Addis Ababa University
School of Graduate Studies
College of Natural and Computational Sciences

Assessment of the Local Distribution and Socio-economic Impacts of S*triga hermonthica* (*Delile*) B*enth.* (Scrophulariaceae) in Dejen Woreda (Abay gorge) East Gojjam Zone Amhara National Regional State, Ethiopia

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A thesis submitted to the School of Graduate Studies of Addis Ababa University in Partial fulfillment of the Requirementsfor the Degree of Master of Biology

August, 2017
Addis Ababa

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DECLARATION

I, the under signed confirm that this thesis is my original work and has not been Presented for a degree in any other University and that all resources of materials used for this thesis have been duly acknowledged.

Name: Minwyelet Belay

Signature: ________________

Date of submission: ______________________

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Abstract

This study is conducted to assess the local distribution of Striga hermonthica and to find out its socio- economic impacts in Dejen Woreda (Abay gorge) East Gojjam Zone.The study was mainly initiated because Striga hermonthica is a challenge for food security in the study area. For this study data were collected through observation, information obtained from farmer and agricultural expert respondents. The tool used was questionnaires. To fill these questionnaires 100 farmer household respondents were selected purposively from elders and farmers renowned for their agricultural performance within the district, and 15 agricultural expert respondents were also involved. The study revealed that Striga hermonthica is highly distributed in the farmlands of the study area. And its infestation is inversely proportional to the soil fertility of the study area. This meanse as the soil fertility decreases Striga hermonthica infestation becomes high.This is confirmed from the response of farmers on crop yield obtained from Striga infested and non-infested cropland. Farmlands which are infested with Striga have shown a decrease in crop yield. This causes food insecurity of the local people. To alIeviate this problem it is recommended that seed which is not contaminated by Striga and fertilizer should be provided to farmers, Woreda agricultural experts should make clear the various mechanisms of Striga dissemination and control to the farmers, the Woreda agricultural office and administrative office should work in coordination to find NGOs that can provide Striga control products to the farmers and finally it is recommended that the woreda health office should educate the local people to limit their family.

Key words: *Dejen Woreda* (*Abay gorge*), *Invasive alien species, Striga hermonthica, local distribution, Socio-economic impact.*

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List of Abbreviations

AATF	African Agricultural Technology Foundation
APS	Agricultural Production System
CSA	Central Statistical Authority
GAPs	Good Agricultural practices
GDP	Gross Domestic Product
HH_S	Households
IAS	Invasive Alien species
IITA	International Institute of Tropical Agriculture
KARI	Kenya Agricultural Research Institute
SSA	Sub-Saharan Africa
UNEP	United Nations Environment Program

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Organisms can move from their native area to any other environment. In the new environment some of them become invasive and referred as Invasive Alien Species (IAS). In this environment they cause biodiversity loss, and threaten not only biodiversity but also economic development and human wellbeing (UNEP, 2013). From the various invasive species, parasitic weeds are those that are highly problematic in the agricultural production system (APS) in the world today (Atera *et al.*, 2011). The impacts of IAS are enormous; they cause alteration in ecosystem processes and community structure, decline in abundance and richness of native flora. Globally the extent of damage caused by invasive species has been estimated to be £ 1.5 trillion per year, close to 5% of global gross domestic product (GDP). In developing countries where agriculture accounts for a higher proportion of GDP, the negative impacts of invasive species on food security and economic performance can be even greater which exacerbate poverty (Solomon Chanie and Adane Assefa, 2015).

As it is shown in Runyon *et al.*, (2009), about 4,500 species of flowering plants (more than 1% of all angiosperms) are parasitic, obtaining some or all of their water and nutrients from other plants. A small percentage of these parasitic species infest agricultural crops and cause series problems for farmers in many parts of the world. These parasitic plants jeopardize the agricultural sector that contributes the largest to the economies and livelihoods of many African countries (Atsbha Gebreslasie *et al.*, 2016). The most economically harmful and devastating parasitic weed seed plant which is known globally is the genus *Striga* commonly called witchweed (Atera *et al*., 2013). Therefore, to make appropriate management and control measures countries should evaluate the distribution and socio-economic impact of *Striga* species.

There are many *Striga* species which are economically harmful. Of the most economically harmful *Striga* species worldwide are purple witch weed *Striga hermonthica*, and Asiatica witchweed (*Striga asiatica* (L.) Kuntze). Striga hermonthica is believed to be originated in the region between the Nuba Mountain of the Sudan (Esilaba, 2006) and the Semein Mountain of Ethiopia (Hayelom Berhe, 2014) where it causes severe losses in most cultivated crops, impacting the livelihoods of over 100 million African people. Though, it is endemic in the African savanna currently, *Striga hermonthica* constrained the production of sorghum globally (Atsbha Gebreslasie *et al*., 2016).

As it is noted in Larsson (2012), worldwide several million hectares of arable land are infected by purple witchweed *Striga hermonthica*, which causes crop losses of billions of $ US per year. It is estimated that 50 million hectares and 300 million farmers in sub-Saharan Africa (SSA) are affected. This estimation is equals to an infestation corresponding to 40% of the arable land and to crop losses of about 7 billion $ US yearly.

Although studies which were carried out so far showed that *Striga hermonthica* causes great loss of cereal crop production, its distribution and socio-economic impacts are not studied. Therefore, the purpose of this study is to examine the distribution and socio-economic impact of *Striga hermonthica* in the study area.

1.2. Statement of the problem

Striga (*Striga* species) or witch weed infestation is increasing as a problem to small-scale subsistence farmers in sub-Saharan Africa and represents today the largest single biological barrier to food production in the region (KARI, 1999). Infestations by *Striga hermonthica* causes severe yield losses, sometimes farmers lose 100% of their harvest (Zerihun Sarmiso, 2015). Therefore, it has a major harmful economic impact for smallholders because it decreases their income and lowers the food supply. So, Striga affect families whose food consumption is dependent on the harvest, so called subsistence farmers (Anderson and Halvarsson, 2011).

As a study conducted by Demeku Mesfin *et al*. (2015), indicated, in Dejen Woreda (Abay gorge) most of the farmers could not produce adequate food to cover all year round. And when the food security status of the area is assessed about 78.3% of the respondents involved in the study said that they are food insecured. This shows that the majority of the populations in the study area are food insecured. According to Demeku Mesfin *et al*. (2015), weeds are considered to be as one factor in decreasing productivity and leading to be food insecured in the study area. From this information it is possible to see that available data and experience indicate that Dejen woreda (Abay gorge) is experiencing a decline in the overall production of cereal crops due to *Striga* infestation and other factors. *Striga* which is a parasitic weed parasitizes sorghum that is cultivated predominantly and is the crop which is used to make the staple food of the people like" injera", bread and a local drink"Tella" in the study area. Therefore, this study seeks to assess the local distribution and socio-economic impacts of *Striga hermonthica* in the study area.

1.3. Hypotheses

Based on a review of related literature, two major plausible hypothesis areas are given:

- It is hypothesized that the local distribution of *Striga hermonthica* is inversely related to the management practices of the farmers
- It is hypothesized that the infestation of *Striga hermonthica* on cereal crops in the study area has a social and economic challenges

1.4. Objectives

1.4.1. General objective

The overall objective of the research is to evaluate the local distribution of *Striga hermonthica* by analyzing its infestation on the farmland and to assess its socio-economic impacts in Dejen Woreda (Abay gorge) in East Gojjam Zone Amhara National Regional State.

1.4.2. Specific objectives

The specific objectives of the study are:

- To show the local distribution of *Striga hermonthica* by analyzing its infestation on farmlands in the study area.
- To examine and identify the socio-economic impacts of *Striga hermonthica* in the study area.
- To identify proper management alternatives to control the weed.

1.5. Research questions

In order to achieve the stated objectives, the study was guided by and tried to answer the following questions:

- Regarding its fertility, what kind of farmland is infested more by *Striga hermonthica*?
- Is there an advantage of *Striga hermonthica* in the study area?
- Which management options should be utilized to control further spreading of *Striga hermonthica*?
- Has the distribution of Striga hermonthica increased from time to time in the study area?
- How do the local people perceive *Striga hermonthica* in the study area?

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Invasive alien species

As it is explained in Shine *et al*. (2009), invasive alien species (IAS) are non-native species whose introduction and/or spread outside their natural past or present ranges pose a threat to biodiversity. They occur in all major taxonomic groups, including animals, plants, fungi and microorganisms, and are considered to be the second most important reason for biodiversity loss worldwide (after direct habitat loss or destruction). The chance for IAS to move beyond their natural biogeographical barrier is increased due to globalization. And the rate at which new species introduced in to an area has risen exponentially in recent decades. This trend is predicted to continue, along with the further spread of already established species.

Many introduced species are of critical importance for production system that underpins a country's economy. They provide a range of employment opportunities and are highly appreciated in society, for example ornamental plants and exotic birds (Shine *et al*., 2009). As cited in Yibekal Abebe (2012), introducing species to new locations has had tremendous contributions to societal development. Human welfare has been improved due to the introduction of many crops out of their native range. However, the subset of introduced species that have become invasive in an area resulted in to unexpected negative outcomes and generate a range of economic, social and environmental impacts that can also be measured in monetary terms and may outweigh their benefits (Shine *et al*., 2009). As pointed in Borokini and Babalola (2012), invasive alien species are characterized by rapid growth rates, extensive dispersal capabilities, large and rapid reproductive output and broad environmental tolerance. Because of this character once they made entry in to a region or country, they become difficult to eradicate and it appears they have come to stay.

As it is shown in Solomon Chanie and Adane Assefa (2015), invasive plant species have broad distribution throughout the world and can directly or indirectly affect the food security of local residents by destroying natural pasture, displace native trees, crops, and reduce grazing potential of range lands and set limitations for economic development.

Globally, the extent of damage caused by invasive species has been estimated to be £ 1.5 trillion per year, close to 5% of global GDP. In developing countries, where agriculture accounts for a higher proportion of GDP, the negative impact of invasive species on food security and economic performance can be even greater which exacerbate poverty Solomon Chanie and Adane Assefa(2015).

Due to its strong parasitic property, aggressiveness, large number of seed production ability, several years of seed dormancy, wind dispersal ability and tolerance to drought and soil infertility *Striga* is one of the invasive plant species that are damaging and even devastating cereal crop yields. Because it has the potential to interrupt the healthy growth of host plant via three processes: competition for nutrients, impairment of photosynthesis and a phytotoxic effect within days of attachment to its hosts (Hayelom Berhe, 2014).

2.2. ***Striga*** **species**

Striga is a parasitic weed that invades farmlands and infests cereals. It damages crop plants by attaching itself to their roots and feeding on their nutrients, causing the crops to be stunted, discolored and twisted. It has invaded an estimated 22 to 40 million hectares of African Cropland, causing damage in excess of US $3 billion per year. *Striga* is a major cause of food insecurity and rural stagnation in Africa (AATF, 2006).

As it is shown in Hayelom Berhe (2014), *Striga* species (witch weed), are root parasitic flowering plants, which are common in sub-Saharan Africa (SSA) causing, severe constraints to crop production. It survives by diverting essential nutrients, which can be taken up by cereal crops such as sorghum, maize etc. *Striga* is the Latin word for" witch"; *Striga* is known as witch weed because plants diseased by *Striga* display stunted growth and an overall drought-like phenotype. It has given different local names, some of these are; in Kenya, farmers refer to it as Kyongo (Luo), Oluyongo (Loyal), Imato (Teso). In Ethiopia it is known as, Akenchira, Metselem (Hayelom Berhe, 2014) and, Atikur' (personal communication).

Striga species are annual (IITA, 1997), obligate hemi-parasite plants that attach to the root of their host to obtain water, nutrients and carbohydrates (Hayelom Berhe, 2014). Crop yield loss due to Striga attacks can vary depending on Striga seed density, soil fertility, rainfall distribution, the cereal host species and variety grown (Hayelom Berhe, 2014). They are chlorophyllous, but require a host to complete their life cycle (IITA, 1997). *Striga* is the most economically important parasitic weed seed plant in the world. It is a genus of various species of parasitic plants that occur naturally in parts of Africa, Asia and Australia. Most *Striga* species do not affect agricultural production, but some have devastating effect on crops particularly those planted by subsistence farmers (Atera *et al*., 2013). *Striga* species is considered to be the greatest biological constraints to food production in sub-Saharan Africa and they are among the most specialized root-parasitic plants inflicting serious injury to their host depriving them water, minerals and photosynthate (Atera *et al*., 2013).

