Local people Perception of Muddy Building Adoption for Conservation of the Vegetation Cover. Case-study Bara Locality, Sudan

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A thesis submitted to the University of Khartoum in fulfillment of requirements for the degree of Master of science in Forestry

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October 2006
Dedication

This work is dedicated to

my family,

my friends

and my colleagues.

With great love
Acknowledgements

Thanks and praise is due to almighty Allah, who provided me with health and capability to study and accomplish this work.

I acknowledge my indebtedness to Dr. El-amin Sanjak Mohammed Ali for his creative, valuable instructive guidance and encouragement as a supervisor of this study.

I owe a particular debt to Dr. Abdelazim Mirdani Ibrahim, the FNC General Director for sponsoring the study.

I am really impotent to sign thanks and appreciations to my friends and colleagues, for the diverse and unlimited assistances they offer during the whole period of the study, Adam Abdalla Adam Hassan, the director of North-Kordofan State forests, Mamoun Gasim Musa, Osman Abdalla Osman, Khalil Hussain Elfaki, Norel Daem Mohammed Abdalla, Isamel Din Hag El-Tahir, Fadel Alla Egail and Abdel-Rahman Khatir.

My thanks are extended to those whom are not mentioned here with no ignorance of their efforts and helpfulness.
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<tr>
<td>DBH</td>
<td>Diameter at Breast Height</td>
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<tr>
<td>EC</td>
<td>European Commission.</td>
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<tr>
<td>ECED</td>
<td>World Commission on Environment and Development.</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations.</td>
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<td>FNC</td>
<td>Forests National Corporation.</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System.</td>
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<td>Ht.</td>
<td>Height.</td>
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<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development.</td>
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<td>ILO</td>
<td>International Labor Organization</td>
</tr>
<tr>
<td>LC</td>
<td>Locality Council.</td>
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<tr>
<td>LOLAS</td>
<td>Law of Local Administrative System.</td>
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<td>NA</td>
<td>Native Administration.</td>
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<td>NGOs</td>
<td>Non-Governmental Organizations.</td>
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<td>NKRDP</td>
<td>North Kordofan Rural Development Project.</td>
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<td>PA</td>
<td>Public Administration.</td>
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<td>PRA</td>
<td>Participatory Rural Appraisal.</td>
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<td>UNSO</td>
<td>United Nations Sudano-Sahelian Office.</td>
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Abstract

Local People Perceptions of Muddy Buildings for the Conservation of the Vegetation Cover, Case-study; Bara Locality, Sudan

The process of desertification is not a matter of shifting sand dunes, or the advance of a wall of sand, but it is patches of increasingly unproductive land. In the dry lands fragile ecosystems, over cultivation, overgrazing and reliance on forest products for buildings and fuel weaken the land particularly during spells of drought. Desertification encompasses all physical processes responsible for continuation of land degradation in which lack of vegetation cover is a central factor. Bara Locality (North Kordofan State) is classified as marginal area with fragile ecosystem. The dominant type of housing is traditional huts made from forest products. These building are liable to renewal every two years on average. These exacerbate the process of desertification in the study area. The starting premise of this research is to investigate the level of adoption of mud buildings, which is introduced by NGOs, as a substitute for traditional buildings. Moreover, the study attempts to explore the economic feasibility of mud buildings and their potentiality in conserving and restoring the vegetation cover in the study area. Six villages were selected from Bara Locality for this research. Three villages were covered by NGOs program of mud buildings and the others were not included in the program (control). Two types of data were collected for this research, namely; primary data and secondary data. The former was collected from households through face-to-face interviewing and mensuration work to investigate the stocking density around the selected villages.

The main findings of the study are; in the short run, the construction cost of muddy buildings is relatively higher compared to the traditional buildings (huts), but on the long run the cost is much lower compared to the traditional huts because the traditional huts are renewed every two years on average (mainly due to decay by pests and occasional fires), while the muddy buildings last for more than twenty years. The mensuration findings revealed that the tree species stocking density around the villages adopted the intervention of muddy buildings is relatively better compared to the control (villages not participated in the program of muddy buildings).

The main conclusions drawn from the study are; muddy buildings contribute to the conservation and rehabilitation of the vegetation cover. Institutional and financial factors are behind the low level of adoption and dissemination of muddy building innovation. Moreover, the study arrived at valuable recommendations emphasizing the importance of establishment of effective extension unit to raise the awareness of the local people about the importance of muddy building in conserving the environment, and consolidation of the efforts at the different levels to enhance the level of adoption.
الخليصة

إدراك السكان المحليين لدور المباني الطبية في المحافظة على الغطاء النباتي.
دراسة حالة: محلية بارا، السودان
Chapter I
INTRODUCTION

1.1. Background
People in rural areas depend on the forest products to satisfy their wide-range of domestic daily needs. For centuries, individuals and communities in these areas have been able to live in harmony with their environment. However, rapid population growth and consequent pressure on the natural resources has accelerated the rate of depletion of natural vegetation. This was quite obvious in areas where the resource base is meager.

The majority of the rural people still live in traditional houses built with wood from the natural forests and stalks of millet and sorghum left after crop harvest and they will continue to do so for long into the foreseeable future. Trees are used to be one of the most important natural building materials. These wood materials are very essential because of their low cost in use especially when it is readily available and easily reached. Also it substitutes costly commercial materials out of reach of the rural poor. Another factor of its importance is that people in rural areas are already familiar with its uses. However, all the houses in the rural areas are still far below the standards with respect to health, hygiene and comfortability. Hence efforts should be made to overcome these problems in order to help the rural people, particularly the poorer, to improve their housing situations.

Adoption of mud for houses construction as an alternative to the local woody materials was found to be a new approach adopted by the local people as personal initiative (on an individual basis), and supported later by different projects working in the area in form of delivery of raw materials or facilitating the transportation of these materials. This strategy of mud adoption can serve in the conservation and rehabilitation of the environment. On the other hand, it contributes to the rural and household economy by saving money used for woody materials.
To reduce pressure on the natural resources, particularly the trees, the present study is an attempt to evaluate the impact of the mud adoption as a potential of earth-based material for rural housing.

1.2. The Scope of the Research
The starting premise of this study is to investigate the acceptability of mud buildings as an alternative to building constructed from local material (forest products). Moreover, the study attempts to explore the feasibility of mud buildings in the conservation of the existing tree cover in the study area which support the resilience of the local communities.

1.3. Problem Statement
Deforestation rates in the whole world are increasing at an alarming rate particularly in the marginal areas (semi arid and low savanna regions). In accordance with its geographical position and climate, Bara locality (the study area) is considered as marginal for both agriculture and forests production. This is due to low rain fall, short growing season, high livestock population and fire hazards. What makes the situation worse, is the reliance on the tree cover for the provision of building materials (poles and forks). The fact that wood fuel represents the largest quantitative demand for wood has at times diverted attention from its other uses.

Wood meets a variety of basic needs for which there are no readily available substitutes. Poles, especially for building purposes, are widely used and are often in scarce supply. They are needed for many traditional types of housing in the rural areas (huts, fence, shed etc…). Forks (Sheeba) are used to support the lower and upper parts of the huts in rural housings. The level of insects and pests infestations necessitates renewal of the timber due to its low durability which varies according to tree types and age. This situation is reflected on the tree cover in the study area which is characterized by low density and degraded land due to the annual removal of the tree cover in the
complete absence of afforestation programs. Looking for alternatives will reduce reliance on the tree cover which in turn contributes to the resilience of local communities in the study area. The adoption of mud in rural housing could be one of the solutions to overcome this problem.

1.4. Objectives of the Research
The overall objective of the research is to assess the perception of mud adoption for buildings in the conservation of the natural vegetation and its contribution to rural sustainable livelihood and development. More specifically, the study attempts to;

- Estimate the quantity of wood materials used in traditional houses and their threat to the natural vegetation cover in the study area.
- Determine the level of mud buildings adoption by local communities and constraints confronting adoption of muddy buildings.
- Assess the stocking density of the tree cover in the study area
- Highlight the advantages of the mud housing over the traditional buildings.

1.5. Research Hypothesis
This study is formulated base on certain assumptions

- Addressing benefits of mud housing in terms of economic feasibility, environment conservation and sustainable livelihood, will enhance adoption of innovation.
- Provision of necessary inputs (mud) and training of local people on mud housing construction will disseminate the intervention.
- The adoption of mud houses will reduce pressure on the tree cover in the study area.
Chapter II
THE STUDY AREA

2.1 Location

North Kordofan State consists of nine localities, namely; Sheikan, Bara, Gabrat El-sheikh, Sodari, Um Ruwaba, Abu Zabad, Wad Banda, Gheibaish and En'nuhood. The total area of the state is about 252000 Km². Bara locality, the study area, lies between latitudes 13°:18”- 14°:31” N and longitudes 28°:45”- 31°:48” E. It shares borders with Gabrat El-sheikh locality and Sodary locality to the north, Um Ruwaba locality and Sheikan locality to the south, En’nuhood locality to the west and White Nile state to the east. The total area of the locality is about 20000 Km².

Fig.2.1 Map of the Study Area
2.2. Administrative Structure

Generally, there are two administrative systems (local and native). The local system covers both rural and urban areas, while the native system is based on rural areas. Each system has specified role to play, but both working in harmony for the welfare of people and promotion of peaceful coexistence or social integration. Both systems are accountable to the locality commissioner (mutamad).

2.2.1 Local Administration

This is organized, in accordance with the law of local administrative system (LOLAS) of the year 2000. At the bottom there is the Public Administration (PA) at the level of individual villages, nomadic camps and town’s quarters. Members of the PA are directly elected through free election for a two year term. The PA is accountable to both Locality Council and locality Executive Apperatus. At the top there is the Locality Councils (LC) at the level of rural and urban/town areas. Bara locality has eight administrative units. Members of the locality councils are also freely elected for a four year term. Membership ranges from 15 to 25 based on population size. The LC is headed by a director and deputy director. The locality has an executive body headed by executive officer assisted by supportive and technical staff.

The locality council is entitled to perform the following:

- Issues local laws, regulations and rules regarding locality affairs.
- Endorses the annual locality operation budget.
- Supervises performance of the executive body at LC level.
- Recommends/nominates to the State government establishment of PA as well as supervises their performance.
- Endorses/approves locality term plan and future policies in line with general plans and policies at the federal level.
- Finally, the locality councils must abide by all legislation and execution policies, federal or state, to avoid overlapping.
2.2.2. Native Administration

Native Administration (NA) was established during the British colonial rule (1920) to assist government to restore order, peace, and collection of taxes. Afterwards, it played an important role in allocation of agricultural lands, settlement of disputes, organization of land and natural resource use, and protection/conservation of the natural environment, range lands in particular, through construction of fire lines. However, the system of NA was dissolved during May regime (1970) and resulted in widespread tree cutting and abandonment of construction of fire lines (NKRDP, 2001).

The NA system regained its power after overthrown of the May regime (1985). Ever since native administration system used to be hereditary and follow the tribal structure i.e. tribe Nazir or Amir, lineage (Umda), and clan (Sheikh). Currently, the leaders of NA are government employee. The Sheikh is elected by the NA unit, a group of sheihks elect their Umda, while Umdas elect their Amir and Co-Amir. However, the Amir nominates three Umdas for the post of Co-Amir who in turn is elected by the Umdas. Bara province has two Amaras, namely Dar Hamid and Maganin, compose of 38 and 6 Umodeyias, respectively. Leaders are entitled to perform the following duties/tasks:

- Abide and empower Islamic principles in all aspects of life.
- Environmental conservation and protection of forests.
- Collection of herd's tax.
- Supervision of nomadic and transhumants camps and routes.
- Settlement/resolution of disputes/conflicts.
- Other duties/tasks requested/commanded by the locality authorities.
- Any duties/tasks and authorities specified in rules and ordinances issued by the State government.
- The NA may be entitled judicial authority over the people who live in their jurisdiction areas.
2.3. Climate
Bara locality is located in the semi-desert zone with rainfall ranges between 100-250 mm per annum. Rain starts in May and continues through October with concentration in July and August. In the past, May and June rain used to be effective in supporting crop production. Recently, July to September represents the potential growing period, though short, for the traditionally grown varieties of various crops. Rainfall quantity has declined over the years. Average annual rainfall has decreased and distribution has worsened as indicated in Fig. (2.2). The temperature is varying, during the year and the season. The hottest months are April and May with a mean maximum temperature of 39°- 40°C. The cooler months are December and January with minimum temperature of 8°- 13°C.

