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The effects of *Prosopis juliflora* (SW.) DC. invasion on Livelihoods and the adaptation mechanisms: A case study on Amibara District, Afar National Regional State, Ethiopia

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A thesis submitted to the Collage of Development Studies of Addis Ababa University in partial fulfilment of the requirements for the degree Of Master of Arts in Development Studies, Environment and Development

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ACRONYMS

ANRS	Afar National Regional State
CSA	Central Statistical Agency of Ethiopia
ETV	Ethiopian Television
FARM-Africa UK	Food and Agricultural Research Management-Africa,UK based International Non-Governmental Organization
FGD	Focused Group Discussion
IAS	Invasive Alien Species
IUCN	International Union for Conservation of Nature and Natural Resource
PJ	*P. juliflora*
SPSS	Statistical Package for Social Sciences
UNEP	United Nations Environmental Program

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ABSTRACT

A survey on the effects of *P. juliflora* invasion on livelihoods and the adaptation mechanisms was carried out in Amibara district of Afar National Regional State, Ethiopia with a general and specific objectives of assessing the effects of the plant species invasion on livelihoods of the people and analyse the adaptation mechanisms towards the invasion, pre and post *P. juliflora* invasion livelihood, any livelihood diversification, and also the opportunities and challenges of *P. juliflora*. Both primary and secondary sources of data's were used. And the data's were analysed using qualitative description and descriptive statistics. The result shows that, the livelihood of the people in Amibara district were predominantly pastoralist indicating that livestock are the main economic and social assets of a house holds before the expansion of *P. juliflora* but their livestock number has decreased through time. One of the major reasons for the declining number of their livestock is the invasion of *P. juliflora*. And people living in the study area are forced to diversify their livelihood. Besides the plant has so many benefits including socio economic and ecological benefits. Despite those benefits *P. juliflora* has been also found to have challenges. Due to this the local people exerted different mechanisms to maximize the benefit and to mitigate the negative impacts. Experience elsewhere in the world shows that eradication of *P. juliflora* is found to be difficult and economically impossible. However there are spaces to reduce its expansion and utilize it, such as *P. juliflora* control through utilization, work in partner ship, differentiate the land use system and livelihood diversification.

Chapter One

1. Introduction

1.1 Background

Prosopis juliflora (SW.) DC. here after written as *P. juliflora* is one of the many exotic plant species introduced to Ethiopia and characterized as an ever green and a multipurpose dry land tree or shrub originally came from South America, Central America, and the Caribbean. It is resistant to drought and poor soils, tolerant to repeated cutting, provides high biomass, grows in poor soils and improves the fertility status and provides different products and services (Pasiecznik et al., 2001).

Under normal circumstances, *P. juliflora* is known for producing a variety of valuable goods and services: construction materials, charcoal, soil conservation and rehabilitation of degraded and saline soils. As a result of this and other benefits *P. juliflora* has been introduced to different parts of the world (Africa, Asia and Australia) during the last 100 to 150 years (Pasiecznik et al., 2001). Despite this however, as Esther and Brent (2005) clearly stated, the spread of the species has come out of control in many countries and is listed as one of the most invading species in the world on global invasive species data base. This leads to problems of different kind like reduction of pasture lands, decline in crop yield, loss of biodiversity, changing water flow, and due to its torn it injuries and poison livestock and human beings (Anderson, 2005).

Over the past years, the plant has invaded millions of hectares of land entitled for different land use system in Africa, Asia, South America and Australia and is still aggressively invading different parts of the world (Pasiecznik, 1999). According to Esther and Brent (2005), in Africa only, *P. juliflora* was introduced in 25 countries and spreading to almost all regions of the continent ,including (Morocco, Algeria, Tunisia, Libya, Egypt) in north Africa; (Cape Verde, Senegal, Gambia, Mauritian, Mali, Burkina Faso, Niger

and Chad) in the Sahel Region of western Africa; (Ghana and Guinea Bissau and Nigeria) in west Africa; (Sudan, Ethiopia, Eritrea, Kenya, Tanzania) in the east and horn of Africa; and (Namibia, Zimbabwe and south Africa) in southern Africa.

As in any other parts of the world *P. juliflora* was also introduced to Ethiopia for its positive outcomes. According to different literatures, it was introduced in 1970 from India by an Indian man and it was planted by food for work program in Dire Dawa, Melka Jebdu area (Rezene and Taye, 2007). Similarly, *P. juliflora* was introduced to the Afar Region some 30 years back. During that time the pastoralists were told about the merits of *P. juliflora* as an additional feed for livestock, fuel wood source, reclaiming salt affected soils etc. Due to the expected benefit it was planted in large areas in the region by programs like food for work until 1988 (Zeray, 2008).

Even though the initial thoughts of introducing *P. juliflora* were positive the outcomes have not been as expected. It intervenes the rural livelihoods negatively. There has been a different corrective measure taken by different actors including the local people but still with little or no success. This study will focus on assessing and analysing the effects of *P. juliflora* invasion on livelihoods and the adaptation mechanisms of the local people in Amibara district of the Afar National Regional State (ANRS).

1.2 Statement of the Problem

The International Union for Conservation of Nature and Natural Resources (IUCN) stated that *P. juliflora* is one of the exotic plant species that is invading different parts of Ethiopia. The Afar National Regional State is one of the severely affected parts of the country. According to Dubale (2006), over 70,000 hectares of land is invaded or at risk by *P. juliflora* in Afar Regional State alone. As a result it is becoming a threat for the livelihoods in the region among the pastoralist, semi-pastoralist, and mechanized farm land owners and others.

Various studies have attempted to examine the invasion of *P. juliflora* and its socio economic impact at the international and regional level. In Ethiopia, some research has been done about the invasion of the plant and many of the previous research attempts failed to uncover the effects of the alien species (P. juliflora) on the livelihoods of various groups of the people and their adaptation mechanisms.

1.3 Objectives of the study

1.3.1. General Objective

The general objective of this study is to assess the effects of *P. juliflora* invasion on livelihoods of the people in Amibara district.

1.3.2 Specific Objectives

- To identify the pre *P. juliflora* invasion on livelihood strategy of the people in amibara district.
- To assess post *P. juliflora* invasion on livelihood and livelihood diversification.
- To assess the opportunities and challenges of *P. juliflora* invasion on the livelihood of the people.

1.4 Research Questions

1. What was the livelihood strategy before *P. juliflora* invasion?
2. What has been changed in the livelihood strategy after *P. juliflora* invasion?
3. What are the opportunities and challenges of *P. juliflora* to local communities?
4. What are the adaptation mechanisms used by the local people?

1.5 Significance of the study

The findings of the study with regard to the effects of *P.juliflora* invasion on livelihoods and adaptation mechanisms are expected to render the following outcomes:

- The outputs of the research will help to assess and describe how *P. juliflora* is affecting livelihoods.
- The outcome of the research will help to create awareness on opportunities and challenges of the species.
- The research will also be useful to point out some possible alternatives to enhance the opportunities and mitigate the problems regarding *P. juliflora* invasion.
- It will also provide vital and accessible sources of information for further studies.

1.6 Limitation of the study

During field work there was limitations on language, the researcher do not speak the local language (Afarigna), and used an interpreters. The use of interpreter was become a barrier to understand their perceived experience and to be able to learn from their fiscal expression. And it hampers to understand their interest and be flexible during the field work. In addition to this there were also limitations on resource, lack of secondary resources about the plant.

1.7 Scope of the Study

This research is confined to assess pre and post *P. juliflora* invasion on livelihoods in Amibara district. It also focuses on the possible opportunities and challenges of *P. juliflora* invasion and any livelihood diversification and adaptation mechanisms. The research lacks coverage on other parts of the country.

1.8 Thesis Organization

This thesis is organized into five chapters. The first Chapter is introduction that provides background information, the statement of the problem, objective of the study, research questions, scope and organization of the thesis. Chapter Two is the part that deals with literature review. Chapter Three deals with socio-economic conditions of the study area and where the methodology behind this thesis is outlined and explains what methods are employed to address the research objectives and questions. It also explains the kind of data collected and gathered using various data collection instruments and looks at how the data gathered through different methods are analysed and presented. Chapter Four deals with results and discussions of the findings of the data gathered during the field work. Chapter five deals with conclusion and recommendations.

Chapter Two

2. Literature Review

2.1 The Introduction of P. juliflora in Africa and Ethiopia

One of the many reasons that *P. juliflora* is introduced in many parts of the world is because of deforestation that people does for fuel wood consumption. This concern brought the solutions of introducing *P. juliflora* as one means to cope up with fuel wood shortage (Mwangi &Swallow, 2005:5).

> *"In some circumstances, P. Juliflora can provide a variety of valuable goods and Services: fuel wood, charcoal, animal feed, construction Materials, soil conservation and rehabilitation of degraded and saline soils" (Pasiecznik 1999; Pasiecznik et al. 2001 as quoted by Mwangi &Swallow ,2008 :1)*

In Africa, *P. juliflora* was introduced in 25 countries spanning all regions of the continent. Some records indicate that the earliest introductions to Africa may have been in Senegal, South Africa, and Egypt in the early to late 19th century, but with a suspect that, earlier introductions may have occurred (Pasiecznik et al, 2001).

Even though many agreed that the major reason for introducing *P. juliflora* is interconnected with responding to deforestation the ways in which it was introduced still remain vague. In some parts of Africa the introductions were from trees with non-palatable pods while in some it may have come in via livestock transportation. When we look at specific countries, for example, in the Sudan it was reported *P. juliflora* plants were grown in experimental plantations in Khartoum in 1928 and 1938, where they were found to thrive best on sand dune crests, eroded slopes and sandy soils (Mwangi &Swallow, 2005). In the case of Kenya, the first documented introductions of *P. juliflora* was in 1973 for the rehabilitation of quarries near the coastal city of

Mombassa, with seed sourced 18 from Brazil and Hawaii (Johansson, 1985 cited in Choge et al, 2002)

In the case of Ethiopia the exact date and source of *P. juliflora* introduction had not been documented. However, it was believed to be introduced from India in 1970s by the ministry of Agriculture for conservation purposes (HDRA, 2005a). Since its introduction, *P. juliflora* has rapidly invaded vast areas of pastoral and agro-pastoral lands in Afar National Regional State and eastern Harargae. The tree has become invasive and is threatening livelihood of pastoralists and agro- pastoralists due to loss of pasture and indigenous trees and destruction of croplands. The invasion also formed impenetrable thickets, which blocked human and herd mobility, and the strong thorns cause mechanical injuries to both humans and animals (Shiferaw et al., 2004).