As indicated in Larsson (2012), globally there are 30 to 35 different species of the genus *Striga* and of these about 23 species can be found in SSA. *Striga* species are one of the most troublesome and damaging weed species in the world. Especially those that can infest agricultural crops are of great economic importance and the most important *Striga* species are purple witch weed (*Striga hermonthica*) and asiatica witch weed (*Striga asiatica* (L.) Kuntze). Of these two Striga species *Striga hermonthica* is the most damaging parasitic weed (Atsbha Gebreslasie *et al*., 2016) and it is an obligate chlorophyll-bearing root parasite, which means that the weed is dependent on its plant host during its entire life cycle, germination-flowering-reproduction (Larsson,2012). The major agricultural *Striga* species are *Striga hermonthica* (Del.) Benth and *Striga asiatica* (L.) Kuntze infecting cereals (maize, sorghum, millet and upland rice), and *Striga gesnerioides* (Willd.) Vatke legumes and tobacco. Other species such as *Striga forbesii* (Benth.) and *Striga aspera* (willd.) Benth have been reported to have sporadic effects on cereal crops (Atera *et al*., 2013).

The greatest diversity of Striga species occurs in grassland. However, *Striga hermonthica* mainly occurs in farmland infecting grasses. The parasite devastating effect is accomplished prior to its emergence from the soil and it may cause yield losses in cereals ranging from 15% under favorable conditions to 100% (Atera *et al*., 2013).

Striga hermonthica problem has been in existence as early as 1936 in the fields of farmers within Lake Victoria Basin, Western Kenya. During the last 20 to 30 years, it has attained devastating proportions due to cereal mono-cropping. The parasite is reported to be infecting about 217,000 hectares in Kenya, causing annual crop losses of US $ 53 million. These losses largely depend on *Striga* density, host species and genotype, land use system, soil nutritional status and rainfall patterns. The most affected are the poor subsistence farmers, who are not aware of the threat that *Striga* poses to their land quality and food security as the weed continues to increase its soil seed bank and spreading to new areas (Atera *et al*., 2013).

As it is shown in Atera *et al*., (2013), a survey conducted in Ghana showed that an average number of 9,384 seeds m^{-2} was found in the land that had been returned to cultivation after fallow. However, some fields had seeds in excess of 14,900 seeds m^{-2}. From this survey it is clear that allowing a farmland for a fallow period is used to reduce *Striga* seeds in the soil. It is also reported that in Western Kenya a single *Striga* plant can produce up to 4,827 seeds, excluding an approximate similar amount of seeds present in a maturing capsule and estimated that the average number of seeds produced per mature *Striga* seed capsule to be 1,188. As it is pointed out in Atera *et al*. (2013), *Striga* has infected farmer's field in Western Kenya with an average of 161 million seeds per hectare. It is also shown that *Striga* density was at least 14 plants per m^2. These results imply that only a few *Striga* plants are sufficient to make cereal production unsustainable.

2.3. Origin, occurrence and distribution of *Striga*

As it is shown in Hayelom Berhe (2014), plants belonging to the genus *Striga* comprise obligate root parasites of cereal crops that inhibit normal host growth. *Striga* are generally native to semi-arid, tropical areas of Africa, but have been recorded in more than 40 countries. It is believed that *Striga hermonthica* and *Striga asiatica* originated in the Nubian hill of Sudan and Semien Mountains of Ethiopia. These areas are also known to be the origin of sorghum and pearl millet which are readily infected by the witchweed. *Striga gesnerioides* may have originated in West Africa. Over the years, *Striga* has spread to other parts of sub-Saharan Africa through the activities of man (Atera *et al*, 2013). *Striga* generally prefer infertile soils in open grasslands and savannah in semi-arid tropical areas. Their seeds are well adapted to hot, dry conditions, remaining dormant until rain (Zerihun Sarmiso, 2015). According to Hayelom Berhe (2014), approximately 30 Striga species have been described and most parasitize grass species. But *Striga gesnerioides* (Willd.) Vatke is the only *Striga* species that is virulent to dicocts. Among the 23 species of *Striga* prevalent in Africa, *Striga hermonthica* is the most socio-economically important weed in eastern Africa. *Striga hermonthica* is particularly harmful to sorghum, maize, millet, but is also increasingly being found in sugarcane and rice fields. Mesfin Abate (2016) has also reported that *Striga hermonthica* is the only species that cause economic losses in sorghum. Hayelom Berhe (2014) has shown that upland rice is becoming more and more important for African agriculture, not least because it can sustain more people per crop area than can maize or sorghum. Crops previously unaffected by *Striga* are now showing serious infestation. *Striga* is, therefore, fast becoming a pandemic of serious proportions in Africa because of its vast geographic spread and its economic impact on millions. The enzyme systems of the parasite thrive under low soil fertility and moisture stress conditions, where most soils have been depleted of fertility through removal of organic matter and limited use of manure.

2.4. Distribution and infestation of *Striga* in SSA

2.4.1. Striga weeds infestation and occurrence

In KARI (1999), it is explained that there are various reasons why Striga has become a highly damaging parasitic weed. These are:

- The complex biology of *Striga* and its interactions with host-crop and the environment.
- Farmers lack awareness and knowledge of *Striga* biology and control or preventive methods.
- Increasing population pressure which results in shorter fallow periods of farmer's field to restore soil fertility.
- Continuous mono-cropping of cereals such as sorghum or maize without balancing losses in soil organic matter and nutrients.

As it is stated in Atera *et al*. (2011) there are several species of *Striga* worldwide, of which only a few are infecting grasses and legumes in SSA. Most of the crop host species for *Striga* are cereals which Africans depend on as food. These are maize, sorghum, rice, pearl millet, finger millet, cowpea and sugarcane. The parasite infests some 40% of the cereal producing areas of SSA resulting to crop losses estimated at US $ 7 billion annually affecting livelihoods of approximately 300 million people. The most affected parts of the population are subsistence farmers losing about 20 to 80% of their yield. From the various *Striga* species, *Striga hermonthica* has a serious infection on maize, sorghum and finger millet, moderate infection on pearl millet, rice and sugarcane and has no effect on cowpea.

It has been reported that five of the Striga species cause devastating effects on crops: *Striga hermonthica*, *Striga asiatica*, *Striga forbesii*, *Striga aspera* and *Striga gesnerioides*. *Striga asiatica* is said to have a wide world geographic distribution as compared to others. In Nigeria three major *Striga* species have been found to be infecting crops: *Striga hermonthica* (sorghum, rice, and maize), *Striga aspera* (rice), and *Striga gesnerioides* (cowpea). In the savanna of guinea, *Striga aspera* occurs in the hydromorphic areas where rice is grown, while *Striga hermonthica* and *Striga asiatica* are found in the free draining upland areas and are regarded as the most infectious. Notably *Striga aspera* is predominantly found in West Africa and sporadically exists in Ethiopia and Tanzania overlapping with *Striga hermonthica* (Atera *et al*., 2011).

The root parasitic weed *Striga* is mainly found in SSA and causes yield losses of cereal crop such as maize. The *Striga* flower produces a very large number of seeds. The seeds are triggered to germinate when there is a potential host, such as maize, close to them. When the seedlings germinate they need to attach to a host's root within 3-7 days, otherwise they die. If the seedlings do not germinate they can stay dormant in the soil for up to 20 years (Andersson and Halvarsson, 2011).

Striga normally emerges about 4-7 weeks after planting. After another 4 weeks it appears as a purple flower. It causes most damage to its host before it emerges and therefore, the use of post emergent herbicides is not of great value (Andersson and Halvarsson, 2011). Today all food crops in Africa are more or less affected by *Striga*. Earlier the Striga problem was not as big as it has become lately. This is because the traditional crops, such as sorghum, have evolved together with *Striga* during a long time and build up a natural resistance. But, now a day farmers choose crops with more focus on high yield and modern food consumption such as maize. These crops have not developed the same level of natural protection against *Striga* since they have not evolved with it. The traditional crops such as sorghum and millet are also more tolerant against drought. A major cause of the spread of *Striga* is the market of seeds. Seeds are normally sold at the market and *Striga* seeds are often mixed with the crops seeds. Consequently farmers in areas with no *Striga* can get the weed from seed purchase (Andersson and Halvarsson, 2011).

2.4.2. Conditions favoring *Striga* growth

As shown in Atera *et al* (2011), *Striga* infestation is steadily increasing as a result of continuous cultivation of cereal crops. Overused, depleted and infertile soils have resulted to high infestation of *Striga*. Pressure on land for continuous cropping of high yielding cereal crops without rotation has resulted to exhausted soils. These are the soils that favor *Striga* infestation in addition to soil moisture conditions. As it is indicated in Kamara *et al* (2007), *Striga* is a serious problem in areas of poor market access where farmers do not apply adequate amounts of fertilizers to crops. This means that *Striga* infestation is correlated with low soil fertility and that improved soil fertility would lead to a reduction of the infestation (Larsson, 2012).

Poverty level of small scale farmers has enhanced the spread of *Striga* through sharing of seeds collected from the various crop harvests. In addition, *Striga* pandemic in SSA has increased due to non advocacy of nutrient replenishment of the soils as a result of mono-cropping, a factor for increased infestation of the weed in size and severity (Atera *et al*., 2011).

Striga produces several seeds, and during tillage the seeds are incorporated in to the soil where they can be dormant for many years (Atera *et al*., 2013). Under suitable soil conditions they may remain viable for as long as 20 years in soil (Adhiambo, 2007). Over time they are spread to new areas by human beings through the tools used for land preparation and weeding. The seeds are also spread by animals moving from one field to another for grazing purposes (Atera *et al*., 2011). Furthermore, *Striga* seeds are extremely small ranging from 0.10 to 0.40 mm in size and 3-15µg in weight and can therefore be easily blown by the wind leading to their dispersal. These factors make *Striga* a very noxious weed that is difficult to eradicate (Adhiambo, 2007). This has culminated to a complex system of spreading the weed to new areas thus reducing crop yield of farmers who are not aware of the devastating effect (Atera *et al*., 2011).

2.5. General characteristics of *Striga hermonthica*

A witch-weed, *Striga hermonthica* is a flowering root parasitic plant, and it leads a hemi-parasitic way of life. It is deemed to be one of the most ubiquitous parasitic weed of food crops (Koua, 2011). *Striga* causes severe constraints in cereal crop production in the sub-Saharan Africa by parasitizing the roots of the host crop. The parasite, attaches itself to the roots of its host from where it withdraws nutrients and water intended for the plant to grow. Several species of *Striga* have been identified worldwide with *Striga hermonthica* being the most notorious and causing damage to the agro economic system. *Striga hermonthica* is herbaceous plant (Koua, 2011) with a hairy, hard and quadrangle-shaped stem (Csurhes *et al*., 2013) and narrow leaf (Kagot, 2013). Its height does not exceed 1 meter. It has purple flowers though they are sometimes white. The seeds usually develop in small capsules which up on maturity, burst open to release the seeds for dispersal. One seed capsule can contain between 250 and 500 minute seeds. A single *Striga hermonthica* plant therefore, has the capacity to produce over 50,000 seeds. If conditions for germination are not conducive the seeds can remain viable in the soil for up to 20 years (Kagot, 2013). The root system in *Striga* is vestigial, in which the germinated seed radical produces haustorium instead of characteristic angiosperm root in order to interact with the host (Koua, 2011).

As it is indicated in Koua (2011), *Striga* infestation results in chlorosis, wilting, stunting and death with losses ranging from slight to 100%. After a connection being established between host and parasite, the parasite exhibits a holoparastic subterranean stage of development at which time damage is inflicted. The parasite then emerges from the soil, develops chlorophyllous shoots (hemi-parasitic stage) and produce flowers and seeds.

2.6. Geographical distribution of *Striga hermonthica*

The geographical distribution and infestation level of Striga are increasing, particularly in sub-Saharan Africa. There are different explanations for this trend such as trade and transport of contaminated seeds, cattle movement between fields, dispersal of *Striga* seeds through wind and surface water flows and lack of knowledge and means to control *Striga*. The main driving forces for the increase of the *Striga* problem, besides convenient climate, however, are (1) reduced soil fertility, (2) increased land use, mostly on depleted soils and (3) expansion of the area cropped with susceptible host crops. Future climate change may further influence the geographic distribution and invasive potential of Striga as habitats suitable for *Striga* growth might expand and/or shift to new areas (Cotter, 2012).

As it is shown in Koua (2011), *Striga* is mainly distributed in tropical arid and semi-arid zones with 400-1000 mm of annual rainfall. The origin of Striga hermonthica is thought to be in the Nuba Mountains of Sudan and partly Ethiopia. The most severely affected countries are Mali, Upper Volta, Niger, Nigeria, Cameroon, Chad, Sudan, Ethiopia, and India. In some regions of these countries where *Striga* is common, crop yields may regularly be reduced by 60-70%. Serious crop losses also occur widely in parts of the Gambia, Senegal, Mauritania, Togo, Ghana, Kenya, Tanzania, Uganda, Botswana, Swaziland and Mozambique and more locally elsewhere in Africa, Asia, Australia, and the USA.