Source: Adapted from IFAD, Baseline Report, and Meteorology Department (2001)

Fig. (2.2): Average Annual Rainfall (mm) of Bara Town.

2.4. Vegetation
Bara locality fall within the gum-belt. Acacia senegal (Hashab) is a dominant species while other species of Acacias are found at different stocking densities. The other dominant tree and shrub species include Acacia tortilis (Seyal), Balanites aegyptiaca (Heglieg), Ziziphus spina.christi (Sidir), Faidelherbia albida (Haraz), Azadirachta indica (Neem) and Leptadenia
The vegetation cover has deteriorated over time particularly during mid eighties where vast areas in the locality became bare lands. Situation has improved afterwards as a result of some forestry programs and improvement in rainfall after mid 80s. Soil deterioration has been manifested in appearance of plant species characteristic for severely deteriorated soils like *Calotropis procera* (Usha) and *leptadenia pyrotechnica*. Deterioration of perennials and trees is severe around villages and water sources due to continuous pressure on land and over stocking. Grasses have also followed the same trend (Sanjak, 2000).

### 2.5. Soils

Stabilized sand dunes, known as *goz*, covers most of the study area. This soil type is characterized by high water permeability, poor water holding capacity and low nutrient contents. The soil is easy to cultivate but has low production potential. Crop establishment poses main difficulty especially in the last two decades due to existence of loose sand that causes scorching during the hot period of late summer and start of rainy season. *Gardoud* soil is the second type of soils, mostly found in limited locations in Bara locality. It is better in productivity potential than *goz* but difficult to manage with simple hand tools. It is characterized by formation of hard crust on surface, i.e. dries up very quickly creating unfavorable environment for crop establishment and growth (Hunting Technical Services, 1977).

### 2.6. Water

There are five types of geological formation that govern availability of underground water in the study area (NKRDP, 2001). These formations are:

- **Basement complex**: composed of granite, crystalline limestone and other igneous and metamorphic rocks.
- **Nawa Formation**: micaceous sandstones.
- **Nubian Sandstone sediments**: fill the base of Bara trough, with tapped thickness between 200 - 300 m.
- Um Ruwaba Formation: borehole logs consists of lat-lying, unsorted and unconsolidated gravel, sands, and clays.
- Bara acquifer complex: is the main water bearing resource. Groundwater occurs at 6 meters in the free water table at Bara.

Recharge is evidenced by seasonal fluctuation in levels of groundwater, long-term consistency of levels, and presence of fresh groundwater. Sources for recharges are rainwater and groundwater inflow from the Nubian basin lying north of the area.

2.7. Population
The total population of Bara Locality for the year 2000 was 297,000 capita with growth rate of 1.7 % per annum. Ninety one percent are rural sedentary, four percent are urban populations whereas the rest (5.0%) are nomadic. Population density is 15 persons per square kilometer. At the village level, population figures used to be obtained from the sugar ration list. However, nowadays figures are obtained from key informants namely the village sheikhs and members of Village Salvation Committee. Accordingly, the percentages of male and female population are 46% male and 54% female and the average household size is 6-7 members.

2.8. Economic Activities
The main economic activities in the area include production of field and horticultural crops, livestock, forestry and other supporting activities (trading, salaries, casual labors). These income-generating activities contributes to the household economy in the following proportions (37%) for cropping, (15.3%) for livestock, (7.4%) for forests products, (10.8%) for casual labors, (1.7%) for salaried labors, (8.6%) for trading, (8.2%) for hand crafting and (11%) for other activities (NKRDP, baseline report, 2001).

2.9. Agriculture
Sedentary farming system dominates in the study area. These are settled rural families who grow crops and raise livestock especially small ruminants for
gaining their livelihood. In recent history, a number of developments have taken place which changed the nature of farming. Farmers are becoming more market-oriented though the nature of market engagement is still rudimentary or underdeveloped. A typical sedentary farmer owns agricultural land that is divided between food and cash crops. A part of this piece of land is often devoted to forestry production (*Hashab*). Livestock, mostly small ruminants (goats and sheep) are also raised as integral component of farming. Serious loss in the number of cattle took place during the droughts of 1984 and 1990, and environment in general has become less favorable for cattle.

Field crops are classified as subsistent crops (millet and sorghum) and cash crops (sesame, groundnut and karkadeh). Watermelon and cowpea have dual purpose in the household and are utilized as food crops or sold as cash crops. Watermelon is an important crop for easing the sharp water problem in the study-areas. Gum arabic production from Hashab tree was once a common practice in the area but has diminished sharply.

### 2.10. Livestock Production

The role of livestock in supporting rural families is increasing as a result of recurrent drought and infestation of pests and diseases. Although, droughts of 1984/85 and 1990/91 had serious effect on livestock number, restocking or regeneration almost kept pace over the years, basically for small ruminants. Ownership composition has changed considerably in many areas, where cattle disappeared all together and only small ruminants are found throughout the study area.

### 2.11. Development Projects worked in the Area

- Restocking of Gum Belt Project: this project started in 1981 to combat desertification and rehabilitate the deteriorated gum gardens within the gum belt through the development of central nurseries for production and distribution of hashab seedlings to farmers.
- Swedish-Sudanese Association Project: This project was started after the famous drought of mid-eighties in Bara province concentrating its activist in five villages around Bara town. The aim of the project is combating desert crawl, and providing villagers with income-generating opportunities. The activities of the project were; establishment of shelter belts around villages, vegetable growing for income generation and provision of clean water.

- ILO Forestry Project: this project started in 1987 to work in Tayeba rural council in the Bara Province. The aim of the project was to increase environmental awareness among farmers and provide them with the required technical and management skills to enable them managing their environment on sustainable basis.

- Community Based Rangelands Rehabilitation for Carbon Sequestration and Biodiversity Project: This project started in 1994 and ended at 1999 with the overall development objective of an effective, appropriate and sustainable natural resource management system at the local level that would rehabilitate and/or improve rangelands, in order to contribute to the reduction of global warming through carbon sequestration, preservation of biodiversity, and reduction of atmospheric dust.

- IFAD Bara Project: the project covers five administrative units including about 516 villages from 206 village councils. The over all goal of the project is to improve living standard of target beneficiaries and assures food security. Specific objectives stem from this main goal, are:
  - Enhance productivity and income generation through technical, logistical and commercial extension support.
  - Provide village communities with capacity for planning, executing, and managing development schemes.
  - Assist village development committees in evolving sustainable participatory informal financial institutions.
Chapter III
METHODOLOGY

3.1. Introduction
Two types of data were used in this research, namely, primary and secondary data. The source of the secondary data includes, relevant literature and IFAD projects documents. While the primary data was collected through personal interviews with individuals using structured questionnaire, observations, focal group discussions and small-scale inventory measurements.

3.2. Selection of the study area
Bara locality falls in the gum-belt zone, in which the hashab tree is predominant. Serious deterioration in the gum-belt has taken place and most of the hashab trees and other tree species have been lost either due to human activities or climate hardship. Removal of trees to satisfy the needs of rural people in their houses construction contributes to the environmental degradation in the study area. Adoption of mud for house construction was introduced into the area as an approach to alleviate the pressure on natural tree cover. Hence it is an attempt to evaluate this approach in term of its impact and rate of adoption by rural people in the area.

3.3. Collection of data
3.3.1 Selection of villages
Six villages were selected around Bara city to represent the study area. Three villages have been adopted mud in their housing introduced by development projects (Gireigikh and NKRDP), while the rest were not involved in those projects activities.

3.3.2. Selection of respondents
A questionnaire sheet was designed to collect information on family structure, house specifications (type, constituents, type and number of woody materials used), socio-economic survey and mud adoption. The respondents were
selected randomly from the six villages to represent all the categories in the villages including the status of living, family size, gender issues (family headed by women) etc. Because the majority of the houses in the area were built by local forest products, 60% of the respondents were selected to represent the dwellers of these kind of housing while the rest, 40% were represent the mud-houses dwellers. For that reason, the number of respondents having mud houses is greater in mud-villages than those of local material housing and in non-mud-villages, most if not, all the respondents have houses made of forest products, hence, the number will be greater.

There are two types of interviewing, the first one regarding the general information about the village concerning its size, social services, economical activities, agricultural production (both crops and animals), the existence of trees in the past and nowadays and the mud for houses construction in the area with regard to its acceptability and rate of adoption. This type of interviewing was held in a group discussion with the leader of the village (sheikh) in the presence of other villagers, mostly the leaders and the elders in each village. The second type, is that carried out in the household by interviewing the family head or one of his/her relatives if he/she is absent.

3.3.3. Permission of data collection
Prior to the start of data collection after reaching any village, the first step is to approach the leader of village (the sheikh) to explain the purpose of the visit and the importance of the study. Afterwards, requesting a permission to conduct the survey among the villagers. This permission is certainly recommended in rural areas where the residents are more suspicious to the outsiders. This permission was taken from the village leader who is also asked to convince the local respondents to co-operate in conducting the research.

3.3.4. 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 other
experts in the field of study helped to reach the final format of the questionnaire. The following guidelines of Burchinal (1986) were also given special considerations in the construction of the questionnaire:

- To be certain that each question was relevant to the topic.
- To express each question as simply as possible.
- State question in specific concrete terms.
- To obtain criticism of all prepared items by colleagues or friends.
- State the items in the language respondents use in everyday conversations.

Two types of questions were used in the questionnaire. Closed-end questions; with mostly multiple choices or yes or no style of answers, and dichotomous questions in step-wise style, each answer leading to a specific set of follow-up. Open ended questions were avoided except where it was inevitable. The reliance on the close ended question was justified according to:

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

3.3.5. Organization of data

The conceptualization step was followed by the organization of the questions. The following guidelines were considered:

- To begin with simple, easy to answer questions.
- To place sensitive or more complex questions late in the questionnaire.
- Where it makes sense, to place items in logical order.
- To try to create an interesting mix of items within the questionnaire.
3.3.6. Pre-testing

The formulation of the questionnaire was followed by a pre-test step to discover and correct any flaws in it. The purpose of the pre-test is to make sure that the questionnaire would deliver reliable and valid data for answering the problem under investigation.

Some colleagues, expert in the field of the study, 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 them, the draft questionnaire was revised. Finally, the supervisor checked the questionnaire, and accordingly, some questions were removed and then the contents of the questionnaire were materialized into simple form with minimum items to obtain necessary information. The questionnaire was finally revised and printed (Annex 1).

3.4. Other source of information

Other required data was collected from different sources including range of documentations prepared by number of projects working in the study area. A baseline survey prepared for IFAD project in Bara locality which considered to be the most important source of information, in the sense that, the survey was carried-out very recently. Gireigikh’s Range Rehabilitation Project, which worked in the study area, also providing useful information. Moreover, several meetings were conducted with local people (group, informal discussions) to collect information regarding the field of the study. The researcher was acquainted to the study area since he worked for 3 years. His experiences and study observations added more information to the data collections.

3.5. assessment of stocking density

A small-scale inventory was carried-out in the 6 selected villages to determine the density of the tree cover around each village. A sampling procedure was conducted and the following steps were made:
- A tree cover around the village was measured using a sampling technique to represent the selected area.

- The targeted area for each village equal to 4676.9 feddan (a circular area with a radius of 2500 meter)

- From the village center, 6 survey lines were arranged sequentially and each adjacent survey lines were 60° a part, starting from the north direction (at 0°)

- Along each survey line, 6 sample plots were located using the GPS.

- Circular sample plots (of 20 m. radius), were demarcated systematically at each sample plot.

- The distance between any two adjacent sample plots is 400 m. starting by sample plot one 400m distant from the village center. Fig. (3.1).

- In each plot, tree diameters were measured (DBH) using callipers.

- Then a random sample of trees was selected for average height measurement.

- Also, the regeneration of all tree species inside the plots were counted.

The sampling procedure was repeated for the six survey lines in all selected villages with an overall sampling percentage of 0.23 %.

Fig.3.1 Survey Lines and Sample Plots distribution
3.6. Data analysis

The statistical analysis was commenced through exploratory manipulations of the data obtained in the study area. This process was accomplished by critically examining data through the use of simple techniques of analysis. The main tools are the construction of simple tables and selected cross-tabulation which allows tentative answers to many of the questions being asked in the study. The analysis of mensuration data was performed using the Statistical Analysis System package (SAS) to determine relations between different variables.
4.1. Sustainable Development

The world commission on environment and development, appeared in 1987, on its final report (Our common future), define the sustainable development, as “that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The commission focused on sustainability because all the evidences they had considered showed that most of human activities are unsustainable (WCED, 1987).

