The Impact of Rainfall on Gum Arabic production in El Obied Area, North Kordofan State, Sudan

By

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Supervision Committee:

Main Supervisor: Prof. HusseinSuliman Adam ……..

Co-Supervisor: Dr. Hasabelrasoul Fadlelmula Mustafa ……..

Dedication

To my mother, my father and soul of my aunt Dr Zakia.

To those who are interested in Gum Arabic, which protects the environment and supports the economy.

Acknowledgement

I would like to thank my main supervisor professor Hussein Suliman Adam for his guidance and facilitating this work.

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My thanks go to El Obied crops market for Gum Arabic Production data to carry out this work.

My thanks go also to the Sudan Meteorological Authority for the rainfall data needed to carry out this work.

My thanks go to my brothers and sisters for their encouragement.

The Impact of Rainfall on Gum Arabic production in El Obied Area, North Kordofan State, Sudan

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M.Sc. in Management of Natural Resources (13 /12/2012)

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Abstract

Gum Arabic is an important natural product obtained by tapping *Acacia senegal L*. A comparative study of gum arabic production in relation to annual and monthly rainfall was conducted in El Obied area in North Kordofan, using gum Arabic production data for the period 1980-2009. The objective of the study was to look into whether there is a correlation between rainfall and gum arabic production. The study used data of gum production from El Obied crop market and rainfall data from Sudan Meteorological Authority to carry out this work. The results showed that there was no clear correlation between rainfall and Gum Arabic production. The main reason is that, the production brought to the market depends on complex socioeconomic factors, which overrides the rainfall effects .The study recommended that better results may be obtained by the study of the gum production per unit area.

اثر الأمطار على كمية إنتاج الصمغ العربي في منطقة الأبيض بولاية شمال كردفان السودان

أريج علي إبراهيم علي

لنيل درجة الماجستير في إدارة الموارد الطبيعية (13 /12/ 2012م)

قسم علوم البيئة والموارد الطبيعية

كلية العلوم الزراعية

جامعة الجزيرة

الخلاصة

يعتبر الصمغ العربي أهم منتج طبيعي يستخرج عن طريق طق شجرة الهشاب وغيره , أجريت الدراسة بشمال كرد فان للفترة من 1980-2009م . استخدمت الدراسة معلومات إنتاج الصمغ العربي من سوق الأبيض للمحاصيل ومعلومات الأمطار من الهيئة العامة للأرصاد الجوية . أوضحت الدراسة بأنه لا توجد علاقة ارتباط واضحة بين الأمطار و إنتاج الصمغ العربي .و يعزى إلى أنّ إنتاج الصمغ الذي يصل إلى الأسواق يعتمد على عوامل اقتصادية واجتماعية معقدة طفت على اثر الأمطار. هنالك حاجه لمزيد من الدراسات على مستوى إنتاج الصمغ في وحدة المساحة.

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CHAPTER ONE

INTRODUCTION

1.1 Gum Arabic belt (Hashab Belt)

Acacia senegal is a small deciduous tree, that grows to a height of 5 to 12m and stem diameter of 30cm, with umbrella shaped crown, greyish rough bark, short black prickles, normally in three and the central one curved down words.

Leaves are small, bi-pinnate with 7-25 pairs of leaflets. Flowers are white and fragrant in 3-12 cm long spikes. Fruits are yellow to brown, papery and dehiscent. Pods are up to 19 cm long , flat and thin with either rounded or pointed ends. Seeds are olive and brown (Ross.1977). Gum arabic is the natural juicy and sticky material which is extracted from *Acacia senegal*, tree through tapping. Hashab trees produce about 90% of the total gum arabic production in Sudan and the remaining 10% comes from Talh tree, *Acacia seyal*. The *A.senegal* trees grow naturally, in the area between latitude 10 ^{o} and 14^{o} N. The total Gum Belt is estimated to cover 520,000 km^{2}, extending over Western Darfor, Northern Darfur, East Darfur, Central Darfur, Southern Darfur, Northern Kordofan, Southern Kordofan, White Nile, Sennar, Bule Nile and al-Gadaref states. Gum arabic is a significant source of income for peasant farmers in the belt. Over five million people work in the gum production. It contributes by 12% of the gross domestic product (Mahmoud, 2004). The production is fluctuating between 20– 40 thousand tons annually. Therefore, Sudan supplies the globe by 80% of Gum arabic. Kordofan and Darfur region contributes 74% of the production in

Sudan. Kordofan region produces the high quality gum. It accounts for about 15% of the income of gum Arabic producers.

