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Socioeconomic Aspects of Agroforestry Systems: The Case of Gum-cultivation Cycle

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Abstract: The purpose of the study was to attempt to understand the nature of the problems related to production and local marketing of gum Arabic as seen by producers and local traders. Using structural questionnaires and multistage stratified sampling, data were collected on economic activities, production and productivity, price and pricing policy and marketing and trade as well as services provided to producers. Statistical analysis was carried out using various descriptive methods including means and means comparisons. The results indicated a general declining trend of the areas tapped by households, productivity per unit area, prices received by producers and different forms of services during the period covered by the study. The level of the producer's price seems to be the most important socioeconomic factor affecting the decision to produce. The need for institutions that are more effective and of services that promote production and marketing were seen as essential. The results have important implications on pricing policies and sustainability of the gum-cultivation cycle as an integrated management system in the gum belt of the Sudan.

Key words: Gum Arabic belt; cultivation cycle; perception; policies; Sudan

INTRODUCTION

Agroforestry has been known and practiced, in various forms, in the Sudan for centuries. The most important form of agroforestry in the marginal lands of the Sudan is the gum-cultivation cycle system (GCCS). The most favourable conditions for this system are on sandy soils with 350-400 mm annual rainfall, although it is also practiced in

clay soils. GCCS is a sequential agroforestry system in which trees of *Acacia senegal* (*hashab)* are cultivated with agricultural crops such as sorghum, millet, sesame and groundnut.

In the traditional system, the *hashab* trees are maintained for about 15-20 years for the production of gum Arabic, followed by field crops for a period of four to five years. The *hashab* cycle ends in a very fertile soil suitable for crop production. After cultivation for four to five years following the *hashab* cycle, the soil fertility declines resulting in a drastic fall in productivity and ultimately farmers abandon the area to a new area. The fallow area will be occupied by *hashab* seedlings naturally or artificially regenerated for the next *hashab* cycle. Hence, the name commonly used is 'bush-fallow system'. This forms uniform and pure stands of *hashab* (known as the gum-belt of the Sudan). This has resulted in the Sudan being recognized as the greatest producer and exporter of the best qualities of gum Arabic.

The GCCS is thus acknowledged as a well-established farming system in the marginal land of Sudan. It used to support the local population's livelihood through the provision of food, cash crops and gum Arabic. Moreover, the *hashab* trees improve the soil fertility.

This traditional system continued for generations in the past. The stability of the natural, social and economic environment is claimed to be the main factor that sustained the system through time. However, there is evidence of disturbance of the system. Rotations for agricultural crops tend to be longer than the soil can support, and the rotations of the bushes or gum trees tend to be shorter (El Houri 1989; Mohamed 2000). Fluctuations in crop and gum production showed a general declining trend through time. This situation has not only resulted in losses of export value, but also, and more importantly, in loss of income to countless families who depend upon the *hashab* tree as an essential source of income during the dry season (Coppen 2000). Moreover, the loss of trees has resulted in loss of fertile soil essential for generating the principal income from agriculture.

The explanation of the declining situation of the system has been studied in the context of local natural factors and biological factors (Ballal 2000; Dewey *et al*. 1997) as well as international market situations (Flowerman 1985; Robbinson 1988; FAO 1996; Sharawi and Adam 2005). Although these studies were relevant, they were undertaken in isolation of underlying socioeconomic factors related to the gum producers at the grass root level and to those related to policies and institutions as these are also important factors (Barraclough and Ghimire 2000). Contributions to such studies are few. For instance, Ahmed (1999) studied factors influencing the decision to retain *hashab* stands as a component of the household farm system. Rahim *et al.* (2007) have focused on analyzing farmers' economic incentives to abandon or expand gum production

The objective of this present study was to analyze socioeconomic and policy factors affecting the availability of the *hashab* trees as well as factors related to production and local marketing of the gum. Specifically, the study analyses perceptions of producers and small traders, at the grass root level, on problems that relate to production and supply of gum in the gum belt of the Sudan.