2.7. Socio-economic impacts of *Striga hermonthica*

Invasive species may cause major economic losses to society, whether in the form of direct economic impact, such as loss of agricultural production or secondary economic impacts caused by human health issues. These economic impacts may include direct costs such as direct loss of crops that is reduction in agricultural production and secondary economic impacts from human health issues associated with disease directly or indirectly caused by invasive species including increased monitoring, testing, diagnostic, and treatment costs, and loss of social productivity due to illness and death in affected people. The indirect cost is lose of human productivity due to time and resources allocated to dealing with invasive species, such as clearing weeds (www.issg.org/pdf/publications/GISP/GISP.../ ManaginginvasivesModule1.pdf).

According to Esilaba (2006), as an invasive species the effect of *Striga* damage on crops is a reduction in yield. The extent of yield loss is related to the incidence and severity of attack, the host's susceptibility to *Striga*, environmental factors (edaphic and climatic) and the management level at which the crop is produced. *Striga* is the most serious biotic problem to cereal production (Berhanu Sibhatu, 2016).

Striga infestation causes a loss of 30-50% to Africa's agricultural economy on 40% of its arable land. A survey conducted in Borno state, northern Nigeria, indicated that farmers rated *Striga* infestation as the leading priority constraint together with low soil fertility to crop production. Similar surveys showed that *Striga hermonthica* as a serious problem in Nigeria and yield losses ranged from 10 to 100%. In Western Kenya, a survey of 83 farmers revealed that 73% of the farmers are infected with *Striga hermonthica*. The average yield loss due to *Striga* is 1.15, 1.10, and 0.99 tons per hectare for maize, sorghum and millet respectively. However, the damage can reach as high as 2.8 tons per hectare in maize and sorghum in some locations with high *Striga* densities (Atera *et al*., 2013).

2.8. The value of *Striga hermonthica*

Besides to its parasitic devastating impacts *Striga hermonthica* is a well known medicinal plant (Koua, 2011). In the African traditional medicine, it has been widely used as a remedy for many ailments. For example it can be used as a remedy for leprosy, ulcers, pneumonia, and jaundice. In addition to this it has trypanocidal, antiplasmodial, antibacterial (Kagot, 2013), antidiabetic and antimalarial (Koua, 2011) effects. However, in agriculture the damage it causes as a weed overrides its health and medicinal benefits.

2.9. Control and management of *Striga hermonthica*

There are several methods to combat *Striga*. According to Joel (2014), appropriate agricultural technologies such as replenishing soil fertility, use of certified seeds, utilizing good agricultural practices (GAPs) and reducing weed soil seed banks have been recommended for the management of the weed. As noted in Kinde Lamessa (2014), several techniques have been applied to manage *Striga*; they consist of those that reduce the number of Striga seed in the soil bank, those that prevents production of new seeds, and those that prevent spread from infested to non-infested soils. *Striga* damage and infestation can therefore be alleviated by adopting management practices and measures that curb its spread at the different stages of development. The different management practices work well when applied in an integrated manner and not in isolation. The different control and management measures include the following:

2.9.1. Hand weeding/Sanitation

Hand weeding effectively manages annual weeds. However, it is time-consuming, labor-intensive, back-breaking, and often costlier than chemical method. This is the most practical of all available management techniques to resource poor farmers in developing countries. It can eventually lead to significant reduction in *Striga* infestation. The potential benefits of this method of control may not be realized until 4-5 years, and time is very critical to ensure effectiveness.

The optimum time for hand pulling of *Striga* is 2-3 weeks after flowering and repeating the operation at 3-4 weeks interval. New shoots may sprout out below the soil from infected plants requiring a second weeding before crop maturity. Uprooted *Striga* plants have to be removed from the field and dried and burned to minimize the risk of re infection. Hand weeding is only practical in preventing build up of the parasite seeds in slightly infested soil.

2.9.2. Crop rotation

Crop rotation is considered as a “panacea” for controlling weeds under crop field ecosystems so for maintaining soil health and sustained crop production. It is highly effective against *Striga hermonthica* (mainly in sorghum and maize).Trap and catch crops should be included in crop rotation particularly for controlling parasitic weeds *Striga* and Orobanche species. Trap crops are nothing but false hosts, which exude *Striga* germination stimulants and induce *Striga* seed germination, but after germination, *Striga* may die-out want/lack of attachment with the roots of a suitable host. This is called suicidal germination. Rotation using non-host crops interrupt production of *Striga* seeds and allow the seeds population in the soil to decline.

2.9.3. Intercropping

Intercropping is a potentially viable, low-cost technology that would enable addressing two important and interrelated problems of low soil fertility and *Striga* infestation. Intercropping legumes (cowpea or common bean) with sorghum is suitable arrangement both in reduction of parasitic weed incidence and increasing cereal yields. Intercropping with non-host plants (trap crops) has been reported to decrease *Striga* infestation by reducing the soil seed bank because of stimulation of suicidal germination of *Striga* weed.

2.9.4. Fallowing

Fallowing implies putting the farmland land out of crop production, which may not be favorably accepted by small-scale farmers. The system increased cereal yield and was found to be effective against *Striga.*

2.9.5. Soil fertility and nitrogen fertilizers

Striga infestation is correlated with low soil fertility and that improved soil fertility would lead to a reduction of the *Striga.* Decreasing soil fertility has lead to the increase of *Striga* infestation due to the lack of nitrogen. Nitrogen is said to have the negative effect of reducing strigolactone production from the host plant and, therefore, inhibits germination of *Striga* seeds. When nitrogen is applied to the crop, *Striga* infestation is reduced and the crop yield increases. Total soil nitrogen content has shown to be negatively correlated with *Striga* seed density in the soil. A good supply of nitrogen into the soil has shown that it is a good way of *Striga* control. Different types of nitrogen fertilizers suppress *Striga* either by the inhibition of *Striga* germination or the production of germination stimulants from the host plants. Crop species and nitrogen levels significantly affect *Striga* emergence. Generally *Striga* reproduces mainly in nutrient poor soils and on fields that are exhausted from several years of cropping. As studies have shown high nitrogen concentration leads to reduced germination stimulant production, and ammonium nitrogen and urea may exert direct toxic effects on the parasite. About 55-82% reductions in numbers and weight of *Striga hermonthica* is observed using urea in Niger. From the practical point of view, nitrogen fertilizers are difficult for poor African farmers to obtain and are generally too expensive to apply at the level suggested for *Striga* control.

2.9.6. Chemical control

Management of *Striga* using chemical herbicides is voluminous; pre and post-emergence vegetative herbicides have been used, soil fumigants to destroy *Striga* seeds and synthetic compounds aimed at stimulating suicidal germination. A single application of ethylene could get rid the soil of up to 90% of viable, preconditioned *Striga asiatica* seeds. Both pre and post-emergence herbicides may affect the probability of emergence, with pre-emergence herbicides affecting the probability of all *Striga* seedlings and post-emergence herbicides affecting the probability of *Striga* seedlings that have yet to emerge as of the time of application.

The literature review which is given in this chapter tries to explain what invasive species are in general. From the various invasive species the literature tried to present Striga species, particularly *Striga hermonthica*. *Striga* weed infestation and occurrence, favorable conditions for

Striga growth and general characteristics of *Striga hermonthica* are discussed. Besides to this the geographical distribution, socio-economic impact, uses value, control and management techniques of *Striga* are explained. Therefore, based on this literature review the researcher tried to assess the local distribution and socio-economic impact of *Striga hermonthica* in the study area because it is challenging the local people by reducing crop yield.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the study area

This study was conducted in Dejen Woreda (Abay gorge), East Gojjam Zone, Amhara National Regional State, Ethiopia. Dejen town the capital of the Woreda is found at a road distance of 335 km south of the Regional capital Bahir Dar, 70 km south of the Zonal capital Debremarkos and 229 km from Addis Ababa along the high way of Addis Ababa-Bahir Dar (Amene Afework, 2011). Dejen Woreda, which is located in figure-1 below, is bordered on the South by Abay River which separates it from the Oromia Region, on the West by Awabel Woreda, on the North-West by Deby Tilatgen Woreda, on the North by Enemay Woreda, and on the East by Shebel Berenta Woreda (*https://en.wikipedia.oprg/wiki/Dejen (woreda)*).

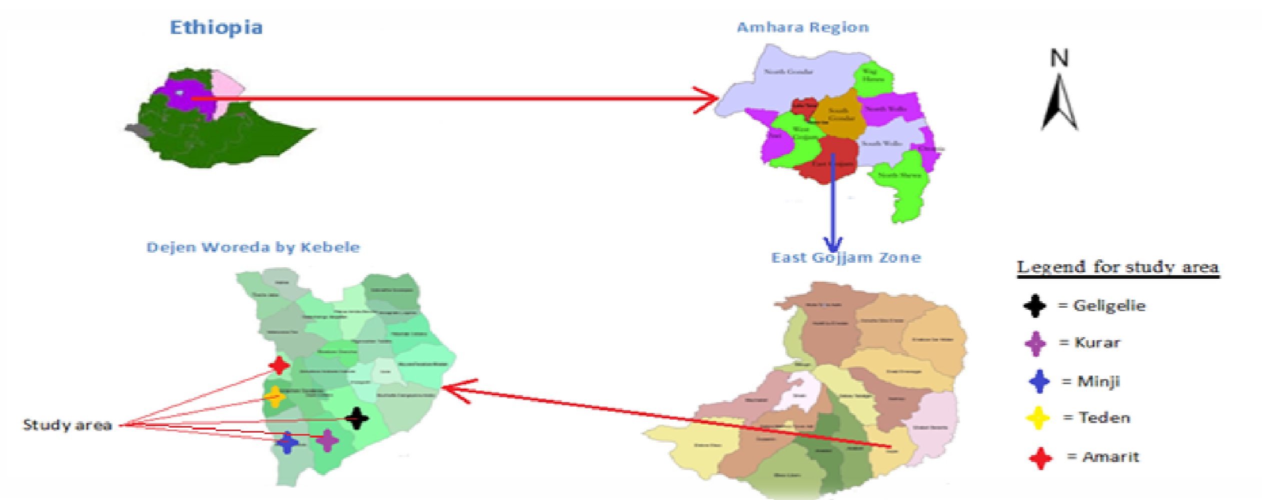

Figure1: Map of the study area

The study area (Abay gorge) is the hot spot for *Striga hermonthica* infestation (Mesfin Abate, 2016) and it is located at 10.1° 55\` N latitude, 38.1° 2\` E longitude (Mesfin Abate,2016) and the elevation range is between 1080 and 2432 masl (Aklilu Agidie *et al*.,2000). The area is characterized by a long rainy season occurring from May to October on average for about 180 days. This study site received a total annual rainfall of 605 mm and the annual temperature of the area on average is 25℃. The soil type is sandy clay with 1.68% organic matter, 14 mg P/kg, and P^H of 6.25 (Mesfin Abate, 2016).

In the study area mixed crop and livestock farming is the predominant mode of agricultural production. Sorghum, maize and teff are the major cereal crops. The majority of the farmers allocate most of their farmland for sorghum as the number one crop followed by teff and maize (Mesfin Abate, 2016). According to the recent census in Ethiopia CSA (2007) Dejen Woreda has a total population of 102,359 of whom 49,487 are males and 52,872 are females. From the Woreda total population 8,700 are urban residences and of these 4,167 are males and 4,533 are females. And the rural population is 93,659 of whom 45,320 are males and 48,339 are females. From the rural Kebeles (local administrative regions) of Dejen Woreda Kurar, Geligelie, Minji, Amarit and Teden are found to be the hot spot areas of *Striga hermonthica infestation* (Mesfin Abate, 2016). The population and number of households of these Kebeles (local administrative regions) are given in Table-1 below.

Table 1: population and number of households of the *Striga hermonthica* hot spot areas.

Kebele	Population			Number of Households
	Male	Female	Total	
Kurar	2,552	2,761	5,313	1,265
Geligelie	2,669	3,006	5,675	1,418
Minji	2,677	2,861	5,538	1362
Amarit	763	896	1,659	432
Teden	1,518	1,612	3,130	784
Total	10179	11136	21315	5261

Source: census, 2007.

3.2. Data source and material

To study the local distribution and socio-economic impacts of *Striga hermonthica* both primary and secondary data sources were used. The primary data were collected from observation, semi-structured interview, and using questionnaires administered to the farmer household and agricultural expert respondents. The secondary data were collected from journals, internate and census reports.

To collect information about the local distribution of *Striga hermonthica*, the socio-economic impacts of *Striga hermonthica* and attitudes of the local people towards the weed (*Striga hermonthica*), questionnaires which are related to the issue were administered to the farmer household and agricultural expert respondents. Besides to this observation and interview were also used as a primary source of data collection.