On sandy soil the trees are tapped in November by removing the bark to form wounds and in December and January on clay soil . The first harvest of nodules of gum are picked after six weeks from tapping. There is a second tapping in March or April which produce more than half of the production (Elkhidir et al , 2010).

1.2 Climate of the Gum Belt

Gum arabic belt is located in the semi-dry climatic zone. The beginning of the rainy season is normally from the last week of June while the end is from 9 up to 22 September. In the semi-dry, zone the sun shine for 3400 hour per year. The solar radiation is 22mJ|m^2/day. The minimum temperature for the coldest month is 16^{o}C in January while the maximum temperature for the hottest month is 40^{o}C in April. The diurnal range is 20^{o}C. The annual rainfall is 350 – 550 mm and the annual evaporation is 2100 mm (Adam, 2008).

1.3 Rainfall in Gum Arabic belt.

Rainfall is the most important climatic element in crop production. It varies in time and space. The spatial variability is large for daily rainfall. The variation from year to year is large in dry area and gets smaller as the rainfall increases. To get meaningful results by analyzing the rainfall, a long period of record is needed, at least 30 years for analysis. The same site may receive the same amount of annual rainfall but monthly distribution may be quite different and hence the effect of rainfall on agricultural production is different.

Rainfall intensity which is expressed in units of millimeters or inches per hour or minutes is very effective in crop production. Twenty millimeters rainfall received in fifteen minutes has a different effect than twenty mm received in an hour. The intensity in the first case is 80 mm per hour while in the second case the intensity is only 20 mm per hour. Linked with the intensity is duration .Rainfall received over a long time is more effective. Monthly rainfall of 150 mm received in 10 days is much more useful than 150 mm received in only two days.

Gum Arabic production was high during 1980, 3358 tons. It decreased during 1990 and 2008 to 792 tons Much research has been conducted on gum production but focused on tapping and socioeconomic factors with little attention given to environmental factors.

1.4 **Objective of the Study**

The main objective was to study the relationship between Gum arabic production and rainfall in Elobied area.

Annex: (1): Annual and monthly rainfall and Gum Arabic production at ElObied (1980-2009)

Years	Rainfall (mm)	Gum Production (Ton)	Month JUN	JUL	AUG	SEP	OCT
l980	365	3358	40	138	75	38	7
1981	315	2768	30	112	65	46	31
1982	202	2229	1	41	90	28	40
1983	352	2705	40	100	138	74	0
1984	126	729	6	76	10	64	0
1985	218	1675	15	53	74	64	0
1986	373	1075	28	94	130	122	2
1987	226	1443	14	29	113	5	58
1989	268	2130	16	57	103	68	45
1990	171	541	7	104	17	40	1
1991	204	683	2	16	87	15	35
1992	514	715	73	145	257	15	32
1993	341	1103	129	118	92	45	22
1994	545	2045	16	215	184	108	0
1995	338	2045	15	146	96	79	2
1996	329	10254	9	15	218	7	6
1997	350	3167	4	23	122	117	19
1998	356	1501	0	0	33	164	68
1999	581	1259	1	130	132	122	54
2000	314	1054	6	57	137	30	44
2001	348	63151	16	134	105	67	1
2002	216	7093	12	81	73	38	11

Continue annex (1)

2003	406	5914	49	150	125	59	32
2004	285	8208	35	96	111	32	9
2005	254	1230	14	56	91	70	2
2006	490	15114	38	191	136	69	51
2007	557	11528	52	219	243	41	TR
2008	411	792	71	112	121	92	8
2009	301	8355	0	122	116	58	0

CHAPTER TWO

LITERATURE REVIEW

2.1 Gum Gardens

Acacia senegal (Hashab) regenerates easily on cultivated land when left as fallow (Jackson & Shawgi,1950; Seif El Din, 1969). The bush fallow system of cultivation is well established as a beneficial and sustainable farming system, particularly on marginal lands of Kordofan. It supports the livelihoods of local population since it is one of the sources of both cash and for daily substance. Farmers have usually grown *A.senegal* trees with sesame and groundnuts as cash crops and millet and sorghum as subsistence crops. In addition to the gum the trees provide the farmer with fuel wood (Sharawi, 1986). Bush fallow is similar to shifting cultivation allows fallow period of 10-15 years (Seif ElDin & Obeid, 1971; Awouda, 1973; Hussein, 1983; Badi, 1989; Ballal 1991). It starts by felling 15-20 years old trees to cultivate millet, sesame, ground nuts or water mellon in association with seedlings or coppice of *A.senegal* for a period of 4-5 years.

