Sudan University of Science and Technology

College of Graduate Studies

Economics of Eucalyptus Private Forests

Case study: Nertitei and Zalingei – Central Darfur State – Sudan

اقتصاديات غابات الكافور الخاصة

دراسة حالة : محليتي نيرتتي وزالنجي – ولاية وسط دارفور - السودان

A thesis submitted for the fulfillment of the requirements of M.Sc. degree in Forestry Science.

By

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October -2020

Dedication

To my wide family, Father, mother, sister

And brothers

To my specific family, my wife, sons and daughter

To my supervisor

I dedicate this effort

Acknowledgement

Thanks and appreciation to my supervisor, ***Dr. Mohammed Osman Mohamed Ibniof***, for encouragement and guidance.

Thanks and appreciation to my colleagues in FNC of Central Darfur for their support.

Thanks and gratitude to the lecturers of Forestry and Range Science Collage-***SUST*** for their encouragement and support.

Special gratitude to my friends Abdalmottalib Adam ,Yasir Yasin, Hasan Altahir ,Dr.Abdalhai Mohammed Almadina and Dr. Musab Abdalla.

Thanks and great appreciation to the Forest Technician (Alhadi Adam) and the group of private forests owners in Nertitei and Zalingei Localities for their helpful collaboration.

ABSTRACT

Economic of Eucalyptus Private Forests Case Study of Nertitei and Zalingei Localities In Central Darfur State

This study was conducted during the period 2015 - 2017 in Nertitei and Zalingei localities purposely, because most of the Eucalyptus private forests of the central Darfur state found in those two localities.

The overall objective is to study the economic aspects of Eucalyptus private forests while the specific objectives were include: measuring the costs, production, return and highlighting the constraints which affect the production processes.

The study population consisted of 101rainfed Eucalyptus private forests, represented by a sample consist of six forests this sample classified into three categories according to area as follow; small area category (small size sample) <1 feddan, medium area category (medium size sample) 1- 4feddan and large area category (large size sample) > 4feddan. Each category area consists of 2 even age forests.

The primary data collected by means of field survey observations, personal interviews, and questionnaire. The sources of the secondary data were the records and reports of FNC and the relevant institutions, references and internet sites. The research followed the Descriptive Statistic Method. The social characteristic data about the owners and the general essential data about the forests were analyzed by use simple tabulation giving percentages. Excel computer program was used mainly for production and financial analysis. Specific forms (tables) were used for costs analysis, production and income as well as the specific equations. Money time value was considered in form; of future value (FV), present value (PV) and

net present value (NPV). Payback period (PBP) of establishment cost was calculated for every area category.The profitability for each category (sample) was evaluated through: Net present value (NPV), Benefit cost ratio (BCR) and Internal rate of return (IRR).

The most important results concluded in: All the respondents having an education ranging from Khalwa to University and they have medium or large family size.The owners established and managed their forests by their self-finance. The dominant Eucalyptus species in the private forests were *Eucalyptus citriodora*, *Eucalyptus umbulata* and *Eucalyptus camaldulensis*. The commercial production type in the private forests was the building poles. The harvest felling system in those forests was the selection felling system. All the forests started to give production after four years from the establishment year then continued annually. The financial analysis revealed that the establishment cost of the small and medium area categories paid back in the third production year that means after 7 years from the establishment year and for the large category paid back in the second production year that means after 6 years from establishment year. The average annual productivity of the private forest was 607 building poles per feddan. The highest cost of the fixed costs was the land purchase while the highest costof the variable costs was the harvest cost. NPV of small area category was 6497.49 SDG; the medium area category was 7824.6 SDG and 19606 SDG of large area category. BCR of the small area category was 1.06; of the medium area category was 1.12 while BCR of large area category was 1.26. IRR results were as follow: 37.43% of small area category, 42.98 of medium area category and 44.69 of the large area category, thus all the forests of the three categories were profitable and economically feasible; the large area category was the most profitable one. The instable security situation; the expensive government fees and lack of agricultural financial institutions were the most important constraints. Therefore, the study

recommendations were to build capacity of the owners, technically and financially, to establish professional associations for the owners and introduce fire wood production in the production rotation, and to raise the awareness of the decision makers in the state and localities governments about the environmental and economic value of the private forests.

مستخلص الدراسة
اقتصاديات غابات الكافور الخاصة

دراسة حالة : محليتي نيرتتي وزالنجي بولاية وسط دارفور

أجريت هذه الدراسة خلال الفترة من 2015– 2017م في محليتي نيرتتي وزالنجي بولاية وسط دارفور غرضيا لتواجد غابات الكافور الخاصة في هاتين المحليتين. يهدف هذا البحث إلى دراسة الوضع الاقتصادي لغابات الكافور الخاصة ، من خلال أهداف تفصيلية هي : حساب التكاليف ، حساب الإنتاج ، حساب الدخل ، تسليط الضوء على العقبات التي تؤثر على العمليات الإنتاجية . مجتمع الدراسة شمل 101 غابة كافور خاصة مطرية مثلت بعينة شملت 6 غابات قسمت إلى ثلاثة فئات حسب المساحة : هي الفئة الصغري < 1 فدان ، الفئة الوسطي 1–4 فدان ، الفئة الكبري> 4 فدان . كل فئة مثلت بغابتين مستاويتي العمر.

شملت وسائل جمع البيانات الأولية : ملاحظات المسح الميداني, المقابلات الشخصية و الاستبيانات . مصادر البيانات الثانوية كانت تقارير وسجلات الهيئة القومية للغابات وبعض المؤسسات ذات الصلة ، المراجع ومواقع الإنترنت.

اتبع هذا البحث المنهج الوصفي الإحصائي, حللتٍ البيانات الاجتماعية والشخصية لأصحاب الغابات والبيانات الأساسية عن الغابات الخاصة بواسطة جداول بسيطة لتحديد النسب المئوية للتكرارات. استخدم برنامج اكسل للتحليل بالحاسوب، لتحليل بيانات الإنتاج والبيانات المالية, صممت جداول خاصة لتحليل الإنتاج ، والتكاليف ، الدخل بالإضافة إلى استخدام معادلات رياضية خاصة مع اعتبار القيمة الزمنية للنقد (القيمة المستقبلية ، القيمة الحالية ، صافي القيمة الحالية). تم حساب فترة سداد تكاليف الانشاء لفئات المساحة الثلاثة. تم تحديد حالة الربحية بثلاث معايير هي صافي القيمة الحالية ، معدل الفائدة إلى التكاليف ومعدل العائد الداخلي .

أهم النتائج التي خلصت إليها الدراسة : كل المبحوثين تلقوا تعليماً بمراحل تعليمية تتراوح من الخلوة الي الجامعة كما انهم يعولون أسر متوسطة أو كبيرة ، كل الغابات إنشئت بتمويل ذاتي من مالكيها.انواع الكافور

السائدة في الغابات الخاصة هي كافورستريودورا وكافور أمبلاتا وكافور كمالديولينسس.الإنتاج التجاري للغابات الخاصة هو أعمدة البناء. نظام القطع المستخدم في الحصاد هو القطع الانتخابي. يبدأ الإنتاج بعد اربعة سنوات من تاريخ الإنشاء وبعد ذلك يستمر سنوياً.

تم سداد تكاليف الإنشاء لغابات فئتي الساحة الصغرى و الوسطى في السنة الثالثة للإنتاج اى بعد سبعة سنوات من الانتاج.تم سداد تكاليف الانشاء لغابات فئة المساحة الكبرى في السنة الثانية للانتاج اى بعد ستة سنوات من الانشاء . متوسط الإنتاجية السنوية (607) عمود بناء للفدان ، قيمة الأرض هي أعلى التكاليف الثابتة . تكاليف الحصاد هي أعلى التكاليف المتغيرة . اظهرت النتائج ان كل الغابات بفئات المساحة الثلاثة تعتبر ذات جدوى اقتصادية و استثمار مقبول ومربح. صافي القيمة الحالية للفئة الصغرى كان 6497.49 جنيه و اما في الفئة الوسطى فقد كان 7824.6 جنيه و19606 جنيه للفئة الكبرى . اما نسبة المنافع الى التكاليف فقد كانت1.06 في الفئة الصغرى ,1.12 للفئة الوسطى و 1.26 للفئة الكبرى . معدل العائد الداخلي للفئات الثلاثة فقد كان كالاتي : 37.43% للفئة الصغرى , 42.98% للفئة الوسطى و 44.98% للفئة الكبرى , علية فان الفئة الكبرى هى الاكثر ربحية

أهم المعوقات هي : عدم استقرار الوضع الأمني, الرسوم الحكومية الباهظة على الإنتاج و قلة مؤسسات التمويل الزراعي .

خرج البحث يتوصيات أهمها بناء قدرات اصحاب الغابات الخاصة فنيا و اداريا و تكوين جمعيات لمنتجي الغابات الخاصة. رفع وعي صانعي القرار في حكومة الولاية وحكومات المحليات بالقيمة البيئية والاقتصادية للغابات الخاصة ، إعفاء الغابات الحديثة الإنشاء من عوائد الغابات للسنوات الثلاث الأولي من الإنتاج . إدخال انتاج حطب الوقود في الدورة الإنتاجية لتنويع الإنتاج

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Abbreviations

BCR	Benefit Cost Ratio
cm	Cent meter
Dbh	Diameter at breast height
Eq	Equation
FAO	Food and Agricultural Organization
FC	Fixed cost
FNC	Forest National Corporation
FV	Future cost
FRA	Forest Resources Assessment
HTS	Hunting Technical Services
IRR	Internal Rate of Return
JMDRP	Jebal Marra Rural Development Project
NGOs	Non-Government Organizations
NPV	Net Present Value
P	Profit
PBP	Payback period
PV	Present value
SDG	Sudanese Pound
TC	Total cost
TR	Total revenue
VC	Variable cost

CHAPTER ONE

Introduction

1.1 General :

As of 9th July 2011 Sudan split into two countries namely the Republic of Sudan and the Republic of South Sudan.

The Republic of the Sudan retains an area of 1,886,000 Km^2 and some 50% of the forest woodlands pre-July (Abdalla Gaafar.2011).

Sudan Forests play a key role in people's lives by providing important services to support their livelihood. Most of the population about 66% live in rural areas and depend on forests for fire woods as source of energy and provide timber for housing construction and furniture, forest provide non wood products that include fruits, seeds, gums, resins, fibers, fodders, medicine and raw materials for local industries, and contribute to the protection of agricultural crops and increase their yields. Thus plays a role in food security and rural development. The forest is a habitat for many species of plants and animals and play important role in protecting the environment through its impact on soil and rain, wind and its relation to climate change and through its work as carbon sink. (FNC, 2013)

Geographical Classification of Sudan Forests:

The Sudan forests geographically are distributed as follows:

Desert Region: in the northern parts of the country and is limited to vegetation rarely around water courses. Annual rain fall 0 -75 mm.

Semi desert region: vegetation types are herbs scattered bushes or truck, annual rain fall 75 -300 mm.

Low rain fall savannah: vegetation type of Acacia species in dry northern area and mixture of deciduous species such as *Combretum spp*,

Terminalia brownii in the southern part where it is most moisture annual rain fall from 300-900mm.

High rain savannah: vegetation mostly of deciduous species such as *Khaya senegalensis*, annual rain fall 900-1000mm.

Mountainous region: Jebal Marra in the west and red sea heights in the east, annual rain fall 500-1000mm. (www.fnc.gov.sd.2013 .

Classification of Forest according to authority bodies:

The forests are classified according to authority bodies those belong and manage it to the following groups:

Governmental reserved forests (that type of the forest which is belonged and managed by government)

Institutional forest (that type of the forests which is managed by the owner institutions)

Community forests (that type of the forests which is belonged and managed by certain communal groups or categories or village counsels).

Private forests (that type of the forest which is managed by the owners)

Definition of the private forest:

The private forest can be defines as a kind of forest that managed by individual owners who make use of the benefits which they get out of it (FNC. west Darfur, 2008).

The situation of the communal forestry in Sudan:

In Sudan the government monopolized most of the forestry management, there are only small opportunities for communal and private forest management, so for successful development in the field of the forest management a great care should be given to communal and private participation in forest management (FNC, West Darfur, 2008).

1.2 **Research Problem**: the ecological conditions of the area, the traditional knowledge, experience of the local community about the

trees represent an essential helpful factors, of the social forestry in spite of that there are some problems and difficulties hindering the development of the private forest. There are lacks of studies about this subject in the study area even though it is of a high importance. Due to Darfur conflict thousands of people lost their income resources as a result of that many of them practice illicit cutting of trees and charcoal making as income resources, therefore it is necessary to think about alternatives income generating activities to help them in raising their incomes and life level and combat poverty. So private forest can be one of those alternatives. The research tries to explain those constrains with more focusing on economical sides and suggest the solutions in order to make the private forest participate in a real community development, based on simple and sustainable economy. How to develop and encourage the diffusion of the idea of the private forest as livelihood activity in the research area?

1.3 **Objectives** :

1.3.1 **General Objective**: to study economic aspects of (*Eucalyptus*) private forest and to highlight the trend of the private forest.

1.3.2 Specific Objectives:

i. To measure the costs (establishment cost and variable cost).

ii. To measure the production and determine the production rotation

iii. To measure the return.

iv. To highlight constrains that affect on the production processes of the Eucalyptus private forest.

v. To analyze the economic situation of the Eucalyptus private forest.

vi. To come to recommendations to enhance the Eucalyptus private forest development.

1.4 **The research questions**:

(1) What are the costs?

(2) What are the forest operations?

(3) What are the returns?

(4) Are the forests profitable or not?

(5) What are constrains that hindering the production processes of the Eucalyptus private forest?

CHAPTER TWO

LETRETURE REVIEW

2.1 Forest in Sudan

Sudan forest area had been declined from 21.83 million hectares in year 2000 to 18.74 million hectares in 2015 (about 9.97% of Sudan area).the annual removal rate declined from 257.86 thousands hectares to 174 thousand hectares during the period (2011 - 2015).The total of the reserved forest area in Sudan is 12.6 million hectares (6%) of Sudan area. About 22.5% of Sudan area that targeted to be reserved according to forest policy , for this condition it had been necessary to planting forest cover reach to the targeted percentage (20% of Sudan area)according to the current policy (about 37.8 million hectares). (FNC. 2014)

Table (2.1) Forests area and annual removal rates

Year	***1990***	***2000***	***2005***	***2010***	***2015***
Annual Removal rates (1000 hectares)	989	589	271	271	174
Forests areas	76,38	70,49	70,22	69,95	19,21

(FNC. 2014)

Table (2.2) land uses in Sudan.

