on integrated sustainability linking ecological potential, socio-economic challenges, and policy gaps. Therefore, this study aims to fill the gap by evaluating the existing gum resource potential and assess the importance of gum Arabic to rural households, with focus on documenting the participation of rural communities in gum Arabic production activities and identifying the challenges confronting gum production. The findings of this study will help the policymakers to draft clear guidelines in improving and sustaining gum production in the area while providing databases for scientists in the field for future research.

2. Materials and Methods

2.1. Study area

North Kordofan State lies between latitudes 16˚ 38″ N and 12˚ 14″ N and longitudes 26˚ 46″ E and 32˚ 22″ E. Sheikan locality is composed of four districts including Kazgail, Abu Haraz, Khor Tagget and Umashira, (Figure 1). Elobeid city is the capital of North Kordofan State, containing the biggest crop market for gum Arabic commodity in the world. The population of Sheikan locality is about 1,430,000 inhabitants, from which 42.2% are women. The average family size is about eight individuals per household. In the past family size was considered as a measure of wealth and status, but nowadays due to the prevailing of harsh economic conditions, there is a tendency towards small family size. However, rural communities in the area mainly depend on agriculture, local trade, and collection of non-wood forest products (NWFPs) such as gum, fruits [8, 11].

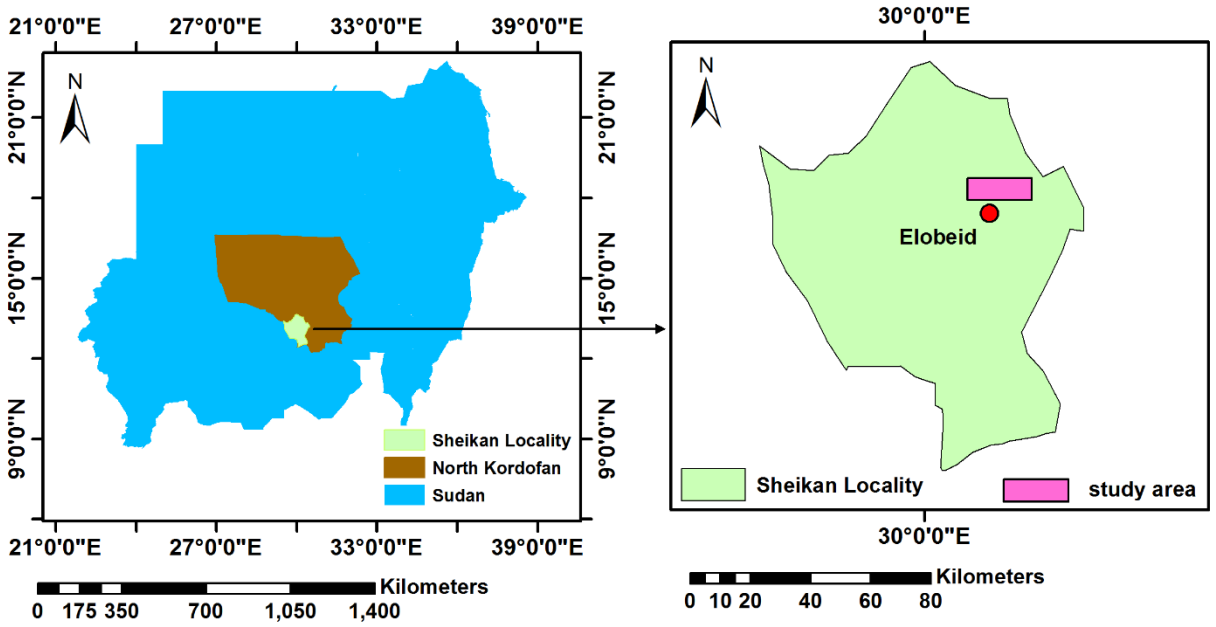

Figure 1. Study area, Sheikan locality, North Kordofan State

2.2. Data collection

A multistage sampling technique was used, where 13 villages across three districts were selected based on presence of gum Arabic producer associations. From an estimated 3,020 households (based on 2008 census), 302 were randomly selected (approximately 10% from each village). Though based on 2008 data, the population trends have remained stable, as confirmed by local administrative records. Data collected from the respondents using a pre-tested structure questionnaire and focus group discussions.