2.2 Production and Economy of Gum

More than 80% of the total Gum arabic is collected from *A. senegal* .The annual trade is around 45 million US$(Bashir, 2001). In addition, *A.senegal* tree is useful as wind break, fodder for livestock, tools handles, strong fibers and charcoal (NAS, 1980).

Gum arabic is used as emulsifier and stabilizer in the food and pharmaceutical industries . Other industrial products that technical grades of

Gum arabic include adhesive ,textiles , printing, lithography, paints, paper sizing and pottery glazing (Mocak et al.,1998).

Gum arabic is used in the treatment of chronic renal failure (Rampton et al., 1984). Supplementation with gum arabic fiber increases facial nitrogen extraction and lowers serum nitrogen concentration in chronic renal failure patients (Bliss et al., 1999)

Drought and desertification is considered to be the main factors that have led to fluctuations in gum arabic yield and the consequent instability of supply (Seif ElDin, 1995; Awouda, 2000). In response large scale planting programs were implemented since the early 1980s to restock the gum arabic belt in order to mitigate desertification and to improve the gum arabic yield in western Sudan. The International institute for Environment and Development (IIED) and the Institute of Environmental Studies (IES) (1989) reported that rainfall and its distribution pattern, minimum temperature during tapping and gum picking, and relative humidity, are the main factors affecting gum yield. Awouda (1973); Abedl Dafei (1978) and Muthana (1988) had reported that rainfall and temperature have an effect on time of tapping the tree and consequently the gum yield. An increase in gum yield with increasing rainfall had been reported by Bateson et al, (1988). Yield was found to be positively correlated with tapping intensity, rain fall and the minimum and maximum temperatures at gum collection(Ballal, et .al. 2005).

Beside the drought spells, the other constraint on gum production is the reduction of forest cover in the gum belt. This is brought about by the

extensive expansion in agriculture for crop production particularly mechanized rain fed farming (Abed Nour, 1996). Gum production communities suffer from the lack of infrastructure, sense of organized co-operative behavior as well as lack of trading information which is due to the inferior economic, social and demographic characteristics of these communities (Ibrahim, 2002). Due to the lack of finance and transportation facilities, small producers sell their produce to the local trader at very low prices . The actual returns of the producer were reported not to exceed 40% of floor price (Ibrahim, 2002). Political unrest and inadequate marketing arrangements have resulted in the emergence of new gum producing countries Chad and Nigeria, which produce mostly Talh (*A.seyal*) gum.

3.2 Quality of Gum

The quality of gum arabic must conform to international specifications (FAO, 1995). Some studies have shown differences between gum arabic of Sudan and other countries such as Kenya in terms of specific rotation, nitrogen and viscosity. These differences may evolve as a result of the differences in edaphic conditions and climatic factor. (Chikamai & Odera, 2002). It has been reported that soil characteristics were major factor that influence gum quality and properties, particularly pH, organic carbon, nitrogen and phosphorus (Joesph et. al., 2009) .

3.3 Gum Production Trends

In modern times, recorded Gum Arabic production during the 1950s averaged just over 40000 tones/year .Since then there have been fluctuations

in production . Five year annual averages for the period 1980-1994 are given in table (1).

Table (1) : Gum Arabic Production in Sudan (5-year annual averages), 1960-1994

year	1960-64	65-96	70-74	75-79	80-84	85-89	90-94
Gum hashab	44299	47434	30910	36026	26721	19777	15358

CHAPTER THREE

MATERIALS and METHODS

The study was conducted in North Kordofan state namely at Elobied (13°. 3' N, 30°. 5' E, Alt 560m). The climate is dry with an average annual rain fall of about 350 mm and the annual mean minimum and maximum temperatures are 20°C and 35°C , respectively. The soils are mainly sandy ,locally known as malic soil, which contain over 90% sand. This soil is inherently impoverished with respect to nitrogen ,phosphorus and organic matter .

Data of gum arabic production were taken from ElObied crop market and records of annual and monthly rainfall from the period of 1980-2009 were taken from Sudan Meteorological Authority (Annex 1).The analysis focused on the relationship between the gum production that exposed at ElObied Crop Market for selling and amount of rainfall in July, July and August, July, August and September, length of rainy season and rainfall above and below the average. Form the analysis it was clear that no further statistical analysis is needed. However ,analysis was done which did not give clear relationship between gum arabic production and all the above mentioned combination rainfall levels.