2.1.1 The introduction of *P. juliflora* in Amibara woreda

P. juliflora was introduced to the Amibara District in 1988 as a windbreak, to protect the citrus and for general amelioration of the harsh environment of the area. *P. juliflora* soon became noticeably invasive and it now threatens fields, rangelands and protected areas. It is aggressively invading pastoral areas where it covers thousands of hectares. The invasion of this species has been affecting livelihoods and native plant species as well as livestock vulnerability.
(http://www.eiar.gov.et/partner/ias_sites.pdf).

The impacts that *P. juliflora* is doing on the biodiversity of the areas it is widely invading and now making it a serious topic in Ethiopia. The fact that it has invaded large areas of mostly grazing land placed it as the national No. 1 invasive plant. Even though the species has been found threatening, there are still advantages; it is providing which has lead to different approaches in managing it. The most important benefit being a source for making charcoal and supports their families by selling it (HDRA, 2005).

Researches conducted in the fast spread and invasion of *P. juliflora* shows that both natural and human factors had contributed a lot. Environmentally, the places like Amibara where there is limited rainfall and saline soils have been conducive for *P. juliflora.* The life style of the nomadic local people has helped, as the animals eat the pods and travel long distances, disseminating seeds to new areas through droppings (HDRA, 2005).

2.2 Definition and Concepts of Invasive Alien Species

Alien refers to the state of being non- indigenous/new to a specific environment and/or context. It is usually attached to the different contexts indicating unfamiliarity. In the context of species, alien is annexed when they are newly introduced into a certain area which is out of their origin. Alien species might be introduced either intentionally or unintentionally to a new environment. Intentionally, they could be introduced for a variety of benefits, for example, for their social, economical and environmental benefits. On the other hand, unintentional introduction of alien species could be through the transportation of people and goods from their country of origin to new environments. Whether they are introduced intentionally or unintentionally many agree that alien species become an issue when they adapt the ecosystem they were introduced and flourish themselves and become invasive. This is when alien species threaten the environment and needs a clear approach to deal with their effects (African Environmental Outlook-2, chapter 10, invasive alien species: 331).

> *"Invasive Alien species, native to one area or region, that have been introduced into an area outside their normal distribution, either by accident or on purpose ,and which have colonized or invaded their new home, threatening biological diversity, ecosystems and habitats ,and human well-being".*

According to IUCN's report there are about 100 new lists of species in the world which are categorized as the worst invasive alien species among which *P. juliflora* is mentioned as one of them (Mwangi & Swallow, 2005:5).

2.3 Origin and Descriptions of P. juliflora

P. juliflora is characterized as an evergreen tree indigenous to South America, Central America and the Caribbean (Pasiecznik et al., 2004). It is also identified by its fast growing, nitrogen-fixing and tolerant to arid conditions and saline soils features. It has a large crown and an open canopy and extends to a height of 14 meters (Pasiecznik et al., 2004). The tree has a stem which is green-brown, sinuous and twisted with axial and strong thorns. The species has a bark of red-brownish colour and rough and has deep taproot system which enables it to go as far as it reaches deep water sources. The leaves are compound, dark bluish-green and have high tannin content (Pasiecznik et al., 2004; Matthews & Brand, 2004). Its yellow flowers appear through out the whole year. Its fruits are pods, where by the colour changes from green to yellow as they get ripen/mature (Masilamani & Vadivelu, 1997). High level of sugar is found in the pods (Talpada & Shukla, 1988; Batista et al., 2002) and is edible to livestock when ripe (Anonymous, 2003). A fully grown *P. juliflora* tree is able to produce 40 kg of pods per year (Alban et al., 2002).

Literatures written on *P. juliflora* indicate that in the early stage *P. juliflora* was given high value as it has the ability to grow where no other species seemed to be able to adapt new environment and grow easily. It was said as easy to plant, protects soil from erosion and sandstorms, use as shade and its pods serve as a source of food for livestock (Lenachuru, 2003).

2.4 Opportunities and challenges of P. juliflora

Many researches show that under the right circumstances, *P. juliflora* has lots of opportunities. The major once include its advantages related to producing a variety of valuable goods and services: construction materials,

charcoal, soil conservation and healing of degraded and saline soils. Its introduction in many parts of the world is also linked to the benefits it has in addressing many peoples' concern related to deforestation, and fuel wood shortages in the late 1970s and early 1980s (Mwangi & Swallow, 2004). Above all, its nature to survive in different environments where other tree species have failed to do so have became a major reason to spread it across the world as a solution to the problems mentioned above.

Generally speaking, the opportunities of *P. juliflora* can be summarized as Economical, Social and Environmental. Summarizing all these opportunities of the species Mwangi & Swallow discussed it as follows:

> *"Being a multipurpose tree, P. juliflora fits very well into 12 dry land agro forestry systems, controlling soil erosion, stabilizing sand dunes, improving soil fertility, reducing soil salinity, providing fuel energy resources, supplying feed and forage for grazing animals, furnishing construction timber and furniture wood, supplementing food for humans, and promoting honey production's. jliflora produces good quality fuel of high quality calorific value, which burns well even when freshly cut. It also produces high quality charcoal and its heartwood is strong and durable. It branches are widely used as fencing posts, while its pods which are high in protein and sugars may be important fodder for livestock, and / or food for humans(2004;11-12).*

The experience of India also shows that *P. juliflora* has been a vital tree for both arid and semi-arid regions and provides approximately 75% of the fuel wood needs (Babul, 2007).

Despite these benefits however, *P. juliflora* has been listed in the 2004 report of IUCN as one of the top 100 least wanted and threat species of the world's (IUCN, 2004).

A research conducted in Kenya showed that, there are several problems related to the species including the reduction of pastures for livestock grazing, reduced farm lands and associated opportunities for cultivation, and the disfiguration of livestock gums (especially goats) and tooth decay, both of which result in deterioration of livestock health and sometimes death. In economic terms *P. juliflora* is also associated with the cost it incurred while clearing it. Many people were also displaced from their home lands to look for Arable lands which might also result in conflict while the displaced seek alternative settlements. Environmentally, *P. juliflora* has also assumed to have killed off important and useful native trees where by the case of Iltepesi, Ilkiloriti, Ilwai, Kalalia are visible in Kenya (Mwangi & Swallow, 2005).

According to Dubale (2006), *P. juliflora* invasion related problems can also be explained in terms of the mechanical injury from thorns, closure of access roads, loss of multipurpose indigenous trees, increased predators population, loss of pasture, health related problems to animals feeding on *P. juliflora* pods, increased cost for land clearance for farming and increased malaria cases were the major problems caused as a result of *P. juliflora*.

2.5 Concepts and Definitions of Livelihoods

The term livelihood is defined by different scholars and development practitioners and written in different reference materials with a common understanding and consensus that it comprises people, their capabilities and their means of living, including food, income and assets. A well know definition is provided by Carney which states:

> *"A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (1998: 4).*

Similarly, Chambers and Conway (1992) on their discussion regarding rural livelihoods provided the following definition which is used as a reference by their successors:

> *"A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living" (Carney, 1998:4)*

The main point behind the above definition provided is the strong links it makes among assets and the different alternatives individuals own in reality to do activities differently that helps them to earn income to survive. Mean while, capabilities in the above definition is linked to the ability of individuals which enables them to use their potential as human beings in terms of being and doing and achieve what they want with their economic, social and personal features (Dreze & Sen, 1998:18).

Generally speaking, livelihood refers to the way people support their lives but not limited to this:

> *"A livelihood encompasses not only the income generating activities persuade by a household and its individuals ,but the social institutions, intrahoushold relations, and mechanisms of access to resources through life cycle" (Valdivia and Quiroz, no date,p:4)*

Thus, livelihood is also seen as the management of relationships, the confirmation of personal significance and group identity, and the interrelation of each of those tasks to the other in addition to meeting various basic needs (Wallman; 1984).

Building on the livelihood definition that Chambers& Conway provided , other group identifies five major categories of capital that adds to assets in the definition of livelihood which are natural, physical, human, financial and social capital, where each of them have their own attributes that builds them(Scoones 1998 in Ellis, 2000:8).

Regardless of the above livelihood concept, Ellis reminds his readers that such kinds of definitions might be attached to risks that are associated including the risks related to lack of flexibility to changes over time. Exemplifying the risks he said that rural livelihood in the present developing countries is fundamentally characterized by the ability to cope up with reality and try to adapt for survival. Thus, he suggested that livelihood should be taken as a continuous and ongoing process where its components change through time.

In contemporary world, many people relate livelihood with poverty and rural development. This is as a result of the fact that many people in the rural side of developing countries, earn their income and support their lives in activities often combined with, or linked to, agricultural production (Ellis, 2000) making water, land as well as livestock an important resources people needs to survive ;

> *"Water, land, livestock, crops and knowledge are essential resources / assets in generating the livelihoods of families in rural areas of the world" (Valdivia and Quiroz,, no date, p:6).*

In line with the discussion on livelihood, the issue of income is usually mentioned as they are inextricably related. This is due to the very reason that the income that individuals or households have at a certain point is said to be the most direct and appropriate measure outcome of the livelihood process. Many scholars agree that income encompass two components which are explained as in cash and in-kind. These two have high contributions to the material wellbeing of an individual or households as a result of the different livelihood activities that individual or household is engaged in (Ellis, 2000: 12).

Income sources with in the context of rural communities are broadly categorized into three major groups. Namely farm, non farm and off farm income sources (Ellis, 2000).

According to Ellis, farm income is broadly defined as those sources of income which include livestock as well as crop income, and comprises both consumption –in-kind of once own farm output as well as these obtained from output sold. On the other hand, off-farm income refers to the wage or exchange labour on other farm which is with in the context of agriculture. This is explained as those incomes including labour payment in kind gained through shared harvesting system and other non-wage labour contracts that are still highly practiced in many developing countries in the world.