METHODS

A survey covering the gum belt of the Sudan was conducted during the period July to August 2000. Data on land-uses, gum production and gum marketing in the gum-belt of the Sudan were collected. The study comprised a set of five structural questionnaires prepared to cover different categories. However, this paper is concerned only with gum producers' and village merchants' questionnaire, which was conducted through personal interview of households. The study area was the gum belt of the Sudan, which is part of the gum belt located in the Savannah area south of the Sahara stretching east from Mauritania and Senegal to the boundaries with Ethiopia.

As this study designates gum Arabic producers and village merchants as the main target group; the sample frame was the producers (and merchants) in the gum belt area of the Sudan. Multistage stratification was undertaken to increase the precision and allow comparisons among

strata. The strata were Upper Nile, White Nile, Blue Nile, Sinnar, South Kordufan, former West Kordufan, North Kordufan, South Darfur, West Darfur, North Darfur and EL Gedarif States. These were the states, which, wholly or partly, fall within the gum belt. Localities (*Mahlia*) were selected using the method of probability proportional to size (PPS). The total number of localities selected was 20. The households that were engaged in gum Arabic production or sale were then selected. The total size of the sample was 3000. Choice of households at the village level was done systematically with a random start using a complete list of heads of households.

The questionnaire consisted of six sections. The required information was on

i. details on the major economic activities of the respondents (occupations, land-use, land tenure, crop production, productivity. etc.);
ii. gum Arabic production, prices and pricing policy and respondents perspectives about them;
iii. gum marketing and trading channels and related problems; and
iv. services provided by some official or other body to enhance production, protection and marketing of gum Arabic and respondent's attitude about them.

Questions on production and marketing covered a six-year period from 1993 to 1999. Data were analyzed using descriptive statistics, and means were separated by Duncan's multiple range test at the 0.05 level of probability.

RESULTS

Economic activities and land resource use

Most of the respondents (98.6%) were farmers and the remaining had other activities besides farming. Family ownership was the most prevalent land tenure system in both crop and gum lands (89.8%, and 87.5% of the respondents, respectively). Other forms of land tenure were hired (8.3%), owned (1.7%), and shared (0.3%).

The mean total area under field crops (1998 season) was 189.79 feddans (One feddan is 0.42 hectare) per household. Sorghum, which is the staple food, was occupying the largest part of the land (81.4 feddans) followed by sesame, the main cash crop (36.6 feddans). On the other hand, the mean total area covered by gum trees (1998 season) was 158.87 feddans per household for the gum belt as a whole, and some states differed significantly in this regard (Table 1). The smallest areas per households were in the western states (with the exception of South Kordufan State), while the largest areas were in Blue Nile and Upper Nile states.

Table 1. Mean total area per household under gum trees by state (1998/99 season)

State	Mean area (feddans)
Upper Nile	1426.70[a]
Blue Nile	630.54[b]
Sinnar	430.08[c]
South Kordufan	217.50[d]
White Nile	209.66[d]
El Gedarif	115.43[d]
West Darfur	68.89[e]
North Darfur	63.59[e]
West Kordufan (former)	56.50[e]
South Darfur	43.57[e]
North Kordufan	25.50[e]

One feddan = 0.42ha

Means in a column followed by a similar letter are not significantly different at P=0.05, according to Duncan's multiple range test.

Gum Arabic production and pricing policies

More than 87% of the respondents tapped natural gum gardens, 5.1% tapped plantations and 6.45 % tapped both natural stands and plantations. At the state level, respondents in Upper Nile State tapped only natural gardens. In the other states, respondents tapped mainly natural gardens with very few tapping of plantations. The exceptions are in White Nile and North Kordufan states where 21% and 30%, respectively, of respondents tapped plantations. This is due to rehabilitation programmes carried out mainly in these two states. As far as the tree species is concerned, 98.2% of the respondents tapped *hashab* trees, 1.3% collected gum from *talh* (*Acacia seyal*), while only 0.5% collected from both *hashab* and *talh*.

