Contribution of Farm Trees to Farmers' Rural Livelihoods in Gedaref State, Sudan

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(Forest Management)

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DEDICATION

I dedicate my effort to my father, mother, brothers, friends and colleagues.

With my love

Mohamed
2016
ACKNOWLEDGEMENTS

I am grateful to Allah for the success to accomplish this research, and let me offer my sincere gratitude to my supervisor, Dr. Yahia Omar Adam, Department of Forest Management, Faculty of Forestry, and U. of. K. This thesis would not have been possible without his help and support. Most sincere thanks to him. Also my gratitude is extended to Mr. Amar Khalil Bandy and Mr. Gumaah Ahmed Gumaah (from FNC, Gedaref State) for their unlimited assistance during the field work. Thanks and appreciations are also extended to the rural people in the study villages (Alsaraf, Kasab and Wad daeeef) in Elgalabat locality, Gedaref State for their exerted time and valuable information.

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I express my deep appreciations to my family members for their patience, moral encouragement and continuous support throughout the course of this study. My thanks and appreciations are extended to those who were not mentioned here without ignorance for their efforts and helps.
Contribution of Farm Trees to Farmers' Rural Livelihoods in Gedaref State, Sudan

Abstract: The objectives of this study were to: (i) determine and analyze the factors that inducing the farmers' decision making on retaining and/ or planting trees in their farmlands; (ii) assess the contribution of farm trees to farmers' income in comparison with other available livelihoods strategies; and (iii) determine the perceptions and attitudes of the farmers towards trees retaining and/ or planting on farms. A sample of 60 farmers was purposively selected from three villages (Alsaraf, Wad daeef and Kasab) in Galabat locality, Gedaref State in 2015. Two types of data were used to collect the necessary information, namely; primary and secondary data. The source of secondary data included available related literature, reports and scientific journals. Primary data were collected using structured questionnaire for interviews, direct observations, group discussion and key informants interviews. The unit of analysis was a farmer who has trees on his farm. The data were analyzed using descriptive statistics and linear regression analysis. The results showed that, the most important factors have significant effects on Household farmer's decision to retaining and/ or planting trees were household land holding (P<0.05), household size (P<0.05) and household income (P<0.05). The findings also revealed that farm trees and their products contributed 31% to farmer's total income. The study findings showed that the respondents in the study area have awareness on the benefits associated with trees on their farms and their attitudes towards trees planting were mostly positive. The study concluded that farmer’s decision to retaining and/ or planting trees on their farmlands was driven by their socioeconomic characteristics. The study recommended that to overcome the factors that confront farmers to retaining and/or planting trees on their farms, land use policies and tree tenure problems must be solved. Additionally, Forest National Corporation (FNC) should consider the socio-economic
characteristics of the farmers as essential in any tree planting programs in the study area.
مساهمة أشجار المزرعة في سبل كسب عيش المزارعين في ولاية الفضافض، السودان

المستخلص: هدفت الدراسة إلى (i) تجديد وتحليل العوامل التي تؤثر على إتخاذ المزارعين لقرار استبقاء أو/و إستيراع الأشجار في مزارعهم، (ii) تقديم مساهمة أشجار المزرعة في دخل المزارعين مقارنة مع استراتيجيات سل كسب عيش المتاحة الأخرى (iii) فهرسة أراء واتجاهات المزارعين حول استبقاء أو/و إستيراع أشجار المزرعة في أراضيهم. تم اختيار 60 مزارع من ثلاثة قرى هي الصراف، ودعع وكاسب في محلة القلاتاب، ولاية الفضافض في العام 2015. تم استخدام نوعين من المعلومات حيث مثلت أدبيات البحث، التقارير والمنشورات العلمية مصدر المعلومات الثانوية، بينما تم الاعتماد على الإستبيان، الملاحظات المباشرة، وجمع النصوص والألفاظ المعرفة في جميع المعلومات الأولية. مثلت مجتمع المزارعين الذين يمتلكون أشجار في مزارعهم الأداة التحليلية للدراسة. تم استخدام الإحصاء الوصفي وتحليل الإحصاء في تحليل البيانات. أوضحت النتائج أن أهم العوامل التي تؤثر على قرار الأسر في استبقاء أو/و إستيراع الأشجار هي مساحة الأرض التي يملكونها المزارع (P<0.05)، عدد أفراد الأسرة (P<0.05) ودخل الأسرة (P<0.05). كما أوضحت الدراسة أن أشجار المزرعة تساهم بحوالي 31% من الدخل الكلي للمزارع. كذلك أظهرت نتائج الدراسة أن المستجيبين في منطقة الدراسة على علم بإدراج الأشجار التي تود بها الأشجار في مزارعهم وكما كانت أراءهم وإتجاهاتهم تجاه زراعة الأشجار إيجابية. خلصت الدراسة إلى أن قرار المزارعين في استبقاء أو/و إستيراع الأشجار في مزارعهم يرتبط بالخصائص الاجتماعية والاقتصادية للمزارعين. أوصت الدراسة بمعالجة سياسات إستخدام الأرض وملكيتها، و كما يجب للهيئة القومية للاعلاب وضع الخصائص الاجتماعية والاقتصادية في الإبتكار في أي برامج تشجع في المنطقة.
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<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAO</td>
<td>Food and Agricultural Organization</td>
</tr>
<tr>
<td>FNC</td>
<td>Forests National Corporation</td>
</tr>
<tr>
<td>CNS</td>
<td>Comprehensive National Strategy</td>
</tr>
<tr>
<td>IEA</td>
<td>International Energy Agency</td>
</tr>
<tr>
<td>NTFPs</td>
<td>Non Timber Forest Products</td>
</tr>
<tr>
<td>PEN</td>
<td>Poverty Environment Network</td>
</tr>
<tr>
<td>FGD</td>
<td>Focus Group Discussion</td>
</tr>
<tr>
<td>KII</td>
<td>Key Informant Interview</td>
</tr>
<tr>
<td>AGE</td>
<td>Age of head of household</td>
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<td>EDU</td>
<td>Educational levels of head of household</td>
</tr>
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<td>HSIZ</td>
<td>Household size</td>
</tr>
<tr>
<td>FLND</td>
<td>Farmer land holding</td>
</tr>
<tr>
<td>FINC</td>
<td>Farmer’s total household annual income</td>
</tr>
<tr>
<td>EXT from FNC</td>
<td>Extension services received from Forests National Corporation</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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</tbody>
</table>
CHAPTER ONE
INTRODUCTION

1.1 Background and Justifications

Sudan covers an area of 1,888,000 km² with a total population of more than 36 million, with rapid growth rate of 2.3% per annum (Bank of Sudan, 2013). However, the majority of population (70.5%) is rural and many of which are considered as forest dependents (Bank of Sudan, 2013). In Sudan the forest resources, are threatened by deforestation driven predominantly by energy needs and agricultural clearance (Badri, 2012). According to (WRI, 1994) the Sudan derives more than 75% of its energy requirements from fuel wood, estimated at 22 million m³ per year. Ayoub (1998) estimated this to be equivalent to about 400 million Acacia trees being cut annually. According to FAO (2013), the ongoing process of environmental degradation is a critical issue that affects the livelihoods of large sector of the population. Removal of tree cover for crop production, felling trees for fuel wood and building poles, in addition to overgrazing are factors that, together with drought conditions, resulted in desertification and consequently, shortage in food crops, and loss of soil fertility (El Tahir et al. 2009). Another cause of land degradation in the Sudan is the rangelands cleared for mechanized rain-fed agriculture and shifting cultivation (FAO, 2001). According to Glover and Elsiddig (2012) and Biro et al. (2013), many areas in central and eastern Sudan covered by natural forests have been converted to mechanized rain-fed agricultural schemes for cultivating cash and subsistence crops.