Sustainable development is for all nations, rich and poor, industrialized and agricultural. Agreement about this is crucial, for it is precisely the developed nations which place the most serious obstacles in the path of sustainable development for the planet as a whole. This is because these states dominate the world economic system and the flow of resources. The obstacles include high level of greenhouse gas emissions; high and wasteful levels of natural resources consumption; the erection of trade barriers which add to the disadvantages of poor countries; insistence on the collection of obviously unpayable debts; and highly subsidized agricultural production which creates unfair competition. The word (development) means many things, but in term of national development, it means more than simple growth, it is here taken to mean “to evolve and to increase the possibilities of”. If development means increasing the possibilities open to all the world citizens, then all nations will claim to be, and want to be, developing (John, and Lloyd, 1991).

There is still much work to be done to bring the ways people feel and what they believe about their environment into the debate on sustainable development. Though conservation is only a small part of the overall concept of sustainable development, there need not necessarily be any antagonism between the two goals. In fact, one school of thought maintains that they are similar (Basher, 1996).
In 1980, the United Nations Environmental Programme (UNEP), the World Wildlife Fund (WWF) and the International Union for the Conservation of Nature and Natural Resources (IUCN) published the World Conservation Strategy. It defines conservation as “the management of human use of the biosphere so that it may yield the greatest sustainable benefit to the present generations while maintaining its potential to meet the needs and aspirations of future generations”. Thus accordingly, the goals of conservation and the goals of sustainable development are inseparable (Muller, 1998).

4.1.1. Strategic imperatives for sustainable development

Sustainable development has become a core issue for all the programs of national government and Non-Governmental Organizations (NGOs). The strategic imperatives for sustainable development imply the followings (WCED, 1987):

- Reviving economic growth.
- Changing the quality of growth.
- Meeting essential needs for jobs, food, energy, water and sanitation.
- Ensuring a sustainable level of population.
- Conserving and enhancing the resource base.
- Reorienting technology and managing risk.
- Merging environment and economics in decision-making.

4.1.2. Indicators of sustainability

It is usually easy to tell when agriculture is unsustainable, harder to say when it is sustainable. The following is a list of indicators of agricultural sustainability.

- Ecological indicators: includes replenishment of soil nutrients removed by crops, maintenance of the soil’s physical structure, constant or increasing levels of organic matter in the soil, no increase in soil acidity or toxicities, constant or increasing soil depth, minimum off-farm environmental contamination, maintenance of habitat for pollinators, biological pest control agents and wildlife, conservation of genetic resources of crop and animal
species. It also encompasses a diversity of species farmed on a given site, and maximum useful nutrient and energy transfer between species, continual cover of the soil by vegetation, high efficiency of water use, minimal evaporation from open water surfaces and spray.

Moreover, it considers the direction of technology change away from the use of non-renewable resources and subsidized energy, and towards the introduction of renewable, making more use of local resources and increasing photosynthetic efficiency.

- Social / cultural indicators: this includes; The farmers plays the leading role in designing the farm system and choosing technologies based on the precise site characteristics and on traditional husbandry techniques, farming and pastoral communities thrive, but not at the expense of other communities, and non-agricultural employment is also available in agricultural areas.

- Output indicators: this includes; yields are reliability, agriculture profitability for the farmer’s family, and farmers’ targets “optimize productivity on a long term basis”,

- Economic, policy and institutional indicator: this includes; prevailing prices, grants and subsidies encourage farmers to maximize long-term productivity and resource conservation, farmer’s net economic benefit and ecological sustainability, regulations are in force to ensure that farming causes little off-farm environmental contamination, land of the highest production potential is allocated to agriculture, where agriculture produces regular surpluses, land is usefully retired to other productive uses, and marginal land is used for environmental conservation, financial assistance to farmers is not linked to specific commodities in a manner that discourages the best use of a region’s ecological suitability (Dover and Talbot, 1987)

4.2. Participation

Participation is a common word on development agendas. Everyone agree that it is absolutely essential and much time is spent in discussing how to
improve it. Rarely, however, does one stop to think about what this so often used term really means (Stefan, 1991).

Participation means taking part in an activity. It involves taking part; physically (being present, using one’s mechanical effort, skills and labor commitment); mentally (conceptualization of the activity, decision making, using mental skills in the organization, and management of the activity); emotionally (assuming power, responsibility, authority over the activity) (D’Arcy Davis-case, 1992). The nature and practice of the participation concept varies according to the roles taken by the development actors. To an individual, participation is the inherent enthusiasm or self-disciplined determination to take part in an activity. In this way, participation is an attitude of mind and a way of life. It is natural or in-born. To a family or household, participation is an internalized or deep feeling of obligation to take part in an activity for the welfare of the family. The family or household is perceived as a singular entity (Mlenge, 1992).

In a community, participation is the spirit of togetherness, solidarity and coherence which encourages taking part in an activity. To the community, participation is a spontaneous way of life. People participate in activities which seek to meet their particular basic felt and/or subsistence needs. They also take part in activities that are immediate, that are personal, family-based or community-based. Such activities may include: growing crop; fire lines construction, collecting fuel wood and building houses (EC, 1996).

4.2.1. Participation in forest management

It is a truism that projects in the forest sector-as is the case with any sector dealing with renewable natural resources- are seldom initiated by communities, farmers or forest user groups themselves but tend to be imposed by government institutions or even external (international) organizations. However, there is over-whelming evidence that projects in which people have
a sense of ownership, or where they have played a part in planning and implementation, have a much greater chance of success (EC, 1996).

To ensure that forestry interventions are as ‘demand-driven’ as possible, forestry planners must seek the integration and involvement of all sectors and stakeholders during a forestry project’s life cycle. This means achieving active participation in designing the project and in the decision-making processes, thus creating a sense of ownership. Tools for ensuring participation must be applied constantly by those who support and advise the actors and stakeholders. These tools include continuous exchange and flow of information, workshops, open group discussions, consensus-building activities, conflict resolution approaches, etc (Oakely, 1988).

Encouraging greater participation may not always be easy. It means empowering people to pursue their own interests and may challenge those with vested interests. Conflict situations may occur. However, with a growing tendency to pass control of forests from governments to local communities, such situations cannot always be avoided. Therefore, activities should systematically seek to prepare the ground for local communities to manage forest resources in an independent and self-controlled manner (Chamber, R. 1983). Key features of successful participation are (Sen and Das, 1987);

- People’s involvement from the beginning: People’s involvement at the design stage is crucial. Projects must be entirely based on the needs and priorities of the people who should be actively involved in the project.
- Relevant benefits: The poor rural farmers are rather busy trying to solve the most urgent of their problems. They can simply not afford to waste time on solving less important problems. Thus, projects must provide some relevant benefits fulfilling acute needs if the farmer is going to participate.
- Quick benefits: Again, the poor rural farmers, trying to find food for the day, can rarely afford to invest their labor, or any other resource, in activities which do not yield immediate benefits.
- Secure benefits: Farmers will not participate unless they have full security that they will receive the benefits of their work, or other forms of inputs. In the case of tree planting of private property, this security is ensured. Quite often local communities establish trees on common land. In such cases, it must be clearly specified at an early stage how the benefits of the trees are going to be shared among the members of the community. If this problem is not solved at an early stage, conflicts may arise when the benefits are to be shared.

- Appropriate technology: If the project activity is supposed to continue after external assistance has been withdrawn, the local people must be able to maintain all project components. In general, the more a project relies on local materials and knowledge the greater the possibilities for long term sustainability. The use of imported advanced technology is sometimes appropriate, but requires secured supplies of spare-parts, and the hard currency necessary to buy those parts, plus the inclusion of a training and maintenance component in the project.

- Long term commitment and maximum flexibility: The complex development task requires long term genuine commitment of all the parties involved. Also, experiences up to date indicate that it is almost impossible to fully predict the interaction of a project and its environment that is, unforeseen problems will always arise in any project confronting such problems, and the project manager must have maximum freedom of action in order to be able to rapidly adjust the project to its continuously changing environment.

4.2.2. Expected benefits from enhancing people’s participation

The following benefits were expected to rural people who involved in participatory projects (FAO, 1994):

- Local knowledge, skills and resources can be better used.
- Initiatives become more effective, more efficient and sustainable.
- People’s awareness of problems, resources, opportunities increases.
• People’s skills are improved and diversified.
• Capable local associations and institutions are created.
• A non-paternalistic society is developed.
• Democracy and equity are promoted.

4.3. **Harmful activities against environment**

The tradition systems by which people manage and preserve the wood resources are breaking down in many parts of the world. Trees resources in open woodlands and around farms and villages are coming under intense pressure. Large areas of closed forests are also being lost each year. The precise reasons for this breakdown vary. In many cases, the greatest pressure is that of land hunger, and the need to clear forest land for agriculture. But excessive cutting of trees for fuel wood, building materials or overstocking with livestock can also reduce the regenerative capacity of local tree resources, pushing them into an accelerating process of depletion.

Discovering why tree resources are being depleted in a particular area is not always easy. Often a number of causes are superimposed on each other; at other time there is a sequence of events in which one type of forest removal creates the condition for another, and is then superseded by it. In all cases, a clear diagnosis of the causes of the breakdown of traditional system is essential if effective remedies are to be found. Only when it is known why the loss of trees is taking place, can the potential role of tree planting as a counter-measure be assessed, and programmes be designed which tackle the very real problem at hand (FAO, 1981).

4.3.1. **Planned Forest Clearance for Agriculture**

In the majority of developing countries, the need to provide extra land for agriculture is the most powerful driving force behind large-scale forest clearance. As rural populations grow, there are an increasing number of people for whom food and work must be found. To these are added the large
number of families which are displaced from their land holdings, or lose their jobs as agriculture is modernized and mechanized. Many developing countries are now undergoing a process of land-use change similar to that which has already taken place in the industrialized nations. Clearing forests to make way for agriculture is an established government policy in some countries, and is carried out as part of integrated development schemes (Geraled and Geoffery, 1984).

The dangers related to forests clearance are very obvious. Even with modern techniques, some forest soils are totally unsuited to permanent agriculture. Once trees cleared, the soil fertility can rapidly decline as nutrients tied up in the vegetative layer are leached away, and soil laterisation; and wind and water erosion set in. In the worst cases, productive forest land can be transformed to unusable wasteland in a matter of years. Where the soils are suitable for farming, the transition from forest to agriculture can be achieved accompanied by a careful land clearance, together with the necessary investments in terracing and other soil conservation measures (Chew, 1987).

**4.3.2. Informal encroachment of forest lands**

Whatever the problems caused by officially planned clearance of forest lands, those which arise as a result of informal encroachment are usually considerably worse. In the majority of countries, this is the greatest single cause of deforestation and the breakdown of traditional systems. Moreover, population pressure and their lack of alternative means of earning a living, is also one of the hardest to control.

Most types of forest encroachment involve clearing the land of trees, usually by burning, and then cultivating it as long as it will produce crops. This informal forest clearances mark the beginning a downwards spiral in the productivity of the land. The main reason is that the squatters who move into forest areas rarely have the knowledge or skills necessary to manage the land sustainably in accordance with traditional practices. Neither do they have the
resources needed to practice modern agriculture. Often the land is farmed to exhaustion, leaving it permanently degraded and useless either for agriculture or productive forestry. Those families are then forced to move deeper into the forest, and clear new areas to farm (FAO, 1979).

4.3.3. Breakdown of Traditional Shifting Cultivation Systems

In traditional shifting cultivation, an area of forest is cleared, usually by burning its tree cover. The ash provides an initial supply of fertilizers for the soil and the area is cultivated intensively for two or three years until its fertility begins to decline. After this, the site is abandoned and the natural tree cover and other vegetation returns. Under favorable conditions, this secondary forest rapidly re-establishes itself. The roots draw up a new supply of nutrients, making it possible to clear the trees and plant new crops after 10 to 20 years. As long as population densities remain low, and the period of cultivation is short relative to the fallow period, the system is perfectly sustainable (Palin, 1980).