Mean *hashab* areas tapped by households showed continuous decline through the study period, from a mean of 88.15 feddans in season 1993/194 to a mean of 38.41 feddans in 1998/99 season, i.e. almost 50% decline in six years (Figure 1). On the other hand, gum prices per Kuntar (One Kuntar = 45 kg) received by producers also showed continuous decline from 24.21 Sudanese Pounds (1US$ = 250 Sudanese Pounds) per Kuntar in 1993/94 season to 13.96 in 1998/99 season, i.e. about 40% decrease (Figure 2). These two figures indicate that areas tapped are affected by price expectations. Mean areas at state level also showed this trend through time for each state, although the decline was more pronounced in Upper Nile State in the last two seasons of the study period (Figures 3).

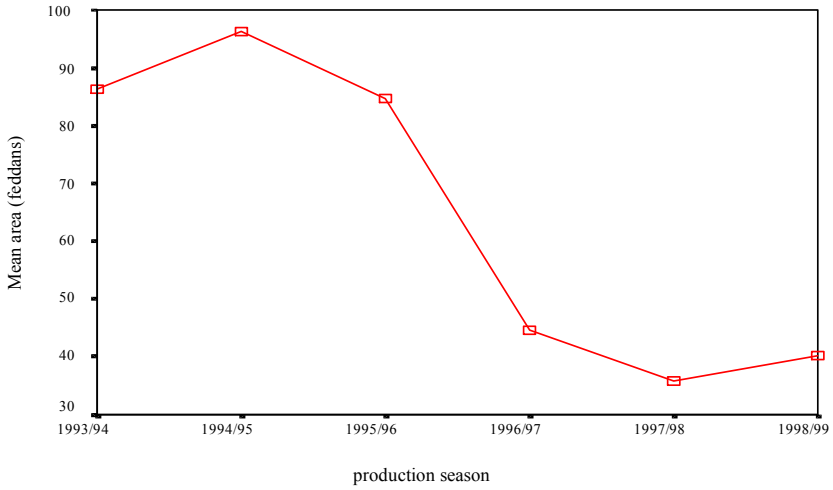

Figure 1. Mean *hashab* area tapped by households in different production seasons in the gum belt of the Sudan

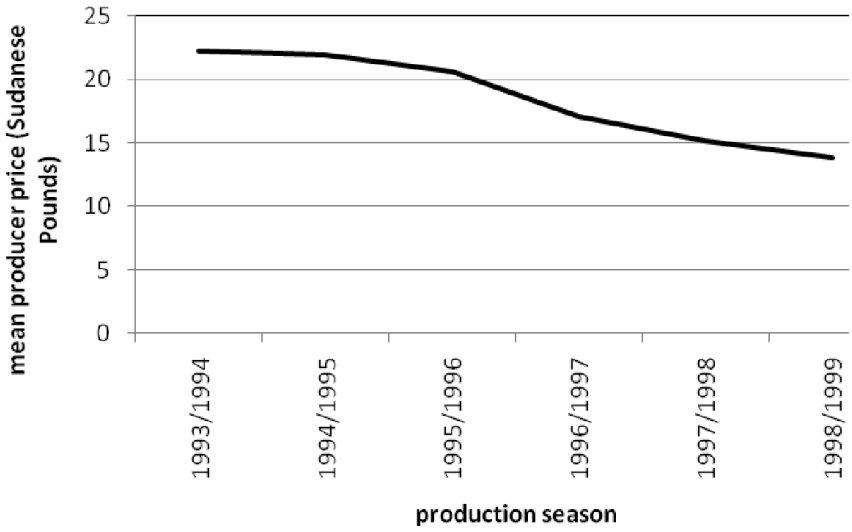

Figure 2. Mean gum price received by producers in different production seasons in the gum belt of the Sudan

