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IMPACTS OF MODIFICATION OF BUSH FALLOW SYSTEM ON THE SUSTAINABLE LIVELIHOOD OF LOCAL COMMUNITIES IN UM RUWABA LOCALTIY, SUDAN

by

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DEDICATION

To

My family,

Friends, Colleagues.

When a smooth rays of the sun appear, disappear,

a new ductless gland of thanks fullness run in my blood

stream.

I owe U a great debt.

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ABSTRACT

IMPACTS OF MODIFICATION OF BUSH FALLOW SYSTEM ON THE SUSTAINABLE LIVELIHOOD OF LOCAL COMMUNITIES IN UM RUWABA LOCALTIY, SUDAN

Hashab tree is one of the most important tree species in the Sudan with wide range of uses. In the study area (Um Ruwaba) like other sites of the gum-belt zone, the tree is traditionally cultivated as a component of an agroforestry system known as the gum bush-fallow cultivation cycle (BFC). This system is subjected to several factors, which affected the sustainability of the cycle. The fallow period which is an essential component in the cycle has been eliminated or drastically reduced. The objective of this research is to investigate the impacts of modifications of the traditional gum cycle on the livelihood and welfare of the local communities. Moreover, the study attempts to explore the main constraints and measures of risks behind the modification of the traditional cycle and the possibility of the adoption of new models-if any- by farmers. The main findings of the research are; the stocking density of hashab tree is almost increased compared with history of the study area, but trees are no longer tapped for gum Arabic by all farmers. On some areas, averages of 3 to 5 hashab trees are kept per feddan in the cycle. Several factors contributed negatively to the sustainability of the traditional cycle among which are; lack of clear marketing policies of gum arabic; unavailability of labor and frequent drought and pests. The extension unit plays a major role in the study area despite the poor infrastructure and limited fund. Despite the modification of the cycle, various productive cycles of fallow period pointed out. A concise description of a fallow vegetation succession is given.

The main conclusions of the study are; gum arabic production is no longer attractive to farmers in the study area, despite the existence of hashab tree on farms; the fallow period has been eliminated or drastically reduced from the cycle. There is intensification of crops cultivation at the expense of fallow period and hashab trees. The study also arrived at some recommendations.

الخلاصة

اثر التغيرات في النظم التقليدية المتبعة في زراعة الهشاب علي نمط الحياة المستدام بمحلية ام روابه، السودان

تعتبر شجرة الهشاب من اهم الانواع الشجرية الموجودة بالسودان وذلك لاستعمالاتها المتعدده. منطقة الدراسة (محلية ام روابه) مثلها مثل غيرها من المناطق الواقعة علي حزام الصمغ العربي ؛ تزرع الشجرة كمكون لنظام الاستزراع الغابي متمثلة في الزراعة التقليدية المتنقلة. هذا النظام من الزراعة اصبح عرضة لعدة عوامل متداخلة اثرت علي استدامة الدورة الزراعية فيه بشكل غير مرضي؛ ففترة البور التي تعد من اهم مميزات الدورة الزراعية قد تلاشت او تقاصرت مدتها في الدورة التقليدية. الهدف من هذة الدراسة هو التحقق من التغيير الحادث في الدورة التقليدية و اثره في المحافظة علي البئية و تحسين اوضاع المجتمعات المحلية؛ بالاضافة الي كشف المعوقات و المخاطر التي ادت لتقاصر او زوال فترة البور و امكانية نجاح نظم جديدة و جدواها في احلال الدورة التقليدية. اهم نتائج هذه الدراسة هي ان اشجار الهشاب بالمنطقة في زيادة مقارنة بتاريخ المنطقة؛ ولكن هذه الاشجار لا تتعرض للطرق بواسطة المزارعين. في بعض المناطق تتراوح اشجار الهشاب في الرقعات الزراعية بمعدل ثلاثة ألي خمسة شجرات بالفدان. هنالك عوامل عديده ساهمت بصورة فعالة في عدم استدامة الدورة التقليدية منها علي سبيل المثال لا الحصر : عدم وجود سياسات تسويقية متعارف عليها لسلعة الصمغ العربي بجانب تعرض منطقة الدراسة لدورات من الجفاف و الافات. الجهاز الارشادي بالمنطقة يلعب دوراً فعالاً في ظل الدعم المحدود و فقر البنية التحتية للمنطقة. بالرغم من التحورات التي حدثت لفترة البوار الأ انه توجد بعض النظم البديلة للانتاج المتعلق بفترة البور؛ كما هنالك وصف للغطاء النباتي المتحور.

خلاصة البحث هي ان انتاج الصمغ العربي لم يعد مغري بالنسبة للمزارعين رغم وجود اشجار الهشاب في الرقعات الزراعية الأ ان بعض المزارعين لا يالون جهداً كبيراً في طق الهشاب. كما ان فترة البور تحورت كثيراً فاصبحت قصيرة العمر او معدومة بسبب تكثيف زراعة المحاصيل الزراعية علي حساب بادرات الهشاب. كما توصلت الدراسة علي عدد من التوصيات.

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CHAPTER ONE
INTRODUCTION

1.1. Background

Research over past 20 years has confirmed that agroforestry can be more biologically productive, profitable and be more sustainable than forestry and agricultural monoculture. Temperate agroforestry systems are already wide spread in many parts of the production in some regions. The capacity of trees and other plants to restore soil fertility was utilized in Africa traditional agricultural systems that were based on shifting cultivation, farmers still grow or leave trees on their lands, often noting that this has beneficial effect, for soil and crop yield.

The economy of the Sudan is predominately agricultural. Agriculture contributes over 35% of the Gross Domestic Products (GDP), over 95% of exports and 80% of employment (FAO, 1983). Forestry sub sector plays significant role in maintaining agricultural productivity, providing fuelwood and charcoal needs of more than 80% of urban population and meeting a significant part of industrial timber needs. The most important forest activity is gum production from *Acacia senegal* and *A. seyal.* Both species spread naturally in the central belt of the low rainfall Savanna, where they exist in pure or mixed stands, in the clay plains in the East and sandy soils in the West. These trees are drought resistant; thrive under conditions down to 200 mm annual rainfall with mean annual temperature between 14-43º C.

In Sudan the gum belt extends from east to west between latitudes 10^0 –14^0 N. *Acacia senegal* has significant economic role for the country, gum arabic plays an important part in rural life, providing a steady income to rural families especially in dry years when crop fail. There are many factors and their interactions affect the ability of trees to produce gum.

1.2. Scope of the research

A. senegal is traditionally cultivated as a component of agroforesty system known as the Bush Fallow System (BFS). It is practiced by the local people; whereby farmers use the land for 4 – 5 years until the crop yield drops and then they shift to another piece of land. The gum trees are tapped for 15 – 16 years. Sites within farms occupied by old gum trees usually after the last tapping they eradicate to offer a vacant lot for the agricultural crops. These sites are recognized as an excellent well established farming system in the marginal land of western Sudan. It supports the local population life through provision of most daily subsistence requirements of food crops (sorghum, millet, and groundnut) as well as cash crops (watermelon, sesame, karkadeh, and gum). The importance of the system at the national level is recognized because the cash crops are most important exports.

The most important role of hashab tree in marginal land of western Sudan, from environmental point of view, is its ability to improve the soil and thus support the production of agriculture crops, and to act as natural hedge against the desert creep from the north. It is envisaged that the system, have been modified to meet the increasing demand for food and fodder under the frequent drought cycles. This modification of the system is the starting premise of this research for sake of highlighting the impacts of the modification of the traditional system on the sustainable livelihood of local communities within the belt of gum arabic. North Kordofan State was selected for this research, more specifically Mediate Um Ruwaba Administrative Unit.

1.3. The research problems

The modification of the traditional gum bush cultivation cycle encountered many difficulties which have to be overcome to safeguard reasonable resilience of local communities in the study area. Some of these difficulties are represented in the climate change and variability. In the study area the

rains have erratic nature and vary considerably in terms of intensity and distribution with long periods of episodes. Frequent drought cycles also contributed to the modification of the traditional system. Raising and tending of seedlings at farm conditions become a risky task, particularly the study area is characterized by acute water shortage (drinking water). The famous drought cycles of the eighties resulted in a sharp decline of crops production, to cope with these situation farmers managed to rely on their forest resources (*Acacia senegal*) as a source of income generation through marketing of fuelwood and charcoals from the gum tree. This reliance on the tree for income generation hampered the development and sustainability of the system where trees were no longer retained in farms to be tapped for 12 – 16 years. Another strategy adopted by the local people to cope with the new conditions, is the migration to other productive sites or to the principal cities. Migration of local people takes different forms, seasonal or permanent, individually or mass migration.

The study area is recognized as marginal area where the ecosystem is sensitive and fragile. The process of desertification in the study area is a rule rather than exception. Sand creep is advancing continuously threatening large tracks of the gum belt leading to conditions difficult for the rehabilitation of the belt and endangering crops production.

Gum prices and marketing mechanism also contributed significantly to the modification of the traditional system of gum garden. The low prices offered by Gum Company were no longer encouraging farmers to resume gum tapping and picking. On the other hand, farmers are exploited by local traders through *shyl* system. It is worth mentioning that, the study area according to the socioeconomic index of poverty is classified as ultra poor area. Farmers are exploited through the *shyl* system in which they used to receive amount of money (loan) to be paid in kind (gum). The results are obvious, an entire area which has previously boasted as being one of the largest producer of gum arabic in the world, and which has created satisfactory production system that

enabled framers to arrive at a balance with nature by incorporating gum arabic as part of fallow cycle, are no longer keen to invest in hashab tree planting.

There are many NGOs projects, like Corporation of American Relief Everywhere (CARE), SOSsahel, Save the Children, International Labor Organization (ILO), International Fund of Agricultural Development (IFAD) and United Nation Sudano-sahelian Office (UNSO) beside many others projects on small scale, exerted considerable efforts to rehabilitate the belt of the gum belt. The post projects reports revealed that the results lag far behind the proposed objectives of these projects due to the above mentioned factors. Therefore, the research managed to investigate the impact of modification of the traditional system on the livelihood of local communities.

1.4. Objective of the study

The broad objective of the research is to investigate the potentiality of the substitutes of the traditional gum system (modifications) to play the traditional role of achieving environment stability and welfare of the local communities. More specifically:

- To explore the impacts of the modification of the traditional system on the resilience of the local communities.
- To investigate the suitability of the newly adopted systems in environment stability
- To highlight the main constraints and measures of risks confronting restoration of the traditional Bush Fallow System.
- To investigate the constraints and measures of risks confronting the traditional BFS**.**

1.5. Research questions

To tackle the research problem and obtain the specified objectives, broad research questions were formulated under the assumption that finding answers to these questions will solve or enhance solving the problem of the research. These questions are;

- How the traditional BFS contribute to the resilience of local communities?
- What are the factors behind the modification of the traditional BFS?
- What is the role of the extension in the rehabilitation and conservation of the gum belt?
- What is the possibility of restoring the traditional BFS?
- What is the potentiality of the alternative models compared to the traditional BFS?

CHAPTER TWO
LITERATURE REVIEW

2.1. Background

Sudan is one of the first countries in Africa and the Near East that had an organized forest administration. The wood and forests department "now the Forests National Corporation" was established in 1902 (Marks1985). The woods and forest ordinance were formulated for the organization of forestry were issued in 1901, 1902 and 1908, and where then followed by forest conservation rules in 1917. In 1932 the Sudan statement of forest policy and the central forest ordinance were issued. In 1939 the royalties order was issued to regulate felling of trees in unreserved land. All these laws aimed at supporting and implementing the forest policy, but no considerations were given to agroforestry (Abded Nour and Abded Majid, 1997).

In Sudan, forest and woodland, (not constituted as forest reserves) are continuously being encroached upon by agriculture, urbanization and uncontrolled felling. The forest reservation process, which started in 1923, was only able to settle and finally gazette 1.7 Million (ha) equivalents to 0.4% of the total area of the country. The National Comprehensive Strategy (1992-2002) called for the allocation of 46.5 million (ha) for natural resources, (forestry, range and pasture and wild life) i.e. 25% of the country area (Ministry of Agriculture, Natural, and Animal Resources, 1994). Among the different options of the forest policies, there were special emphasis on the role of the forests in environmental protection and the establishment of community forests, private and institutional forests (Ministry of Agriculture and Forest. 1996).

Participatory forestry has been well established for centuries in many countries. The main functions of participatory forestry include establishment of protection forests and the creation of village (forest areas) and urban phalloid areas (shepherd, 1990). During the last decade the understanding of

the importance of forestry for local communities has been recognized and become apparent. To stimulate forestry and crop production in rural communities, new approaches should be worked out to overcome the various obstacles, which have limited the acceptance of forestry by local communities in the past. Gradually several responses to the limiting factors for forestry development in rural areas have been recognized (Wiersum, 1984).

2.2. Agroforestry

2.2.1. Introduction

Agroforestry is the intentional growing of trees and shrubs in combination with crops or forage. Agroforestry also includes tree and shrub plantings on the farm or ranch that improve habitat value or access by humans and wildlife, or that provide woody plant products in addition to agricultural crops or forage. Agroforestry is distinguished from traditional forestry by having the additional aspect of a closely associated agricultural or forage crops (Natural Resources Center Services, NRCS.1996). Cultivating trees and agricultural crops in intimate combination with one another is an ancient practice that farmers have used throughout the World. The ultimate objective of agroforestry practices was not tree production but food production (Nair, 1993).

Tracing the history of agroforestry, King (1987) states that in Europe, until the middle Ages, it was the general custom to clear-fell degraded forest, burn the slash, cultivate food crops for varying periods on the cleared areas, and plant or saw trees before, along with, or after sowing agricultural crops . This farming system is no longer popular in Europe, but widely practiced in Finland up to the end of the last century, and was being practical in few areas in Germany as late as the 1920s. In tropical America, many societies have simulated forest conditions to obtain the beneficial effects of the forest ecosystem. In Central America, it has been a traditional practice for along time. In Asia, the Hanunoo of the Philippines practiced a complex and somewhat sophisticated type of shifting cultivation by retaining some trees at

the end of the rice-growing season to provide a partial canopy for new foliage and to prevent exposure of soil to the sun. Trees were an indispensable part of Hanunoo farming system and were either planted or preserved from the original forest to provide food, medicines, construction wood, and cosmetics (Conklin, 1957). Similar farming systems have also been common in many other parts of the humid low land tropics of Asia.

The situation was little different in Africa (Forde, 1937). The Yoruba system of western Nigeria is practiced on intensive system of mixing herbaceous, shrub, and tree crops. The system conserves human energy by making full use of the limited space. Moreover, this system is an inexpensive means of maintaining the soil fertility, as well as, combating erosion and nutrient leaching (Ojo, 1966). However, there are innumerable examples of traditional land-use practices involving combined production of trees and agricultural species on the same piece of land in many parts of the World.

