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FARMERS PERCEPTIONS TOWARDS AGROFORESTRY SYSTEMSINNORTH AND SOUTH KORDOFANSTATES, SUDAN

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Abstract

This study was conducted during 2010 and 2011 in North and South Kordofan States with objectives of to identify and assess the most important agroforestry systems, to characterize major tree species in different agroforestry system, to prioritize major constraints on agroforestry systems in the region, and to study the current status of gum Arabic trees and their contribution on farmers livelihood.Data were collected through community meeting, individual interviews and direct field observation. The common agroforestry systems in the region are scatter trees on farm land, followed by wind breaks and boundary planting. The important trees in the study area are *Acacia senegal*83%, followed by *Fadherbia albida*46%, *Ziziphus spina- christia*43% *and Balanites aegyptiaca* 41%. The most important field crops that cultivated in agroforestry system are groundnuts, millet, sorghum, sesame and roselle. The environmental benefits of trees in farm which was identified by the respondents include protection of farm against wind erosion, improvement of the soil properties, improvement of the micro-climate and providing a source for income which was indicated by the majority of respondents. Across all sites 93% of respondents showed that gum Arabic have a significant contribution to their family income. The study recommended that a multi-purpose tree species such as *Acacia senegal* should be maintained for amelioration of soils fertility and increase crop productivity in the fragile ecosystems such as that of the study sites.

Keywords: Scatter trees on farmland, Shifting cultivation, gum Arabic, Kordofan, Sudan

Introduction

Agroforestry is a term of varied and complex meaning. It has been subjected for many attempts to define it. The most widely accepted definitions are the following:

"Agroforestry is a collective name for land use systems and technology where woody perennials (trees and shrubs) are deliberately used on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence (Lundgern, 1984)".

"Agroforestry is a sustainable land management system that increases overall production, combines agricultural crops, tree crop and/or animals simultaneously or sequentially and applies management practices that are compatible with the cultural pattern of the local population (Raintree, 1984)".

"Agroforestry is a collective term for system and technology of land use where perennial woody plants (trees, bushes, shrubs, scrubs, (and by assimilation, palms and bamboos) are deliberately cultivated on ground otherwise used for crop and/or livestock raring in spatial or temporal arrangements, and where there are interactions at once, ecological and economical, between the woody plants and other components of the system (Baumer, 1990)".

Agroforestry, however, is probably more important for improving and sustaining the productivity of land with soil fertility and soil moisture problems and where lack of rural infrastructure and cash make it necessary for people to produce most of their own basic needs for food, fuel, fodder and shelter.

Appropriate agroforestry systems can help through direct and indirect ways, in controlling soil erosion, maintain soil organic matter, improving soil physical properties, enhancing nitrogen fixation, increasing nutrient input, improving nutrient cycling, ameliorating soil activity, increasing soil water availability, helping in reclamation of degraded soils and maintains soil fertility (Young, 1989).

Agroforestry has drawn the attention of scientist and development planner to improve traditional farming systems to make them more productive, and to create a harmony between food production and ecological conditions of the area, and implement land use goals based on socio-economic considerations.

In the Kordofan region of Sudan the traditional field crops including groundnut (*Arachis hypogaea*), millet (*Pennisetum glaucum*), sesame (*Sesamum indicum*), roselle **(***Hibiscus sabdariffa*) and watermelon (*Citrullus lanatus*) are rotated with some important trees such as *Acacia senegalb*, *Ziziphus spina-christi* and *Balanites aeygptiaca* in various forms of agroforestry systems. In this region *Acacia senegal* tree is managed in a time sequence with traditional field crops.This traditional agroforestry system is known as a bush fallow system and was well acknowledged and regarded as sustainable in terms of its environmental, social and economic benefits (Ballal, 1991). This system is practiced as a means of restoring soil fertility and promoting gum Arabic production (FAO, 1978; DANIDA, 1989;Hussein, 1990 and Daldoum and Nimer, 2002).

