



**EFFECT OF PARTHENIUM (*Parthenium hysterophorus*) WEED ON RANGE LAND
PRODUCTIVITY AND LIVESTOCK PRODUCTION IN LIBEN DISTRICT OF
GUJI ZONE, SOUTHERN ETHIOPIA**

MSc thesis

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2022

DILLA ETHIOPIA

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**BY
BISHAR IBRAHIM HALEKE**

**SUBMITTED TO DEPARTMENT OF ANIMAL AND RANGE LAND SCIENCE,
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MASTER OF SCIENCE IN ANIMAL PRODUCTION**

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DILLA ETHIOPIA

APPROVAL SHEET
SCHOOL OF GRADUATE STUDIES

DILLA UNIVERSITY

As Thesis Research advisors, we here by certify that we have read and evaluated this Thesis prepared, under our guidance, by Bishar Ibrahim entitled “effect of *Parthenium* (***Parthenium h.***) weed on range land and livestock production in Liben woreda, Guji Zone, Southern Ethiopia”

I recommend that it can be submitted as fulfilling the thesis requirement for the degree of Master Science in animal production.

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As member of the Board of Examiners of the MSc. Thesis Open Defence Examination, we certified that we have read, and evaluated the Thesis prepared by Bishar Ibrahim and examined the candidate. We recommended that the Thesis is accepted as fulfilling the requirement for the Degree of Master of Science in animal production

_____ Chairperson	_____ Signature	_____ Date
_____ Internal Examiner	_____ Signature	_____ Date
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DEDICATION

I dedicate this thesis manuscript to my late son Imran Bishar

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my bona fide work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfilment of the requirements for MSc. degree at Dilla University and it is deposited at the University Library to be made available to borrowers under rules of the Library.

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Name: Bishar Ibrahim Signature_____

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Date of submission:, 2022

BIOGRAPHICAL SKETCH

Bishar Ibrahim Halake was born in Negelle Borena District, Guji Zone, and Oromia regional state on June 30, 1986. He attended his elementary and junior education at Ogoba, Liben and Gumigayo elementary and junior schools. He also attended his high-school education at Negelle Borena senior secondary school. After completion of his high school education in , He joined Alage TVET college to attend diploma program in animal science and He graduated in 2007 year then after He served for four years as development worker in the district He joined Mada Walabu University and He graduated in (2016 year). After he graduation from University He served as agricultural activity coordinator for last six years in Liban district. He joined in 2018 G.C. the School of Graduate Studies at Dilla University Department of Animal and Range Science to pursue his MSc. study in the specialization of Animal Production program.

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LIST OF ABBREVIATIONS AND ACRONOMYS

IV	Importance value
RD	relative density
RF	Relative frequency
LPDO	Liben Pastoral Development Office
IPSR	Invader Plant Species Ratio
HH	Household
DA	Development Agent
PA	Peasant Association
SPSS	Statistical Packages for Social Sciences
GLM	General Leaner Model
He	Hectar
HIS	High Infestation Site
LIS	Low Infestation Site
MIS	Medium Infestation Site

