


Journal of
Marketing Studies
(JMS)

**Efficiency Estimation of Gum Arabic Production Cost in North and
West Kordofan States, Sudan**



Efficiency Estimation of Gum Arabic Production Cost in North and West Kordofan States, Sudan

¹Mohammed Osman Hassan, ²Ali Abdelaziz Salih, ³Ibrahim Elnour Ibrahim, ^{4*}Muneer

 Elyas Siddig Eltahir, ⁵Hassan Elnour Adam, ⁶Salih Omer Tutu, ⁷Hanan Elsadig Alhabeeb

^{1,4*}Institute of Gum Arabic Research & Desertification Studies, University of Kordofan, Sudan

²Faculty of Agriculture, University of Khartoum, Shambat, Khartoum North, Sudan

^{3,5,6,7}Faculty of Natural Resources & Environmental Studies, University of Kordofan, Sudan.

Accepted: 19th Oct 2023 Received in Revised Form: 6th Nov 2023 Published: 17th Nov 2023

Abstract:

Purpose: The aim of the study was to estimate the cost efficiency of gum Arabic Production under the applied free –trade policy in North and West Kordofan States.

Methodology: Primary data was collected in 2016 by using a structured questionnaire and direct interviews with a sample of 100 gum Arabic producers; about 15% of the population of the study. Secondary data was collected from related official documents. Primary data was analyzed using, maximum-likelihood parameters of stochastic frontier cost function analytical methodology was used to estimate economic efficiency the level of the gum production cost. The factors of gum Arabic production tested were tapping tools, tapping labor, picking tools, picking labor, packing tools and transport.

Findings: The coefficients of all these factors was found significant at 1% level of significance indicating the profitability of gum Arabic production. The mean economic efficiency for gum Arabic cost function was (0.97), indicating there is a likelihood increase of gum Arabic production by (97%). The cost efficiency range was between (81% to100 percent) only 2% lied between 61% to 80% range. This range implies that the cost efficiency of gum production was found to be high. As such, the variable cost of gum production was low since gum Arabic production needs only two main operations, tapping and picking. The tapping and picking tools were extremely of negligible cost.

Unique Contribution to Theory, Policy and Practice: The study recommended getting benefit from low cost of gum Arabic production to allocate all the covered areas with gum trees, registering gum Arabic orchards, to provide a grantee for financing institutions.

Keywords: *Gum Arabic, Acacia Senegal, production, liberalization, cost efficiency.*

1.0 Introduction

Gum Arabic (*Acacia* species) is the dominant leguminous tree crop that belongs to the family *leguminaceae*. It includes over three hundred species of which *Acacia senegal* and *Acacia seyal* represent commercially traded species (Wuranti, 2010). These two main species have different distributions. *Acacia senegal* grows in areas receiving 300-450 mm of annual rainfall. The tree can reach 4–5 meter in height. *Acacia. senegal* grows well in soils that are sandy, droughty, and low in organic nitrogen (Aghughu, 1998). *Acacia seyal* requires annual rainfalls of 250-1000 mm and can withstand inundation better than other acacias (Mohammed, 2011). It is small to medium-sized tree that reaches 3-17 meters' height and can grows in heavy clay soils, water-accumulating, and high-rainfall areas. It can also grow on stony and even sandy soils (Vogt, 1995) and Elamin, (1990) cited that *Acacia seyal* is wide spread in grass and wood land savannah in dry cracking clays, higher slopes of valleys, hard clay plains of central Sudan and seasonally wet depression. The density of gum Arabic producing trees varies from area to another but the main zone of production of gum Arabic is located in West and North Kordofan States (Habish, 2012). The best gum Arabic quality is produced from *Acacia senegal* (L.)Willdenow (*Hashab*). Most of gum is produced by small holders on individual farms where the trees grow. To get the gum, the tree bark is partially removed, where gum is exuded in droplets from the wound. These droplets grow to nodules 2–5 cm in diameter and then picked. Additional pickings commonly follow after two weeks (Seifel Din and Zrroug, 1996). Gum production begins to decline when the tree is about 15 years old. When the land is taken back into cultivation, the tree is coppiced. The land is then cultivated until its fertility falls below an acceptable level. During this time most of the trees regenerate naturally by coppice growth. Three to five years after cutting, trees tapped again. (Badi *et al*, 1989). The *Acacia senegal* tree is tapped after the end of the rainy season. The suitable time depends on the end period of rain. The best time for tapping is usually recognized by the shedding of leaves and changes in the color of the inner bark from white to red (Hassan, 2008). Tapping is practiced during two different periods. Early tapping is conducted from October until the end of November. Late tapping is done only for trees in agro- forestry system where *Hashab* trees were grown and the crops were cultivated between the trees, or for those trees in water collecting sites, from December till the end of February. The tools of tapping *Hashab* trees were the traditional axe and the developed 'Sonki (Adam *et al*, 2016). Gum exudation takes place a few weeks after tapping and is enhanced by hot weather whereas the yield of gum delayed and decreased by cold weather. The gum is collected in a number of pickings depending on the time of tapping. The first picking is collected five to six weeks after tapping. And then, the gum is collected in a series of subsequent pickings, until the end of picking season. Up to seven pickings could be reached if the tapping is done early. An average tree can yield about 100-300 gram per year. On scattered wooded stand it was possible to collect 12-16 Kg per feddan one feddan is equal to (.44hectare), while on a densely wooded stand, the yield can increase to about 40 Kg per feddan. The peak of production is obtained from the third, fourth and fifth pickings (Taha, 2000). Seif El Din (1982) studied the formation of