CHAPTER FOUR

RESULTS and DISCUSSION

El Obied- area for a very long time has been classified as one of the largest producers of gum Arabic in Sudan. Large numbers of citizens work in the production of gum arabic since the income they get from it is higher than what they get from traditional agriculture. Gum arabic is brought by small farmers and big traders to be sold by auction, the market mechanism set the price. The fluctuation in gum arabic production were price dependent and the price depends on the social, economic and agricultural conditions. The Gum Arabic corporation declares the prices but the big traders buy the Gum from small farmers .

From the scattered diagrams it is clear that is no point in carrying out further statistical analysis. However statistical analysis was done which did not give clear relationships between gum arabic production and all the rainfall levels. Figure (1) revealed that seven years with rainfall between 20 and 60 mm had the same range of production (1000-3500) tons as the seven years with rainfall between 90 mm and 150 mm .Also rainfall of about 90mm gave 1000 tons in one year and more than 8000 tons in another year. That result proved there was no clear correlation between July rainfall and gum production.

In Figure (2) rainfall of 125 to 150 mm gave the same range of production as the rainfall between 200 and 230 mm .

Figure (3) showed scattered points that ,there were 19 years with the production about 3000 tons while rainfall ranged between 150 and 350 mm .In the same range of rainfall there were five years that gave production(6000-10000)tons. The highest production exceeding 12000 tons occurred in two years when rainfall exceeded 400 mm.

Figure (4) gave very clear example of absolutely no clear correlation .With production ranged from very low values of 2000 tons to high value of 12000 tons when the length of season extended to four months. Similarly the production ranged from 1000 to 14000 tons when the length of season exceeded four months.

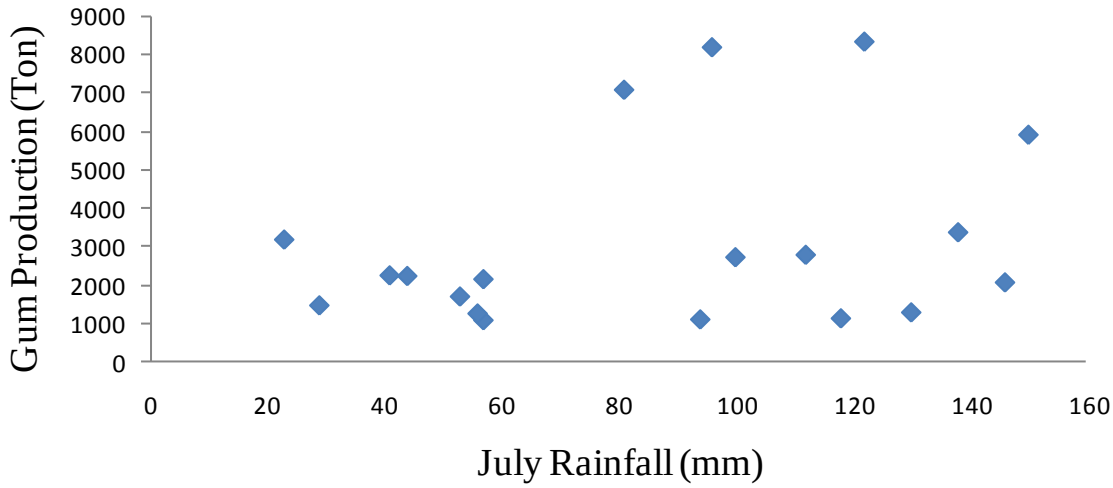
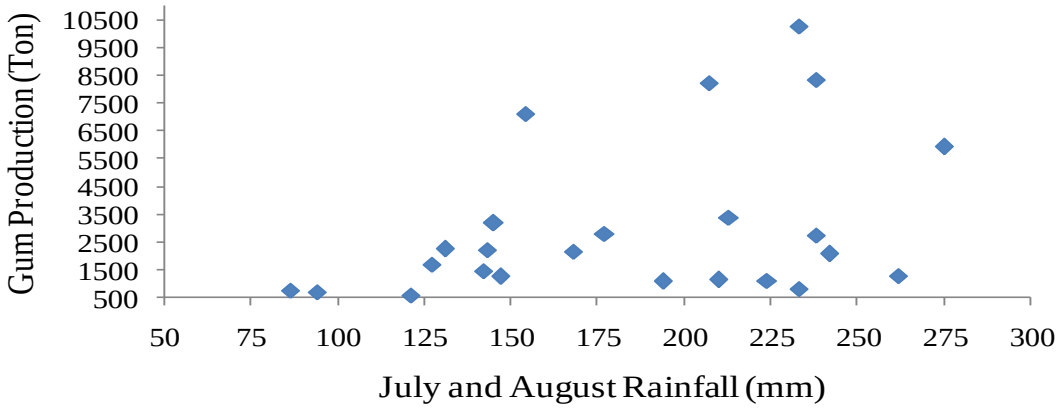


Fig (1): Relationship between the amount of rains in July and gum arabic Production in El Obied area (1980-2009).