Land uses	***Bare land***	***Range***	***Agriculture***	***Forest cover***	***Water***	***Citizen area***
percentage	47%	26%	15%	11%	0.17%	0.83%

(FNC. 2014)

2.2 Vegetation of the Sudan:

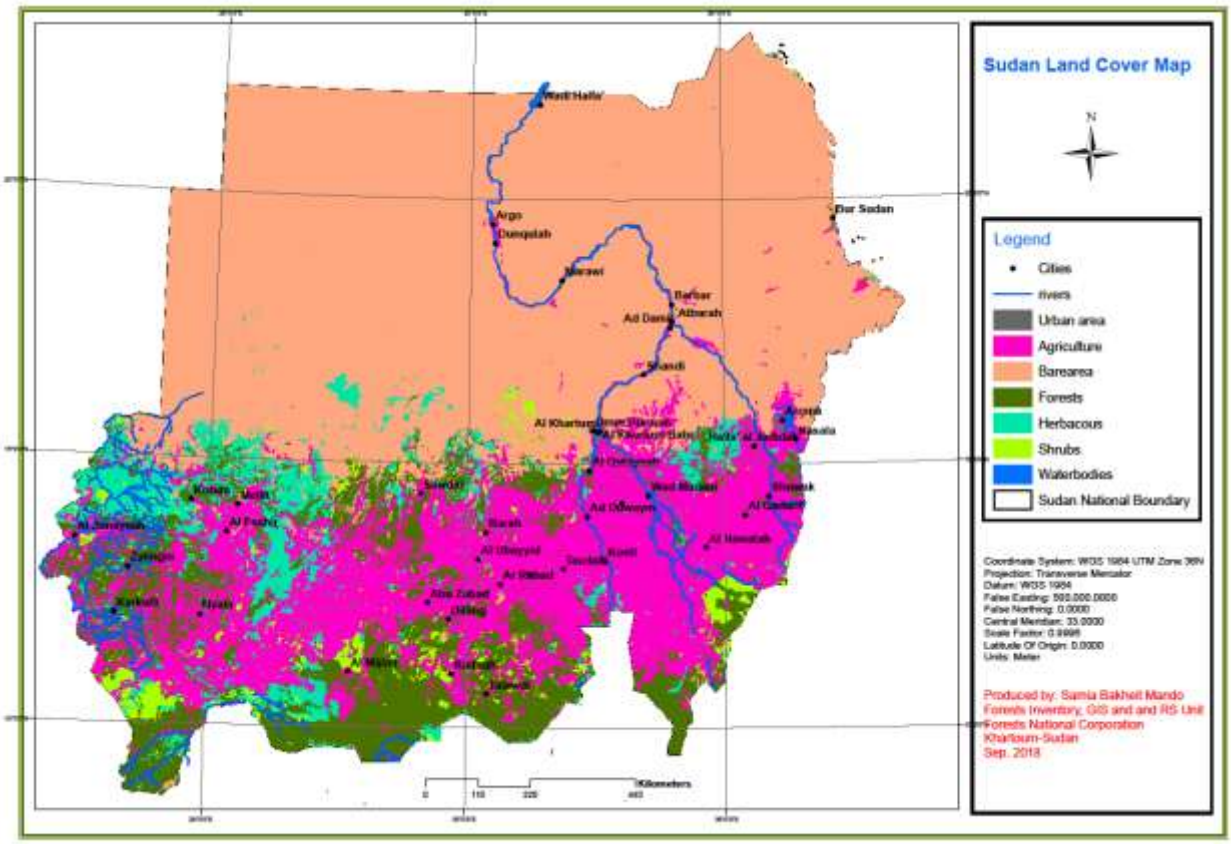
Abdalla Gaafar. 2011 reported that the ecological classification of forest and wood land in the republic of the Sudan is that:-

Desert: - 727000Km^2 represent 38.6% of Sudan area

Semi – desert: 496000km^2 represent 26.3% of Sudan area

Low rain fall Savanna 517000km^2 represent 27.4% of Sudan area.

High rain fall savanna 17000km^2 represent 0.9% of Sudan area Special areas 129000km^2 represent 6.8% of Sudan area.



Sudan Land Cover Map (1)

2.3 Social Forestry activities in Sudan:

Small scale community woodlots, including that any user groups, women and schools, etc. undertaken in common land or land leased out to the user groups. Farm forestry (including planted in the compounds …etc.).

Tree planting in compact blocks under taken by institutions like agriculture corporations in irrigated areas – protection and aesthetic planting (includes shelterbelts, wind break, urban forestry etc.) undertaken on government land by government with local level participation.

Rehabilitation of degraded an abandoned farm lands by individuals, communities and companies with involvement of government.

Cultivation of gum Arabic trees by individuals and group on own land or land leased to them from government (Talaat D.A.Magid and Elsiddig).

2.4 Contribution of the forests in Sudan national economy:

It is very difficult to calculate the contribution of forest resource in countries especially in under developing. In Sudan the ministry of finance the forest sector contribution in the total national product by (3.3%) depending on the revenue of forest exported product although the forest contributes with (69%) of the total energy consumption in Sudan. Also the forest provides the national cattle by 30-70% of it fodder in rainy and dry season. Forest employs about (15%) of rural labors, approximately forest covers all the country needs of hard timbers.

The forests have many advantages through its role in supporting agricultural and animal production, supporting food security, reducing poverty rate and environment reservation. (FNC, 2014)

2.5 Social forestry concept and definition: -

Social forestry is a term applied to trees planting or natural forests management designed to meet forestry – related basic needs of rural people.

Social forestry had been defined as encompassing "any situation which intimately involves local people in forestry activities for the direct benefit of those people ".

Sudanese Social Forestry Society defined social forestry as the involvement of the different sectors of the society in planning, management and protection of forests (Talaat D.A and Elsiddig.2003).

2.6 The history of the private forest in Jebal Marra Rural Development Project area.

The terminology of (Rural Forestry) which is the more accurate in the case that targeted the small farmers that plant the trees either in their farms or in houses yard than the terminology of (social forestry) which include forestation activities of institutes , town streets, high ways, shelterbelt in mechanized agricultural schemes. The early beginning of rural forestry program in Jebal Marra Rural Development Project (JMRDP) was in season (81-1982) by production of *Faidherbia elbida* seedlings for valley's rehabilitation in the area whenever observed that most of *Faidherbia elbida* trees which cover the valley's area are old and threating to be extinct because the absence of the natural regeneration. Fuel wood assessment was carried during the season (1982-1983) and as

a result of this assessment (JMRDP) involve in the program of collective woodlots in some villages by planting of Eucalyptus trees. The two experiments did not gave a mentioned success so (JMRDP) carried other assessment to evaluate the experiments in the beginning of 1985. Its result showed that the local community does not prefer the collective work because they have a negative impact about the experiment of the cooperative mills in their village, most of them clear that they prefer to plant the trees privately, so the program changed to encourage the individuals to plant Eucalyptus and *Ziziphus spp* trees privately in or around their farms or in or around their houses yard.

The program began with limited number of villages but it expand at the end of 1980s when the first pioneers produced their first product of eucalyptus poles and gained profitable revenue that encourage the others to follow them. At the beginning of the 1990sJabalMarra Rural Development Project (JMRDP) encouraged some farmers for establishing their private forest nurseries by providing them by tools materials and technical knowhow. (Abdalhameed. 1998)

2.7 Eucalyptus in Sudan:

The first eucalyptus species that introduced in Sudan was *Eucalyptus microtheca*. It was introduced in 1922 by Mr. Massey (Government Botanist) from South Africa from the seed of this introduction a plot was planted on Gazira Agricultural Research at Wad Madani in 1932.

The result was very encouraging and the species tried under irrigation on heavy clay soils. In Jebel Marra eucalyptus was introduced in year 1958 for production of poles, fuel wood and watershed management in deep volcanic soils (Bayoumi.1985).

2.8 *Eucalyptus camaldulensis* Dehn:

Tall tree up to 30 m high, bark smooth deciduous, usually white or ash – colored, sometimes with reddish – pink tinge, rough at base of bole brownish, flaking in plates. Juvenile leaves Lanceolate, 12 – 22x1.5-3.5cm, aromatic, coriaceous; petioles about 2cm long, pink, glabrous. Inflorescence more than 7- flowered umbels; peduncles terete 10- 15mm long; operculum conical to rostart 1.5-2.5 times longer than the goblet – shaped calyx tube; another versatile obviate; opening in barrel slits; dorsal gland small, obviate, small globular. Fruit is hemispherical to broadly turbinate 7 - 8 x 5- 6 mm. Flowers in Darfur (Jebal Marra) and Equatoria Sept- Des. fruit October -December : Native of Australia grown in forest plantation in Darfur (J. Marra, Mortegello, Nyrtete)/ Blue Nile and a shelter belts in Khartoum Green Belt.(D. Hamza-1990).

2.9 Eucalyptus citriodora

It is a large tree up to 50m high Bark smooth deciduous. Leaves lemon – scented , alternate , narrow to board Lanceolate, 10 – 16x1-2cm. Inflorescence termindcorymbose, 3-5 flowered umbels on terete peduncles 5-7mm long; operculum hemispherical, shorter than the calyx tube ; another obviate, ovate, Fruit Lanceolate, contracted into short thick neck, pedicel late, about 10x10 mm. Flowers June – July, native of Australia, will grow in deep soils with high water table and in wind sheltered localities (Hamza.1990).

2.10 Eucalyptus species:

Eucalyptus is a diverse genus of flowering trees and shrubs in family myrtaceae, member of the genus dominate the tree flora of Australia. There are more than 700 species of eucalyptus, mostly native

to Australia, and very small number found in adjacent area of New Guinea and Indonesia. Only fifteen species occur outside Australia, with just nine of these not occurring in Australia. Species of eucalyptus are cultivated widely in tropical and temperate world, including the Americas, Europe, Africa, Mediterranean Basin, the Middle East, China, and the Indian subcontinent, though most species do not tolerate frost.(Sellers,C.H. 1910).

The generic name is derived from the Greek words ευ (eu) "well" and καλύπτος (kalýpto) "covered", referring to operculum on the calyx that initially conceals the flower. (Gledhill, D. 2008).

2.10.1 Size and habit:

A mature eucalyptus may take the form of a low shrub or a very large tree. There are three main habits and four size categories that species can be divided into as generalization "Forest trees" are single-stemmed and have a crown forming a minor proportion of the whole tree height. "Woodland trees" are single-stemmed, although they may branch at a short distance above ground level.

"Mallees" are multi stemmed from ground level, usually less than 10 m in height, often with the crown predominantly at the ends of the branch lets and individual plants may combine to form either an open or closed formation. Many mallee trees may be so low-growing as to be considered a shrub.

Tree sizes follow the convention of:

- Small - to 10 m in height
- Medium sized - 10–30 m

- Tall- 30–60 m
- Very tall- over 60 m (Brooker & Kleining .2006)

2.10.2 Leaves:

Nearly all eucalyptus species are evergreen, but some tropical species lose their leaves at the end of the dry season. As in other members of the myrtle family, eucalyptus leaves are covered with oil glands. The copious oils produced are an important feature of the genus. Although eucalyptus trees are usually towering and fully leafed, their shade is characteristically patchy because the leaves usually hang downwards.

The leaves on a mature eucalyptus plant are commonly Lanceolate, petiolate, apparently alternate and waxy or glossy green. In contrast, the leaves of seedlings are often opposite, sessile and glaucous.

Four leaf phases are recognized in the development of a eucalyptus plant: the ‘seedling’, ‘juvenile’, ‘intermediate’, and ‘adult’ phases. However, there are no definite transitional point occurs between the phases. The intermediate phase, when the largest leaves are often formed, links the juvenile and adult phases (Brooker &Kleining, 2006).

2.10.3 Flowers:

The most readily recognizable characteristics of eucalyptus species are the distinctive flowers and fruit (capsules or "gum nuts"). Flowers have numerous fluffy stamens which may be white, cream, yellow, pink, or red; in bud, the stamens are enclosed in a cap known as an operculum which is composed of the fused sepals or petals, or both. Thus, flowers have no petals, but instead decorate themselves with the many showy stamens. As the stamens expand, the operculum is forced off, splitting

away from the cup-like base of the flower; this is one of the features that unite the genus. The woody fruits or capsules are roughly cone-shaped and have valves at the end which open to release the seeds, which are waxy, rod-shaped, about 1 mm in length, and yellow-brown in color. Most species do not flower until adult foliage starts to appear. (https://id.biodiversity.org.au/instance/apni/455721).APNI.2015

2.10.4 Bark:

The appearance of eucalyptus bark varies with the age of the plant, the manner of bark shed, the length of the bark fibers, the degree of furrowing, the thickness, the hardness, and the color. All mature eucalypts put on an annual layer of bark, which contributes to the increasing diameter of the stems.

Different types of bark that are commonly recognized include: Stringybark — consists of long fibers and can be pulled off in long pieces. It is usually thick with a spongy texture.

- Ironbark — is hard, rough, and deeply furrowed. It is impregnated with dried Kino (a sap exuded by the tree) which gives a dark red or even black color.
- Tessellated — bark is broken up into many distinct flakes. They are corkish and can flake off.
- Box — has short fibers. Some also show tessellation.
- Ribbon — has the bark coming off in long, thin pieces, but is still loosely attached in some places. They can be long ribbons, firmer strips, or twisted curls. (Brooker & Kleining, 2006).

2.10.5 Cultivation and uses:

Some eucalyptus species have attracted attention from horticulturists, global development researchers and environmentalists because of desirable traits such as being fast growing sources of wood, producing oil that can be used for cleaning and as natural insecticide, or an ability to be used to drain swamps thereby reduce the risk of malaria. Outside their natural ranges, eucalyptus species are both lauded for their beneficial economic impact on poor population and criticized for being "water - guzzling" aliens.(Luzar.J.2007)

In Portugal and also Spain, eucalyptus has been planted in pulpwood plantations. Eucalyptus is the basis for several industries such as sawmilling, pulp, charcoal and others. Eucalyptus have many uses which have made them economically important trees, have become a cash crop in poor area as Timbuktu, Africa and Peruvian Andes (Luzar J. 2007 & World watch institute 2007).

Due to their fast growth, the foremost benefit of these trees is their wood. They can be chopped off at the root and grow back again.

They provide many desirable characteristic for use as ornament, timber, firewood and pulpwood. It also used in a number of industries, from fence posts and charcoal to cellulose extraction for biofuels. Fast growth also makes eucalyptus suitable as windbreaks and to reduce erosion.

Eucalyptus draws a tremendous amount of water from the soil through the process of transpiration. They have been planted (or replanted) in some places to lower the water table and reduce soil salivation. Eucalyptus have also been used as a way of reducing malaria by draining the soil in Algeria, Lebanon, Sicily, elsewhere in Europe, in Caucasus (Western Georgia) and California (Mrs. M, Grieve. 2005).

2.10.6 Pulpwood:

Eucalyptus is the most common short fiber source for pulpwood to make pulp. The fiber of eucalyptus is relatively short and uniform with low coarseness compared with other hardwoods commonly used as pulpwood (Nanko, Hirko, button, Allan, Hillman, Dove, 2005).

2.10.7 Eucalyptus oil:

Eucalyptus oil is readily steam distilled from the leaves and can be used for cleaning and as an industrial solvent, as an antiseptic, for deodorizing, and in very small quantities in food supplements, especially sweets, cough drops, toothpaste and decongestants. It has insect repellent properties (Jahn, Cary. 1991).

2.10.8 Honey:

The nectar of some eucalyptus produces high quality monoclonal honey.

2.11 Economics:

2.11.1 Definitions of Economics: according to Konna & Makki. (2005) the most acceptable definition among most of the economists is that which say (one of the social sciences which search in the human productive behavior in the society through the relationship between unlimited needs and scarce production resources that have multi alternative uses to achieves more efficient satisfaction to this needs .

2.11.2 Economic Objectives:

According to konna and Makki (2005) Economics concentrate in achieving the following essential objectives:

1. Price stability.
2. Fair distribution of the income.

3. Keep the unemployment in low rate.
4. Economical satisfaction achievement.
5. Economic growth achievement.

2.11.3 Forest economics:

Forest economics are the application of economic principles to a wide range of subjects extending from management of the various forest resources through the processing, marketing and consumption of forest products.

(http://www.thecanadianecyclopedi.ca/en/article/foresteconomics/2006)

2.11.4 Forestry from an economic view point:

Forests are economic resources because we can use them to help produce goods and services that people want to consume. This is the definition of economic resources (or" factors of production" as they are called in economic text books) – things in limited supply that be combined with other things to produce product and services that consumers want thus, we can make use of a forest, combined with some labor and other input, to help produce consumer product such as housing, newspapers, fuel wood, outdoor recreation and environmental service. It is this usefulness of forests that make them valuable economic resources.