Integration of trees on farm land is considered to have a positive effect on soil physical and chemical properties, protecting the farm against soil erosion, improving the micro-climate and providing the farmers' needs for fuel wood, charcoal and fencing materials (Fadl and Gebauer, 2004). The negative effect of trees on farm land can be seen in competition for light and moisture and reducing the soil nutrient (Fadl and Gebauer, 2005).

In the last three decades and after the drought of 1984 the natural resources in Kordofan region have shown a general trend of deterioration. In particular, tree cover is declining in density and diversity. The most severe is the expansion of crop production in marginal areas using practices incompatible with resources maintenance (Bunderson, 1999). The resources degradation is particularly acute in the northern part of the region which is fragile to prevailing crop activities. Land preparation involving complete tree felling and removal of grasses followed by hand hoe cultivation is contributing to resources degradation (Saad *et al.*, 1999). Therefore, the majority of farmers in the region depend on rainfed agriculture. The frequent severe droughts coupled with frequent failures in food crop production, lead to food deficit and famine. The objectives of the present study was to assess and describe agroforestry practices, to characterize major tree species in the region, to prioritize major constrains related to agroforestry systems and to study the contribution of these systems to the farmer livelihood.

Material and Methods

Study area

This study was conducted in Kordofan region in three villages Umgalgi representing the northern part, Umlubana representing the western part and Nabag representing the southern part of the region. Kordofan region comprising the States of North Kordofan and South Kordofan cover an area of about 380,000 km^2. It is predominantly an area of extensive livestock production, rainfed cropping and forest product utilization, principally fuel wood and gum Arabic. The area is vulnerable to drought, especially in the north. The population in the region is approximately 3.8 M persons, with 75% in rural areas. Precipitation is greatest from June to October, with concentration of 80 to 90% in July to September. The mean annual isotherm is 27° C with extreme temperatures ranging between 10°C to 46° C. Mean relative humidity ranges from 20% in winter to 75% during the rainy season. Soils in the region range from sandy in the north to heavy cracking clay in the south. The region has diverse and rich vegetation resulting from the variability in soils and rainfall. The north and west are generally covered with low desert and semi-desert scrub. The central sandy soils are covered with *A. senegal* savanna. The clay soils of south Kordofan are covered with broad-leaved savanna woodland *Acacia seyal* and *Balanites aegyptiaca*.

Methods

The three villages were selected randomly to investigate the agroforestry activities during 2010. Fifty households were selected randomly from each village. A questionnaire was developed which sought data on the arrangement of trees on farm land, advantages and disadvantages of growing trees on farm land, field crops used in the agroforestry systems, major constraints for cultivation of the field crops with trees, the status of the gum Arabic trees and their contribution to farmers income. The questionnaire was tested before the survey and the tested group responded positively to the questionnaire. The SPSS (Statistical package for social sciences) was used for data analysis.

Results and discussion

The respondent's sources of income are shown in figure1. The main source of income in the study area are farming which was indicated by (74, 48 and 74%) at the three villages. The second source of income was animal production (2, 10, 2%), followed by forest

products, merchants, jobs, farming and other off season activities. The source of income depends on occupational category of the respondents and it is an indicator of livelihood and welfare of the household. These results are in conformity with the finding of Eldukheri, (1997), who reported that agriculture constitutes the main source of income for over 80% of the population in Sudan.

