

Research Application Summary

Modeling factors influencing production of Gum Arabic by households in Sheikan locality, North Kordofan State

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Abstract

Gum Arabic is a resin of immense economic and industrial value in Sudan especially among rural smallholder producers whose income and livelihood is dependent on its production. Recently, production of this important resin has seen turbulent times with reductions affecting the overall export base for Sudan. A dearth of information exists that pertains to factors influencing gum Arabic production. This study modeled the factors influencing gum Arabic produced by household in the rural areas of Sheikan Locality, North Kordofan State, Sudan. Data were collected by three multistage sampling technique targeted selected of sites. A semi-structured questionnaire was randomly distributed among 300 using a cross-sectional household survey w. Descriptive analysis was used for surveyed data to describe the status of gum Arabic production, while simple regression approach was applied to determine the factors influencing gum Arabic production. Results showed that 95% of respondents owned land for gum Arabic production, from which, 93% inherited their land. On average households owned 32.84 ± 2.14 feddans with an average of 28.68 ± 1.7 trees/feddan. The average seasonal production of gum Arabic by household was 88.84 ± 7.37 kg/feddan/season. The production of gum Arabic in the area was found to be significantly influenced by income source ($P \leq 0.01$), size of gum gardens ($P \leq 0.05$) and amount of rainfall ($P \leq 0.1$). The predictive power of the model was significantly high ($P \leq 0.001$) and it is consequently recommended for prediction of gum Arabic production in Sheikan Locality, North Kordofan State.

Key words: Drought, Gum Arabic, Sheikan locality, Sudan

Résumé

La gomme arabique est une résine d'une immense valeur économique et industrielle au Soudan, en particulier chez les petits exploitants ruraux dont le revenu et les moyens de subsistance dépendent de sa production. Récemment, la production de cette résine a vu des turbulences avec des réductions affectant le taux d'exportation globale du Soudan. Une pénurie d'informations existe qui concerne des facteurs influençant la production de gomme arabe. Cette étude a modelé les facteurs qui influencent la gomme arabique produite par les ménages des zones rurales de la localité Cheikan de l'État du Nord de Kordofan du Soudan. Les données ont été collectées par trois techniques d'échantillonnage

à plusieurs étages sur des sites ciblés. Un questionnaire semi-structuré a été distribué de manière aléatoire à 300 répondants en utilisant une enquête en coupe transversale. L'analyse descriptive a été utilisée pour des données collectées pour décrire le statut de la production de gomme arabique, tandis qu'une approche de régression simple a été appliquée pour déterminer les facteurs influant sur sa production. Les résultats ont montré que 95% des répondants possédaient des terres pour la production de gomme arabique, dont 93% ont hérité de leurs terres. Les ménages moyens possédaient $32,84 \pm 2,14$ feddans avec une moyenne de $28,68 \pm 1,7$ arbres par feddan. La production saisonnière moyenne de gomme arabique par ménage était de $88,84 \pm 7,37$ kg/ fededan / saison. La production de gomme arabique dans la région est significativement influencée par la source de revenu ($p = 0,01$), la taille des champs exploités ($p = 0,05$) et la quantité des précipitations ($p = 0,1$). La capacité prédictive du modèle était significativement élevée ($p = 0,001$), par conséquent, elle est donc recommandée pour la prédiction de la production de gomme arabique dans la localité des cheikan, l'État du Nord de Kordofan.

Mots-clés: Sécheresse, gomme arabique, Localité de Sheikan, Soudan

Introduction

Gum Arabic, a product of *Acacia senegal* and *Acacia seyal*, is a commodity used in food and pharmaceutical products and is a major source of foreign exchange for Sudan. Gum Arabic accounts for about 13% of Sudan's annual export earnings and supports more than five million people. It also provides on average 19% of household incomes (Geller *et al.*, 2006). Over several years, Gum Arabic based income has played an important role in the economy of smallholder farmers of the Gum Arabic belt of Sudan, in particular in Kordofan region (Ibnaof *et al.*, 2011). It is argued that mismanagement of the production processes as well as drought has been responsible for poor production outcomes of Gum Arabic. Owing to this, Gum Arabic exports have declined at an average rate of 2.2% per annum between 1970 and 2005. This is despite large increases in the swaths cultivated with *Acacia senegal* plantations (International Monetary Fund, 2013).