The third category under income source is the non –farm income sources which refer to the non-agricultural income sources that individuals or households are engaged in to support their livelihoods. Examples given for non-farm income sources include non farm rural wage or salary employment, non-farm rural self employment (Ellis, 2000:13-14).

While categorizing income sources in to the above three broad definitions, Ellis tried to clearly state that these income classification might not be the same for all. Some gives classification which is different to the one stated as farm, non farm and off farm sources. As an example he put the definition

that Adam and He (1995) gave based on their study in Pakistan. These two researchers utilize six major income source categories as agriculture, non-farm, livestock, rental, domestic remittance and international remittance. What the scholars remind us is that income classifications are adapted to suit the methods and purpose of analysis. Based up on this freedom to divide up income sources to suit for different situations, the researcher stick to Agriculture and Pastorialism for the purpose of this research.

2.5.1 Livelihood diversification and Adaptation mechanisms

In this section livelihood diversification and Adaptation mechanisms by households as coping strategies and a means to respond to vulnerability and livelihood shock are discussed.

Different literatures suggested that over the past few decades many households are finding it difficult to survive with only a single activity. Rather, they are forced to devise different mechanisms as an income generating means for a variety of reasons, for example, due to natural stresses. A survey done in the horn of Africa showed that pastoralists have adapted their way of life over many centuries to cope with erratic rainfall (Stephen, 2006). The same survey revealed that households faced with a livelihood shock in Somali Region adopt a similar range of coping strategies. Immediate responses includes rationing of food consumption, call on support from relatives and redistributing food. Despite this however, these responding mechanisms are not long lasting and push people to look for alternative ways. Studies show that one of the mechanisms that households cope up with changes and survive is the maintenance and continuous adaptation to a diversified livelihood portfolio (Ellis, 2000: 2).

In the last decades quite a lot of evidences show that many people particularly in the rural areas of the developing countries are changing livelihoods due to several factors:

In line with this understanding diversification is defined by different people in different ways, though, the basic idea is to show the multiplicity of income sources for perusing people's livelihoods. One of the popular definitions of rural livelihood diversification is the one that Ellis put forward. According to his definition:

> *"rural livelihood diversification is defined as the process by which households construct a diverse portfolio of activities and social support capabilities for survival and in order to improve their standard of living" (2000 :17).*

Adding to this livelihood diversification in the rural context, some scholars including Ellis also define livelihood diversification from poor countries perspective. According to him (2000: 3) livelihood diversification in poor countries doesn't mean a combination of farming with short period of wage activity on a neighbour's farm or in a nearby rural town. According to the literature most people in the rural have in fact diversified sources which they get income from including non agricultural activities, trading (2000: 3). There is also empirical evidence from sub-Saharan Africa which testify this argument/statement:

> *"Studies show that between 30 and 50 percent of rural household income in sub-Saharan Africa are derived from non-farm sources" (Ellis, 2000:3-4)*

With in the discussion of livelihood diversification what comes in is the issue of determinant factors of livelihood diversification. Different types of determinant factors are forwarded explaining why people adopt diversified income portfolios. Among the many reasons, consideration of risk spreading, seasonality, credit market failures, and coping with shock are some of them which constitute different but still overlapping forces and processes that lead

"When definite outcomes in relation to income streams are replaced by probability of occurrences, the social unit diversifies its portfolio of activities in order to anticipate and to ameliorate the threat to its welfare of failure in individual activities".

In other words, risk strategies taken by individuals or households refer to the actions people take in advance when they perceive that their means or getting income is getting risky and they tend to diversify/substitute /complement their basic sources of income with an additional occupation.

Factors that increase risk are of different types and their effects differ from one income source to the other. This is to mean that risk related to natural disasters, for instance, might not have similar impact for the people who are engaged in different source of livelihood. This can be better explained with in the context of rural livelihoods in many developing countries, which are highly dependant on agriculture. That is individuals or households getting their income from their own farm production and agricultural wage labour are at a high risk with effects related to natural disaster like droughts and floods (Ellis, 2000:71).

The other determinant factor for diversification which is relevant to the discussion of this paper is the post reaction that individuals or households undertake. This mainly refers to coping or adaptation mechanisms. The major distinguishing factor between risk and coping/adaptation is the timing that people take measure. In other words risks refer to the pre action and the coping/adaptation refers to the post action.

In a detailed manner Walekr &Jodha (1986) as referenced by Ellis (2000) put the difference between the two as follows:

"Risk management is then interpreted as a deliberate household strategy to anticipant failures in individual income streams by maintaining a spread of activities; while coping is the involuntary

response to disaster of unanticipated failure in major sources of survival."(72).

Risk plays a key role in the activity diversification process because it strongly influences rural production, income and welfare, and as such, is major "push" factor that encourage households to turn to a more diversified portfolio of activities. As shown in many studies, households have incentives to combine traditional crops with new crops, agricultural crops with animal husbandry or forestry activities, and/or agricultural activities with off-farm activities such as migration and tourism (Demurger et al., 2007:10).

When we look at pastoralists' they also diversify their livelihood for a number of reasons. Pastoral diversification is defined as the pursuit of any non-pastoral income earning activity in both urban and rural environment. this includes various forms of wholesale and retail trade (e.g. selling livestock, milk, hides and skins, honey and artisan goods etc), rental property ownership and sales, wages employment (local and non-local, including working as a hired herder, farm worker, and migrant labourers), farming (subsistence and commercial) and the gathering and selling of wild products (Little, 2001; Watson and Binsbergen, 2008:1)

An example of pastoralist diversification is that of pastoralists in Turkana, and east Africa in general ,who are increasingly pursuing non- pastoral income strategies to meet consumption needs and to buttress against shocks caused by climatic fluctuation ,animal disease ,market failure and insecurity (Little, 2001; Watson and Binsbergen, 2008 :1).

As it has been already stated livelihood can fall under threat due to a number of factors. The introduction of alien species has been a big threat in many places putting livelihood activities under threat. Diversification contributes positively to livelihood sustainability because it reduces proneness to stress and shocks.

Chapter Three

3. MATERIALS AND METHODS

3.1 Location and description of the study area

The study is undertaken in Afar National Regional State, which is found in north eastern part of Ethiopia (Fig.1). The region covers 10% of the total area of Ethiopia. It has an area size of 100,860sq km which is stretching from Awash Station and the Allideghi plain of the Middle Valley in the south to the coastal depression of the Red Sea in the North (François Piguet, 2002). It is located 300 Km East of Addis Ababa. In Amibara 16 out of 18 Kebeles are invaded by *P. juliflora* (Amibara pastoralist and agricultural office). Amibara is characterized by pastoralists farming system with extensive communal range lands and commercial farms in the area (Senait et al., 2004)

Figure 1 Map of the Afar National Regional State

Source: http://www.ocha-eth.org/Maps/downloadables/AFAR. pdf research sites

3.2 Climate

Amibara is characterized by high temperature; it ranges from 25°c to 35°c.Usually the mean annual precipitation is less than 600 mm. May/June is the driest season of the year. The main rainy season (Karima), which accounts for above 60% of the annual total rainfall are from July to September. This is followed by the best grazing season of Kayra that occurs form September to November. Another minor rainy season is Sugum and appears during March and April. The Sugum accounts for 20% of the total rain fall. Gilal is less severe dry season with relatively cool temperatures (November to March). Occasional rainfalls called dada may interrupt Gilal (Abdurahman, 2004).

3.3 Population

According to a recent population census conducted by the Central Statistical Agency (CSA, 2008), Amibara district where the study has taken place has a population size of 63,280 out of which 35,301 are male and 27,979 are female and land area of 3,949 km2.

3.4 Economic characteristics

The most important income generating activity for Afar is animal husbandry. Largely, rearing of cattle, camel, sheep and goats for the daily subsistence need of milk and milk products, meat and hide. The people in the region are pastoralists who earn their living from their livestock. According to Abdurahman (2004) due to the aridity of the physical environment and widely dispersed nature of the natural resources, the Afar are likely to increase their movement from one place to the other seeking pasture and water. In addition to pastoralist ways of life the presence of the major river the Awash and the experience gained from the state farms established some four decades ago was supposed to bring a possibility of applying the wide use of irrigation farming to the region (Abdurahman, 2004).

members leave their home; some remain to safeguard their land and property.

3.6 Sampling procedure and sample size

The target population of this research is those kebeles affected by the alien species in Amibara district. In the district there are 18 Kebeles, out of these Kebeles 16 Kebeles are invaded by the species. Therefore, the focus was only on the 16 Kebeles and these 16 Kebeles are considered to be in a similar agro ecological zone. From these 16 Kebeles 4 Kebeles (serkemo,halaydegie,bedlualie,sidhafagie) were selected randomly using lottery method and because of the temporal and spatial mobility of people in the sample area, the local people who live in the four kebeles move with their herds in search of water and pasture to surrounding areas. Due to this, convenience sampling is found to be suitable to address and interview the sample respondents in this study.

Therefore, interviewee was conducted on four kebeles proportionally (34 respondents each) and total number of 136 respondents. The researcher believes that the sample size would have been good if it were more than this but due to financial and logistic limitation it was difficult to handle more than the stated number of sample.

3.7 Methods of Data Collection

The researcher has employed both primary and secondary sources of data. Using a combination of both sources to help the researcher to understand people, ideas and events from the past.

According to Eamon (2004) Primary sources of data are those sources which are original and first-hand accounts that people use as building blocks to create stories from the past. They are called primary sources because they are the first evidence of something happening, or being thought or said. He also added that primary sources of data are created at the time of an event,

or very soon after something has happened and gives an inside view of a particular event.

On the other hand secondary sources of data are different from those of primary sources since they are Second-hand and published accounts. They are given the name secondary because they are created after primary sources and they often use or talk about primary sources. These types of sources are very useful to get additional opinions on a past event or on top of a primary source (Eamon, 2004).

In this study, Primary data were gathered through survey study on livelihoods that are affected by the invasion of *P. juliflora*, governments and non government organizations and also mechanized farm land owners in the area using questionnaire, interview, focused group discussion and also observation techniques. Secondary data sources were also used including published and unpublished materials, books, journals, websites, maps, and so on.