2.2.1.1. The concept of agroforestry

Agroforestry is the growing of both trees and agricultural/horticultural crops on the same piece of land. They are designed to provide trees and other crops products and at same time protect, conserve, diversify and sustain vital economic, environmental, human and natural resources. Agroforestry differs from traditional forestry and agriculture by its focus on the interactions among components rather than just on the individual components themselves (ICRAF, 1993). The concept of agroforestry emerged to the surface by scientists and planners for agricultural development and environment conservation as solution to rural development need in Africa. The term "agroforestry" as word and the optimism associated with it are widely shared, but the actual meaning of agroforestry is often misunderstood. Although agroforestry is an age–old practice, modern concept for this kind of land use are only being developed recently (Bene *et. al.,* 1997). In general, agroforestry practices involve close association of trees or shrubs with crops,

animal and/or pasture. This association is both ecological and economical. Agroforestry may involve a combination of practices in the same place at the same time (intercropping and related practices), or practices in the same place but at different times (rotational practices). The place may be as small as a single garden or cropland plot or as extensive as a small watershed or a vast stretch of communal grazing land (Rochleau, 1988).

2.2.1.2. Definition of agroforestry

Agroforestry is a collective name for land-use systems and practices where woody perennials are deliberately integrated with crops and/or animals on the same land management unit. The integration can be in either spatial mixture or temporal sequence. There are normally both ecological and economic interactions between the woody and non-woody components in agroforestry (Lundgren, 1982). Agroforestry is a relatively new name for a set of practices that have been developed by farmers over thousands of years. The narrowest definition of agroforestry confines it to a type of intercropping where trees are grown to exploit a beneficial interaction with crops or pasture (Chew, 1987). A broader, more holistic, definition includes the full range of tree planting and woodland management practices such as living fences, hedges, woodlots, fruit trees near houses, woodland use and management. This broader definition covers practices included under the head of "social forestry" (ICRAF, 2000).

2.2.13. Prospects of agroforestry

Agroforestry is promoted on the basis that it can provide biological, economic, and social advantages. ICRAF's Strategic Plan states that resource-poor rural households benefit from improved soil fertility coming from the introduction of nitrogen-fixing trees. This in turn guarantees additional income through sales of tree products and gain improved food security. Moreover, the quality of the environment is maintained through the maintenance of biological diversity, preservation of water catchments and soil quality, and a halt to the net loss of forested land.

Large proportion of farmers perceives the role of agroforestry technologies as an attractive alternative to shifting cultivation. However, agroforestry research in general has not yet validated many of the claims made for site improvement, increased yield, and sustainability by the adoption of agroforestry practices. Similarly, many of the disadvantages, such as competition for light, water and nutrients remain unquantified. Many of the perceived benefits of agroforestry remain unsubstantiated and untested. Few new technology packages have emerged from agroforestry research and been widely adopted by farmers. There has also been a tendency to concentrate on technical aspects of agroforestry with little complementary research on the social, economic and policy matters that will ultimately determine adoption of the practice (Chanyan, 1994).

In agroforestry systems, there may be root competition between trees and crops for water and nutrients, as well as shoot competition for light (IITA, 1991). Root competition seems to pose the most severe problem, especially with fast growing trees. Root competition may be alleviated by digging trenches between the trees and the crops, or by using intensive soil tillage to destroy tree roots in the topsoil before planting the crops (Schroth *et al*., 1995). By planting trees, the area of land available for crops is reduced. Therefore, there may be a loss of immediate income, which one gets from crops. When trees are harvested from a system, nutrients are lost in the product and by leaching. However, if trees are replanted, losses can be reduced. Planting and harvesting trees requires a lot of labor. In areas where labor costs are high, agroforestry can be expensive. In some cases, the use of machinery can alleviate this problem. Changing current agricultural practices to one that integrates trees can be very costly (Jordan, 1995). It involves giving up current cropland for the planting of trees. Therefore, money is lost initially due to the reduction of food products and is lost in the purchase of trees. The economical benefits of agroforestry are not immediately apparent. It may be 20 years before trees can be harvested. Therefore, one has to be

prepared to wait before seeing financial profit from implementing agroforestry practices. If fruit or nut-bearing trees are planted, products will be seen much sooner (Haynes, 1998).

2.2.2. Classification of agroforestry

The main purpose of classification of agroforestry system is to provide a practical framework for the synthesis and analysis of the information about the existing systems and the development of the new and promising ones (Anderson and Sinclair, 1983). The most obvious and easy-to-use criteria for classifying agroforestry systems are spatial and temporal arrangement of components, the importance and role of components, the production aims or output from the system, and social and economic features, function (output), socioeconomic nature or ecological (environmental) value. These characteristic also represent the main purpose of classification schemes. Therefore, agroforestry systems can be categorized according to these sets of criteria (Chew, 1987):

- Structural basis: refers to the composition of the components, including spatial arrangement, vertical of stratification, and temporal arrangement of the different components.
- Functional basis: refers to the major functions or roles of the system, usually furnished by the woody components (services or protective nature)
- Socioeconomic basis: refers to the level of inputs of management and commercial goals (subsistence, commercial, intermediate).
- Ecological basis: refers to the environmental condition and suitability of systems based on assumption that certain types of systems can be more appropriate for certain ecological conditions.

These broad bases of classification of agroforestry are by no means independent or mutually exclusive (Nair, 1993). However, according to (ICRAF, 1992a) the main Agroforestry types are: silvopasture (Wood-pasture), mixing trees and pasture/forage, silvoarable (Wood/field crops,

intercropping or alley cropping), mixing trees and arable or horticultural crops, forest farming (taungya), forest gardening – imitating complex forest ecosystems to produce many products

2.2.3. Benefits of agroforestry

Agroforestry has major role to play particularly in degraded soil which occupies a significant area of temperate biomes. Agroforestry improves soil quality by protecting it from erosion and by adding a lot of organic matters. Wind carries away a lot of nutrient rich soil, but windbreaks can greatly decrease this effect. By improving the quality of the soil and protecting crops from the damaging effects of the wind, agroforestry can increase crop production (Jordan, 1995). Combining trees or shrubs with one or more of these other land use systems provides a greater variety of products (fruits, vegetables, beef, dairy products, cash crops and timber). Since agroforestry increases the variety of products, it provides a more stable income. Agroforestry production is also more evenly distributed over time (summer and winter) (Jordan, 1995). After fossil fuel burning, the clearing of forests for agriculture is second in importance as a net source of atmospheric carbon dioxide, one of the most significant greenhouse gases (Booth, 1994).

The forests of the world sequester and conserve more carbon than all other terrestrial ecosystems and account for 90% of the annual carbon flux between the earth's surface and the atmosphere (Winjum *et. al.*, 1993). The implementation of agroforestry practices replenishes many of the lost trees, thus contributing to the lowering of atmospheric carbon dioxide. Riparian buffer strips take up 80% of nitrogen and phosphorous from surface water runoff. This reduces the amount of nitrogen and phosphorous entering our waterways, thus helping reduce evaporation. Incorporating trees into agricultural systems increases species diversity and provide habitat for wildlife. Agroforestry increases landscape diversity when it incorporates both terrestrial and aquatic environments (Jordan, 1995). Moreover, agroforestry contributes to economic sustainability by providing year round distribution of

income, employment, and products (Haynes, 1998). Most, if not all, agroforestry systems aim to maintain or increase production (of preferred commodities) a well as productivity (of the land) like increased output of tree products, improved yields of associated crops, reduction of cropping system input, and increase labor efficiency. In the agroforestry systems the issue of productivity is closely linked with sustainability. By conserving the production potential of the resource base, agroforestry can achieve and indefinitely maintain conservation and fertility goals. Agroforestry systems are particularly suitable for certain Non-Wood Forest Products (NWFP) and for certain situations where there is land scarcity.

2.2.3.1. The tree species potential for agroforestry

Multipurpose tree species are most commonly used in agroforestry systems. The range of trees or woody species integrated into agricultural land use systems in Africa is vast and their products are varied. The development of NWFP in agroforestry systems has the advantage of diversifying the economic base and enhancing the supply of products for household use (Dember, 1996). If trees are to be successfully integrated onto agricultural land, the species and their management and use must be compatible with the farming system in biophysical, economic and social terms. Accordingly, all the relevant factors must be considered in examining the potential for development of NWFP in agroforestry systems. Consideration must be given to the ecological interactions between the tree and crop and tree and livestock components of the system, the economic viability and efficiency, and marketing needs. Problems of resource depletion are less likely to occur when the development of NWFP is carried out on private agricultural lands (Chandrasekharan, 1998).

2.2.4. Agroforestry practices

2.24.1. Windbreaks

Field windbreaks are one or more rows of trees that are planted adjacent to a cultivated field and are oriented perpendicular to the hot drying summer wind

and to the harsh winter wind (ICRAF, 1992a). In windbreaks it is advised to plant tall, fast growing trees. Shrubs planted between the rows provide even more protection. The main purpose of field windbreaks is to provide crops with protection from drying and erosive effects of wind beside protection of fine soil, which contains mostly humus and is nutrient rich, which move readily by wind. Windbreaks can provide benefits to a distance of 10-20 times the height of the trees within a windbreak (Garrett and Buck, 1997).

Field windbreaks also trap and distribute snow over fields in the winter which increases overall soil moisture. They also intercept sunlight thereby further decreasing the risk of moisture deficit (NRCS, 1996). By reducing loss of nutrients and increasing moisture, field windbreaks can increase crop yields. Livestock windbreaks are trees that are planted to shelter livestock from cold wind, and blowing soil and snow. Protecting livestock from harsh elements reduces the stress on the animals. This in turn increases their health, reduces mortality, decreases feed requirements, and provides an overall increase in profit. Windbreak trees can also bring a profit to farmers if fruit or nut-bearing trees are planted. Moreover, when thinning windbreaks, the trees can be harvested for timber, fuelwood, or Christmas trees (Haynes, 1998).

2.2.4.2. Alley cropping

The alley cropping system is an improved bush fallow system. It retains the basic features of the traditional fallow system, integrating the art and wisdom of traditional farmers with the efficiency of current science. Alley cropping refers to widely spaced rows of trees or shrubs that create alleyways in which crops are grown (Garrett & Buck, 1997). It reduces soil erosion due to wind and water, improves crop production, creates wildlife habitat, and provides corridors for wildlife to pass through. To reduce the risk of diseases and pests, it is best to plant more than one tree species in alley cropping systems. (Haynes, 1998)

To deal with the unique problems of managing large areas of the humid and subhumid zones of sub-Saharan Africa soils, scientists at the International Institute of Tropical Agriculture (IITA) in the 1970s began to use woody species in the crop production system. This led to the development of the alley cropping system. In alley cropping, food crops, preferably legumes spaced 4-6 cm a part, are grown in alleys formed by hedgerows of trees and shrubs. The hedgerows are cut back at planting and periodically pruned during cropping to prevent shading and to reduce competition with the associated food crops. Root pruning is recommended during early stages of hedgerow establishment. The hedgerows are allowed to grow freely to cover the land when there are no crops (Anderson and Farrington, 1996). One major advantage of alley cropping is that cropping and fallow phases can take place concurrently on the same land. This allows the farmer to crop the land for an extended period without a fallow period. Although alley cropping was designed for small-scale farmers, it is adaptable to mechanized farming with appropriate machineries.

The International Livestock Research Institute (ILRI) has extended the concept of alley cropping to include livestock by using a portion of the hedgerow foliage for animal feed. On non-acid soils, hedgerows of fast growing trees and shrubs, particularly leguminous species such as *Leucaena leucocephala* and *Gliricidia sepium*, do well and can provide green manure and mulch to crops grown between the hedgerows. This green manure/mulch contributes significantly to: nutrient recycling, nitrogen supply, soil conservation, weed suppression, and maintenance of soil productivity (ICRAF, 1992b). In addition, trees and shrubs may provide fuel, staking materials and livestock feed. The intensive use of *L. leucocephala* and *G. sepium* in agroforestry systems is attributed to their potentiality in offering manure/mulch advantages which benefit soil fertility in three ways: contribution of nitrogen to soil, improvement of physical conditions of soil, and improvement of soil moisture retention (Kang *et. al*., 1977). In a long-

term trial conducted on non-acid soil in Nigeria, high maize yield was obtained with or without nitrogen application when mulched with *L. leucocephala*. Some progress has also been made in adapting the technology to acid and unfertile soils (IITA, 1991).

Traditional farmers have practiced alley cropping effectively in the wooded fallow. The same concept is also utilized in planted fallow and agroforestry systems. Woody species such as *Gliricidia* spp have been used successfully for reclaiming *Imperata*-infested lands (Wiersum and Dirdjosoemarto, 1987). Atta-Krah (1987) also showed that uncut *Gliricidia* hedgerows are effective in controlling *Imperata*. In the forest Savanna transition zone, alley farming with *Gliricidia* spp and *Leucaena* spp even with annual cropping reduced *Imperata* infestation as compared to no tree control plot (IITA, 1991). In the forest zone Yamoah *et. al*., (1986) reported lower weed yields less than two years of uncut hedgerows of *Gliricidia*, *Cassia siamea* and *Flemingia* spp. In alley farming trials using hedgerow combinations of *Leucaena* and *Acioa*, Siaw *et. al*. (1991) observed no difference in weed biomass yield between alleys farmed and control treatments. There was however a significant shift in weed composition in plots alley farmed with *Leucaena* and *Acioa* compared with the control plot. Weed suppression in alley farming appears to be due to shading, mulching or allelopathy or a combination of these factors (FAO, 1993).

2.2.4.3. Silvopastoral management and forest farming

This is a tree-animal system in which forages are grown with trees under intensive management for livestock grazing (Garrett & Buck, 1997). While Forest Farming is an agroforestry practice, which involves growing shade tolerant crops, in natural forest stands, which are sold for ornamental, culinary or medicinal purposes (Garrett and Buck, 1997). Examples of specialty crops in temperate regions, particularly in North America, include wild mushrooms, sugar maple, and ginseng (Haynes, 1998).

2.2.4.4. Tree plantations

Tree Plantations are usually old shaped plots of land where trees are planted for future harvest. There are a variety of types. In timber plantations, trees are harvested for building or for pulp and paper. They can take as long as 60 years and as short as 25 years to be ready for harvesting (USDA. 1996). Fuelwood plantations, where trees are grown for fuel, can be harvested in as few as 5 years (USDA. 1996). Therefore, fuelwood can be harvested when thinning a timber plantation (Haynes, 1998). However, there are various interactions, taking place between tree and non-tree components through the soil or microclimate, may have favorable or adverse effects:

- Shading: shading of the crop by the tree may be adverse, neutral or favorable to crop growth.
- Provision of organic matter and nutrients: trees normally have beneficial effects on soil fertility. Trees contribute to improvement of soil organic matter through nitrogen fixation, increase organic matter from leaf litter and root residues; bring up nutrients released by weathering in lower soil horizons; trap and recycle nutrients that would otherwise have been lost by leaching, thereby making the plant-soil system more closed.
- Effect on microclimate and soil moisture: through the microclimatic effects of shading and windbreaks, trees can conserve soil moisture
- Effect on soil conservation: trees alone do not normally protect against soil erosion, except closely planted shrub hedges and tree. Trees planted on contour strips can stabilize grass strips, bunds, terraces, and at the same time use them productively. (IITA, 1991).