Between 2000 and 2014, the exports for Gum Arabic coming from Sudan significantly fluctuated between 23,000 tons in 2002 to 32,000 tons in 2008 but declined to 18,000 tons in 2010. This decline in production was associated with a decline in the area planted to Gum Arabic (Eltohami, 2018). Owing to the importance of Gum Arabic in Sudan's economy, some interventions in the last decade (e.g., by World Bank Gum Arabic Multi-Donor Trust Fund Project) were initiated that have seen some upward trend in production once again (World Bank, 2013). For example, between 2013 and 2014, exports of up to 60,000 tons were realized. Besides the interventions initiated, the upward trend in production was attributed to the increase in international prices as well as regulation of Gum Arabic trade by the Gum Arabic Board (Kalame *et al.*, 2011; Adam *et al.*, 2017a). However, these perceived production factors remain without empirical data. Accordingly, this study investigated and modeled the factors influencing Gum Arabic production in Sheikan Locality in North Kordofan State, Sudan.

Methodology

Study area. This study was conducted in Sheikan Locality, North Kordofan State. The State lies between latitudes $12^{\circ} 14' - 16^{\circ} 38' N$ and longitudes $26^{\circ} 46' - 32^{\circ} 22' E$. Sheikan locality lies in the central part of greater Kordofan (Figure 1). Elobeid town is the capital

of the State and an important market and business hub with the world’s largest gum arabic market. The latitude 13° N divides the State into two parts, the desert area with annual rainfall of 60 mm in north and semi-desert zone with annual rainfall of 240 mm to the south. At the far southern part of the State, rainfall reaches 440 mm per year (Adam *et al.*, 2017 a). The vegetation is classified into zones based on mean annual rainfall, rain belts and soil types. North Kordofan State is covered by the following three zones: desert (0-74 mm rainfall) characterized by an association of *Acacia tortilis*, *Acacia raddiana*, and *Capparis decidua*; semi- desert (74-300 mm rainfall), vegetation are *Cappers decidua*, *Salvadora persica*, *Ziziphus spina-christi* and low rainfalls (300 – 1000 mm), characterised by vegetation of *Acacia senegal*, *Combretum spp.*, and *Leptadenia pyrotechnica* (Adam *et al.*, 2017 a). Many types of soils are found in this area, sandy soils (goz) with low water holding capacity and poor fertility status, constitute more than 70% of the agricultural land, sandy clay soils (gardud) constitute 20%, clay soils characterized by high fertility (Adam *et al.*, 2017 a). The location of this study was within the low rainfall savannah zone.