2.3. Data analysis

All the data collected from individual face-to-face interview and group discussions were compiled and organized into meaningful tables for analysis. Descriptive statistics such as mean, frequency, percentages were calculated as well as correlation. The analysis was carried out using Statistical Packages for Social Sciences (SPSS, version 22.0), OriginPro 2024b and Microsoft Excel.

3. Results and Discussion

3.1. Demographic characteristics of households

The farmers in rural areas produce multi-products in one farm. However, households owned gum gardens and agricultural crops in the same land. The average size of gum gardens as compared to crop lands are described in (Table 1), it is clear that the farmland is almost divided equally into two parts, whereas part for gum production and the another for agricultural crops production. These findings are in line with study conducted by [26] who reported that the priority for land utilization is given to food and cash crop production then gum production. Conversely, [27] described that farmers have developed mitigation strategy to reduce risk and conserve natural resources by keeping *A. senegal* stands together with agricultural crop production. Our findings also reflect the existence and/or absence of infrastructure and basic services in the study area from which it is obvious that there is a lack of basic services and village development infrastructure (Table 1), though these issues could impact gum storage and transportation in rural areas. So, an effort is needed to develop basic infrastructure to grantee sustainable supply and appropriate productivity and similarly reported by [28]. Additionally, gum producers in the area face numerous challenges and constraints pertinent to gum production. In the meantime, similar limitations and constraints have been addressed in other parts of the state [4], while [29] highlighted that indigenous knowledge is among factors affecting gum productivity.

3.2. Current situation of gum gardens

The majority (93%) of the respondents owned gum Arabic tree gardens (Ginaina), although not all used for gum production (Figure 2). It is worth mentioning that males constitute 83% of those who owned gum gardens compared to 17% females (Figure 2). This result indicates that, males are the main actors and dominating the

ownership of gum gardens, but some women still were involved. On the other hand, due to lack of infrastructure, storage facilities, low price, and other local constraints, gum producers reduce the tapping of gum trees while some converted to crops production. Several studies addressed these challenges which encourage local producers with the help of related institutes to establish gum Arabic producers' associations (GAPAs) [27, 11]. These associations work collaboratively with producers to improve their skill in tapping, collecting and marketing their products. Although most of the issues have been addressed, however, lack of finance during the tapping and collection period remains the main challenge that impacts gum production sustainability in the area.

3.3. Experience in gum Arabic production

Experience is important factors that can affect production and sustainability of gum. We found that 37% of respondents have less than ten years' experience in gum tapping and production (Figure 3). Although, this experience is related to the age of respondents. However, a study by [14] reported that gum production activities are elders' jobs while the new generation are not participating in gum production. The involvement of new generation in gum activities leads to the importance of the product and its contribution to the local community. Meanwhile less participation of younger age groups in gum production activities could lead to less sustainability of knowledge transformation and reduce the experiences of new generation in particular field. The less attention of young generation in gum production activities could be from low and unstable economic return, labor-intensive and physically demanding, lack of modernization and innovation, limited access to land resources, migration and urban aspirations, as well as lack of extension services and training. These factors significantly impact the interest of local producers in gum production and its sustainability.

3.4. Parameters of gum Arabic production

The important parameters of gum Arabic production, which were considered essential for sustainable supply of gum Arabic are summarized in (Table 2). We found that the average area of gum owned by small farmer, number of trees in feddan, number of pickings per season, tree production/season and gum production in kg per feddan was 32.84 feddan, 28.68 tree, 6.05-time, 2.79 kg, 88.84 kg, respectively (Table 2). Though decreasing gum production per tree significantly impacts the total production per season. The picking time and amount of gum produced by tree/year have been similarly reported by [5, 30, 31]. However, sustainable gum production is due to a promising resource base [32]. But the number of trees per feddan is less compared to some parts which could be from conversion of land to cash crops production whereas it contributes significantly to household income compared to gum production and its long process. Therefore, enrichment of tree cover programs is essential, and plantation activities are needed in the area to increase awareness and vegetation cover. The gum production per tree varies which is influenced by numerous factors such as tapping time, tree age and number of branches as well as tapping direction [5, 31]. Consequently, a significant variation was observed in gum production per feddan across area, these findings confirmed that, number of trees, age, crown cover, number of branches, tapping tools and direction are main drivers of increasing and decreasing gum production per area. Similar parameters have been addressed by several researchers [5, 11, 12, 31].