3.3. Study design and sampling

Reconnaissance survey was conducted towards the end of September, 2016 and a photograph showing a crop plant infested with *Striga hermonthica* and the one which is not infested in the study area, was taken. Besides to this to have an impression about the attitude of the local people towards the weed (*Striga hermonthica*) in the study area the researcher interviewed farmers randomly in the study area. Following the reconnaissance survey 100 farmer household respondents were selected purposively among elders, farmers renowned within the district and agricultural experts were also included.

To study the local distribution and socio-economic impact of *Striga hermonthica* observation, semi-structured interview and questionnaires were used as a primary research information source. The questionnaires were translated in to the respondents' vernacular language, then 100 questionnaires for farmer household and 15 questionnaires for agricultural expert respondents were distributed in the study area.

For this study on the local distribution and socio-economic impacts of *Striga hermonthica* purposive sampling technique was used. The total sample size of farmer household respondents was divided in to the five selected local administrative regions (Kebeles) which are the hot spot areas of *Striga hermonthica* infestation using proportional sample allocation formula:

nh = (Nh/N) n

Where: nh = Sample size of each kebele

Nh = Total number of HHs in each Kebele

N = Total number of HHs in the study area (total HHs)

n = Total sample size

Source: Amene Afework (2011)

Table 2: Distribution of representative sample household respondents in the study area.

Kebele	Total number of households	Sampled households	Percentage
Kurar	1,265	(1,265/5,261)100 = 24	24
Gelgelie	1,418	(1,418/5,261)100 = 27	27
Minji	1,362	(1,362/5,261)100 =26	26
Amarit	432	(432/5,261)100 = 8	8
Teden	784	(784/5,261) 100 =15	15
Total	5,261	(5,261/5,261)100 =100	100

Respondents which were selected purposively from the study area filled the disseminated questionnaires and these questionnaires were collected properly. After the completion of data collection the collected data were analyzed using descriptive statistics and Excel 2007. Data that were collected from open-ended questionnaires and observation were organized and analyzed qualitatively. And the research findings were systematically organized, summarized and presented in the form of tables and charts.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. The Demographic Characteristics of respondents’

4.1.1. Sex of the respondents’

The major factor that determines the participation of an individual in farming activity is sex. In the study area males are mainly involved in farming activity than females (observation). Therefore, it is expected that they are rich in information related to their agricultural activity. This means that males can provide well organized information about *Striga hermonthica* for this study. Because of this more chance to respond to the questionnaires was given to males, showing this the farmer household respondents sex ratio is given in figure- 2 below.

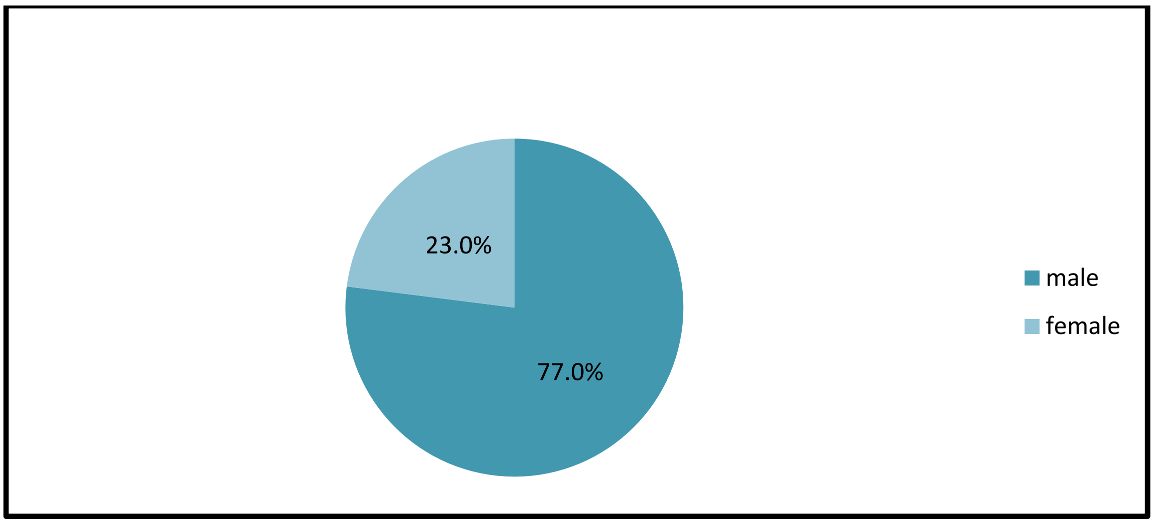

Figure 2: Sex ratio of the Farmer household respondents.

4.1.2. Age of the Respondents’

To participate in farming activity with full potential age is a determining factor. It is at the working age that an individual is allowed to participate in all agricultural activities in the field as well as in the house. Therefore, when the age of the farmer household respondents’ in the study area is analyzed it is found to be 8% of the respondents’ are in the age category between 21-30, 27% of the respondents’ were in the age category between 31-40, 29% of the respondents’ were in the age category between 41-50, 23% of the respondents’ were also found in the age category between 51-60, and 13% of the respondents’ are above 60 years of old (Figure-3). From this result it is possible to conclude that majority of the farmer household respondents’ were adults. This indicates that the majority of the farmer household respondents’ are matured and relatively well experienced and familiar with the weed *Striga hermonthica* in their agricultural activity. Therefore, they may provide plausible information for the questionnaires that were asked. Because, farmers which are found at adult age group and well experienced in farming activity can provide reliable information more than those which are found out of the adult age group (Bizuayehu Alemu, 2014).

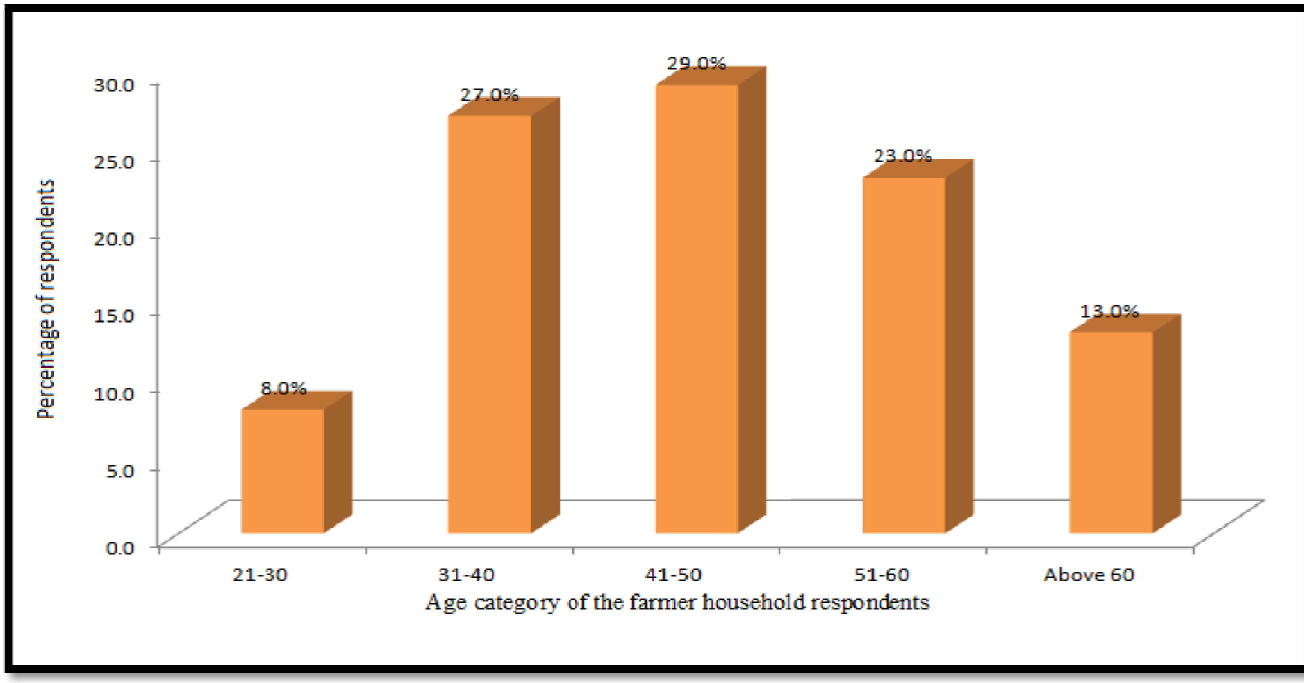

Figure 3: Age of farmer household respondents'.

4.1.3. Years farmer household respondents live in the study area

It is a general fact that survival of an individual in a particular area for a long period of time directly corresponds to his ability to know his environment where he lives. Therefore, the data that deals with the survival of an individual in the study area was analyzed and provided as in Table-3. The result of the analysis has shown that 22% of the respondents live from 21-30 years, 33% of the respondents live from 31-40 years, 28% of the respondents live from 41-50 years, 14% of the respondents live from 51-60 years, 2% of the respondents live from 61-70 years and only 1 % of the respondents live for more than 70 years. The mean value for how long a respondent live in the study area was found to be 39.8 ±2.2 (SE) (Table-3). From this result it is possible to conclude that respondents can have full information about *Striga hermonthica*. Because they live in the study area on average for about 39.8 years which might be sufficient to be rich in information.

Table 3: Years farmer household respondents live in the study area

Number of years	Percentage	Mean	Std.Error
20-30 years	22	39.8	2.2
31-40 years	33		
41-50 years	28		
51-60 years	14		
61-70 years	2		
71-80 years	1		
Total	100		

4.1.4. Educational Status of the Respondents

Education is a means to solve socio-economic problems. So looking at the educational level of the farmer household respondents is very important for this study, because if they are educated they are expected to take measures that solve *Striga hermonthica* problem in the study area. Results of the survey regarding educational status of the respondents of both farmers and agricultural experts were analyzed and it was found to be as in Table-4. According to the analysis 52% of the farmer household respondents are illiterate, 30% can read and write, 11% attend grade 1-6, 3% attend grade 7-10 and 4% of the respondents attend grade 11-12. As the result has shown majority of the farmer household respondents are illiterate, so there might be a problem of knowing the possible measures to control *Striga hermonthica*. On the other hand all the agricultural expert respondents are first degree graduates. From the agricultural expert respondents 60% are specialized in plant science and 40% are specialized in animal science.

Since most of them are plant science specialized experts it is expected that they might help farmers in controlling *Striga hermonthica* problem. Although, the educational level of agricultural experts is sufficient to support farmers, *Striga* problem is still increasing in the study area. This may be due to the inability of the agricultural experts to use their full potential to support farmers or they are not trained properly and provided with all the necessary technologies required to teach and guide farmers on the methods of *Striga* control.

Table 4: Educational level of respondents

Educational level of farmers	**Percentage**	**Educational level of agricultural experts**	**Percentage**
Illiterate	52	First degree plant science specialized	60
Read and write	30	First degree animal science specialized	40
Grade 1-6	11		
Grade 7-10	3		
Grade 11-12	4		
Total	100		

4.2. Distribution and expansion of *Striga hermonthica*

The distribution and expansion of *Striga hermonthica* was analyzed based on the response given by the farmer household and agricultural expert respondents.

4.2.1. Characteristics and introduction of *Striga hermonthica*

According to the farmer household respondents *Striga hermonthica* is a flowering weed plant that grows in desert area. The weed infects cereals mainly sorghum by parasitizing its root. This result is similar to the finding of Koua (2011), which says *Striga hermonthica* is a flowering root parasitic plant that leads a hemi-parasitic way of life and cause severe constraints in cereal crop production. Farmer household respondents have shown that the plant was introduced in to the study area when they buy and use seeds from other areas. A study conducted in Kenya by Andersson and Halvarsson (2011), supports this by showing that farmers in areas with no *Striga* can get the weed from seed purchase.

Regarding its year of introduction in to the study area most of the farmer household respondents said that they know *Striga hermonthica* since they start to live in the study area. As the response of the farmer household respondents has shown about 65% of the respondents have more than 25 years of farming experience and they suffer from this weed during this time of farming experience. Therefore, farmers in the study area are well familiar with *Striga* and it is expected that they can give reliable information.

The response of the farmer household respondents has also shown that in the 59% of the farmers' farmland *Striga* exists for more than 25 years. This indicates that farmers are unable to eradicate the weed from their farmland, so that it persists for a long time on their farmland. And, from the data analysis it is revealed that 88% of the farmer household respondents agreed that *Striga* distribution has increased from time to time. For this increased distribution of *Striga* from time to time it has to disseminate from one area to the other through various mechanisms. The response given by farmer household and agricultural expert respondents regarding dissemination

Table 5: Mechanisms by which *Striga* disseminates from place to place

Mechanism of dissemination	Farmer household respondents Percentage	Agricultural expert respondents Percentage
Contaminated seeds	3	40.00
Cattle movement between farmlands	34	13 .33
Dispersal of seeds by wind	27	33.33
Dispersal of seeds by water	36	13.33
Total	100	100

Most of the farmer household respondents said that *Striga* disseminates by dispersal of seeds by water. This may be due to the topography of the study area. Because the study area land form is not plain, it is exposed for run-off. The next large number of farmer household respondents said, *Striga* disseminates by the movement of cattle from one farmland to the other because when they move they carry *Striga* seeds with them. But it must be clear that these two are not the only mechanism of *Striga* dissemination, seed contamination and wind dispersal of *Striga* seeds are also other ways of *Striga* dissemination. Most of the agricultural experts also said *Striga* disseminates due to seed contamination.