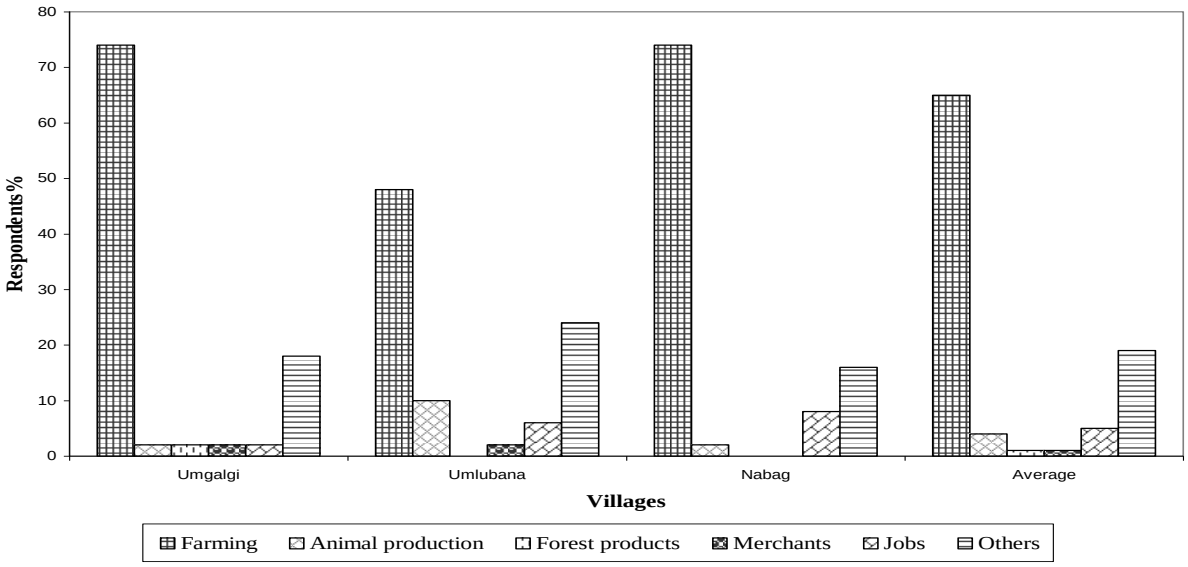

Figure1: Respondents sources of income in the study area

Land tenure system in the study area can be categorized in four forms. Real owners (inherited), followed by rented, share cropping and toungya figure2. Across the three sites the real owners were reported by 75% of the respondents. Within the sites the percentage of real owners averaged 94% in Umlubana, 88% in Umgalgi and 43% in Nabag. This differences could be attributed to the fact that most of inhabitant of Nabag village are emigrant who settled in the village but have no right to land acquisition. This result was attributed to the fact that land is acquired through various regulation systems resulting in different land tenure types. These results are in line with the finding of Eldukheri, (1997) who stated that "land acquisition in Kordofan is primarily owned through inheritance".