Forest economic deals more narrowly with choices about other factors of production, such as labor capital are used in forest production, utilization and conservation, and what and how much forest economic applies the discipline of economics to decision making in forestry and converse whole forest sector. (Daowei, Peter, 2011).

2.11.5 Basic economic questions for forestry management:

Every society must deal with three fundamental economic questions. Given it's a limited endowment of productive resources and unlimited wants that they must serve a society must somehow make decision about:

- Which good service, of the almost infinite variety that it is technically possible to produce with their resources, will actually get produced, and in what quantities.
- Which of the producing each good and service will be adopted in each case
- How the goods and services produced will be distributed among member of the society. (Daowei & Peter, 2011)

2.11.6 Production

According to Kona & Maki, (2005):-

The production is a process of converting the things from its present from to another form of more efficiency to satisfy the utility:

2.11.6.1 Production factors:

The factors of production are the building blocks of the economy; they are what people use to produce goods and services. Economist divided the factors of production into four categories: land, labor, capital and entrepreneurship.

2.11.6.2 Land:

Land, but it includes any natural resources used to produce goods and services. This includes not just land, but anything that comes from land. Those natural resources can be renewable, such as forest, or nonrenewable such as oil and gas. The income of the resource that owners earn is return for land resources in called rent.

2.11.6.3 Labor:

Labor is the effort that people contribute to the production of goods and services. The income earned by labor is called wages and is the largest source of income for most people.

Labor refers to human input invested in production process.

2.11.6.4 Capital:

Capital includes types of property such as building humans use to produce goods and services. The income earned by owners of capital resources in interest.

2.11.6.5 Entrepreneurship:

An entrepreneur in a person who combines the other factors of production – land, labor, and capital – to earn profit like labor, entrepreneurship in a human input factor but it refers to more than just work; it refers to creativity needs to start a business, develop new goods and services, or improve on the development and distribution of existing product.

(http://www.shmoop.coom/economic-principles/factors-production.html).2006.

2.11.7 Production Function:

The relationship between quantity of inputs used to make good or service and quantity of output of that good or service is called the production function.

2.11.8 Total Production:

It is the total production that obtained from one production factor at different levels with assumption that other factors quantities fixed.

2.12 Revenue:

2.12.1 Total Revenue (TR):

Amount received for sale of all the product units (outputs).

2.12.2 Average Revenue:

It is revenue rate received to producer from sale certain quantity of commodity.

2.13 Costs:

2.13.1 Concept and Definition:

It is amount which is paid to the different production factors for its contribution in production process, some paid to fixed production factors and other paid to variable production factors.

2.13.2 Fixed Costs (FC):

The amount paid to the fixed production factors, and it do not vary in value with quantity of outputs variation.

(FC) = number of fixed input units * unit price .(Almahal,2005)

2.13.3 Variable Costs (VC):

The amount that paid to variable production factors, and it increase with the increase of the outputs and decrease with the Decrease of the outputs (Almahal, 2005).

(VC) = number of variable input units * price.

2.14 Profit:

2.14.1 Profit Concept:

According to accountancy perspective it is the difference between the revenue and the other cost not the profit after recovers all cost, thus it not consider a return or functional income like wages rent and interest (production factors returns) where the firm can a chive loss or the profit may be zero.

In economic perspective, profit is the entrepreneur earn, and must calculate within the cost, it is the normal profit that actualize in the make of perfect competition, and represent the different between the revenues and costs which include this profit.(Almahal, 2005).

2.14.2 Profit Formula:

Profit or gain = S.P – C.P

Where: S.P. is the price at which the article is sold. C.P is the price at which the article is purchased (NBA crystal Ball, 2015)

2.15 Cash Flow:

Cash flow is a net amount of cash and cash equivalent moving into and out a business. Positive cash flow indicates that the company's liquids assets are increasing, enable to settle debts, reinvest in its business, return money to shareholders, pay expenses and provide a buffer against future finance challenges. Negative cash flow indicates that a company's liquid assets are decreasing. Net cash flow is distinguished from net income. Which includes account receivable and other items for payment has not actually been receivable and other items for payment has not actually been received. Cash flow is used to assess the quality of company's income, that is how liquidity in, which can indicate whether the company is positioned to remain solvent.

(www.investopedia.com/terms/c/cashflow.asp). 2015.

2.16 Interest Rate:

2.16.1 Simple Interest:

The simple interest formula is used to calculate the interest accrued on loan or savings account that has simple interest. The simple interest formula is fairly simple to compute and to remember.

S= P (r) (t)

Where s = simple interest

P = principal

r = rate

t = time (www.financeformula.net/simple-interest.html).2015.

2.16.2 Compound Interest:

The compound interest formula calculates the amount of interest earned on account or investment where amount earned in reinvested. By reinvesting the amount earned, an investment will earn money based on effect of compounding.

$C = P\left[(1 + r)^n - 1\right]$

Where

C = compound interest.

P = principal (Original balance).

r = rate pre period. (www.financeformula.ne/compound-interest.html).2015.

2.17 The Time Value of Money:

The amount of money originally invested is called, the principle amount, the amount of money to which it will grow when the interest rate added is called the future value.

Calculating the future value of a payment or series of payments is called compounding. The payments are compounding to some future year. Calculating the present value of future payment is called discounting. Payments are discounted back ward to the present (William A. 1984).

2.17.1 Present Value:

Present Value is a formula used in finance that calculate the present day value of amount that is received at future date, the promise of equation in that there is (time value of money).

Present value (PV) $= \frac{C_1}{(1+\gamma)^n}$

Where: C_1 = cash flow at period 1, (r) = rate of return, (n) = number of periods.

(www.financeformula.net/present-value.htm).2015.

2.17.2 Future Value (FV):

Is a formula to calculate the value of cash flow at later late than originally received, this idea that an amount today is worth different amount that future time is based on the time value of money.

FV = $C_0(1+r)^n$

Where: C = Cash flow at period 0, (r) = rate of return

(n) – number of periods (www.financeformula.net/future-value.html).2015.

2.17.3 Net Present Value (NPV):

NPV = $-C_0 + \frac{C_1}{1+\gamma} + \frac{C_2}{(1+\gamma)^2} + \cdots + \frac{C_t}{(1+\gamma)^T}$

Where: - C_0= initial investment, C = cash flow, (γ) = discount rate, (T) = time.

Net present value (NPV) is a formula used to determine the present value of an investment by discounted sum of cash flow received from the project.

When company or investment takes on project or investment, it is important to calculate an estimate of how profitable the project on investment will be in the formula, the (C_0) is the initial investment, which is a negative cash flow showing that money is going out as opposed to coming in. considering that money going out is subtracted from the discounted sum of cash flows coming in, the net present value would need to be positive in order to considered a valuable investment. (www.financeformulaet/net-resent-value.html) .2015.

2.18 Internal Rate of Return:

The internal rate of return of a project is the rate of interest which, when used to present value results in the discounted income being exactly equal to the discounted costs. In other words, the internal rate of return represents the financial yield or profitability of a project in term of percentage rate of interest (R.J.N.Vusby.1985).

2.19: Discount Rate:

The interest rate used in discounting future cash flow; here also called capitalization rate.

(www.investwords.com/1478/discount-rate.html)

2.20 Benefit Cost Ratio:

A benefit cost ratio (BCR) is an indicator used in the formula discipline of cost- benefit analysis, that attempts to summarize the overall value for money of project or proposal, BCR is the ratio the benefits of project or proposal, expressed in monetary terms. All benefit cost should be expressed in discount present value, Benefit Cost Ratio (BCR) takes into account the amount of monetary gain realized by performing a project versus the amount it cost to execute the project, the higher the BCR the better the investment. Rule of thumb is that if the benefit is higher than the cost the project a good investment.

Calculation: BCR = $\frac{Discounted\ Value\ of\ incremental\ benefit}{Discounted\ value\ of\ incremental\ costs}$.

Accept all projects with BCR greater than 1, when costs and benefits are discounted at opportunity cost of capital.

(https://en.wikibedia.org/wiki/benefit-cost-ratio). 2015.

2.21 Payback Period:

Is the time in which the initial cash out flow of an investment is expected to be recovered from the cash is flows generated by the investment it one of the simplest investment appraisal techniques. The formula to calculate payback period of a project depends on whether the cash flow per period from project is even or uneven. In case they are even, the formula to calculate payback period is:

$$\text{Payback Period} = \frac{initial\ investment}{cash\ in\ flow\ period}$$

When cash flow are uneven, we need to calculate the cumulative net cash flow for each period and then use the following formula for payback period:

$$\text{Payback Period} = A + \frac{B}{C}.$$

(A) Is the last period with negative cumulative cash flow

(B) Is the absolute value of cumulative cash flow at the end of period (A)

(C) Is the total cash flow during the period A

Both of the above situations are applied.

(www.accounting explained.com/managerial/capital-budgeting/payback-period)

CHAPTER THREE

STUDY AREA

3.1 Central Darfur State:

Central Darfur State (where the research area is located) is a new established state, which had being separated from west Darfur in 2012. The total area of the state is about 9486666 feddan (39844 Km^2). The area of natural forest and range is about 2371488 feddan (9960 Km^2) represent 25% of the total state area. The population of the state is about 1133491 people. The economic activities of the population are agriculture, cattle herding, trade and handcraft making. The area of reserved forest is about 273091 hectares. (Ministry of Agriculture and Animal Resources – Central Darfur state 2013)

3.2 The Private Forests in the Study Area:

Zalingei and Nertitei localities in central Darfur state where there are many private forests, those private forests are small areas serving as livelihood activities, they are small enterprises aimed to raise family income and improve their living standards. Eucalyptus represent the dominate tree in the private forest in the study area. The actual formal and organized beginning of the private forest in the area was the season of 1985 -1986, by Jebal Marra Rural Development Project (JMRDP) which distribute seedlings to the target farmers and followed with extensional services to teach the farmers how to establish their own forest (FNC-west Darfur 2008).

3.3 Location and Area: The research area consist of Zalingei and Nertitei Localities located at east of Central Darfur State, it lies between longitudes $22^0\ 12''$ - $24^0\ 16''$ E and latitudes $12^0\ 30''$ - $14^0\ 19''$ N.

The area of Zalingei locality is 672.3 Km^2 approximately. Nertitei area is 288 Km^2 approximately. .(Survey Administration - Zalingei office 2015).

3.4 Soil and topography

The predominate soils are sandy loam, becoming loam sandy clay with depth other soils range from grey to brown gravelly clays of Pedi plains, to alluvial and co alluvial soils (clay loam) in depression and alongside of the main valleys water course to volcanic ash and sandy loam of piedmont plain.

Topographically, the area is dominated by the volcanic complex of Jebel Marra Massif with maximum elevation of 3047m. above sea level and basement complex with Pedi plain, hills and wadi beds which range from 600 to 1000 meters in altitude (HTS.1958).

3.5 Water System:

The water system of the area consists of many permanent streams running across the area coming down from Jabel Marra Mountain. All those streams are at the youth stage , this water system is useful in cultivating wide areas around the streams. Jebel Marra waters are of interest to local communities living in Jebel Marra area and the plains surrounding it, as well as the international significance, contributing to Nile Basin and Lake Chad waters. The mountain constitutes the most important catchments resulting in many waterfalls and permanent and semi- permanent streams that support the livelihood of people and add the tourism potentials (Elsiddig . 2007)

3.6 Climate:

The rainy season usually begins in June and extends to October, with occasional few showers in April and May. In Zalingei locality through the last five years the annual rain fall rate ranged between 379 – 725 mm. in Nertitei locality the annual rain fall rate range between 450 - 1000mm. (Zalingei Meteorological Station, (2014)

3.7 Common Tree Species:

The most dominant species are; *Albizia amara*, *Balanite egyptiaca*, *.Azanza garkeana, Acacia senegal*, *Acacia grardii*, *Acacia melifera*, *Acacia seiberiana*, *Acacia nilotica, Faidherbia albida*, *Ziziphus (spp)*, *Anogeissus leiocarpus*, *Ficus spp, Comberetum spp, Boswellia papyrifera and Bohemia roffisen*. There are also some exotic trees adapted very well to the local climate like *Eucalyptus spp*, this genus spread very widely in villages and towns, farms, private forests and more widely in reserved forests plantation.

Cupressus spp had been grown very well in Baldong reserve forest plantations at elevation of about 1500 above sea level.

There were about 200 private forests in the research area with total area approximately about 750 feddans (310 hectares) there were (3) types of these forests (house steads woodlots, Agro- forestry and farm forests) . Eucalyptus species which planted in the private forests are *Eucalyptus citriodora*, *Eucalyptus camaldulensis*, *Eucalyptus torliana, Eucalyptus umbulata*). (FNC West Darfur, 2008)

3.8 Population and Livelihood Activities:

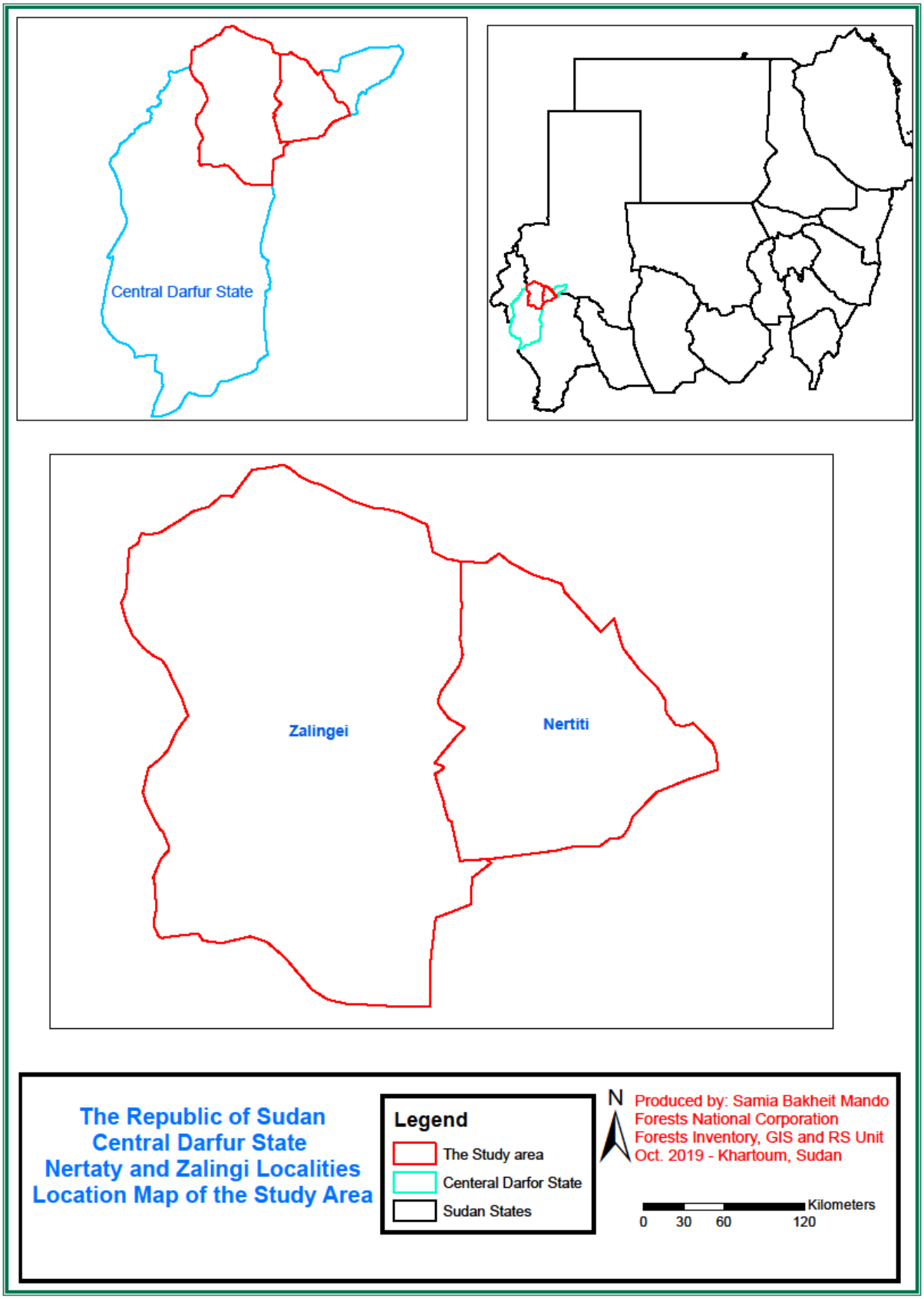
The population concentrates in towns and large villages like Zalingei, Abata, Trage, Nertitei, Beldong, Tour and Gildo. The nomads scatter in some (Damrras).