2.2.4.5. Taungya

The Taungya system is a temporal agroforestry system, which combines production of forestry tree crops and agricultural crops on forestlands. It has been practiced for a long time in various parts of the tropics. In the taungya system food crop production takes place during the period between land

clearing and the plantation establishment phase. The system, though hailed as a successful means of combining food and forest production, is often unattractive to farmers. This system persists in areas with high population pressure, where there is adequate government support (IITA, 1991).

2.2.4.6. Others form of agroforestry

- Compound farming: In this system subsistence crops, tree crops, and sometimes cash crops are grown mainly around the homestead. The system takes other terms like; compound farm, home garden, village-forest garden, kitchen garden, and household garden (IITA, 1991). Michon (1983) define the system as "a clean and carefully tended production system just surrounding the house; often with small acreage, fenced and planted with various plants from herbaceous vegetable species to medium size trees up to 20 m high. Compound farms are not static but change with new opportunities and socioeconomic conditions. Population pressure appears to have a profound effect on the stability of compound farms. Although compound farming is commonly practiced in the humid zone of Africa, little detailed information is available about these complex systems, particularly on the factors that contribute to their yield and environmental stability (Richards, 1996).

- Household gardens tend to be located close to dwellings for security, convenience, and special care. They occupy land marginal to field production and marginal labor to major household economic activities, (Soemarwoto, 1987). Several features of the gardens show the imitation of the natural forest with respect to diversity of cultivated plant species, multi-storied vegetation structure, cycling and recycling of matter, resulting in maintenance of soil fertility. These features contribute in several ways to the stability and sustainability of the agro-ecosystem of compound farming, Michon (1983)

- Strip plantation: The establishment of strips of perennial vegetation between bands of crops is appropriate throughout West Africa, from the humid coastal areas well into the drier parts of the Sahel. Ultimate objectives of the system

vary widely. The interactive effects between crops and trees need consideration when designing such systems for a particular agroclimatic environment (Brown and Schreckenberg, 1998). Several studies in the African semi-arid tropics have reported increased crop yields between strips, (Bognettean-Verlinden, 1980).

2.3. Shifting cultivation cycle

In this system the farmer, after farming on a piece of land for a few years, leaves it for another piece of land without any intention of coming back to it. The system is associated with unlimited supply of land and low population density. It happened to be the earliest system of agriculture practiced in the world and often called the *Hoe tillage system.* The system has the advantage of helping the soil to regain fertility without any effort made by the farmer. However, the system was subjected to modification due to various factors among which is the population pressure and the disintegration of land tenure through inheritance among descendents (Odi, 1998). Ruthenberg (1980) showed that the land under this system is cultivated for less than 33 percent of the time.

The traditional system of the shifting cultivation results in various plant cover appearances in the different parts of the world (FAO, 1974). In this system the existing vegetation on plots is cleared and burnt afterwards. Therefore the lower herbaceous vegetation layer is removed, followed by partial tree and shrub removal. Trees that deliver fruits to harvest are sometimes left. In the next phase crops cover the land. Because this production system is extensive, the crop cover might be mixed with spontaneous re-growth of vegetation that developed soon after the plot is burnt. A common worldwide crop combination starts with cereals, later interplant with a root crop before the cereal is harvested. After the cultivation period is completed, the secondary semi-natural vegetation starts to fully develop. The amount of this type of semi-natural vegetation increases steadily. As soon as this secondary vegetation dominates the cultural plants, the area is no longer classed under

"cultivated terrestrial Areas," but under natural and semi-natural vegetation (FAO, 1993).

Shifting cultivation is estimated to support currently between 300-500 million people worldwide. In some parts of the world, particularly in the tropics, the system resulted in negative impacts on the environment and the sustainable livelihood of local communities. In fact, research studies on shifting cultivation in the tropics point, rather, to the strength and resilience of many of these systems, the high returns to labor they offer; and, as importantly, the species enrichment and biodiversity conservation they allow. Evidence suggests that traditional systems of shifting cultivation are not necessarily a major cause of forest loss, and that greater attention needs to be given to other causes of deforestation, including resource privatization, land speculation, fiscal incentives for land conversion, tenurial policies etc. (Odi, 1998).

2.3.1. A typology of shifting cultivation systems

One reason for the widely held negative view of 'shifting cultivation' is the failure of many observers to differentiate between the wide varieties of practices which tend to be lumped together under this label. Broadly, shifting cultivation refers to any temporally and spatially cyclical agricultural system that involves clearing of land - usually with the assistance of fire - followed by phases of cultivation and fallow periods (Thrupp *et al.*, 1997). The principal arguments made with respect to various shifting cultivation systems are summarized by Sunderlin's (1997). Within the continuum from long fallow rotation to permanent cultivation, it is possible to identify a number of points at which shifting cultivation appears in one form or another. The classic model of long fallow shifting cultivation, with 2–3 year periods of crop growth followed by long fallows is found under conditions of low population pressure. Moving along forest farming continuum into areas where land scarcity exerts a pressure on resource use, short fallow shifting cultivation is likely to figure as one type of rotational system in which decisions as to whether to fallow the land, plant it with leguminous crops or

invest in agroforestry technologies. The next model is where many forest farmers are from cultures with a long history of shifting cultivation, and communities which have maintained a long association with the forest area and expect to do so into the distant future. This imposes a rotational and managerial character on the system which is an important positive feature of this type of forest use.

2.3.2. The rationality of shifting cultivation

There is a common belief that shifting cultivation is an outmoded and irrational system which is in urgent need of replacement. Boserup (1995) showed that this system is far from being an irrational system and the system might well represent a highly efficient adaptation to conditions where labor, not land, is the limiting factor in agricultural production, particularly if special consideration is given to development of infrastructure, tending of drought, animals, etc…. The main reason that more intensive systems are adopted is lack of choice faced with declining returns to labor; the farmer is forced to invest increased labor in order to preserve the existing levels of output (Brown and Schreckenberg, 1998). The demand for improved techniques aimed at increasing yield should be facilitated by measures that tax and limit shifting cultivation and reduce the risks inherent in the intensification of agriculture. To accomplish prohibition of this nature, however, infrastructure development can be used as a means of encouraging people to settle in regions of higher agricultural potential, and way from areas deserving protection (Ismail, 1990).

A modified form of shifting cultivation is called Land Rotation. Under this system, a farmer clears and cultivates a piece of land for a number of years. When the plot becomes poor, farmers shift to another plot. Farmers return to the original plot after some years. Such areas are known for the rapid regeneration of its secondary vegetation. However, the condition is different for grassland areas as the grass does not drop enough litter to restore the fertility of the soil rapidly. Another factor which makes shifting cultivation

and land rotation undesirable in the grassland areas is the frequent destruction of humus by bush fire. Sometimes the fire spreads over to the fallow plots and destroys the vegetative cover as well as any litter that could have been added the soil. The soil is exposed to unnecessary leaching and soil wash (IITA, 1996).

2.3.4. Myths and realities about shifting cultivation

Thrupp *et. al.* (1997) showed different myths and realities about shifting cultivation:

- The system is a primitive precursor to more commercial forms of production in the theoretical stages of agricultural development.
- The systems in tropical rainforests are uniform and unchanging, and shifting cultivators are homogeneous poor people.
- The system is the sole activity among rural subsistence farmers in forest margins and is unconnected to commercial market activities.
- Shifting cultivation is always characterized by low productivity and low yields and can support only low population densities.
- The systems are environmentally destructive, wasteful, and cause the majority of tropical deforestation and soil erosion. Cultivators use primitive, low levels of technology, have limited knowledge about the environment, and rarely adopt new technologies.
- The systems exist in empty, open-access forests without any form of legal rights or controls, thereby necessitating control for management. State and international agencies use interventions and policies to bring about beneficial agricultural and environmental changes affecting the practiced of shifting cultivation.

Brown and Schreckenberg (1998) pinpointed eight of the realities associated with shifting cultivation:

1. Shifting cultivators respond to agroecological and socioeconomic factors in dynamic and nonlinear ways.

2. The systems encompass a diverse range of land use practices changed over time in varied social, ecological, economic, and political settings.
3. Cultivators engage in a wide variety of activities and often merge subsistence production with commercial surplus-oriented production.
4. The systems are often productive, make relatively efficient use of resources, and have supported large populations.
5. The systems have varying and complex environmental impacts, some of which may be sustainable and enhance biodiversity.
6. Techniques used in the systems are generally appropriate for their agroecological contexts, and cultivators often have complex and useful knowledge about resources, land use, and surrounding environment
7. Shifting cultivation cultures embrace a variety of tenure regimes that mediate access, use, and transfer of resources, including informal community-based, household, and individual rights.
8. Mainstream programmers and policies influencing cultivators are biased designed to stop or replace shifting cultivation or to introduce land use practices that may not be desired by local people.

2.4. Bush fallow systems (BFS)

This system is one of the forms of shifting cultivation. It is usually practiced when the farmer observes that the soil has lost much of its fertility. The farmer moves to another plot of land leaving the former plot to develop into a bush. When a plot is under bush fallow, there is hardly any addition of nutrients to the soil. If, however, the fallow period extends to five or more years, the roots of the plants in the plot will grow deeper into the subsoil. There, they will recapture the nutrient elements lost from the top soil through leaching and return them to the top soil through leaf fall. This accounts for the rejuvenation of soils under bush fallow (Abdel Nour, 1997).

2.5. Gum arabic belt

The bush fallow system in Sudan is practiced mainly within the gum belt zone which stretches between latitudes 10^0 – 14^0 N extending from the red sea to

the border with Chad (Abdel Nour, 1997). This system of production has been known in this belt for centuries (Sanjak, 2000). It is practiced traditionally in the form of gum bush cultivation cycle where the hashab tree finds very favorable growth conditions on sandy soils with 350-400mm annual rainfalls. Five-year-old trees are ready for tapping, and production peaks between 7 and 15 years. The traditional bush-fallow system is followed with a 20-year rotation during which Acacia *senegal* is grown for 15 years. Agricultural crops are grown for five years, followed by five years with young, unproductive *A. senegal* trees, which later produce gum during the last 10 years of the rotation. Corresponding to this rotation, $1/4^{th}$ of the land is kept in agricultural crops, $1/4^{th}$ in young unproductive trees, and 1/2 in productive trees (NFTA, 1991). Recently, the cycle takes about 12 years after six years of which the hashab trees are ready to be tapped for gum arabic. After 5-6 years of tapping, the trees are cut down for charcoal and the field is cleared to be cultivated with crops. The fallow period -which is an essential component in the gum-bush cultivation cycle- has been eliminated or drastically reduced from the system. The traditional pattern is no longer followed as the fallow periods have been reduced to extend the cultivation of cash crops which has displaced gum arabic and became the main cash crop in the gum belt (Sanjak, 2000). In the past the cycle last for 20 years and the fallow period extend to 3-4 years (Born, 1965). Several factors attributed to the modification of the traditional system among which are; population pressure, land tenure system, climate change and variability, frequent drought, market prices and marketing mechanism.

2.5.1. *Acacia senegal*

Acacia senegal is a multipurpose tree belongs to subfamily mimosoideae, (family Leguminosae). The tree highly valued for centuries for gum arabic production. Today, *A. senegal* is grown primarily for gum, but plays a secondary role in agricultural systems, restoring soil fertility and providing fuel and fodder (NFTA, 1991). *Acacia senegal* is a bush or small tree, usually

2 -6 m high, occasionally reaching 10 m under optimal conditions, frequently forming thickets. It has a short stem, the crown eventually flattened, umbrella-shaped. Bark pale brown to pale grey, smooth in young individuals, brown scaly on the older parts, slash mottled red and white, prickles up to 0.5 cm long. Leaves bipinnate, small, greenish-grey, with 3-6 pairs of pinnulae having 10-20 pairs of leaflets each. Flowers very fragrant, creamy white, usually appearing before the leaves in pedunculate spikes 3-10 cm long either solitary or two to three together. Pods 7-10 cm long x 2 cm wide, flat and thin, papery, attenuated at both ends, containing 3-6 flat, round, light-brown to brown-greenish seeds. Both tap roots and lateral roots are very developed; the latter may spread many metres from the tree, particularly in sandy terrain. The tree is deciduous, drooping its leaves in November in the Sudan (Le Houerou, 1980 and El Amin, 1990).

The tree has many uses, the wood is a good fuel and leaves and pods are eaten by herbivores. The leaf fall is mineralized to build up the fertility of sandy soils for ensuing crops. The tree produces gum exudates and sold as gum arabic. The Camels and goats browse on the tree and reduce gum production (Skerman, 1977). Moreover, the tree is used in the folk medicine; bark, leaves and gum are used to treat gastritis disorders, hemorrhage, ophthalmic, colds, and diarrhea. Also the tree used as emollient, astringent; the gum is considered an aphrodisiac (Le Houerou, 1980). *Acacia senegal* and *Acacia seyal* are the defined source of commercial gum arabic. Gum arabic has been used for at least 4,000 years by local people for preparation in food, in human and veterinary medicine, in crafts, and as a cosmetic. Moreover, gum arabic is used in the food industry as a flavor fixative and emulsifier, to prevent crystallization of sugar in confections, as a stabilizer in frozen dairy products, for its viscosity and adhesive properties in bakery products, and as a foam stabilizer and clouding agent in beer. In pharmaceutics, it is used as a stabilizer for emulsions, binder and coating for tablets, and as an ingredient in cough drops and syrups. A soothing and softening agent, gum arabic is

extensively employed in folk medicines. Among many other uses, it is used internally for coughs, diarrhea, dysentery, hemorrhage, and externally to cover inflamed areas.

Acacia senegal wood is locally valued for fuelwood and charcoal although biomass yield per unit land area is not sufficient to plant *A. senegal* purely for fuelwood. Wood is used in local construction for poles and fence posts; the light-colored wood is used for tool handles and dark heartwood for weaver's shuttles. Strong ropes are made from the bark fibers of the tree's long surface roots. Dried and preserved seeds of *A. senegal* are used as vegetables (NFTA. 1991).

2.5.2. Gum production and ownership

The hashab tree form the major tree constituent of bush fallow period and coppice growth was encouraged as a part of traditional gum cultivation cycle (CRAIG, 1991). The ownership of *Acacia senegal* trees used to be common for tree to be owned by a tribe and allocated to individuals for tapping with rents paid to the tribal authority (Abd al Ghaffar, 1974). Now private ownership is more common. Some gum gardens are owned by the Forestry Department and rented out (CRAIG, 1991). Gum arabic is the main product of *A. Senegal.* The tree produces some 90 % of the marketed gum arabic sold in the world. Annual world commercial production varies from 20,000 to 60, 000 tons per annum, averaging 40,000 (Le Houerou.1980). In areas where collection of gum arabic from *Acacia senegal* constitutes important source of income, rights to tap gum trees growing on virgin soil are allocated by the local chiefs. However, where *A. senegal* seeds germinate naturally on land left fallow, the land called gineina (garden) and is under the private control of the cultivators. Trees of *A. senegal* being to yield gum at an average yield of 1-5 Ib per tree after about 5 years (Blunt, 1926), and they remain productive for about 15-20 years, then they are cut down and the fields are cultivated for 4-5 years (CRAIG,1991).