The majority of Sudanese farmers depend on rain-fed farming. In addition to these traditional farmers, a large modern mechanized rain-fed agricultural sector has developed since 1944-1945. Large investments continued to be made in the mechanized, irrigated, and rain-fed cultivation. The increase, however, has
mainly been expanding the cultivated area rather than by increasing productivity (Abdelmagid and Warrag, 2011). This expansion of mechanized farming, which aims at horizontal development of cropland, contradict with the comprehensive national strategies (1992-2002 and 2003-2007) which stated that the forest and other natural resources policy objectives aim at conservation, environmental protection and poverty alleviation at national and community level. Large scale forest losses and environmental degradation have created a state of vulnerable condition at various sites within the dry lands of Sudan. According to FAO (2001), during the 1980s and 1990s there was a rapid expansion of rain-fed mechanized cultivation with the aim of attaining self-sufficiency in food production. According to Salih (1987), the land area for mechanized agriculture increased from about 2.0 million ha in 1954 to about 14 million ha in 1994, a rate of 300,000 ha per year. Large scale mechanized farming has been the main factor contributing to deforestation and consequent land degradation (FAO, 2001). Similar findings by the World Bank (1984) confirmed that in the Sudan (Kordofan and Darfur), about 88,000 ha of woodlands are cleared each year for conversion to mechanized agriculture.

To safeguard against the problems of deforestation and land degradation, the Sudanese government introduced the Investment Act of 1990 and the Ministerial Order 345/95 which obliged all land proprietors to conform to the allocation of 10% of their rain-fed farmland, for forestry (shelterbelts or forest cover); and to allow 20% of the holdings for forestry (that is by not clearing that margin in the first place) in case of new licenses (Abdelnour, 1999; Ibrahim, 2002; ADB/EC/FAO, 2003; FNC, 2003). The mentioned legislation has been supported by the Comprehensive National Strategy (CNS) for socio- economic development (1999-2002) which has been formulated and enacted by the Federal Government. There has been also rapidly growing interest in development and conservation initiatives that enhance livelihood contributions
from woody vegetation in rural communities in international research and development organization (IUCN, 2012).

Traditionally, resource development interventions have concentrated their attention to mainly understanding the biophysical implications of the plantations within the context of the corporate profitability and without taking into consideration the inherent collateral livelihood implications to communities and their families. However, there no detailed studies have undertaken to evaluate the contribution of the trees on farmlands to farmers’ livelihood improvement in traditional rain-fed agricultural sector. It is important that a realistic and informed view of the role of trees on farmlands in farmers’ livelihood improvement should be articulated. Such information is important addition to the body of literature on trees on farmlands and livelihood of farmers in traditional rain-fed agricultural sector as well as for policy and management interventions to enhance the farmlands trees establishment and thus improve the livelihoods of the farmers.

1.2 Problem Statement

There is widely differing and often contradictory claims about the livelihood impacts of land use change to plantations which have been widely reported. Many authors (e.g. Bayala et al., 2014; Luedeling and Neufeldt, 2012; Mbow et al., 2014) mentioned that, there is an increasing scientific interest in understanding effects of woody vegetation on agricultural lands for different aspects of human well-being including climate change mitigation and adaptation. There is few studies (e.g. Nsiah 2010) evaluated the contribution of farm plantation to the livelihoods of farmers in Africa (Kiiyngi et al. 2016) and there is still a significant gap in the literature (Chirwa and Mala 2016). Such information is important and necessary for providing the policymakers with feedback for policy adjustment and thus helps informing the design and
development of future forestry projects which target farmers for improving their rural livelihoods.

1.3 Research Objectives
The main objective of this study was to explain and analyze the factors inducing farmers' to retaining and/ or planting trees for rural livelihood improvement. Specifically, the study objectives were:

- To identify and analyze the factors that influencing the farmers' decision on retaining and/ or planting trees on their farmlands;
- To assess the contribution of farm trees to farmers' income in relation to other available livelihoods strategies; and
- To determine the perceptions and attitudes of the farmers towards trees retaining and/ or planting on farms.

1.4 Research Questions
To realize the above objectives, the following research questions were set:

- What are the factors that influencing the farmer's decision to retaining and/ or planting trees on their farmlands?
- To what extent do trees on farmlands contribute to direct farmer's cash income in relation to other available livelihood strategies?
- What are the farmer’s perceptions and attitudes towards trees retaining and/ or planting on their farmlands?

1.5 Rationale of the Research
The present research is significant in terms of its contribution to both theory and practice, particularly, relevance in the influence of factors that inducing farmer's decision-making behavior in relation to retaining and/ or planting trees on agricultural lands. Majority of the studies that have been conducted in the country concerning tress development on the farms have relied exclusively on descriptive statistics and have few interesting to test the relationships between
the trees and farmers' livelihood strategies. However, the research adds knowledge on how trees retaining and/or planting of farmlands influence the improvement of the farmers' cash income generation from the farming activities. It recommends future policy that enables farmers to successfully adopt trees establishment and management on their farms. The major output of research is on lessons learnt from studying the relationship between trees establishment and the farmer’s cash income generation improvement. The full understanding of the relationship between trees establishment on farmlands and farmer's cash income generation improvement is a major step toward designing intuitional support structures, formulating policies, and extension programs that aim at supporting the establishment of trees on agricultural farms and sustaining and enhancing revenues for the farmers at local level.
CHAPTER TWO
LITERATURE REVIEW

2.1 Conceptual Framework for the Study

The study attempts to analyze the factors influencing farmers to retaining and/or planting and manage trees on their farmlands and its contribution to farmer's cash income. According to Scherr (1997), the analysis of farmer’s incentives to integrate trees into their farming systems requires a comprehensive analytical framework. Hence the study adopt the portfolio view (Shively, 1999) and diversification (Ellis, 2000) to holistically analyze these factors. Based on the research questions and the theoretical framework for the study, the conceptual model (Figure1) was used to guide the study.

Figure 2.1: Conceptual framework for the study modified from Nesiah (2010).
The conceptual framework shows the linkage and interaction between different factors and their influence on farmers to retaining and/or planting and manage trees on their farmlands. The underlying principle of the framework propose that the decision of farmers to allocate their agricultural lands for retaining and/or planting and manage trees can be influenced by a wide array of factors that are internal to farmers including size of household labor, age and education of household head, size of farm land and annual income. (Mekonnen, 2009; Gebreegziabher et al., 2010a; place et al., 2012). On the other hand, there are factors that are external to farmers and which also have effect on their decision, such as, policy, ownership of planted trees on private land and extension services (Ewentu and Bliss, 2010; Gibreel, 2013). The above factors were used as inputs to analyze their influence on farmers to retaining and/or planting and manage trees on their farmlands.

2.2 Trees Establishment on Farmlands as Means to Combat Deforestation and Land Degradation

Globally, forests provide important economic and environmental benefits. In addition, small woodlots on agricultural land play similar roles and are increasingly recognized for their contribution to solving energy problems, enhancing biodiversity conservation, addressing deforestation and mitigating climate change (Acharya, 2006; Deressa et al., 2009; Dixit and Dixit, 2010; Garrity and Stapleton, 2011). For instance, as the rates of deforestation continue to rise in some tropical countries, governments are faced with the challenge of finding approaches which can reduce deforestation and provide rural livelihoods in addition to protecting the environment. Much of these policies focus on the promotion of farm forestry, by providing incentives that encourage the farmers to establish and manage their own sources of wood and non-wood products on their farmlands.
In Sudan however, several strategies have been adopted for renewable natural vegetation. Among these is the requirement to plant a 10% of land around each mechanized scheme. Inclusion of shelterbelt in the mechanized farming system started in 1994 (Glover, 2005). However, these measures, although insufficient to bring back the degraded forest, have not yet been fully enforced, and the application was by and large ignored (FAO, 2008).