4.2.2. Farmers' response on which farmland *Striga* expands most

Striga hermonthica expands most on sorghum farmlands. This is assured from the response given by the farmer household respondents, 100% of the farmer household respondents said that *Striga* is infested mostly on sorghum farmlands. This means that the weed damages sorghum which is used most by the people in the study area. This result of the study is in agreement with the study conducted by Mesfin Abate (2016), in Ethiopia, which revealed that *Striga hermonthica* is the only species that cause economic losses in sorghum.

Generally it is possible to conclude that *Striga hermonthica* is a highly spreading weed causing a devastating effect on cereal crop production. This is assured by the response of the farmer HH and agricultural expert respondents.

4.2.3. The landscape, village, and farmlands of the study area before and after 25 years

The farmer household respondents explained that before 25 years the study area was covered with forest as a result it was fertile and farmers did not use fertilizers. Because of this it was suitable for crop production. And it was possible to gain better yield due to high soil fertility. Although, the soil was fertile *Striga* was present, however, its distribution was insignificant. The population was low and there was no farmland problem and it was possible to allow a fallow period for farmlands.

After 25 years deforestation has occurred and the soil fertility decreased due to deforestation and erosion. As a result the farmlands became unable to produce without fertilizer. The village has expanded and the population increased. This results in scarcity of farmlands which in turn prevent a farmland for a fallow period, because to feed the increased population farming the farmland and producing the extra food for the increased population is required. This cause for the distribution of *Striga* to become more and more, that is it becomes expanded highly, and results in the loss of crop yield.

4.3. Socio-economic impact of *Striga hermonthica*

4.3.1. The most important source of HH income and most commonly growing crops in the study area

Based on the response gained from the farmer household respondents the most important source of income in the study area was found to be as in figure- 4. And the most commonly growing crops in the study area were as in figure 5. Although 97% of the farmer household respondents said cropping is the most important source of income and 81% of the farmer household respondents said the most commonly growing crop is sorghum, *Striga* highly constrained sorghum. This is assured by 100% of the agricultural expert respondents and farmer household respondents. They agreed in that *Striga* has a negative impact and decrease crop productivity. This is similar to the finding of Mesfin Abate (2016), which says *Striga hermonthica* is the only species that causes economic losses in sorghum which is one of the cereal crops.

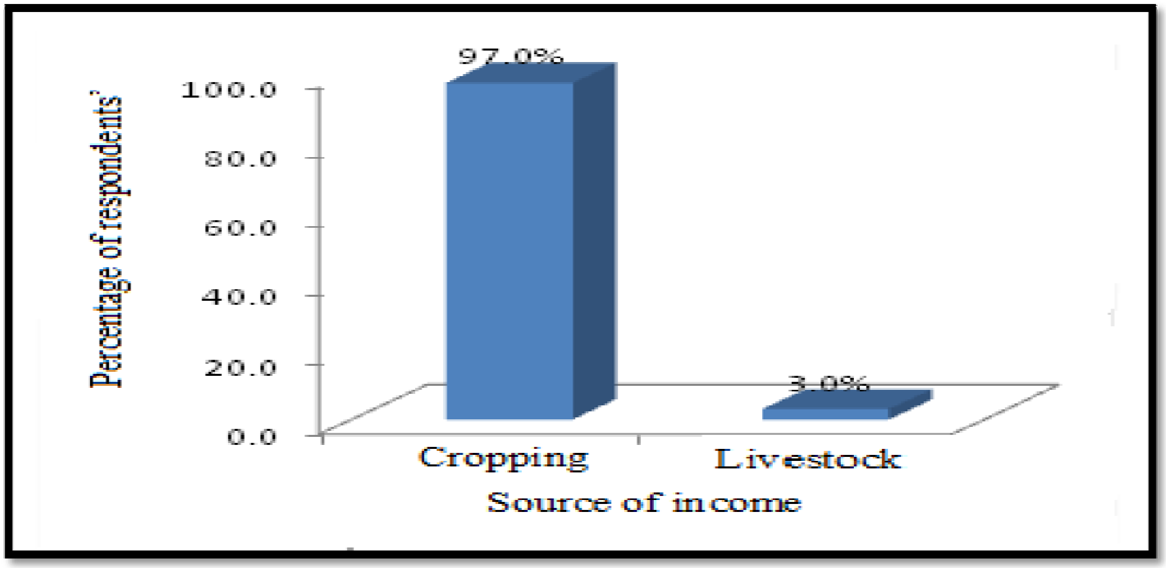

Figure 4: The most important source of household income in the study area.

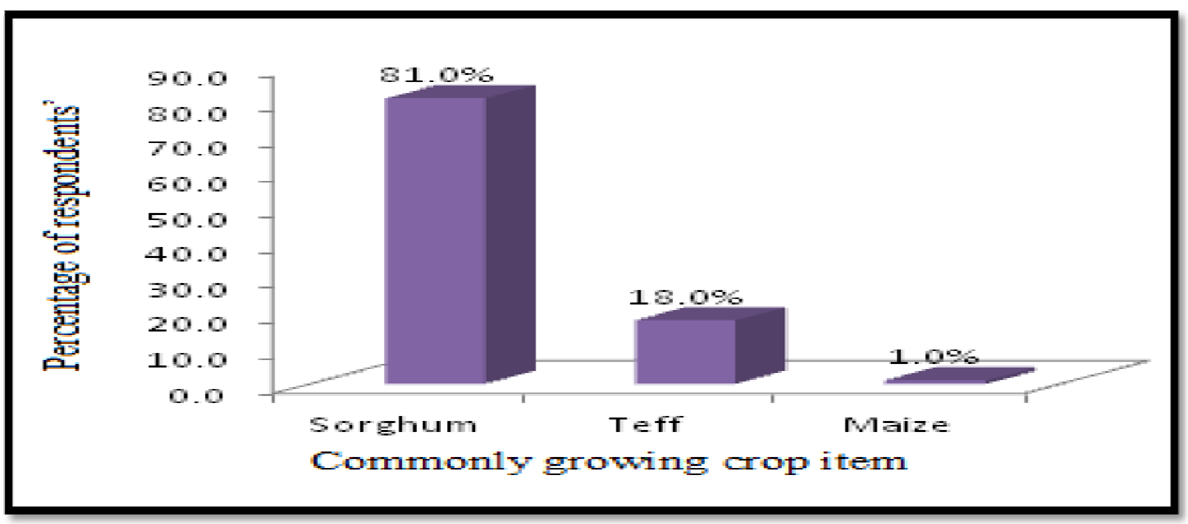

Figure 5: Commonly growing crop items in the study area.

4.3.2. Proportion of farmland allocated for different crops in 2016/17 cropping season.

Farmers in the study area in the 2016/2017 cropping season allocated most of their farmland for sorghum production. The data analysis revealed that 40.15%, 37.83%, and 16.50% of the farmland was allocated for sorghum, teff, and maize respectively. And the remaining 5.52% was allocated for other crops (Table-6). This result obtained from the respondents is similar to the finding of Mesfin Abate (2016), in that the majority of the farmers (53%) allocated most of their land for sorghum as the number one crop followed by teff and maize. This might be due to suitability of the climate in the study area for sorghum production.

Table 6: Estimated farmland allocated for different crops in 2016/17 cropping season.

Crop type	Farmer household respondents percentage	Percentage of farmland allocated for different crops
Sorghum	53	40.15
Teff	42	37.83
Maize	5	16.50
Others		5.52

4.3.3. Perception of farmer household respondents about the soil fertility status of the study area.

Farmers' perception on the soil fertility status of the study area was analyzed based on the response gained from them, and it was found that ,2% of the respondents said the soil fertility is high, 47% of the respondents said the soil fertility is medium , and 51% of the respondents said the soil fertility is low. According to the majority of the respondents the soil in the study area is infertile, which is conducive for *Striga* infestation. The result is in agreement with the explanation given by Atera *et al* (2011) and (Larsson, 2012) which says overused, depleted and infertile soils have resulted to high infestation of *Striga* and *Striga* infestation is correlated with low soil fertility. *Striga* infestation and soil fertility have inverse relationship. That is the intensity of *Striga* infestation depends on the status of soil fertility.

4.3.4. Status of soil fertility for dense *Striga* growth.

The status of soil fertility for dense *Striga* growth was assessed and analyzed based on the response gained from the farmer household respondents and it was found to be as in Figure-6. The result has shown that the majority of the farmer household respondents (78%) said *Striga* grows densely when the fertility of the soil is low. Besides to this 80% of the agricultural expert respondents said *Striga* infestation becomes more and more when the soil losses its fertility. This is similar to the finding of Larsson (2012) in Kenya, which says *Striga* infestation is correlated with low soil fertility and that improved soil fertility would lead to a reduction of the infestation.

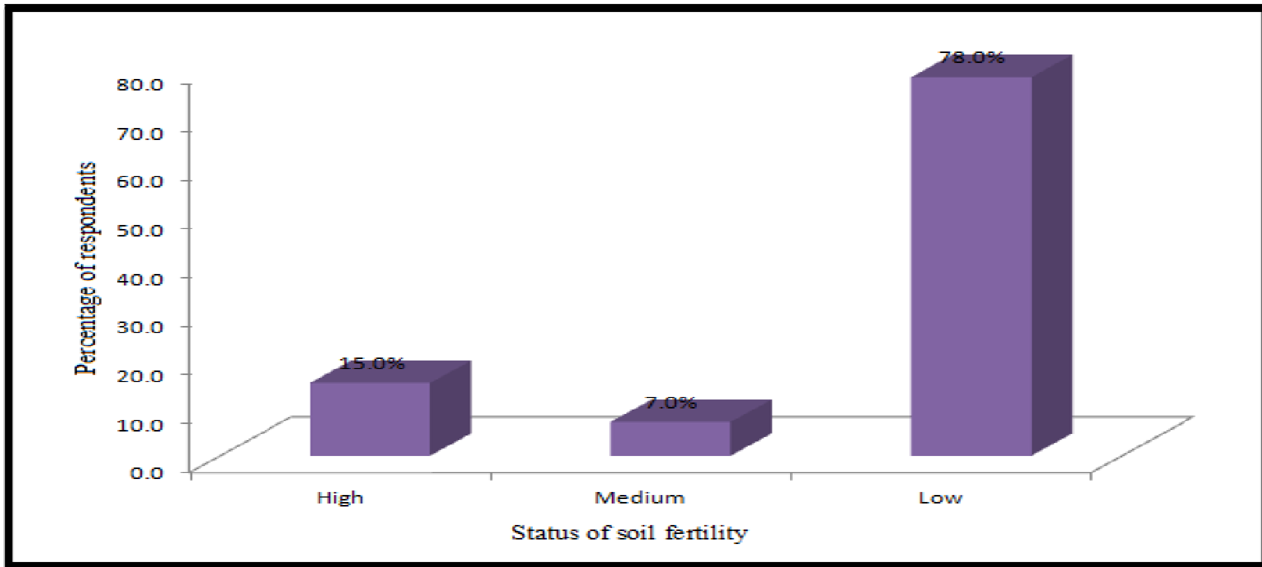

Figure 6: Farmers' response on the status of soil fertility for dense *Striga* growth

4.3.5. The consequence of *Striga* expansion on the local people.

The respondents' result concerning the consequence of *Striga* expansion on the local people is given below as in Table-7. The farmer household respondents explained that the distribution of *Striga* has increased and it results in a decrease of crop yield. Therefore, when the data concerning the consequence of *Striga* expansion is analyzed, 73% of the farmer household respondents and all agricultural expert respondents agreed that if proper control measure is not taken poverty level of the society in the study area increase and the society becomes chronically food insecured. AATF (2006) also explained that *Striga* is a major cause of food insecurity and rural stagnation in Africa. And 21% of the famer household respondents said income of the society decreases. A small portion (6%) of the farmer household respondents said *Striga* problem may displace the society from their village which is a socio-economic problem.

Table 7: Farmer HH and agricultural experts' response concerning the consequence of *Striga* expansion on the local people.

Effect of *Striga* on the society	Farmer household respondents' Percentage	Agricultural expert respondents' Percentage
Increase poverty level and cause food insecurity	73	100
Displace the society from their Village	6	0
Decrease income of the society	21	0
Total	100	100

4.3.6. Controlling measures used to reduce *Striga* expansion

The data analysis has shown that 99% of the farmer household respondents have tried to control the invasion of *Striga* on their farmland. The mechanism which was implemented to control *Striga* invasion looks as in Figure-7.