gum Arabic in relation to the anatomy of *Acacia senegal* tree. Gum exudes were found in rays and rings in the early sliced bark wood samples. Gum Arabic from *Acacia senegal* is a pale to orange-brown colored and solid, which breaks with a glassy fracture. The best grades are in the form of whole round nodules, kibbled grades are much paler and have a glassy appearance. Inferior grades may not have the characteristic nodule shape and are often darker in color. *Acacia seyal* gum is yellowish – brown solid material the drying nodules are brittle and can easily break into siftings. It is odorless and has stringent taste; it is highly soluble in water and insoluble in Ethan (Ali, 1998). This aim of the study was to estimate the efficiency level of gum Arabic Production cost under the applied free –trade policy North and West Kordofan States

2.0 Material and method

2.1 Study area:

This study was carried out in North and South Kordofan States, Sudan. The area is located in the central parts of western Sudan between latitudes 9° 50` and 16° 40` North and longitudes 27° and 32° East. This area is located in tropical climate with high temperature in summer (March - July) moderate to dry cold in winter (November – February) and rainy in (July – October). The main vegetation types include semi-desert, short grass savanna, tall grass savanna, flood plains and mountain plants. The majority of the population depends on agricultural and natural resources activities in which traditional and mechanized farming systems are dominated (Tutu & Elkhalfa, 2012).

2.2 Methodology:

Primary data was collected in 2016 by using A structured questionnaire was used to obtain data from 100 contact farmers sampled through random sampled procedure which represented (15%) of the targeted population, while secondary data was collected from related official documents. Primary data was analyzed using, maximum-likelihood parameters of stochastic frontier cost function to estimate the efficiency level of the gum production cost in order to test the gum production cost (tapping tools, tapping labor, picking tools, picking labor, packing tools and transport).

2.3 Data Analysis:

Data analysis was performed using Excel 2010, SPSS version 24 software and Stochastic Frontier Analysis (SFA) to estimate the efficiency level of gum Arabic production cost.

The conceptual frontier cost function is defined as the minimum possible level of cost at which a certain level of output is produced, given the input prices (Thapa, 1998).

The stochastic frontier cost function model for estimating farm level overall economic efficiency is specified as:

6

$$\ln C = \beta_0 + \beta_1 \ln(Q) + \sum_{j=1}^6 \beta_j \ln x_{ij} + (v_i + u_i)$$

Where:

\ln = the natural logarithm;

C = Total cost of inputs for gum Arabic production

Q = the revenue of gum Arabic product

X_1 = the total cost for gum Arabic tapping tools (An axe and Sonki)

X_2 = total cost of tapping (labor hiring)

X_3 = cost for picking tools (leather bag, plastic bucket)

X_4 = cost for picking (labor hiring)

X_5 = the cost of packing tools (empty sags)

X_6 = cost of transport

β_0 and β_1 are unknown parameters to be estimated for variables respectively.

v_i represents the statistical error and the other factors which are beyond the producers control and other factors which are not included, and may be positive, negative or zero.

u_i is a non-negative random variable which are assumed to account for the cost of inefficiency in production, which are often assumed to be iid (Coelli, 1995).