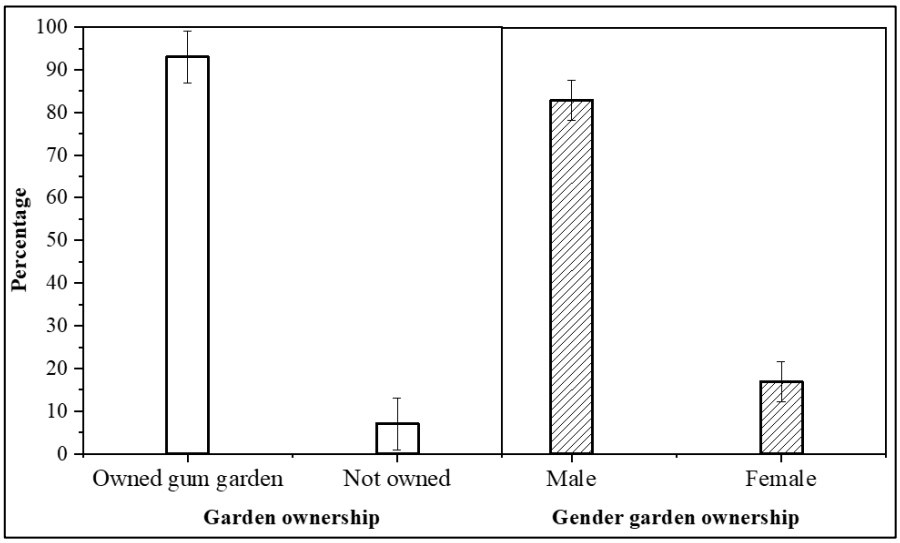

Figure 2. Gum Arabic garden ownership

Table 1. Village average gum garden, average farm size, services and problems

Village	Average Gum Garden size	Average farm size	Available services	Main problems/challenges
El Sonut West	2.70	2.44	Drinking water, health centre, basic school	A few ones solved by village committee
Farag allah	2.27	2.07	Drinking water and basic school	Presence of many Herder
Abu Khirais	2.47	2.31	Store	Gum burglary
El Domokia	2.52	2.20	2 water sources (donkey), basic school, health centre, 2 mosques, electric generators	Camel grazing and no access to credit
El- Kara	2.50	2.29	No water sources, basic school, health centre, private electric generators	No access to credit
El-Himaira	2.67	3.00	Water store, store building	Camel grazing and water access
Om Higleeg Elbiremia	2.67	2.67	Hafir, basic school, tractor	Shortly access to water and credit
Um Sharaity	2.36	2.00	Hafir, basic school, tractor	shortly access to water and credit
Omgawawa	2.16	2.21	Hafir, basic school, health centre	No access to credit
El Taloshi	2.40	2.13	Hafir, basic school, health center	No access to credit
El Massara	3.00	2.57	Water pumps	No access to credit
EltadamonBotai	2.67	2.55	One donkey, mixed basic school and health center	No access to credit
El giraiwidMema	2.48	2.33	Water transported by tankers, mixed basic school health center	No access to credit