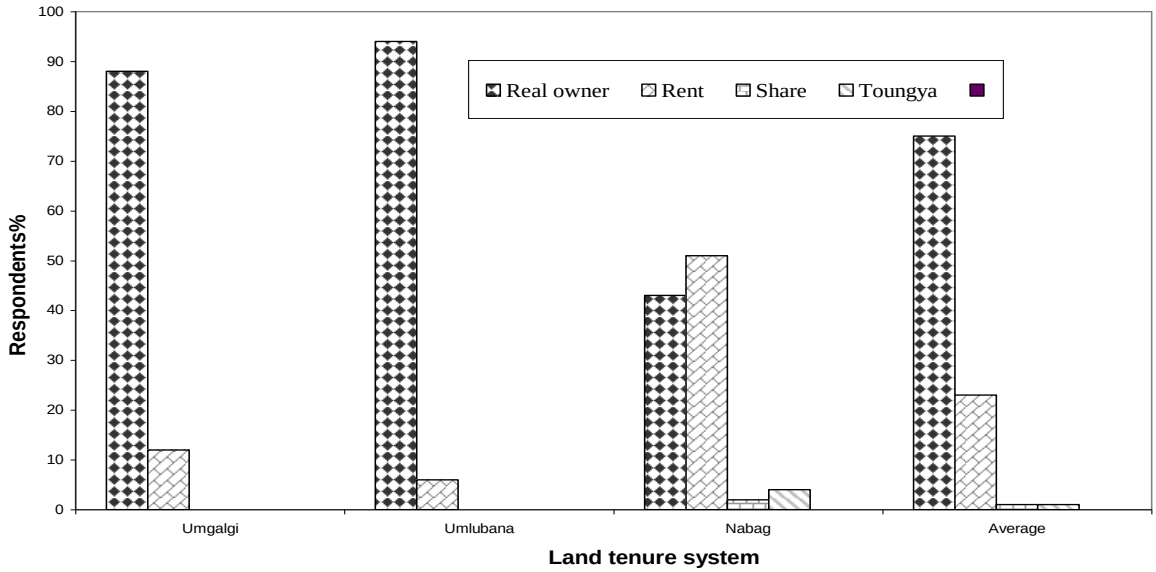

Figure 2: Land tenure systems in the study area

The occurrence of tree species in the study area varies depending on soil type, environmental factors such as altitude, rainfall, temperature and topography. According to the information from the farmers and personal observation the dominant tree species across all sites are *Acacia senegal* 83%, followed by *Fadherbia albida*46%, *Ziziphus spina-christia*43% *and Balanitesaegyptiaca*40%. The lowest presence of trees in the three villages was recorded for *Delbergia melonoxylon*. The differences in tree species could be attributed to the differences in ecological zone, soil type and rainfall. Names of the most commonly found trees and shrubs in the target areas are indicated in (Table1). This result are in line with the finding of El Tahir *et al.,* (2010) who stated that the vegetation composition in Kordofan region varies greatly and corresponding mainly to the soil type, texture, pattern and distribution of the rainfall.

Table1. Important trees in farm land at the study area

Scientific name	Local name	Percentage			Means
		Umgalgi	Umlubana	Nabag	
Acacia Senegal	Hashab	96	89	65	83
Fadherbia albida	Haraz	30	96	14	46
Ziziphus spina –Christi	Nabag	80	12	39	43
Balanities aegyptiaca	Heglig	42	0	78	40
Guiera senegalenses	Gubeish	0	67	14	27
Leptedenia pyrotechnica	Marikh	66	6	6	26
Combretum spp	Habil	0	67	4	23

Albizia amara	Arad	0	39	22	20
Boscia senegalenses	Korsan	0	17	16	11
Acacia tortliles	Seyal	32	0	0	10
Adansonia digitata	Tabaldi	0	15	4	6
Acacia nilotica	Sunt	0	2	16	6
Maerua crassifolia	Sarih	2	2	2	2
Tamarrandus indica	Aradeb	0	0	4	1
Acacia mellifera	Kitir	0	0	4	1
Caparis dicudua	Tundub	0	2	0	1
Grewia tenax	Gudeim	0	0	2	1
Delbergia melanoxylon	Abanos	0	0	2	1

The most important agroforestry system in the three sites is scatter trees on farm land which was indicated by 77%, followed by wind breaks 13% and boundary planting 10% (figure3). Within the sites scatter trees on farmland was indicated by 92, 86 and 73%, followed by wind breaks 2, 13 and 23% and boundary planting 6, 1 and 4% for Umglgi, Umlubana and Nabag respectively. This implies that scatter trees on farmland was an easiest agroforestry system among respondents. However, due to the poor agroforestry extension services the dissemination of improved agroforestry systems is poor. This result are in line with the finding of Fadl,(2008) who reported that the most important agroforestry systems in the northern part from South Kordofan State are parkland cropping system, Home gardens and boundary planting.