TABLE OF CONTENT

	Page
APPROVAL SHEET	i
DEDICATION.....	ii
STATEMENT OF THE AUTHOR	iii
BIOGRAPHICAL SKETCH	iv
ACKNOWLEDGEMENTS.....	v
LIST OF ABBREVIATIONS AND ACRONOMYS	vi
LISTS OF TABLE.....	ix
ABSTRACT.....	x
1. INTRODUCTION	1
1.1. Background of the study	1
1.2. Statement of the Problem	3
1.3. Objectives of the study	4
1.3.1. General objective	4
1.3.2. Specific objectives	4
1.4. Significance of the Study	4
1.5. Scope of the Study.....	5
1.6. Limitations of the Study.....	5
2. LITERATURE REVIEW	6
2.1. Botanical Description and Germination of Parthenium weed (<i>parthenium hydrosporus</i>)	6
2.2. Seed Dispersal	7
2.3. Status and Distribution of Parthenium in Ethiopia.....	8
2.4. The Impact of Invasive Weeds.....	9
2.4.1. Rangeland productivity and animal production	9
2.4.2. Impact on forage production.....	10
2.5. Methods of Control of Parthenium Weed	11
2.5.1. Use of competitive plants.....	11
2.5.2. Pasture and grazing management.....	12
2.5.3. Using herbicides.....	15
3.1. Description of the Study Area	17
3.1.1. Altitude and Climate	17
3.1.2. Topography and Demography	18
3.1.3. Economy Level and Production Systems	19
3.1.4. Infrastructure and Social Facilities	19
3.1.5. Soil and Vegetation types	19
3.1.6. Data Sources	20
3.1.7. Survey of the pastoralist' perception on the effects of Parthenium weed.....	20
3.1.8. Sampling of vegetation	21

3.2. Data Analysis	23
4. RESULT AND DISCUSSION	24
4.1. Sex and Age composition of the Households (HHs) in the study area	24
4.1.1. Marital Status	25
4.1.2. Major livelihood activities of the respondents	25
4.1.3. Livestock number and composition in the district	26
4.2. Distribution of Parthenium weed in the study district	27
4.2.1. Parthenium weed distribution agent and suitable season	28
4.2.2. Causes of aggressiveness of <i>parthenium</i> weed	29
4.3. Effects of Parthenium weed on range land plants	30
4.4. Effects of Parthenium Weed on Milk production and quality	32
4.5. Impact of Parthenium weed on Animal health	33
4.3.1. Management practices of Parthenium weed	34
4.4. Effects of Parthenium weed on other Species composition in the study area	35
4.5. Impact of Parthenium weed on herbaceous species diversity, richness and evenness in three different infested area	38
5. CONCLUSION AND RECOMMENDATION	40
5.1. Conclusion	40
5.2. Recommendations	41
6. REFERENCES	42

LISTS OF TABLE

	Page
Table1: Gender Compositions and response rate by Kebeles.....	24
Table 2 Marital status of the respondent living in the pastoral area.....	25
Table 3 major livelihood Activities of the respondents.....	25
Table 4 Livestock holdings of the respondents.....	27
Table 5.Distribution of Parthenium weed in different parts of a range land.....	27
Table 6.Distribution agent and Favourable season for Parthenium weed distribution.....	29
Table 7, Causes of aggressiveness for infestation of Parthenium weed.....	30
Table 8, Effects of Parthenium weed on range land plants.....	31
Table 9, Effects of <i>Parthenium</i> weed on cow Milk production and quality.....	32
Table 10, Animal health problems caused by Parthenium weed and most affected Animals.....	33
Table. 11. parthenium weed management practices in study area.....	34
Table 12.Mean cover percentage (m-2) of grasses, non-grass species and parthenium weed at three <i>P. hysterophorus</i> infestation levels in the rangelands of south Ethiopia.....	35
Table 13 mean $\pm$ SD value of herbaceous richness (r), evenness (E) and Diversity (H'). in three different infested Pastoral associations.....	38

ABSTRACT

The study was done in selected three (3) Pastoral associations based on the level of infestation of Parthenium weeds such as (high, medium and low) in Liben district. Both the qualitative and quantitative data were gathered through structured questioner, focus group discussion, direct observation and measure effects of parthenium weed on aboveground herbaceous vegetation. Three long transects 1 km apart from each other and each containing 9 quadrats totally 27 quadrants (20m x 20m) and small sub-sample quadrants (1m x 1m) were laid and the samples were collected at 500m interval in the transect. Majority 77.5% of the respondents were male and majorly engaged on mixed livestock and crop production. High number of livestock were found in low infestation area and the Parthenium hysterophorus is distributed everywhere in the district at this time, however, the weed highly distributed in farm land. Water and Wind are the major agents for distribution and also Livestock movement and human factors are also important agents for the distribution. P hysterophorus is an annual weed its infestation greatly differs from season to season, mostly dominate on summer and some are in winter. Overgrazing was the major factor which was aggravates weed infestation, the weed is highly compete with other vegetation for resources and reduce the composition of other species. The weed changes Milk taste and reduces Milk fat. Diarrhoea was the major diseases caused by Parthenium weed in the district and cattle's are majorly affected. Hand weeding and using Herbicides are the major way of controlling weed. Most of the valuable species essential for grazing animals have already disappeared due to the continued increase of the Parthenium weed and livestock selection pressure. High densities of P. hysterophorus were recorded in most land use types namely arable land, pasture land, road side and residential areas.