A vital feature of traditional shifting cultivation system is that the farmers involved have a vested interest in maintaining the stability of the system, and through long experience have learnt the techniques necessary to achieve this. When the land is cleared, some of the trees are usually left in place. Others are just lopped, so they can grow back quickly. In response to increased competition for land, however, shifting cultivators are being forced to change their traditional patterns of activity. Fallow periods are being reduced, with the result that trees and shrubs have less time to regenerate, thus undermining their vital role in restoring soil fertility. The primary cause of this breakdown of traditional shifting cultivation system is population pressure. As a result of these pressures, there are relatively few places remaining where shifting cultivation in its true traditional form is still being carried out. As with other types of land clearance, the transition from shifting cultivation to permanent agriculture can be achieved successfully, provided additional inputs such as fertilizers and applied soil conservation measures.
4.3.4. The Impacts of Grazing Animals and Fires

In moderate numbers, grazing animals cause little serious damage to the forests. The effect of their browsing upon tree foliage and undergrowth is not sufficient to prevent natural regeneration. Some nomadic pastoral societies have lived in harmony with their natural woodland environments for long period of history. When the numbers of livestock increase, the problems of forest depletion begin to arise. Trees become damaged through excessive removal of foliage, with consequent stunting of their growth (Cernea, 1990).

The damaging impact of livestock grazing and fodder gathering is considerably greater than fuelwood cutting in some woodland areas. Public forests are used both for grazing and for the collection of tree fodder by hand (Gerald and Geoffrey, 1984). The area required for sustainable fodder production was estimated to be three to five times greater than that needed to provide for the combined timber and fuel needs. This suggest that the large animal population is probably the most important factor in the forest depletion taking place in the area (Wyatt-Smith, 1982).

Overgrazing by animals is also a major contributory factor in the desertification. As populations of human and their animals grow, increased herds often combine with reduced pasture availability. The result is to concentrate more and more animals into small areas (Cernea, 1990). The environmental degradation, particularly around water sources and along transhumant routes can be severe and has been noted in many of the semi-arid grassland areas in East Africa, the Middle East, and the Sahel (Grainger, 1982). An additional influence in forest degradation is the deliberate starting of forest fires. The objective is to clear the ground so that a fresh crop of grass, fertilized by the ashes from the fire, is quickly produced when the rain is come. An additional reason is that, it helps to control cattle ticks (Murray, 1981).
Fires probably represent the most serious factor for degradation. Accidental fires are rare, the majority of them are started for various reasons: for grazing, cleaning, collection of secondary forest products, hunting, cropping, etc… These fires are rarely controlled and they spread more easily, causing more destruction (Lanly, 1982).

In arid and semi-arid regions, repeated burning to stimulate grass production can lead to gradual degradation of the ecology of the area. Because of the fires, the original tree species are reduced to those which are fire-tolerant. The animals which graze the grass produced after the fire also destroy the tree seedlings on which the full regeneration of the forest depends. The final result is the disappearance of trees completely, with a conversion of forest land to grass savanna or shrub savanna ecology (Carney, 1998).

4.3.5. Fuelwood Crisis

Fuelwood cutting can contribute significantly to the pressures on tree resources. Where population densities are low, the demand for fuelwood can usually be met without damaging the local standing stock of trees. It may be possible to incorporate fuelwood gathering with other activities. Sometimes it is traditionally done when returning from the field in the evening. Those with land holdings may be able to obtain the fuel they need from their own trees. If there are forests nearby, people may have legal or customary rights to gather wood (Cernea, 1990).

When trees are plentiful and easily accessible, only dead wood is collected. It is lighter to carry than green wood, easier to cut, and burn better. Though branches may be lopped off, whole trees are rarely felled merely to provide fuel. Under these circumstances, the fuelwood supply and consumption system will be in approximate equilibrium. If the population begins to increase, the extra demand will normally be met by widening the area over which fuelwood collection takes place. Problems begin to arise when the time required for collection starts to become an unacceptable burden, or when
new sources of supply are no longer available within walking distance. In both case, the collection zone become limited and fuelwood gathering from then onwards is concentrated upon a fixed area of wood resources (Carney, 1998).

4.3.6. The Impact of Urban and Industrial Woodfuel Demands

Provided rural areas remain relatively isolated, the effect of increasing fuelwood pressure is gradual. When areas become subject to concentrated urban or industrial demands this can bring about a great increase in the rate at which depletion takes place. The impact of an urban woodfuel market has been described as follows: it creates a distinctive spatial character for fuelwood production, change the character of fuelwood exploitation, selective of tree species, more wasteful of the wood resources, employs paid labour, deal with problems of storage and seasonality in production and supply and diverts wood fuel from subsistence use as poor people in areas of short supply sell their wood or charcoal to higher income groups in the towns” (Morgan, 1983).

Wood cutting, to supply the urban markets, is usually carried out by large well-organized producers. More often poor peoples are involved as they are forced to turn to wood selling because of the lack of other income earning opportunities.

4.4. Mud as potential material for rural housing

Housing may be the Third World’s most intractable problem. In the rural Third World, virtually all houses are far below the most minimal standards of health and hygiene. Mud, earth-brick, soil-cement and other traditional building materials are cheap, readily available and can be made and easily used by the poor people to build their own homes. These distinguished characteristics are found to satisfy the housing needs of the poor. Mud is the most widely used building material in the world. Mud has made palaces, cathedrals, and arches. In the Nile valley, some of them have stood for a
thousand years. Traditional building materials, such as, mud, timber, thatch and stones, have been used by people for centuries, and meet all these three criteria (Agarwal, 1981).

Over half of the Third World’s population lives in houses that made of mud in one way or another. Mud is at once the most widely-used and the most neglected building material in the world. Builders, planners and governments are not really interested in mud because it is a low-status material. Another advantages of mud, beside the others mentioned above, is that, it provide excellent heat insulation, so inside a mud building is cooler in summer and hotter in winter than a building made with steel or concrete. Also it is strong in compression, so make good walls. The disadvantages of mud, as building material, are; it is eroded easily by water, which make its use difficult in areas with high rainfall or possibilities of flooding. Also it is susceptible to mechanical damage, i.e. by rodents, which can easily make holes in mud walls and under the floor. Another disadvantage, of mud, it soaks up water and become very heavy which affect the roof and make it susceptible to damage (Thomas, 1972).

Most of these disadvantages can be overcome by suitable improvements in design and technology. Soil stabilization can be applied, by adding cement to mud, to improve its strength and resistance to water. Sun-dried brick’s wall is a sort of design used to ensure the straightness and strength of the mud buildings. Bitumen (asphalt) can also be used, when it is available, to improve the resistance of mud to the water, but it does not alter its strength. Lime is also used for soil-stabilization and it is more easily available and cheaper than either cement or bitumen, but it is not as stronger or water-resistant as cement. Various materials, ranging from plant straw (wheat straw) to cow dung or donkey dung have been mixed with mud, or used for rendering (painting on the outside of the wall) to make mud wall more water proof (Agarwal, 1981).
5.1. General characteristics of respondents

Different issues were considered to reflect the general characteristics of respondents in the study area. These characteristics are, relation to the family, family size, educational level and occupations, important variables and have direct relations with the potentiality of any society to cope with natural resources management for sake of sustainable development.

5.1.1 Relation to the family

In the marginal areas, particularly rural areas, the sources of income are limited. As a result it is common to find some households headed by women or relatives due to the migration of the males. In this research special consideration was given to head of the household since he represents the decision maker for issues related to the natural resources in the rural areas. Table (5.1) shows the head of the households in the study area.

Table (5.1): Heads of households in the study area

<table>
<thead>
<tr>
<th>Village</th>
<th>No.of respondents</th>
<th>Relation to family</th>
<th>Member of family</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Elkallassa</td>
<td>15</td>
<td>10.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>18</td>
<td>15.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>20</td>
<td>14.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Um sereilha</td>
<td>15</td>
<td>8.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>17</td>
<td>12.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Mashga</td>
<td>15</td>
<td>15.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100</td>
<td>74.0</td>
<td>13.0</td>
</tr>
</tbody>
</table>

The majority of the interviewed sample (74%) claimed that their household is headed by males a reflection of the stability of the study area. In similar rural areas the level of migration is relatively high compared to the study area (NKRDP, 2001). Therefore, the number of households headed by women is high. In the study area only 13% of the interviewed sample is headed by
females either due to the death of the husband or to migration for sake of good job opportunities in the principal cities, and a similar percentage of respondents declared that the head of the household is a member of the family or the extended family.

5.1.2 Family size

The household in the study area is characterized by big families. The majority of the respondents (68%) showed that their family size falls within the range of 4 – 8 persons, (20%) of the families have less than four members, while the rest of families, (12%) consist of more than 8 members. Figure (5.1) shows the sizes of families in the study area.

![Figure (5.1): Family sizes in the study area](image)

Therefore, families in the study area consist of relatively big size. This finding could be verified by the fact that the male in the rural areas tend to have big families where the phenomena of polygamy is common. Moreover, the household members are considered as transformational capacity in agricultural activities under the light of labor shortages. Also, the big family
sizes have its social prestige value. It worth mentioning that, the simplicity of life and marriages contributes to the phenomenon of big families.

5.1.3. Educational level and occupations

Educational level could be considered as an indicator to detect the possibility of changing positively, the attitudes and raising the awareness of the communities towards conservation of the environment and formulation of plans to mitigate the irrational use of natural resources through adoption of certain programs. Fig. (5.2) shows the distribution of the interviewed sample with respect to educational level.

![Bar chart showing educational level distribution](chart.png)

**Figure (5.2): Educational level of the interviewed sample**

Nearly, half of the respondents (53%) had access to schools ranging from the primary schools through the intermediate to the secondary school. None of the interviewed sample had the chance to pursue education to the university level, and 7% of the interviewed sample ceased their education at the khalwa level. The level of illiteracy is relatively high where 41% of the respondents are illiterates. This is attributed to the lack of enough schools within the vicinity of the study area. The study area, due to its remoteness from the seats of government at Khartoum, is considered as marginalized area. Accordingly, public services like schools, health care centres, electricity and water services
are limited. Villagers tend to send their children to the principal cities for education where they accommodated by their relatives or hosted by foreigners.

The high level of illiteracy reflects the difficulty of adoption of innovations introduced by the extension service. Illiterates are incapable of following instructions and interpretations of drawings and symbols. This situation necessitates the use of certain extension methods (individual and group methods) which are very expensive and needs a large number of extensionists, a case difficult to fulfill under the poor financial situations of the FNC which is always under-funded and under staffed.

5.1.4. Sources of income in the study area

In Sudan in general and in the rural areas in particular, agriculture represents besides animal rearing the main source of income generation. Recognition of the main economic activity of any community helps in formulating plans for managing the site on sustainable basis. In the study area 59% rely on agricultural activities as a main source of income generation. Table (5.2). This percentage is relatively low compared to other rural areas of the country. The mere justification of this low percentage is the fact that agricultural practices is risky and farmers always have nagging doubts about the rainy season because rains in the study area is erratic in nature with long periods of episodes. This fact is also applicable for rangelands where the nature of the study area is characterized by low rain fall which is not always enough to grante successful development of grasses. However, livestock, mostly small ruminants (goats and sheep) raised as integral component of farming. The role of animal rearing supports rural families with dairy products. Despite this fact, only 16% of the families depend on animals as a source of income.
Table (5.2): Sources of income in the study area

<table>
<thead>
<tr>
<th>Village</th>
<th>Total</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>H. wife</td>
</tr>
<tr>
<td>Elkallassa</td>
<td>15</td>
<td>0.0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>18</td>
<td>2.0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>20</td>
<td>2.0</td>
</tr>
<tr>
<td>Um sereiha</td>
<td>15</td>
<td>4.0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>17</td>
<td>3.0</td>
</tr>
<tr>
<td>Mashga</td>
<td>15</td>
<td>0.0</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Private business represents a source of income to 19% of the interviewed sample. This finding clearly shows the limited choices of off-farm employment. This fact is supported by the limited government posts where only 12% of the interviewed sample relies on government posts for income generation. Trading is the main private business in the study area and usually deals with marketing in agricultural and forest products. Trading usually takes place at village markets which organize and operate on weekly basis. These markets represent the main outlet for agricultural productions. Weekly markets are events that are hardly missed by rural people under normal circumstances (NKRDP, 2001). The rest of the respondents (10%) are housewives.

This result reflects the fact that, the majority of the rural families are engaged, to varying degree into crop production for gaining their livelihood, and the limited choices for income generation.

5.1.5. Land tenure in the study area

In the study area customary land tenure is the most dominant type of land ownership, whereby land is owned and disposed of in accordance with customary regulations. However, formerly, there was a distinction between the land and those who reside on it. A tribal land "Dar" named after a tribe currently signifies the dominance of the respective ethnic group on that particular area, but this does not necessarily mean that the ethnic map of a
region coincides with the administrative boundaries of the various tribes. Therefore, the entire interviewed sample holds lands under communal/tribal and family tenure. The areas of the agricultural land differ between respondents. This variation is attributed to the fact that lands are usually owned through inheritance. In case of bigger families the land is usually segregated to more owners compared to small families. Fig. (5.3) shows the variation of land holdings in the study area.