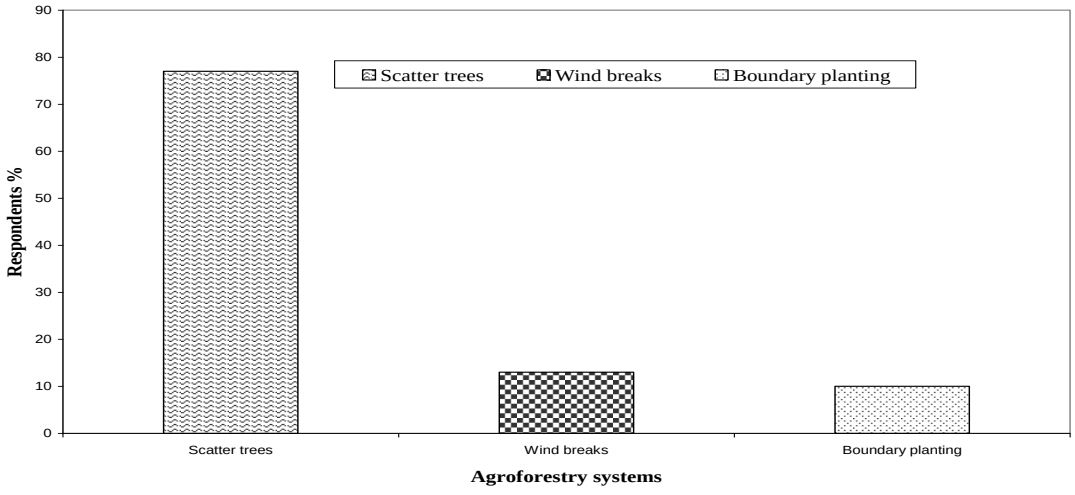

Figure3: Type of agroforestry systems in the study area

Table 2 shows the important filed crops in the study sites. A cross all sites groundnut is the most important field crops (68%), followed by millet (55%), sorghum (52%) and sesame (41%). This could be attributed to the fact that groundnut is the most important cash crops, while cowpea is considered as a minor crops in western Sudan. This result is in agreement with the finding of Osman, (2003) who stated that Kordofan region is the second largest producers for groundnut. Similarly, Bashir, (2001) reported that groundnut is an important cash crop in Kordofan region. It is grown in an area from 0.5 to 1.0 million feddan annually. The bulk of the crop is in Western Kordofan State particularly in Elnuhud and Guebeish localities. The other cash crops include sesame, roselle which widely cultivated in small scale in Western Sudan. The sorghum and millet are an important food crops for majority of framers in Kordofan states.

Table2. The main field crops in the study area

Field crops	**Percentages**			**Means**
	Umgalgi	**Umlubana**	**Nabag**	
Groundnut	36	75	93	68
Millet	44	58	63	55
Sorghum	24	58	74	52
Sesame	84	31	8	41
Roselle	24	37	47	36
Cowpea	2	19	86	35.7
Water melon	20	25	25	23.3
Okra	0	29	31	20

Perceived advantages and disadvantages of multipurpose trees in agro forestry systems in the targeted area are reported in Table 3. Across all sites 91% of the respondents mentioned that the main advantage of presence of the trees on farm land are:) protect the farm against moving sand, 2) soil erosion, 3) increase soil fertility, 4) improving the microclimate 5) providing shelter for field crops 6) reducing the temperature, 7) source of income (fuel wood, charcoal, gums, bulling poles,…) and 8) improving the microclimate.

Across all sites 59 % of the respondents mentioned that the disadvantage of presence of trees on farm land include: 1) competition with the field crops for water, 2) competition for light , 3) make some difficulties in movement for the performance of other cultural practices such as (sowing, weeding, harvesting,…) and 4) host for birds. These results could be attributed to the fact that in the arid region competition for water is more sever between the trees and their

associated crops .These results are in line with the finding of Fadl and Gebauer, (2004) who attributed the decrease in crop yield in *Acacia senegal* agroforestry system in North Kordofan State to water and light competition between trees and their associated crops. The competition is expected to be more severe in agroforestry system compared to sole cropping. (Singh *et al*., 1989) reported that in semi-arid zones below ground competition for water seems to be more severe than for light.