2.3 Factors Affecting Farm Trees Planting and Management

The most important factors found in the available literature include farm size, sex, age and education of household head, household size, wealth and livestock holdings as well as access to forests (Shackleton et al., 2008; Mekonnen, 2009). Factors are unlikely to be valid across national regions (Nadyambaje et al., 2013). However, there are a number of empirical studies that have looked into several determinants of farmer’s tree planting behaviour and the types of trees planted (Bluffstone et al., 2008; Mekonnen and Damte, 2011). Mekonnen and Damte (2011) found that the availability of resource endowments, household characteristics and institution-related factors influenced households’ tree planting behaviour. In their study in Bangladesh, Salam et al. (2000) showed that economic factors play a role than ecological factors in determining farmers' decision to plant tree, in contrast to the findings of Emtage and Suh (2004) from the Philippines where tree planting was driven by the household needs for timber and building materials. Gebreegziabher et al., (2010) in Northern Ethiopia, reported that land size, age, and agro-ecology were among important factors that enhance the farmer tree planting decision, while increased livestock holding affected this decision negatively.

On the other hand, institutional factors like land and tree security, extension services and information sources also have effect on household's decision to plant trees (Ewnetu and Bliss, 2010). Moreover, a large number of studies support the influence of income incentives on households’ tree planting
behaviour (Gyau et al., 2014; Wunder et al., 2014; Belcher et al., 2015; Cobbinah, 2015; Kibria et al., 2015). Other characteristics have been explained to affect tree planting decision include household income, livestock, distance to market, labor availability and size of holding (Ewnetu and Bliss, 2010). In Sudan however, a recent study on the adoption of traditional Gum Arabic agroforestry system in western Sudan investigated factors that influence the decision to adopt this technology (Gibreel, 2013). The results show that farmers with less commercialization, access to credit, less fragmented land, more education, high gum Arabic gate price, located away from the markets and with more year of experience in farming, are more likely to adopt the traditional gum Arabic agroforestry system. In contrast, the allocation of more working days for commercial sole crop production, more fragmented land and higher commercialization index reduce the likelihood of adoption.

2.4 Contribution of Trees to Livelihoods
Over thousands of years million all over the world relied on forests as a resource for their rural livelihood, and remained food forests (Vinceti, 2008; Powell, 2011). Forests and trees out-side forests contribute to rural livelihoods of more than 1.6 billion people (FAO, 2010). The literature has documented that non timber forest products (NTFPs) provide a wide range of subsistence and cash income to a large number of household in many countries (Narian et al., 2005). Some scholars (Angelsen et al., 2014; L’Roe and Naughton-Treves, 2014) indicated that cash and non-cash incomes from NTFPs range up to 60% of total household income. Also there are now numerous empirical studies showing that the proportional income from NTFPs is typically markedly higher for the poorest household within community (Paumgarten and Shackleton, 2009; Rueff et al., 2008; Kar and Jacobson, 2012). In dry land of Sudan, however, Adam and Pretzsch (2010) reported that NTFPs are the sole source of income generating during the dry season as well as reduce unemployment in
Nuba Mountains. Globally, it’s estimated that 50 percent of all fruits consumed by humans originate from trees (Powell et al., 2013). A wide range of studies indicated an important role for NTFPs in supporting rural peoples‘ livelihoods (Table 2.1).

On the other hand the reliance on wood fuel markets to generate income during periods of stress has been widely observed, but seldom well documented. In his assessment of household responses of food shortages in Malawi in 2003, Zulu (2010) mentioned that, more than 40 percent of the surveyed households who generate income from the sale of charcoal or wood fuel use the income to purchase maize, in response to famine conditions. The Poverty-Environment Network (PEN) studies (CIFOR, 2011), for example showed that income from unprocessed and processed forest products accounted for income shares of 16.3% and 5.4%, respectively. Wood fuel and charcoal is the most significant in the mix, accounting for 37% of forest income, and representing about 7% of total household income. In Africa, however, wood fuel markets have been estimated to employ about 7 million people, and are worth about $8 billion per year (World Bank, 2012).

Table 2.1: Case studies indicate the proportional contribution of non-timber forest products to household’s incomes

<table>
<thead>
<tr>
<th>Reference</th>
<th>Location</th>
<th>Land use type</th>
<th>% of income to household total income</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adam and Pretzsch (2010)</td>
<td>Sudan</td>
<td>Savanna woodland</td>
<td>54</td>
<td>Ziziphus fruits</td>
</tr>
<tr>
<td>FAO (2011)</td>
<td>Sahel</td>
<td>Parkland, Savannah</td>
<td>80</td>
<td>Shea nut</td>
</tr>
<tr>
<td>Pouliot (2012)</td>
<td>Burkina Faso</td>
<td>Parkland, Forest</td>
<td>28</td>
<td>Woodfuel, baobab Fruit and leave Thatching grass</td>
</tr>
<tr>
<td>Bwalya (2013)</td>
<td>Zambia</td>
<td>Natural forest woodland</td>
<td>30</td>
<td>Honey, mushrooms Tubers, berries, wood Fuel, poles</td>
</tr>
</tbody>
</table>
The role of trees and forests in increasing food security and reducing poverty is gaining recognition. A large proportion of the dry land inhabitants depend on forests for subsistence or income. They use trees in natural forests or on the farm, to generate food or cash. However, some scholars (e.g. Angelsen and Wunder 2003; Belcher et al., 2005) have raised doubts on the potential of forest regarding poverty alleviation, arguing that this potential is currently small. This conclusion has been, however, challenged by many scholars. For example, Shackleton et al. (2008) reported that employment in informal and formal sector assist in moving households out of poverty. Likewise, Lopez-Feldman et al. (2007) and Tesfaye et al. (2010) indicated that forest income could raise the income levels of poor households closer to the level of the wider community, and sometimes lift people out of poverty (Adam et al., 2013).
CAHPTER THREE
MATERIALS AND METHODS

3.1 Study Area

3.1.1 Location

The current study conducted in Gedaref State. It located in eastern central of Sudan and borders with Kassala state on the East; River Nile and Khartoum states to the North; Gazera and Sennar to the west; and the Ethiopian borders to the south (Figure 3.1). It lies between longitudes 33° 45 to 36° 15 East; and latitudes 12° 45 to 14° 25 North with an area of approximately 78, 000 km² (Sulieman, 2008).

3.2.1 Topography and Soil

The general landscape of the study area is characterized by the undulating surface and hilly areas, with highly fertile clay soil in the central, southern and western part, and higher precipitation in mountain wood land savannas near the Ethiopian border (Gedaref State Statistics Department, 2009). The state is characterized by the presence of various soil types; the most important being the southern central clay plain which cover most of the state areas. This soil is heavy cracking clay with dark grey or dark brown color. The permeability of soil is very low than wet, that can be on source of water logged for certain period, during wet season soils are very sticky (Mustafa, 2006).
Figure 3. 1: Map of the Study Area in Gedaref State, Sudan.
3.3.1 Climate
According to the study of climatic zones of Sudan 2009, the study area is classified under tropical sub humid region, the state characterized by the high solar radiation during the rainy seasons; sunlight energy is enormous and amounts to 17.5 mega Joule/m²/day (Khartoum Metrological station, 2009). The annual rainfall concentrates in a single relatively short summer season during June to September, and amounts to around 670mm. Temperature ranged from a mean minimum of 21° C in January to a mean maximum of 36.4° C in April and May. The mean annual temperature is about 28.70° C (Figure 3.2).