The majority of the respondents (65%) possess agricultural lands of areas more than 15 mukhamas (one mukhamas is equivalent to 1.75 fed). For some respondents the area of the agricultural land exceeds 100 mukhamas, while only 5% have areas less than 5 mukhamas and the land-less families constitute only 1%. The rest of the respondents (29%) have land area varies between 5 – 15 mukhamas, 16 % of them possess an area varies between 11-15 mukhamas.

![Fig. (5.3): Areas of agricultural lands in the study area](image)

These results reveal that, there is a horizontal expansion in the cultivated lands which will contribute to the land degradation and deterioration of the environment. The justification of practicing agriculture on devastated areas is
attributed to the fact that crop productivity declined dramatically compared to the history of crop production in the study area. Accordingly farmers tend to cultivate expanded area without rotation or assigning some parcels of lands for fallow period, which is an essential component in agricultural practices in the past, for sake of harvesting similar quantities obtained in the past. However, the main crops produced in the study area are cash crops, sesame and hibiscus, and subsistent crops mainly millet and sorghum.

5.2. Housing
5.2.1. Type of housing
The majority of houses in the study area are traditional made basically from forest products. The main components of the building structure consists of fork (sheeba), korki (kau), gazaz, rassas, mirrig, and matarig. Adoption of mud for houses construction was introduced recently to the area. The main innovation focus on the adoption of Durdur building as an economical and environmental friendly substitute for the traditional buildings which is made of forests products. It worth mentioning that the adoption of durdur building reduce reliance on forest product where the mud replaces the forks used in the lower part of traditional hut. Usually an average of nine to ten forks are used per hut and it needs a regular renewal (sometimes annually) due to many factors.

5.2.2. Traditional houses
The traditional houses in the study area consists mainly of huts, sometimes durdurs, under shade (rakouba) and the fence is mainly made of wood materials and/or thorns and rarely, brick-wall and mud-wall rooms. This form of buildings is very common and 91% of the respondents clarified that their houses are of traditional style. The number of the huts per house varies considerably according to the size of the family. Table (5.3). The majority of the respondents (56%) stated that their house encompass 1 – 2 huts, while 35% claimed that their houses are made of more than 3 huts.
Comparing between villages adopted mud intervention with the others, the number of respondents having 1 – 2 huts is higher (30%) in villages adopted mud buildings, while for the other villages, the number of respondents having more than 2 huts is higher (21%). This indicates that, adoption of mud building reduced the number of huts in the study area.

Despite the tremendous efforts exerted by the Community-Based Rangeland Rehabilitation for Sequestration and Biodiversity Project at Gireigikh, in the study area for the adoption of mud as a constructional material, yet the level of adoption lag far behind expectations.

Table (5.3): Percentages of traditional huts and durdur

<table>
<thead>
<tr>
<th>village</th>
<th>Traditional hut</th>
<th>Durdur</th>
<th>Rakuba</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-2  &gt;2</td>
<td>1-2  &gt;3</td>
<td>1-2  &gt;3</td>
</tr>
<tr>
<td>Elkallassa</td>
<td>10  5</td>
<td>9     1</td>
<td>13    0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>8   5</td>
<td>10    4</td>
<td>13    0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>12  4</td>
<td>12    1</td>
<td>19    1</td>
</tr>
<tr>
<td>Sub-total</td>
<td>30  14</td>
<td>31    6</td>
<td>45    1</td>
</tr>
<tr>
<td>Um seriha</td>
<td>9   6</td>
<td>1     1</td>
<td>11    4</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>9   8</td>
<td>1     0</td>
<td>10    6</td>
</tr>
<tr>
<td>Mashga</td>
<td>8   7</td>
<td>0     0</td>
<td>14    1</td>
</tr>
<tr>
<td>Sub-total</td>
<td>26  21</td>
<td>2     1</td>
<td>35    11</td>
</tr>
<tr>
<td>Total</td>
<td>56  35</td>
<td>33    7</td>
<td>80    12</td>
</tr>
</tbody>
</table>

Only 37% of the respondents adopted the innovation of mud houses (durdur). The majority of this group are from Elkallassa, Eyal Ali and Umdabous villages (31%). The respondents showed that, they possess 1-2 durdur within the vicinity of their houses while (7%) of the respondents asserted that, they possess more than 2 durdur, almost all from the above-mentioned villages. The justification of the low level of adoption is attributed to the fact that the innovation of adoption of mud buildings was introduced in the last phase of the project activities. After the phase out of the project, the local government put hands on all the infrastructure of the project among which is the truck which transport the raw material (mud) from the seasonal water courses sites. Although the local communities, after the gaining considerable technical
know-how, managed to sustain and replicate the adopted innovations, they were confronted by the difficulty of transporting the raw material. The majority of the respondents have 1 or 2 rakuba per house as stated by 80% of the respondents. The rest of the respondents possess more than two. In either case, this reflects the high pressure exerted on the natural resources in the study area.

Moreover, almost all the respondents (92%) have under shades (rakouba) at their houses. The under shade is considered as an essential component of the house in the rural area because it provides shelter against hot weather. The number of rakuba also varies according to family size and the number increase in case of polygamy.

5.2.3. Type and numbers of wood materials used in house construction

The types and numbers of wood materials used in the different components of houses in the study area are different. Table (5.4) shows the types and the average number of the components of the different construction of the houses in the study area. These results were achieved through the Participatory Rapid Appraisal (PRA). The average number or the agreed upon number or time was considered for this study.

<table>
<thead>
<tr>
<th>Type of building</th>
<th>Hut</th>
<th>Durdur</th>
<th>Rakuba</th>
<th>Dimensions (Average)</th>
<th>Durability (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fork</td>
<td>9</td>
<td>0</td>
<td>9</td>
<td>11</td>
<td>94 (%) 6 (%) 0 (%)</td>
</tr>
<tr>
<td>Kau</td>
<td>22</td>
<td>22</td>
<td>0</td>
<td>8</td>
<td>0 (%) 3 (%) 97 (%)</td>
</tr>
<tr>
<td>Gazaz</td>
<td>10</td>
<td>0</td>
<td>25</td>
<td>7</td>
<td>91 (%) 9 (%) 0 (%)</td>
</tr>
<tr>
<td>Matarig</td>
<td>400</td>
<td>250</td>
<td>250</td>
<td>4</td>
<td>96 (%) 0 (%)</td>
</tr>
<tr>
<td>Rasas</td>
<td>15</td>
<td>15</td>
<td>22</td>
<td>7</td>
<td>3 (%) 86 (%) 11 (%)</td>
</tr>
<tr>
<td>Mirrig</td>
<td>0</td>
<td>0</td>
<td>1-2</td>
<td>18</td>
<td>0 (%) 12 (%) 88 (%)</td>
</tr>
<tr>
<td>Amina</td>
<td>0</td>
<td>0</td>
<td>Some 1</td>
<td>22</td>
<td>0 (%) 13 (%) 87 (%)</td>
</tr>
</tbody>
</table>

From the above table the importance of the fork is obvious in hut construction, it supports the heavy load of the rest of the building. Therefore, it should have certain specification like straightness, reasonable length and
soundness to play this role. To meet all these specification a whole tree should be removed because the branches of the trees in the study area do not meet these specifications. The key informants in the study area stated that the minimum diameter for fork to support hut building is between 8 -14 cm. Therefore, the average diameter for the fork to be used for hut construction is almost 11 cm. Sometimes forks with less than 8 cm are used for hut construction. This size could be obtained in the past from a branch of a tree but now, cutting of the whole tree is the only possible mean for obtaining such specification. What makes the situation worse, the fact that the fork used for hut construction should be renewed after 1 – 3 years after establishment as asserted by 94% of the respondents.

The importance of mud buildings emerge from this point, where forks are eliminated in the construction of the mud buildings. This intervention conserves the surrounding environment by reducing pressure on the vegetation cover. Although the number of kau and rassas are similar in huts and durdur, the number of matarig is relatively lower in durdurs compared to huts where about 400 mutrag is needed in a hut compare to 250 for durdur. Figures (5.4a and b) show the structure of the traditional hut and durdur. From these findings, it possible to conclude that the amount of forest products exploited in durdur housing is relatively low compared to huts. This fact is attributed to the dramatic changes in the vegetation zones of the country. The old classification of the study area is semi arid vegetation cover where the zone is dominated by certain species like hashab, seyal, habil, kitir and others. Due to climate change and variability beside other factors, there were selective dying of certain species and new invaders started to colonize the study area. Recently, the climate zone of the study area is almost arid zone which is subject to desert encouragement and fluctuating rainfall. If reliance on the tree cover proceeds in the same manner the study area might become a desert particularly under the assumption of difficulties of afforestation programs.
5.2.4. Durability of wood

Wood durability is one of the criterions for the selection of forest products for house construction. The durability of forest products for construction purposes differs according to its position in the construction and the type of the tree. Table (5.4) reflects the durability of forest products used in houses construction. From this table it is clear that there is significant variation between the different types of poles. The durability of the fork is two to three years and sometimes less than one year. This short durability of the fork is attributed to the position of fork in relation to the house. Forks are buried on the soil, therefore it is affected directly by the soil moisture content which rotten the wood. Moreover, this position makes the fork liable to termite's infestation which is very common in the study area. This result reflects the huge amount of forks needed every one to three years to renew the buildings, bearing in mind the trees of the study area provides 1 – 2 forks. As mentioned earlier 94% of the houses in the study area are made of traditional style (huts and rakuba). To renew all the houses a devastating area has to be cleared to offer the necessary products.

Gazazs is also less durable, similar to the forks; the key informants clarified that it renewed every 2 – 3 years or renewal after more than 3 years. The justification of the low durability is the direct contact with the soil, like the
fork. Contrary, the other components which are used in the upper part of the house last for a relatively longer period compared to gazaz and fork. This period might extend to twenty years. The entire interviewed sample mentioned the main reasons behind the low durability of the fork and gazaz compared to the other components of the house structure. The main are; fungus, termite and other insects.

These results clearly show the importance of adoption of mud as an innovation to reduce pressure on the vegetation cover in the study area. Adoption of durdur innovation will enhance the conservation of the natural vegetation through elimination of gazaz and fork from the structure of the houses in the rural area. The other components of the upper part of the house structure do not represent a real challenge to the vegetation cover since they are high durable and obtain from the branches, therefore, not endangering the vegetation cover.

5.2.5. Sources of wood materials

Sources of wood materials for construction purposes are obtained from different sources. Fig.(5.5) shows the different sources of woody materials for house construction. The majority of the respondents (58%) clarified that these products are affordable at the local markets. According to their opinions, these trees are from the study area but brought from a distant a part. The respondents asserted that forests products have high demand in the study area, therefore, under the lack of forest laws enforcement and free access to natural resources, this activity generate a reasonable income to well-to-do inhabitants who are financially potential to invest in this activity. The second source for woody building materials is from the reserved and unreserved forests around villages in the study area as accentuated by 33% of the respondents. This is the most critical factor endangering the vegetation cover in the study area. The study area is a marginal area liable to desert encouragement and the possibility of afforestation is almost nil because the FNC is under-funded and under-staff.
Figure (5.5): Sources of forest products in the study area

Some respondents (18%) rely on their own resources for the provision of forests product (farms and houses). Usually farmers used to retain some trees at their farms, particularly hashab trees, as a contingency asset to be used during times of emergency. Moreover, the history of the study area indicates the existence of good stocking density of hashab trees in the farm lands. Therefore, the study area in the past is recognized as potential for gum Arabic production.

5.2.6. Distance of collection

As far as wood is becoming scarce, wood collectors have to cross long distances for sake of attaining forest products. Accordingly, much time is needed and additional efforts are require for transporting the collected forests products. Respondents were asked to estimate the nearest possible places from which forest products can be collected for building purposes. Table (5.5 ) furnishes the responses of the interviewed sample. Generally, the distance
varies between the villages but it is common that wood nowadays is more or less far from these villages. It worth mentioning that, some villages were included in activities of the Gireigikh project while some other villages were not. The vegetation cover is expected to be a distance a part form the villages which were not included by the project activities.