Table3. Advantage and disadvantage of trees in farm lands

Advantage and disadvantage of trees on farmlands	Percentages			Means
	Umgalgi	**Umlubana**	**Nabag**	
Advantage				
Protection against soil erosion	2	2	2	2
Increasing soil fertility	1	4	2	2.3
Improving micro climate	1	1	2	1.3
Source income (gum, fuel, etc.)	6	1	3	3.3
All mention	90	92	91	91
Disadvantage				
Competition for water and nutrients	70	2	2	24.7
Competition for light	1	2	2	1.7
Host for birds	1	2	8	3.7
Constrain for easy movement	28	2	2	10.7

The presence of gum Arabic trees and their sources are shown in figure 4 and 5. Across all sites 89% of the respondents have gum Arabic trees on their farm while, only 11 don't have. Within the sites the percentages of (94, 92 and 80%) of respondents have gum Arabic trees in their farm.

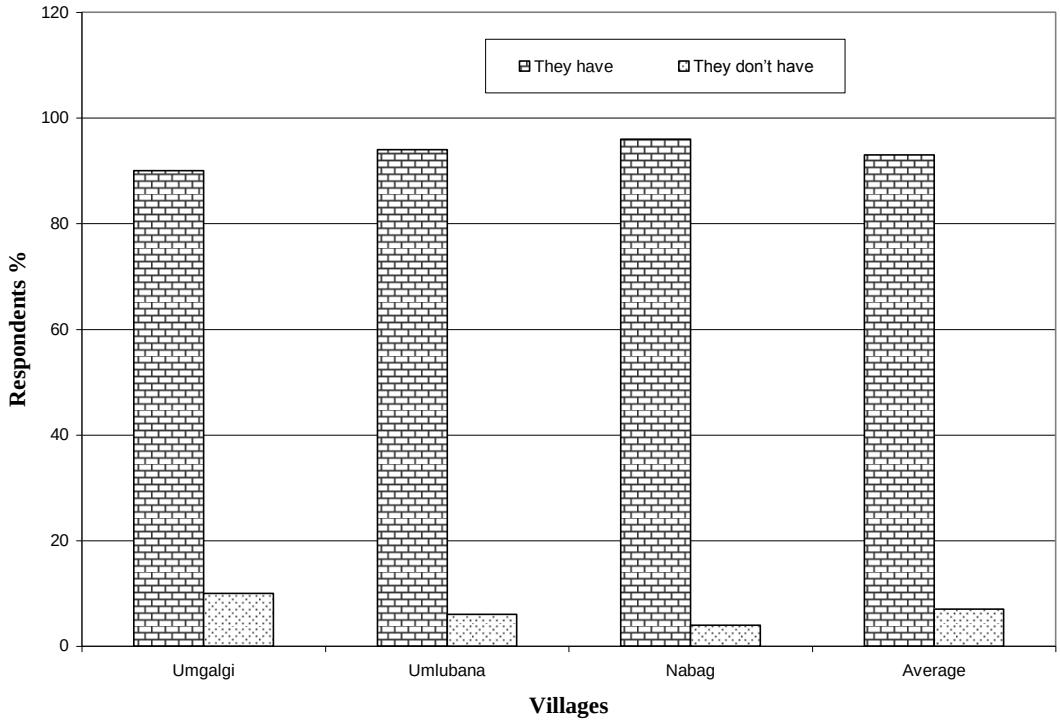

Figure4. Presence of *Acacia senegal* trees in the study area

The gum Arabic tree sources showed that across all sites 78% of respondents mentioned that the tree growing naturally in their farm land, 13 they plant the tree in their farm land while, 9% of the respondents they have both natural and plantation. This result was attributed to the fact that all the study sites are located with the gum Arabic belt where the tree is growing naturally. This result is in line with the finding of IIED and IES (1989) who reported that the gum belt in Sudan is dominated by *Acacia senegal* and other species of genus Acacia which is grown naturally in Kordofan, Darfur, Upper Nile, White Nile, Kassala and Blue Nile.