![Figure 3.2: The mean annual rain fall for nine years ago in Gedaref State](image)
Source: Government of Gedaref State 2010

3.4.1 Population
According to the 2008 census, the total population of Gedaref State is 1.34 million (Table 3.1) with an annual population growth rate of 4.7% higher than national growth rate (CBS 2012).
Table 3.1: The population of Gedaref State per locality

<table>
<thead>
<tr>
<th>Locality</th>
<th>Male population</th>
<th>Female population</th>
<th>Total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al Butana</td>
<td>38 375</td>
<td>32 990</td>
<td>71 365</td>
</tr>
<tr>
<td>Al Fashaga</td>
<td>60 005</td>
<td>60 830</td>
<td>120 835</td>
</tr>
<tr>
<td>Central Gedaref</td>
<td>56 239</td>
<td>55 430</td>
<td>111 669</td>
</tr>
<tr>
<td>Gedaref City</td>
<td>136 434</td>
<td>132 961</td>
<td>269 395</td>
</tr>
<tr>
<td>Alfaw</td>
<td>86 850</td>
<td>89 812</td>
<td>176 662</td>
</tr>
<tr>
<td>Al Rahad</td>
<td>96 671</td>
<td>99 767</td>
<td>196 438</td>
</tr>
<tr>
<td>QalaAlnahal</td>
<td>31 373</td>
<td>34 749</td>
<td>66 122</td>
</tr>
<tr>
<td>Western Galabat</td>
<td>44 768</td>
<td>47 107</td>
<td>91 875</td>
</tr>
<tr>
<td>Easter Galabat</td>
<td>79 043</td>
<td>81 580</td>
<td>160 623</td>
</tr>
<tr>
<td>Al Goreisha</td>
<td>40 059</td>
<td>43 335</td>
<td>83 394</td>
</tr>
<tr>
<td>Total</td>
<td>669 817</td>
<td>678 561</td>
<td>1348</td>
</tr>
</tbody>
</table>

Source: 5th Sudan Population and Housing Census (2008)

3.5.1 Vegetation Cover

Generally, the vegetation of the area is largely dependent on rainfall and soil types. According to (Harrison and Jackson, 1958) the area lies in low rainfall wood land savannah belt on clay. However, the natural vegetation cover at the study area classified as an *Acacia seyal* and *Balanites aegyptiaca* wood land savannah. On the clay plain, *Acacia seyal*, *Acacia Senegal* and *Ziziphus orthacantha* are the dominant trees. Common grasses include *Cymbopogon nervatus*, *Aristid amutabilis* and *Ctenium elegans*. The vegetation on the higher stonier land is less affected by human influences (Sulieman, 2008).

3.6.1 Land Use and Livelihoods

In total, the State has around 4.2 million ha of cultivable land and its disposal (MFC, 2012). However agriculture is the main livelihood activity, followed by livestock rising in the traditional seasonal transhumance pattern. Gum production and trading forests products and charcoal production are other traditional forms of livelihoods. Thus people derive their income from various
combinations of the three main forms of land use: Agriculture, grazing and forest exploitation (Glover, 2005).

Table 3.2: Distribution of state lands by agricultural activities

<table>
<thead>
<tr>
<th>No.</th>
<th>Land use category</th>
<th>Area / Acer</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rainfall Agricultural Lands</td>
<td>7315000</td>
<td>42.6</td>
</tr>
<tr>
<td>2</td>
<td>Range Lands</td>
<td>4000000</td>
<td>23.3</td>
</tr>
<tr>
<td>3</td>
<td>Forests Lands</td>
<td>3363722</td>
<td>19.6</td>
</tr>
<tr>
<td>4</td>
<td>Horticulture</td>
<td>300000</td>
<td>1.8</td>
</tr>
<tr>
<td>5</td>
<td>Irrigated Lands</td>
<td>120000</td>
<td>0.7</td>
</tr>
</tbody>
</table>


3.2 Materials and Methods
3.2.1 Study Approach
This research employed a case study approach to explore the factors inducing farmer’s decision to retaining and/or planting trees on their farms. A sample size of 60 farmers was selected purposively in April-May of 2015 from three villages (20 households from each village) in EL Galabat locality. These villages’ are ALsaraf, Wad daeef and Kasb. These villages were closely located and had similar general conditions (homogeneity of population); thus were considered as one case study while conducting the analysis. EL Galabat locality was selected due to the implementation of the ministerial decision with regard to 10% tree planting on the agricultural farm. The unit of analysis is a farmer who has trees on his farm. To fulfil the objectives of this study, the selection of farmer was based on ownership of trees on farms and farm tree products selling for one season at least.
3.2.2 Data Collection

The study employed a combination of methods and techniques during the data collection process. These were included:

- **Secondary Data**: a considerable amount of literature and secondary sources of information on the contribution of trees managed on agricultural farms to household’s livelihood were gathered between March and June 2015 from articles, published reports, books, policy documents from relevant institutions which provided base-line information for the study.

- **Reconnaissance Survey**: A reconnaissance surveys was conducted in the study area to enable the researcher to get a better insight of the study communities. This step was helped the researcher to establish contacts with some key personalities within the communities and select field assistants to help in collecting field data. In all, two field assistant and two enumerators together with the researcher conducted the farmer socio-economic surveys, focus group discussion and key informant interview. The criterion used for selecting the assistants was based on their local knowledge about the study area.

- **Household Interview**: after pre-testing the questionnaires with ten farmers in the study area, the modification of the questionnaire was made by omission of irrelevant questions and addition of new relevant ones. More detailed information was collected at the farmer interviews using structured interviews. The questionnaire consisted of questions on farmer characteristics such as age, educational levels, and number of households, farm information, e.g. agricultural land holdings, type of species, source of livelihoods income and income source from each of the various sources. The farmer interviews were conducted face to face in people‘s homes and places of work. Questions were directed to each respondent by the interviewer. To every interviewee, the
purpose of the research and its importance was explained by the interviewer in order to build confidence in the participants to respond to all questions.

- **Focus Group Discussion (FGD):** Focus Group Discussion is a tool used to gather information through a discussion on a particular topic with a group of people (5-7 people) was selected for the discussion. For purpose of this study, the (FGD) were carried out by the researcher and field assistants. (A total of 5-7 participants including elder farmers and teachers. The FGD generated information on land uses patterns in the study area, and obtained a more detailed understanding of how the farmers have incorporated trees into their farming system and their role in livelihood strategy of farmers. Moreover the FGD extract some information, in particular on positive and negative consequences of trees management on farmland like benefits, threats, advantage and disadvantage.

- **Key Informants Interview (KII):** a number of key informants including, forestry officials, and head of community (called Omda) and farmer’s union members in Gedaref state were interviewed during the data collection. This discussion offered the opportunity to obtain further information and cross-check information given by the other respondents for validating the findings and revealing any ambiguities.