Table (5.5): Distribution of tree cover in relation to villages

<table>
<thead>
<tr>
<th>Village</th>
<th>No. of respondents</th>
<th>Distance of collection</th>
<th>Means of transport</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&gt; 1</td>
<td>1-2.5</td>
</tr>
<tr>
<td>Elkallassa</td>
<td>15</td>
<td>4.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>18</td>
<td>4.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>20</td>
<td>1.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>53</td>
<td>9.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Um sereiha</td>
<td>15</td>
<td>0.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>17</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Mashga</td>
<td>15</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>47</td>
<td>3.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100</td>
<td>12.0</td>
<td>27.0</td>
</tr>
</tbody>
</table>

Twelve per cent of the interviewed sample asserted that the forests products for building purposes can be obtained from a distance less than 1 km. (the majority of them (9%) are from Elkallassa, Eyal Ali and Umdabous villages), while 27% claimed a distance of 1-2.5 km. The majority of this group is from villages adopted mud innovation for building purposes. Sixty-one per cent of the interviewed sample mentioned a distance of more than 3 km for the collection of forest products for building purposes. The majority of this group is from villages not addressed by the project for the adoption of mud innovations (Um sereiha, Elgenaina and Mashga villages). This finding prove the role of muddy buildings in reducing pressure on the vegetation cover. In villages adopted muddy buildings, trees are available at a relatively shorter distances compared to villages not adopted the intervention.

Different means are used in the study area to transport forest product to the villages. Animals, particularly donkeys, are used to transport forest products as claimed by 84% of the respondents and 5% mentioned that the products are
transported as head load, a clear sign for nearness of the resource. Few percentage (1%) use trucks to transport the forest products. Irrespective of the mean of transportation of forest products, heavy reliance on the vegetation cover to meet the requirements of buildings construction will lead to deforestation of the study area.

5.2.7. Preferences of tree species for building materials

The preferences of tree species for huts construction is based on the availability and accessibility of the forest resources at the time of needs. However, although the study area is rich in biodiversity, only few species provide the necessary specifications for hut construction. Therefore, the preference of the tree species is limited to certain species. Fig. (5.6) shows the tree species on which the local inhabitants rely for the provision of building materials.

Fig. (5.6): Preference of tree species for huts construction

From the above figure, it is clear that seyal tree is the most preferable tree for huts construction. in spite of the bad quality of the wood of the tree, the local people rely on it for the provision of building materials. The main reason is
the dominance of the tree in the study area and it is rarely used for charcoal making. The local people rely on this tree for the provision of forks for the construction of the huts and rakoubas. The branching habit of the tree qualifies the tree as the best tree for forks. Hashab tree comes next in ranking as far as fork production is concerned as asserted by 68% of the respondents. In the past the tree is dominant in the study area and the whole study area was named after the tree (gum belt zone), but in the last decade of the last century the tree decline in stocking density and gum arabic production due to several factors. Hashab tree is considered as a main component in the traditional gum-bush cultivation cycle. Farmers rely on the tree for gum production during times of no or limited sources of income. According to the gum bush cultivation cycle, the old trees (no longer productive) are eradicated to offer a vacant lot for the agricultural crops. The main uses of the eradicated trees are provision of firewood and building poles. Moreover, preference of seyal tree over hashab tree is attributed to the high demand of firewood of hashab tree compare to seyal tree.

The third ranked tree species for the provision of building poles is neem tree as mentioned by 58% of the respondents. Those trees are mainly raised by the local people at their farms or at their houses. The tree is considered as the most productive tree as far as building poles are concerned. Other tree species used for provision of building materials are hegleig and sidir as asserted by 48 and 10% of the respondents, respectively.

5.3. Adoption of mud in the area
Mud, as building material, was introduced in the area since the mid eighties of the last century. The initiatives were motivated by the famous drought cycles that struck the whole sahelian region. As a result many NGOs projects managed to cooperate with the national and regional governments to tackle the issues of deforestation and desert encouragement. These organizations formulated different plans and strategies to reduce reliance on natural vegetation and execution of afforestation programs. One of these strategies
was adoption of mud as a vital substitute of forests products used in houses construction. Therefore, the main philosophy of the intervention is to conserve the environment. Although considerable effort was made for the dissemination of the innovation, the results lagged far behind expectations where only 40% of the respondents adopted the innovation, the majority of them (37%) are from villages addressed by NGOs and the rest (3%) are from other villages to transfer and replicate the idea from villages adopted muddy buildings. Table (5.6). This finding is verified by the fact that the projects started with a selection of a small number of villages (pioneer villages) to be as a model to be replicated in other sites within the study area.

5.3.1. Initiator of the activity

From the documents and archives of the FNC it was clearly stated that the NGOs are behind the idea of introducing the activity of mud building in the study area. The respondents were interrogated to investigate their perception of the initiator of the idea of mud innovation and to predict whether the local communities were consulted before the initiation of the activity. Table (5.6) shows the level of adoption of mud innovation and the initiator of the activity as perceived by the local people.

Table (5.6): Level of adoption of mud intervention in the study area

<table>
<thead>
<tr>
<th>village</th>
<th>No. of respondents adopted mud</th>
<th>Who is introduce mud</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NGOs</td>
</tr>
<tr>
<td>Elkallassa</td>
<td>10</td>
<td>9.0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>14</td>
<td>11.0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>13</td>
<td>4.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>37</td>
<td>24.0</td>
</tr>
<tr>
<td>Um sereiha</td>
<td>02</td>
<td>0.0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>01</td>
<td>0.0</td>
</tr>
<tr>
<td>Mashga</td>
<td>00</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>03</td>
<td>0.0</td>
</tr>
<tr>
<td>Total (%)</td>
<td>40</td>
<td>24.0</td>
</tr>
</tbody>
</table>

The level of adoption of mud intervention is reasonable (37%) in villages covered by projects and very poor in the other villages. It could be as a good
start and the experience gained could be used as a model to convince other inhabitants to adopt the innovation. The perception of the local people regarding the initiation of the activity varied between respondents. Twenty-four percent of the interviewed sample asserted that the NGOs and developmental projects were behind the intervention. This group represents 60% of the respondents who adopted the innovation. The pioneer NGOs projects worked in this field in the study area IFAD and Gireigikh Project. Fifteen percent of the respondents asserted that their adoption of the innovation was based on personal initiatives, and this group represents 37.5% of the adopters of the mud intervention. This finding supports the idea of the possibility of replicating the model irrespective of existence of NGOs, but the situation necessitates the existence of effective and qualified extension unit to help in transferring the necessary knowledge regarding the technical know-how through training sessions particularly demonstration.

The role of the government in the process of adoption of mud building intervention is almost nil, where only 1% of the respondents mentioned the involvement of government institutions in the activity of mud building. It is universally knowledgeable that the commitment of the governments to the plans, strategies and activities introduce by NGOs would guarantee the sustainability of the introduced activity.

5.3.2. Assessment of the level of adoption of the mud building

For the adoption of new intervention, a scientific extension message should be formulated for sake of changing attitudes and raising the level of awareness. The extension message should be socially accepted, economically feasible and do not contradict with the traditions and believes of the local community. Different extension methods can be deployed to convey the extension message (mass media, individual method and group extension method). Moreover, the selection of the proper channel for displaying the extension message which affects the adoption and acceptability of the new intervention is also important. However, the perception of the local communities to the
intervention is good. Although only 40% of the respondents adopted the innovation, 94% of them are convinced or partially convinced by the role of the mud building in reducing financial cost and sparing leisure time. The NGOs in the study area use group discussion as a method to convey the extension message regarding the adoption of the mud buildings. This finding reflects the importance of addressing other extension methods for sake of recruiting new comers to the activity of mud building. Existence of partially convinced local people shows the urgent need for extension services to mobilize and sensitize the local communities. The most vital way of achieving this is addressing of the incentive agenda. This can take the simple form of transporting the raw material (mud) from the sites of seasonal water courses because the availability of the raw material represent a real challenge for the dissemination of the innovation in the study area. Table (5.7) shows the level of adoption as perceived by the local people.

**Table (5.7): Level of adoption of mud buildings in the study area**

<table>
<thead>
<tr>
<th>village</th>
<th>No. of respondents</th>
<th>Satisfaction with innovation</th>
<th>Level of adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Extremely convinced</td>
<td>Partially convinced</td>
</tr>
<tr>
<td>Elkalassa</td>
<td>15</td>
<td>15.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>18</td>
<td>18.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>20</td>
<td>20.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>53</td>
<td>53.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Umseriha</td>
<td>15</td>
<td>13.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>17</td>
<td>5.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Mashga</td>
<td>15</td>
<td>1.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>47</td>
<td>19.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100</td>
<td>72.0</td>
<td>22.0</td>
</tr>
</tbody>
</table>

The level of adoption of mud innovation in the study area varies considerably between villages Table (5.7). In some villages like Eyal Ali and Umdabous the level of adoption is very high (83.3% and 85%, respectively), and the level of adoption is medium in some villages like Elkaslassa where the entire
interviewed sample asserted that they have adopted the innovations. In the rest of the villages the level of adoption is very low particularly in Um sereiha, Elgenaina and Mashga villages. From the above table 54% of the respondents assess the level of adoption of the mud intervention as medium or good and 34% classified it as low.

5.4.3. Determinant factors for the adoption of mud intervention

Despite the acceptability of the mud intervention in the study area, the level of adoption is relatively low particularly in villages not addressed by NGOs projects. Several factors are responsible for the gap between acceptability and level of adoption, as shown in Table (5.8) The main factor is the availability and accessibility to mud sites. As the soil of the study area is predominantly sandy soil, the mud, usually, brought by trucks from clay pockets in the area which are usually a distant a part. Therefore, if the truck is out of order the whole activity will cease.

Table (5.8): Determinant factors for the adoption of mud intervention

<table>
<thead>
<tr>
<th>village</th>
<th>No. of respondents</th>
<th>Provision of fund</th>
<th>Provision of material</th>
<th>Availability of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elkallassa</td>
<td>15</td>
<td>15.0</td>
<td>0.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>18</td>
<td>4.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>20</td>
<td>15.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>53</td>
<td>34.0</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Um sereiha</td>
<td>15</td>
<td>3.0</td>
<td>13.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>17</td>
<td>15.0</td>
<td>2.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Mashga</td>
<td>15</td>
<td>15.0</td>
<td>0.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>47</td>
<td>33.0</td>
<td>15.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100</td>
<td>67.0</td>
<td>16.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

The second factor is the financial resources of local communities. This factor closely linked with the first factor. Even if the trucks are well performing they operate through hiring. The cost of transporting the mud is out of reach of most of the local communities. The study area is classified as ultra poverty area according to the socioeconomic index of poverty of the country. Therefore, there is a need for revolving fund to cover the expenses or a need
for incentives and subsides to guarantee the transport of mud at reasonable prices. The third factor is the availability of water. The study area is characterized with water shortage due to the low level of precipitation and the type of the soil which has low water retention. The rain water penetrate very fast except at sites of clay pockets. Extraction of underground water is very expensive because the underground water is very deep in the study area.

5.4.4. The benefits of mud buildings compared to traditional buildings

Comparing the two types of buildings (durdur and woody buildings) as perceived by the target group, the benefits of the mud building are appreciable by the respondents who were able to pinpoint some indicators. Mud buildings contribute significantly to the conservation of the environment as perceived by (90%) of the respondents. Table (5.9). Construction of one hut using woody materials necessitate felling of nine to ten trees which will be replace by a similar number after two to three years.

Table (5.9): The benefits of mud buildings

<table>
<thead>
<tr>
<th>village</th>
<th>No. of respondents</th>
<th>Nature conservation</th>
<th>Saving money</th>
<th>Aesthetical values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elkallassa</td>
<td>15</td>
<td>15.0</td>
<td>3.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>18</td>
<td>18.0</td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Umdabous</td>
<td>20</td>
<td>20.0</td>
<td>18.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>53</td>
<td>53.0</td>
<td>26.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Um sereiha</td>
<td>15</td>
<td>13.0</td>
<td>10.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>17</td>
<td>10.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Mashga</td>
<td>15</td>
<td>14.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>47</td>
<td>37.0</td>
<td>12.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Total (%)</td>
<td>100</td>
<td>90.0</td>
<td>38.0</td>
<td>14.0</td>
</tr>
</tbody>
</table>

Therefore, adoption of mud building will conserve the environment. Saving of money and time was mentioned by (38%) of the respondents. As mentioned earlier, a considerable proportion of the respondents get their forest products for building purposes from the local market. Even in the case where they collect it personally, they have to cover the cost of transportation. It worse mentioning that the cost of durdur is higher than the cost of woody
hut, but the cost of the durdur is a fixed cost i.e. no maintenance is needed or needed after long intervals. Moreover, adoption of mud building contributes to the amenity and protection against fire hazards which is very common in the study area. Some respondents, (14%) mentioned the aesthetical value of the durdur buildings compared to the traditional hut. Fig.(5.7).