3.7.1 Primary data sources

The researcher used different techniques of primary data collection. These were questionnaire, interviews, focus group discussions and also observation. Primary data were collected by a 50 day field work in the study area in 3 rounds.

3.7.2 Questionnaire

Questionnaire was one of the main sources of data for this research. Questionnaires are usually used to carry out an enquiry involving human beings. It gives the chance for people to tell about themselves (Cohn, 1993). This method was used as one primary source of data in this study and helped to get first hand information from the people who are affected by the invasion.

A total of 136 questionnaires were distributed to the selected kebeles proportionally. Field assistants were hired from the district in distributing and collecting the questionnaire. They were given training on some important general introductory procedures and how to handle the questionnaire. Due consideration was given while selecting the assistants since the quality of these people is one of the most crucial factor in determining the quality of information to be collected. Thus, the selected ones were those who know the place very well, which made it easy for the data collection, as they are well aware of the people living in the area.

3.7.3 Key informant interview

Interview are a common types of methods used while conducting social science research. They are taken as a straightforward and non-problematic ways of finding things out (Cohn; 1993). Defining interview Cannel and Kahn as cited by Cohn stated that interviews are one type of data collecting method 'initiated by the interviews for the specific purpose of obtaining research –relevant information and focused by him on content specified by research objectives of systematic description ,prediction or explanation'(Cohn, 1993:229).

Different scholars give different views on the types of interviews. Some differentiates the types of interview based on the degree of structure or formality of the interview. Here the basic difference is on the way the interview are set. That means, interview could be fully structured interviews where predetermined set of questions are asked and the responses recorded on a standardized schedule. The second one is semi structures interviews ,where the interviews has worked out the questions in advance but has a liberty to refine or modify the order depending upon her/his perception what seems most relevant in the context of the conversation. The types of modification could be rewording the questions, give explanation or cut out questions which don't seem relevant (Cohn, 1993)

Others like Powney and Watts (1987) differentiated the types of interviews as respondent interviews and informant interview. According to their explanation, respondent interviews show the interview remains in control all the way through the process implying that the interviews are unavoidably structured to some extent by the interviewer. Where as, in informant interviews, the principal concern is for the interviewee's opinion within a particular situation or context.

The key informant interview is a powerful data collecting instrument in social science research. These are people who understand the information needed and who are willing to provide the information they have. The key informant may be an expert or knowledgeable person with the first hand information about the research problem under investigation.

15 key informants were identified and recruited to tell important information about *P. Juliflora*. The key informants were chosen strategically in this study considering the content of the inquiry. The key informants included were of experts from Amibara district agricultural office, Farm Africa, farm land owners and elders.

3.7.4 Focus group discussions (FGDs)

Focus group discussion was also used to find information for the problem under investigation in this study. This type of method is carried out under the condition that the members of each focus group have something in common, characteristics which are important to the topic of study (Hancock; 2002).

Two focus group discussions were formed with the dwellers of two Kebeles: Allidegie and Bedlialie. In the focus group discussion 12 to 14 persons participated out of which only 3 were female. The number of female was few because of the fact that many were unwilling to participate in such kinds of gatherings where women are not highly encouraged to speak out their

minds. Some also refused for the focus group discussion for the main reason that they have tasks to handle at home. Similar cases of low number of women's participation were observed to feel out the questioner for the same reason of household burden.

Figure 1 FGD in Amibara district (Halaydegie)

During the discussion the researcher had an interview guide to direct a dialog among the focus group discussion in order to find their experience and view on *P. juliflora.* The FGDs were so vital in the research to get the lived experiences of the pastoralists and semi-pastoralists such as the main problems, challenges and opportunities *P. juliflora.*

The researcher used tape recorder to record the discussion and take note during the time of discussion. The use of audio helped a lot in capturing most of the points raised by the participant. The materials were later transcribed and used as necessary.

3.7.5 Observation

Another primary data collection instrument or tool used was personal/direct observation. This type of tool helps the researcher to gather some information which might not be found through other types of data collection methods. Observation is considered as a natural and obvious technique when actions and behaviour of people are crucial aspect of an enquiry.

According to Cohn (1993), different approaches to the use of observational method in enquiry have been developed. These are participant and structured observation. The first one is basically a qualitative type where as the second one a quantitative style. Even though, both have their own distinctive difference they share a major advantage as a technique since they are direct. As a result observation is taken as the appropriate technique for getting at "real life "in the real world (Cohn, 1993:191).

Despite these major advantages, observation has also disadvantages that many researchers agree on. One of the major concerns is the extent to which an observer affects the situation under observation. Another practical problem when employing observation as a technique to collect data is the fact that it is time consuming.

The researcher tried to use this mechanism with care so that personal biases don't pollute the findings.

3.8 Secondary Data Sources

Secondary data are collected by others for different purpose. Secondary data are used from various sources produced by different government and non government organizations according to their relevance to the purpose of the study. These data are helpful to conceptualize and provide clear ideas to analyse the research work. Secondary data also helps to gain better insight of the issue under study before and after getting in to the field work.

The researcher used secondary data from different sources that comprises published and unpublished sources, newspapers, articles, websites etc and also used census data produced by the Central Statistics Agency (CSA) in order to know the over all situation of the population of the region in general and the district in particular.

Furthermore, the researcher used documents produced by different organizations that are working on *P. juliflora* such as EIAR, Farm Africa and others that are required to collect data important for the study.

3.9 Data Analysis

Once the data have been collected for the needs assessment or the evaluation, it needs to be sorted out and make sense of what it means. Many of the data mainly fall under two major categories –words or numbers. However, those data that are collected as numbers data can be turned into words and some features of words can be captured in numbers (Cohn, 1993).

According to a report by United Stated General Accounting Office, GAO (1992:8) a successful data analysis, whether quantitative or qualitative, requires (1) understanding a variety of data analysis methods, (2) planning data analysis early in a project and making revisions in the plan as the work develops; (3) understanding which methods will best answer the study questions posed, given the data that have been collected; and (4) once the analysis is finished, recognizing how weaknesses in the data or the analysis affect the conclusions that can properly be drawn.

The process of data analysis under this study was carried out using qualitative description and descriptive statistics. The survey data were also analysed using descriptive statistics with the help of statistical Software (SPSS). SPSS stands for 'Statistical Package for Social Science Product'.

Further information from focus group discussion and key informants were crosschecked and analysed through triangulation. Observations from the field visit were described based on the check lists prepared from literature. None quantifiable information from open ended questions, key informants, interviews and focus group discussions were analysed through qualitative description.

Chapter Four

4. Result *and* Discussion

4.1 Socio-economic and Demographic Characteristics of the sample

A total of 136 respondents from four kebeles (serkemo, halaydegie, bedlualie, sidhafagie), in each kebele 34 respondents got the chances to respond to the interviews. When we look at the age category of the respondents 21.3% were in the age category of 20-30, 37.5% were within the age category of 31-40, 25.7 were from 41-50, 12.5% were within 51-60, 2.2% aged from 61-70, and only one respondent(0.7%) was over 70 (Table 1)

Table 1Age of respondents

Age Category	Frequency	Percent
20-30	29	21.3
31-40	51	37.5
41-50	35	25.7
51-60	17	12.5
61-70	3	2.2
70 and above	1	.7
Total	136	100

Of the total respondents from the distributed questionnaire only 21 of them were female, while the remaining 115 were male (Table 2). The number of female was lower due to the main reason stated on section 4.5.3. Of the respondent 95.6% were married and the remaining 4.4% were single who are youngsters and students (Table 3)

Looking at the educational level of respondents, generally speaking the educational level of the respondent is very low. According to the result 105 of them were illiterate, 17 were able to read and write and the remaining 14 educate up to grade 6 (Table 4)

Table 2 sex of respondents

Sex of respondent	Frequency	Percent
Male	115	84.6
Female	21	15.4
Total	136	100

Table 3 Marital status of respondents

Marital status	Frequency	Percent
Married	130	95.6
Single	6	4.4
Total	136	100

Table 4 educational level of respondents

Educational level	Frequency	Percent
Read and write	17	12.5
Illiterate	105	77.2
Modern Education(grade 1-6)	14	10.3
Total	136	100

4.2 Introduction of P. juliflora *in Amibara district*

The majority of the respondents (86%) responded that they knew *P. juliflora* between 10 to 20 years. Out of the remaining 14 % of the respondents, 1.5% were aware of the existence of the species 10 years ago, 8.8% of the respondent knew *P. juliflora* less than 10 years time. The remaining 3.7% were aware of it for more that 20 years (Table 5).

Table 5 How long did you know PJ

How long did you know PJ	Frequency	Percent
Less than 10 years	12	8.8
10 yr	2	1.5
11-20 yr	117	
More than 20 years	5	3.7
Total	136	100

According to Rezene et al,(2007) and Dubale (2006) the introduction of P. juliflora in Ethiopia was recorded to be in the 1970's by an Indian man . Since then the species has been introduced to other parts of the country including Amibara. According to key informants and from focus group discussion it was understood that the species was first introduced in the Amibara district some 20 years ago. Explaining how it was introduced the elders stated that "it was during the Derg regime that the local people were called for meeting in a place called Worer where some white men told to the crowd that the area, that is Amibara, is desert with no plants and they asked them to introduce the new plant species that would make their area green".

Some elders from the crowed asked the scholar if there could be any negative impact as a consequence of the introduction of the new plant. But they were told that there was no negative impact. Rather, they were convinced that the plant has benefits to them as well as their animals by being a fodder, shade, and by making the area green. Finally the local people agreed to introduce plant species. As a result *P. juliflora* were planted in a place called Mesno. Following this the local people started to come and take the seed and planted in their surrounding. But their effort was not successful and the plant didn't grow up. What they did was they went back to the scholar and asked why it did not grow up. The scholar informed the local people that the way they followed to spread the plant was not the right way and he advised them to give the pods of the plant to their animals to eat and then it will spread after it comes out with their dung. This is because

the fruit is not digestible and spread after it comes out through animal dung. The local people took the advice and did what they were told and they said this is how *P. juliflora* spread over.

On the other hand experts from Amibara agricultural and pastoral office said that, there are two assumptions on how *P. juliflora* was introduced in the area. The first assumption is that people brought it from eastern part of Ethiopia, and then planted it in Amibara. The second assumption says that there was a British man named Willil Ulcro, who used to work in Amibara irrigation development office and he is assumed to bring the species and planted in the area for its economic and environmental values.