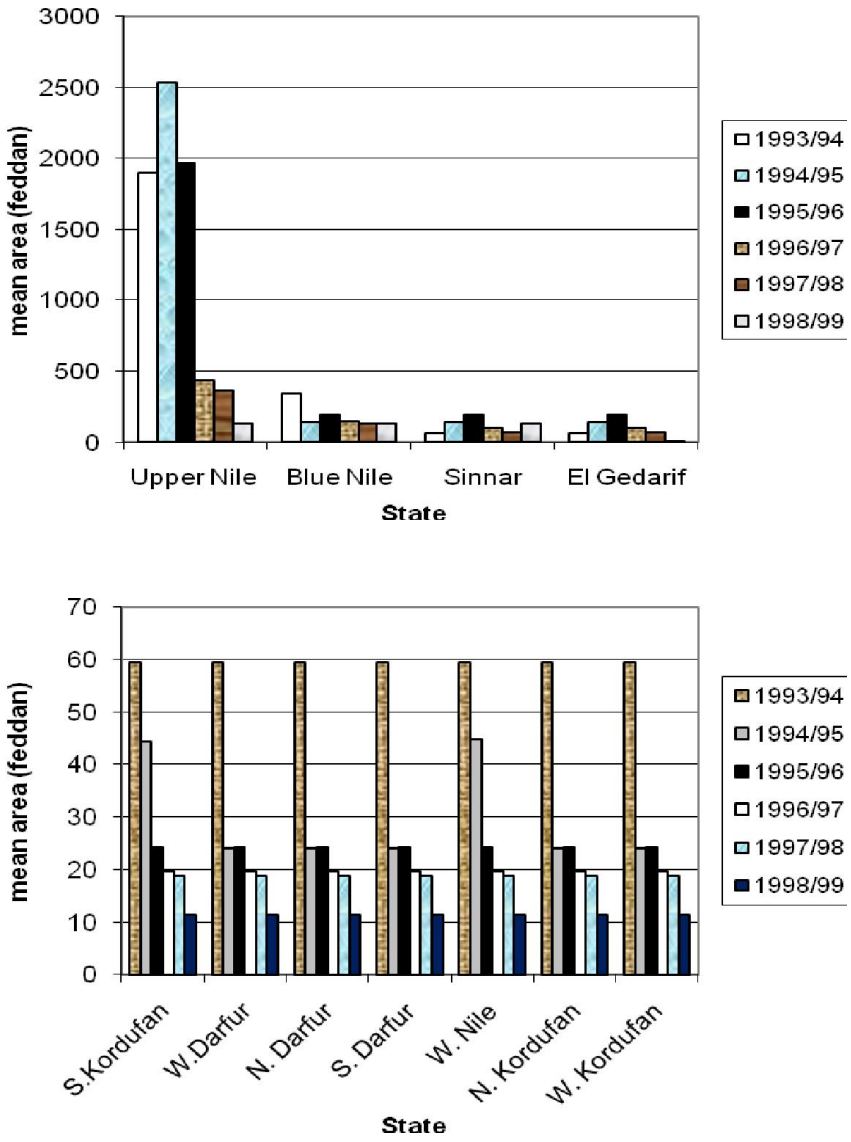

Figure 3. Mean tapped areas by individual households classified by state in different production seasons

More than 67% of respondents did not tap gum trees in either of the two last seasons of the study period. Of those who did tap in the mentioned seasons, 41.4% indicated that they would not tap next year, and 5% indicated that they could not decide before hand; the rest said they intend to tap.

Gum production in Kantar/feddan was given by respondents for different types of gum gardens (natural or plantations) and for different states. Variation between natural and plantation gardens in per unit area production was also given for the 6 production seasons covered by the study. Productivity varied between 1.4 and 1.96 for naturally regenerated *hashab* gardens and between 2.79 and 0.93 for plantations. Upper Nile and White Nile states were distinctively the most productive states throughout the 1993/94-1995/96 production seasons. During the last 3 years of the study period, however, the White Nile State was the most productive state, although with declining trend (mean of 4.0 Kuntars /feddan). In the Upper Nile State, productivity fell from 5.6 in season 1993/94 to only 0.81 in season 1998/99. The rest of the states followed a similar declining trend over time (Table 2).