Fig.(5.7): Aesthetical value of the durdur buildings

5.4.5. The roles of the traditional leaders in dissemination of mud buildings
Village's leaders i.e. native administration members, people's committees members and or the elders have a vital role to play in the communities. They mobilizing the communities and encouraging the social activities. Regarding the introduction and adoption of mud in the area, respondents have varied attitudes towards the roles of leaders as shown in Fig. (5.8) below.

**Figure (5.8): The role of traditional leaders**

This result reveals that, the role of leaders, regarding adoption of mud intervention, is quite obvious in the villages adopted mud i.e. positive, while in non-mud-villages (villages not adopting mud), the role is negative as it was stated by the respondents. 45 respondents out of 53 representing the mud-villages agreed that the leaders have a positive role and only 8 respondents described the role of leaders as negative. The role of leaders, concerning mud building, was found to be in the form of organizing the communities in participatory activities to share efforts physically, mentally and emotionally. This participatory approach is called *(nafir)* and it is very effective in minimizing the cost particularly for the poor people. The importance of participation is due to the fact that, it is the feasible possible mean through
which people could be encourage to expend their energy, time and other local resources to generate more resources within the community (FAO,1985).

5.4. Cost Analysis of hut and durdur building

Special attention was made to compare the cost of the two types of buildings (hut and durdur). Table (5.10) shows the quantities of the different items used in the two building units and their costs.

<table>
<thead>
<tr>
<th>Items</th>
<th>Hut Quantity</th>
<th>Cost</th>
<th>Durdur Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fork</td>
<td>9</td>
<td>3600</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Kau</td>
<td>22</td>
<td>8800</td>
<td>22</td>
<td>8800</td>
</tr>
<tr>
<td>Gazaz</td>
<td>10</td>
<td>2000</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Rasas</td>
<td>15</td>
<td>3000</td>
<td>15</td>
<td>3000</td>
</tr>
<tr>
<td>Matarig</td>
<td>400</td>
<td>6000</td>
<td>250</td>
<td>3750</td>
</tr>
<tr>
<td>Grass</td>
<td>6 Camel load</td>
<td>12000</td>
<td>4 camels load</td>
<td>8000</td>
</tr>
<tr>
<td>Mud</td>
<td>00</td>
<td>00</td>
<td>2 trucks load</td>
<td>14000</td>
</tr>
<tr>
<td>Water</td>
<td>00</td>
<td>00</td>
<td>198 gallons</td>
<td>5400</td>
</tr>
<tr>
<td>Cement</td>
<td>00</td>
<td>00</td>
<td>3 sacks</td>
<td>10500</td>
</tr>
<tr>
<td>miscellaneous</td>
<td>00</td>
<td>00</td>
<td>differ</td>
<td>3000</td>
</tr>
<tr>
<td>Construction</td>
<td>Labor cost</td>
<td>17500</td>
<td>Labor cost</td>
<td>25000</td>
</tr>
</tbody>
</table>

| Total cost | 52900 | 81450 |

This result reveals that, the cost of durdur is higher than the cost of woody hut, (81450 and 52900 respectively). Therefore, the initial cost of the durdur is relatively higher compared to the cost of traditional hut, but bearing in mind that the traditional hut is renewed every two years (on average), where the essential components of the skeleton (fork and gazaz), are liable to damage by insects, while the woody components of the durdur are renewed after 20 years. Accordingly, on the time series the cost of durdur is much lower compared to the cost of the traditional huts. Moreover, durdur increase the amenity of local communities against fire hazard which sometimes destruct the whole village where the woody components enhance fire spread from a house to another. Furthermore, durdur buildings contribute to the
conservation of the environment and add aesthetical value to the general scene of the villages.

5.5. The assessment of stocking density results

5.5.1. The number of trees per villages

From the social survey, relying on the perceptions of local communities, the stocking density of the vegetation cover is very low. In this study 36 sample plots were inventoried in the six villages (216 sample plots). The majority of the sample plots are bare areas (119 sample plots) and 97 sample plots (44.9%) have trees. Table (5.11) shows the distribution of trees in the study area.

Table (5.11): The number of trees per villages (NT)

<table>
<thead>
<tr>
<th>Village</th>
<th>NO of Plots</th>
<th>Mean</th>
<th>Maximum</th>
<th>Std Dev</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyal Ali</td>
<td>21</td>
<td>6.143</td>
<td>17</td>
<td>4.39</td>
<td>71.56</td>
</tr>
<tr>
<td>Umdabous</td>
<td>17</td>
<td>6.118</td>
<td>17</td>
<td>5.30</td>
<td>86.67</td>
</tr>
<tr>
<td>Elkallasa</td>
<td>14</td>
<td>4.286</td>
<td>22</td>
<td>5.42</td>
<td>126.63</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>20</td>
<td>4.650</td>
<td>12</td>
<td>3.65</td>
<td>78.41</td>
</tr>
<tr>
<td>Mashga</td>
<td>13</td>
<td>2.000</td>
<td>5</td>
<td>1.15</td>
<td>57.74</td>
</tr>
<tr>
<td>Umsereiha</td>
<td>12</td>
<td>2.667</td>
<td>7</td>
<td>1.88</td>
<td>70.31</td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From this table, it is clear that the stocking density of the tree cover is low where the average number of trees varies between 5 trees to 22 trees per sample plot, with an over all average of 4.58 trees per village. The distribution of trees among villages vary considerably. ($x^2 = 68.335$ at probability 0.694)
Table (5.12) shows the number of trees in the different villages.

**Table (5.12): Class range of tree number by villages**

<table>
<thead>
<tr>
<th>Village</th>
<th>1 – 5</th>
<th>6 – 10</th>
<th>11 – 15</th>
<th>16 – 20</th>
<th>&gt; 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>10</td>
<td>10.30</td>
<td>8</td>
<td>8.24</td>
<td>2</td>
</tr>
<tr>
<td>Umdabous</td>
<td>9</td>
<td>9.27</td>
<td>4</td>
<td>4.12</td>
<td>3</td>
</tr>
<tr>
<td>Elkallasa</td>
<td>12</td>
<td>12.36</td>
<td>1</td>
<td>1.03</td>
<td>0</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>14</td>
<td>14.42</td>
<td>4</td>
<td>4.12</td>
<td>2</td>
</tr>
<tr>
<td>Mashga</td>
<td>13</td>
<td>13.39</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>umsereiha</td>
<td>11</td>
<td>11.33</td>
<td>1</td>
<td>1.03</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>69</td>
<td>71.07</td>
<td>18</td>
<td>18.54</td>
<td>7</td>
</tr>
</tbody>
</table>

Chi-square ($x^2$) 68.335 at probability 0.694

Sixty-nine sample plots have number of trees between 1 – 5 trees and this represent 71.1% of the sample plots and 18 sample plots have trees between 6 – 10 (18.5% of the total sample plots). Moreover seven sample plots (7.2%) have trees between 11 – 15 and 2 sample plots (2.1%) have trees between 16 – 20 trees. Only one sample plot have number of trees more than 20 trees (Elkallassa village).

The analysis of variance, Table (5.13) showed that, there is significant differences regarding the number of trees in relation to villages. The coefficient of determination was 12.7%.

**Table (5.13): Dependent variable: NT**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F value</th>
<th>Pr &gt; F1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5</td>
<td>223.260</td>
<td>44.652</td>
<td>2.66</td>
<td>0.0272</td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td>1526.409</td>
<td>16.774</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>96</td>
<td>1749.670</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-square C.V.</td>
<td></td>
<td>0.1276</td>
<td>89.475</td>
<td>4.096</td>
<td>4.58</td>
</tr>
<tr>
<td>Root MSE NT mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Duncan's multiple range test for the number of trees in the different villages showed insignificant differences between Eyal ali, Um Dabous, Elkallasa and Elgenaina villages (the last village was not included in the program of muddy buildings). Number of trees in Mashga and Um serriha differ significantly from the above-mentioned villages.

Table (5.14): Duncan's Multiple Range Test for Variable: NT

<table>
<thead>
<tr>
<th>Village</th>
<th>Number</th>
<th>Mean</th>
<th>Duncan Grouping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyal Ali</td>
<td>21</td>
<td>6.143</td>
<td>A</td>
</tr>
<tr>
<td>Um Dabous</td>
<td>17</td>
<td>6.118</td>
<td>A</td>
</tr>
<tr>
<td>Elkallasa</td>
<td>14</td>
<td>4.286</td>
<td>AB</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>20</td>
<td>4.650</td>
<td>AB</td>
</tr>
<tr>
<td>Umsereiha</td>
<td>12</td>
<td>2.667</td>
<td>B</td>
</tr>
<tr>
<td>Mashga</td>
<td>13</td>
<td>2.000</td>
<td>B</td>
</tr>
</tbody>
</table>

5.5.2. Diameter classes per villages

This variable determines the size of different wood products that necessary for house construction, mainly the fork which is the most important forest product for construction.

Table (5.15): Villages by Diameter-classes (Dcl)

<table>
<thead>
<tr>
<th>Village</th>
<th>5 – 17.9</th>
<th>18 – 29.9</th>
<th>30 – 41.9</th>
<th>42 – 53.9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>16</td>
<td>16.49</td>
<td>4</td>
<td>4.12</td>
</tr>
<tr>
<td>Um Dabous</td>
<td>11</td>
<td>11.34</td>
<td>3</td>
<td>3.09</td>
</tr>
<tr>
<td>Elkallasa</td>
<td>5</td>
<td>5.15</td>
<td>8</td>
<td>8.25</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>16</td>
<td>16.49</td>
<td>1</td>
<td>1.03</td>
</tr>
<tr>
<td>Mashga</td>
<td>10</td>
<td>10.31</td>
<td>3</td>
<td>3.09</td>
</tr>
<tr>
<td>Umsereiha</td>
<td>5</td>
<td>5.15</td>
<td>3</td>
<td>3.09</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>64.93</td>
<td>22</td>
<td>22.67</td>
</tr>
</tbody>
</table>

Chi-square (x²) 38.176 at probability 0.001

Sixty-three sample plots have the diameter classes between 5 – 17.9 cm and this represent 64.9% of the sample plots and 22 sample plots have diameter classes between 18 – 29.9 cm (22.7% of the total sample plots). Moreover six sample plots (6.2%) have diameter classes between 30 – 41.9 cm and 6 sample plots (6.2%) have diameter classes between 42-53.9 cm.
5.5.3. The number of regeneration per villages

Relying on the perceptions of local communities, the number of the tree regeneration is relatively high compared to tree species. In the 216 inventoried sample plots, 179 sample plots, which represent 82.9% of the sample plots, have regenerations and 37 sample plots (17.1%) have no regeneration. Table (5.16) shows the distribution of the regenerations among villages.

**Table (5.16): The number of regeneration per villages**

<table>
<thead>
<tr>
<th>village</th>
<th>NO of Plots</th>
<th>Mean</th>
<th>Maximum</th>
<th>Std Dev</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyal Ali</td>
<td>36</td>
<td>13.917</td>
<td>82</td>
<td>18.782.</td>
<td>134.960</td>
</tr>
<tr>
<td>Umdabous</td>
<td>36</td>
<td>15.083</td>
<td>89</td>
<td>18.784</td>
<td>124.532</td>
</tr>
<tr>
<td>Elkallasa</td>
<td>36</td>
<td>14.833</td>
<td>67</td>
<td>16.549</td>
<td>111.564</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>36</td>
<td>27.167</td>
<td>86</td>
<td>21.576</td>
<td>79.420</td>
</tr>
<tr>
<td>Mashga</td>
<td>36</td>
<td>6.222</td>
<td>22</td>
<td>5.948</td>
<td>95.592</td>
</tr>
<tr>
<td>Umsereiha</td>
<td>36</td>
<td>24.972</td>
<td>86</td>
<td>27.698</td>
<td>110.915</td>
</tr>
</tbody>
</table>

From this table, it is clear that the regeneration density is high where the average number of the regeneration varies between 22 to 89 per sample plot, with an overall average of 72 seedlings per village.

Table (5.17) shows the class-range of regeneration in the different villages.