CHAPTER THREE
STUDY AREA

3.1. Location

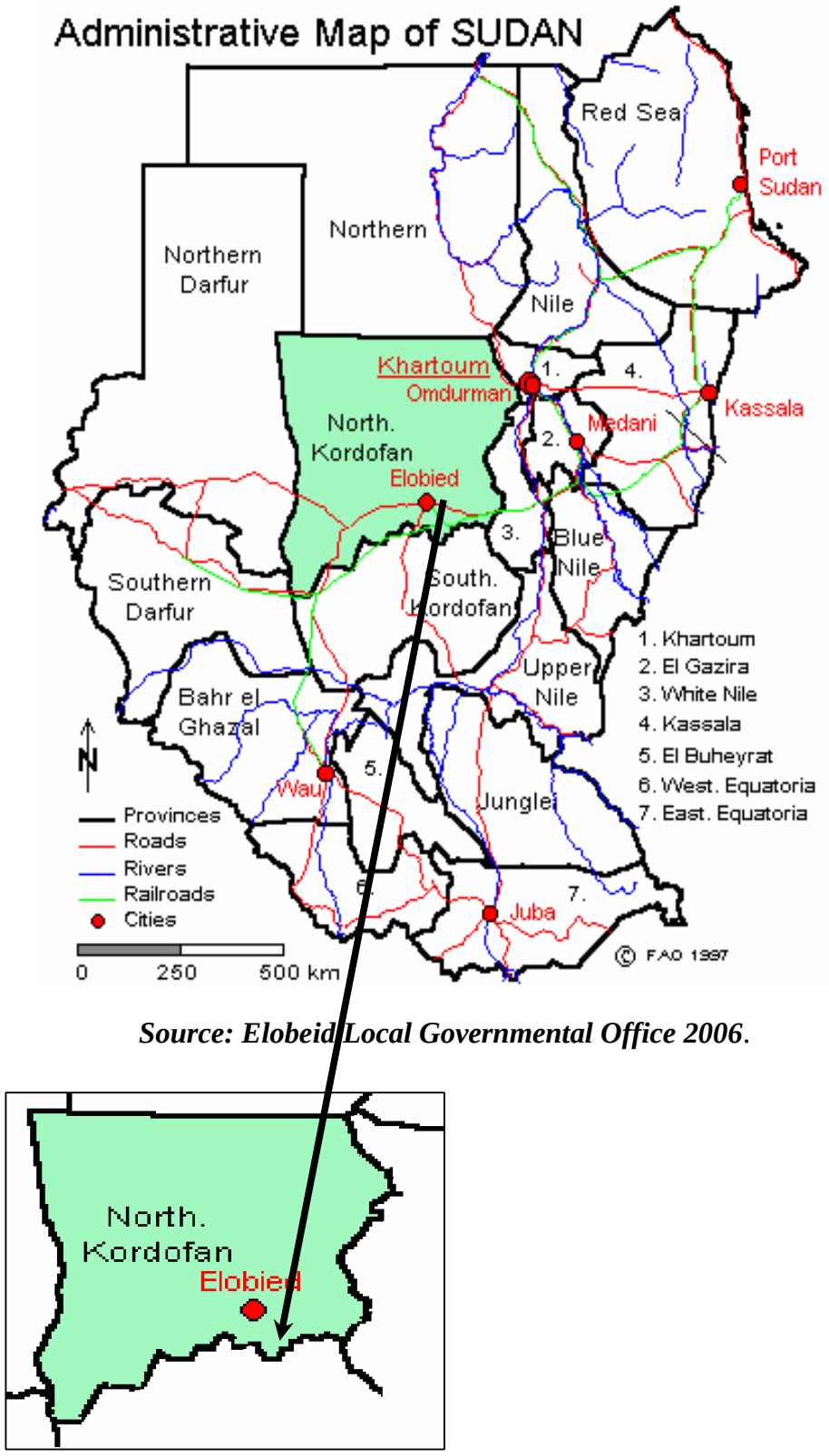
The study area (Um Ruwaba locality) is one of the localities of Northern Kordofan State beside Sheikan, Bara, Sodari, Jabreat Al Sheikh, Al Nehood, Abu Zabad, Wad Bandah and Gebaish. Um Ruwaba locality falls between latitude 12° and 10^0 N., and longitudes 30° and 12^0 E. It share borders with the White Nile State from the east and Southern Kordofan State from south and west. In the north the state share border with Sheikan Locality (Fig. 3.1. Map of the study area).

3.2. The administrative structure of the study area

Northern Kordofan State which is one of the 25 states of the country, administratively divided into nine localities, namely; Sheikan, Um Ruwaba, Bara, Sodari, Jabreat Al Sheikh, Al Nehood, Abu Zabad, Wad Bandah and Ghebaish (Table 3.1). Each of these localities is divided into some administrative units.

Table (3.1): The administrative structure of the study area.

North Kordofan State	
Localities	**Administrative Units**
Abo Zabad	Abo Zabad
Al Nehood	Al Khoay- Al Nehood- Ayail Bakhiat
Bara	Um Keraidum- Um Sayala- Um Gerfah Al Mazroub- Taybah- Jerajying
Ghebaish	Ghebaish- Abo Ray- Al Idayah
Jabreat Al Sheikh	Hamrat Al Wiz
Shiekan	Shiekan- Abo Haraz- Kazagail- Rify Al Obied
Sodari	Hamrat Al Sheikh- Um Badir
Um Ruwaba	Mediate Um Ruwaba-Wad Ashanah- Al Rahad
Wad Bandah	Wad Banadah-Sagga AL Jamal- Foja



***Source: Elobeid Local Governmental Office 2006*.**

Figure (3.1): Map of the study area.

3.3. Climate

Um Ruwaba locality falls within the semi arid zone of Sudan. It receives an average of 300mm per annum. Rainfall in general consists of storms of short duration between July and September, with highest precipitation generally occurring in August. The amounts of monthly distribution of rainfall in Elobeid town during 1961- 1990 are shown in Table (3.2). The average rainfall for the period 1961-1990 is 296.8 mm per annum (Elobeid Metrology Center, 2004). Mean annual maximum and minimum temperatures for 30 years (1961- 1990) for Elobeid town were 34.6 Cº and 20.1 Cº (Table 2.3). The coldest months were December and January with 14.1 Cº and 13.5 Cº respectively. The hottest months were April, May and June with average mean temperatures exceeding 30 Cº. The mean relative humidity ranged between 21% in the dry season and 75% during the rainy season. The prevailing winds in the dry season blow from the north east that sometimes cause sand storms, while during the rainy season the prevailing winds blow from the south and southwest (Elobeid Metrology Center, 2004).

Table (3.2): Averages of rainfall and air temperatures in the localities

Month	Rainfall	Air temperature (Cº)	
		minimum	Maximum
January	0	13.5	29.9
February	0	15.4	32.2
March	0.4	19.1	35.7
April	1.4	21.9	38.6
May	8.5	24.6	39.4
June	22.3	24.6	37.5
July	90.4	23.1	33.9
August	104.9	22.4	32.9
September	54.2	21.8	34.8
October	14.4	22.9	36.4
November	0.3	18.3	33.6
December	0	14.1	30.5
Mean	-	20.1	34.6
Total	**296.8**	**-**	**-**

Source: Elobeid Metrological Station, 2004.

3.4. Vegetation cover

The forest vegetation type in the Sudan follows variations in rainfall and soil type and to a lesser extent the effect of topography which is confined to certain localities. The study area is naturally dominated by *Acacia senegal* and *Acacia melliferea* with few scattered shrubs and trees of *Boscia seneglensis, Guiera senealensis, Caparis deciddue* and *Balanites egyptica* (Badi, 1989). The main grasses and bushes include: *Cenchorous biflorous, Cassia senna, Datylodenium aegyptium, Trbulus longipetalous* and *solanum dubium* (Badi, 1989).

3.5. Population

The population of the study area is composed of a multitude of different ethnic groups. These groups have been associated with different economic activities and have been integrated to some extent in wider systems of land use (CRAIG, 1991). The main tribes in the study area are *Jawama, Bagara, Kababish, Bazaa, Dar Hamid, Majanin and Shanblah*. According to 1993 Sudan's National Population census, Northern Kordofan state is inhabited by about 1578972 capita (Table 3.3).

Table (3.3): Distribution of the population in the different localities

Provinces	Capita
Sheikan	372346
Um Ruwaba	466356
Bara	264737
Jabreat Al Sheikh	51329
Sodari	172298
Al Nehood	37543
Abu Zabad	67724
Wad Bandah	136111
Gebaish	10028
Total	**1578972**

Source: CBS, 1993.

3.6. Land use

The people are mostly subsistence farmers, using shifting cultivation to produce sorghum, millet, watermelon, sesame, groundnut, karkadah and on small scale vegetables. Livestock rearing is of only secondary importance to the villages, particularly goats and sheep in addition to their dependence on the forest as income generating source, especially during seasons of low crops production.

CHAPTER FOUR
METHODOLOGY

4.1. Introduction

This chapter includes description of the scope of the research, the target group, and sample selection. Moreover, the data collection instrument (questionnaire) is also described in the forms of its construction, validity and field – testing as well as the procedures and methods employed for data analysis.

The study was undertaken for the purpose of investigating the traditional shifting cultivation with special emphasis on the BFS and its modifications besides its contribution to the rural development and conservation of the environment. Two types of data were collected from the study area for this research, namely; primary and secondary data. The source of the secondary data includes FNC reports and documents**,** Elobeid Local Governmental Office documents, and Elobeid Metrology Center documents. The primary data was collected by different methods; interviewing (face-to-face) with farmers, self-administered questionnaire with FNC personnel, group discussion and observations. The main items of the questionnaire (conceptualization) which is the main tool for data collection tackle the research questions of the research (Appendix (1)).

4.2. Selection of villages and respondents

Umm Ruwaba Locality consists of three administrative units; namely (Mediate Um Ruwaba, Wad Ashanah and Al Rahad). Mediate Um Ruwaba Administrative Unit was selected for this research. The spatial bias was behind the selection of this administrative unit. The other administrative units (Wad Ashanah and Al Rahad) have no regular transportation beside the difficulty of the routes. Moreover, the money allocated for this research is not enough to cover remote areas. For the selection of the villages, the researcher relied on the results of FNC survey of the Gum Producers Association in the

locality. The results of the survey revealed that there are 25 villages in Mediate Um Ruwaba administrative unit. Four villages were selected for this research. Table (4.1) shows the selected administrative unit, selected villages and the number of respondents.

Table (4.1): Selected villages and the number of respondents

Locality	Administrative unit	Selected village	No of respondents
Um Ruwaba	Mediate Um Ruwaba	Aman Alla	30
		Alalifon	30
		Aladyat	30
		Mabrouka	30
Total			120

The household is the basic unit of production and consumption in the rural areas. Hence it was used as the unit of analysis in this study. Vedeld and Ougaed (1982) reported that household members could be identified on combination of the following:

- Residence: the household members live in the same house.
- Production or working unit: the household members work in a common field.
- Consumption: the household members pool their income from the area.

Many household fulfill all the above Criteria. In each surveyed village simple random sampling of 30 household selected for the interview.

4.3. Construction of the questionnaire

The construction of the questionnaire was made according to the guidance of FAO (1985). The suggestions of the supervisor as well as ideas of the experts in the field of study helped to design the final format of the questionnaire. The following guidelines of Bruchinal (1986) were also given special consideration in the construction of the questionnaire.

- To be certain that each question was relevant to the topic.

- To express each question simply as possible and state questions in specific concrete terms.
- To obtain criticism of all prepared items by a colleague or a friend to state the items in the language respondents' use in everyday conversation.

Two types of questions were used in the questionnaire. Close – end question, with mostly multiple choices or yes and no style of answers or tables, and dichotomous questions in step-wise style each answer leading to a specific set of follow up questions with no open-ended questions except where it is inevitable. This type of questions was used in the questionnaire in order to:

- Make the least demand upon respondents
- Permit quick, efficient collection of data permit easy, quick and accurate analysis of answer.
- The combination of question and associated response categories sometimes help respondents to under stand the question more clearly.
- They are more useful in obtaining answer to sensitive questions.

4.4. Pre – testing

The formulation of the questionnaire was followed by a pre-test step to discover and correct any flows in it. The purpose of the pre- test is to make sure that the questions would deliver reliable and valid data for answering the problem under investigation. The final year students of Faculty of Forestry, University of Khartoum, as a part of their study course were asked to critique the questionnaire, and to estimate how the respondents will be able to respond to the questionnaire. According to the comments of the students, the draft questionnaire was revised. Finally, the supervisor checked the questionnaire, and accordingly, some questions were removed. After the pre-testing, the contents of the questionnaire were materialized into simple forms with

minimum items to obtain necessary information. The questionnaire was finally revised and printed.

4.5. Permission for data collection

Prior to the start of the data collection, the Director of the FNC was informed about the nature of the research and the study area. A request letter was addressed to the General Manager of the FNC to allow the collaboration of the FNC staff in the study area to offer the possible assistance and to help in data collection.

After reaching any selected village, the first step involved obtaining permission from local authorities before conducting the survey. This permission is certainly recommended for survey in rural areas where the residents may be more suspicious of outsiders. The permission was taken from the local authorities. The leaders were also asked to convince the local respondents to cooperate in conducting the research.

4.6. Other Sources of primary data

An informal interview was conducted using group discussion with the village leaders, extension works beside the direct observation of the author. This type of data was collected for the sake of enriching the collected information and to reveal ambiguities of the collected data through structural interview with the villagers.

4.7. Statistical analysis

The statistical analysis was commenced through exploratory manipulations of the data obtained in the study area. This process was accomplished by critically examining the data through the use of simple techniques of analysis. The main tools are the construction of simple tables and selected cross – tabulation which allow tentative answer to questions being asked in the survey.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1. General characteristics of the respondents

5.1.1. Family size and source of income

In rural areas family size is an important variable in the success of the agricultural activities where household members are considered as the main source of labor. According to the traditions of rural areas the household members conduct most of the agricultural activities and the harvesting usually take place through *nafir* or assistance of relatives. This is mainly due to the poverty levels of the rural areas. In the study area 49.2% of the respondents showed that their household consists of 5-8 members and 44.2% showed that their family sizes is greater than 8 persons (Table (5.1)). This result clearly reflects the population density in the study area. Existence of big families has its implications on the utilization of natural resources particularly in rural areas where less attempts is made to conserve natural vegetation. Only 6.7% of the respondents have families consisting of less than five members. Big family size has its prestige value in the study area. Big families may be of great advantage as far as labor force is concerned. However, the disadvantage is of two folds. It leads to decrease in land holding size per capita within family and it leads to increase in forest products consumption which may lead to trees depletion (Koli, 2002).