Regarding the effect of current gum prices on the producer's decision to produce, 53.7% of the respondents decided that they will not produce if prices remain the same, 24.3% said that they will produce less, 15.5% will produce more and 6.5% said that it will have no effect on their decision to produce.

Gum revenue seemed to be an important part of the household income. On average, it comprised 19.5% of the total income. In particular, this was most important in the Blue Nile State (35% of the income) and least important in North Darfur State (5.87% of the income). In the other gum producing states, gum sales contributed, on average, 17% of the total income.

Table 2. Mean per unit area production of *hashab* gum (Kuntar/feddan[1]) in different states (season 1993/94-1998/99).

State	season 1993/94	season 1994/95	season 1995/96	season 1996/97	season 1997/98	season 1998/99
Upper Nile	5.60[a]	6.50[a]	8.52[a]	4.30[a]	3.59[a]	3.22[a]
White Nile	4.14[a]	4.30[a]	4.30[b]	2.39[ab]	1.65[b]	1.00[b]
West Darfur	2.31[b]	1.96[b]	3.14[bc]	1.64[b]	1.64[b]	1.42[b]
West Kordufan (former)	1.60[b]	1.79[b]	1.94[bc]	1.55[b]	1.23[b]	1.41[b]
Sinnar	1.56[b]	1.58[b]	1.62[bc]	1.53[b]	0.99[b]	1.01[b]
South Darfur	1.38[b]	1.37[b]	1.45[bc]	0.94[b]	0.92[b]	1.00[b]
North Kordufan	1.23[b]	1.22[b]	1.42[bc]	0.94[b]	0.90[b]	0.94[b]
North Darfur	1.08[b]	0.93[b]	1.01[b]	0.65[b]	0.70[b]	0.84[b]
El Gedarif	0.82[b]	0.84[b]	0.76[b]	0.64[b]	0.63[b]	0.81[b]
Blue Nile	0.80[b]	0.76[b]	0.75[b]	0.64[b]	0.59[b]	0.58[b]
South Kordufan	0.65[b]	0.3[b]	0.72[b]	0.51[b]	0.57[b]	0.32[b]

Means in a column followed by a similar letter are not significantly different at P = 0.05, according to Duncan's multiple range test.

[1]One feddan = 0.42ha

In response to the inquiry about the gum price at which producers will like to sell next season, the mean desired price for the gum-belt was 57.82 Sudanese Pounds. However, significant differences were obtained between the states where the highest desired price was in the White Nile State (71.61 Sudanese Pounds) and the lowest was in North Darfur State (43.82 Sudanese Pounds). Respondents reported various reasons for their decisions. The most frequent reasons for deciding to collect gum in the following season (given by ≈ 85% of the respondents) were in the following order:

1. They expect that gum prices will rise, because there are signs of concern from authorities in this season (31.7%);
2. they will tap if the price rises (14.3);
3. they want to increase their incomes (31.3%); and
4. gum collection is their traditional profession and they cannot abandon it (7. 4%), that is they will tap in all cases.

On the other hand, the most frequent reasons for ≈ 85% of those who decided not to collect were in the following order:

1. Prices are too low (69.7%);
2. returns from gum do not cover costs (12.1%); and
3. trees are gone or not accessible (6.5%).

Concerning gum producer's opinion on the current gum-pricing policy, 93.1% of the respondents revealed their dissatisfaction; the most frequently given answers by ≈85% of the dissatisfied respondents were in the following order:

1. Too low prices are offered (49.2% of the dissatisfied respondents);
2. it causes losses to producers (30.2%); and
3. the pricing policy is degrading production (8.2%).