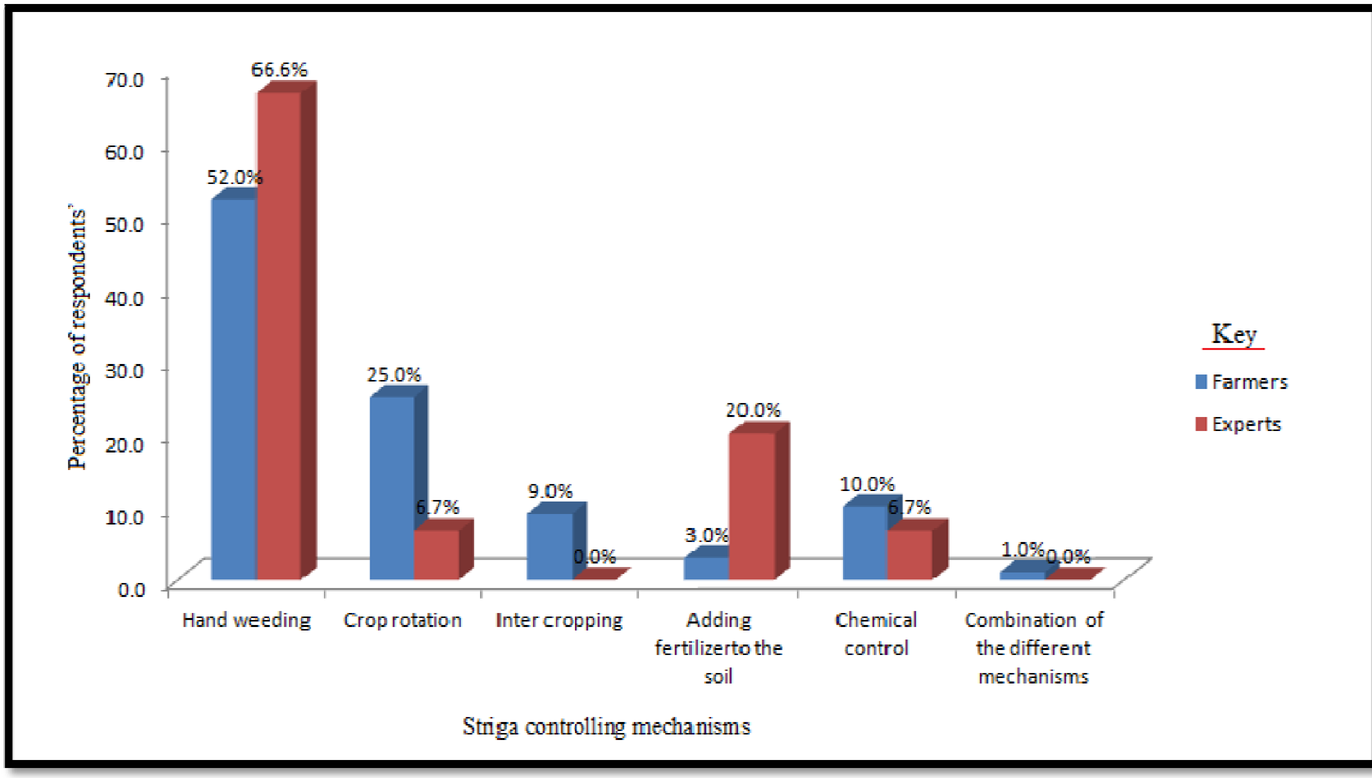

Figure 7: Respondents' response on the implemented mechanisms to control *Striga hermonthica.*

As it can be seen from Figure-7 above, the most frequently used *Striga* controlling mechanism in the study area was hand weeding/sanitation that is removing the weed by hand from the farmlands. The next largest frequently used is crop rotation. From this it can be seen that, farmers implemented hand weeding and crop rotation most frequently for clearing their farmlands from *Striga* because these two controlling methods may not need cost, they can be carried out by their own labor and decision. But, Kinde Lamessa (2014) explained that the different controlling mechanisms work best when they are applied in an integrated manner.

4.3.7. Farmers' response on the control of *Striga* by hand weeding/sanitation.

Most of the farmers (95%) agreed that they have tried to control *Striga* by hand weeding/sanitation. Hand weeding is time-consuming, labor-intensive, and back-breaking method, but the most practical of all available management techniques to resource poor farmers in developing countries (Kinde Lamessa, 2014). And farmer household respondents said that if there were no *Striga* on their farmland they were able to use the time that they spent for weeding *Striga* to perform other agricultural activities such as livestock management, removing other weeds that has no any devastating effect on crops etc.

4.3.8. Farmers' response on whether they use other person or not to clear their farmland from *Striga*.

The majority (60%) of the farmer household respondents clear their farmland from *Striga* by their own labor. But the remaining 40% of the farmer household respondents said they use any other person to clear their farmland from *Striga*. This costs farmer household respondents. As it is obtained from their response on one of the open-ended questions they paid the mean value of Ethiopian birr 264±23.88 (SE), for a hectare of crop land per year. This is a loss of money due to *Striga* infestatation. They said that if there were no *Striga* on their farmland they could not loss this amount of money and they were able to use this money for livestock breeding like goats and sheep, for seed purchase, for their children school expense etc.

4.3.9. The main driving for*ce that increases Striga problem*

The distribution and expansion of *Striga* on farmlands is caused by certain driving forces. All (100%) of the agricultural expert respondents said that *Striga* expansion is due to reduction in the fertility of the soil (Table-8) which is also described in Cotter (2012). Cotter (2012), explained that reduced soil fertility, increased land use, mostly on depleted soils and expansion of the area cropped with susceptible host crops in addition to convenient climate are the main driving forces for the increase of *Striga* problem. Therefore, what the agricultural expert respondents said is not the only force that drives the expansion of *Striga.* All agricultural experts are also in agreement in that mono-cropping of cereals make *Striga* problem more series which is also described by Atera *et al.* (2011). According to Atera *et al.* (2011), mono-cropping prevents nutrient replenishment of the soils, which results to increase infestation of *Striga* in size and severity.

Table 8: Agricultural expert's response on forces that increase *Striga* problem.

Driving forces	Agricultural experts response Percentage
Reduced soil fertility	100
Increased land use mostly on depleted soil	0
Expansion of the area cropped with susceptible host crops	0
Total	100

4.3.10. The use of *Striga hermonthica* in the study area.

Some (16%) of the farmer household respondents explained that *Striga* can be used for medical purpose for example they have used it to treat certain kind of wound in cattle. But the majority (84%) of the farmer household respondents said that *Striga* has no any medical value, so that they have not used for medical purpose. However, Koua (2011) and Kagot (2013) have found out that *Striga* is a well known medicinal plant. Therefore, the inability of most of the farmer household respondents to use *Striga* for medical purpose might be lack of knowledge about the use of *Striga* for medical purpose. As a result of this the harmful effect of *Striga* overrides its advantage in the study area. Therefore, if there were no lack of time and money it could be possible to create awareness about the use of Striga hermonthica for medical purpose to the local people.

4.3.11. Yield loss due to *Striga* infestation

Striga infestation causes from a very mild up to a very great yield loss and even it causes severe devastating effect on crops. When the impact of *Striga* on cereal crops in the study area is analyzed it was found to reduce a mean value of 7.3 ± 0.3999 (SE) quintals of crop yield from a hectare of farmland(Table-9) which is nearly equal to the average yield loss as described by Atera *et al* (2013), in Kenya. In Atera *et al*., (2013) it is described that *Striga* infestation causes an average yield loss of 1.15, 1.10 and 0.99 tons per hectare for maize, sorghum and millet respectively. Most (38%) of the farmer household respondents estimated that *Striga* causes a reduction of about 10 quintals of crop yield per hectare.

Table 9: Estimated yield loss due to *Striga* infestation from a hectare of farmland

Loss in quintal per hectare	Percentage	Mean	Std. Error
2.5 quintals	22	7.3	0.3999
5 quintals	31		
10 quintals	38		
15 quintals	8		
20 quintals	1		
Total	100		

4.3.12. Comparison of crop yield obtained from *Striga* infested and non-infested farmland per hectare

Crop yield from *Striga* infested and non-infested farmland was assessed based on the response given by farmer household respondents and the result is given as in Table-10A and Table-10B respectively for *Striga* infested and non-infested farmland. The mean value of crop yield obtained from *Striga* infested farmland was found to be 5.03± 0.4 (SE) quintals per hectare and the crop yield obtained from non-infested farmland with *Striga* was found to be 13.51± 0.55(SE). The value of the difference of these two means was 8.48 quintals per hectare. This result has shown a loss of 8.48 quintals of crop yield per hectare due to *Striga* infestation which is close to the average yield loss due to *Striga* infestation as described by Atera *et al*., (2013) in Kenya. Therefore, there is a difference between the crop yield obtained from *Striga* infested and non-infested farmland. *Striga* infestation causes a reduction in crop yield. Generally the amount of crop yield (dependant variable) depends on the presence or absence of *Striga* (independent variable) on a farm land.

Table 10A: Estimated crop yield obtained from *Striga* infested farmland

Yield in quintal per hectare	Percentage	Mean	Std. Error
1-5 quintals	72	5.03	0.4
6-10 quintals	19		
11-15 quintals	6		
16-20 quintals	2		
21-25 quintals	1		
Total	100		

Table10 B: Estimated crop yield obtained from a farmland non-infested with *Striga*

Yield in quintal per Hectare	Percentage	Mean	Std Error.
1-5 quintals	4	13.51	0.55
6-10 quintals	29		
11-15 quintals	37		
16-20 quintals	23		
21-25 quintals	5		
26-30 quintals	1		
31-35 quintals	1		
Total	100		

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS.

5.1. Conclusion

The result of this study has shown that *Striga hermonthica* is highly distributed on the farmlands of the local people in the study area. The expansion of *Striga hermonthica* is more on farmlands with low soil fertility. It has a long history of survival in the study area. At present *Striga hermonthica* has become expanded and the consequence of its expansion impacts the livelihood of the local people. To alleviate its harmful impact most of the farmers tried to control it, but its distribution is increasing from time to time because farmers did not use all possible measures of controlling *Striga* in combination. There is a problem of *Striga* control management practice. They practice only a single *Striga* control mechanism which is carried out by most farmers that is hand weeding, which is not effective in isolation.

The most important source of income for the local people is cropping, but *Striga* is found to be a challenge for cereal crop production. Among the cereals that grow in the study area sorghum which is most commonly grown and staple food crop of the local people is more affected by *Striga hermonthica*. In the study area a farmland infested with *Striga* shows a significant reduction in crop yield than the non-infested one. As a result of this, poverty level increases and the local people becomes food insecured. Therefore, this study assured that *Striga hermonthica* is distributed in the farmlands of the study area and influencing the socio-economic activity of the local people and support the hypothesis that were proposed. The result also indicates that more investigation must be carried out on *Striga hermonthica* and eradicate it from the study area, so due attention must be given to it.

5.2. Recommendations

Based on the results obtained from this study the following recommendations are forwarded:

- The Woreda agricultural office should arrange and provide *Striga* free seeds to the farmers in the study area.
- The Woreda agricultural office should make clear the various mechanisms by which *Striga* disseminates from place to place.
- The Woreda agricultural office should arrange and provide sufficient amount of fertilizer to the farmers in the study area.
- The agricultural experts should advice farmers to divert their commonly growing crop from *Striga* intolerant to *Striga* tolerant type. Because in the absence of the host plant, seeds of *Striga hermonthica* could not germinate and will be eradicated in the long run.
- The Woreda agricultural office should be coordinated with the Woreda administrative office and work to find Non-Governmental organizations (NGOs) that can provide *Striga* control products to the farmers.
- Agricultural experts should advice farmers to use *Striga* control mechanisms in an integrated manner not in isolation, because increased yield and productivity can be attained from the use of integrated *Striga* control measures.
- The woreda health office should create awareness to the local people how to limit their family size, which helps to reduce population growth.

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APPENDICES

Appendix 1: Farmer household survey questionnaires

This questionnaire is prepared for a research as a partial fulfillment of the master's degree in general biology.

The main objective of this research is to assess the current state of the local distribution and socio-economic impact of *Striga hermonthica* in Dejen woreda (Abay gorge). Therefore, for the successful completion of this study your genuine response is very important. So, you are kindly requested to give your response honestly according to the approach of each question given here under. Thank you.

Section I. Background Information of the Respondents

1. Sex: 1. Male 2. Female

2. For how long did you live in this area (locality)? (Year)__________________

3. Age category: 1. between 21-30 2. Between 31-40 3. Between 41-50

4. between 51-60 5. Above 60.