The population of Zalingei locality	246705
The total population of Nertitei locality	221000
Total population	467,705

These figures are according to 1993 census, with an annual birth rate of 3.40. (Abdel Hameed and Khatir, 2008)

The living's means for majority of people in the area is agriculture, pasture and trade in addition to some traditional small industries (hand crafts, leather industries, local oil mills, carpentry and bricks making….etc.).

The main agricultural crops in the area are; Sorghum (Sorghum bicolor), Millet, (*Pennisetum glaucum*), Potato (*Solanum tuberosum*), Onion (*Allium cepa*), Okra (*Abelmoschus esculentus*), Tomato (*Solanum lycopersicum*) Corn (*Zea mays*) and Peanut *(Arachis hypogaea*). The main fruits that produce in area study are Mango (*Mangifera indica*), Lemon (*Citrus aurantiifolia*), Orange (*Citrus sinensis*), Grapefruit (*Citrus paradisi*) and Gawafa (*Posidium guagava*) (Agricultural Services – Zalingei Office, 2008).


Central Darfur State
Zalingei
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Nertaty and Zalingi Localities
Location Map of the Study Area
Legend
The Study area
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Produced by: Samia Bakheit Mando
Forests National Corporation
Forests Inventory, GIS and RS Unit
Oct. 2019 - Khartoum, Sudan
Kilometers
0 30 60 120

Map (2)

CHAPTER FOUR

RESEARCH METHODOLOGY

4-1 Background:

This research followed the case study method which is classified as a part of the descriptive method. This chapter showed the procedures of scientific steps which build up the methodology of the research which consist of study area selection , field visit , data collection, study population of study area , sample unit and analysis method.

4-2 Selection of study area:

Zalingei and Nertitei localities were chose as study area because the Eucalyptus private are forests concentrated in these to localities.

4-3 Field visits:

The Eucalyptus private forest in the study area scattered through some villages (Tor, Galol, Baldong, Lagi and Kalo in addition to Zalingei and Nertitei towns. Five field visits had been carried during period (2015 – 2017).

4-4 Data collection:

Data collected by two means (Primary and Secondary means).

4-4-1 Primary data collection means:

The primary data collected by means of (Field observations, Interviews for local leaders and FNC staff and questionnaire which targeted the forests owners)

4-4-2 Secondary data collection means:

In this study the secondary data means were include references, Internet sites and the records and reports of FNC and relevant institutions.

4-5 Study population:

The study population consisted of 101rainfed Eucalyptus private forests.

4-6 Sample units

The study population was represented by 6 forests divided into three area categories, each category represented by two even age forest, the 3 categories were as follow:

Small area category (small size sample) <1 feddan

Medium area category (medium size sample)1- 4 feddan

Large area category (large size sample)> 4 feddan

4-7 Analysis method:

Descriptive statistic approach used as main scientific method in this study. Excel Computer Program was used mainly for data analysis. The essential characteristic data about the forest and the owners reviewed and treated using simple tables to give frequency percentages. The data concerned with the financial operations analyzed through 2 stages, every stages lead to the next stages.

The first stage: data analysis carried out for every area category (size sample) of the three categories separately, by analysis the average of the analyzed data of the two forests which formed the certain category.

The second stage: the conclusion of data analysis of the three categories.

Specific forms (tables) used in the financial analysis these which were (production analysis tables, cost analysis tables, income analysis tables and IRR tables).

4-7-1 Cost analysis:

Successive process carried to give the annual cost value. Establishment costs (fixed costs) calculated in unit area (feddan). Variable costs calculated annually per feddan and assorted in form of operations which were silvicultural operations cost, protection operations cost and harvest operations cost.

Total costs calculated by the flowing equation, TC=FC+VC (Almahal 2005).

Eq (4.1)

Where = TC = total cost – FC = fixed cost

VC = variable costs.

Cost present value calculated using formula

1/ PV= $\frac{C_1}{(1+r)^n}$ Eq (4.2)

Where:- C_1 = cash flow at period 1.

(r) = interest rate. (n) = number of period.(www.financeformula.net/present-value-html)

2/ V_0= $\frac{V_n}{(1.0+i)^n}$ Eq (4.3)

Where V_0 = the present value of a single payment.

V_n = the future value of a single payment in year (n).

(i) = interest rate. (n)= the year in which payment occurs. (William A.1984).

4-7-2 Production analysis: All private forests in the study population of the study are managed under technical rotation, this rotation is concerned with the size more than the tree age, the rotation aims to produce a certain desirable timber size for market demand (Korki & Rossass), Korki (<7-10 cm) diameter and Rossass (10-17cm) diameter, the trees that reach to marketable size selected to be felled, The suitable felling system is the selection felling system. Forms of production table designed for analysis of the production data.

4-7-3 Establishment cost payback: The period during which the establishment cost paid back was determined, money time value used by compounding the money value successively to the future value, using the equation.

$$FC = C_0 (1+r)^n \qquad \text{Eq(4.4)}$$

Where: C_0 = cash flow at period 0. (r) = Rate of return

(n) Number of period (www.financeformula-net/future-value.html.)

4-7-4 Income analysis:

Annual Income per feddan determined , then discounted to present value at interest rate 15% Annual benefit (profit) calculated by subtracting cost present value from income present value.

Benefit cost ratio calculated using the formula

$$BC = \frac{discounted\ value\ of\ incremental\ benefit}{discounted\ value\ of\ incremental\ cost} \qquad Eq\ (4.5)$$

(https//en.wikipedia.org/wiki/benefit-cost-ratio)2015.

The (BCR) of the whole production period calculated.

Net present value (NPV) calculated using the equations

1/ $NPV = -C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_t}{(1+r)^t}$

$(Eq\ (4.6)$

Where: C_0 = initial investment C = cash flow. (r)=discount rate

(t) = time (www.finnanceformula.net/present-value.html).

2/ NPV = $\sum_{t=0}^{n} \left(R_t - C_t \right) \frac{1.0}{(1.0+i)^t}$ $Eq(4.7)$

Where: NPV = the net present value (R_t) = the revenues or positive cash flow in year (t). (Ct) = the costs or the negative cash flow in year (t)

(t) = the year in which the cash flow occurs.

(i) = the rate (William A, 1984).

4.7.5 Internal rate of return: It is a rate of return that when used to discount the cash flows to the present value it result in discounted income equal to the discounted cost. The internal rate of return calculated using specific table and formula.

1/ $IRR = i_1 + (i_2 - i_1) \times \left(\frac{NPVi_1}{NPVI_1 + (NPVi_2)} \right)$ $Eq(4.8)$

Where: IRR = internal rate of return. i_1 = the lower interest rate.

i_2 = the higher interest rate. NPV_i = net present value at lower interest rate. $NPVi_2$ = the net present value at the higher interest rate. (http:/www.sfre.ufl.edu/extension/floridaforest.IFAS)

2/ IRR = The lower of the interest rates used to drive NPVs + The difference between the two interest rates used × $\frac{NPV \text{ at the lower interst rate}}{NPV \text{ at the lower interest rate minus the NPV at the higher interest rate}}$

CHAPTER FIVE

RESULTS & DISCUSSION

5.1 General information about forests owners

Table (5.1): Classification of the respondents according to sex

No	**Sex**	**Percentage**
1	Male	100%
2	Female	-
3	Total	100%

Source (Field Survey 2015)

According to the result of table (5.1) all the respondents were male because most of the land in study area belonged to men, also in addition to that the cost of establishment and management of the private forest need much money more than the ability of the most of women in the study area.

Table (5. 2): Age categories

No	Age categories	Percentage
1	Over 55 years	50%
2	40-55 years	50%
3	Total	100%

Source (Field Survey 2015)

The results of table (5. 2) showed that respondents age were terminated in two age categories (over 55 years and 40-55 years) most of the land in the study area was belonged to owners related to these two age categories . The investment in forestry field need high patient and mature mined because it is a long term investment so most of the people whose related to the age from 40-55 year are characterized by this manner.

Table (5.3): Education level of private forests owners:

No	Education Level	Percentage
1	Illiterate	-
2	Khalwa	66.6%
3	Primary	-
4	Secondary	16.7%
5	University	16.7%
6	Total	100%

Source (Field Survey 2015)

According to table (5.3) all the respondents were literate, 66.6% of them were learned in Khalwa (Khalwa is traditional local school for Quran), in spite of this high percentage there were some respondents obtained advanced education level in secondary school and university with percentage of 16.7 % for each .The education is very important factor in adopting the private forest idea among the community, this is in line with Kouther. 2017, when she stated that (the education is an important indicator in determining the status of the community and its development).

Table (5.4): Main jobs of the private forests owners:

No	Main Job	Percentage
1	Farmer	83.3%
2	Harder	-
3	Worker	-
4	Merchant	-
5	Government employee	16.7%
6	Free Job	-
7	Total	100%

Source (Field Survey 2015)

According to table (5.4) most of the respondents with percentage 83.3% are farmer, they belong the land and have the experience those, two factors encourage them to involve in the private forest field, 16.6% of the respondents were government employees, their relation with FNC staff help them to establish their forests.

Table (5.5): Family size:

No	Family Size	Percentage
1	Less than 5 persons	-
2	5-9 persons	66.7%
3	Over 9 persons	33.3%
4	Total	100

Source (Field Survey 2015)

According to table (5.5) 66.7% of the respondent have a medium sized family, 33.3% of the respondents have big size family (over 9 persons) and there were no small family size.

Both big and medium size families are in need to addition income resources so private forest can achieve this objective. The family size is an important helpful factor in private forests management because the family members collaborate in many forest operations and activities.

5-2 Essential information about the forests:

Table (5.6): Forests location

No	Location (villages/towns)	Percentage
1	Nertitei	50%
2	Zalingai	16.7%
3	Beldong	16.7%
4	Galol	16.6%
	Total	

Source (Field Survey 2015)

According to table (5.6) 50% of the forests located at Nertitei area because Nertitei is the capital of West Jebal Mara locality, most the locality population concentrated around Nertitei and the security state to some extend better than the other villages .

Table (5.7): Land ownership types

No	Land owner ship type	Percentage
1	Heredity	50%
2	Gift	33.3%
3	Purchase	16.7%
4	Rent	-
	Total	100%

Source (Field Survey 2015)

The results of table (5.7) revealed that 50% of the respondents owned their forests through heredity, 33.3% owned their forests through the gift and 16.7% owned their forests through purchase, no one established his forest on a rented land the private forest is a long term investment with wide range of risk.

Table (5.8): Dominant tree in the private forests

No	Dominant trees	Percentage
1	Eucalyptus	100%
2	Other trees	-
	Total	100%

Source (Field Survey 2015)

The results of table (5.8) insure that Eucalyptus is the only dominant tree in the private forests of the study area, the owners were preferred Eucalyptus because of its high coppicing power and its fast growing speed, has less cost than the other trees species, easy to manage and marketable, moreover the all the respondents said that they are not plant any agricultural crops beside Eucalyptus in their forests, because the trees spacing are not wide enough to grow agricultural crops.

Table (5.9): Eucalyptus species of private forests

No	Eucalyptus species	Percentage
1	*Only Eucalyptus citriodora*	66.7%
2	*Eucalyptus citriodora, Eucalyptus camaldulensis and Eucalyptus umbulata*	33.3%
3	Total	100%

Source (Field Survey 2015)

According to the result of table (5.9) 66.7% of respondents planted *Eucalyptus citriodora alone* while 33.3% of the respondents planted a mixture of *Eucalyptus citriodora* , *Eucalyptus camaldulensis* or Eucalyptus umbulata, this result insure that *Eucalyptus citriodora* the most preferred species in the private forests then *Eucalyptus camaldulensis* and *Eucalyptus umbulata* in the second degree. This result was similar to the case of the of eucalyptus plantation in Jebal Marra Forest circle according to FNC (2005) *Eucalyptus citriodora* , *Eucalyptus panculata* and *Eucalyptus umbulata* have superior poles for which there is high demand and *Eucalyptus camaldulensis* attain size that give saw logs which make them more preferred .

Table (5.10): Trees felling system

No	Felling system	Percentage
1	Selection system	100%
2	Clear felling system	-
3	Total	100%

Source (Field Survey 2015)

According to results of table (5.10) all the respondents 100% used selection system for harvesting their yield, because the area of most of the private forest area was very limited and the yield was restricted in a certain production size ranged between (7-17 cm) in diameter, while selection felling system and clear felling system were both used in eucalyptus plantation of Jebal Marra Forest Circle. According FNC (2005) single-stemmed seedling origin plantations of eucalyptus are managed under clear felling system regulated on area basis target diameter range (10-15.9 cm). The coppice crop, with 2-3 stems per stump, is managed on selection system by harvesting target size-classes (10-15.9 cm) removing 1-2stems and leaving 1-2 stems per stump.

5.3: The difficulties and constraints which faced the private forests.

Table (5.11): difficulties in seedlings and polythene bags supply**.**

No	Supply of seedlings and polythene bags	Percentage
1	There are difficulties	100%
2	No difficulties	-
3	No reply	33.3%
4	Total	100%

Source (Field Survey 2015)

The result of table (5.11) revealed that 66.7% of the respondents faced difficulties in providing seedling, and polythene bags while 33.3% of respondents do not mentioned this issue as problem in their statement. All though FNC have annual seeding distribution program in Nertitei and Zalingei central nurseries there were difficulties in transplanting seedling to the remote forests through the hard roads.

Table (512): Difficulties of nurseries establishment

No	Nurseries	Percentage
1	There are a difficulties	33.3%
2	No difficulties	-
3	No reply	66.7%
4	Total	100%

Source (Field Survey 2015)

33.3% of respondents said there were difficulties in nursery establishment because of lack of money and tools and inputs difficult to obtain, when 66.7% of the respondents not mentioned this problem.

Table (5.13): The effect of instability of security

No	Security state	Percentage
1	bad impact	100%
2	no impact	-
3	Total	100%

Source (Field Survey 2015)

According to the result of table (5.13) all the respondents agreed in considering the security state was the most severe problem that hindered the development of private forests.

Table (5.14): Government fees

No	Government fees	Percentage
1	Expensive	50%
2	Suitable	-
3	No reply	50%
4	Total	100%

Source (Field Survey 2015)

50% of the respondents said that the government fees were expensive and they found a great difficulty to pay it so this affect on the production, 50% of the respondents were not mentioned if they considers it one of the difficulties or not. Abdalla Gaafar. (2011) confirmed that the royalties and taxes on forest products discourage the private growers from developing their forest enterprises.