Key words:-*Parthenium, range land, livestock, densities, species, vegetation*

1. INTRODUCTION

1.1. Background of the study

Parthenium weed (*Parthenium hysterophorus* L.) belongs to the family Asteraceae, It is an extremely diverse family with a cosmopolitan distribution. It is described as an annual or under certain conditions, it is a short-lived perennial, procumbent or with an erect stem and at maturity the weed develops several branches in its top half and becomes a diffused leafy herb with a height of 0.5 to 1.50m, reaching a maximum of 2m in good soils (Tessema et al., 2010, Adkins and Shabbir, 2014, Abdulkerim-Ute and Legesse, 2016, Bagachi et al., 2016, Hundessa et al., 2016 Mekonnen, 2017).

Parthenium weed is characterized by deep tap root, pale green leaves and an erect stem that becomes woody gradually. The alternately arranged leaves are simple with stalks (petioles) narrowly winged up to 2 cm or 2.5cm long and form a basal rosette during the early stages of growth. The lower leaves are comparatively large (3 to 30cm long and 2 to 12cm wide) and are strongly dissected (bi-pinnatifid or bipinnatisect) than the leaves on the upper branches. Mature stems are greenish and longitudinally grooved and covered in small stiff hairs (hirsute) (Abdulkerim-Ute and Legesse, 2016; Bagachi et al., 2016, Bobo and Abdeta, 2016, Mekonnen, 2017 and Royimania et al., 2019)

Parthenium weed is the most obnoxious, allergenic, and environmental pollutant weed (Maszura et al., 2018), which is supposed to have originated in the area surrounding the Gulf of Mexico, Southern USA, West Indies, and Central South America (Adkins and Shabbir, 2014 and Bagachi et al, 2016). The aggressive and pernicious weed is recognized as one of the top ten worst weeds in the world and has colonized and naturalized in many regions of the world, including Asia, Australia and Africa (Saini et al., 2014), Maszura et al., 2018, Royimani et al., 2018 and Zelalem and Tora, 2019). African countries are at high risk of invasion (Bagachi et al., 2016; Bobo and Abdeta, 2016) and in Africa, Parthenium has become prevalent in the eastern and southern parts of the continent (Royimani et al., 2018). While *P. hysterophorus* was first documented in Ethiopia in 1968 at Haramaya University, Herbarium there is no tangible evidence hitherto concerning its mode of introduction (Tessema et al., 2010; Lisanework and Sharma, 2013).

It is supposed that the weed was introduced accidentally as a seed contaminant of food grains imported from overseas where *Parthenium* occurred on farmlands or during the Ethio-Somalia war in 1976 to 1977 by army vehicles (Tessema et al., 2010; Lisanework and Sharma, 2013; Hundessa and Belachew, 2016). *Parthenium* is currently spreading at an alarming rate in various parts of Ethiopia (Bobo and Abdeta, 2016; Zelalem and Tora, 2019) mainly following the direction of low slope and waterways (Belachew and Tessema, 2015; Hundessa et al., 2016). The seeds of the weed are primarily dispersed through transport, agricultural implements, crop seeds, wind compost, organic manures, flood water, and tire-carried mud of vehicles. Following its introduction into Ethiopia, it dispersed across the whole country within a few years (Kebede, 2008, Tessema et al., 2010, Lisanework and Sharma, 2013, Bobo and Abdeta, 2016 and Maszura et al., 2018).