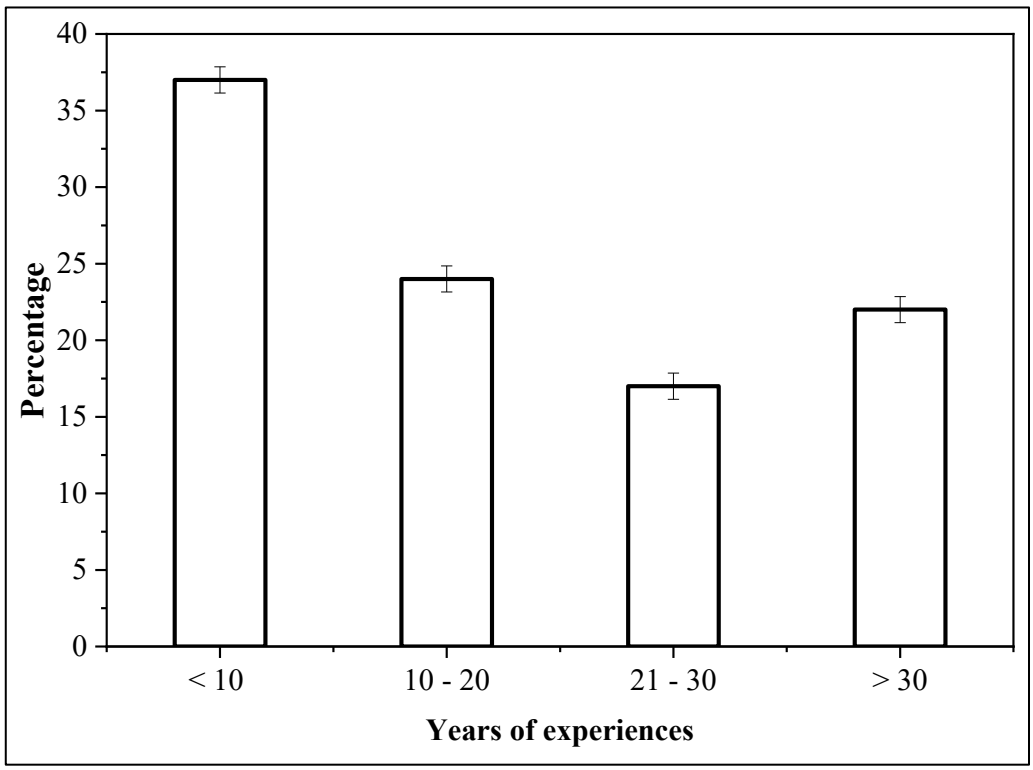

Figure 3. Respondents experience in gum Arabic production

Table 2. Parameters of gum production in the study area

Parameters	Min.	Max.	Average	Std.
Area of gum garden in feddan	1.75	262.50	32.84	2.14
No. of Trees/feddan	1.14	228.57	28.68	1.7
No. of Pickings/season	2	8	6.05	0.07
Production of one tree/season	0.29	8.09	2.79	0.08
Production in kg/feddan	2.57	831.81	88.84	7.37

3.5. Uses and benefits of A. senegal tree

The study found that there is rich indigenous knowledge with regards to benefits and services provides by *A. senegal* tree to local communities. Traditional knowledge extends to specification of different parts of the tree and uses. The findings showed that 60% of the respondents use gum in their food such as edible food, drinks and juice. However, 25% of the respondents stated that other parts of the tree such as leaves and fruits are used as fodder while 70% stated that they use as medicine, as well as 42% of the respondents mentioned that tree bark is used as injury healing and cure. These findings are in line with [33-35] who reported that gum tree parts such as leaves, bark, fruits have an important role in traditional medicine, for example stomach pain, diarrhea and injuries. Additionally, based on producers' perception 80% of the respondents stated that poles from *A. senegal* trees are used for construction and 90% used as building materials and fuelwood. Local communities cut *A. senegal* tree at the end the rotation cycle and use it in form of fuelwood, charcoal, building materials and tool handles and similarly reported by [36]. With reference to the local community's knowledge in the area 72% of the respondents think that the tree provides environmental services while 65% of the respondents think it is important for shade and fodder which indicates the awareness of local communities on environment and its conservation. Moreover, rich indigenous knowledge of gum producers on environment was reported by [37].

3.6. Factors affecting gum Arabic production

The findings indicate that gum production is negatively affected by both biotic and abiotic factors. However, biotic factors mentioned by respondents include pests and diseases, and livestock grazing, whereas abiotic factors include environmental, fires, socio-economic, and institutional factors. The majority of

respondents (80%) stated that strongly greed that pests and diseases outbreak are affecting gum production negatively. It is worth mentioning that main pests of *A. senegal* stands are tree locust and long horn beetles. However, 90% of the respondents agreed with effect of grazing on the vegetative foliage of *A. senegal* tree as well as natural regeneration and consequently might affect gum productivity. On the other hand, 78% of the respondents stated that frequent fires on bushes represent another constraint on the production of gum Arabic, while 87% reported that rainfall and distribution is the main abiotic factor threatening the sector. In the meantime, 83% of the respondents mentioned that drought and desertification significantly impact gum production. Of which 48% of the respondents confirmed that lack of basic infrastructure are main reason for weakening the sector. These factors are significantly limiting gum production and its sustainability in the area and significantly impacting country supply.