Table (5.15): Agricultural land legislations

No	Agricultural land legislation	Percentage
1	Effective	-
2	Not effective	16.3%
3	No reply	50%
4	Total	100%

Source (Field Survey 2015)

According to the results of table (5.15) 16.3% of the respondents said that there are no government legislation for agricultural land to protect the land and the farmers while 83.7% of the respondents not talked about this subject, because they are not know the importance of the agricultural legislations for protecting the farmers and the land. Abdalla Gaafar. (2011) insured the importance of the agricultural legislations when he said that the absence of low governing tenure issues resulted in a situation that let to conflicts between land uses and land users.

Table (5.16): Finance resource

No	Finance source	Percentage
1	Self-financing	100%
2	Bank financing	-
3	Government financing	-
4	Others	-
5	Total	100%

Source (Field Survey 2015)

The result of table (5.16) revealed that all the respondents were depended on their own resources to financing their forest establishment and activities, because there were no others effective source of finance.

5.4 The financial analysis of small size sample

5.4.1 The fixed costs (forest establishment costs)

Table (5.17): Establishment costs of small size sample in average per feddan.

Activities	Costs SDG	Cost percentage
Land price	916.5	74.4%
Fence establishment	95.5	7.7%
Land preparation	81.5	6.6%
Seedling (purchase & transportation)	79.0	6.4%
Planting	60.0	4.9%
Total	1232.0	100

- The two forests were established in year 1992 so the establishment costs expended one time in that year.
- The two forests were rain fed, so there is no cost of irrigation unit establishment.
- There is no cost expended for fire line establishment.
- The establishment costs (fixed costs) of this sample include land purchase, fence establishment, land preparation, seedling and planting.
- Land purchase was the highest costs in the establishment costs represented 74.4% of the total establishment costs while whole others establishment costs (Fence establishment, land preparation , seedling and planting) equaled 25.6% of the total establishment cost, so if the farmer had his own suitable land it will be easy to establish a private forest .

5.4.2 The variable costs of the small size sample unit.

Table (5.18): Variable costs details of the small size sample unit in average per feddan

Year	Silvicultural costs (SDG)			Protection cost (SDG)				Harvest cost (SDG)			Total
	Replanting	Weeding	Sub total	Fence maintenanc	Pests control	Guard	Sub total	Felling & extraction	Governme nt fees and taxes	Subtotal	
1992	-	-	-	-	20.0	-	20.0	-	-	-	20.0
1993	17.5	10.5	28.0	6.0	17.5	-	23.5	-	-	-	51.5
1994	10.0	11.0	21.0	7.0	12.5	-	19.5	-	-	-	40.5
1995	-	13.0	13.0	8.0	-	-	8.0	-	-	-	21.0
1996	-	14.5	14.5	9.0	-	-	9.0	247.0	56.4	303.4	326.9
1997	-	17.5	17.5	10.0	-	-	10.0	100.0	20.0	120.0	147.5
1998	-	20.0	20.0	12.5	-	-	12.5	237.5	52.0	289.5	322.0
1999	-	22.0	22.0	14.0	-	-	14.0	243.0	106.0	349.0	385.0
2000	-	25.5	25.5	15.0	-	-	15.0	387.5	165.0	552.5	593.0
2001	-	29.0	29.0	17.5	-	-	17.5	396.5	220.0	616.5	663.0
2002	-	35.0	35.0	22.5	-	-	22.5	707.0	285.0	992.0	1049.5
2003	-	39.5	39.5	25.0	-	50	25	646	336	982	1096.5
2004	-	46.5	46.5	27.5	-	60	27.5	1018	402.5	1420.5	1554.5

2005	-	53.5	53.5	32.5	-	65	97.5	842.5	464	1306.5	1457.5
2006	-	60.5	60.5	37.5	-	75	112.5	1182.5	531	1713.5	1886.5
2007	-	66.0	66.0	42.5	-	85	127.5	955	595	1550	1743.5
2008	-	82.5	82.5	50.0	-	100	150	1417.5	621.5	2039	2271.5
2009	-	92.5	92.5	57.5	-	115	172.5	1212.5	747.5	1960	2225
2010	-	107.5	107.5	65.0	-	125	190	1645	817.5	2462.5	2760
2011	-	125.0	125.0	75.0	-	150	225	1535	943.5	2478.5	2828.5
2012	-	142.5	142.5	87.5	-	175	262.5	2137.5	1060	3197.5	3602.5
2013	-	165.0	165.0	100.0	-	200	300	2056.5	1272	3328.5	3793.5
2014	-	187.5	187.5	115.0	-	275	390	2395	1326	3721	4298.5
2015	-	215.0	215.0	130.0	-	250	350	2400	1530	3930	4525
2016	-	265.0	265.0	150.0	-	300	450	2512.5	1692	4204.5	4919.5
2017	-	285.0	285.0	175.0	-	300	475	2100	1630	3730	4490
Total	27.5	2131.5	2159.0	1291.5	50	2325	3666.5	26374	14872.9	41246.9	47072.4

The variable costs of this sample were classified into three classes as flow:

(a) Silvicultural costs which include, replanting costs and weeding and climbers cutting costs.

(b) Protection costs which include disease and pest control, fence maintenance and guard. The activity of fire lines opening was absent because the area was small so the owners make use of all the land in plating trees.

(c) Harvest cost include, trees felling and extraction and government fees

(d) The harvest cost were the most expensive variable costs

5.4.3. The production analysis of the small size sample.

Table (5.19): Production analysis of the small size sample

	Quantity produced		
Year	Korki	Rossass	Total
1996	355	350	705
1997	115	160	275
1998	320	200	520
1999	418	112	530
2000	428	122	550
2001	435	115	550
2002	450	120	570
2003	450	110	560
2004	460	115	575
2005	475	105	580
2006	465	125	590
2007	480	115	595
2008	462	103	565
2009	473	102	575
2010	435	92	545
2011	462	93	555
2012	442	88	530
2013	447	83	530
2014	426	84	510
2015	425	85	510

2016	385	85	470
2017	337	71	408
Total	9163	2635	11798
%	78%	22%	100%

- The first production was performed after 4 years from establishment year. There was slight difference between this result and what Elsiddig A.E (1996) reported in the case of Eucalyptus reserved government plantation , he stated that the seedling origin plantation of 6-7 year from the date of plantation would be felled under clear felling .This difference due to the purpose of the production rotation , on the case of the private forests the production rotation aimed to produce only light building poles while the production rotation of the reserved government plantation aimed to produce light and heavy building poles in addition to saw logs.
- The production going successively giving a year of high followed by a year of low production then again a year a high production and so on the owner organized this system to insure sustainable and continuous desirable production grades.
- The highest production appeared in the first production year = 705 building poles.
- The lowest production appeared in the second production year (275 building poles).
- The production was classified into two major grades of building pole which was korki with diameter (< 7-10cm)and Rossass with diameter from 11 up to 17 cm. On comparison this result with the case of eucalyptus reserved government plantation, Elsiddig E.A (1996) stated

that the first felling conducts when the targeted diameter at breast height reaches 15.9 cm.

The table (5.21) revealed that most of the production 75% of the total production were korki grade while 22% Rossass, because the technical rotation aimed to produce small diameter according to market demand to use it as local building materials .

5.4.4 / Costs analysis of small size sample

Table (5.20): The cost analysis in average per feddan

Year	Fixed costs SDG	Variable costs (SDG)	Total costs (SDG)	Total costs present value at 15% (SDG)
1992	1232.5	20.0	1252.5	1252.50
1993	-	51.5	51.5	44.78
1994	-	40.5	40.5	30.62
1995	-	21.0	21.0	13.81
1996	-	326.9	326.9	186.91
1997	-	147.5	147.5	73.33
1998	-	322.0	322.0	139.21
1999	-	385.0	385.0	144.74
2000	-	593.0	593.0	193.85
2001	-	663.0	663.0	188.47
2002	-	1049.5	1049.5	259.42
2003	-	1096.5	1096.5	235.69
2004	-	1554.5	1554.5	290.55
2005	-	1457.5	1457.5	236.88

2006	-	1886.5	1886.5	266.62
2007	-	1743.5	1743.5	214.27
2008	-	2271.5	2271.5	242.74
2009	-	2225.0	2225.0	206.76
2010	-	2760.0	2760.0	223.02
2011	-	2828.5	2828.5	198.75
2012	-	3602.5	3602.5	220.17
2013	-	3793.5	3793.5	201.55
2014	-	4298.5	4298.5	198.59
2015	-	4525.0	4525.0	181.79
2016	-	4919.5	4919.5	171.86
2017	-	4490.0	4490.0	136.40
Total	1232.5	47072.4	48304.9	5753.28

Table (5.20) designed for cost analysis of small size sample divided into five columns, the first column showed the years in which costs expended, the second showed the fixed costs (FC) the third column showed the variable costs (VC) the fourth column showed the total costs (TC)

TC = FC + VC, the fifth column showed the total costs present value

PV = $\frac{C1}{(1+r)^n}$

5.4.5/ Income analysis of small size sample.

Table (5.21): Income analysis in average per feddan

Year	Income SDG	Income present value at 15% (SDG)	Total cost present value at 15% (SDG)	NPV (Benefit) SDG	Benefit cost ratio SDG
1992	-	-	1252.5	-1252.5	-
1993	-	-	44.78	-44.78	-
1994	-	-	30.62	- 30.62	-
1995	-	-	13.81	- 13.81	-
1996	1460.0	834.76	186.91	647.85	3.466
1997	648.0	322.17	73.33	248.84	3.393
1998	1451.5	627.52	139.21	488.31	3.508
1999	1391.0	522.93	144.74	378.19	2.613
2000	1893.5	618.99	193.85	425.14	2.193
2001	1793.0	509.68	188.47	321.21	1.704
2002	2490.5	615.61	259.42	356.19	1.373
2003	2480.0	533.06	235.69	297.37	1.262
2004	3337.5	623.8	290.55	333.25	1.147
2005	3482.5	566.00	236.88	329.12	1.389
2006	4622.5	653.29	266.62	386.67	1.462
2007	4647.5	571.15	214.27	356.88	1.666
2008	5745.0	613.94	242.74	371.20	1.529
2009	6002.5	557.79	206.76	351.03	1.698
2010	7217.0	583.17	223.02	360.15	1.615
2011	7417.5	521.19	198.75	322.44	1.622
2012	9267.5	566.25	220.17	346.08	1.572

2013	9387.5	498.76	201.55	297.21	1.475
2014	11976.0	553.30	198.59	354.71	1.786
2015	11955.5	480.31	181.79	298.52	1.642
2016	14433.0	504.21	171.86	332.35	1.934
2017	12275.0	372.89	136.40	236.49	1.734
Total	125374.0	12250.77	5753.28	6497.49	1.129

Table (5.21) showed the income analysis for the small sample size. The first column showed the year in which the income earned , the second column showed the undiscounted income, the third column showed the income present value (discounted income) the fourth column specified the total cost present value, the fifth column showed the benefit (discounted income- discounted costs) .

The sixth column showed the benefit cost ratio (BCR)

$$\text{BCR} = \frac{Benefit}{(1+r)^n} \div \frac{Costs}{(1+r)^n} = \frac{Benefit(1+r)^n}{cost\ (1+r)^n}$$

The analysis of the table (5.23) revealed the following result.

- Net present value (NPV). NPV $= -C_O + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \ldots\ldots\ldots \frac{C_t}{(1+r)^t}$

  = 6497 – 49 SDG during (1992 – 2017)
- The total of undiscounted income during (1992- 2017)

  = 125374 SDG.
- The highest discounted income appeared in the first production year (1996) in amount of 834.76 SDG.
- The lowest discounted income appeared in the second production year (1997) in amount of 322.17 SDG.

- The highest BCR appeared in the third production year = 3.51.
- The lowest BCR appeared in the ninth production year = 1.15.
- The BCR of the whole production period (1992-2017) = 1.13

5.4.6: The steps of payback the establishment costs of the forest number 1:

The future value of variable costs during (1992- 1996) in year 1996,

FV = $c_o \ (1+r)^n$

Where c_o = cash flow at period 0, r = rate of return, n = number of periods (www.financialformulanet/html). 2015.

Year	1992	Fv=$c_o \ (1+r)^n$	0		0
Year	1993	Fv=$c_o \ (1+r)^n$	32(1.15)3	32(1.520875)	48.67 SDG
Year	1994	Fv=$c_o \ (1+r)^n$	29(1.15)2	29(1.3225)	38.35SDG
Year	1995	Fv=$c_o \ (1+r)^n$	34(1.15)		39.1
Year	1996				378.8
					504.92 SDG

2. Establishment costs (fixed cost) at year 1992 = 1590 SDG

3-Future value of the Establishment cost at year 1996

FV = $c_o \ (1+r)^n$ = 1590 $(1.15)^4$ = 1590 (1.7490062) = 2780.92 SDG

4-The value of the total cost in year = FC + VC = 2780.504.92 = 3285.84 SDG.

5-The average of profit / feddan in year 1996 = Income – TC.

= 1776-3285.84 = - (1509.84)

I.e. there was 1509.84 SDG out of establishment cost not paid.

6-The future value of the establishment costs at year 1997.

FV = $C_O\ (1 + r)^n$ 1509.84 (1.15) = 1736.316

TC at year 1997 = VC + FC = 185 + 1736.316 = 1921.316.

The profit in year 1997 = income – TC = 811 – 1921.316 = - (1110.316) SDG

I.e. there was amount of 1110.316 SDG out of the establishment costs not paid.

7-The future value of the rest establishment costs at year 1998.

FV = $C_O\ (1 + r)^n$ 1110.316 (1.15) = 1276.863 SDG.

Total cost (TC) at year 1998 = FC + VC = 1276.863 + 497 = 1773.863SDG.

Total cost (TC) at year 1998 = FC +VC = 1276.863 + 497 = 1773.863 SDG.

The average profit / feddan in year 1998 = income – TC.

2259 – 1773.863 = 485.137 SDG.

I.e. year 1998(the third production year) is the first year for real profit because the establishment cost was completely paid in this year.

5.4.7 The steps of payback the establishment of cost and gain first real profit of forest number 2:

1-The value of variable costs in feddan during the period (1992-1996)

Year 1992: FV = $C_0\,(1+r)^n = 40\,(1.15)^4 = 69.69$ SDG

Year 1993: FV = $C_0\,(1+r)^n = 71\,(1.15)^3 = 107.982$ SDG.

Year 1994: FV = $C_0(1+r)^n = 52\,(1.15)^2$ = 68.66 SDG.

Year 1995: FV = $C_0(1+r)^n = 8\,(1.15)$ = 9.20 SDG.

Year 1996: = 275.00

Total = 530.912 SDG.

2-The future value of establishment cost per feddan at year (1996) .

FV = $C_0 = (1+r)^n = 875\,(1.15)^4$ = 1530.381 SDG.

TC at year 1998 = VC + FC = 530.912 + 1530.381 = 2061.293.

Profit year 1996 = Return – TC – 1240 – 2061.293 = - (821.293) SDG.

I.e. in year 1996 (the first production year) there was amount of (821.293) SDG had been not paid yet.

3-The future value of the rest of establishment costs in year 1997

FV = $C_0 = (1+r)^n = 821.291\,(1.15)$ = 944.487 SDG.

TC in year 1997 = FC + VC = 944.483 + 110 = 1054.483SDG.

Profit in year 1997 = Return – TC = 622 – 1054.483 = - (432.483) SDG.