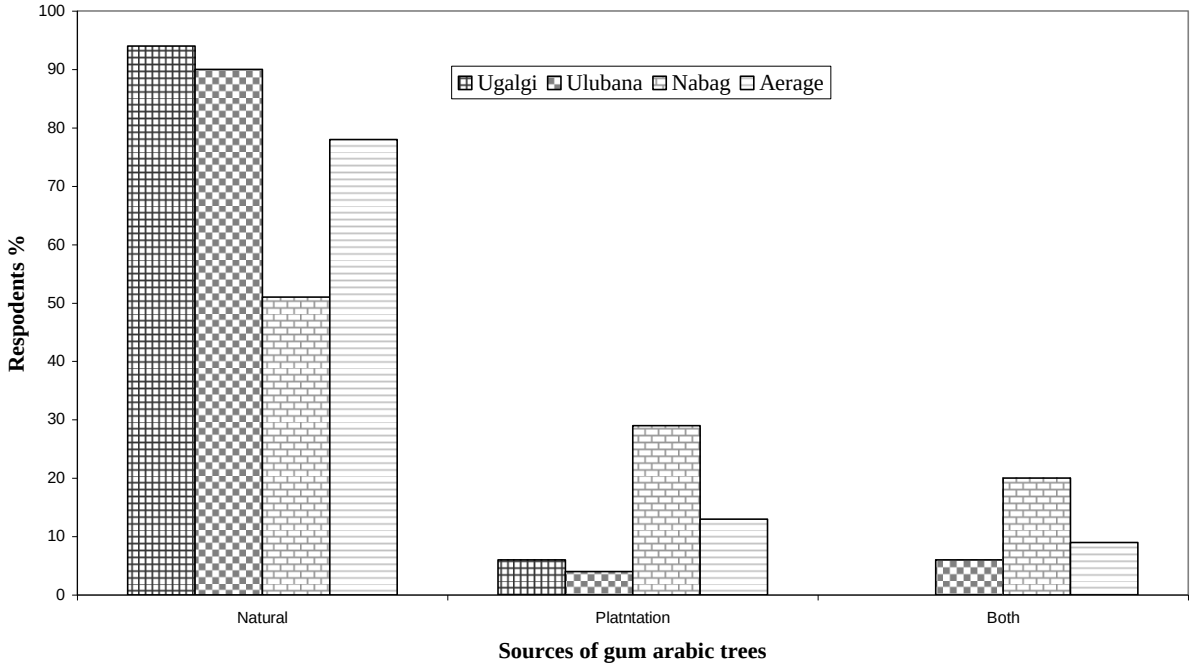

Figure5: Sources of gum Arabic trees in the study area.

The status of the gum Arabic trees are shown in figure6**.** Across all sites56% of respondents mentioned that the trees were decreased, 43% mentioned that trees were increased while, only one percent showed no change in the status of the tree. Within the sites, the percentage of 72, 64 and 31% indicated that gum Arabic trees in all villages are decreased, 28, 33 and 69% perceived that gum Arabic trees in the study area was increased, while only 3% at Umlubana village showed no change in the number of trees. The main reasons for decreasing in number of trees are drought and the death of the mother trees, followed by clearances for cultivation of field crops, low and erratic rainfall, pest and diseases, drought and illicit cutting. These results are in line with the finding of (Ballal, 1991 and Fadl and El sheikh, 2010,) who stated that drought, desertification, over cutting, over cultivation and increase in human and animal population are the main causes for decreasing the stocking density of the trees.