Table (5.1): Family size and source of income of the respondents

Village	N	Family size (%)			Source of income (%)		
		1-4	5-8	>8	Agriculture	Animal rear	Others
Aman Alla	30	10.0	56.7	33.3	100.0	0.0	10.0
AL-Adayat	30	6.7	50.0	43.3	100.0	0.0	0.0
Al-Alifon	30	10.0	40.0	50.0	96.7	3.3	26.6
Mabrouka	30	0.0	50.0	50.0	100.0	0.0	0.0
Total	**120**	**6.7**	**49.2**	**44.2**	**99.2**	**0.8**	**9.1**

Source of income is an indicator of the main occupation of the respondents and expresses the degree of reliance of the activities for the livelihood and welfare of the household. In most of the rural areas of Sudan, farming is the dominant source of income. In the study area agriculture, in its different forms traditionally incorporate crop farming in conjunction with hashab tree. This is the dominant type of farming and practiced by the majority interviewed sample (99.2%), while animal rearing is practiced by 0.8%. These findings clearly show the lack of income generation alternatives. This fact is supported by 9.1% of the respondents who stated they used to support their income by other activities (private business).

5.1.2. Educational level and age groups

The educational level could be considered as a monitor to detect the possibility of creating changes in attitudes and rising of awareness regarding restoration of the ecological balance in the study area. Table (5.2) shows the high level of illiteracy in the study area where 46.7% are illiterates, and 12.5% had the chance to informal education (*Khalwa)*. Only 5.8% of the respondents had the chance to pursue their education beyond the preliminary level, and 35.8% had the chance to pursue education to primary levels. Just (5.8%) of the respondents had the chance to secondary and university level.

Table (5.2): Educational level and age groups of the respondents

Village	N	Age (%)			Education levels (%)			
		20-40	41-60	> 60	Illiterate	Khalwa	Primary	Others
Aman Alla	30	16.7	46.7	36.7	30.0	20.0	46.7	3.3
AL-Adayat	30	6.7	50.0	43.0	53.3	10.0	33.3	3.3
Al-Alifon	30	33.3	46.7	20.0	36.7	20.0	30.0	13.3
Mabrouka	30	0.0	36.7	63.3	66.7	0.0	30.0	3.3
TOTAL	**120**	**14.2**	**45.0**	**40.8**	**46.7**	**12.5**	**35.8**	**5.8**

This situation reflects the difficulties of adopting any new innovations unless an effective extension unit is available to disseminate information and to raise the awareness of the local people. As far as age groups are concerned, the bulk of the respondents (85.8%) have age greater than 41 years. This could be verified by the

fact that the selection criterion for the research was based on household. This patch of respondents could be considered as key informants backed with indigenous knowledge. Forty-five per cent of the respondents have age between 41-60 years and 40.8% have age greater than sixty years. The youth is represented by 14.2% of the target group.

5.2 .Types of land ownership

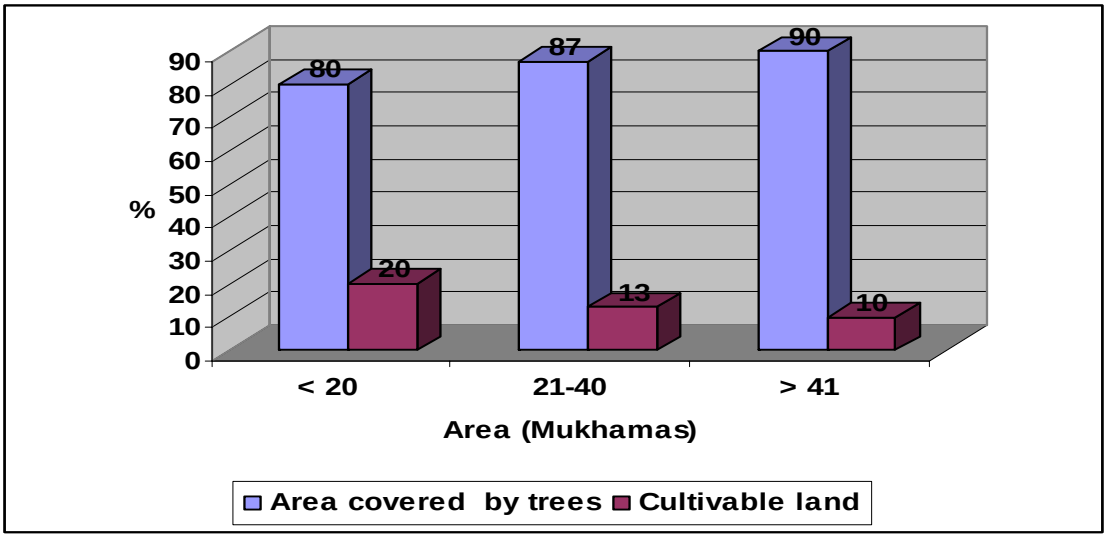
Land tenure is one of the most sensitive issues concerning forestry activity. Usually private forest lands in the study area are acquired through inheritance. The dominant form of land tenure is customary land tenure in which the land is owned and disposed off according to customary regulation. Wilkens (1978) showed that under the condition of inheritance, the ownership is subjected to changes in a form of reduction in land size and as a result tree has to be cleared to provide a vacant lot for the family. In Sudan different forms of forest land ownership exist and it sometimes takes a complicated form in which the land is owned by a person while the trees in the same land belong to another person (Koli, 2002). In the study area 36.7% of the respondents clarified that the area of their land varies between one to twenty mukhamas (1 mukhamas is equivalent to 1.75 feddan), 38.3% possess between twenty one to forty mukhamas, and (24 %) own land of more than forty mukhamas (Table 5.3)

Table (5.3): Types and areas of agricultural lands

Village	N	Land tenure type (%)		Areas of agricultural lands (%)		
		Customary	Other	1- 20	21-40	> 40
Aman Alla	30	100.0	3.3	20.0	40.0	36.3
AL-Adayat	30	100.0	0.0	53.3	33.3	13.3
Al-Alifon	30	100.0	16.7	36.7	30.0	33.3
Mabrouka	30	100.0	3.3	36.7	50.0	13.3
TOTAL	**120**	**100.0**	**4.2**	**36.7**	**38.3**	**24.0**

The exploitation of the farm lands varies considerably between the respondents. Some farmers intensify farming in small parcels and allow trees to develop in the rest of the farm, while some others prefer to incorporate trees and crops simultaneously in the farm (Figure. (5.1)). For respondents who possess an area less than 20 mukhamas, agriculture activity comprise 20% of the farm area and the rest of the area is assigned for trees, while for respondents who possess an area between 21 – 40 mukhamas 87% of the area is left for the trees and agricultural crops is practiced in the rest of the farm (13%). As the area of the farm increase more parcels are devoted for trees. Ninety percent of the area is covered by trees for farmers who have farm area greater than 41% of the total land owned and crop production is practiced in 10% of the farm.

Figure (5.1): Exploitation of lands for trees and crops in the study area

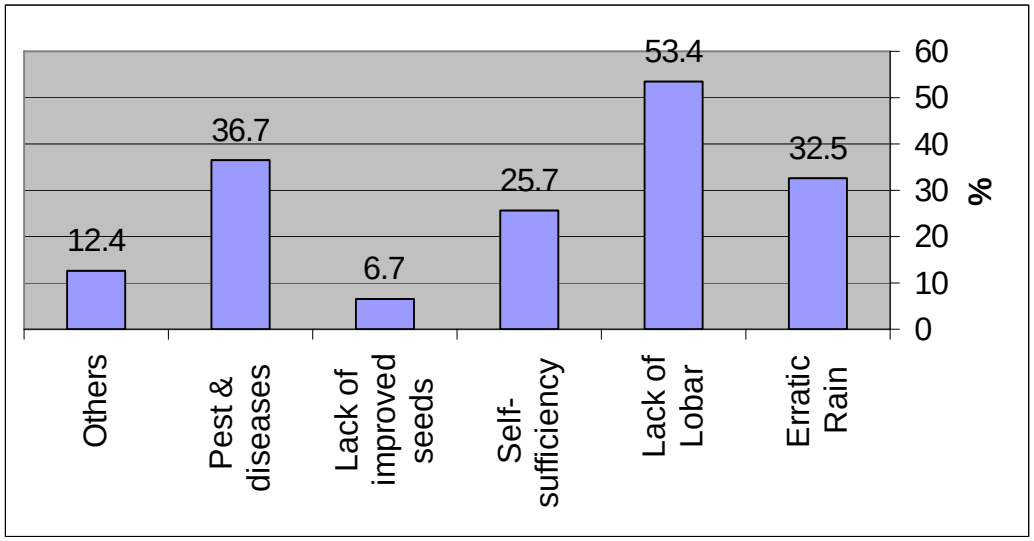


Farmers in the study area are reluctant to expand the cultivable areas where the area is characterized as marginal areas with erratic nature of rainfall and frequent drought cycles. Labor shortage also considered as a determinant factor for the cultivable area in the farm.

5.3. Agriculture constraints and problems

Several factors act as measures of risk confronting expansion of crop cultivation in the study area. Farmers nominated the different factors which they considered as determinant factors for the success of the agricultural season (Figure. (5.2)).

Figure (5.2): Agriculture constraints and problems



Lack of labor is mentioned as the most critical factor for the expansion of the cultivable land in the study area as mentioned by 53.4% of the respondents followed by the high infestation of diseases and pests particularly rodents as claimed by 35%. The fluctuation of rainfall in terms of distribution and intensity makes the farmers hesitant to expand the cultivable lands as asserted by 32.5% of the respondents.

More over, drought is unwelcome visitor to the study area where several drought cycles were reported and continue every now and then (Mohamed, 2000). Twenty-five percent of the interviewed sample asserted that the misperception of possibility of development of agricultural activity is one of the constraints confronting expansion of the cultivated areas. Most of the farmers practice farming for self-sufficiency. This might be attributed to the marketing mechanism and availability of markets for the agricultural crops.

In the socio-economic context of forestry, marketing is one of the means, in combination with processing and resource management, to cater for the needs of people involved. Marketing provides a set of tools with which people can create more efficiently economic value for the resource and products made of it. Proper marketing also assists in a more equal distribution of the economic value created among the participants. Marketing is therefore vital not only to medium and large-scale industrial enterprises but also in helping small farming and forestry

communities move from a subsistence economy to one in which they can start and sustain profitable enterprises on their own (FAO, 1993). In the study area there were 350 villages, the market facilities and operations are shown in Figure (5.3).

Lack of improved seeds also considered as a constraint by 7% of the respondents where farmers are reluctant to look for improved seeds known for their suitability to the site. Some respondents (8.4%) mentioned other factors hindering expansion of agricultural activity like overgrazing, frequent fires, and urbanization.

5.4. Typology of bush-fallow cultivation cycle

The cultivation of hashab tree is a traditional agroforestry practice in the study area. The system has different models that dated back to pre-historic times (Gamser, 1987). Hashab trees are grown on approximately a 20 years rotation, with tapping occurring at age 5 or 6 years, and with intercropping during the first few years of trees growth. In the study area all the respondents stated that they still following the traditional gum bush cultivation cycle with subtle or major modifications. The traditional cultivation cycle implies that the area of fallow land is similar or larger than the cultivated area.

In the study area 97.5% of the respondents emphasized the incorporation of the fallow period in the cultivation cycle and the rest (2.5%) claimed that they are no longer retaining some parcels of the farm for the fallow period. According to the traditional system, crop production is practiced in the same area for 3 – 4 years. When comparing this with the present cultivation cycle 25.8% and 29.2% of the respondents cultivate the same area of the farm for three and four years, respectively.

Figure (5.3): Marketing facilities in the study area.

The rest of the respondents (46%) used to expand the period of cultivation in the same area. Some farmers (6.8%) used to cultivate the same area for ten years (Table (5.4)). From Table (5.4) it is possible to conclude that the traditional system is subject to modification, but Al Alifon village show the conservation of the traditional system with subtle modification.

Table (5.4):Typology of cultivatable land.

Villages	N	Shifting cultivation (%)	Follow Rotation (%)	Fallow Period (years) (%)			
				3	4	5	10
Aman Alla	30	100.0	90.0	26.7	13.3	36.7	10.0
AL-Adayat	30	100.0	100.0	26.7	30.0	30.0	6.6
Al-Alifon	30	100.0	100.0	30.0	50.0	26.7	4.8
Mabrouka	30	100.0	100.0	20.0	23.3	63.3	3.3
TOTAL	**120**	**100.0**	**97.5**	**25.8**	**29.2**	**39.2**	**6.8**

From these findings it is clear that the fallow period which is an essential component in the gum–bush cultivation cycle has been drastically reduced in the system. This agrees with Born, (1965) and Mohamed (2000) who stated that there is serious modification of the fallow period in bush fallow system. These modifications of the system reflect the challenge that faces the hashab trees and consequently gum and crop production.

5.5. Production of the agricultural system

As mentioned earlier, the BFS encompasses different components where trees, crops and sometimes animals exist at the same time or alternate within the same area over time. Generally, the production of the system is confined to gum tapping, cultivation of subsistent crops (millet and dura), cash crops (ground-nuts, kerkadae, sesame) and animal husbandry (sheep, goats). In Northern Kordofan State, this multi-resource management is fundamental aspect of farmers' survival strategy.

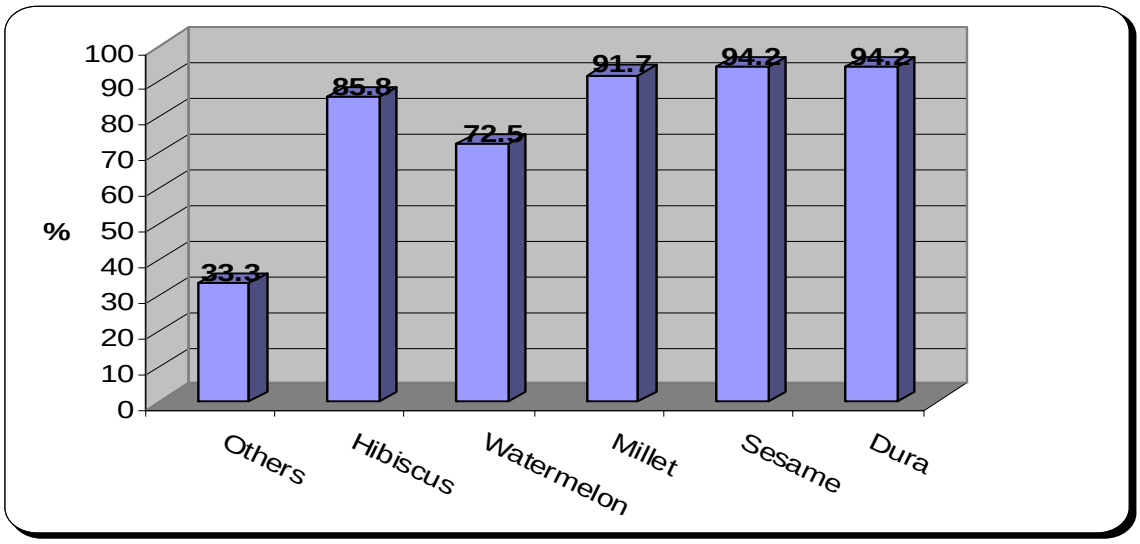
In the study area production of agricultural crops, agriculture is the dominant type of cultivation where there is no alternative. The rainy season extend for three months (July –September). The farmers asserted that they face persistent decline of crop yield and recurring crop failures and death of large numbers of animals in the last ten

years. The most important, as far as productivity is concerned, is whether the cultivable land is old or newly opened. Moreover, yields vary considerably from one year to another according to rainfall. Equally important are the effects of pests and diseases.