Fig(2) :Relationship between the amount of rains in July and August and gumarabic production in El Obied area (1980-2009).

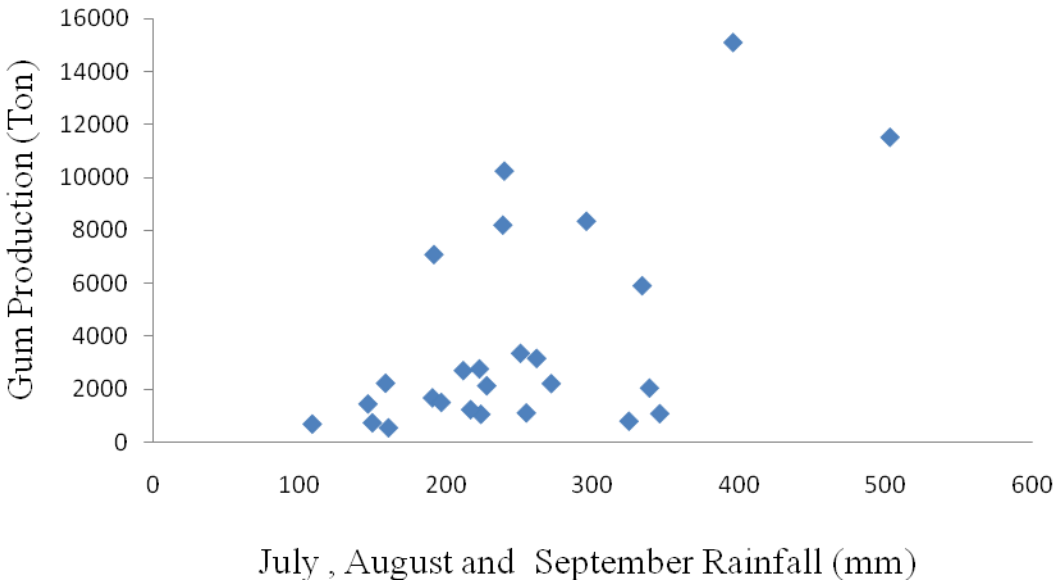


Fig (3): Relationship between the amount of rains in July, August and September and gum arabic production in El Obied area (1980-2009)

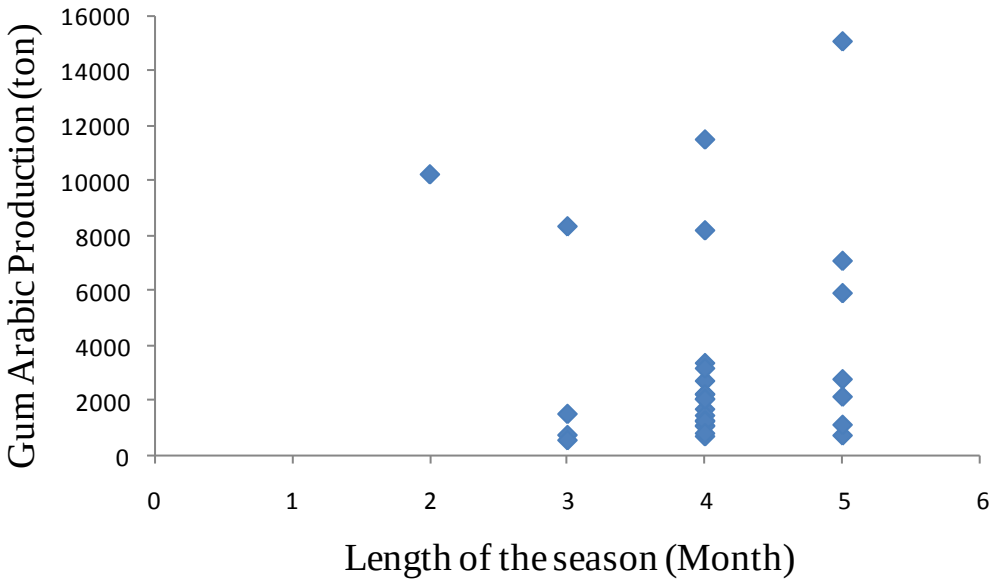


Fig (4): Relationship between the length of rainy Season and gum Arabic production

Figure (5) shows the rainfall below the mean (337 mm) and Gum production. There were, 13 years below normal. 10 years gave about the same production while rainfall ranged from 150 to 300mm.