4.3 Expansion of P. juliflora in Amibara

The majority of the respondents 84.6%, responded that animals were the means for the expansion of *P. Juliflora* in the area, 0.7% expansion through human being and the remaining 14.7% responded both animals and human being are the means for the expansion of P. Juliflora (Table6).

Table 6 how PJ expanded in Amibara

How PJ Expand	Frequency	Percent
Human	1	.7
Animal	115	84.6
Human and Animal	20	14.7
Total	136	100

Information gathered from key informants and FGD also indicated that, animals are the main means for the expansion of *P. juliflora*. According to them, animals eat the pod of *P. juliflora*; however it comes out through their dung undigested in their stomach. This helps it to germinate easily everywhere because it is resistant to drought and poor soils (Pasiecznik et al., 2001).

They also indicated that it is also spread by human beings through a similar process. According to them, the pod is testy and eaten up by children. However, it is not easily digested like that of the animals and comes out through their waste and germinates every where. The other way of its spread goes inline with their understanding of the potential benefit. That means, in the first years of the introduction of *P. juliflora* in Amibara, people planted it in their surrounding considering the positive aspects. As Lenachuru (2003) stated people in different part of the world plant P. juliflora to protect the soil from erosion and sandstorms, used as shade and its pods served as a source of food for livestock.

4.4 Livelihood in Amibara

The livelihood of the population of Afar in general and Amibara in particular was predominantly pastoralist indicating that livestock are the main economic and social assets of a household:

> *Afar pasturealism represents a highly rational adaptation to severe and adverse environment. In the traditional context, like other pasturealists, they keep multi-species, multi- purpose stock: to provide sufficient milk and meat, for social exchange and occasional sale. The afar value the camel more than any other animal (kassa* ,37: 2001).

The findings from respondents also show that, (97.8%) were pastoralist, before the expansion of *P. juliflora.* And only 1.5% was semi-pastoralist and 0.7% merchants (Table 7).

Table 7 previous livelihood of the respondents

Previous livelihood	Frequency	Percent
Pastoralist	133	97.8
Semi-pastoralist	2	1.5
Merchant	1	.7
Total	136	100

All the respondents said that their livestock number has decreased through time when they compare number of livestock they had before *P. juliflora* invasion and number of livestock they have today.

Before the expansion of *P. juliflora* in Amibara almost all of the respondents were pastoralists and they had many livestock's as it is shown in Table 8. The statistical figure shows that there were only 11.8% of the respondents who did not have camel before the expansion of *P. juliflora*. Others 88.2% had camels ranging from 1 to 400 and above before the introduction. Nevertheless the current figure indicates that the number of camel has decreased. As it can be referred in table 9, 30.1% of the people do not have camel currently and the remaining 69.1% have camel but ranging from 1 to 100.

Table 8 number of camel before the expansion of PJ

No of camel	Frequency	Percent
none	16	11.5
1-10	7	5.1
11-20	10	7.4
21-30	24	17.6
31-40	12	8.8
41-50	17	12.5
51-60	8	5.9
61-70	3	2.2
71-80	5	3.7
81-90	5	3.7
91-100	10	7.4
101-150	1	.7
151-200	4	2.9
251-300	1	.7
301-400	1	.7
>400	12	8.8
Total	136	100

Table 9 number of camel currently

No of camel	Frequency	Percent
none	41	30.1
1-10	63	46.3
11-20	11	8.1
21-30	8	5.9
31-40	3	2.2
41-50	6	4.4
51-60	3	2.2
91-100	1	.7
Total	136	100

When we see the case of cattle, it can be noted that 20 years ago only 1.5% of the respondent didn't have cattle where as the remaining 98.5% of the respondent had cattle which ranges from 1 to 400 and above (Table 10). While the current situation shows that 11% of the respondent do not have cattle and others (89%) have cattle ranging from 1 to 100 (Table 11). This shows a decrease both in number of cattle and ownership.

Table 10 number of cattle before the expansion of

No of cattle	Frequency	Percent
none	2	1.5
1-10	1	.7
11-20	11	8.1
21-30	8	5.9
31-40	14	10.3
41-50	17	12.5
51-60	15	11.0
61-70	6	4.4
71-80	9	6.6
81-90	4	2.9
91-100	17	12.5
101-150	9	6.6
151-200	8	5.9
201-250	2	1.5
251-300	1	.7
301-400	3	2.2
>400	9	6.6
Total	136	100

Table 11 number of cattle currently

No of cattle	Frequency	Percent
none	15	11.0
1-10	60	44.1
11-20	26	19.1
21-30	12	8.8
31-40	7	5.1
41-50	6	4.4
51-60	4	2.9
61-70	2	1.5
91-100	4	2.9
Total	136	100

The other livestock which the people living in Amibara depend on for a living is sheep .When we looked at the number of sheep before the expansion of *P. juliflora* and after has a major difference. Accordingly, 20 years ago only 13.2% of the respondents did not have sheep, the remaining (86.8% of the respondents) had sheep ranging from 1 to 400 and above (Table 12). Looking at the current figure it shows that 55.9% of the respondents do not have sheep, the remaining 44.1% have sheep ranging from 1 to 50. Similar to the decreasing trend of cattle, the finding shows that there is a decreasing trend both in the number of owners as well as number of sheep per person (Table 13).

Table 12 number of sheep before the expansion of PJ

No of sheep	Frequency	Percent
none	18	13.2
1-10	4	2.9
11-20	14	10.3
21-30	21	15.4
31-40	13	9.6
41-50	22	16.2
51-60	7	5.1
61-70	4	2.9
71-80	7	5.1
81-90	3	2.2
91-100	8	5.9
101-150	4	2.9
151-200	2	1.5
251-300	2	1.5
301-400	1	.7
>400	6	4.4
Total	136	100

Table 13 number of sheep currently

No of sheep	Frequency	Percent
none	76	55.9
1-10	33	24.3
11-20	14	10.3
21-30	7	5.1
31-40	4	2.9
41-50	2	1.5
Total	136	100

The same has been observed with regards to the decrease in the number of goats and donkeys before and after the expansion of the species in the area. Accordingly, looking at the figure 20 years ago only 7.4% of the respondents were found to have no goat, where as the other 92.6% respondents said they had goats ranging from 1 to 400 and above (Table 14). When looking at the current status, 19.9% of the respondents responded that they do not have goat. The remaining 79.1% of the respondents have goats but decreased through time and ranges from 1 to 60 (Table 15).

Table 14 number of goat before the expansion of PJ

No of goat	Frequency	Percent
none	10	7.4
1-10	3	2.2
11-20	13	9.6
21-30	14	10.3
31-40	18	13.2
41-50	10	7.4
51-60	15	11.0
61-70	6	4.4
71-80	7	5.1
81-90	2	1.5
91-100	16	11.8
101-150	10	7.4
151-200	2	1.5
201-300	2	1.5
301-350	1	.7
351-400	2	1.5
>400	5	3.7
Total	136	1oo

Table 15 number of goat currently

No of goat	Frequency	Percent
none	27	19.9
1-10	44	32.4
11-20	41	30.1
21-30	17	12.5
31-40	3	2.2
41-50	3	2.2
51-60	1	.7
Total	136	100

The study also found out a similar tendency in the case of donkey. According to the finding 54.4% of the respondents did not have donkey 20 years ago, where as the remaining 45.6% of the respondents had donkeys ranging from 1 to 70(Table 16). This situation has now changed and the number of people having donkeys has dramatically declined after the expansion of the species. Accordingly, 82.4% of the respondents do not have donkey, only 17.6% of the respondents said they have donkey ranging from 1 to 10(Table 17). This pattern in turn tells us that there is a decrease both in the number of owners and number donkeys per respondent.

Table 16 number of donkey before the expansion of PJ

No of donkey	Frequency	Percent
Do not have	74	54.4
1-10	58	42.6
11-20	2	1.5
21-30	1	.7
61-70	1	.7
Total	136	100

Table 17 Number of donkey currently

No of donkey	Frequency	Percent
Do not have	112	82.4
1-10	24	17.6
Total	136	100

In general it can be deducted for the finding that the number of livestock's in the district has decreased, which is as a result of many reasons. One of the main questions raised in this study was to find out the negative impacts of *P. juliflora* in Amibara. The results from the respondent clearly showed that one of the major reasons for the declining number of their livestock is the invasion and spread of the species.

Accordingly, of the respondents, 86.8% responded that their livestock number has decreased because of shortage of pasture land, drought and animal health problem, 6.6% responded because of shortage of pasture land and animal health problem, 2.2% said it is because of animal health problem and drought, 0.7% responded that the reason is that of the shortage of pasture land and animal health problem, 0.7% because of drought and the remaining 2.9% said it is as a result of shortage of pasture land (Table 18).

Table 18 the reasons for the decreasing number of livestock

Reasons for the decrease in livestock	Frequency	Percent
Shortage of pasture land	4	2.9
drought	1	.7
Shortage of pasture land and drought	9	6.6
Shortage of pasture land and animal health problem	1	.7
Drought and animal health problem	3	2.2
Shortage of pasture land, drought and animal health problem	118	86.8
Total	136	100

A similar phenomenon has also been observed in Kenya. According to a case study conducted by Mwangi and Swallow (2005) which looked in to Invasion of *P. juliflora* and local livelihoods in the Lake Baringo area of Kenya, they found out that in Ngambo, which was one of the study focus area , respondents noted that the most severe problems in relation to *P. juliflora* invasion is the reduction of pastures for livestock grazing, reduced farm lands and associated opportunities for cultivation, disfiguration of livestock gums (especially goats) and tooth decay, both of which result in deterioration of livestock health and sometimes death.

From those who responded that the major decrease in the number of their livestock is in relation to the shortage of pasture land 88.2% related it with the expansion of *P. juliflora*. They indicated that the expansion of the species

has resulted in shortage of pasture lands in the area since it occupies most of the space and prevent other types of plants including grasses to grow. The remaining respondents, 8.1%, relate the shortage of the pasture land due to the lack of rain, where as 3.7% did not give any answer (Table 19).