### 3.2.3 Data analysis

The type of data analysis to be conducted relies on the type of data collected, whether qualitative or quantitative data or both. However, the present study employed a combination of qualitative and quantitative methods to analyze the field data by using the Statistical Package for Social Survey SPSS Version 20 with the aid of Microsoft Excel version 2010. The data was analyzed using the following:

- **Descriptive Statistics:** Descriptive statistical methods were applied to data concerning socio-economic characteristics, perception and attitudes of
households towards establish and manage trees on their farms in form of frequency, percentage distribution.

- **Regression Analysis**: Linear regression analysis was applied to understanding a number of factors and their influence on farm household’s decision to retaining and/or planting and manage trees on their farms (see chapter 2, section 2.1, and figure 2.1) for an overview of various explanatory variables included in the linear regression used in the present study). This model has been widely applied in these kinds of studies (Thacher et al., 1997; Salam et al., 2000; Otsuka et al., 2001; Nkamleu and Manyong, 2005).

**Table 3.3**: Description of explanatory variables used in linear analysis for the tree adoption in the farmlands.

<table>
<thead>
<tr>
<th>Parameter name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>Age of head of household</td>
</tr>
<tr>
<td>EDU</td>
<td>Educational levels of head of household</td>
</tr>
<tr>
<td>HSIZ</td>
<td>Household size</td>
</tr>
<tr>
<td>FLND</td>
<td>Farmer land holding</td>
</tr>
<tr>
<td>FINC</td>
<td>Farmer's total household annual income</td>
</tr>
<tr>
<td>EXT from FNC</td>
<td>Extension services received from Forests National Corporation</td>
</tr>
</tbody>
</table>

For the present research, a number of contextual variables were regressed with the dependent variable (Y) to estimate the parameters (βi). The equation (population model) to be estimated based on following explanatory variables is as follows:

\[ Y_i = \beta_0 + \beta_1 (AGE) + \beta_2 (EDU) + \beta_3 (HSIZ) + \beta_4 (FLND) + \beta_5 (FINC) + \beta_6 (EXT \text{ from FNC}) + \epsilon \]

Where \( Y_i \) = the dependent variable; \( \beta_0 \) = the intercept term; \( \beta_1, \beta_2, \beta_3 \ldots \beta_x \) = regression coefficients associated with each explanatory variables; and \( \epsilon \) = the
error term. The qualitative dependent variable is planted tree area. Explanatory variables and justification are discussed below.

The independent variables (AGE) is the age of head of household, it was expected that a young head of household has a greater opportunity of adopting new activities (tree plantation) than an older head of household, because he is more willing to or capable of taking risks as suggested by Sidible (2005). Household head education (EDU) measures the level of education of the head. It takes the value 1, 2, 3, 4, 5, and 6 if no formal education or Khalwa\(^1\) education or completed primary, secondary level, or university level respectively. Education thus is expected to have a positive effect on the decision to adopt on-farm tree planting.

Household size (HSIZ), measure the number of people living in the household. It was expected that the larger number of household are more likely to adopt tree planting. Thus household with many members and with educated head, has higher probability of adopting tree planting (Buyinza, 2008). This similar situation occurs for farmers with a large land holding (FLND) and within a high income (FINC). It’s expected that farmers owing big portions of land may face less pressure to establish trees on their farms and this may negatively affect adoption of on-farm tree planting. Extension services from FNC (EXT from FNC), measure the contact of farmers with FNC and receive any kind of extension from FNC. It was hypothesized that (EXT) positively influenced farmer’s decision to establish and manage trees on their farmlands.

3.2.4 Computation of Cash Income from Different Farmer’s Livelihood Strategies
Descriptive analysis was applied to estimate the average cash incomes and their percentages to total household cash income. The cash income from different

\(^1\) Religious system in which Muslim learns Holy Goran and its studies
livelihood activities were averaged and converted to US $ using the conversion rate for Sudanese pound at the time of the survey (2015). The annual cash income from trees products was obtained by multiplying the amount of the products sold annually by mean price obtained from the local markets and interviews. Cash income from commercial farming was computed by multiplying the crop yields with their farm gate prices. Cash income from land renting was computed by multiplying the area of land rented with the price of Feddan renting. On the other hand cash income from livestock was obtained through the interview by asking the respondents to estimate their income from livestock if any. Cash incomes from remittances and off farm were excluded because the respondents mentioned that, they have no receive any remittances.
CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 General
This research focuses on contribution of retaining and/or planting trees on agricultural farms to the farmer's livelihood in Gedaref State. This chapter presents the results of descriptive statistics which were used to describe the farmers’ socio-economic characteristics in the study area (Table 4.1), and the results of regression analysis which were used to identify and analyze the factors affecting farmer's decision to retaining and/or planting trees on the farmland (Table 4.2). Moreover, the chapter will cover the results of contribution of trees to farmer's income (Table 4.3) and perception and attitudes of the farmers towards trees retaining and/or planting on agricultural farmlands (Table 4.4).

4.1.1 Socioeconomic Characteristics of the Farmers
Results in Table (4.1) shows that the average age of the head of household is 53.25 ± 1.8 Std.error, however, the majority of respondents (58.3%) were at age above 50 years (50-87 years), while only (11.7% and 30%) at age 18-38 years and 39-50 years respectively. This results indicated that, the elder farmers have gain a good experience in deal with trees on their farms, on the other hand this findings reflected that the absence of young people efforts. Hence the extension programs must conduct to target these groups of farmers concerning the trees planting on their farms.

The findings in Table (4.1) displayed that, the majority of respondents (94.4%) have attended educational levels ranging from Khalwa, primary, secondary and university (5%, 16.7%, 70%, 6.7%) respectively, while only 1.7% was illiterate. These results revealed that most of respondents have enough educational levels, hence they can easily understand and make use of the advanced extension
methods such as: lectures, seminars which can eventually enhance and increase their attention towards tree planting.

The results also show that the majority of respondents (61.7%) have owned land with average size of 139.65 ± 23.9 Std.error Feddan (fa). However, approximately (63.3%) of the respondents own less than 100 fa of land (33.3%) of the respondents own land ranging between 100-500 fa and only (3.3%) of the respondents have more than 500 fa of land. Thus a considerable number of farmers have very limited amount of farmland. The average of household size was 8 ± 0.16 Std.error members. Agriculture was the main source of income for approximately 90% of the households. The results in Table (4.1) show that, economic situation of the respondents (60%) were medium and (40%) were poor. These results revealed that the majority of farmers are in good economic situation to adopt tree planting.
### Table 4.1: Farmers' Socioeconomic Characteristic in the Study Area (n=60)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Household age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-38</td>
<td>7</td>
<td>11.7</td>
</tr>
<tr>
<td>39-50</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>&gt;50</td>
<td>35</td>
<td>58.3</td>
</tr>
<tr>
<td><strong>Average = 53.25 ± 1.8 Std.error</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Household size (No. of family members)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;8</td>
<td>35</td>
<td>58.3</td>
</tr>
<tr>
<td>8-15</td>
<td>20</td>
<td>33.3</td>
</tr>
<tr>
<td>&gt;15</td>
<td>5</td>
<td>8.3</td>
</tr>
<tr>
<td><strong>Average = 8 ± 0.16 Std.error</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Educational levels</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Khalwa</td>
<td>3</td>
<td>5.0</td>
</tr>
<tr>
<td>Primary</td>
<td>10</td>
<td>16.7</td>
</tr>
<tr>
<td>Secondary</td>
<td>42</td>
<td>70.0</td>
</tr>
<tr>
<td>University</td>
<td>4</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Land holding per household (Fa)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>38</td>
<td>63</td>
</tr>
<tr>
<td>100-500</td>
<td>20</td>
<td>33.3</td>
</tr>
<tr>
<td>&gt;500</td>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Average = 139 Fa ± 23.9 Std.error</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Land ownership</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner</td>
<td>37</td>
<td>61.7</td>
</tr>
<tr>
<td>Rented</td>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td>Inherited</td>
<td>17</td>
<td>28.3</td>
</tr>
<tr>
<td>Shared</td>
<td>4</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Basic occupation of household head</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer</td>
<td>49</td>
<td>81.7</td>
</tr>
<tr>
<td>Trader</td>
<td>1</td>
<td>1.7</td>
</tr>
<tr>
<td>Teacher</td>
<td>3</td>
<td>5.0</td>
</tr>
<tr>
<td>labor</td>
<td>3</td>
<td>5.0</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Source of family income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>54</td>
<td>90</td>
</tr>
<tr>
<td>Non-agriculture</td>
<td>6</td>
<td>10</td>
</tr>
</tbody>
</table>