Economic efficiency

$$EE = TE * AE$$

$$EE = 1/CE$$

Where:

EE = Economic efficiency

CE = Cost efficiency

TE = Technical efficiency

AE = Allocative efficiency

Inefficiency Effect Model:

The u_i in the stochastic cost function frontier model is a non-negative random variable, associated with gum Arabic producer's economical inefficiency in gum Arabic cost production and assumed to be independently distributed, such that:

$$\mu_i = \delta_0 + \sum_{s=1}^6 \delta_s Z_{si}$$

Z_{1i} :age Z_{2i} educational level Z_{3i} marital status Z_{4i} family size

Z_{5i} :experience Z_{6i} finance are the inefficiency tested variables of socio- economic characteristics of the producers.

δ_0 and δ_s coefficient are unknown parameters will be estimated with the variance.

The parameters of the stochastic frontier cost function model are estimated by the method of maximum likelihood estimation (mle), using the computer program, Frontier Version 4.1 (Coelli, 1995).

3.0 Results and Discussions

3.1 Maximum-likelihood estimate of Parameters of stochastic frontier cost function model for gum Arabic production

Table (1) presents the results of gum Arabic cost-likelihood analysis. As shown in the table (1), the mean cost efficiency for gum Arabic cost of production was 0.97. This indicates there is likelihood to increase gum Arabic production by 97%. The estimated co-efficient of gum Arabic production revenue per *Kantar* was positive and significant at 10% level of significance. This result indicated that gum Arabic production was profitable. The estimated coefficient of cost of tapping tools (Sonki and Axe) of gum Arabic was positive and significant at 1% level of significance. This means that revenue would increase as the number of gum Arabic tapping tools increase. The coefficient of labors tapping cost is positive and significant at 1% level of significance. This means that the revenue of gum Arabic would increase as the number of tapping labors increase. The coefficient cost of gum Arabic picking tools (leather bags and plastic buckets) is significant and positive at 1% level of significance. This means that the revenue of gum Arabic would increase as the number of the picking tools of gum Arabic increase. The estimated coefficient of picking labors cost was positive and significant at 1% level of significance. This means that the revenue of gum Arabic would increase as the number of picking labors increase. The coefficient of packing tools (sacks of plastic and jute) cost of gum Arabic production was positive and significant at 1% level of significance. This implies that the increase in packing tools would lead to increase in gum Arabic revenue. The coefficient of gum Arabic product transport cost was positive and significant at 1% level of significance. This reveals that the increase in transport cost would raise the revenue of gum Arabic production.

Table (1) **Maximum-likelihood estimate for Parameters of stochastic frontier cost function model for gum Arabic production**

Variables	Coefficient	Standard – error	t- ratio
Constant	1. 33***	0.024	54.85
Revenue/Kuntar	0.016*	0.012	1.3
Tapping tools cost	0.098***	0.007	13.4
Labor tapping cost	0.36***	0.022	16.15
Picking tools cost	0.057**	0.027	2.11
Labor picking cost	0.39***	0.007	55.9
Packing tools cost	0.03***	0.005	6.4
Transport cost	0.07***	0.006	11.12

Source: Derived by authors 2016

***, ** and * asterisks on the value of the parameters indicate its significant at 1%, 5% and 10% level of significance respectively

3.2 Maximum-likelihood estimate of the Parameters of cost inefficiency (effect) model for gum Arabic production

The cost inefficiency parameters included age, marital status, family size, educational level, years of experience, and finance as shown in Table (2). The positive and significant variables of level of education and experience of producers in all operations dealing with producing gum Arabic means that inefficiency parameters would increase the cost inefficiency effects and would decrease the cost efficiency. The negative and statistically significant variables such as age and finance mean that the inefficiency parameters would decrease the cost inefficiency and would increase the cost efficiency.