Table 19 why shortage of pasture land

Why shortage of pasture land	Frequency	Percent
Because of *P. juliflora*	120	88.2
nothing	5	3.7
Shortage of rain	11	8.1
Total	136	100

This finding coincides with the research undertaken by Shetie (2008). According to the evidence provided by the researcher the land invaded by *P. Juliflora* is increasing every time which in turn lead to the shortage of land used by the local community for different purposes. Comparing the land coverage of the species he found from the map of the study area, Shetie put that from the 1986 land use/land cover map interpretation and classification; *P. Juliflora* accounted 5.45% of the study area, where as in the year 2001 the figure has increased to 6.75% . From this finding he concluded that *P. Juliflora*, which was introduced to the area before 20 years, has been found and invading almost all land use types in the study area. However he commented that the extent and severity of invasion differ from one land use/land cover type to another (Shetie, 2008:44).

The other finding of this study relates to the decreasing and increasing pattern in the size of cultivation land through time. From the respondents 52.2% alleged that the size of land for cultivation in the area has increased in the last 20 years and 22.1% responded it has decreased and the remaining 25.7% declined from giving answer for the question.

also people who responded that they pursue two types of livelihoods at the same time. Accordingly, 20.6% pursue for a living as pastoralist and as civil servant and 2.2% responded that they are both pastoralist and merchant. (Table 21).

Table 21 Current livelihood

Current livelihood	Frequency	Percent
Pastoralist	59	43.4
Semi-pastoralist	25	18.4
Merchant	2	1.5
Employed	18	13.2
Civil servant	1	.7
Pastoralist and Employed	28	20.6
Pastoralist and Merchant	3	2.2
Total	136	100

Further information gathered from the FGD, and key informants also shows that the majority of the local people previously were pastoralist, highly dependent on the livestock they had. However, this has now changed due to the loss of the livestock and forced them to look for other alternatives as livelihood strategies. According to them, until recently people's livelihood in Afar regional state in general and Amibara district in particular were linked to pastoralism making livestock an essential asset. It was difficult to think their life with out the livestock they own. These livestock (camel, cattle, sheep, goat and donkey) were sources of income that the individual and households peruse as their livelihood.

Until recently the areas were favourable for these livestock. There were very large area of pasture land and different water sources suitable for livestock. Due to this people in the area had many camel, cattle, sheep, goat, and

donkey and used this as a source of food and also to buy industrial products. But, since the last 20 years most of the households in Amibara found it difficult to survive by perusing pastoralism as a main source of livelihood. As a result of this many are forced to divers their livelihood to semi-pastoralist, merchant, daily labourer, civil servant and guard as sources of income.

The main reason for livelihood diversification is because of the loss of livestock in the area due to from time to time drought, animal disease and invasion of *P. juliflora* on pasture land. From these three reasons many agree that the invasion of *P. juliflora* on pasture land is the major one. The invasion of *P. juliflora* contributed to the decline of the livestock in many ways. It was noted that in previous times, there were large area of pasture land in the area suitable for livestock, but, now most of these grazing lands are invaded by *P. juliflora* (16 out of 18 kebeles in the district is invaded by this species) and no plant species including grass is able to grow on the invaded land. This has resulted in the lack of availability of enough food for the livestock to eat. Moreover *P. juliflora* is invading different source of water and preventing livestock to drinking water in the area.

Similar to that of the Kenyan case mentioned earlier , in Amibara it was observed that livestock like sheep and goats are eating the pods of *P. juliflora* which makes them vulnerable to illness and goes to the extent of killing the livestock (Dubale, 2006).

All this contributed towards the decreasing number of livestock of many pastoralists in the district and became a push factor for them to change their livelihood from pastoralist to semi-pastoralist, merchant, civil servant and also pursue their livelihood as a daily labourer and guard in the private mechanized farming in the area. Some have also took other alternatives including cultivating different type of crops in a very small area of land. They started to produce crops like Maize, Teff, and Onion after clearing the area covered by *P. juliflora* besides raring livestock.

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As it is clearly stated in table 21 about 1.5% of the respondents have also said they have become merchants and pursue it as a way of their livelihood. Even though they become merchants it was found that this way of livelihood is still highly dependent on the species. From the focused group discussion the researcher was able to get the information that these merchants sell charcoal which they produced from *P. juliflora*. These results of the research agree with the study conducted by Shetie (2008). According to his findings the wood of the plant for firewood was the second and charcoal was the third most frequently mentioned product of *P. juliflora* in Amibara district where the research was conducted.

Figure 3 Selling charcoal has now become a source of income for many people in Amibara

4.6 Opportunities and Challenges of P. juliflora

In this section of the research the opportunities and challenges that *P.juliflora* brought to Amibara district. In accordance with the responses that were collected from the respondents there are benefits that the plant has and explained in different aspects including socio economic benefits and ecological benefits. I have tried to look at each of these benefits as follows.

4.6.1 Socio economic benefits of P. juliflora

Socio economic benefits refer to those benefits that the people got both socially and economically. The understanding of the respondents towards the benefits of the plant is accompanied by their thought of the plant still being harmful. Of the surveyed households 73.5% responded that *P. juliflora* is harmful and 26.5% responded *P. juliflora* is both harmful and beneficial. However, there was no one who responded *P. juliflora* is beneficial with out harm. From the households who said *P. juliflora* has same benefit, 19.1% of them use *P. juliflora* for charcoal, fuel wood, forage, house construction, furniture and fence.

Supplementary information gathered from key informants and FGDs also shows that the wood of the plant is used for firewood and charcoal. This is because the indigenous plants that were used for fire wood by the local people has now being replaced by *P. juliflora* and pushed them to use it for making charcoal as their main source of income. The researcher has also observed that both sides of the Addis –Djibouti highway is highly occupied by fire woods and charcoal available for sale for those who passes by. Dubale (2006) in his research tried to see the impacts of *P. juliflora* invasion and control using charcoal production in Afar National Regional State, Ethiopia and indicated that people have organized themselves in cooperatives and sales charcoals as income sources. In the three cooperatives (Serkamo, Sidehafagae and Gelaladura) he tried to look at the charcoal that it is sold on average at 36.32 ETB/bag in Addis Ababa for traders. However, this is not always the case since it sometimes can drop to 29 ETB/bag when a large amount of charcoal is supplied to the market. The main reason being the establishment of many cooperatives in the area and the involvement of individuals and investors in charcoal production and marketing.

Looking at the economic benefits of *P. juliflora* use in the Ng'ambo and Loboi areas in Kenya, fuel wood and charcoal were found to be important benefits

that people living in the area identified from the plant. In addition to these benefits most of the respondents (50 out of 65) said they harvested *P. juliflora* products for subsistence. This study has also tried to see the income people started to generate through *P. uliflora.* The statistical figure shows that Individuals in Ng'ambo area generate average benefits of Ksh 16,019(average exchange rate in 2003-4 was 75 Ksh = 1 US$) annually from the use of pods as dry season livestock fodder, construction poles, fencing poles, honey, fuel wood, charcoal and ropes. Where as in Loboi, the study indicated that the average annual value of *P. Juliflora* products was Ksh 9,613 per person. Fuel wood was identified as the most important benefit, with a mean annual value of Ksh 9,263 per person (Mwangi and Swallow, 2005).

The local people utilize the maximum opportunities out of the invasive species for different purposes. As it is clearly shown in the picture underneath the local people use *P. Juliflora* as a dead and live fencing around their houses. This has helped them to protect them and their livestock from enemies and intruders. Information provided by key informants also shows that fencing has helped them to live in peaceful with their neighbourhoods and enabled them to clearly distinguish once boundary from the other.

Figure 4 Animals fenced by P. juliflora

Figure 5 the local people also use the plant as a fence around their houses

The other social benefit people in Amibara experience is related to the uses of the plant as shade and stick. As it is known, Afar is one of the hottest place in the country. The weather condition in this area forces people to look for different alternatives to protect themselves form the sun. In Amibara district people gather /sit under *P. juliflora* looking for shades. The researcher has also witnessed this through observation where by people used the plant as a shade during the day time.

Another social and economical benefit that the species brought to other country like India is by being a source for honey production (Paceznick, 2001). This is due to the fact that it has flowers that attract bees. However, such benefit has not yet been observed in Amibara district.

According to the information gathered from FARM Africa of Amibara office, the species is now becoming a major source of fodder for livestock in the area. This is because of the edible nature of its pods. To maximize this opportunity they have organized a cooperative where by the members of the cooperative gather the pod of *P. juliflora* and grind it with a machine and then mixed with other animal forage and make it very good forage for the

livestock. *P. juliflora* has High level of sugar in the pods and are edible to livestock when ripe (Talpada & Shukla, 1988; Batista et al., 2002). A fully grown *P. juliflora* tree is able to produce 40 kg of pods per year. In addition to bring a fodder for the livestock this system had additional benefit in relation to controlling the expansion of the species. They explained that when the pod is grinded it will not germinate when it comes out through the animal dung ,which has been found as the main means where by P. juliflora has expanded a lot in the area. The cooperative members also use P.juliflora to produce charcoal for house hold consumption and for sell.

Figure 6 P. juliflora pods

Figure 7 P. juliflora has become a source of food for the livestock

As it has been clearly stated in the literature part of this study *P. juliflora* introduction in many parts of the world is in one way or the other linked to the benefits it has in addressing many peoples' concern related to deforestation, desertification and fuel wood shortages in the late 1970s and early 1980s (Mwangi & Swallow, 2004). Researches in Kenya show that under the right circumstances, *P. juliflora* has lots of benefits. The major once includes its advantages related to producing a variety of valuable goods and services: construction materials, charcoal, soil conservation and healing of degraded and saline soils. The experience of India also shows that *P. juliflora* has been a vital tree for both arid and semi- arid regions and provides approximately 75% of the fuel wood needs (Managing *P. juliflora* (Vilayati babul, 2001).