*n = number of interviewees*  
**Source:** Field Survey (2015).
4.1.2 Farm Trees Management and Type of Species

During the field work the researcher observed that trees grow and regenerate naturally without any action from the farmer. However, the majority of farmers left trees to grow and spread on their own farms as a source of subsistence and cash income. The majority of the farmers (71.7%) do not apply any silvicultural operations with exception to (28.3%) who do thinning and pruning techniques. This means that the most common management activity is often limited to harvesting of trees products, hence improved extension activities are commonly recommended in order to enhance the success of tree retaining and/or planting and management (Roshetko et al., 2007). However, there are conflicting opinions between authors about the effect of knowledge on retaining and/or planting trees for instance, silvicultural operation, type of species and the spatial distribution of the tree on farmlands. Despite of a local or traditional knowledge of farmers on tree planting there is a general lack of knowledge and skills related to tree planting and management amongst farmers which is considered to be major constraint to successful tree retaining and/or planting on farmland (Pattana yak et al., 2013; Cossalter and Pye Smeth, 2003). The current tree species dominate in the study area are mainly Acacia senegal (Hashab), Acacia seyal (Talh) and Balanites aegyptiaca (Heglig). However, selection of appropriate species is one of the most important thing to be made and has strong influence on the success of tree planting efforts (Kallio, 2013). In the study area, it was observed that the spatial distribution of the trees on farmland is almost scattered trees and windbreaks. Farmers stated that pure hashab trees stand are dominant on their farm and rotate with field crops such as millet, sorghum, groundnut and sesame. According to the response of the majority of farmers, the popularity of hashab on their farmlands is due to the fact that Hashab tree is supporting the farmer with income form gum Arabic and firewood beside the agricultural crops.
4.2 Factors Affecting Farmer's Decision to Retaining and/or Planting Trees on their Farmlands

The results of the linear regression analysis table (4.2) show that, the household land size (FLND) \( (P = .000) \), Household total income (FINC) \( (P = .042) \) and household size (HSIZ) \( (P = .009) \) are the main factors that affecting farmers’ decision to adopt tree planting in the study area at 5% level of significance \( (P<0.05) \).

One of the variables that strongly influenced Farmers to retaining and planting trees was land size (FLND). This factor was highly significant \( (P = .000) \), (Table 4.2), and positively related with retaining and/or planting of trees. This finding could be explained by the land size being large enough for establishing trees with crop in the study area and this implies that households with large farmland are more likely to plant trees than those with small land or no land. However, this result is in agreement with Kulindwa (2016) in his study in Tanzania, found that the land size is the most important factors have significantly positive effects on households’ tree retaining and/or planting behaviour. Similarly, Ashraf et al. (2015) and Danquah (2015) conducted studies in India and Ghana, respectively, and found that farm size had a significantly positive influence on tree planting behaviour and its extent. This finding is in line with the study carried out by Fahmi et al (2015), who stated that, household with a large land size (100-399) Feddans showed particular interest in integrating trees with crop on their farmland.

The factors such as farmer's household size (HSIZ) and household total income (FINC) were also significantly associated with willingness of farmers to retaining and/or planting tree \( (P=.009, P=.042) \), respectively, (Table 4.2). However the effect of household size can be explained by the fact that small families more easily can meet their needs with small part of their land, while the large families have a better labour availability to work on the farm (Fahmi, et
In addition, there are more mouths to feed, and thus, more labour is channeled into crop cultivation (Yirga, 2007; Deressa et al., 2009). This result is consistent with Munner (2008) who found that the family size (≥11) members in North Kordofan, Sudan were more innovative in practicing agroforestry systems than family with small size. This finding is also reflects the results of previous studies, which indicated that more trees were planted when family sizes increased (Duguma and Hager, 2010; Gebreegziabher and Kooten, 2013). However, our results contradicts the result of several studies carried out by Kulindwa (2016) and Jenbere et al. (2012) which indicated that family size have negative impact on tree planting behaviour. Total household income (FTINC) however, significantly affected farmers’ tree retaining and/or planting. This finding could be explained by the fact that when a household has high income he or she will have a greater chance to make a better life including tree planting, because his/her economic conditions make him/her possible to take risk for adoption new activities and similar results were shown by Kakuru et al. (2014) who point out that households income is the main drives for adoption of on-farm tree planting in Kibaale district in western Uganda.

The other factors like age of head of household (AGE), educational levels (EDU) and extension services received from Forests National Corporation (EXT from FNC) did not have significant influence on household tree retaining and/or planting (Table 4.2). These findings in line with Kulindwa (2016) and contradicts with the result of Mekonnen and Damte (2011) who found that age of household heads and the level of education of the head have significant influence on tree planting behaviour.
Table 4.2: Factors Affecting Farmers‘Decision to Retaining and/ or Planting Trees on their Farmlands

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>Std.Error</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>112.027</td>
<td>165.304</td>
<td>.678</td>
<td>.501</td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>-2.471</td>
<td>1.608</td>
<td>-.185</td>
<td>-1.536</td>
<td>.130</td>
</tr>
<tr>
<td>HSIZ</td>
<td>13.183</td>
<td>4.828</td>
<td>.336</td>
<td>2.731</td>
<td>.009</td>
</tr>
<tr>
<td>EDU</td>
<td>20.452</td>
<td>26.930</td>
<td>.080</td>
<td>.759</td>
<td>.451</td>
</tr>
<tr>
<td>FLND</td>
<td>.245</td>
<td>.035</td>
<td>.708</td>
<td>7.050</td>
<td>.000</td>
</tr>
<tr>
<td>FINC</td>
<td>-.001</td>
<td>.000</td>
<td>-.213</td>
<td>-2.089</td>
<td>.042</td>
</tr>
<tr>
<td>EXT from FNC</td>
<td>-56.859</td>
<td>41.477</td>
<td>-.131</td>
<td>-1.371</td>
<td>.176</td>
</tr>
</tbody>
</table>

Note: Bold values contribute significantly at P<0.05

$R^2 = 0.557$
4.3 Contribution of Farm Trees to Farmer's Income

Cash incomes in the study area are generated from four major activities: (i) farm trees (US$ 1467), (ii) agriculture (US$ 2481), (iii) livestock (US$ 171) and land renting (US$ 893). The farmer's total annual average cash income in the study area was (US$ 5012). However, the results show that, the agriculture was the first most important contributor to farmer’s annual total cash income (52%) followed by forest products local trade (31%), land renting (13%) and livestock (4%) (Table 4.3).