In Kordofan, Born (1965) showed that in the 1960s the hectare yields of cereal crops is up to 1000 kg per hectare could be harvested in the southern parts of the North Kordofan State. In the northern parts they were as low as 100 kg per hectare and in bad years the crops failed completely. Coughenour and Nazhat (1985) showed that millet yields in North Kordofan State have declined sharply over the past 25 years, from 640 kg/ha in the 1960s to 377 kg/ha in the 1970s and to as low as 210 kg/ha in the early 1980s. Farmers in the study area cultivate subsistent crops (dura and millet) for self-satisfaction and some cash crops Figure (5.4). High percent interviewed sample (94.2%) cultivates dura and 91.7% cultivate millet. The main cash crops in the study area are sesame, hibiscus and watermelon as stated by 94.2, 85.8 and 72.5%, respectively. Usually sesame is planted between the rows of dura.

Watermelon is cultivated in the study area for the economical value of the seeds beside the assurance of water during the times of water shortage, while vegetables and other crops are cultivated by farmers to diversify their nutritional diet. However, this usually takes place in a small parcel of the farm. However, the productivity of any type of the different crops varies considerably. Table (5.5) show that dura productivity is better than millet where 24.1% of the respondents asserted that they harvested more than ten sacks per mukhamas and 66.6% harvested between 5 – 10 sacks per mukhamas.

Figure (5.4): Cultivated crops in the study area



For millet, only 4.1% of the respondents harvested more than ten sacks per mukhamas, while 70.8% harvested between 5 – 10 sacks per mukhamas. The productivity of cash crop is relatively better compared to the subsistence crops. Some farmers (8.3%) harvested more than 20 sack of hibiscus per mukhamas and 23.4% harvested between 10 – 20 sacks per mukhamas. The rest of the respondents harvested less than 10 sacks of hibiscus per mukhamas. For sesame, 61.7% of the respondent harvested between 5-10 sacks per mukhamas and 28.3% harvested more than 10 sacks per mukhamas last season. The rest of the respondents harvested less than 5 sacks per mukhamas last year. Generally, the productivity of hibiscus is much better than the productivity of the sesame in the study area.

Although the productivity of cash crops is relatively better than the subsistence crops, the farmers used to allocate small parcels for the cash crops because the prices of the cash crop is very low and not encouraging for expansion of areas for cash crop. Therefore, preference is given to the subsistence crops to guarantee a steady supply of daily requirements.

Table (5.5): Crop productivity in the study area

villages	N	Production of agricultural crops							
		Durra (%)		Millet (%)		Hibiscus (%)		Sesame (%)	
		5-10	> 10	5-10	>10	5-10	>10	5-10	>10
Aman Alla	30	63.4	20.0	66.7	6.6	66.7	6.6	63.3	16.6
AL-Adayat	30	70.0	23.3	86.7	0.0	86.7	0.0	80.0	13.3
Al-Alifon	30	50.0	36.7	76.6	6.7	76.6	6.7	43.3	43.3
Mabrouka	30	83.3	16.6	93.4	3.3	93.4	3.3	60.0	40.0
TOTAL	120	66.6	24.1	70.8	4.1	70.8	4.1	61.7	28.3

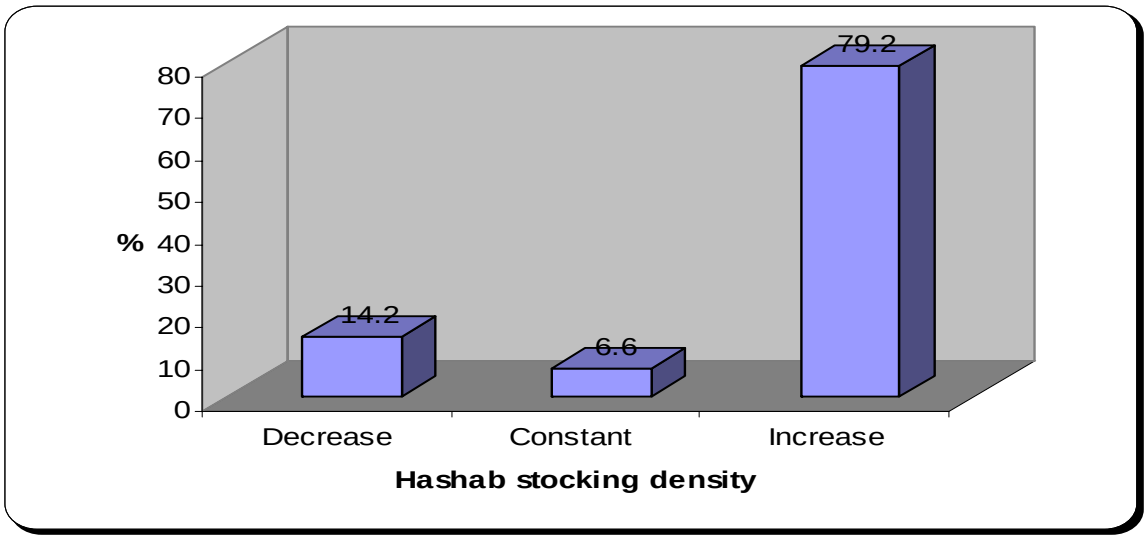
5.6. Status of hashab trees in the study area

Despite the fact that the farmers in the study area consider hashab tree as a contingency asset to meet times of emergency, the stocking density of hashab tree increased dramatically in the study area. This fact is supported by 79.2% of the respondents particularly in Aman Alla and Aladayat villages, while 14.2% stated that hashab trees at their lands are decreasing, particularly in Mabrouka village (Figure (5.5)). However, there is no standard unit for determining the optimal number of trees per mukhamas, but Awouda, (1973) stated that a typical gum garden would have about 600 trees/ha and start producing gum after four years. Ballal (2002) refers to a stocking density of 400 tree/ha as a good stocking for a good gum yield.

The rest of the respondents 6.6% believe that there is neither increase nor decrease in the stocking density of the hashab trees. From these findings the stocking density of hashab tree is a debatable issue and either of the two parties could verify his allegation, but a general consensus is that stocking is increases as confirmed by 70.9% of the respondents. However, the increase of the stocking density in the study area can be attributed to the large scale afforestation campaign executed by different NGOs projects like UNSO, SOSsahel, CARE, ILO and others beside the Forests National Corporation (FNC) activities. All the NGOs projects worked in the study area exerted considerable efforts in raising the awareness of the local people towards conservation of the environment and the importance of the hashab trees. Moreover, these projects used to distribute seedlings and improved seeds to the farmers. On the other hand, for those who claimed that the stocking density of hashab trees

deteriorated, several factors support their allegations like frequent droughts, locust and other factors

Figure (5.5): Status of hashab trees in the study area



5.7. Types of regeneration of hashab trees

For sustainable BFS, the regeneration of hashab tree should be guaranteed. According to Harrison and Jackson (1958), El Amin (1990) and Badi, (1989) the study area falls within the gumbelt zone where the tree exists as wild and in plantation forms. This gives an indication of natural regeneration in the study area. The majority of the respondents in the study area (84.2%) rely on natural regeneration while the rest rely on artificial regeneration (Table 5.6). This may be verified by the fact that the viability of the seeds of *Acacia senegal* encourages the farmers to rely on natural regeneration. The majority of the farmers who follow artificial regeneration (69.2%) showed that they rely on seeds for planting the trees, and the rest asserted that they used seedlings in the artificial regeneration.

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Figure (5.6): *Acacia senegal* tree in the study area

Acacia senegal

Aman Alla Village-2005

Acacia senegal

Mabrouka Village-2005

Table (5.6): Types of trees covered

Villages	N	Types of trees cover (%)	Seeds collection (%)		Best methods of Regeneration (%)	
		Natural	Randomly	selective	Seedlings	seeds
Aman Alla	30	76.7	90.0	6.7	20.0	76.7
AL Adayat	30	83.3	93.3	6.7	36.3	63.3
Al-Alifon	30	93.3	83.3	16.7	43.3	56.7
Mabrouka	30	83.3	70.0	30.0	20.0	80.0
TOTAL	**120**	**84.2**	**84.2**	**15.0**	**30.0**	**69.2**

The common method of seed collection is random selection as asserted by 84.2% of the respondents. Few farmers follow selective collection of seeds from mother trees. Probably, the market prices of the gum beside the complications of the marketing mechanism are not encouraging the farmers to collect seeds from mother trees known with their high yield of gum. This agrees with Collinson (1981) and Scherr (1997) who stated that rural households operate complex farming system, allocating their limited resources among many enterprises in a manner determined by their priorities, preferences and their biophysical and socioeconomic circumstances.

5.8. Silvicultural treatment of hashab trees

Hashab tree becomes ready for tapping few years after the juvenile stage of development. The period varies from region to another and from tree to another, but generally the tree is tapped for gum after four years of successful development. The respondents were asked to comment on the different silvicultural operations for the hashab tree. However, the hashab trees when well established do not require intensive silvicultural operations. In the past, the respondents mentioned that they used to receive seedlings from the projects in the study area, and with the phase-out of these projects they rely on natural regeneration for hashab trees.

Five percent of the respondents showed that they planted their hashab trees (Table (5.7)). Seventy-five percent of the interviewed sample practiced tending operations to hashab stand. The main operations are weeding and singling of seedlings.

Protection of hashab as a silvicultural treatment was mentioned by 53.3% of the respondents. Usually farmers protect their hashab gardens against illicit felling and theft of gum nodules. It is especially important to protect young trees, and to reach this aim, a plantation of *Acacia senegal* needs 8 years during which access to animals is forbidden. It is also better to avoid goats and cattle in young plantation, whereas sheep can be tolerated (Rochleau el. al., 1988).

Table (5.7): Silivcultural treatment for hashab tree

Villages	N	Silvicultural treatment of hashab (%)			Best situation (%)		
		Planting	Tending operation	Protection	Only trees	Agric. crops	Trees + crops
Aman Alla	30	0.0	60.0	50.0	6.7	0.0	90.0
AL Adayat	30	3.3	73.3	63.3	0.0	0.0	100.0
Al-Alifon	30	0.0	80.0	70.0	10.0	16.7	73.3
Mabrouka	30	0.0	80.7	30.0	6.7	0.0	93.3
TOTAL	**120**	**5.0**	**75.0**	**53.3**	**5.8**	**4.2**	**89.2**

The majority of the respondents (89.2%) asserted the importance of incorporating trees and crops in the system. Their preference of this system is justified by existence of different sources of income and benefits, while 5.8% believe that it is better to devote all the farm area to trees. This group supports the idea of difficulty of attaining satisfactory crop production in such marginal area. The rest of the respondents (4.2%) prefer the retention of the entire farm area for crop production due to the difficulties associated with hashab planting.

5.9. Distribution of the trees on the farm

There are different forms of spatial arrangement of hashab tree on farm including the BFS. Under the BFS the distribution of trees in the agricultural land takes different forms. The dominant form is parklands system in which trees are distributed irregularly (randomly) over the entire area as indicated by (89.2%) of the respondents, some respondents tend to keep trees in form of strips as stated by (8.3%). The rest of the respondents eradicate all the hashab trees from the

agricultural land and hashab trees are left on the boundary to act as live fence or windbreaks (Table (5.8)).

Table (5.8): Distribution of trees in the farm

Villages	N	Distribution of trees in farm (%)			Best trees distribution (%)	
		Random	In rows	Others	Randomly	Hedgerow
Aman Alla	30	76.7	16.7	3.3	60.0	20.0
AL-Adayat	30	93.3	6.7	0.0	70.0	23.3
Al-Alifon	30	100.0	0.0	0.0	66.0	33.3
Mabrouka	30	86.7	10.0	10.0	63.3	33.3
TOTAL	**120**	**89.2**	**8.3**	**3.3**	**65.0**	**25.5**

Some farmers (25.5%) manage to retain trees at their farms following hedgerows system. It seems that the population pressure pushed farmers to intensify crop production at the expense of hashab trees. Accordingly, farmers tend to cope with this situation through eradication of trees to offer a vacant lot for the crops.

Moreover, the decline of gum prices offers a good opportunity to the farmers to invest in charcoal and Fuelwood production. In the past, old trees (unproductive trees) are cut and the area is left for the fallow period. Recently, some farmers used to cut productive trees for Fuelwood and charcoal making particularly in seasons of poor crop harvest.

5.10. Objectives of tree planting (Benefits)

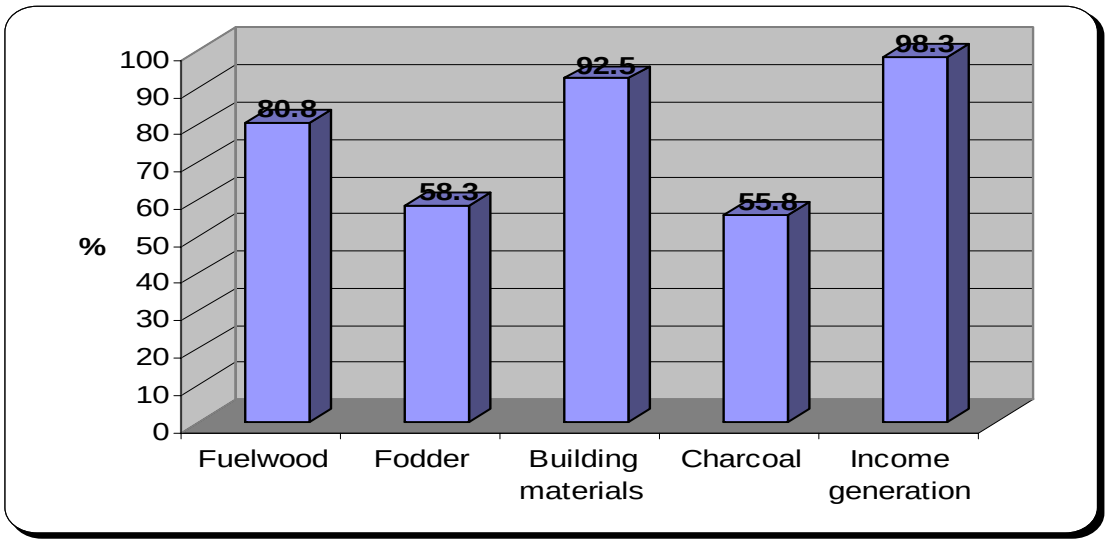
Hashab tree is of a significant importance to the rural dwellers as well for the country as a whole. All the respondents in the study area appreciate the role of the tree in providing a source of income generation. Income generation from hashab principally depends on marketing of the gum. Others source of income from hashab tree are obtained from charcoal and fuelwood enterprises. In the traditional system reliance on hashab tree for firewood did not endangered the system because the felling of trees take place to the old trees (unproductive trees). According to several studies (El. Sammani, 1985 and Mohamed, 2000), now hashab tree is subjected to cutting before arriving twelve years for sake of obtaining a quick return from the fuel

wood sales. Some respondents (55.8%) assess the benefit of hashab tree as a main source of charcoal. Trading in charcoal and charcoal making is one of supplementary source of income to the farmers particularly during years of frequent droughts. Similar to charcoal, 80.8% of the respondents consider the hashab tree as the main source of Fuelwood for trading and consumption. This attitude reflects the challenge confronting the existence of the hashab trees particularly under continuous decline of gum prices and failure of agricultural seasons. This situation is accelerated with the decline of the gum arabic prices and the deterioration of environmental factors beside the destruction of hashab stands by locust.