I.e. in year 1997 (second production year) there was amount of 432.483 SDG, had not been paid yet.

4-The future value of the rest of establishment costs in year 1998

FV = $C_0 = (1 + r)^n$ = 432.483 (1.15)= 497.355 SDG.

TC in year 1998 = FC + VC = 497.355 + 147 = 644.355 SDG.

Profit in year 1998 = income- TC = 768 – 644.355 = 123.645 SDG.

I.e. in year 1998 (the third production year) all the establishment costs had been completely paid back and the forest achieved it's first real profit.

5.4.8 Internal rate of return of small size sample.

Table (5.22): IRR in average per feddan

Year	Cash flow			Net present value	
	Income SDG	Total cost (SDG)	Net cash flow (SDG)	at 15%	At 38%
1992	-	- 1252.5	- 1252.5	-1252.50	- 1252.50
1993	-	- 51.5	- 51.5	- 44.78	- 37.32
1994	-	- 40.5	- 40.5	- 30.62	- 21.27
1995	-	- 21.0	- 21.0	- 13.81	- 7.99
1996	1460.0	- 326.9	+1133.1	674.85	312.43
1997	648.0	- 147.5	+500.5	248.84	100.00
1998	1451.5	- 322.0	+1129.5	488.31	163.54
1999	1391.0	- 385.0	+1006.0	378.19	105.55
2000	1893.5	- 593.0	+1300.5	425.14	98.87

2001	1793.0	-663.0	+1130.0	321.21	62.25
2002	2490.5	- 1049.5	+1441.0	356.19	57.53
2003	2480.0	- 1096.5	+1338.5	297.37	40.02
2004	3337.5	- 1554.5	+1783.0	333.25	37.38
2005	3482.5	- 1457.5	+2025.0	329.12	30.76
2006	4622.5	- 1886.5	+2736.0	386.67	30.12
2007	4647.5	- 1743.5	+2904.0	356.88	23.16
2008	5745.0	- 2271.5	+3473.5	371.20	20.08
2009	6002.5	- 2225.0	+3777.5	351.03	15.82
2010	7217.0	- 2760.0	+4457.0	360.15	13.53
2011	7417.5	- 2828.5	+4589.0	322.44	10.09
2012	9267.5	- 3602.5	+5664.0	346.08	9.03
2013	9387.5	- 3793.5	+5594.0	297.21	6.46
2014	11976.0	- 4298.5	+7677.5	354.71	6.43
2015	11955.5	- 4525.0	+7430.5	298.52	4.51
2016	14433.0	- 4919.5	+9513.5	332.35	4.18
2017	12275.0	- 4490.0	+7785.0	236.49	2.48
Total	125374.0	- 48304.9	77058.1	6497.49	- 164.8

Table (5.22) specified to calculate (IRR). The internal rate of return is the interest rate that when it used to discount the future cash flows back to the present it result in the discounted income being exactly equal to the discounted cost, represents the financial yield or profitability of a project in term of percentage rate of interest.

First column showed the years during which cash flows occurred, the second column showed cash flows divided into three divisions which were income (positive cash flow), total cost (negative cash flows) and net

cash flow, the third column showed net present value at two interest rate, the lower one 15% which determined previously, the upper interest rate estimated to give negative NPV 38%, The internal rate of return calculated using the next formula

$$\text{IRR} = i_1 + (i_2 - i_1) \text{ x } \left(\frac{NPV\, i_1}{NPV\, i_1 + (NPV\, i_2)}\right)$$

Where:

i_1 = the lower interest rate. i_2 = the upper interest rate

$NPV\, i_1$ = net present value at lower interest rate.

$NPV\, i_2$ = net present value at upper interest rate.

$$\text{IRR} = 15 + (38\text{-}15)\left(\frac{6497.49}{6497.49+164.86}\right) = 15 + 23\left(\frac{6497.49}{6662.35}\right).$$

$$= 15 + 22.43 \qquad = 37.43\%$$

5.5/ Financial analysis of medium sample size

This sample is the case study two (the medium size area) from one feddan to four feddan, it consists of two forests. After achieved the financial analysis for every one of the two forest alone, we will summarize the financial analysis as one case study as medium sample size.

Generally this sample consist of two forests of medium size area , the two forests were both established at year 1997.

The average area of the sample is 1.25 feddans (0.525 hectares).

Location: West Jable Merra locality (Galol and Baldong villages).

5.5.1 / Establishment cost of the medium size sample

Table (5.23): The establishment costs details in average per feddan

Practices	**Cost /SDG**	**Percentage**
Land price	1100.00	78.43
Planting	150.00	10.70
Seedling	112.50	8.02
Land preparation	40.00	2.85
Total	1402.50	100.00

The most highest establishment costs was the cost of the land purchase it represent 78.43% of the total establishment costs , the others establishment costa were very low , so according to this result it will be easy to a simple farmer to establishes a private forest if he was owned the land.

5-5-2/ Variable costs of the medium size sample

Table (5.24): Variable costs detail of medium size sample in average per feddan

Year	**Silvicultural costs (SDG)**			**Protection costs SDG**	**Harvest costs (SDG)**			**Total SDG**
	Replanting	Weeding & climbers cutting	Sub total	Diseases & pests control	Trees felling extraction	Government fees	Sub total	
s1997	-	-	-	45	-	-	-	45.0
1998	25	25.5	50.5	30	-	-	-	80.0
1999	-	29.5	29.5		-	-	-	29.5
2000	-	34.5	34.5		-	-	-	34.5

2001	-	38.5	38.5		399.0	290.0	689.0	727.5
2002	-	43.5	43.5		202.0	155.0	357.0	400.5
2003	-	51.0	51.0		555.0	444.0	999.0	1050.0
2004	-	59.5	59.5		272.5	224.0	496.5	556.0
2005	-	67.5	67.5		722.0	608.0	1330.0	1397.5
2006	-	77.5	77.5		340.0	306.0	646.0	723.5
2007	-	90.0	90.0		850.0	772.0	1622.5	1712.5
2008	-	102.5	102.5		522.5	396.0	918.5	1021.0
2009	-	119.0	119.0		1247.5	1046.5	2294.0	2413.0
2010	-	136.0	136.0		714.0	562.5	1276.5	1412.5
2011	-	157.5	157.5		1660.0	1411.0	3071.0	3228.5
2012	-	180.0	180.0		1017.5	740.0	1757.5	1937.5
2013	-	207.5	207.5		2377.5	1902.0	4279.5	4487.0
2014	-	240.0	240.0		1312.5	910.0	2222.5	2462.5
2015	-	272.5	272.5		3295.0	2325.0	5620.0	5892.5
2016	-	315.0	315.0		1567.5	1188.0	2755.5	3070.5
2017	-	365.0	365.0		3712.5	2970.0	6682.5	7047.5
Total	25	2612.0	2637.0	75	20767.5	16250.0	37017.5	39729.5

The variable costs were classified in this study under three main groups as follow.

a) Silvicultural costs group which contain replanting cost, weeding and climbers cutting. Weeding sometimes follow by micro water catchment.

b) Protection costs group which contain fence maintenance , fire lines opening , guard , diseases and pests control .The only activity of this group used in this sample was diseases and pests control by using insecticide against

termite during the early age of seedling (first and second year of establishment).

c) Harvest costs group: this group include trees felling, extraction and government fees, government fees contain tax, zakat, localities fees and forest royalties. There was no cost of transportation to the market because the merchants pay in the forest. Most of the variable cost concentrated in Harvest cost group.

5-5-3/ Production analysis of the medium size sample

Table (5.25): Production analysis in average per feddan

Year	Quantity produced		
	Korki	Rossass	Total
2001	408	317	725
2002	153	157	310
2003	475	265	740
2004	235	85	320
2005	575	185	760
2006	252	88	340
2007	583	192	775
2008	275	85	360
2009	615	190	805
2010	286	89	375
2011	634	196	830
2012	293	77	370
2013	634	161	795
2014	295	55	350
2015	642	133	775

2016	274	56	330
2017	629	114	743
Total	7258	2445	9703
percentage	74.8%	25.2%	100%

The results of the table (5.25) revealed the following points:

* The first had been earned after four years from establishment year then the production going annually.

* The production grades size were Korki and Rossass according to the market demands, use as building poles. This result can be compares with Jebel Marra Forest Circle management plan, according to Elsiddig (2007) the management plan for the period (1996-2005) Jebel Marra eucalyptus plantation adopted the first felling of eucalyptus at age 6-7 years of the seedling crop, the coppices crop managed on selection felling system every two years

* Korki (7 – 10 cm) in diameter and Rossass (11 – 17cm) in diameter.

* The annual production continued successively giving a year of a high production, then a year of a low production and then again a year of a high production and so on, so as to insure sustainable desirable production size.

* The highest production acquired in the 11^{th} production year (830 poles) while the lowest production appeared in the second production year (310poles).

* The average of annual production per feddan 571poles.

* The establishment costs had been completely paid back in the third production year so the forest began to give a real profit.

5-5-4/ Costs analysis of medium size sample

Table (5.26): Costs analysis in average per feddan

Year	Fixed costs(FC) (SDG)	Variable costs (VC) (SDG)	Total costs (TC) (SDG)	Total cost present value at 15% (SDG)
1997	1402.5	45.0	1447.5	1447.50
1998	-	80.5	80.5	70.00
1999	-	29.5	29.5	22.31
2000	-	34.5	34.5	22.68
2001	-	727.5	727.5	415.95
2002	-	400.5	400.5	199.12
2003	-	1050.0	1050.0	453.94
2004	-	556.0	556.0	209.02
2005	-	1397.5	1397.5	456.85
2006	-	723.5	723.5	205.66
2007	-	1712.5	1712.5	423.30
2008	-	1021.0	1021.0	219.46
2009	-	2413.0	2413.0	451.01
2010	-	1412.5	1412.5	229.57
2011	-	3228.5	3228.5	456.28
2012	-	1937.5	1937.5	238.11
2013	-	4487.0	4487.0	479.50
2014	-	2462.5	2462.5	228.83
2015	-	5892.5	5892.5	476.14
2016	-	3070.5	3070.5	215.75
2017	-	7047.5	7047.5	430.60
Total	1402.5	39729.5	41132.0	7351.58

Table (5.26) analysis the costs of the two forests which formed the sample size as one unit using the same method and the same equation using previously in costs tables of the two forests.

5-5-5/ Income analysis of medium size sample

Table (5.27): Income analysis in average per feddan

Year	Income at 15% (SDG)	Income PV at 15% (SDG)	Total cost PV at 15% (SDG)	Benefit(Net present value) (SDG)	Benefit cost ratio (SDG)
1997	-	-	1447.50	-1447.50	-
1998	-	-	70.00	-70.00	-
1999	-	-	22.31	-22.31	-
2000	-	-	22.68	-22.68	-
2001	2359.5	1349.05	415.95	933.10	2.243
2002	1230.0	611.53	199.12	412.41	2.071
2003	2927.5	1265.64	453.94	811.70	1.788
2004	1378.5	518.23	209.02	309.21	1.479
2005	3717.5	1215.26	456.85	758.41	1.660
2006	2000.0	568.52	205.66	362.86	1.764
2007	5087.5	1257.55	423.30	834.25	1.970
2008	2717.5	584.11	219.46	364.65	1.662
2009	6900.0	1289.66	451.01	838.65	1.86
2010	3564.0	579.25	229.57	349.68	1.523
2011	8849.0	1250.62	456.28	794.34	1.741
2012	4415.0	542.58	238.11	304.47	1.279
2013	10743.5	1148.10	479.50	668.6	1.394
2014	5112.0	475.04	228.83	246.21	1.076

2015	13255.0	1071.07	476.14	594.93	1.249
2016	6407.5	450.23	215.75	234.48	1.087
2017	16362.5	999.75	430.60	569.15	1.322
Total	97026.5	15176.19	7351.58	7824.61	1.064

Table (5.27) specified in income analysis, the table showed the annual income then calculate the income present value in the third column according to formula present value (PV) = $\frac{C_1}{(1+r)^n}$

Where: C_1 = cash flow at period 1

(r) = rate of return

(n) = number of period (www.financeformula.net/present-value.html) , the cost present value inserted in the fourth column so as to use it and income present value to calculate the annual benefit and the net present value , NPV calculated using the formula :

NPV = $\sum_{t=0}^{n}(R_t - C_t)\ \frac{1.0}{(1.0+i)^n}$

Where: R_t = the revenues or positive cash flows in year (t)

C_t = the costs or negative cash flow in year (t). (t) = the year in which the cash flow occurs. (i)= the interest rate (WilliamA.1984).

In the sixth column benefit cost ratio (BCR) calculated according the formula:

BCR = $\frac{discounted\ value\ of\ incremental\ benefit}{discounted\ value\ of\ incremental\ costs}$

(https:/en.wikibedia.org/wiki/benefit-cost-ration) .2015

Table (5.27) revealed the following results.

* The highest discounted income earned in the first production year (2001).

* The lowest discounted income appeared in the sixteenth production year (2016).

* The net present value (NPV) of the period (1997 – 2017) = 7824.61 SDG per one feddan.

* The highest BCR achieved in the first production year 2001 = 2.24.
* The lowest BCR appeared in the fourteenth production year (2014) = 1.076
* BCR of the whole production period (2001 – 2017) = 1.064.

5-5-6/ Steps of payback the establishment cost and gain first real profit of the forest number 3

1- The future value of variable cost in feddan during the period (1997-2001)

Year 1997: FV $=C_0 (1+r)^n = 30(1+0.15)^4 = 30(1.15)^4 = 52.470$ SDG

Year 1998: FV $=C_0 (1+r)^n = C_0 (1+0.15)^3 = 71(1.15)^3 = 107.982$ SDG

Year 1999: FV $=C_0 (1+r)^n = C_0 (1+0.15)^2 = 24(1.15)^2 = 31.74$ SDG

Year 2000: FV $=C_0 (1+r)^n = C_0 (1+0.15) = 29(1.15) = 33.35$ SDG

Year 2001: = 762

The accumulation of variable cost future value at year 2001 = 987.542

2- The future value of establishment cost in year 2001 first production year

FV $= C_0 (1+r)^n = 1315(1.15)^4$ = 2299.943 SDG

The accumulation of total cost (TC) till year 2001 (first production year)

TC = FC +VC = 2299.943+987.542 =3287.485

Profit in year 2001 = Income – TC = 2152 – 3287.485 = - (1135.485)

I.e. in year 2001(first production year) there was amount of 1135.485 SDG out of establishment cost had not been paid.

3- The future value of the rest of establishment cost in year 2002

$FV = C_0 (1+r)^n = 1135.485 (1.15)$ =1305.808 SDG

TC in year 2002 = FC + VC = 1305.808 + 421 = 1726.808 SDG

Profit in year 2002 = Income –TC = 1140 – 1726.808 = - (586.808) SDG

ie in year 2002(the second production year) there was amount of 586.808 SDG from establishment costs not paid.

4- The future value of the rest of establishment cost in year 2003

$FV = C_0 (1+r)^n = 586.808(1.15) = 674.829$ SDG

TC in year 2003 = FC – VC = 674.829 + 1078 = 1752.829

The profit in year 2003 = Income – TC = 2653 – 1752.829 = 900.171

I.e. in year 2003(the third production year) the establishment costs had been completely paid back and the forest achieved the first real profit.