4.6.2 Ecological Benefits of P. juliflora

The other major benefit *P. juliflora* brought is explained in terms of ecological benefits. Key informants from Amibara agriculture and pastoralist office told to the researcher that, *P. juliflora* is the only plant species which grows well in desert areas with an evergreen leaves and stems under moisture stressed conditions and there by it improves the climate conditions of the area. According to the respondents, the nature of the plant play significant role in reducing soil erosion and the speed of wind has decreased after the plant has been introduced. Shetie (2008) also clearly stated that the existence of the species has contributed a lot for the ecological sustainability of the Amibara district, for instance, in reducing soil erosion. He also found out from the local people explanation that there were bare lands where other plants couldn't grow owing to the saline nature of the soil. *P. Juliflora* was the only plant that had invaded the area. This inturn has contributed a lot in protecting the areas from desertification.

A study conducted in Kenya to see the Spread of the introduced tree species *P. juliflora* in the Lake Baringo area, Kenya (Andersson, 2005) shows that there has been Improvements shown in soil water movement, moisture

holding capacity and hydraulic conductivity due to root penetration in soils planted with *P. Juliflora.*

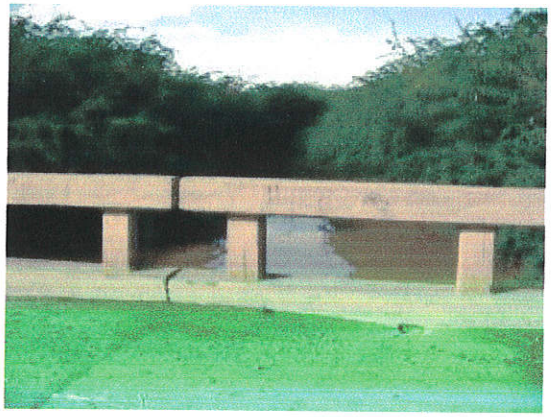
4.6.3 Challenges of P. juliflora

Despite those benefits mentioned above *P. juliflora* has been also found to have costs. The costs incurred by the plant are explained both directly and indirectly. From the respondents who respond *P. juliflora* is harmful, all said that *P. juliflora* has invaded pasture lands and farm lands affecting the mobility of herds, danger on human being and livestock due to the thorn, invaded settlement areas, blocking foot path, host to predators like hyena.

From the observation and as it is captured in the pictures underneath, *P. juliflora* has invaded both sides of the road which is making it difficult for the local people and their livestock to cross roads. It also invaded water sources making it difficult for the people to access water they use for different purposes.

The other cost incurred due to the invasion, as explained during the focus group discussion, was in relation to the decreasing volume of pasture land. The abundant growth and invasion of shared grazing lands is alleged to have reduced the amount of pastures available for local livestock. The main reason for this is that its deep rooting system consumes much moisture as well as shading under its thick canopies, which restricts grass growth and lead to little or no grass for livestock. This has become a major push factor for the local community to travel long distances in search for grass for their livestock. This has in turn brought a negative impact on their time that they would spend for other purposes.

Figure 8 Communities find it difficult to access water sources and the Roads due to the invasion of PJ



The study that Mwangi and Swallow (2005) conducted in Kenya revealed that *P. juliflora* has contributed towards water pollution since it drops its leaves on water. They also found out that the leaves make the water bitter. *P. juliflora* also obstructs drainage since it blocks watercourses and worsening the periodic effects of flooding. Similar to that of the Amibara case they also found out that *P. juliflora* has blocked key paths and roads used by both humans and livestock, requiring longer walking times to get to desired destinations.

The information collected through key informant interviews also revealed that for those people making a living as a farmer the plant has become a challenge as it is invading their cultivation land. According to them the abundant expansion of *P. juliflora* places a distinct danger to their farming activities. Many agreed that the cost incurred to clear up the land invaded by the plant and prepare it for farming is costly. To deal with the clearing they have to higher external labour since it is difficult to be handled by individual. Such kinds of investment on clearing up the land can only be afforded by few who have the capacity to do so and are becoming a challenge for many.

The other information collected from the key informants particularly from merchandize farm land in Amibara shows that *P. juliflora* prevents the smooth flow of water for irrigation. In addition they are afraid of walking and moving in the areas invaded by the plant since the thorn hurts them and also damage tyre of vehicle (tractors and cars). This in turn has imposed additional expenditures to clear up *P. juliflora* in the area, through hiring daily workers. To deal with this, merchandize farm lands usually allocate budget to control *P. juliflora* while it starts to germinate.

When the cost is calculated in terms of money, for instance, Middle Awash Agricultural Development PLC spends one million birr every year, to clear *P. juliflora* and to cover costs to medical expense for victimized workers or expenses for the damaged vehicles tyer. In a similar manner Africa Agricultural Development PLC also spends up to five thousand birr monthly, for clearing up *P. juliflora* and deal with the problems in relation to *P. juliflora*. According to the PLCs the clearance for *P. juliflora* consumes human power which can be used for other productive work.

Figure 9 Thorn of P. juliflora

Where as , some key informants from FARM AFRICA, and NGO worked in the area for about 10 years and currently working on *P. juliflora,* retaliate that in order to say *P. juliflora* is beneficial or harmful there needs to be two things to be taken under consideration :

1. The livelihood of the people where there is *P. Juliflora.*
2. The ecology of the area where there is *P. juliflora* invasion.

Explaining the above two factors for comparing the benefit and costs of the species, for instance, they said that the livelihood might be one of the major factor that could aggravate the negative impact of the plant. The people in Amibara district is highly related with pasture land and any thing that could affect the availability of the land has a direct implication in their lives, which has been observed because of the invasion of *P. juliflora.* However, if it were introduced in a different environment where the livelihood of the people is not heavily dependent of pastoralist, for instance, traders the impact might not have been as that of the pastoralists.

The second factor they put forward as a precondition to compare the benefit and costs of the plant is in relation to the ecology where it is introduced. This means that *P. juliflora* might be introduced for its environmental benefits. In this case we could say its benefits overweight the costs. Based on these two conditions it can be deducted that *P. juliflora* can be both harmful and beneficial to that specific area.

4.7 Controlling and Adaptation Mechanisms

The following paragraphs try to deal with the different controlling mechanisms as well as the mechanisms adapted in the area to minimize the cost incurred due to *P. juliflora* and maximize its benefits.

As it is clearly shown in the table underneath respondents' exerted different efforts to control the *P. juliflora* problem. These efforts have been undertaken both at the individual and group level. Among the different controlling mechanisms followed by the local people uprooting, group cutting, individual cutting, and burning are the major ones. From the respondents 38.2% said they tried to control *P. juliflora* by uprooting, 25% through group cutting, 24.3% through individual cutting , 7.4% by cutting and burning animal dung and 0.7% through burning animal dung. The remaining 1.5% responded that it is beyond their control.

Table 22 controlling mechanisms of P. juliflora

Controlling	Frequency	Percent
Cutting	33	24.3
Burning of *P. juliflora*	1	.7
Burning of animal dung	4	2.9
Group cutting	34	25.0
Nothing	2	1.5
Cutting and Burning of animal dung	10	7.4
Uprooting	52	38.2
Total	136	100

Figure 10 shows how the local people organize themselves into groups and clear up and burn those lands invaded by *P. juliflora* and prepare it for crop cultivation.

Figure 10 Burning of P. juliflora, Photo credit/ Dubale (2006)

While looking at the costs incurred by *P. juliflora* it was understood that the local people found it difficult to control it at individual level except for few. Due to this major reason the local people devised a mechanism to work in collaboration to clear up the invaded lands. According to elders the people including women and youth were called up and mobilized to remove *P. juliflora* from invaded areas and make it appropriate for cultivation.

Until recently the study area was favourable for the livestock that the people had since there was ample area for pasture land, which makes it suitable for livestock. Due to this people in the area had many camel, cattle, sheep, goat, and donkey and used this as a source of food and also to buy industrial products. However, since the last 20 years most of the households in Amibara are finding pastoralist difficult to survive. The main reason for this

was loss of livestock in the area; this is because of drought, animal disease and invasion of P. juliflora on pasture land. Due to this they are trying to use different adaptation mechanisms for survival as well as minimize the risks associated with the invasive alien.

As per the information the researcher got from key informants and FGD the local community in Amibara District are using different coping strategy such as diversifying their livelihood from pastorialism to other possible livelihood strategies. Consequently, many are forced to diversify and shift their means of livelihood to semi-pastoralist, merchant, daily labourer, civil servant and guard as an incoming source.

Kassa (2001) also stated in his book that many pastoral houses in Afar are gradually becoming sedentary, town dweller, engaging in casual farming, trade, production and sale of the diary products and other marketable goods, while others are engaged in wage employment. These coping strategies have enabled the local people to adapt to a change in socio-economic conditions.

The other coping strategy that the local people devised related is to allocating specific areas for grasses to grow where livestock could go and get their food from. As it was explained by elders the way they do it is that every dweller in the district fences an area which is protected from any personal and animal movement. On the one hand, this helps a lot for the grasses to grow without any interruption until they are ready to be used as livestock food. On the other hand, it will contribute for the decrease in the expansion of *P. juliflora* since there will not be any waste from animals in the protected area which has been found as a major way to spread and help *P. juliflora* to germinate. The local people also travel long distance to feed their livestock and are tired to adapt the problem they have in relation to the lack of accessibility of livestock fodder in their surroundings.

Chapter Five

5. Conclusion and Recommendations

5.1 Conclusion

As in many parts of the world the species was introduced to Ethiopia and Amibara district in with the assumption that it has benefits in addressing major concerns like deforestation and soil erosion. However, through time the species become an invasive plant and accompanied by challenges. The findings of the study revealed that *P. juliflora* has affected the livelihood of the study areas in different ways.

Almost all of the residents in the study area were pastoralist, depend on their livestock and some pursue their livelihoods as semi-pastoralist and merchants. However, after some time the number of livestock's they have decreased due to a variety of reasons, such as shortage of pasture land, drought and animal health problem. From those reasons the expansion of *P. juliflora* is the major factor for the shortening of pasture lands in the area.

Because of this shortage of pasture land, which is a major factor for the pastoral livelihood many have been pushed to diversify their livelihood to others. Due to this, as compared to the previous times, the number of people who were pastorals has dramatically decreased. Accordingly, 43.4% said they still pursue pastoralism as a way of living, which used to be (97.8%) before the introduction of *P. juliflora.* Others also have now became semi-pastoralist, guard or daily labourer in the mechanized farm's in Amibara district, merchants, and civil servants,

The research finding showed that *P. juliflora* has both benefits and costs to the local people and the different organizations working in the area. Its benefits are as a source of charcoal, fuel wood, forage, house construction furniture and fence. Furthermore, it reduces soil erosion and reclaims

degraded saline soil lands. The costs ,on the other hand, relates to the decreasing volume of pasture lands and farm lands, affect mobility of herds, danger on human being and livestock due to the thorn, invaded settlement areas, blocking foot path, and host to predicators like hyena. The pastoralists and agro pastoralists lost many livestock and spend a great deal of money to control the plant from the farm lands.