In the study area the primary objective of planting hashab tree is for income generation as stated by 98.3% of the respondents Figure. (5.6). Most of the respondents evaluate other benefit of hashab tree as a source that provides them with building material as stated by 92.5% of the respondents. It worth mentioning that most if not all of the buildings in the study area are made from forests products. The reliance on the hashab for poles is due to the dominance of the species in the area. Hashab trees provide the necessary components of the local building material (shiba, rasas, kriki, and mutrag).

As far as the animal wealth in the study area is concerned, 58.3% of the respondents mentioned that hashab trees provide fodder during times of no herbs or grasses exist in rangelands. The leaves and pods of the tree collected by herdsmen or directly by camels contribute to the survival of livestock in the study area. Moreover, the respondents mentioned other benefits of Hashab like the manufacture of ropes from the fibers of the roots, protection of the soil from erosion, maintaining soil fertility beside the aesthetic value of the tree.

Figure (5.7): Objectives of tree planting (Benefits)



5.11. Tapping of hashab trees and yield

Although all the respondents possess hashab trees at their farms, not all of them tap their trees for gum production. Table (5.9) shows that 91.7% of the farmers used to tap their hashab trees for gum and the rest (8.3%) do not tap their hashab trees annually. It seems that the problems of tapping associated with marketing of the gum and the prices mechanism. For those who collect their gum annually (48.3%) stated that they used to pick the gum on the intervals of 12 days, while the rest (51.7%) on 15 days intervals. All the respondents agree that the age at which trees are ready to be tapped for gum production is 4 to 5 years.

As far as gum yield is concerned, the respondents in the study area showed that it depends on several factors particularly climatic condition and farm-gate prices. However, the majority of the respondents (90.8%) asserted that the average yield per tree varies between 1 – 3 lb and 3.3% mentioned 4 -5 lbs per tree. Some farmers (4.2%) mentioned that the average productivity of their trees of gum is greater than 5 lb. This greatly agrees with Blunt (1926) who found that *A. senegal* begin to yield gum at an average yield of one to five/lb per tree after about five years and they remain productive for about fifteen to twenty years then they are cut down and the fields are cultivated for four to five years.

Table (5.9): Tapping of hashab tree and yield

Villages	N	hashab tapping (%)	Gum collection intervals (days) (%)		Yield of gum /Ib /tree (%)		
			After 12	After 15	1-3	4-5	>5
Aman Alla	30	100.0	66.7	33.3	86.7	0.0	6.7
AL-Adayat	30	100.0	53.3	46.7	96.7	3.3	0.0
Al-Alifon	30	96.7	33.3	66.7	90.0	3.3	6.7
Mabrouka	30	70.0	40.0	60.0	90.0	6.7	3.3
TOTAL	**120**	**91.7**	**48.3**	**51.7**	**90.8**	**3.3**	**4.2**

5.12. Disposal of gum arabic production

Marketing of gum arabic is one of the most important factors influencing the production of the gum and conservation of the tree. In the study area several channels are used for marketing the gum (Table (5.10)). Most of the respondents (49.1%) prefer to dispose their gum to the brokers and mediators at the village level, particularly in Aladayat village where (96.7%) of the respondents disposed their production to the brokers and mediators. The preference of the brokers and the mediators is due to the fact that the farmers are not financially backed to cover the additional costs of transporting their yields to other markets. Under the shyl system the farmer has to pay back his debts to local traders. The rest of production (gum) is not encouraging to the farmers to transport it to the near principal cities (El Obeied, El Rahad and Um Ruwaba) where prices are relatively better than at the village. Some of the respondents (39.2%) dispose their production to gum companies (Gum Arabic Company, Warm Sea Company). This group of farmers is well-to-do and capable of transporting their gum to the principal cities. Some farmers (19.2%) dispose their gum to the local traders either for sake of paying their debts or to skip the cost of transportation of the gum.

Table (5.10): Disposal of the gum arabic production

Villages	N	Methods of marketing (%)				Price suitability (%)
		Village markets	Companies	Local traders	brokers & mediators	Satisfactory
Aman Alla	30	73.3	50.0	36.7	26.7	26.7
AL-Adayat	30	90.0	13.3	3.3	96.7	30.0
Al-Alifon	30	53.3	56.7	36.7	56.7	6.3
Mabrouka	30	73.3	36.7	-	83.3	3.3
TOTAL	**120**	**72.5**	**39.2**	**19.2**	**49.1**	**16.7**

The majority of the farmers are not convinced with the prevailing prices where only 16.7% of the respondents stated that the prices are satisfactory. Most members of this group are capable of transporting their gum to the principal cities and therefore they are not exploited by the local traders or mediators. This agrees with the World Bank (1976) that showed that marketing of gum arabic is arranged by merchants who buy at auctions, clean, grade, pack, and deliver to the warehouse of Gum Arabic Company.

5.13. Problems associated with gum marketing

Several factors confront marketing of gum in the study area. Besides the marketing channels and declining prices of the gum, the farmers mentioned other factors which directly affect their attitudes towards investment in gum production. The majority of the respondents (76.7%) stated that the price of the gum is fluctuating and not stable to build on. Transportation of gum from sites of production to gate houses, where auctions take place, represent a real challenge to considerable percentage of farmers as declared by 31.7% of the respondents. The farmers could hardly fulfill the financial obligations of gum tapping and picking. Under such situation coupled with lack of storage facilities, farmers tend to get rid of their gum at the available prices irrespective of the channel. Few respondents (12.5%) consider brokers and mediators as a constraint confronting marketing of gum arabic. Although farmers are quite sure that the mediators and peddlers are exploiting them through offering relatively lower prices compared to other marketing channels, still most of the

farmers are not complaining from them because they offer money at the time of delivery of the gum.

Table (5.11): Problems confronting marketing of gum

Villages	N	Problems confronting marketing (%)				
		Price fluctuation	Monopoly	Transportation	Mediators	Storage
Aman Alla	30	73.3	16.7	10.0	3.3	6.7
ALAdayat	30	56.7	13.3	60.0	6.7	13.3
Al-Alifon	30	80.0	10.0	30.0	13.3	10.0
Mabrouka	30	96.7	26.7	26.7	26.7	10.0
TOTAL	**120**	**76.7**	**16.7**	**31.7**	**12.5**	**10.0**

Ten per cent of the interviewed sample complained from the lack of storage facility at their areas. Under such conditions farmers have to dispose their products at the prevailing prices which are always low particularly in years of high gum production, while 16.7% complained from the monopoly of gum marketing by Gum Company.

5.14. Obstacles against gum arabic production

Several factors affect the productivity of gum arabic. The majority of the respondents (68.3%) stated that declining or fluctuation of gum arabic prices is the great challenge confronting the development of gum marketing and consequently plantations development. Low gum prices push the farmers to be less keen to tap and pick the gum. Under certain circumstances, the trees are cut for building poles trade or converted to charcoal. Most of the villages in the study area suffer from water deficit. There are no enough water reservoirs in the study area. Drinking water shortage, for human and livestock, is a serious problem. Therefore, 65.8% of the respondents consider lack of drinking water as the main reason behind ignorance of hashab tree. This agrees with (Ramli, 2006) who stated that the main cost of gum production is the cost of drinking water because water have to be transported to labor camps from water station which is usually a distant a part from the hashab fields. Pests also aggravate the risks of seedlings development and gum production. This fact is supported by 26.7% of the respondents. Seedlings at juvenile stage are threatened by rodents particularly rabbits and rats. Moreover, the study area is a theatre for locust swarms annually. The study area falls within the migratory route

of *Sari ellail* locust (*Anacridum melanohordon)* which is destructive to the hashab tree.

Table (5.12): Constraints and problems of gum production (%)

Villages	N	Pests	Prices	Others	Water	Stores	Credit accessibility
Aman Alla	30	46.7	43.3	63.4	100	10.0	10.0
AL-Adayat	30	20.0	66.7	23.4	76.4	6.7	23.3
Al-Alifon	30	30.0	73.3	20.0	60.0	30.0	13.3
Mabrouka	30	10.0	90.0	26.7	26.7	40.0	23.3
Total	**120**	**26.7**	**68.3**	**33.4**	**65.8**	**21.7**	**17.5**

Lack of stores represents one of the main constraints to invest in hashab planting as claimed by 21.7% of the respondents. In seasons of exceptional high production farmers have to dispose their gum at relatively lower prices because they have no stores. This problem is clearly evident in Mabrouka village which is characterized by high yield of gum compared to other villages in the area.

Farmers in the study area sometimes are financially incapable to support the different activities of gum tapping and picking. Lack of credit accessibility discourages farmers to make large-scale investment in gum collection as stated by 17.5% of the respondents. One strategy adopted by farmers is to tap small parcel of land and ignore the rest of the gum garden. Another strategy adopted by farmers is the *shyl* system in which the farmers use the eventual crop as collateral; therefore, it separates the farmers from their product. Provision of credit accessibility will enhance investment in hashab trees which ultimately lead to the conservation of tree and the environment.

5.15. Source of labor force in the study area

Agricultural activity in the study area is practiced during the rainy season (July–September) after which the local people search for a supplementary source of income, but the majority remain idle until the prevalence of the next rainy season. This situation assumes the availability of the labor force for the different agricultural activities. This fact is supported by (90.8%) of the respondents who confirmed the availability of labor force during the agricultural season Table (5.13). This

availability is attributed to the growing importance of wage labor. Landless inhabitants and sometimes farmers tend to work as labors in other's people farms rather than at their own. One reason could be the fact that this group is not sure about the suitability of the rainy season, another factor could be lack of financial capability to cover the different cost of cultivation or for sake of gaining cash at times of cash scarcity (after nine months of idleness).

Despite the availability of labor force, 9.2% of the respondents claimed that the salaries the labors asked for is far beyond their potentiality. Under such circumstances, farmers tend to rely on other sources of labors. Under certain conditions farmers are obliged to look for hired labors particularly for gum tapping and picking. Therefore, gum production offers job opportunities particularly during times that not coincide with the agricultural season. This agrees with the World Bank (1976) stated that gum arabic collection provides employment during summer months, when alternatives were unavailable.

Table (5.13): Source of labor force in the study area

Villages	N	Source of labor (%)			Labor availability (%)	
		Family members	Nafir	Waged labor	Available	High wages
Aman Alla	30	96.7	3.3	3.3	96.7	3.3
AL-Adayat	30	100.0	0.0	0.0	100.0	0.0
Al-Alifon	30	83.3	10.0	26.7	76.7	23.3
Mabrouka	30	96.7	3.3	6.7	90.0	10.0
TOTAL	**120**	**94.2**	**4.2**	**9.2**	**90.8**	**9.2**

Table (5.13) shows that only 9.2% of the respondents rely on hired labors for the execution of the different operations of the farm, while the majority of the respondents (94.2%) rely on members of the household for conducting the different activities. As mentioned earlier, the majority of the families in the study area consist of big family size; therefore most of the farmers do not find difficulties to deal with labor scarcity or high salaries. Another strategy to deal with labor scarcity is the

adoption of nafir (reciprocal exchange of labor or working party) as asserted by 4.2% of the respondents.

5.16. Services and assistance provided in the study area

The study area due to its remoteness from the seats of government at Khartoum is considered as marginalized area. Necessary government services rarely find its way to the study area. Education service is relatively better compared to other services (Table (5.14)). The majority of the respondents (94.2%) asserted that they are appreciating the role of education in changing their lives to better standards. Accordingly they tend to send their children to other villages where schools are allocated. Sometimes students have to cross long distances sharing a donkey with a relative or colleague. Sometimes villagers send their children to their relatives or as guests with foreigners where schools exist. In the study area there only one primary school located in Mabrouka village.

Table (5.14): Assistance provided in the study area

Villages	N	Governmental assistant provided (%)			Local assistance provided (%)		
		Education	Health care	Other	Extension	Provision of seeding	Others
Aman Alla	30	100.0	3.3	6.7	73.3	23.3	6.7
AL-Adayat	30	90.0	3.3	0.0	80.0	26.7	10.0
Al-Alifon	30	93.3	0.0	6.7	83.3	30.0	6.6
Mabrouka	30	93.3	0.0	6.7	76.7	16.7	66.6
TOTAL	**120**	**94.2**	**1.7**	**5.0**	**78.3**	**24.2**	**22.5**

Health services receive less consideration where only 1.7% of the respondents asserted that they have health centers at the villages, none of the respondents is from Al Alifon or Mabrouka villages. Even for the other two villages, the respondents confirmed the existence of a building (one room) for health care, but there is no even a nurse to look after patients. This may verify the wide spread of the folk medicine in the study area. Five per cent of the interviewed sample showed there are other services provided by the government like construction of hafir for drinking water. In

some villages in the study area, NGOs like UNICEF, SOSsahel, UNSO and IFAD provide some services to the local communities.

The role of the FNC in providing services to local communities is appreciable. Local communities in the study area have sound relations with the FNC particularly the unit of extension as claimed by 78.3% of the respondents. This relationship was built through the systematic visits made by the extensionists in the study area. The extension unit, as part of their duties, distribute improved hashab seeds and seedling to willing farmers as stated by (24.2%) of the respondents to encourage expansion of areas covered by hashab trees particularly in abandoned fields. Other services provided by the FNC are credit accessibility, formation of farmers associations at different villages and training on administrative issues regarding the management of hashab stands and adoption of new innovations of ideal tapping and picking.

5.17. Training in the study area

Dissemination of information and changing of attitudes of clients is not an end by itself. This step should be followed by intensive training and refreshment training to guarantee the transfer of skills from the source (extensionists) to the recipient (client). However, in the study area the extension unit is keen to hold training sessions to the local people covering different topics (Table (5.15)). This fact is supported by 40.8% of the respondents. Different institutions participated and contributed to the training of the local people in the study area. Forty per cent of the interviewed sample mentioned the FNC as the institution that tackle the issue of training in the study area and they focus on the afforestation, protection and seedlings production.