4. Family size (in no):______________________.

5. Educational status: 1. Illiterate 2. Read and write 3. Grade 1-6 4. Grade 7-10

5. Grade 11-12 6. Any other(specify)_________

Section II. Local distribution and socio-economic impact information of *Striga hermonthica*

1. Do you know *Striga hermonthica*? What type of plant is it? When did you know this plant?

____

2. Who and how do you think *Striga hermonthica* is introduced in to your locality (area) first?

____

3. When do you started into cultivation (give the year):______________________________

4. Proportion of farmlands allocated for different crops grown in 2016/17cropping season (give

in percentage)? Sorghum: _____Maize: ______ Teff: _______

5. Which types of crops is commonly grown in your locality (area)?
1. Sorghum 2. Teff 3. Maize 4. Other (specify). --------------------

6. What do you consider to be the most important source of household income? Choose one:

1. Cropping 2. Livestock 3. Off-farm income 4. Other(specify)_________

7. What is your perception of soil fertility in your locality (area)? 1. High 2. Medium 3. Low

8. For how long (years) have you had *Striga hermonthica* on your farm (no. of years):______________________.

9. Has it expanded since the first time you noticed it (if yes, how much and in which farm land?)

1. Sorghum 2. Teff 3. Maize

10. Is the spread of *Striga hermonthica* increasing from time to time?

1. Yes 2. No

11. If your answer for question No. 10 is yes. What will happen in the next 15 years?

1. Our income will decrease 2.Our crop yield will decrease and we will be food insecured. 3. We will be displaced totally from our village.

12. Does the plant invade cereal croplands? 1. Yes 2. No

13. Does *Striga hermonthica* decrease cereal crop production?

1. Yes 2. No

14. Have you ever tried to control invasion of *Striga hermonthica*?

1. Yes 2. No

15. If your answer for question No.14 is yes which mechanism did you apply to control?

1.Hand weeding.   5. Adding fertilizer to the soil.

2. Crop rotation.   6. Chemical control.

3. Inter cropping.   7. Combination of the above mechanisms.

4. Fallow.

16. If you are aware of any above *Striga* control mechanisms but your answer for question No. 14 is not, what is the most important reason that prevents you from applying the controlling mechanism?____

17. Have you ever been made your farm cleared from *Striga hermonthica* by any other person?

1.Yes   2. No

18. If your answer for question No.17 is yes how much you paid for a hectare of crop land?

____

19. How is the plant disseminated from one area to the other?

1. Through contaminated seeds.

2. Through cattle movement between farmlands.

3. Through wind dispersal of seeds.

4. Through dispersal of seeds by water

5. Others (specify). ---

20. Have you used *Striga hermonthica* for medicinal purpose?

1. Yes　　　　2. No

21. If your answer for question No.20 is yes list the types of diseases that can be treated by *Striga hermonthica*:_____________________________________

22. *Striga hermonthica* grows densely when the fertility of the soil is,

1. High　　2. Medium　　3. Low

23. *Striga hermonthica* is a big problem in farming because it reduces crop yield.

1. Agree　　　　2. Disagree

24. What did the landscape; your village and farmlands look 25 years ago?

____

____

25. What has changed since then?

____

____

26. Have you tried to control *Striga hermonthica* by hand weeding/sanitation?

1. Yes 2. No

27. If your answer for question No. 26 is yes and if there were no *Striga hermonthica* on your farmland for what purpose would you use the time that you loss for weeding?____

28. Have you ever paid money for controlling *Striga hermonthica*?

1. Yes 2. No

29. If your answer for question No.28 is yes and if there were no *Striga hermonthica* on your farmland what would you do with the money?

____

30. What is the amount of crop yield obtained from *Striga hermonthica* infested cropland in quintal per hectare?

____

31. What is the amount of crop yield obtained from uninfested cropland with *Striga hermonthica* in quintal per hectare? ____

32. What do you think is the average yield loss due to *Striga hermonthica* infestation from a hectare of cropland in quintal? Choose one.

1. About 2.5 quintals 2. About 5 quintals

3. About 10 quintals 4. About 15 quintals 5. About 20 quintals

Appendix 2: Woreda agricultural experts survey questionnaires

This questionnaire is prepared for a research as a partial fulfillment of the master's degree in general biology.

The main objective of this research is to assess the current state of local distribution and socio-economic impact of *Striga hermonthica* in Dejen woreda (Abay gorge). Therefore, for the successful completion of this study your genuine response is very important. So, you are kindly requested to give your response honestly according to the approach of each question given here under. Thank you.

Section I. Background Information of the Respondents

1. Sex: 1. Male 2. Female

2. For how long did you live in this Woreda? (Year)__________________

3. What is your educational level? ____

4. What is your field of specialization? ____

Section II. The current local distribution and socio-economic impact information of *Striga hermonthica.*

1. When *Striga hermonthica* is appeared first in this area? (year)____________________.

2. In Dejen Woreda (Abay gorge) *Striga hermonthica* was present

1. 5 years ago 2. 10 years ago 3. 15 years ago 4. 20 years ago 5. 25 years ago

3. What type of farmland is more affected by *Striga hermonthica*? ______________________

____

4. What are the main agents that distribute the plant (*Striga hermonthica*) to different areas?

1. Through contaminated seeds.

2. Through cattle movement between farmlands.

3.Through dispersal of seeds by wind.

4. Through dispersal of seeds by water.

5. Others (specify)

5. *Striga hermonthica* has a negative impact on crop productivity. 1. Agree 2. Disagree

6. Does the plant (*Striga hermonthica*) decrease the productivity of crops?

1. Yes 2. No

7. The major impact of *Striga hermonthica* on the society is increasing poverty and to displace the society from their village. 1. Agree 2. Disagree

8. What controlling measures were implemented to reduce the invasion of *Striga hermonthica*?

1. Hand weeding
2. Crop rotation
3. Inter cropping

5. Adding fertilizer to the soil
6. Chemical control
7. Combination of the above mechanisms

4. Fallow

9. If proper controlling measure is not taken what will happen in the woreda in the next 10 to 15 years?

1.Poverty level of the society will increase.

2. The society will be displaced from their village.

3. Income of the society will decrease.

4. Others (specify)____

10. Subsistence farmers are more affected by *Striga hermonthica*.

1. Agree 2. Disagree

11. If your answer for question No. 10 is yes what is the reason?

____

12. What comments do you have about the distribution of *Striga hermonthica*?

____

____

13. Could you give general comments of the impact of *Striga hermonthica* on the society____

____

14. What are the advantages and disadvantages of *Striga hermonthica* in this area?

Advantage (if any) ____

____

Disadvantage____

____

15. As an expert what controlling measures should you recommend to be taken ?

____

____

16. What do you think is the main driving force that increases *Striga hermonthica* problem?

1. Reduced soil fertility

2. Increased land use mostly on depleted soil

3. Expansion of the area cropped with susceptible host crops

4. Any other (specify)

17. Continuous mono-cropping of cereals such as sorghum or maize make *Striga hermonthica* problem more series.

1. Agree 2. Disagree

Appendix-3፡ ለናሙናነት በተመረጡ ቤተሰቦች የሚሞላ መጠይቅ

ይህ መጠይቅ የተዘጋጀዉ በሰነህይወት ትምህርት ክፍል የ2ኛ ዲግሪ ትምህርት ማሟያ ጥናታዊ ፅሁፍ ለማዘጋጀት ነዉ፡፡

የጥናቱ አላማ፡- በደጀን ወረዳ በተለይም በአባይ ሸለቆ አካባቢ አሁን ያለዉን የአጥቁር(የአቀንጭራ) አረም ስርጭት፤ ማህበራዊና ኢኮኖሚያዊ ተፅዕኖ ለመገምገም ነዉ፡፡ ስለሆነም ለዚህ ጥናት መሳካትና መሟላት አርስዎ ለእያንዳንዱ ጥያቄ የሚሰጡት ትክክለኛ መረጃ ወሳኝ ነዉ፡፡ ስለዚህ ከዚህ በታች ለቀረቡት ጥያቄዎች እንደየአቀራረባቸዉ በታማኝነት ተክክለኛዉን መልስ እንዲሰጡ አጠይቃለሁ፡፡የተከበሩ ተጠያቂ የሚሰጧቸዉ መልሶች በሙሉ ለጥናትና ምርምር አላማ ብቻ የሚዉሉ ሲሆኑ ምስጢራዊነታቸዉም የተጠበቀ ያሆናል፡፡ ስለትብብርዎ በጣም አመሰግናለሁ፡፡

ክፍል አንድ፡- አጠቃላይ የተጠያቂዎች መረጃ፡-

1. ፆታ፡ 1. ወንድ 2. ሴት

2. እዚህ ቦታ ወይም አካባቢ ለምን ያህል ጊዜ(አመት) ኖረዋል? ------------------------

3. እድሜ፡- 1. ከ21-30 2. ከ31-40 3. ከ41-50

   4. ከ51-60 5. ከ60 በላይ

4. የቤተሰብ ብዛት------------------

5. የትምህርት ደረጃ

   1. ማንበብና መፃፍ የማይችል 4. ከ7-10ኛ ክፍል የተማረ

   2. ማንበብና መፃፍ የሚችል 5. ከ11-12ኛ ክፍል የተማረ

3. ከ1-6ኛ ክፍል የተማረ 6. ሌላ ካለ ይጥቀሱ---------------------------

ክፍል ሁለት፡-አሁን ያለዉን የአጥቁር(የአቀንጭራ) አረም ስርጭት፤ማህበራዊ እና ኢኮኖሚያዊ ተፅዕኖ በተመለከተ መረጃ የሚሰጥ መጠይቅ፤

1. አጥቁር(አቀንጭራ) የተባለ አረም ያዉቃሉ? መልስዎ አዎን ከሆነ ምንአይነት አረም ነዉ? ከመቸ ጀምሮ ነዉ የሚያዉቁት?---
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2. አጥቁርን(አቀንጭራን) ለመጀመሪያ ጊዜ እርስዎ ወደሚኖሩበት አካባቢ እንዲገባ ያደረገዉ ማን እና እንዴት ነዉ ብለዉ ያስባሉ?

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3. እርሻ ማረስ የጀመሩት መቸነዉ(ከመቸ አመተምህረት ጀምሮ ነዉ)?

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4. ከጠቅላላ የእርሻ መሬትዎ ለ2009 ዓ ም የምርት ዘመን ለተለያዩ ሰብሎች የመደቡትን በፐርሰንት ይግለጡ፤

ለማሽላ---------------------------

ለበቆሎ---------------------------

ለጤፍ----------------------------

5. በአካባቢዎ በይበልጥ የሚመረት የሰብል አይነት የትኛዉ ነዉ?

1. ማሽላ 2. ጤፍ 3. በቆሎ
4. ሌላ ካለ ይጥቀሱ

6. ለቤተሰብዎ ዋነኛ የገቢ ምንጭ የሆነዉ የትኛዉ ነዉ?

1. ሰብል ምርት 3. ከግብርና ዉጭ የሆነ ገቢ

2. ከብት እርባታ 4. ሌላ ካለ ይጥቀሱ--

7. በአካባቢዎ የአለዉ አፈር ለምነቱ ምንያህል ነዉ?

1. ከፍተኛ 2. መካከለኛ 3. ዝቅተኛ

8. በእርሻ ቦታዎ ላይ አጥቁር(አቀንጭራ) ለምን ያህል ጊዜ(አመት) ቆይቷል?

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9. አጥቁር(አቀንጭራ) ለመጀመሪያ ጊዜ በእርሻ ቦታዎ ላይ ከታየ በኂላ እየተስፋፋ መጥቷል? መልስዎ አዎ ከሆነ ከሚከተሉት በየትኛዉ ሰብል የእርሻ ቦታ ላይ ነዉ እየተስፋፋ ያለዉ?

1. ማሽላ 2. ጤፍ 3. በቆሎ

10. የአጥቁር(አቀንጭራ) አረም ከጊዜ ወደ ጊዜ እየተስፋፋ መጥቷል?

1. አዎ 2. የለም

11. ለጥያቄ ተራቁጥር 10 መልስዎ አዎን ከሆነ በሚቀጥሉት 15 አመታት ምን ሊሆን ይችላል ብለዉ ያስባሉ?

1. ገቢያችን ይቀንሳል

2. የሰብል ምርታችን ይቀንስና የምግብ እጥረት ይገጥመናል

3. አካባቢያችንን ጥለን አንሰደዳለን

12. አጥቁር(አቀንጭራ) በጥራጥሬ እህሎች የእርሻ ቦታ ላይ ወረራ ያካሂዳል?

1. አዎ 2. የለም

13. አጥቁር(አቀንጭራ) የጥራጥሬ እህሎችን ምርት ይቀንሳል?

1. አዎ 2. የለም

14. የአጥቁር(የአቀንጭራ) ወረራን ለመከላከልና ለመቆጣጠር ሞክረዉ ያዉቃሉ?