Gum Arabic marketing and trade

This part investigates availability and quality of cooperative society services, marketing channels and producer's perception about them. As far as cooperative societies were concerned, the results indicated that only 11% of the respondents were members of these societies. While

75% were not members, over 13% never heard of such societies. Of the members, 52.8% perceived cooperatives as beneficial, while 47.2% saw them as not beneficial. The most frequent reason reported by those who see them as beneficial was that cooperatives provide services such as tree protection (30.3%), offer good gum prices (18.4%) or provide services and finance to production (13.8%). The most frequent reason for seeing cooperatives as useless was that they do not provide services for producers (62.5% of those not pleased). Other reasons were that cooperatives do not fulfil their promises of problem solving (20.8%), or their activities were frozen years ago (6.7%). This means that, through time, less and less producers were provided with services.

As for the gum marketing channels, the majority of responded producers consistently sold to village merchants or crop auction market (that is, they habitually continued to use the same channel from season to season). Producers selling through village merchant were between 49.2 and 51.7% of total producers. Crop market showed slightly lower percentages. Village merchants financed only 10.5% of the producers who sell to them. The main form of this finance was cash loans and/or food material (46.1% of the respondents using this channel) and *shale*[1] system (17.6%). Although most producers sold to village merchants, the majority of respondents revealed their preference to sell directly at the auction market (40%), the most frequent reason being that much better prices were obtainable. The reason for selling to the village merchant, despite producer preferences for the auction market, was that village merchants provide better services.

There were 21 different types of taxes paid by producers when selling their gum (some of which of local nature).

Services and institutions

According to producers, services received during the study period were provision of water, marketing related services, product transport, extension services and tree protection services. The number of

[1]Shale system means cumulative amounts shouldered by the producer to the village merchants to whom the producer pledges the produce before it is ready for the market.

producers who received such services has continuously decreased through the study period reaching a minimum in season 1998/99. As for the producers perception about the quality of the services provided by the producer associations, only 20.4% expressed their satisfaction. The most frequent reasons given by 85% of respondents in this category were in the following order:

a. Services are not intended to benefit producers (58.2% of the unpleased); and
b. associations do not reach producers, as the former are located in towns and not in producing areas (27.4%).

Less than 10% of the respondents received extension services during the 6-year study period. About 83.4% of those who received such services perceived them as beneficial. Those who did not receive them, or were not pleased about what they had received gave a large variety of opinion on how extension services could be of benefit. The following were the most important:

a. Provision of seedlings (19.9% of this category);
b. continuous follow up by the extension agents during production seasons (12.4%); and
c. provision of protection services (11.8%).

Locust attack of the *hashab* trees was seen as the most important hazard, where more than 72% of the respondents had their trees attacked. Reaction of producers to get rid of locust varied from informing concerned official authorities (Forest National Corporation, Plant Protection Department. etc.) to using traditional control methods. Most of the affected respondents said that they contacted concerned authorities (50% of those whose gardens were affected), followed by those who did nothing but praying to God (28%). Direct control with insecticides and poison was used by only 5 % of the affected. The most important traditional method of control, used by 7.5% of the affected respondents, was setting fire around the forest. Eighty-five percent of the affected respondents revealed that notifying authorities was effective against locust attack, while 6% thought that direct use of insecticides and pesticides was effective.

DISCUSSION

Land tenure system in the gum belt of the Sudan is mostly family ownership that is passed through inheritance. Farm land size is, therefore, subject to reduction through fractionation. In the pursuit of producing more food, and as population size increases and families multiply, younger families will have smaller and smaller pieces of land that would not allow them to practice the traditional system of integrated land management. This entails clearance of land of trees which may result, in the short-run, in loss of income associated with trees. In the long–run, farm and off-farm income may be reduced. Since the majority of gum producers are originally farmers, income obtained from gum sales is an important off-farm supplement received when mostly needed. Thus, the sustainability of this income directly relates to the sustainability of the GCCS. The availability of income during the slack agricultural seasons encourages farmers to stay in their villages throughout the year and prevents the unwanted and perhaps the irreversible, social instabilities such as migration to cities and conflicts due to resource degradation. However, given the present conditions in the gum belt, this source of income is endangered. The declining trend through time in the areas tapped by household producers and in productivity per unit area caused a declining position of the gum business at the household level, to the extent of abandonment during at least the two last seasons covered by the study.