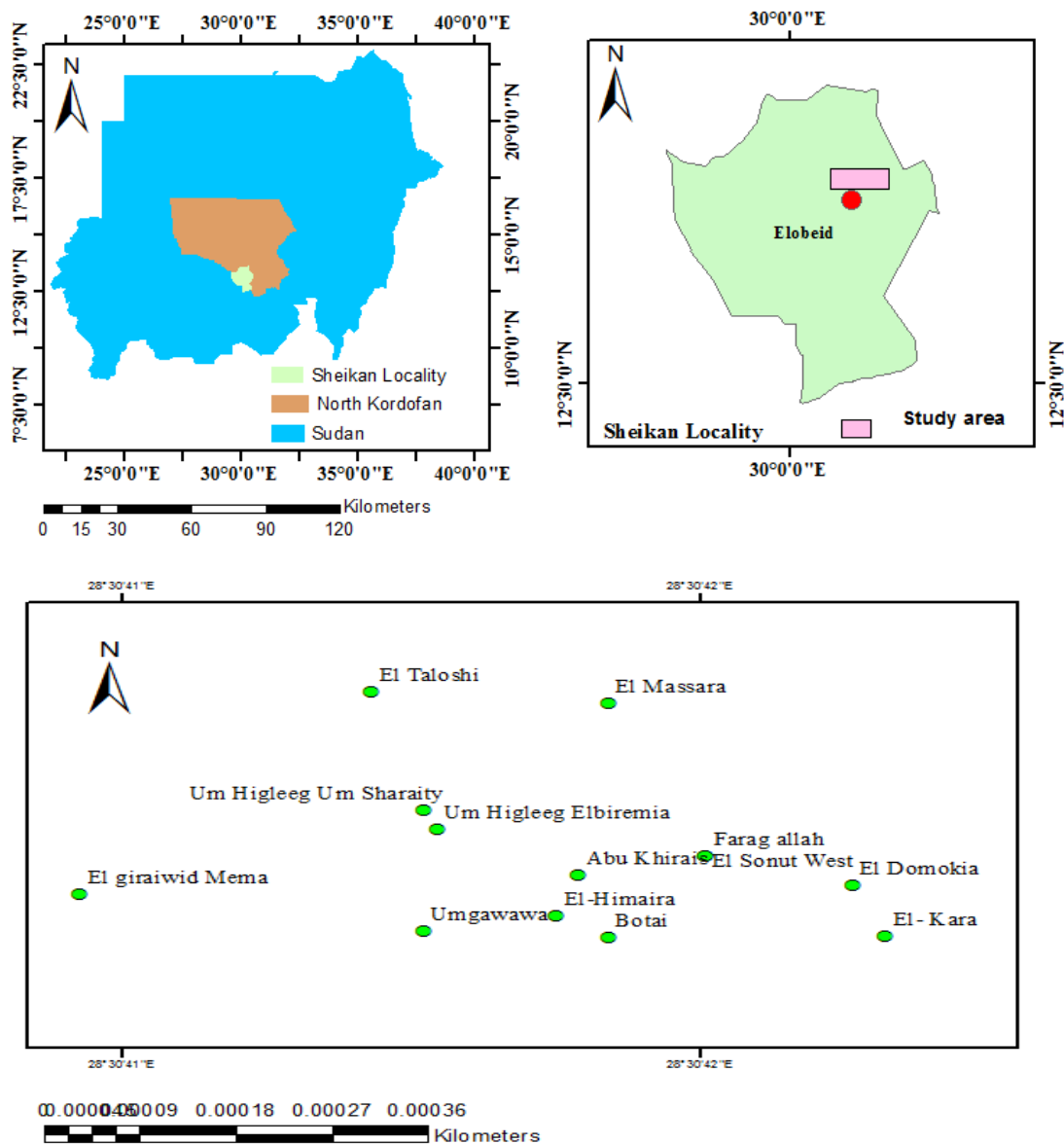


Figure 1. Maps of targeted villages in Sheikan locality, North State, Sudan 2017

Data collection and analysis. A cross-sectional survey involved 300 randomly selected households was undertaken in the study areas using semi-structured questionnaires that were administered by way of guided interviews. The survey questionnaires contained questions identifying various factors which are influencing Gum Arabic production. In order to identify the survey areas, multistage sampling technique was applied. The first stage involved a purposive selection of three administrations (KhorTaggat, Umashira and Umsomaima) of Sheikan locality based on the general population census in 2008. The second stage was purposively selecting 12 villages from the three administrations, because these villages were among the leading Gum Arabic producing areas and have a functional Union for Gum Arabic producers. The final stage involved the selection of households from the selected villages making a total of 300 households for interview from which 227 households practicing Gum Arabic production activities were considered in the model. Thus, modeling the Gum Arabic production was based on households who practiced the gum production activity.

Data analysis was performed using Excel 2007 and SPSS version 20 software. Descriptive statistics such as means for continuous and proportion for categorical variables were computed to describe Gum Arabic production status in the study area. In order to assess the differences, different indicators stratified analysis was performed based on area and other related variables. In determining the factors influencing Gum Arabic production, a simple linear regression analysis was undertaken. The linear regression equation was expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_8 X_8 + \varepsilon \quad (1)$$

Where:

Y = gum arabic production in (kg)

X_1, X_2, \dots, X_8 = Independent variables

β_0 = constant

$\beta_1, \beta_2, \dots, \beta_8$ = Beta values (estimated parameters)

Results

Characteristics of Gum Arabic production. Table 1 presents a summary of key production characteristics for Gum Arabic in Sheikan locality. The average area per Feddan was 32.8% (4500 m²). The average number of trees per Feddan was 29 trees. The average number of pickings was 6 picks. The average production of one tree and of one Feddan per season was 2.79 kg and 88.84, respectively. The prices for one kilogram and one kantar was 15.66 and 694 Sudanese Ginaih (SDG), respectively. The average total revenue for Feddan was about 74719.46 SDG.