**Tables (5.17): The class-range of the regeneration by villages**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Eyal Ali</td>
<td>15</td>
<td>6.90</td>
<td>7</td>
<td>3.22</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Umdabous</td>
<td>18</td>
<td>8.28</td>
<td>7</td>
<td>3.22</td>
<td>2</td>
<td>0.92</td>
</tr>
<tr>
<td>Elkallasa</td>
<td>15</td>
<td>6.90</td>
<td>6</td>
<td>2.76</td>
<td>5</td>
<td>2.30</td>
</tr>
<tr>
<td>Elgenaina</td>
<td>11</td>
<td>5.06</td>
<td>6</td>
<td>2.76</td>
<td>7</td>
<td>3.22</td>
</tr>
<tr>
<td>Mashga</td>
<td>24</td>
<td>11.0</td>
<td>5</td>
<td>2.30</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Umsereiha</td>
<td>13</td>
<td>5.98</td>
<td>4</td>
<td>1.84</td>
<td>5</td>
<td>2.30</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>44.1</td>
<td>35</td>
<td>16.1</td>
<td>19</td>
<td>8.74</td>
</tr>
</tbody>
</table>

Chi-square (x²) 335.067 at probability 0.080

Ninety-six sample plots have number of regeneration between 1 – 13 trees and this represent 44.2% of the sample plots and 35 sample plots have
regeneration between 14 – 26 (16.1% of the total sample plots). Moreover 19 sample plots (8.7%) have regenerations between 27 – 39 and 11 plots (5.1%) have regenerations between 40 – 52. Ten sample plots have number of regenerations between 53 – 65 and 8 sample plots (3.7%) have more than 65 regeneration.

The analysis of variance procedure for the dependent variable (R), table (5.18) showed that, there is significant differences regarding the number of regenerations in relation to villages. The coefficient of determination was 13.9%.
Table (5.18): Analysis of variance procedure, dependent variable: Regeneration

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>10</td>
<td>12443.38</td>
<td>1244.337</td>
<td>3.31</td>
<td>0.0005</td>
</tr>
<tr>
<td>Error</td>
<td>205</td>
<td>77053.394</td>
<td>375.870</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>215</td>
<td>89496.773</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-square</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.V.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root MSE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1390</td>
<td>113.826</td>
<td>19.387</td>
<td>17.032</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Duncan's multiple range test for the regenerations in the different villages showed insignificant differences between Um serriha and Elgenaina villages. Number of trees in Eyal ali, Um Dabous, Elkallasa and Mashga is differ significantly from the above-mentioned villages.

Table (5.19): Duncan's Multiple Range Test for Variable: regeneration

<table>
<thead>
<tr>
<th>Village</th>
<th>Number</th>
<th>Mean</th>
<th>Duncan Grouping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elgenaina</td>
<td>36</td>
<td>27.167</td>
<td>A</td>
</tr>
<tr>
<td>Umsereiha</td>
<td>36</td>
<td>24.972</td>
<td>A</td>
</tr>
<tr>
<td>Umdabous</td>
<td>36</td>
<td>15.083</td>
<td>B</td>
</tr>
<tr>
<td>Elkallasa</td>
<td>36</td>
<td>14.833</td>
<td>B</td>
</tr>
<tr>
<td>Aeyal Ali</td>
<td>36</td>
<td>13.917</td>
<td>B</td>
</tr>
<tr>
<td>Mashga</td>
<td>36</td>
<td>6.222</td>
<td>B</td>
</tr>
</tbody>
</table>
6.1. Conclusions

- The level of adoption of mud intervention is reasonable and sometimes is based on personal initiatives, while the government role is passive.
- Different extension method can be deployed to convey the extension message (mass media, individual method and group extension method).
- Existence of partially convinced local people shows the urgent need for extension services to mobilize and sensitize the local communities. The most vital way of achieving this is addressing of the incentive agenda.
- Despite the acceptability of the mud intervention in the study area, the level of adoption is relatively low. Several factors are responsible for this like availability and accessibility to mud sites, financial resources of local communities, and availability of water.
- Mud buildings contribute significantly to the conservation of the vegetation cover, saving of money and time, besides the aesthetical value of mud buildings.
- In the short term, the cost of durdur is higher compared to the cost of the traditional hut, but on the long run the cost of durdur is very low compared to the cost of the hut.
- The role of traditional leaders concerning mud building, takes the form of mobilizing and organizing the communities in participatory activities to share efforts physically, mentally and emotionally to build house.
- The stocking density of the vegetation cover in general, is very low and there is significant differences in the number of trees in villages adopted mud compared to that not adopting mud.
• The majority of the household is headed by males and consist of relatively big families which are reflecting the stability of the study area.

• The level of illiteracy is relatively high due to the lack of enough schools. The high level of illiteracy reflects the difficulty of adoption of innovations introduce by the extension service.

• Agriculture and animal rearing are the main source of income generation. Farming practices is risky and farmers always have nagging doubts about the rainy season. Other sources of income includes private business, government posts and trading.

• The majority of houses are traditional, consists mainly of huts, sometimes durdurs, under shade (rakouba) and fence made basically from forest products (forks, korki, gazaz, rassas, mirrig, and matarig).

• Adoption of mud for houses construction (durdur) was introduced to the area for sake of economical, social benefits and as environmental friendly substitute for the traditional buildings.

• An average of nine to ten forks are used per hut and it needs a regular renewal (sometimes annually) due to many factors causing decaying of wood by termites, while in the durdur there is no need for the fork in the structure of the building.

• The fork should have certain specification like straightness, reasonable length and soundness, to meet all these specification a whole tree should be removed because the branches of the trees in the study area do not meet these specifications.

• The average diameter for the fork to be used for hut construction is almost 11 cm. Sometimes forks with less than 8 cm are used for hut construction.

• The durability of forest products for construction purposes differs according to its position in the construction and the type of the tree. There is significant variation between the different types of poles.
Gazaz and forks are renewed annually in the traditional huts while the other components take a relatively longer period to be replaced.

- The main factors behind the low durability of the fork and gazaz compared to the other components of the house structure are; fungus, termite and other insects.
- Wood materials used for construction purposes are obtained from different sources; local markets, reserved and unreserved forests around villages, and private resources (farms and houses).
- The preferences of tree species for huts construction is based on the availability and accessibility of the forest resources. However, although the study area is rich in biodiversity, only few species provides the necessary specifications for hut construction.
- The most preferred species for houses construction are *A. tortilis, A. Senegal, Azadrachta indica, Balanities agyptiaca and Zizyphus spina-christi.*
- Many NGOs projects managed to cooperate with the national and regional government to tackle the issues of deforestation and desert encouragement through mud buildings intervention. The pioneer NGOs projects worked in this field in the study area are IFAD and Gireigikh Project.
6.2. Recommendations

- An extension message should be formulated, by the FNC, for sake of changing attitudes and raising the level of awareness. The extension message should be socially accepted, economically feasible and do not contradict with the traditions and believes of the local community.

- The afforestation programmes should consider the suitability of tree species to meet the needs of the communities as far as building materials are considered.

- Certain preservative elements should be added to the sheebas to prolong their strengthness.

- A revolving fund is needed to cover the expenses or to guarantee the transport of mud at reasonable prices.
References


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APPENDIXES
The Questionnaire

This questionnaire is formulated for the study regarding the impact of muddy buildings in the conservation of the natural vegetation cover in Bara locality.

1. General

1.1. Locality?
1.2. Administrative Unit?
1.3. Village Name?
1.4. No. of population?
1.5. No. of household?
1.6. Name of family head?
1.7. Male ( ) Female ( )
1.8. Relation to family? ( ) family head ( ) husband ( ) wife ( ) member of family

2. Family specifications

<table>
<thead>
<tr>
<th>No</th>
<th>Sex</th>
<th>Age</th>
<th>Educational level</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td></td>
<td>Illiterate ( )</td>
<td>Farmer ( )</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
<td>Koran school ( )</td>
<td>Merchant ( )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Primary ( )</td>
<td>Gov. employee ( )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intermediate ( )</td>
<td>Students ( )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Secondary ( )</td>
<td>Private business ( )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>University ( )</td>
<td>Others ( )</td>
</tr>
</tbody>
</table>

3. House specifications

3.1. Type of house? ( ) modern ( ) traditional (mud) ( ) traditional (woody materials) ( ) both mud and woody materials ( ) others (specify)

3.2. House constituents

<table>
<thead>
<tr>
<th>Type</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick-wall Rooms</td>
<td></td>
</tr>
<tr>
<td>Mud-wall Rooms</td>
<td></td>
</tr>
<tr>
<td>Durdur</td>
<td></td>
</tr>
<tr>
<td>Traditional hut</td>
<td></td>
</tr>
<tr>
<td>Under-shade (rakouba)</td>
<td></td>
</tr>
<tr>
<td>Surrounding length in meter</td>
<td></td>
</tr>
</tbody>
</table>

3.3. Types and numbers of woody materials used for building in the house

<table>
<thead>
<tr>
<th>Type</th>
<th>No.</th>
<th>Tree species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fork (sheeba)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gazaz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kou</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mirrig</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rassas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Matarig</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.4. The average diameter of the fork? ………..cm.

3.5. The source of woody building materials?

( ) purchased  ( ) collected from the forests
( ) collected from trees in open lands  ( ) from trees inside the house
3.6. In case of direct collection, the distance of collection in kilometer?

……………………………………………………………………………..

3.7. The means of transportation? ( ) animals ( ) head ( ) trucks ( ) others

3.8. What are the preferred tree species for building materials?
1/ ……………………….. 2/ ………………………..
3/ ……………………….. 4/ ………………………..
5/ ………………………..

3.9. What is the durability of each type of building materials?

<table>
<thead>
<tr>
<th>Type</th>
<th>Durability in years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forks</td>
<td></td>
</tr>
<tr>
<td>Gazaz</td>
<td></td>
</tr>
<tr>
<td>Kou</td>
<td></td>
</tr>
<tr>
<td>Mirrig</td>
<td></td>
</tr>
<tr>
<td>Amina</td>
<td></td>
</tr>
<tr>
<td>Rassas</td>
<td></td>
</tr>
<tr>
<td>Matarig</td>
<td></td>
</tr>
</tbody>
</table>

3.10. Specify the main causes of damage to the woody materials?
( ) termite  ( ) fungus  ( ) fire insects  ( ) others (specify)

4. Socio-economic survey

4.1. The family's primary source of income?
( ) agric. Production  ( ) raising animals  ( ) government salaries
( ) trading  ( ) others (specify)

4.2. How much lands do the family own?
( ) less than 5 feddans  ( ) 6 – 10 feddans
( ) 11 – 15 feddans  ( ) more than 15 feddans

4.3. What is the total area cultivated for crop production?
…………………….. Feddans

4.4. What is the main crops produced in this area with an average production?

5. Mud adoption

5.1. Have you adopt mud building in your house?
( ) yes  ( ) no

5.2. If no, what are the reasons?
( ) no mud available  ( ) shortage of water
( ) very expensive  ( ) no need
( ) others (specify)

5.3. If yes, who is initiating the idea?
( ) NGOs and development projects  ( ) government institutions
( ) personal initiative  ( ) others (specify)

5.4. Is there any extension messages conducted in the area regarding mud buildings?
( ) yes  ( ) no

5.5. If yes, how the message is conducted?
( ) open group discussion  ( ) lectures
( ) audio-visual devices  ( ) others (specify)

5.6. The degree of satisfaction with mud innovation?
( ) extremely convinced  ( ) partially convinced  ( ) not convinced

5.7. The reason of that?
……………………………………………………………………………..

……………………………………………………………………………..
5.8. The level of mud adoption?
( ) high ( ) medium ( ) low

5.9. Determinant factors behind the mud adoption?
( ) Provision of fund ( ) provision of materials
( ) provision of water ( ) others ( ) specify

5.10. The benefits of mud buildings?
1/ …………………………………. 2/ ………………………………….
3/ …………………………………. 4/ ………………………………….

5.11. The roles of the leaders in the dissemination of the idea?
( ) positive ( ) negative ( ) no role

5.12. The cost of mud buildings?

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost / dinnars</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mud</td>
<td>Water</td>
</tr>
<tr>
<td>Durdur</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fence</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# The stocking density form.

Village name: .................................................................
Survey line No.: ...............  
Sample plot No.: ...............  
Soil type: .................................................................

<table>
<thead>
<tr>
<th>Tree species</th>
<th>No. of trees</th>
<th>Average Ht./ m.</th>
<th>DBH / cm.</th>
<th>Regeneration (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

General observations:
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
---------------------------------------------------------------------
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