These findings revealed that forest trees make significant contribution to total income of farmer in the study area. Although, trees on farms were not the main livelihood activity for the farmers, the income received from it was used for expected and unexpected expenditures including: income generation, domestic subsistence, safety net and livelihood security. These findings is reflect the results of previous studies which indicated that, the income gained from tree planting can contribute to farmers daily income and consumption and in many developing countries trees can also act as farmer saving accounts and safety nets (Van Noordwijk et al., 2007; Perdana et al., 2012). In the study area, however, income from farm trees is the second most important source of farmer's annual income when compared with land renting and livestock as main activities in the study area.
Table 4.3: Distribution of Household’s Income (US$) from Different Economic Activities in the Study Area (n= 60)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Annual total income US$</th>
<th>Annual average Income US$</th>
<th>% of contribution to total income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>148,876</td>
<td>2481</td>
<td>52</td>
</tr>
<tr>
<td>Farm trees (forest products)</td>
<td>88,060</td>
<td>1467</td>
<td>31</td>
</tr>
<tr>
<td>Land renting</td>
<td>38,440</td>
<td>893</td>
<td>13</td>
</tr>
<tr>
<td>Livestock</td>
<td>10,293</td>
<td>171</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>285,669</strong></td>
<td><strong>5012</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

n = number of respondents; 1US$ = 7.5 SP (Sudanese pound) at 2015.
4.4 Respondents' Perceptions and Attitudes towards Trees Retaining and/or Planting on their Farmlands

Results in Table (4.4) shows the benefits of trees on farms in the study area. These benefits include: income generation (95%), increase the productivity of agricultural crops (90%), increase availability of firewood (88%) and reduce damage of crops (80%). These high percentages of tree benefits indicated by the farmers obviously explain the fact that trees on farms provides farmers with additional source of income in terms of cash through selling of timber products and subsistence through non-timber products as well as reduction in crops damage and hence lead to enhance the productivity of agricultural crops. However, these findings are in line with to the work of several studies carry out in Nigeria, Tanzania and Zambia (Ajay et al., 2009) who reported that trees on farms improved crop yield and increase income through the sale of tree products such as fruits, firewood and poles, moreover in line with Muneer (2011) in Gezera scheme shelterbelts, who reported that, farmers whose farms are located close to shelterbelts have got high crop yield compared to farm located away from shelterbelts.

Meanwhile, the findings of the study (Table 4.4) revealed that the farmers have negative attitudes towards trees on farms. This negative attitude is coming from the idea that trees on farmlands are: increase pest outbreaks (78.3%) and ineffectiveness of the policies and laws regarding tree growing on farmlands (56.7%). These negative attitudes, however, could tract it to the legislation of the FNC which obliged all farmers on rain-fed schemes to conform to the allocation of 10% of their farmlands, for forestry (shelterbelt or forest cover). To safeguard against this negative attitude the FNC should activate this legislation, as observed through the interview and (FGD), that most of farmers gains this negative attitude due to the fact that some of farmers whose hold a large land
size and have not allocate this percent in compare with those have small land size. Moreover, the results shows that, all of respondent are aware about the importance of trees on farms as they bring rain and thus the majority of them (90%) have interested in planting trees regardless of their socioeconomic characteristics. Nevertheless the farmers have no idea regarding silvicultural operations of trees (71.3%) and less of them (28.3%) are personally conducted some of silvicultural practices (pruning and thinning), through their own experience. However, as mentioned by (Byron, 2001) a lack of technical knowledge or training is often one of factors that limiting farmers’ silvicultural activities application. Hence, the FNC must conduct and arrange extensive program and extension services to the farmers to be fully recognized the importance of proper silvicultural operations to improve their tree productivity, quality and quantity. Generally, the results showed that the respondents in the study area are aware of the benefits associated with tree retaining and/or planting and their attitudes towards tree retaining and/or planting mostly positive despite of the negative side of the forest polices and laws. This means that farmers associated more positive outcomes than negative ones from tree retaining and/or planting on farmlands. However, the attitudes are difficult concept to understand and measure, attitudes are a latent construct and as such. They cannot be directly observed (Milfont and Duckitt, 2010).
Table 4.4: Farmers Perceptions and Attitudes towards Trees Retaining and/or Planting on their Farmlands (n =60)

<table>
<thead>
<tr>
<th>Perceptions and attitudes towards trees planting on farms</th>
<th>Frequency and percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Planting trees on my land will increase my cash income</td>
<td>57</td>
</tr>
<tr>
<td>Planting trees on my land will reduce the damage crops</td>
<td>48</td>
</tr>
<tr>
<td>Planting trees on my land increase pest outbreaks</td>
<td>47</td>
</tr>
<tr>
<td>Planting trees on my land increase the productivity of agricultural crops</td>
<td>54</td>
</tr>
<tr>
<td>Planting trees on my land leads to water scarcity on my farmland</td>
<td>00</td>
</tr>
<tr>
<td>Planting trees on my land will increase the availability of firewood</td>
<td>53</td>
</tr>
<tr>
<td>Awareness of forest policy and law regarding tree planting on farmlands</td>
<td>44</td>
</tr>
<tr>
<td>Forest policies and laws towards trees growing on agricultural farms are effective</td>
<td>26</td>
</tr>
<tr>
<td>Awareness of silvicultural operations for trees</td>
<td>17</td>
</tr>
<tr>
<td>I have the will to grow trees on my lands</td>
<td>54</td>
</tr>
</tbody>
</table>
CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Some conclusions can be drawn from the analysis in this study as follow:

- The majority of respondents in the study area are of old age, educated and gain a good knowledge in dealing with trees in their farms. On the other hand, the study area has the absence of youth or young people efforts in this regard.
- The considerable number of respondents (63%) have limited amount of land (<100 Feddans) and the agriculture was the main source of income for approximately 90% of the sampled respondents.
- The most common type of trees in the study area is *Acacia senegal* (hashab) which is dominant but in the form of parklands trees and windbreak.
- The study concluded that farmer’s decision to retaining and/or planting trees on their farmlands rely on many factors which were important and have significant effect on tree adoption on farmland, including farmer land holding (FLND), household size (HSIZ) and household income (FINC).
- The main constraint or determinants factor was farmer land holding (FLND) to promote tree planting by farmers.
- The study findings illustrate that for farmers who are residing in the study area, trees on their farmlands make significant contribution to total income and is ranked as the second important source of income after agriculture.
- Trees on farmlands, however, provide about 31% of farmer's total income followed by land renting and livestock.
- Gum Arabic trees were the dominant and it is adding considerable amount of cash income to the farmers.
- The respondents in the study area are aware of the benefits associated with tree retaining and/or planting and thus their attitudes towards tree planting on
farmlands is mostly positive. This means that farmers associated more positive than negative outcomes from tree retaining and/or planting on their farmlands regardless of their socioeconomic characteristics.

- Although the various measures that were taken to cross-check and verify information on farmer's income, the accuracy of responses to qualitative question could sometimes not fully ascertained. This problem was attributed to farmer's low level of comprehension of numerical question, for instance, information on farmer's income. It is hence quite difficult to predict the extent to which the study findings can be applied in other areas of Sudan or land use.