Table 1. Selected parameters of Gum Arabic production in Sheikan locality

Important parameters	Min.	Max.	Average	Std.
Area of Gum garden/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	2.00	8.00	6.05	0.07
Production of one tree/season	0.29	8.09	2.79	0.08
Production in kg/feddan/season	2.57	831.81	88.84	7.37
Average prices SDG/kantar	110.00	1200.00	694.03	11.04
Average prices SDG/kg	2.48	27.07	15.66	0.25
Total Revenue SDG/feddan	30.40	16071.05	1489.20	133.74
Total Revenue SDG/garden	182.43	2907449.00	74719.46	14271.50

* Feddan = 4200 m²; 1USD= SDG

Land tenure and source of land for gum gardens. The land tenure system in which the Gum Arabic gardens have been established is one of the most important issues regarding the sustainable management of the resource. Table 2 indicates that 95% of the households owned the land for their Gum Arabic garden and the 5% was distributed between renting and sharing the produce with Gum Arabic garden owner. The ownership of land for Gum Arabic garden is an indicator of the land tenure system. The results indicate that about 95% of those who owned Gum Arabic gardens had inherited the land from their grandfathers (Table 2).

Table 2. Land tenure types and sources of land for Gum arabic production

Type of land ownership	Percent
Owned	95.0
Rent	4.7
Share with land owner	0.3
Source of land	
Inherited	93
Buying	3
Gift	3
Inherited and buying	1

Gum Arabic production activities and experience. The study findings reveal that about 57% and 29% of respondents indicated that their Gum Arabic tapping periods were in the months of October and November, respectively. This tapping period is mapped by the signs of tree maturity which was often coupled with the time the trees are shading leaves. There is an additional tapping period around February and March (summer season). Producers gained accumulated knowledge in Gum Arabic production as about 37% (with 10 years and below experience) and 22% (with 30 years' and above experience) of the respondent indicated to be having in Gum Arabic production (Figure 2). Recommended tool (sonki) for tree tapping was used by 63% of the respondents, while 15% of them used the traditional small axe (Farar) and 23% used both.

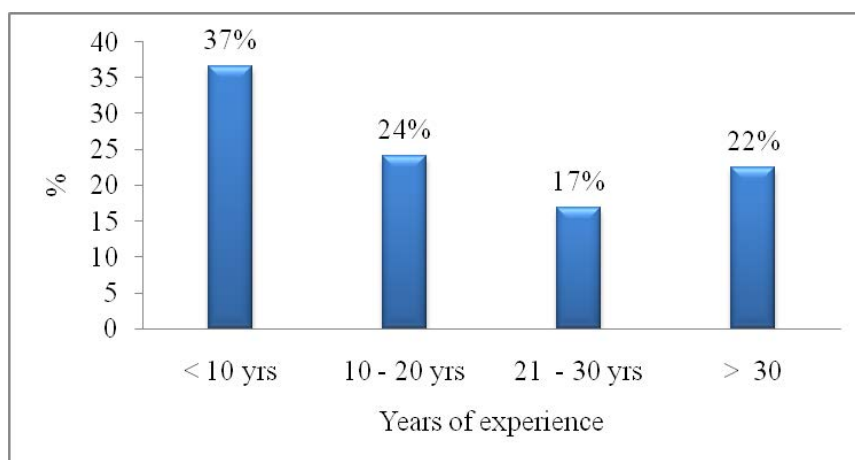


Figure 2. Respondents experience in gum arabic production

In terms of picking routines, 39% of respondents picked the gum arabic at least six times per season, and followed by those who picked at least five times (36%) per season (Figure 3). A small proportion of Gum Arabic producers reach 7-8 pickings per season depending on rainfall amount, edaphic factors and other genetic characteristics.