Although reduced productivity per unit area may not necessarily mean that productivity per tree has declined or that the number of trees per unit area has decreased, it may only mean that the number of tapped trees is reduced. It is not foreseen, in the near future, that gum land would be cleared of trees, rather trees would be left on land and tapping would be abandoned (Rahim *et al.* 2007). This is expected to happen whenever there are more rewarding off-farm opportunities. The decline in production and productivity levels follows the same declining trend of the producer prices during the same period. It is, therefore, natural to expect the negative effect on profitability of producing gum. As expected, nearly half of the respondents readily

decided not to tap *hashab* trees in the future in case prices would not improve. This may mean that those producers have other more rewarding alternative opportunities such as working in cities or raising animals. Concerning the other half of the producers, they still have faith in *hashab* and still hope that prices will improve and they perceive gum as an essential part of their income. The implication is that *hashab* business cannot easily be deserted specially for those who see it as a traditional profession that has been passed through generations and they see no alternative of a comparable value. The problem is that habits and faith are subject to be weaken by successive disappointments particularly when income and survival are at stake, as in such vulnerable environments.

Differences among states in the size of gum land retained by households and in production per unit area seem to vary as environmental conditions and population size vary. In the marginal areas, households tend to keep less forest (gum) land than in areas of better environmental conditions. In the former areas, the traditional GCCS described earlier is expected to be more prone to modifications than other areas. Producers in the more resource-abundant states are more prepared to switch from the gum business, than producers in the resource poor states are, despite the higher productivity per feddan in the former. Generally, smallholder activities are more diversified in the clay areas of the gum belt (Upper Nile, Sinnar, Blue Nile, Gedarif and White Nile states) than in the sand areas (West Darfur, North Darfur, North Kordufan, former West Kordufan states). The exception is the State of South Darfur (sand) where livestock raising plays a major role in the household economy (FAO 1996). This partly explains the significantly higher gum prices desired by producers in White Nile and North Darfur states as compared to the former West Kordufan, South Kordufan and North Kordufan states. Prices are "desired" because local gum market is not a free market and prices are predetermined by a pricing policy, which is affected partly by international market prices. However, even for the least price desired (43.82Sudanese pounds/ Kuntar) it is more than three times the price offered in 1998/99 season (13.51 Sudanese pounds/Kuntar). With this pricing policy, the

motive to produce seems to be weak indeed. When returns are substantially lower than the minimum required level, looking for alternatives becomes eventually the inevitable choice. It can be inferred from the above that producer price is the more obvious factor affecting the decision to produce gum.

The purpose of establishing cooperative societies and producer associations was to help in solving producer problems, providing better services and fetching maximum prices to members. Some of the services, which were introduced with the rehabilitation programmes, included such services as locust control, introduction and promotion of extension services besides introducing village bank system to finance producer groups. These measures, although limited to a certain area, were effective in increasing production (Awouda 2000) before prices were lowered due to surplus supply. All these services were continuously declining. Some of them have completely disappeared by the 1998/99 season. The said institutions have failed to maintain them. The need for extension services, for example, can be seen when considering problems such as locust attack. Most of the respondents who contacted concerned authorities at the event of the attack revealed their satisfaction with the results. On the other hand, other forms of reaction were reported not to be successful. The extension services in this regard can be of value by distributing such information. The effect of extension and other services on production might not be as strong as prices; nonetheless, producer attitude towards them was generally positive.

Because most of those engaged in gum tapping and collection are ‘small’ producers; they have no connection with or influence on these institutions and, therefore, do not benefit from them. This is due to the fact that producer representatives are not chosen by those producers; rather there are socio-political factors that contribute to this choice. However, half of the cooperative members seemed to acknowledge the important role cooperatives play as providers of services such as tree protection. The rest perceive cooperatives as not being up to their duties, especially in negotiating prices. The source of conflict needs

closer investigation. However, it can be inferred that, during part of the study period cooperatives were beneficial in providing protection to some producers who were covered by rehabilitation programmes, despite their failure when it came to negotiating prices.