The high germination capacity and Seed production an easy distribution mechanism, allelopathic effect on other plants, a short life cycle, and un palatability to grazers contributed to the spread of the weed. Likewise, small and light seeds, absence of natural enemy large viable seed bank high survival rate and a good adaptation to a wide range of environmental factors have been associated with the rapid spread of the weed in Ethiopia (Abdulkarim-Ute and Legesse, 2016; Royimania et al., 2019). It aggressively colonizes natural and manmade ecosystems and causes major negative impacts on grassland habitats, open woodlands, riverbanks, flood plains, wildlife parks, open field of settlement areas, and bare areas along road sides (Shiferaw et al., 2018).

Consequently, *Parthenium* causes immeasurable ecological losses each year (Adkins and Shabbir, 2014), through displacement of native flora and fauna as well as the significant decline in local biodiversity (Royimania et al., 2019). On the other hand, *Parthenium* affects agriculture (crop and livestock production) through its effect on crops and grazing lands. In Ethiopia, the noxious weed species is seriously affecting crop yields (Bajwa et al., 2018) where it has become a grave poser in the cultivation of major crops in eastern part of the country in addition to being a major problem on range and waste lands (Bobo and Abdeta, 2016). Conversely, *Parthenium* is known to affect animal health, milk and meat production (Shashie, 2007; Hundessa and Belachew, 2016; Royimania et al., 2019).

The notorious weed can cause serious allergic reactions respiratory problems and other health complications (Bobo and Abdeta, 2016 and Bajwa et al., 2018) in livestock including eye irritation, skin lesions, anorexia, pruritus, alopecia, dermatitis, diarrhea, mouth ulcers with excessive salivation , and sometimes death) due to rupturing and hemorrhage of internal tissues and organs (Mekonnen, 2017, Birhanu and Khan, 2018). Besides, the toxins derived from the weed reduce quality of meat, cause tainting in milk, and reduce yields of milk of Goat, Sheep and Cow (Kilewa and Rashid, 2013).

Effects of Parthenium are very conspicuous in agricultural ecosystems leading to economic losses to the nation due to reduced crop productivity (Saini et al., 2014). Subsequently, invasion of Parthenium weed in a crop lands may contribute to social and economic instability, causing poverty and food insecurity. Parthenium clearly poses a major threat to the health of humans (Tamado et al, 2002; Kathiresan et al., 2005; Kumar, 2013; Kilewa and Rashid, 2013; Seta et al, 2013; Zuberi et al, 2014; Hundessa and Belachew, 2016; Maszura et al., 2018). In humans, the weed causes Allergic Respiratory Problems, Mutagenicity, contact dermatitis Allergic Rhinitis, Asthma, Bronchitis and Dermatitis (Tessema et al., 2010; Kilewa and Rashid, 2013, Roy and Shaik, 2013; Hundessa and Belachew, 2016)

1.2. Statement of the Problem

Parthenium colonizes disturbed sites very aggressively, impacting croplands and pastures. It generates allelopathic effects through root exudates and leaching, decaying plant residues into the soil. These secondary metabolites or allelo chemicals- inhibitors like lactones and phenols inhibit the germination, growth and yield of neighbouring plants. Similarly, in grasslands dominated by Parthenium, native plant species composition and abundance was found to be low (Amalia et al, 2012). Thus, reduces growth and depresses forage production. Parthenium weed is a serious problem to natural plant communities (Ani k 2014 and EPA, 2011). Under the present scenario of squeezing grazing lands in the country and continued heavy grazing it is capable to exclude useful forage plants and can become dominant resulting in decreased pasture productivity, carrying capacity and land values. liben range land is one of the good range land in Ethiopia for the last decayed but know a day these range land is highly affected by several man-made and natural factors. Parthenium has been quickly spreading in different parts of Ethiopia (Javari and Ritz, 2012) and enormous losses to cattle and human health; decrease quality and quantity of Milk and Milk products and suffer allergic Skin, asthmatic reactions in the Parthenium weed infested areas and in addition to this decrease crop and

range land production. It is to be threatening to infest other fodder and cereal crops as well as vegetables like Bitter, Gourd and Melons as well as Timber crops (Shabbier and Bajwa, 2006).