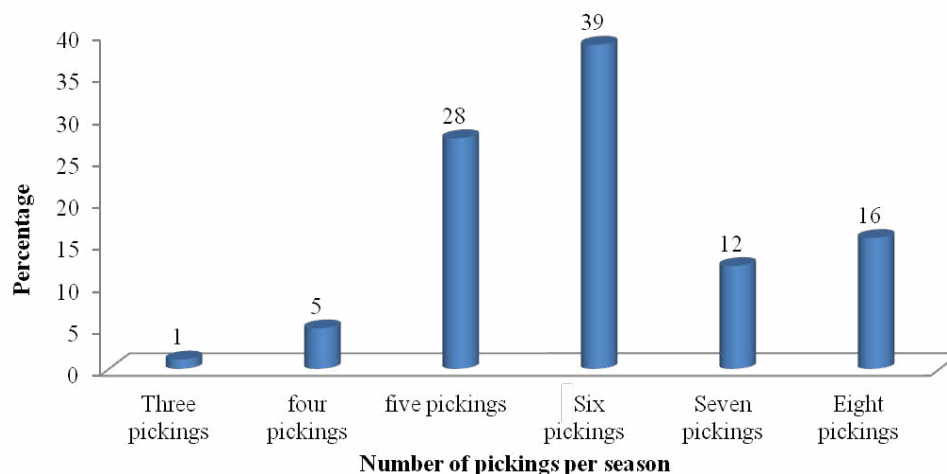


Figure 3. Number of pickings of Gum Arabic in a season

Gum arabic production function regression model. The applied linear regression model (Table 3) showed that the f-value was 403.4 and significant ($P \geq 0.01$). This result indicates that the model explanatory variables have good fitness for expressing the different variable factors influencing Gum Arabic production. The estimated adjusted R^2 value was 0.95. This indicates that about 95% of the variation of Gum Arabic production was explained by the factors identified. The estimated coefficient of Gum Arabic garden area and income from Gum Arabic sale were positive and significant at 10% and 1% level of significant, respectively, while the rainfall status was negatively significant at 10%. Thus, the significant with positive sign indicated that any increase in any one of the variables would lead to increase in Gum Arabic production. On the other hand, all the factors with a negative sign (respondent age, number of pickings, rainfall status and credit facilities) have a negative influence on Gum Arabic production in Sheikan locality.

Table 3. Estimation of Gum Arabic production function with production factors

Variables	Beta (β)	Coefficient	t-ratio	Sig.
(Constant)	16648.62	21488.449	.775	0.440
Respondent age	-491.86	350.618	-1.403	0.163
Gum garden area in feddan	13039.13	**5147.07	2.533	0.010
number of pickings	-914.778	982.84	-.931	0.353
Income from Gum arabic sale	0.044	*** 0.001	55.194	0.000
Rainfall status	-4798.57	* 2881.21	-1.665	0.098
Experience in gum production	293.50	293.20	1.001	0.318
Hire Labor	2912.78	4814.02	0.605	0.546
Credit facilities	-4392.93	4343.42	-1.011	0.313
R^2		0.952		
Adjusted R^2		0.950		
F- value		***403.4		

*** Significant at 0.01, ** significant at 0.05 and * significant at 0.1 level of significant

Based on Table 3, the linear regression model was developed for Gum Arabic production function and is presented in equation (2). The developed linear regression model was tested for fitted variable and resulted in highly significant model ($P \geq 0.000$) (Table 4)

$$Y = 16648.6 - 491.9 X_1 + 13039 X_2 - 914.8 X_3 + 0.044 X_4 - 4798.6 X_5 + 293.5 X_6 + 2912.8 X_7 - 4393 X_8 \dots (2)$$

Where:

Y = Gum Arabic production in Kg (dependent variable)

X1, X2, X3, X4, X5, X6, X7, X8 = independent variables

Table 4. ANOVA table for Gum Arabic production linear regression model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	7.392E12	8	9.240E11	403.378	.000 ^a
Residual	3.711E11	162	2.291E9		
Total	7.763E12	170			

a. Predictors: (Constant), Credit facilities, Income from Gum arabic sale, Respondent age, Gum Arabic garden area in feddan, number of pickings, Rainfall status, Hired Labor, Experience in gum production

b. Dependent Variable: Gum arabic production in kg

Discussion

The generated linear regression model is strongly influenced by the income source. This might be attributed to the fact that the farmers within the Gum Arabic belt have been practicing Gum Arabic production activity in the off-farm season after harvesting their agricultural crops. Therefore, this activity is an additional source of income for small farmer across the Gum Arabic belt of Sudan. A recent study by Adam *et al.* (2017 b) in Sheikan locality reported that the contribution of Gum Arabic to the average household income was 38% and this might reflect the significance of income source in the model.

Gum Arabic garden area is also one of significant factors due to the fact that the more area of Gum Arabic garden tapped the more production will be obtained and vice versa. Rainfall also is important factor. A good rainy season contributes a lot to production but prolonged of rainy season delay the time of tapping trees and consequently affected the production. This is also reflect by this factor in the generated model.

Conclusion

The study has provided a dependable linear regression production function model for gum arabic prediction. Eight factors were used as variables to generate this model. The model is useful in estimating Gum Arabic production and identifying the most significance factors that influence the production in Sheikan locality.

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