It is commonly stated that the producers are unable to sell their produce directly in the crop market in spite of their wish to do so; instead, they sell through village merchants because merchants provide finance when it is mostly needed (Rahim *et al.* 2007). Contrary to this belief, only 10% of such producers received finance in various forms, which means that finance was not the only reason for selling to village merchants. The reason why those not receiving finance still use this channel is probably due to the high cost relative to the amount that individual producers are supplying. The cost of transaction is not just weak infrastructure (transport in particular) but also taxes and levies that are collected at the crop market which reduce returns substantially. Lack of the role of institutions in facilitating marketing and negotiating for lower taxes and better prices has thus lead producers to accept lower prices than otherwise was obtainable; this has then diminished the gum business in later seasons.

There are two endeavours that occurred during the period 2005 to 2008 to improve the gum business situation. One major change was the change of the status of the Gum Arabic Company from a monopolistic to a competitive company by opening the way for other companies to entre the market. The other change was the establishment of the Gum Arabic Board. Both changes were expected to affect, among other things, the local market. Producer prices were positively affected as the price has increased by 70% in 2009/2010 as compared to previous seasons. Whether this will be sustained depends on how the international price and market margins can absorb such a huge change in the local price. In all cases, the change in prices is part of the story and other changes are required such as improving the services and empowering producers (especially negotiation power).

In conclusion, the problems facing the sustainability of the GCCS are closely linked to the stabilization of the gum business. They are not only due to natural causes or world gum market situations. Production and marketing policies of such an important commodity were ineffective and have led to the detracting situation of the gum business. The producer's socioeconomic problems at the grass-root level seems more fundamental, since upon them the whole process of production depends. The provision of fair (not necessarily high) producer prices and services effectively delivered to those mostly in need of them seems to be the key to sustained production. There is a need to extend extension services. The role of institutions needs to seriously be scrutinized. If their services can not be improved, alternative ways have to be considered, e.g. organizing small producer production and marketing firms. The continuation of the above mentioned situation may lead to further negative effects on the sustainability of the integrated management system in the gum belt. In the short run, producers may confine to mono-cultural practices, and switch to alternative off-farm activities if they seem to be more rewarding under the current situations. In the long- run, however, and due to the vulnerable nature of marginal lands even this may not be sustained.

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الجوانب الاجتماعية-الاقتصادية لنظم الزراعة الغابية: حالة دورة الصمغ الزراعية

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موجز البحث: هدفت هذه الدراسة الى محاولة فهم طبيعة المشاكل المتعلقة بالانتاج والتسويق المحلي للصمغ العربي من وجهة نظر المنتجين و التجار. باستخدام الاستبيان الهيكلي و العينات متعددة الطبقات، جمعت بيانات عن الانشطة الاقتصادية وانتاج وانتاجية الصمغ العربي والاسعار والسياسة التسعيرية والتسويق والتجارة والخدمات المقدمة للمنتجين. تم التحليل الاحصائي باستخدام طرق وصفية مختلفة بما في ذلك المتوسطات ومقارنتها. تشير النتائج الى وجود تناقص في المساحات التي يتم طقها بواسطة الاسر والانتاجية والاسعار وذلك أثناء فترة البحث. يبدو ان مستوى الاسعار التي يتلقاها المنتج هو اهم عامل يؤثر على قرار الانتاج. خلصت الدراسة الى ضرورة وجود مؤسسات أكثر فاعلية وخدمات تؤدي الى تطوير الانتاج والتسويق. لنتائج هذه الدراسة تداعيات على السياسة التسعيرية واستدامة دورة الصمغ الزراعية كنظام اداري متكامل في حزام الصمغ العربي في السودان.