Table (5.15): Training in the study area

Villages	N	Training (%)	Direction of Training (%)			Impacts of Training (%)	
			FNC	IFAD	Others	Negative	Positive
Aman Alla	30	40.0	36.7	46.6	0.0	3.3	70.0
AL-Adayat	30	33.3	36.7	33.3	3.3	16.7	76.7
Al-Alifon	30	43.3	40.0	10.0	10.0	6.7	70.0
Mabrouka	30	46.7	40.0	20.0	6.7	13.3	76.7
TOTAL	**120**	**40.8**	**38.3**	**27.5**	**12.5**	**20.0**	**73.3**

IFAD (International Fund for Agricultural Development) also hold training sessions as confirmed by 27.5% of the respondents. This organization is motivated by increasing the productivity of the gum, therefore focuses on training on ideal picking to guarantee the cleanness of the collected gum. Also there are other institutions contribute to the training of the local people as claimed by 5% of the respondents. Among these institutions are Gum Arabic Company, Warm Sea and Sudanese Society for Environmental Conservation.

The role of the different institutions is appreciated by the local people as confirmed by 73.3% of the respondents, while 20% believe that these institutions exerted negative impacts in the study area through their bias to certain categories of the community in terms of credit accessibility and training.

5.18. Extension

The relationship between learning and education is becoming increasingly important in community and rural development, especially under centralization, decentralization and collaborative net working between public and private institutions. The main task of extension services is to disseminate necessary information to the clients in order to change their attitudes towards environmental and development problems and adoption of suitable innovations that enhance conservation of the environment.

In the study area two types of extension services are provided to the clients, namely agricultural and forestry extension (Table (5.16)). Some respondents (33.3%) ensured the existence of agricultural extension services which deals with distribution of improved seeds, better selection of crops, pesticides and fertilizers at subsidized prices. However, a high agricultural extension service is provided at Aman Alla village as asserted by 62% of the respondents compared to 6.7% at Mabrouka village. This big variation might be due the spatial bias under which extensionists prefer to visit the near sites systematically and the remote sites sporadically.

Table (5.16): Extension in the study area

Villages	N	Agri. Extension (%)	Subjects covered by forestry extension (%)			
			Tree planting	Energy substitutes	Marketing	protection
Aman Alla	30	62.0	30.0	16.7	0.0	50.0
AL-Adayat	30	30.0	60.0	6.7	6.7	3.3
Al-Alifon	30	33.3	13.3	3.3	13.3	73.3
Mabrouka	30	6.7	56.7	6.7	3.3	50.0
TOTAL	**120**	**33.3**	**40**	**8.3**	**5.8**	**44.2**

As far as forestry extension is concerned, the respondents showed that the forestry extension services are relatively better than the agricultural extension services. Forestry extension in the study area covers different fields where 44.2% of the respondents stated that the extension unit focuses on the rational use of the natural resources with special emphasis on the protection and conservation of the resources. One strategy to attain this broad objective is through reduce pressure on the natural resources although adoption of energy substitutes as asserted by 8.3% of the respondent, intensification of tree planting in private forest, farms and within house yard and streets as claimed by 40%. The extension service realized the negative impacts of gum prices fluctuation on the conservation of the hashab tree and sustains gum production, therefore managed to develop a reasonable market analysis and development of the gum to encourage farmers to invest in gum production as mentioned by 5.8% of the respondents.

The forestry extension unit in the study area relies on different extension methods for the dissemination of information to clients (Table (5.17)).

Table (5.17): Methods of forest extension in the study area

Villages	N	Forest extension methods (%)		
		Formation on farmers union	Meeting	Demonstration
Aman Alla	30	86.7	56.7	36.7
AL-Adayat	30	100.0	36.7	26.7
Al-Alifon	30	100.0	50.0	60.0
Mabrouka	30	100.0	66.0	33.3
TOTAL	**120**	**96.7**	**52.5**	**39.2**

Home and farm visit is the main method of extension as mentioned by the majority of the respondents (96.7%). Through this method the extension unit was successful in organizing the local communities into associations (gum producers association) to tackle the issue of gum marketing and minimizing the possibilities of exploiting farmers by brokers, peddlers and mediators beside the eradication of the *shyl* system. Public meetings also used by the extensionist as asserted by 52.5% of the respondents.

For the nursery techniques and tree planting, the extension unit follows demonstration method to guarantee the transfer of knowledge to the clients as mentioned by 39.2% of the respondents. From these findings it is clear that the extension unit plays a major role in the study area despite the poor infrastructure and limited fund assigned for these tasks. This agrees with FAO (1985) which necessitate for effective pattern of forestry extension, existence of a functional approach that means the designers must, with the cooperation of the people concerned, define certain goals which are of importance to the people and decide on the steps that must be taken to achieve these goals, the goals themselves must be clearly defined if the process of achieving them is to operate effectively. The other important point is to understand that, nature has an important role in achieving the set objectives in a short time and with minimum cost, if we work with it (Bradshaw, 1995). Having realized this, what is necessary then is a systematic approach to each specific eco-system, interrelating the qualities of the sites and needs of the people (Bradshaw, 1995).

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1. CONCLUSIONS

- The study area is characterized by big family sizes and the household members play an important role in the agricultural activities and gum production.
- The main source of income in the study area is agriculture and gum production which provide farmers with income during times of no other available source of income.
- The educational level is very low and the illiterate and those who have khalwa education represents the bulk of the target group. This is due to the lack of schools within the vicinity of the villages.
- Customary land tenure is the dominant type of ownership in the study area. With the increase of the population pressure the farms are disintegrating through inheritance and this has its drawbacks on the traditional system of cultivation.
- Although the areas of landholdings still suitable for practicing BFS, many farmers have landholding less than ten mukhamas which does not qualify them to follow the traditional system.
- There is great modification of the BSF and very few farmers abandon the area of their farms for fallow period to allow the soil to restore its fertility i.e. there is intensification of crop production at the expense of hashab trees. This situation change with the increase of the area of the land holdings.
- The fallow period which is an essential component in the gum-bush cultivation cycle- still exists in the modified systems, but its period is very short compared to traditional BFS.
- The agricultural productivity is declining compare with the history of production in the study area. Although the productivity of the cash crops is relatively higher than the production of the subsistent crops, preference is given to the subsistent crops because of the market mechanism.

- Labor shortage is a critical factor for agricultural and gum production due to the coincidence of the two activities in time series. High infestation of diseases and pests particularly rodents, frequent drought and the practice of farming for sake of self-sufficiency are among the constraints confronting the development of agricultural production.
- Although a great proportion of the respondents do not tap their trees for gum production annually in the study area, the stocking density of hashab trees is increasing as confirmed by the majority of the respondents. This improvement is attributed to the efforts exerted by the NGOs worked in the study area (IFAD, UNSO, SOS, CARE, etc....).
- Natural regeneration of hashab trees is dominant method of regeneration. No attention is given to the selection of mother trees with known high yield of gum. Few respondents manage to collect seeds from good mother trees.
- Hashab tree after establishment does not need any treatment except that for gum production. The only silvicultural treatments are weeding, singling and protection.
- One sign of modification of the old BFS is the emergence of new distribution trends of trees. In the past trees are distributed randomly in the farm, recently trees are retain in the form of hedgerows or windbreaks for sake of retaining additional parcels for agricultural crops.
- Hashab trees is an important asset for the sustainable livelihood in the study area where the tree besides production of gum provide the local people with building pole, Fuelwood, charcoal, folk medicine, food, ropes beside other uses.
- The productivity of hashab tree from gum varies considerably in the study area, the bulk of the respondents asserted that the average production of the tree is between 1- 5 lb.
- The majority of the farmers in the study area have different channels for marketing their gum. Preference is given to local traders, brokers, peddlers and mediators on the expense of gate houses and companies. This mainly due to the fact that those channels provide money at the same time of the delivery

of the product. Moreover, through using these channels farmers are able to skip the cost of transportation.

- Gum production is confronted by many constraints and measures of risk. The most important factor is fluctuation of gum prices which sometimes make the farmers reluctant to invest in gum production. Other factors include; lack of drinking water, locust infestation, lack of storage facilities, and monopoly of gum marketing and lack of credit accessibility.
- Due to its remoteness from the seat of government at Khartoum, the study area is marginalized where limited public services are provided to the local people. Different villages have to share one school with no campus. There is no electricity and proper water services in the study area.
- Different institutions contribute to the training of local communities in the study area, namely; FNC, IFAD, Gum Arabic Company, Warm Sea and Sudanese Society for Environment Conservation.
- Despite the harsh condition of the study area coupled with lack or limited infrastructure and under-fund, the extension unit is running the extension services smoothly with subtle pitfalls.
- The extension method deployed by the extension unit is; home and field visit, public meetings and demonstrations. The major outcome of the extension services is the organization of local communities into associations to tackle the issues of marketing and to have control on the prices of gum arabic.

6.2. RECOMMENDATIONS

- Provision of water services and qualifying the extension staff and supporting them with the necessary equipment and facilities will encourage farmers to retain trees at their farms and lead to the rehabilitation of the gumbelt.
- Provision of credit accessibility will eradicate the phenomenon of shyl system and make the farmers financially backed to transport and marketing their gum at the gate houses at the prevailing prices without being exploited.
- Special extension package (messages) should be formulated by the extension staff addressing the importance of the fallow period in shifting cultivation and collection of seeds from mother trees known with their superior genotype.

- The farmers association in the study area should not focus only on marketing of the gum; it has to play the major role in the development of the communities and conservation of the environment.

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APPENDIX
FARMERS QUESTIONNAIRE

This questionnaire was designed to collection information about Bush Fallow System (BFS) in your area. The information will be utilized in research for M.Sc degree. Please answer the following questions as accurately as possible. Where actual data are not available, please use your closest estimation. Your answer will be strictly confidential. In a question where you are asked to tick one or more of the cases, indicate this in the place provided. Thank you for your contribution.

First Section: Personal Details

1. Village? ……...……..

2. Education level?

(1) Illiterate (2) primary (3) secondary (4) khalwa (5) others.

3. Age?

(1) 20-40 (2) 41-60 (3) < 60.

4. Martial status?

(1) single (2) married (3) divorce

5. Number of household member?

(1) 1-4 (2) 5-8 (3) < 8

6. Source of income?

(1) Agriculture (2) animal rearing (3) trading (4) forestry activities.

Second Section: land use and Productivity

1. What is the land tenure like?

(1) Real owner (2) rent (3) share participation (4) others.

2. Area of your agricultural land / mukhamas?

Area of agricultural land	1-10	11-20	21-30	31-40	41-50	51-60	< 60
Real agricultural land							
Cultivated area							
Number of trees							

3. If you can not cultivate all the area you owned, what are the reasons?

(1) Rain fluctuation (2) migration (3) lose of labor (4) self-sufficiency (5) others……..

4. Is there difficultly concerning possession of the land?

(1) yes (2) no

4.1. If the answer (yes), fill the reasons?

(1) period drought (2) lose of soil fertility (3) pest and diseases

(4) erosion (5) high cost of lobar (6) unimproved seeds (7) others

5. What is the traditional method followed in agriculture?

(1) shifting cultivation (2) settled agriculture cultivation

6. Do you apply the period of following in the cultivation method?

(1) yes (2) no

6.1. If the answer (yes), specify?

.....

7. What is the type of trees in your land?

(1) natural (2) planted

7.1. If they are planted, what is your source for?

(1) FNC (2) NGOs (3) private production

7.2. What is the method of seeds collection?

(1) randomly (2) systemic

7.3. What is the best method of regeneration of trees?

(1) Seedlings (2) seeds.

8. What is arrangement of trees in your land?

(1) boundaring (2) wind breaks (3) in rows (4) park land

8.1. What are the determinations of trees distribution?

……..…….……..…...

8.2. What is the best method of trees distribution?

……..……..……...…….

9. What is the object of growing trees in your land?

(1) to halt soil erosion (2) net income (3) fodder (4) shade (5) others

What are the different uses (Benefits) of hashab tree?

.....

10. Are the hashab trees in your land increasing or decreasing?

(1) increasing (2) decreasing (3) constant

10.1. If an answer is decreasing specify the reasons?

.....

11. What is the best situation for your farm?

(1) existence of trees (2) agricultural crops (3) both

12. Is the concern emphasizing on hashab led to ignorance other trees species?

(1) yes (2) no

12.1. If the answer (yes), specify the other trees species?

...…….……

13. What are the different silvicultural treatments for hashab tree cultivation?

….……..…….

14. What are the main risks and constraints confronting Hashab tree?

(1) Pests (2) reduction of prices (3) need of fuel wood and charcoal

(4) Others, (specify) ……..……..…...

15. What are the agricultural crops you cultivate frequently?

Crop	Cultivated area	Production / sake	2002	2003	2004
Dura					
Millet					
Sesame					
Hibiscus					
Watermelon					
Others					

16. How you dispose your production of crops?

(1) shyl system (2) porkers (3) mediators (4) transported to Umm Ruwaba City

17. Is trees hindrance agricultural production?

(1) yes (2) no

17.1. If the answer (yes), how?

…….……..…..……...…….

18. Do you tapping hashab for gum?

(1) Yes (2) no

18.1 If the answer (no), specify the reasons?

.....

19. What are the gum collections intervals like?

(1) nine days (2) twelve days (3) fifteen days

20. What is the productivity of your land from gum?

(1) 10-15 Lb (2) 16- 20 Lb (3) < 20 Lb.

21. What are the main risks and constraints contorting the production of gum arabic?

……..……

22. How you dispose your gum production?

(1) Gum Arabic Company (2) Warm Sea Company (3) local traders (4) porkers (5) others.

23. Is the price of gum satisfactory to you?

(1) Yes (2) no

24. What are the main risks and constraints confronting marketing in your area?

…….…… ……..…..…

25. What is your main source of employment for the different agricultural activities?

(1) Family members (2) through nafir (3) payment lobar (4) others

25.1. Is the lobar force available or there are times of scarcity?

(1) Available (2) there is scarcity

25.2. If there is scarify, what are the main reasons?

(1) Migration (2) prices are not attractive (3) others

Third Section: Social Services:-

1. What are the services asses by the local government?

(1) Educational (2) heath care (3) others

2. What is the assistance provided by FNC?

(1) extension (2) seedlings (3) training (4) others

3. This there any agricultural extension?

(1) yes (2) no

4. What are the major subjects guided by forestry extension?

(1) Environmental and ecological subjects (2) energy substitutes

(3) afforestation (4) marketing issues (5) conservation of natural resource.

5. Which type of extension services provided by FNC stuff?

……...……..……

6. Is there any training in gum arabic field?

(1) yes (2) no

6.1. If your answer this (yes), who asses the work?

…….....

7. Is your area dear from migration?

(1) yes (2) no

7.1. If the answer (yes), is it temporal or permanent?

(1) Temporal (2) permanent

7.2. What this the reasons of migration, did you think?

……. .....

8. Is the return from agriculture satisfactory for daily needs?

(1) yes (2) no

8.1. If the answer (no), how you provide your resent livelihood?

…… …….....

9. What are you think about farmer's producers association?

……..….. …….…….……..