Rainfall of about 350 mm gave a range of less than 1000 tons to more than 3000 tons (Figure 6). Again, supporting the previously mentioned results there was no correlation between rainfall and gum arabic production.

The result showed that there was no correlation between gum production and rainfall. So other factors play an important role in gum production i.e temperature during the tapping and relative humidity, high temperature at tapping is conducive to high gum production while low temperature seems to seal off gum exudation points resulting in low yield similar results have been reported by (IIED and IES, 1998).

Rainfall with minimum and maximum temperature during tapping and gum picking ,and relative humidity are the main factors affecting gum yield.

Acacia senegal is adapted to low rainfall, however biological socioeconomic factors such as population movement, civil conflict and change in farming practices have negatively impacted gum production, the results are in agreement with several studies e.g. (Abed Rahaman et al.,(2000) with respect to impact of all or some of these factors on gum production. Also rapid population growth and increase in the demand for woody forest result in decline of gum area due to the expansion in

agriculture for crop production in addition to decline in gum prices compared to other field crops such as sesame and ground nuts.

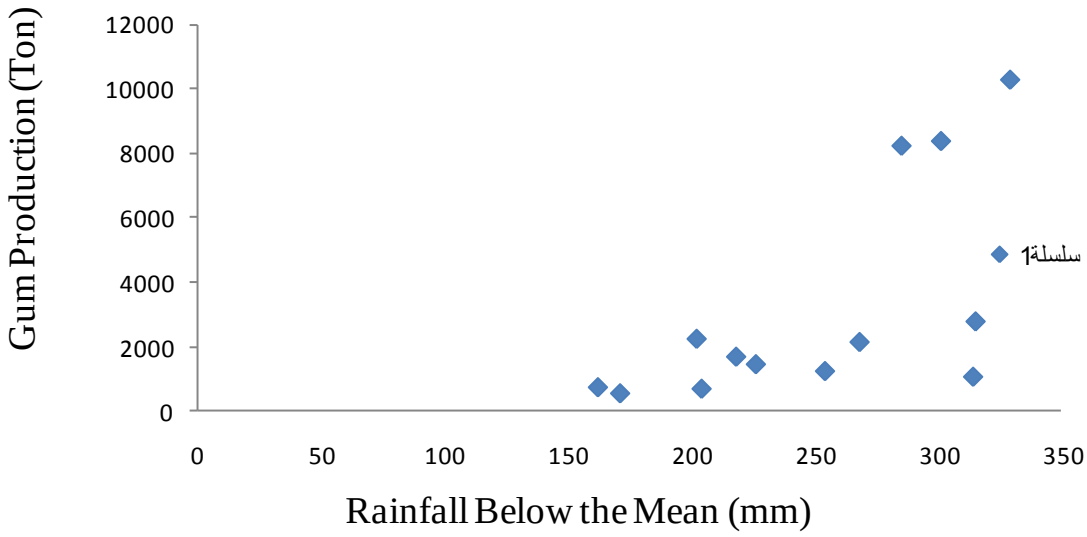


Fig (5): Relationship between the rainfall below the mean and gum arabic production in El Obied area (1980-2009).