**5.2 Recommendations:**

The study recommends that:

- To overcome the factors that confronting farmers to retaining and/or planting trees on their farms, land use policies and tree tenure problems must be solved.
- Forests National Corporation (FNC) must take the socio-economic characteristics of the farmers as essential in any tree planting programs in the study area.
- Government should introduce extension services to facilitate awareness process.
- Further studies can include the farm trees role in rural livelihoods of landholders from different regions of the Sudan to facilitate comparison and generalization of the findings.
REFERENCES


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Buyinza, M., & Wambede, N. (2008). Extension for agroforestry technology adoption: mixed intercropping of crotolaria (Crotolaria grahamiana) and


Muneer, S. E. T. (2011). Do tree shelter belts have the relative advantage to convince farmers to grow them: an empirical example from the Gezira Agricultural Scheme, Sudan? *Department of Agricultural Extension and Rural Sociology Faculty of Food and Agricultural Sciences King Saud University.*


APPENDIXES

FARMERS QUESTIONNAIRE

This questionnaire was designed to collection information about contribution of farm trees to farmer’s rural livelihoods in your area. The information will be utilized in research for M.Sc. degree. Please answer the following questions as accurately as possible. Where actual data are not available, please use your closest estimation. Your answers will be strictly confidential.

Thank you for your contribution.

Section 1: Identification

1.1 Name of Household head (Farmer) ..................................................

1.2 Name of Enumerator: .................................................................

1.3 Date of Interview: .................................................................

Section 2: Personal-demographic characteristics of the Farmers

2.1 Gender of household head?
   Male (   ) =1 Female (   ) =2

2.2 Age of household head ............... (Years)

2.3 In total how many people live in the household? ......................

2.4 Marital Status?
   Single (   ) =1 Married (   ) =2 Divorced (   ) =3 Widowed (   ) =4

2.5 Household head years of education?
   Illiterate (   ) =1 Khalwa (   ) = 2 Primary School (   ) =3 Secondary School
   (   ) = 4 university (   ) =5 other (   ) = 6

2.6 Household head main occupation?
   Farmer (   ) =1 Trader (   ) =2 Teacher (   ) =3 Laborer (   ) =4 Other (   ) =5

2.7 What is the wealth status of your household?
   Better-off (   ) =1 Average (   ) = 2 Poor (   ) = 3
Section 3: Resource endowments of the households (land holding and farm characteristics)

3.1 What is the total size of the land managed by household? 
………………………………………………………………………………. Fe

3.2 Land and Area

<table>
<thead>
<tr>
<th>Kind</th>
<th>Area / Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops</td>
<td></td>
</tr>
<tr>
<td>Trees</td>
<td></td>
</tr>
</tbody>
</table>

3.3 How was land managed by the household acquired?
Owned ( ) = 1 Rented ( ) = 2 Inherited ( ) = 3 Share ( ) = 4

3.4 Did the household renting the land before?
Yes ( ) = 1 No ( ) = 2

3.4.1 If yes, why? And what is the total value of income you received from it?
Reason? ……………….. Value of income? ………………………………………..SDG

Section 4: Farm trees plantation management

4.1 Household current trees plantation development activities

4.1.1 How many farm trees plantation plot do you won?
1 ( ) = 1 2 ( ) = 2 3 ( ) = 3

4.1.2 Indicate the size and year of establishing each of the farm trees plantation plots?

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Size (Fe)</th>
<th>Year of establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.1.3 What was the condition of the land when you first established your plantation?
Good condition (not degraded) ( ) = 1 slightly degraded ( ) = 2 Degraded ( ) = 3 other ( ) = 4
4.1.4 Name the trees species you have planted on your private land

<table>
<thead>
<tr>
<th>Tree No.</th>
<th>Name of tree species</th>
<th>Source of seedling or seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.1.5 What are silvicultural activities do you performed on your plantation farm?
- Pruning (   ) = 1
- Thinning (   ) = 2
- Singling (   ) = 3
- None (   ) = 4

4.1.6 What is the shape of agriculture?
- Scattered (   ) = 1
- Shelterbelts (   ) = 2
- live fence (   ) = 3
- other (   ) = 4

4.1.7 What are the benefits of trees?
1. 
2. 
3. 
4.

4.1.8 If there is any problems due to existing of trees on farm?
- Yes (   ) = 1
- No (   ) = 2

4.1.8.1 If (yes) what are the problems?
1. 
2. 
3. 
4.

4.1.9 What are the species do you prefer on farms?
1. 
2. 
3. 
4.

4.2 Market and prices for farm forest products

4.2.1 What are the products did you get from trees?
- Gum (   ) = 1
- Firewood (   ) = 2
- Construction materials (   ) = 3
- Non timber (   ) = 4

4.2.2 Do you have market for your farm forest products?
- Yes (   ) = 1
- No (   ) = 2

4.2.3 Do you have buyers for your farm forest products?
- Yes (   ) = 1
- No (   ) = 2
4.2.4 Indicate your level of satisfaction with the current prices paid for your plantation products

Very satisfied ( ) = 1      Satisfied ( ) = 2      Not satisfied ( ) = 3
Don’t know ( ) = 4

4.2.5 Indicate your perception about future demand for plantation products?

High ( ) = 1    Medium (same price as now) ( ) = 2    Low ( ) = 3
Don’t know ( ) = 4

4.2.6 Indicate what you think the future prices for plantation products

Increase ( ) = 1       Decrease ( ) = 2       Remain the same ( ) = 3
Don’t know ( ) = 4

4.3 Source of information regarding trees plantation development

4.3.1 Did you seek advice before establishing your farm trees plantation?

Yes ( ) = 1          No ( ) = 2

4.3.2 If yes, indicate where or from whom you got advice? ………………………

4.3.3 Did you received extension services from Forest National Corporation (FNC)?

Yes ( ) = 1          No ( ) = 2

4.3.4 Are you aware of the forest policy and law regarding the allocating of 10% for trees?

Yes ( ) = 1          No ( ) = 2

Section 5: Household livelihoods activities

5.1 Earning from other livelihood strategies

5.1.1 Indicate the type activities you sold in the last agricultural year, the quantity of crop harvested, the value of total income generated and the operational cost incurred.
## Livelihood activities

<table>
<thead>
<tr>
<th>Livelihood activities</th>
<th>Total income generated (SDG)</th>
<th>Estimated operational cost incurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02 livestock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03 Labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04 Remittance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05 Renting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06 Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2 **Earning from Trees planting**

5.2.1 How many percent did the forest products contribute on your income?
- 50%
- Greater than 50%
- Less than 50%

5.2.2 Indicate the type of activities you sold from trees planted in the last year, the type of product harvested, the quantity, price per unit, the value of income generated and operational cost incurred.

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
<th>Price per unit</th>
<th>Cost</th>
<th>Income</th>
<th>Net income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuelwood</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gum Arabic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Section 6: Perceptions and attitudes towards the trees management on Farms

With what of the following statements do you agree or disagree?

Planting trees on my land will reduce the damage of the crops?
- Yes ( ) = 1
- No ( ) = 2

Planting trees on my land increase the productivity of agricultural crops?
- Yes ( ) = 1
- No ( ) = 2

Planting trees on my land will increase my income?
- Yes ( ) = 1
- No ( ) = 2

I have the awareness of silvicultural operations for trees?
- Yes ( ) = 1
- No ( ) = 2

52
Planting trees on my land increase pest outbreaks?
  Yes ( ) = 1           No ( ) = 2

How do you perceive forest policies and laws toward trees growing and manage on agricultural farms?
  Effective ( ) =1      in effective ( ) =2

Planting trees on my land leads to scarcity of water on my land?
  Yes ( ) = 1           No ( ) = 2

Planting trees on my land will increase the availability of firewood
  Yes ( ) = 1           No ( ) = 2

I have the awareness of forest policy and law regarding tree planting on farmlands?
  Yes ( ) = 1           No ( ) = 2

I have the will to grow trees on my land?
  Yes ( ) = 1           No ( ) = 2