To cope with the problem local people have diversified their livelihood to cover crop cultivation, selling labour and charcoal marketing. The dilemma on the benefit and adverse impact of *P. Juliflora* can be solved by enhancing the benefits and implementing proper management options. Complete eradication of *P. Juliflora* is impossible at the current state of management options but it is possible to reduce further spreading with proper and efficient utilization of the plant. Currently, the local people are trying to manage the expansion of *P. juliflora* through uprooting, group cutting, individual cutting, cutting and burning of animal dung, burning of animal dung. In addition to this the local people are trying to diversify their livelihood and moving from place to place with their livestock as a reaction to the problem they face due to *P. juliflora.*

In general, from the respondents and key informant interview it can be said that currently the disadvantages of the plant out weigh the advantages. Thus, the pastoralists and agro-pastoralists highly recommended for the complete removal of the plant from the area. However, the researcher believes that minimizing the challenges and maximizing the benefits rather than going for *P. juliflora* eradication is very important.

5.2 Recommendations

Experience elsewhere in the world shows that eradication of P. juliflora is found to be difficult and economically not possible. However based on the finding of the research there are spaces for the local people and organizations working in the area to reduce its expansion and utilize it. Based on the results obtained from the study and field observations, the following recommendations are forwarded:

- Control through utilization; P. juliflora has both positive and negative impact on the livelihood of the local people as well as on the ecology. Therefore, it has to be controlled to minimize the negative impact and maximize the positive impact. This can be realized through organizing the local people to utilize the plant effectively, control further Invasions and diversify source of income of the local people, collect and grind the pods of P. juliflora for livestock consumption, charcoal production and clearing P. juliflora for farm land.
- Work in partnership: experiences show that individual solution to deal with P. juliflora has been less fruitful. Thus, to make the management and efforts more effective partnership among different stockholders such as government and non government organization as well as the local community is highly important.
- Differentiate the land use system; the majority of the local community livelihood is highly dependent on pastoralism making pasture land a high valuable asset. As a result of this pasture land has to be protected from animal and peoples movement making it suitable for grasses to grow for livestock.
- Apply different controlling mechanisms simultaneously: to control the expansion of P. juliflora there needs to be different mechanisms applied rather than sticking to one or two. A combination of uprooting the seedling, cutting, and burning the plant and animal dung might be a better way of controlling the expansion.
- Livelihood diversification: even though the local people have started to diversify their livelihood this needs to be encouraged a lot which would help a lot to minimize the risks they experience as a result of the expansion of P. juliflora in the area.

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Annex

A. Interview based questionnaires for households

This is a survey for an independent study by a graduate student at Addis Ababa University colleges of development studies, environment and development. In this survey there are several questions that you are kindly requested to provide your real feeling on the invasion of P. juliflora and its effect on livelihood. Your honest answers are helpful for the study .this survey is anonymous.

Thank you for your cooperation in advance!

_General information

- Kebele/village name	
- Enumerator name	
- Time of interview	
- Questionnaire No.	
- Date	

1. name of respondent
    a. Age _____
    b. Sex_____
    c. Marital status _____
        ☐ married
        ☐ single
    d. educational level of the respondent
        ☐ Basic education (religion)
        ☐ Formal schooling (grade)_____

☐ Illiterate

1 Pre –P. juliflora invasion livelihood information

1. How long did you know P. juliflora?
   a. less that 10 years
   b. 11-20 years
   c. More than 20 years
2. How was it expanded in Amibara?
   a. Human beings
   b. Animal
   c. Flood
   d. Wind
   e. Others, specify _____
3. For <Q2> if <a> is chosen, please explain how?
   _____
   _____
   _____
4. For <Q2> if <b>is chosen ,please explain_____
   _____
   _____
5. Pre-P. juliflora invasion livelihood of the household depend on
   a. Pastorialism
   b. agro-Pastorialism
   c. Trade, specify _____
   d. Employed ,specify _____
   e. Share from clan land
   f. Others, specify _____
6. For <Q5> if <a>is chosen ,please explain the trend of livestock you had

Species	No.
Camel	
Cattle	
Sheep	
Goat	
Donkey	
Don't have	
Others ,specify	

7. For <Q5>if <b>is chosen please explain the trend of cultivation you had

   7.1 size of the land owned (ha) _____

   7.2 cultivated area_____

   7.3 List of crops cultivated before in the order of importance

      a. _____

      b. _____

      c. _____

II. Post –P. juliflora invasion Livelihood information

8. Current livelihood/or post P. juliflora livelihood of the house hold depends on

   a. Pastorialism

   b. agro-Pastorialism

   c. Trade ,specify_____

   d. Employed, specify _____

   e. Share from clan land_____

   f. Others ,specify_____

9. For <Q8>if <a>is chosen, please explain the trend of livestock size you have

Species	No
Camel	
Cattle	
Sheep	
Goat	
Donkey	
Don't have	
Others, specify	

10. For <Q8>if<b>is chosen, please explain the trend of cultivation

10.1 size of the land you have currently (ha) _____

10.2 cultivated area_____

10.3 lists of crops cultivated now by order of importance

a. _____

b. _____

c. _____

d. _____

11. For <Q8>if <c>is chosen, what kind of trade? And explain why you change the livlihood_____

_____

_____

12. For <Q8> id <d>is chosen ,where are you employed and how you are employed_____

_____

_____

13. Main reason for the decrease in livestock trend (choose only one)
    a. Shortage of grazing land
    b. Drought
    c. Disease
    d. Others, specify_____

14. For <Q13>if <a>is chosen, please specify_____

_____

_____

15. The size of land for cultivation in the last 20 years
    a. Increased
    b. Decreased

16. For <Q15>if <b>is chosen , please explain why

_____

III. Information on opportunities and challenges of P. juliflora invasion

17. The effect of P. juliflora on household
    a. Beneficial
    b. Harmful
    c. Both a and b
    d. No effect

18. A. For <Q17>if<a> is chosen, what are the benefit of P. juliflora , choose more that one when necessary

Service	For household consumption	For trade	Amount unit /day/week/monthly/yearly
☐ Charcoal			
☐ Fuel wood			
☐ Forage			
☐ Household construction			
☐ Local furniture			
☐ Fence construction			
☐ Shade			
☐ Honey			
☐ Walking stick			
☐ Others ,specify			

B. if you have chosen charcoal for trade what is your monthly /annual income? Explain

_____

18. For <Q17>if <b>is chosen ,what are the harms of P. juliflora ,choose more than one when necessary

- ☐ Denied access to grazing land
- ☐ Denied access to farm land
- ☐ Disruption of seasonal mobility of herds
- ☐ Loss of crop land (hectare)
- ☐ Injury to livestock (due to its thorn), explain _____
- ☐ Injury to farming (due to its thorn), explain_____
- ☐ Invading settlement areas/villages
- ☐ Troubling herders for site control of other herds
- ☐ Other, specify _____

19. How are you managing P. juliflora invasion ,explain_____
20. What traditional methods are used to avoid P. juliflora invasion,explain_____
21. What traditional methods are applied to enhance the opportunities of P. juliflora invasion? Explain_____
22. What traditional methods are applied to mitigate the problems of P. juliflora invasion? Explain_____

B. **Questions for Government Officials**

- How long has it been since P. juliflora was introduce to Amibara? What are the factors that contribute for the expansion of P. juliflora?
- What was the livelihood of the people do like before P. juliflora invasion?
- What about the current livelihood of the local people?
- What are the benefits of P. juliflora to the local people?

- What are the problems of P. juliflora to the local people?
- What was the area covered by P. juliflora before 20 years and the current land coverage of P. juliflora?
- What was the farming land coverage before P. juliflora and what is the current farm land coverage in Amibara?Why did the coverage increased /decreased?
- What was the grazing land coverage before P. juliflora and after Prosopis Juliflora? Why did it increased/decreased?
- What measures are taken to enhance the opportunities and mitigate the challenge?
- What activities are undertaken by the government and non-government organizations?
- What impacts does it have on the economic, social and environment both in terms of positive and negative aspects?

C. **Questions for Non Governmental Organizations**

- What are the objectives, role and mandate of your organization? What are the advantages and disadvantages of the invasion of P. juliflora?
- Do you think P. juliflora is useful? If yes, how? If not, how?
- What impacts does it have on the economic, social and environment both in terms of positive and negative aspects?
- What are the problems to enhance the opportunities and to mitigate the problems?
- Any thing you did so far?
- What are other countries experience on the benefit and management?
- What are the factors that contribute for an effective management of P. juliflora?
- What should be done for the future?

D. **Questions for Farm Land Owners**

- What do you cultivate?
- Area of land you have?
- Any impact of P. juliflora on your cultivation?
- How much is the cost you spend to eradicate the invasion?

- What are the problems to manage the invasion of P. juliflora?
- What are the responses of the regional and national government?
- What do you think are the most serious problem you have to manage Prosopis Juliflora?
- What do you suggest as a solution?

E. **Questions for Focused Group Discussion**

- Do you remember how P. *juliflora* is introduced in the area? What was the situation look like during that time?
- What are the factors that contribute for the expansion of *P. juliflora*?
- What was the livelihood of the people do like before *P. juliflora* invasion?
- What about the current livelihood of the local people?
- What are the benefits of *P. juliflora* to the local people?
- What are the problems of *P. juliflora* to the local people? What impacts does it have on the livestock, grazing land, cultivated land, etc?
- Do you want its existence in the future? If yes, why?
- What do you want to be done for you for the future?
- Is there any livelihood diversification because of *P. juliflora* invasion?
- What are the responses of the regional and national government?
- Do you have any traditional methods to manage the invasion of *P. juliflora* ?
- What do you suggest as a solution?

Declaration

I, the undersigned, declare that the thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

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