5-5-7. Steps of pay back the establishment costs and obtaining the first real profit of the forest number 4

1- The future value of variable cost per feddan during the period (1997 – 2001)

Year 1997: $FV = C_0 (1+r)^n = 60(1+0.15)^4 = 60(1.15)^4 = 104.941$SDG

Year 1998: $FV = C_0 (1+r)^n = 90(1.15)^3 = 136.879$ SDG

Year 1999; $FV = C_0 (1+r)^n = 35(1.15)^2 = 46.288$ SDG

Year 2000: $FV = C_0 (1+r)^n = 40(1.15) = 46.000$ SDG

Year 2001: = 693

Total = 1027.108

2- The future value of establishment cost in year 2001 (first production year):

$FV = C_0 (1+r)^n = 1490(1.15)^4 = 2606.02$ SDG

The accumulation of total cost (TC) till year 2001 (first production year)

TC = FC + VC = 2606.02 + 1027.108 = 3633.128 SDG

Profit in year 2001 = Income – TC = 2567 =- 3633.128 = - (1066.128) SDG

I.e. in year 2001 (the first production year) there was amount of 1066.128 SDG out of the establishment cost had not been paid

3- The future value of the rest of the establishment cost in year 2002

$FV = C_0 (1+r)^n = 1066.128 (1.15) = 1226.05$ SDG

TC in year 2002 = FC + VC = 1226.05 + 380 = 1606.05 SDG

The profit in year 2002(the second production year) = Income – TC

= 1320 – 1606.05 = - (286.05) SDG,

I.e. in year 2002 (the second production year) three was amount of 286.5 SDG out of establishment cost had not been paid.

4- The future value of the rest of establishment cost in year 2003

The profit in year 2003

$FV = C_0 (1+r)n = 286.5(1.15)$ = 329.48 SDG

Total cost (TC) in year 203 = FC + VC = 329.48 + 1022 = 1351.48 SDG

The profit in year 2003 = Income – TC = 3202-1351.48 = 1850.52 SDG.

I.e. in year 2003 (the third production year) the establishment costs had been completely paid and the forest achieved the first real profit.

5.5.8/Internal rate of return of medium size sample

Table (5.28): IRR in average per feddan

Year	Cash flow			Net present value	
	Income (SDG)	Costs (SDG)	Net cash flow (SDG)	at interest rate 15% (SDG)	at interest rate 44% (SDG)
1997	-	-1447.7	-1447.5	-1447.50	-1447.50
1998	-	-80.5	-80.5	-70.00	-55.90
1999	-	-29.5	-29.5	-22.31	-14.23
2000	-	-34.5	-34.5	-22.68	-11.55
2001	2359.5	-727.5	1632.0	933.10	379.55
2002	1230.0	-400.5	829.5	412.41	133.97
2003	2927.5	-1050.0	1877.5	811.70	210.57
2004	1378.5	-556.0	822.5	309.21	64.06
2005	3717.5	-1397.5	2320.0	758.41	125.48

2006	2000.0	-723.5	1276.5	362.86	47.95
2007	5087.5	-1712.5	3375.0	834.25	88.03
2008	2717.5	-1021.0	1696.5	364.65	30.73
2009	6900.0	-2413.0	4487.0	838.65	56.44
2010	3564.0	-1412.5	2151.5	349.68	18.79
2011	8849.0	-3228.5	5620.5	794.34	34.10
2012	4415.0	-1937.5	2477.5	304.47	10.44
2013	10743.5	-4487.0	6256.5	668.60	18.30
2014	5112.0	-2462.5	2649.5	246.21	5.38
2015	13255.0	-5892.5	7362.5	594.93	10.39
2016	6407.5	-3070.5	3337.0	234.48	3.27
2017	16362.5	-7047.5	9315.0	569.15	6.34
Total	97026.5	-41132.0	55894.5	7824.61	-285.39

Table (5.28) designed to calculate IRR of the medium size sample. IRR calculated by using the following steps:

1- Determination of the years in which cash flows occurred.

2- Determination of the positive cash flows (income) and the negative cash flows (costs) by calculating the average of the annual income and costs of the two forests which formed the case study two (medium size sample.

3- Calculate the annual net cash flows = Income – costs in other words the algebraic sum of positive cash flows (income) and negative cash flows (costs).

4- Determine net present value (NPV) of net cash flows at two interest rates the first one is the lower (15%) which determined previously and the second is the higher of the interest rates estimated to be 44% then use the formula shown below.

IRR= The lower of Interest rates used to drive NPVs + Difference Between the two interest rates used × $\frac{\textit{NPV at the lower interest rate}}{\textit{NPV at the lower interest rate minus the NPV at the higher interest rate}}$

IRR = 15 + (44-15) $(\frac{7824.6}{7824.6-(-285.39)})$ = 15+29($\frac{7824.9}{7824.6 \mp 285.39)}$)

= 15+29 $(\frac{7824.9}{8109.99})$ = 15+27.98 = 42.98%

5.5.9/ Sample profitability

Three criteria can used to identify whether the investment is acceptable or not, those criteria are NPV, IRR and BCR.s

NPV: according to (William A.1984) an investment is acceptable if NPV is positive and is not acceptable If NPV is negative. Table (5.27) showed a positive NPV at rate interest rate 15% so the investment in this sample is acceptable and profitable.

IRR: If IRR of a project exceeds the company's required interest rate, this means the project is desirable and if IRR is fall below the required rate of interest, the project should be rejected (www.investinganswer.com/financial-dictionary2013).

According to the results of table (5.28) , IRR = 35.93% so it exceed the required interest rate which 15% , that means the investment is desirable because it is profitable.

BCR: it is indicator for project acceptance. The higher BCR the better the investment, If the benefit is higher than the cost the project is a good

investment, accept all the projects with BCR greater than 1(http://en.wikibedia-org.2015).

According to table (5.27) the benefit is greater than the cost, benefit = 7824.6 SDG while the costs = 7351.58SDG, and BCR is greater than one (BCR = 1.064) so the sample is a good investment.

5.6 Financial analysis large size sample

This sample is the case study three (the large size sample), it consist of two forests, each forest area is more than 4 feddan.

5.6.1 The fixed costs of the forests establishment operations of the large size sample area in average for one feddan (year 2005)

Table (5.29): Fixed costs details

No	Forest establishment operations	Costs (SDG)	Costs percentage
1	Land price	2925	69.3
2	Fence establishment	515	12.2
3	Land preparations	325	7.7
4	Seedlings (purchase & transportation)	205	4.9
5	Planting	250	5.9
6	Total	4220	100

- The forests are rain fed for that there are no cost of irrigation units establishment.
- There were no costs of fire line establishment.
- The fence was made up of low stone wall because the stones are available and cheap material in Jebal Marra area.

5.6.2 / large size sample variable cost

Table (5.30): variable costs details of the large size sample unit in average for one feddan

Years	Silvicultural cost			Protection cost	Harvest cost			Total
	Replanting	Weeding & climbers cutting	Sub total	Pests & diseases control	Trees felling and extraction	Governmental fees	Sub total	
2005	-	-	-	50	-	-	-	50.0
2006	125	190	315	35	-	-	-	350.0
2007	-	192.5	192.5	-	-	-	-	192.5
2008	-	205	205	-	-	-	-	205.0
2009	-	235	235	-	805.0	1006.5	1811.5	2046.5
2010	-	270	270	-	270.0	337.5	607.5	877.5
2011	-	310	310	-	1312.5	1487.5	2800.0	3110.0
2012	-	362.5	362.5	-	1135.0	1135.0	2270.0	2632.5
2013	-	415	415	-	2102.5	2148.0	4250.5	4665.5
2014	-	480	480	-	1607.5	1521.0	3128.5	3608.5
2015	-	545	545	-	3005.0	2775.0	5780.0	6325.0
2016	-	612.5	612.5	-	2250.0	2130.0	4380.0	4992.5
2017	-	725	725	-	4077.5	3840.0	7917.5	8642.5
Total			4667.5	85			32945	37698

Table (5.31): Present value of variable cost at interest rate 15% for large sample unit in average per feddan

Years	PV of Silvicultural cost SDG	PV of protection costs SDG	PV of harvest cost SDG	Total
2005	-	50.00	-	50.00
2006	273.91	30.43	-	304.34
2007	145.56	-	-	145.65
2008	134.79	-	-	134.79
2009	134.36	-	1035.73	1170.09
2010	134.24	-	302.03	436.27
2011	134.02	-	1210.52	1344.54
2012	136.28	-	853.38	989.66
2013	135.66	-	1389.33	1524.99
2014	136.45	-	889.32	1025.77
2015	134.71	-	1428.73	1563.44
2016	131.65	-	941.45	1073.10
2017	135.51	-	1479.84	1615.35
Total	1767.14	80.43	9530.33	11377.90

The variable cost were classified into three type, they were

a- Silvicutural costs which include replanting weeding and climbers cutting cost, the farmers make small spots water catchment in a same operation with weeding.

b- Protection cost which include diseases and pests control and guard, fence maintenance not used as important activity because the fence made of stone, also no fire lines opening.

The harvest cost (trees felling, extraction and government fees) were most expensive cost costs, this result insure that the cost of the tending and protection operations (pre harvest operation) is very low and not cost the farmer much.

5.6.3 Production analysis of large sample size.

Table (5.32): Production details of large size sample size during production period

Year	Quantity produced		
	Korki	Rossass	Total
2009	425	380	805
2010	115	110	225
2011	613	262	875
2012	420	148	568
2013	695	200	895
2014	475	110	585
2015	785	167	925
2016	495	105	600
2017	798	162	960
Total	4794	1644	6438
percentage	74.45%	25.55%	100%

Table (5.32) showed the annual production and unit price of the yield then calculate the income, the table analysis revealed the following results.

- The forest (sample size) specified on building poles production mainly of production grade korki (< 7- 10 cm) diameter and Rossass (11-17 cm) diameter.

- The production began after four year from establishment year (first production year 2009) then the production going annually, giving year of high production then a year of low production and so on.
- Yield unit price varies annually corresponding production grade variation.
- The highest production appeared in the ninth production year (2017).
- The lowest production appeared in the second production year (2010).
- The average of annual production per feddan during production period (2009-2017) was 715 light building poles detailed as follow :

  Korki = 531

  Rossass = 183

  715/feddan or 1702 /light building pole/hectare. In comparison with FNC eucalyptus plantation in Jebal Marra Forest Circle, as Elsiddig E.A (2007) reported that the selection harvesting system result in 20-25% removal every two years producing 300-400 stem/ hectare from the good stocked stands.

5.6.4 Cost analysis of the large size sample.

Table (5.33): Costs analysis for large size sample in average per feddan

Years	Fixed cost (SDG)	Variable costs (SDG)	Total costs (SDG)	Total cost PV at 15% (SDG)
2005	4220.0	50.0	4270.0	4270.00
2006		350.0	350.0	304.35
2007		192.5	192.5	145.56
2008		205.0	205.0	134.79
2009		2046.5	2046.5	1170.09
2010		877.5	877.5	436.27
2011		3110.0	3110.0	1344.54
2012		2632.5	2632.5	989.65
2013		4665.5	4665.5	1525.16
2014		3608.5	3608.5	1025.76
2015		6325.0	6325.0	1563.44
2016		4992.5	4992.5	1073.10
2017		8642.5	8642.5	1615.35
Total	4220.0	37698.0	41918.0	15598.06

Table (5.33) designed to analysis the costs of the large size sample. The costs of the large sample size were discounted to cost present value at interest rate 15 %, using equation $V_O = \frac{V_n}{(1.5+i)^n}$

Where: V_O = the present value of single payment

V_n = future value of single payment that is made in (n) year

i = the interest rate

n = the year in which the payment occurs

5.6.5 Income analysis of the large size sample.

Table (5.34): Income analysis of the large size sample in average per feddan

Years	Income (SDG)	Income PV at 15% (SDG)	Total costs PV at 15% (SDG)	Benefit (Net present value) (SDG)	Benefit cost ratio
2005	-	-	4270.00	- 4270.00	-
2006	-	-	304.35	-304.35	-
2007	-	-	145.56	-145.56	-
2008	-	-	134.79	-134.79	-
2009	8987.5	5138.63	1170.09	3968.54	3.39
2010	2950.0	1466.67	436.27	1030.4	2.36
2011	11475.0	4960.96	1344.54	3616.42	2.69
2012	8312.5	3124.98	989.65	2135.33	2.16
2013	14640.0	4785.84	1525.16	3260.68	2.14
2014	10627.5	3021.00	1025.76	1995.24	1.95
2015	19307.5	4772.52	1563.44	3209.08	2.05
2016	14207.5	3053.81	1073.10	1980.71	1.85
2017	26125.0	4882.95	1615.35	3267.60	2.02
Total	116632.5	35207.30	15598.06	19609.30	1.26

Table (5.34) used for income analysis the first column showed the year during which the income was earned, the second column for the undiscounted income, the third column calculate the present value of the income at interest rate 15%, the fourth column for the present value of the total cost which calculate previously in table (5.33) the fifth column showed the benefit cost ration (BCR).

The equation $V_0 = \frac{V_n}{(1.0+i)^n}$ used to calculate PV

Net present value calculated using the equation

NPV = $\sum_{t=0}^{n} (R_t - C_t) \frac{1.0}{(1.0+i)^t}$ used to calculate PV

Benefit cost calculated using equation

BCR = discounted value of incremental benefit ÷ discounted value of incremental cost. (https://en.wikipedia-org).

Table (5.34) analysis revealed the following results :-

- The total of discounted income (PV) during production period = 35207.36.
- Net present value NPV = 19609.30 SDG.
- The highest discounted income appeared in the first production year (2009) in amount of 5138.63 SDG.
- The highest BCR appeared in the first production year (2009) = 3.39.
- The lowest BCR appeared in the eighth production year (2016) = 1.85.
- The BCR for the whole production period (2009-2017) = 1.26.

5.6.6 The steps of pay back of establishment cost and get the first real profit of the forest number 5:

1-The future value of the variable costs for the period (2005-2009)

FV = $C_o\ (1+r)^n$ Where: C_o = cash flow at period 0, (r) = rate of return.

n = number of periods (www.finaceformula.net/future-value.html)

I- Year 2005: FV = $C_o\ (1+r)^n$ = $30(1+15)^4$ = 52.470 SDG

II- Year 2006: FV = $C_o\ (1+r)^n$ = $330(1+0.15)^3$ = $330(1+0.15)^3$= 501.889 SDG

III- Year 2007: FV = $C_o\ (1+r)^n$ = $185(1+0.15)^3$ =$185(1+0.15)^3$ = 244.663 SDG

IV- Year 2008: FV = $C_o\ (1+r)^n$ = $210(1+0.15)$ =210 $(1+0.15)$ = 241.50 SDG

V- Year 2009 = 2103.00 SDG

The accumulation value of variable costs 2009 3143.522 SDG

2-The future value of establishment cost at year 2009

FV = $C_o\ (1+r)^n$ = $3990(1+0.15)^4$ =6978.535 SDG

TC in year 2009 = FC + VC = 6978.535 + 3143.522 = 10122.06 SDG.

The profit in year 2009 = income – TC = 8910 – 10122.06 = - (1212.06) SDG

I.e. there was 1212.06 SDG out of establishment cost not paid.

The future value of the rest of establishment costs at year 2010.

FV = $C_O\ (1+r)^n$ = 1212.6 (1.15) =1393.87 SDG.

TC at year 2010 = FC + VC = 1393.87 + 874 = 2267.87 SDG.

Profit year 2010 = income – TC – 2820 – 2267.87 = 552.13 SDG , i.e. in year 2010 the second production year the establishment cost had been completely paid back and the forest achieved its first profit.

5.6.7. Steps of payback of establishment cost and get the first real profit of the forest number 6:

1-The future value of the variable costs for period (2005-2009)

FV = $C_O\ (1+r)^n$

Where: FV = Future value C_O = cash flow at period 0, r = rate of return, n = timer.