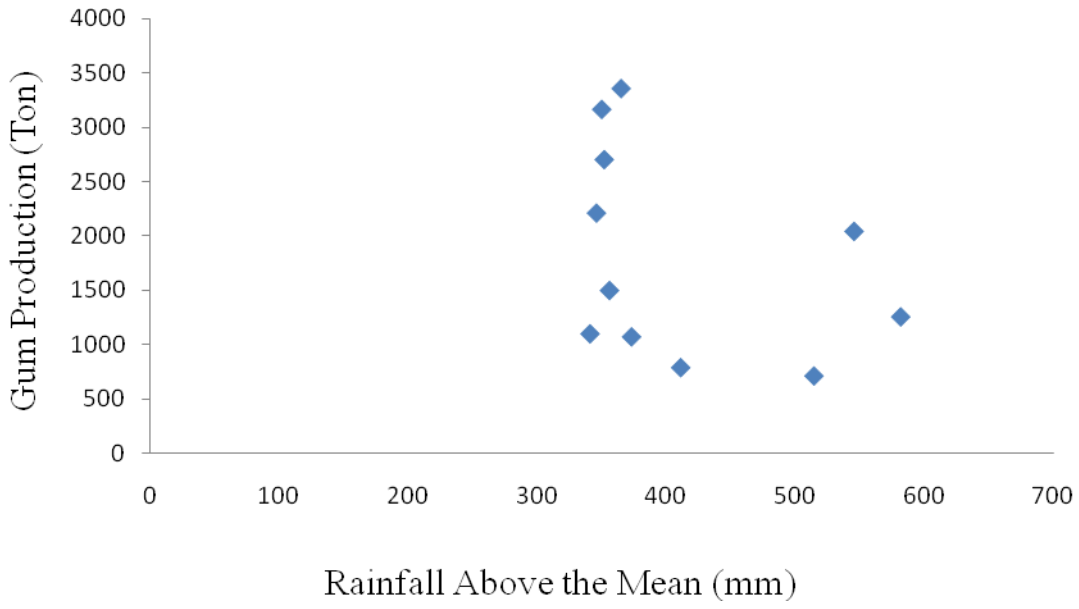


Fig (6): Relationship between the rainfall above the mean and gum arabic production in El Obied area (1980-2009).

Management in terms of tapping intensity or sustainable management of the gum gardens through natural seed fall and artificial regeneration are also important factors that affect the sustainability of gum production. Therefore clearance of *A. senegal* stands for firewood and charcoal has negative effects on gum yield while tapping intensity is positively correlated with gum yield . Labor a viability during gum tapping and collection is also an important factor that affects production.

Fluctuation in gum production due to political unrest and inadequate marketing have resulted in the emergence of new gum producing countries such as Chad and Nigeria .In recent years , gum producers suffered from many problems e.g. lack of finance and transportation facilities, high rates of several taxes, Ushoor and Zakat , crops selling out of market premises or if price was low the produce is kept in stores to be sold next year. In addition, the Producers suffer from price fluctuation which negatively affect the processes of tapping and picking of gum. In general gum arabic production is controlled by many factors, namely environmental, social, economical and political.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

1.5 Conclusions

The study showed that there was no clear correlation between Gum Arabic production and rainfall being dropped in July, July and August, July, August and September below or above the normal rainfall.

The gum production during the period ranged between 541 and 63151 tons.

The highest production was in the year 2001with rainfall 348mm while the lowest production 1990 with rainfall 171 mm.

The production reached the market showed weak correlation between rainfall and gum production.

5.2 Recommendations

Experimental investigation on the relationship between the rainfall and gum production is needed to be undertaken in research plots for along time.

The study should include gum factors such as price and others factors.

Competition of gum arabic trees and other crops, should be considered.

This is a difficult work with low man power.

REFERENCES

Abedel Dafei, A. R (1978). Annual Report of 1978, Gum Research Division ,Elobied ,Sudan.

Abedel Rahaman, H. M (2000). Effect of Some Growth Parameters and Age on Gum and Seed Yield of *Acacia senegal* Plantations and Natural Stands in North Kordofan. M.Sc, Faculty of Forestry, university of Khartoum.

Adam (2008). Agroclimatology, Crop Water Requirement & Water Management .Gezira printing &publishing company, Wad Medani, Sudan.

Awouda, E. H. M (1973). Social and Economic Problems of the Gum Arabic Industry. A Thesis Submitted for the Degree of Bachelor of Letters ,Oxford University.

Awouda, E, M (2000). Production and Commercialization of Gum Arabic .Work Shop on Management of Trees for Farm Land Rehabilitation and Development ,Khartoum ,Sudan.39p.

Ibrahim, A. M (2002). Gum production in Africa with special References to Sudan to Sudan and Emphasis on Potential for Poverty Alleviation. Work shop on Gum Arabic Production , processing and Trade in Africa, Khartoum –Sudan, 22-25 April 2002.

Badi, et. Al. (1989). The Forest of the Sudan. Agricultural Research Conical, Khartoum.184p.

Bashir M. 2001. Sudan country study on biodiversity ;silver press ,Khrtoum ,Sudan.

Ballal, M. E (1991). *Acacia Senegal* a Multi –Purposes Tree Species for Arid and Semi-Arid Tropics M.Sc. University of Wales UK.

Ballal; A. E. El Siddig ; Elfadol & Luukkanen (2004). Gum Arabic Yield in Differently Managed *Acacia Senegal* Stands in Western Sudan .Agro Forestry Forum (2005) 63;237-245

Barbier, E. B (2001). The Economic Linkages between Rural Poverty and Land Degradation ;Some Evidence from Africa .Agriculture Ecosystems and Environment 82;235-260.