1. አዎ 2. የለም

15. ለተራቁጥር 14 መልስዎ አዎ ከሆነ የትኛዉን የመከላከያ ዘዴ ነዉ የተጠቀሙት?

1.በእጅ በማረም

2.አዝርዕትን አፈራርቆ በመዝራት

3.አዝርዕትን አሰባጥሮ በመዝራት

4.የእርሻ መሬትን ያም በማሳደር

5. በአፈር ላይ ማዳበሪያ በመጨመር

6. ኬሚካል በመጠቀም

7. ከላይ የተጠቀሱትን በማቀናጀት

16. ከላይ ለተዘረዘሩት የአጥቁር(አቀንጭራ) መከላከያ ዘዴዎች እዉቅና ካለዎትና ለተራቁጥር 14 መልስዎ የለም ከሆነ መከላከያ ዘዴዎችን እንዳይጠቀሙ ያደረገዎ ምንድን ነዉ? ---------
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17. ሌላ ሰዉን በመጠቀም የእርሻ ቦታዎን ከአጥቁር ለመከላከል (ለማፅዳት) ሞክረዉ ያዉቃሉ?

1. አዎ 2. የለም

18. ለጥያቄ ተራቁጥር 17 መልስዎ አዎ ከሆነ ለአንድ ሄክታር ምንያህል ይከፍላሉ?

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19. አጥቁር (አቀንጭራ) ከአንድ ቦታ ወደ ሌላ ቦታ የሚስፋፋዉ በምንድን (እንዴት) ነዉ?

1. በአጥቁር ዘር የተበከለ የሰብል ዘር በመጠቀም

2. ከብቶች ከአንድ የእርሻ ቦታ ወደ ሌላ የእርሻ ቦታ በሚያደርጉት እንቅስቃሴ

3. በነፋስ አማካኝነት በሚደረግ የአጥቁር ዘሮች እንቅስቃሴ

4. በዉሃ አማካኝነት በሚደረግ የአጥቁር ዘሮች እንቅስቃሴ

5. ሌላ ካለ ይጥቀሱ--

20. አጥቁርን(አቀንጭራን) ለመድሀኒትነት ተጠቅመዉ ያዉቃሉ?

1. አዎ 2. የለም

21. ለጥያቄ ተራቁጥር 20 መልስዎ አዎ ከሆነ አጥቁርን እንደመድሀኒት በመጠቀም ሊፈወሱ የሚችሉ በሽታዎችን ይዘርዝሩ ---

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22. አጥቁር(አቀንጭራ) በስፋት የሚበቅለዉ የአፈሩ ለምነት ምን ሲሆን ነዉ?

1.ከፍተኛ 2. መካከለኛ 3. ዝቅተኛ

23. አጥቁር(አቀንጭራ) በሰብል ማምረት ሂደት ዉስጥ ከፍተኛ የሆነ ችግር ነዉ፡፡

1. እስማማለሁ 2. አልስማማም

24. ከ 25 አመታት በፊት አካባቢዎና በአካባቢዎ ያለዉ የመሬት ገፅታ ብሎም የእርሻ መሬትዎ ምን ይመስል ነበር? --

25. ከ 25 አመታት በኂላስ ምን የተቀየረ ነገር አለ?

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26. አጥቁርን(አቀንጭራን) በእጅ በማረም ወይንም ነቅሎ በመጣል ለመከላከል ሞክረዉ ያዉቃሉ?

1. አዎ 2. የለም

27. ለተራቁጥር 26 መልስዎ አዎ ከሆነ አረሙ ባይኖር ኖሮ ለዚያ የሚያጠፉትን ጊዜ ለምን ያዉሉት ነበር? --

28. አጥቁርን(አቀንጭራን) ለመከላከል ገንዘብ አዉጥተዉ ያዉቃሉ?

1. አዎ 2. የለም

29. ለጥያቄ ተራቁጥር 28 መልስዎ አዎ ከሆነ በእርሻ መሬትዎ ላይ አጥቁር (አቀንጭራ)

ባይኖር ኖሮ ገንዘቡን ለምን ያዉሉት ነበር?

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30. በአጥቁር(በአቀንጭራ) ከተጠቃ የእርሻ መሬት ላይ በሄክታር ምንያህል ኩንታል ምርት ያገኛሉ?
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31. በአጥቁር(በአቀንጭራ) ከአልተጠቃ የእርሻ መሬት ላይ በሄክታር ምንያህል ኩንታል ምርት ያገኛሉ? ---

32. በአጥቁር(በአቀንጭራ) የተጠቃ የእርሻ መሬት በሄክታር ስንት ኩንታል ምርት ይቀንሳል?

1. 2.5 ኩንታል የሚሆን 4. 15 ኩንታል የሚሆን

2. 5 ኩንታለ የሚሆን 5. 20 ኩንታል የሚሆን

3. 10 ኩንታል የሚሆን

Appendix 4: በግብርና ባለሙያዎች የሚሞላ መጠይቅ

ይህ መጠይቅ የተዘጋጀዉ በሰነህይወት ትምህርት ክፍል የ2ኛ ዲግሪ ትምህርት ማሟያ ጥናታዊ ፅሁፍ ለማዘጋጀት ነዉ፡፡

የጥናቱ አላማ፡- በደጀን ወረዳ በተለይም በአባይ ሸለቆ አካባቢ አሁን ያለዉን የአጥቁር(የአቀንጭራ) አረም ስርጭት፤ ማህበራዊና ኢኮኖሚያዊ ተፅዕኖ ለመገምገም ነዉ፡፡ ስለሆነም ለዚህ ጥናት መሳካትና መሟላት አርስዎ ለእያንዳንዱ ጥያቄ የሚሰጡት ትክክለኛ መረጃ ወሳኝ ነዉ፡፡ ስለዚህ ከዚህ በታች ለቀረቡት ጥያቄዎች እንደየአቀራረባቸዉ በታማኝነት ተክክለኛዉን መልስ እንዲሰጡ አጠይቃለሁ፡፡የተከበሩ ተጠያቂ የሚሰጧቸዉ መልሶች በሙሉ ለጥናትና ምርምር አላማ ብቻ የሚዉሉ ሲሆኑ ምስጢራዊነታቸዉም የተጠበቀ ይሆናል፡፡ስለትብብረዎ በጣም አመሰግናለሁ፡፡

ክፍል አንድ፡- አጠቃላይ የተጠያቂዎች መረጃ፡-

1. ፆታ፡ 1. ወንድ 2. ሴት

2. እዚህ ወረዳ ላይ ለስንት አመት ኖረዋል? ---

3. **የትምህርት ደረጃዎ** (Educational level) **ምንድን ነዉ**? ------------------------------------

4. **ያጠኑት የትምህርት አይነት** (Field of specialization) **ምንድን ነዉ**? --------------------

ክፍል ሁለት፡-አሁን ያለዉን የአጥቁር(የአቀንጭራ) አረም ስርጭት፣ማህበራዊ እና ኢኮኖሚያዊ ተፅዕኖ በተመለከተ መረጃ የሚሰጥ መጠይቅ፤

1. አጥቁር(አቀንጭራ) እዚህ ወረዳ ላይ (አባይ ሸለቆ) አካባቢ ለመጀመሪያ ጊዜ የታየዉ መቸ ነዉ? ---------- --

2. አጥቁር (አቀንጭራ) በደጀን ወረዳ በተለይም በአባይ ሸለቆ አካባቢ ከስንት አመት በፊት በእረሻ ቦታዎች ላይ የታይ ነበር?

   1. ከ 5 አመት በፊት
   2. ከ10 አመት በፊት
   3. ከ 15 አመት በፊት
   4. ከ 20 አመት በፊት
   5. ከ 25 አመት በፊት

3. አጥቁር (አቀንጭራ) የሚያጠቃዉ ምንአይነት የእርሻ መሬት ነዉ?

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4. አጥቁርን (አቀንጭራን) በዋነኛነት ከቦታ ወደ ቦታ እንዲስፋፋ የሚያደርገዉ ምንድን ነዉ?

1. በአጥቁር ዘር የተበከለ የሰብል ዘር በመጠቀም
2. ከብቶች ከአንድ የእርሻ ቦታ ወደ ሌላ የእርሻ ቦታ በሚያደርጉት እንቅስቃሴ
3. በንፋስ አማካኝነት በሚደረግ የአጥቁር (የአቀንጭራ) ዘሮች እንቅስቃሴ
4. በዉሀ አማካኝነት በሚደረግ የአጥቁር (የአቀንጭራ) ዘሮች አንቅስቃሴ
5. ሌላ ካለ ይጥቀሱ--

5. አጥቁር(አቀንጭራ) በሰብል ምርት ዉጤት ላይ አሉታዊ ተፅዕኖ አለዉ፡፡

   1. አስማማለሁ 2. አልስማማም

6. አጥቁር(አቀንጭራ) የሰብል ምርት ዉጤትን ይቀንሳል?

   1. አዎ 2. የለም

7. አጥቁር (አቀንጭራ) በዋነኛነት በማህበረሰቡ ላይ የሚያደርሰዉ ተፅዕኖ ድህነትን ማባባስና አካባቢያቸዉን ለቀዉ እንዲሰደዱ ማድረግ ነዉ፡፡

   1. እስማማለሁ 2. አልስማማም

8. የአጥቁርን (የአቀንጭራን) መስፋፋት ለመከላከል ምንአይነት የመከላከያ እርምጃዎች ተወስደዋል? ---

9. አግባብነት ያለዉ የአጥቁር(የአቀንጭራ) አረም መከላከያ ዘዴዎችን መጠቀም ካልተቻለ በደጀን ወረዳ በተለይም በአባይ ሸለቆ አካባቢ የሚኖረዉ የማህበረሰብ ክፍል በሚቀጥሉት 10 እና 15 አመታት ዉስጥ ምን ሊገጥመዉ ይችላል?

1. የማህበረሰቡ የድህነት መጠን ይጨምራል

2. ማህበረሰቡ አካባቢዉን ጠሎ ይሰደዳል

3. የማህበረሰቡ የገቢ ምንጭ ይቀንሳል

4. ሌላ ካለ ይጥቀሱ

10. በአጥቁር (በአቀንጭራ) አረም በይበልጥ የሚጠቁት ለመኖር ከእጅ ወደ አፍ ምርት የሚያመርቱ አራሾች ናቸዉ፡፡

1. እስማማለሁ 2. አልስማማም

11. ለጥያቄ ተራቁጥር 10 መልስዎ አስማማለሁ ከሆነ ምክንያቱ ምንድን ነዉ?

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12. አካባቢዉ ስላለዉ የአጥቁር (የአቀንጭራ) አረም የስርጭት መጠን ምን አይነት አስተያየት አለዎት? ---- ---

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13. አጥቁር (አቀንጭራ) አረም በህብረተሰቡ ላይ ስለሚያደርሰዉ አሉታዊ ተፅዕኖ ጠቅለል ያለ አስተያየት ይስጡ፤--- -- ---

14. አጥቁር (አቀንጭራ) በደጀን ወረዳ በተለይም በአባይ ሸለቆ አካባቢ ለህብረተሰቡ የሚሰጠዉ ጥቅምና የሚያደርሰዉ ጉዳት ምንድን ነዉ?

ጥቅም (ካለ)--

ጉዳት---
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15. እንደባለሙያ አጥቁርን (አቀንጭራን) ለመከላከል ዉጤታማ የሆነ ምን አይነት እርምጃ መወሰድ አለበት ይላሉ? --

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16. የአጥቁርን (የአቀንጭራን) ችግር በዋናነት ያባብሳል ብለዉ የሚያስቡት ምንድን ነዉ?

1. የአፈር ለምነት መቀነስ
2. ለምነቱ የተጎዳን መሬት በተደጋጋሚ መጠቀም
3. ለአጥቁር(ለአቀንጭራ) ተጋላጭ የሆኑ ሰብሎች የሚመረቱበትን የእርሻ ቦታ ማስፋፋት
4. ሌላ ካለ ይጥቀሱ---

17. በአንድ የእርሻ መሬት ላይ ለአጥቁር (ለአቀንጭራ) ተጋላጭ የሆኑ እንደ ማሽላ ወይም በቆሎ ያሉ ሰብሎችን በተከታታይ ማምረት የአቀንጭራን ችግር የከፋ ያደርገዋል፡፡

1. እስማማለሁ 2. አልስማማም

APPROVAL SHEET

SCHOOL OF GRADUATE STUDIES

ADDIS ABABA UNIVERSITY

As thesis research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my guidance, by Minwyelet Belay entitled 'Assessment of the Local distribution and Socio-economic Impact of [*Striga hermonthica* (Del.) Benth] in Dejen Woreda (Abay gorge) East Gojjam Zone Amhara National Regional State. I recommend that it be submitted as fulfilling the thesis requirement.

______________________________ ______________________________

Advisor Signature Date