I year 2005: FV = $C_O\ (1+r)^n$ =70 $(1+0.15)^4$ = 70 $(1+15)^4$ = 122.43 SDG.

II Year 2006: FV = $C_O\ (1+r)^n$ =370 $(1+0.15)^3$ = 562.724 SDG.

III Year 2007: FV = $C_O\ (1+r)^n$ =200 $(1+15)^2$ = 264.50 SDG.

IV Year 2008: FV = $C_O\ (1+r)^n$ =200 $(1+15)$ = 230.00 SDG.

V Year 2009: = 1990.00 SDG.

The accumulative value of variable costs (2005-2017)

= 3169.654 SDG.

The future value of establishment cost at year 2009

FV = $C_o\ (1+r)^n$ = 4450 $(1+r)^n$ = 7783.078 SDG.

The accumulative value of total cost at year 2009 =

FV + VC = 7783.078 + 3169.654 = 10952.732SDG

The profit in year 2009 = income – TC = 9065 – 10952 – 732= -(1887.732) SDG

I.e. there were amount of 1887.732 SDG out of the establishment cost not paid yet.

2-The future value of the rest of the establishment cost at year 2010

FV = $C_o\ (1+r)^n$ = 1887 $(1+0.15)$ = 1887 (1.15) = 2170.892 SDG.

Total cost in year 2010 – TC = FC = 2170.892 + 881 = 3051.892 SDG.

Profit in year 2010 = income – TC = 3080 – 3051.892 = 28.108 SDG, i.e. in year 2010 (the second production year) the establishment cost was completely paid and the forest achieved its first real.

5.6.8. IRR of large size sample.

Table (5.35): Internal rate of return for the large size sample

Years	Cash flow			Net present Value	
	Income	Total cost	Net cash flow	At 15%	At 45%
2005	-	-4270.0	-4270.00	-4270.00	-4270.00
2006	-	-350.0	-350.00	-304.35	-241.38
2007	-	-192.5	-192.50	-145.56	-91.67
2008	-	-205.0	-205.00	-134.79	-67.21
2009	+8987.5	-2046.5	+6941.00	3968.54	+1570.36
2010	+2950.0	-877.5	+2072.50	1030.40	+323.32
2011	+11475.0	-3110.0	+8365.00	3616.42	+900.43
2012	+8312.5	-2632.5	+5680.00	2135.33	+421.36
2013	+14640.0	-4665.5	+9974.50	3260.68	+510.47
2014	+10627.5	-3608.5	+7019.00	1995.24	+247.67
2015	+19307.5	-6325.0	+12982.50	3209.08	+316.03
2016	+14207.5	-4992.5	+ 9215.00	1980.71	+154.69
2017	+26125.0	-8642.5	+17482.50	3267.6	+202.13
Total	+116632.5	-37698.0	+74714.50	19609.3	-23.71

Table (5.35) designed to analysis cash flow in order to calculate internal rate of return, the internal rate of return is the rate of interest when used to discounted cash flow to present value it result in discounted in come being exactly equal to the discounted costs. In other word the internal rate of return represent the profitability of the project in terms of percentage rate of interest.

The first column showed the year in which cash flow occurred, the second column showed cash flow in three type, income (positive cash flow), costs (negative cash flow) and net cash flow, the third column calculate the net present value at two interest rate the first (15%) the lower it was determined previously to calculate net present value it result in positive NPV, the second rate is estimated to be the higher one with negative NPV and closed to the first one.

After having derived two NPVs, one positive and the other negative, determined the IRR using formula show below

IRR = The lower of interest rate used to drive the NPVs + the difference between the two interest rate used x =

$$\text{IRR} = i_1 + (i_2 - i_1) \times \left\{ \frac{NPVi_1}{NPVi_1 + NPVi_2} \right\}$$

* As the NPV at the higher rate of interest will be negative this means adding the two NPVs together as so they are both positive (R.J.N Busby. 1985).

$$\text{IRR} = 15 + (45 - 15) \left(\frac{19609.3}{19609.3 + (23.71)} \right) = 15 + 30 \left(\frac{19609.3}{19633.01} \right) =$$

15+29.96 = 44.69%.

5.6.9 Sample profitability

NPV, IRR and BCR were used to identify whether the investment is acceptable or not.

NPV & IRR: - They are criteria widely used and accepted investment criteria recognizing time value of money. NPV: According to William A.

(1984) an investment is acceptable if NPV is positive and is not acceptable if NPV is negative, the table (5.34) showed positive NPV (+19609.3SDG). IRR**:** If IRR of project exceeds company's required rate of interest rate, that project is desirable, if IRR fall below the required rate of interest, the project should be rejected (www.investing answer.com/financial- dictionary .2013)

According the results, IRR was 44.69% it is exceed interest rate which used in NPV (15%) therefore the investment is desirable.

BCR: it is indictor for projects acceptance. The higher BCR the better the investment, if the benefit is higher than the costs the project is a good investment, accept all the projects with BCR how greater than 1 (https: // en. Wikipedia – org.2015)

According to table (5.34) result, BCR is 1.26 so the ratio was greater than 1 and the benefit is higher than the cost, therefore the project is a good investment.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion:

The analysis of the social characteristic of the owners concluded in. All the respondents are educated in different education level (khalwa 66.6% secondary school 16.7%, university 16.7%.

Most of the forests owners (83.3%) were employed farmers as main job and 16.7% of them were government employees.

Most of the respondents established the forests in their own land, no one of them established forest in rented land.

There was no any financial institution offered finance to the owners.

The analysis of the essential information of the forests revealed the following conclusion:-

83.4% of the forests located in Nertitei locality while 16.6% located in Zalingei locality.

Eucalyptus is the only tree that planted in the private forests for commercial value, and the dominant Eucalyptus species in the forests are *Eucalyptus citriodora, Eucalyptus umbulata and Eucalyptus camaldulensis*.

Selection felling was the trees felling system which used in the harvest.

The constraints that hindering the private forest development include:

The instable security situation was the most severe problem, difficulties on establishing nurseries as result to lack of money and tools, the

expensive government fees which have a bad effect upon the production, the agricultural legislations are insufficient to protect land and farmers and lack of agricultural financing institutions.

The financial analysis concluded in the following results:

The highest cost in the fixed costs (establishment costs) was the land purchase cost which was represented 74.4% of the establishment costs in the small size sample, 78.4% of the establishment costs in the medium size sample and 69.3% of the establishment costs in the large size sample. The highest cost of the variable costs was harvest cost. It represent (89.7%) of the variable costs average.

The production rotation is a technical rotation, aimed to produce building poles according to the market and population demand, the production grades were Korki (< 7-10 cm) in diameter and Rossass (11-17 cm) in diameter, the first production earned after four years from the establishment year, then continued annually, the owners managed their annual production to give a year of a high production then a year of a low production then a gain a year of high production so as to insure sustainable and desirable production grade.

The average of annual production:

The average of annual production of the small area category (small size sample) = 536 building poles / feddan, of the medium area category (medium size sample) = 571 building poles / feddan while the average annual production of the large area category (large size sample) was 715 building poles / feddan.

The average annual production in study area = 607 poles/ feddan.

The highest production year:

The year of the highest production in the small size sample was the first production year, the year of the highest production in the medium size sample was the 11^{th} production year and the year of the highest production in the large size sample was the 9^{th} production year.

The lowest production year:

The year of the lowest production in the three samples (small, medium and large) was the second production year because the yield of the first two production years produced from the origin stem then in the next years the yield produced from the coppices .

The production began to deteriorate from 13^{th} production year.

The establishment costs of the small and medium area categories were paid back in the third production year that means after 7 year from establishment year, while in the large category area were paid back in the second production year that means after 6 years from establishment year, generally, whenever the area increased the establishment cost would paid faster.

The highest income:

Generally the highest discounted income earned in the first production year because the yield of first production is of a good quality, good grade and well matured, it produced from the origin stem which expended four years of increment and tending.

(Benefit Cost Ratio) BCR:

The highest BCR for the three size sample appeared in the first year 2.24 for the medium size sample.

The lowest (BCR) of the small size sample appeared in the 9th production year = 1.147, the lowest (BCR) of the medium size sample appeared in the 14th production year = 1.076 and the lowest BCR of the large size sample appeared in the eighth production year = 1.85.

The BCR for the whole production periods for the three samples were, 1.12 for the small size sample, 1.064 for the medium size sample, 1.26 for the large size sample.

IRR:

The internal rate of return of the small category (small size sample) was achieved at 37.43%, of the medium category (medium size sample) was achieved at 42.98% and of the large category (large size sample) was achieved at 44.69%.

Samples profitability:

The three sample were acceptable and profitable investment because, NPVs of all samples were of positive value, the benefits were greater than the costs, BCR greater than (1) and IRR was exceeded the required interest rate that used in the samples. The large size sample is the most profitable because it achieved the greatest IRR 44.69% then the medium size sample in second degree with IRR= 42.98% and finally the small size sample with IRR = 37.43%.

6.2 Recommendations:

The study suggest some recommendation it ought to be applied by concerned stake holders so as to contribute in development of the private forests, these recommendation are :

Recommendation to FNC:

To activate the role of the forest extension so as to adopt the idea of the private forest among the community and explain to the decision makers in the state and localities governments and make them content of the environmental and economic high importance of private forests and enhance them to support the community forestry.

To declare supporting legislations to encourage the communal forestry in many ways serving in simplified the processes of the private forests registration and reservation, to reduce forest royalties and to exclude the new established forests of forest royalties for the first three production years, forming professional associations for owners similar to Gum Arabic Producers Society and conduct continual trainings to the community on the technical and financial administration of the private forest.

Recommendation to be achieved collectively by the owners and FNC:

Variegate the production by introducing fire wood production in addition to the building poles production.

Make further attention to the application of the silvicultvral tending operation (weeding, climbers cutting, thinning, and fire lines opening).

Recommendations to be achieved by integration of FNC and Forest Research Division in Agricultural Research Corporation:

To carry out studies to identify the physical rotation of Eucalyptus trees in the study area so as determine the tree age in which the productivity start to deteriorate so it must be uprooted to plants new seedling .

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Appendices

Appendix (1)

Annual rain fall average for the period 2008 - 2017

year / Localities	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Zalingei	561	409.8	540.1	553.6	785.3	474.4	387.4	374.8	481.2	711
Nertitei	954	601.5	1003	666.9	1407.8	1188.6	507	559.7	856.3	719
Average annual rain fall	757.5	505.7	771.6	610.3	1096.6	831.5	467.3	467.3	668.8	715

Zalingei Meteorological Station (2017)

استبيان

هذا الاستبيان صمم لجمع معلومات لأغراض دراسية تختص باقتصاديات غابات الكافور الخاصة بمحليتي زالنجي ونيرتتي بولاية وسط دارفور.

1/ معلومات عامة عن أصحاب الغابات الخاصة:

1-1 الاسم

1-2 الفئات العمرية

أقل من 24سنة ( ) من 24إلى 39سنة( ) من 40 إلى 55 سنة ( )

فوق 55 سنة ( )

1-3 الجنس: ذكر ( ) انثى ( )

1-4 حجم الأسرة: أقل من 5 فرد( ) من 5 إلى 9 فرد ( ) أكثر من 9 فرد ( )

1-5 المستوى التعليمي: أمي ( ) خلوة( ) ابتدائي ( ) ثانوي ( ) جامعي ( )

1-6 المهنة الاساسية: مزارع ( ) راعي ( ) عامل ( )

تاجر ( ) موظف حكومي ( ) أعمال حرة ( )

2/ معلومات اساسية عن الغابة:

2-1 الموقع:- المحلية :.....المدينة أو القرية:.....

2-2 تاريخ انشاء الغابة:.....

2-3 تاريخ بداية الانتاج :.....

2-4 نوع الملكية :- الشراء ( ) ورثة ( ) هبة ( ) ايجار ( )

2-5 إذا كانت مستأجرة ما مدة الايجار.....

2-6 مساحة الغابة :.....

2-7 نظام الري :- مطري( ) ري بالطلمبات ( ) ري فيض ( )

2-8 الأصناف الشجرية السائدة:- 1.....

2..... 3.....

2-9 الأصناف الشجرية الأخرى غير الكافور المستغلة تجارياً ونسبة مساحتها إن وجدت:

الرقم	الصنف	نسبة المساحة

2-10 أصناف الكافور بالغابة :- 1.....

2.....3.....

2-11 هل هناك فروقات في أسعر أصناف الكافور؟.....

2-12 ما مدى الدورة الانتاجية؟.....

2-13 نوع التمويل :_ تمويل ذاتي( ) تمويل حكومي( ) تمويل بنكي ( )

2-13 نظام الحصاد:- قطع كامل( ) قطع انتخابي( )

3/ الانتاج:

3-1 نوع الانتاج:- اعمدة بناء( ) حطب وقود( ) كتل نشر( )

3-2 تصنيف الانتاج من حيث الحجم:

الرقم	تصنيف الاعمدة المستديرة	القطر/سم
	كوركي درجة ثانية	
	كوركي درجة اولى	
	رصاص درجة ثانية	
	رصاص درجة اولى	

4/ التكاليف

4-1 التكاليف الثابتة:

الرقم	العمليات	التكاليف عند الانشاء (بالجنيه)	القيمة المعادلة لها حال (بالجنيه)
	سعر الارض بالفدان		
	انشاء المضخة والبئر (وحدة الري)		
	تحضير الارض (الحراثة، إزالة الادغال،...الخ)		
	الشتول		
	الغرس		
	الزرائب		
	منشآت		
	الجملة		

4-2 التكاليف المتغيرة:

4-2-1 تكاليف العمليات التربوية

الرقم	العمليات	التكلفة السنوية للفدان(بالجنيه)
	الرقاعة	
	الحش وقطع المتسلقات	
	صيانة وتشغيل البئر والمضخة	
	أخرى(أذكرها)	
	الجملة	

4-2-2 تكاليف الحماية

الرقم	العمليات	التكلفة السنوية للفدان(بالجنيه)
	الصيانة الدورية للزريبة	
	الفتح السنوي لخطوط النار والتفتيش	
	الحراسة	
	مكافحة الامراض والآفات	
	أخرى (أذكرها)	
	الجملة	

4-2-3 تكاليف الحصاد والتسويق

4-2-3-1 أعمال الحصاد

الرقم	الأعمال	التكلفة السنوية للفدان(بالجنيه)
	قطع الاشجار والمجاردة	
	الترحيل الى السوق	
	أخرى (أذكرها)	
	الجملة	

4-2-3-2 الرسوم الحكومية

الرقم	الجهة المتحصلة	نوع الرسوم	التكلفة السنوية للفدان (ج)	الشخص الذي يتحمل التكلفة	
				التاجر	المزارع
		العوائد الجليلة(الغابات)			
		الضرائب			
		الذكاة			
		المحلية			
		الجملة			

5/ العائدات (الدخل):

5-1 العائدات من الإنتاج الغابي:

الرقم	تصنيف الاعمدة المستدي	سعر القطعة		الانتاج السنوي للفدان(ج)
		في الغابة(ج)	في السوق(ج)	
	كوركي درجة ثانية			
	كوركي درجة اولى			
	رصاص درجة ثانية			
	رصاص درجة اولى			
	الجملة			

2-5 العائدات من الإنتاج الزراعي إن وجدت

الرقم	المحصول الزراعي	التكلف السنوية للفدا (ج)	العائد السنوي (ج)

6/ حدد فترات التوقف من الإنتاج إن وجدت مع ذكر أسبابها:

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7- ماهي الصعوبات التي تعترض العمليات في الغابات الخاصة؟

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