Bateson, et al (1988). Sudan Gum Arabic Sector Analysis and Policy Options. Report Prepared for the United States Agency for International Development.

Bliss, et. Al. (1996). Supplementation With G. A. Fiber Increases Fecal Nitrogen Excretion and Lowers Serum Urea Nitrogen Concentration in Chronic Renal Failure Patients Consuming a Low-Protein Diet. Am. J. Clin. Nutr. 63, 392-398.

Chikamia, B. N. and Odera, J. (2002); Gums and Gum resins in Kenya: sources of alternative live hood and economic development of the dry lands, Nairobi: English press.

Elkhidir, E. E.; A. Z. B, Baharum shah & T. S. Yew (2010) Estimation of Technical Efficiency for Share Contract of Producing Gum Arabic; Kordofan Gum Arabic Belt ,Sudan.4: 185-193.

FAO (1995). Food Nutrition. FAO, Rome.

Hussein, S. E. G (1983). A Preliminary Study of Soil Under Acacia Senegal (L) Willd .Sudan Sliva. 5: (25) 125-135.

IIED and IES (1989). Gum Arabic Rehabilitation in the Republic of the Sudan ; Stage1 Report. International Institute for Environment and Development (IIED) and Institute of Environmental Studies (IES), IIED , London.

Joseph K.L.M.O Odee.D. W. WeKesa, C. and Ndakwe, B. (2008) Effect of chemical properties of soils on gum elementary compositions from Acacia senegal varities sis in Samburu and Marsabit districts. African Journal of plant sciences vol 4 (2),pp 021-025.

Muthana, K. D (1988). Gum Arabic –The Back bone of Kordofan Region, Sudan .My forest. 24, 95-98.

Mocak, J.et.al. (1998) .The classification of Natural gums x. chemo metric characterization of exudates gum that conform to the revised specification of gum Arabic for food use, and the identification of adulterants food Hydrocolloids 12:141-150.

Mahmoud, T. E (2004). The Adequacy of Price Incentives on Production, Processing and Marketing of Gum Arabic in Sudan: A Case Study of North and West Kordofan. Institute of Forest Economics and Forest Management Planning. Germany.

NAS (1980). Fire Wood Crops, Shrubs and Tree Species for Energy Production .V ol.1. National Academy of Sciences, Washington. D. C, Oleghe, P. E, Akinniesi, F. K, 1992. Nitrogen Fixing Tree Research Reports,Vol.10.pp .106-109.

Ross, J. H. 1977. Conspectus of the African Acacia Senegal species.

Rampton et. al. Treatment of chronic renal failure with dietary fiber. Cline Nephrol 1984:21:59-163.

Seif El Din A.G. 1969 the natural regeneration of Acacia Senegal (L.) Wiled MSC thesis, university of Khrtoum, Sudan.

Seif El Din, A. & M. Obied (1971). Ecological Studies of the Vegetation of the Sudan. Sudan first National Communication vol.1, Section 2 Kordofan Agriculture and Forestry.

Seif El Din A. G. 1995 Gum Arabic production in Sudan. Agricultural **Sharawi, H. A.** (1986) Acacia Senegal in the Gum Belt of western Sudan :A Cost Benefit Analysis . MSC, Thesis Department of forestry university college of north Walles, Bangor. Memories of the Botanical Survey of south Africa No.44.

Annex (1): Length of Rainy Season and Gum Arabic Production (Ton)

Length of Season(month)	Gum Arabic Production (Ton)
4	3358
5	2768
4	2229
4	2705
3	729
4	1675
4	1075
4	1443
4	2213
5	2130
3	541
4	683
5	715
5	1103
4	2045
4	2045
4	3167
3	1501
4	1259
4	105

Continue annex (1)

5	7093
5	5914
4	8208
4	1230
5	15114
4	11528
4	792
3	8355

Annex (2): Annual Rainfall Below the Mean and Gum Arabic Production (Ton)

Rainfall Below the Mean (mm)	Gum Arabic Production (Ton)
315	2768
202	2229
162	729
218	1675
226	1443
268	2130
171	541
204	683
329	10254
314	1054
285	8208
254	1230
301	8355

Annex (3): Rainfall above the mean and Gum Arabic production (Ton)

Rainfall above the mean	Gum Arabic production (Ton)
365	3358
352	2705
373	1075
346	2213
514	715
341	1103
545	2045
350	3167
356	1501
581	1259
411	792
365	3358