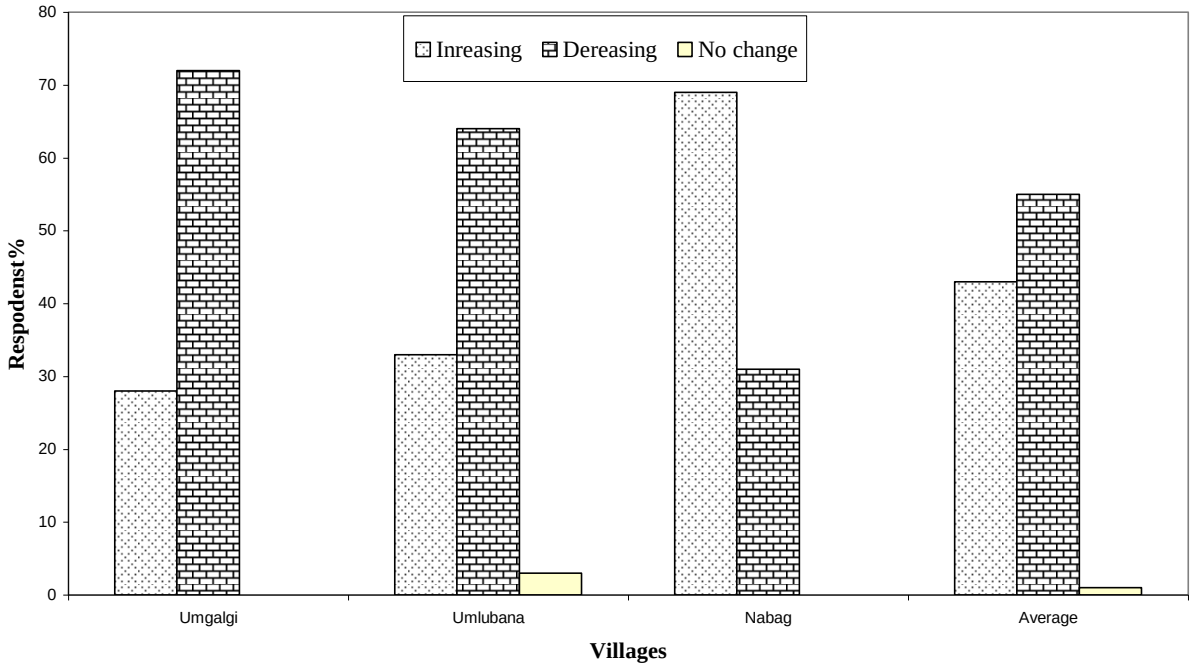

Figure 6. Current status of the gum Arabic trees in the study area.

The contribution of gum Arabic production to farmer's income and the channel of gum Arabic marketing are shown in Table 4. Across all sites 93% of respondents showed that the gum Arabic have a significant contribution to their family income while only 7% of the respondents mentioned that gum production have no contribution to their income. Within the three villages (90, 94 and 96%) of the respondents mentioned to the gum Arabic contribution to their income, while few of them (10, 6 and 4%) perceived that gum Arabic have no contribution in their income.

Across the sites 78% of the respondents sell their gum to village merchants, while few of them (2, 3, 4 and 13%) sell their production to gum Arabic companies, brokers, village's merchants and porkers. This results are in line with the finding of Fadl and Gebauer (2004) who stated that "agroforestry systems including *Acacia senegal* provide a good household income from gum Arabic production amounting to (346US$ per ha / season) which can easily compensate for the yield losses from agricultural crops.

Table4. Contribution of gum Arabic to the farmer's income

Contribution of gum arabic	Percentages			Means
	Umgalgi	**Umlubana**	**Nabag**	
Have contribution	90	94	96	93
Have no contribution	10	6	4	7
Marketing Channels				
Gum arabic company	0	2	4	2
Village merchant	70	92	71	78
Broker	0	4	6	3
Other	30	0	9	13

Conclusion

In the traditional rainfed area of Kordofan region and with increasing rate of desertification and natural resources degradation managing the traditional field crops with *Acacia senegal* and other tree species can increase productivity and crop value, and improve land use efficiency. The agroforestry systems in this area have a useful role to play in sustaining agriculture production and providing revenues to the poorest farmers in Kordofan region.

The most important agroforestry system in the study area was found to be scatter trees on farm land. Shifting cultivation is still practice by more than 50% of the respondents. Trees have a positive effect in restoring soil fertility and improving the microclimate and the gum production plays a vital role in farmer's income.

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