The estimated of gamma (γ) parameters which is associated with the variance of the economic inefficiency effects in stochastic frontier cost function it range between (0 and 1) the value of gamma was 0.99 and has are positively significant, which implies that, the significant value of gamma indicates that there are significant economic inefficiency effects in production of gum arabic. This model of variance was significantly different from zero at 1% level, which implies that the inefficiency effects were significant in determining the level of revenue for gum Arabic production.

Table (2) Maximum-likelihood estimate for Parameters of cost inefficiency effect model for gum Arabic production

Cost inefficiency	Coefficient	Standard - error	t- ratio
Constant	0.03*	0.03	1.1
Age	-0.006***	0.0009	-6.96
Marital Status	0.54 ^{ns}	0.66	0.8
Family size	-0.04 ^{ns}	0.58	-0.7
Education	0.03***	0.008	3.4
Experience	0.008***	0.002	4.8
Finance	-0.12***	0.012	10.6
Sigma square	0.005***	0.002	2.8
Gamma	0.99***	0.0008	1195.7

Source: Derived by authors 2016 ***, ** and * asterisks on the value of the parameters indicate its significant at 1%, 5% and 10% level of significance, respectively, *ns* refers to not significant

3.3 The individual gum Arabic producers Cost Efficiency Estimates

Table (3) illustrates the cost efficiency range for the individually gum Arabic producers, the results indicate that 98% of gum Arabic producers were restricted between efficiency level (81 -100) , and only 2% lied between (61 - 80) level of efficiency. This range implies that the cost efficiency of gum production was found to be high. As such the variable cost of gum production was low. Gum Arabic production needs two main operations. One was tapping the trees at a certain period of time after the emergence of tree maturity and picking of gum nodules. The cost of the tapping tools (Sonki and Axe) and the cost of picking tools (leather and plastic) were of extremely negligible cost.

Table: (3) **Frequency Distribution of Cost Efficiency**

Efficiency range	Frequency	%
10 – 20	-	-
21 – 40	-	-
41-60	-	-
61- 80	12	2
81-100	98	98
Total	100	100
Minimum	64.7	
Maximum	100	
Mean efficiency	1.03	
Mean economic efficiency	0.97	

Source: Derived by authors 2016

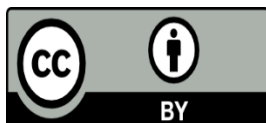
4.0 Conclusion and recommendations

This study aimed to estimate the cost efficiency of gum Arabic. The which have been tested were tapping tools, tapping labor, picking tools, picking labor, packing tools and transport. The coefficients of all these factors are significant at 1% level of significant. The mean economic efficiency for gum Arabic cost of production was (0.97), indicating there is a likelihood increase of gum Arabic production by (97%). The cost efficiency range was between (81% to100%). Only (2%) was between (61% to 80%). The comparative analysis results indicated the positive effect of the free-trade system in providing incentives to gum producers. Almost all the producers preferred free-trade policy as it gives more price incentives. Thus the new policy encouraged gum producers to increase their cost efficiency up to 80%-100%, as verified by the maximum likelihood analysis results with 1% significance level, and encouraging the producers to conserve and reforest instead of cutting *Hashab* trees The study recommended, to obtain the benefit of low cost of gum Arabic production to allocate all the covered areas with gum trees involving the private sector to provide credit to the gum Arabic producers to increase their gum production area and register gum Arabic orchards to provide a grantee for financing institutions.