Our study found that there are two types of labor engaging in gum Arabic harvesting such as family labor and hired labor. However, 67.1 % of the respondents stated that they hired labor in harvesting and other gum production activities, while family labor was found to be a case of agricultural crops production. Although it could be family members are engaging in other agriculture work, or they have less experience in tapping and harvesting gum. This is due to the fact that the tree is thorny and gum tapping and harvesting is quite difficult task. A study by [12] found that gum harvesting usually comes in the time where they do not interfere with agricultural activities, while [8, 38] who reported that household with hug family member tend to collect more non wood forest products within a short time compared to less family members, though less family members with huge amount gum trees can hire labor for gum tapping and harvesting. Additionally, there are many institutional factors influencing gum production of which 72% of the respondents stated that prices and price setting, 55% credit facilities, 40% policies and legislation, and 80 % fees and taxes on gum Arabic commodity. A similar study by [39] reported that pricing policy is the key factor behind low gum productivity in Sudan. It is worth mentioning that small farmers are rarely able to provide guarantees for credits, therefore, they are greatly dependent on informal credit (shail) which acts as constraints and prevent farmers from receiving good prices for their gum because the price is predetermined by local credit providers.

Moreover, 38% of respondents stated that trees can produce gum at 3 years old (Figure 4). However, a study by [5, 13] reported that tapping age of gum tree depends on method of establishment/plantation and availability of rain and the optimum age varies between 3-5 years. Most respondents 62.8 % stated that they use recommended tapping tools in tapping gum tree. This result indicates that in spite of the effort exerted to promote the adoption of the recommended tools, which is characterized by less harmfulness to the tree and producers. Conversely, similar findings by [12] reported that research centers have to exert more efforts in extension to attain adoption of research findings. In the meantime, there is a need for more extension packages to minimize practices of the axe in tapping and reduce the risk of gum tree life span.

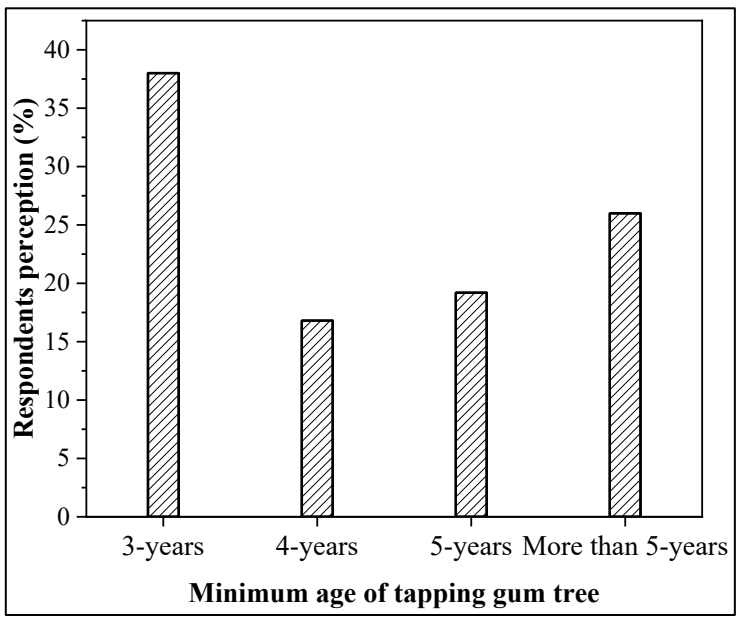

Figure 4. Respondents' perception on first tapping of gum tree in the area

3.7. Correlation between different sources of household income

Correlation analysis between various income sources as shown in (Table 3) indicate a highly positive significant correlation (α = 0.01) between income generated from gum Arabic and crops (r = 0.821), gum Arabic and livestock (r = 0.727), as well as income from livestock and other NTFPs (r = 0.794). These findings are in line with [40]. The main occupation of households inhabitants in the area are farmers, herders and gum Arabic producers with high experiences in agriculture activities, this may be the reasons behind the positive relationship between their income sources. The positive relationship between off-farm and crops income may be due to their second occupation activities.

Table 3. Correlation between different sources of household income in study area

Variable	Gum Arabic	Crops	Livestock	NTFPs	Fodder	off-farm income
Gum Arabic	1					
Crops	0.821**	1				
Livestock	0.727**	0.235**	1			
NTFP s	0.582	0.112	0.794**	1		
Fodder	0.188	0.314	0.416	0.0	1	
off-farm income	0.111	0.253**	0.283*	-.072-	.165	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4. Conclusion

Sustainable gum Arabic production in Sheikan is achievable by aligning traditional knowledge with targeted intervention. Tapping should be begun when trees are 3 – 5 years old; experienced tappers, preferable trained youth, can ensure better yield. Supply chain weaknesses including price instability, credit access, and pos-harvest losses need urgent reform. Future studies should quantify village-level annual yields and track production trends longitudinally.

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6. Conflict of Interest

It is declared that there is no conflict of interest among and between authors.

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