References

- Adam, H. E. (2011). Integration of remote sensing and GIS in studying vegetation trends and conditions in the *Gum Arabic* belt in North Kordofan, Sudan, PhD thesis Berliner Verlag, Germany, ISBN 978-3-941216-58-7.
- Adam, Hassan, E., Muneer E. S. Eltahir, Mohamed T. Elhaja, Osman E. A. Abdelkareem, Zeinab M. Hammad, Awad Elkarim S. Khalifa, Tarig E. Mahmoud, Mohamed E. O. Elsayed, Hatim M. A., Elamin, Mohamed E. Taha, Abdelateif H. Ibrahim (2016). Management of Gum Arabic Production Potentialities in the Gum Belt, Kordofan – Sudan.
- Aghughu, O. (1998). Nursery practice of A. Senegal. A paper presented at Ahmadu Bello University, ABU, Zaria.
- Ali, E. M. O. (1998). Nitrogen and specific Rotation as qualifying indices for gum Arabic derived from *Acacia senegal*. M. Sc. Thesis University of Khartoum- Sudan.
- Badi, K.H., Ahmed A.E.H. and Bayoumi A.A.M.S. (1989). The Forests of the Sudan. Agricultural Research Council, Khartoum, Sudan, 184 pp.
- Coelli, T. J (1995). A Guide to Frontier Version 4.1: A computer program for stochastic Frontier production and cost function estimation.
- Habish E. M. (2012). the Determinants of the Gum Arabic Producers Participation in the Gum Industry of Sudan PhD thesis Dept. of Agricultural Economics, University of Baheri- Khartoum Baheri- Sudan.
- Hassan, M. O. (2008). Assessment of Gum Arabic Marketing System in Main Auction Markets of North Kordofan State- M. Sc. Thesis University of Khartoum- Sudan.
- Mohammed, H. M. (2011). Management of Natural Stands of *Acacia seyal* Del. Variety seyal (Brenan) for Production of Gum Talha, South Kordofan, Sudan“PhD Dissertation, Tharnadt- Germany.
- Okoro, C. (2011). Gum Arabic production and marketing in Nigeria. Nigeria Economic Summit Group NESG, Agricultural summit, pp.60-36.
- Pretzsch, Jürgen and (Mohamed E. Taha, Muneer E. Siddig, Taisser H. H. Deafallad, Hatim M. A. , Elamin (2014). Valuation of Environmental Role of *Acacia senegal* Tree in the Gum Belt of Kordofan and the Blue Nile Sectors, Sudan Tropentag 2014, Prague, Czech Republic September 17-19, 2014 Conference on International Research on Food Security, Natural Resource Management and Rural Development organized by the Czech University of Life Sciences Prague Purdue University, West Lafayette, IN 47909–2009, USA bemiller@purdue.edu.

- Seif el Din, A.G. and Zarroug M. (1996). Production and commercialization of gum Arabic in Sudan. In: FAO (eds), Re-port of the International Expert Consultation on Non-Wood Forest Products: Yogyakarta, Indonesia, 17–27 January1995.Food and Agricultural Organization, Rome, Italy, pp.465, 1–7.
- Seif Eldin, A. G. (1982). The Study of the Formation of Gum Arabic in Relation to Anatomy of *Acacia senegal* (L.) Wild. In: Sudan Silva No. 24 Vol. IV 1981/82. Khartoum, Sudan.
- Taha, M. N. (2000): The Socio-Economic Role of *Acacia senegal* in Sustainable Development of RuralAreas in the Gum Belt of the Sudan. PhD Dissertation, Institute of International Forestry and Forest Products (Tharandt), Technical University of Dresden, Germany.
- Thapa, P. K. (1998). Economic Efficiency of Contractual Vegetable Seed Production in the Eastern Hills of Nepal, Ph.D Thesis Submitted to the Faculty of the Graduate School, University of the Philippines.
- Tutu, S. O., & Elkhalfa, K. F. (2012). Shoot morphology of some Capparaceae and Combretaceae plantations in the Kordofan region of the Sudan*. *Rostaniha*, 13(2), 152–163.
- Wuranti, Valla (2010). Resource use Efficiency in gum Arabic production among farmers in Yobe State, Nigeria Kogi State University, Anyigba, Kogi State, Nigeria -International Journal of Food and Agricultural Economics ISSN 2147-8988 Vol. 2 No. 1 pp. 77-84 77.
- Vogt, K. (1995). A Field Worker’s Guide to the Identification, Propagation and Uses of Common Trees and Shrubs of Dry Land Sudan (p. 61). SOS Sahel International, London. Khartoum, Sudan.



©2023 by the Authors. This Article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>)