Parthenium weed is widely spread in the rangelands of south-east Ethiopia (Tamado and Milberg, 2000; Amaha, 2006; Mcconnachie et al., 2010) and the communities there depend on livestock production as a major source of their livelihood. Thus, it is hypothesized that the spread of parthenium weed modifies the structure of the invaded rangeland communities by decreasing the abundance of native grass species and reducing species diversity on Liben range land since limited time. However, there have been no specific studies on the impact of parthenium weed on range land and livestock production in this area. Therefore, this study was undertaken to determine the distribution and spreading pattern of parthenium weed and its impact on species composition, plant diversity and on livestock production on Liben range land of south Ethiopia.

1.3. Objectives of the study

1.3.1. General objective

To assess the effects of Parthenium weed on Range land productivity and on Cow Milk production and quality in the study area

1.3.2. Specific objectives

The specific objectives of the study is

- To assess pastoralist perception on the effect of Parthenium on livestock production
- To assess effect of Parthenium weed on range land productivity
- To assess distribution and spread of Parthenium weed

1.4. Significance of the Study

The study will contribute the following benefits to the pastoral society

- It provides information how the infestation of Parthenium weed can decrease the availability of livestock feed resource by affecting range land productivity
- It fills the information gap about degree of distribution of Parthenium weed in the study area.
- It suggests how to control Parthenium weed in the study area.
- The information will help as a guide line and input for concerning governmental and non-governmental bodies that are working in the study area.

The findings of this study will be also provide the base line data which will be used as an input for researchers to conduct a research ,

1.5. Scope of the Study

This study was conduct in Ethiopia, Oromia Region, Guji Zone, Guji Zone has 12 rural districts and three city administrations and Liban District is one of the 3 pastoralist district of Guji Zone. So this study will be focus on liben District effects of Parthenium weed on Range land productivity and livestock production.

1.6. Limitations of the Study

Limitations are obstacles or constraining factors that will happen and has adverse impacts on the study procedure and eventually bound study quality.

The researcher faces several constraints and challenges during data collection (difficulty of getting pastoralist and other key informants in the stipulated time, lack of well recorded, kept, and related data and others). Some constraining factors that happened; Security issue-there were a rumour of conflict between Government Army and Shene ABO groups and therefore, some of the adult males were hiding away around the border area between the two antagonists to protect their environment against enemy and are not available for participation. However, these challenges are substantiated by other means such as the use of diverse techniques to collect necessary information for the study and thus the limitations do not have significant impact to decrease the credibility of the study.

2. LITERATURE REVIEW

2.1. Botanical Description and Germination of Parthenium weed (*parthenium hydrosporus*)

Parthenium is an annual herbaceous plant under the family of Asteraceae, with a deep tap root and an erect stem that gradually changes into semi-woody with age. It has bi-pinnated and pale green leaves covered with soft fine hairs (Prasanta et al., 2005). Parthenium can grow and reproduce itself any time of the year. During a favorable growing season, four or five successive generations of seedlings can emerge at the same site. Pandey et al. (2003) reported that the photosynthetic characteristics of Parthenium leaf is mostly related to C₃ type pathway and exhibits a photosynthesis rate of 25-35 °C and a high CO₂ level. Low temperature considerably reduces plant growth, mainly flowering and seed production by reducing leaf area index, relative growth rate, net assimilation rate, and leaf area duration (Navie et al., 1996; Pandey et al., 2003). The weed grows fast and comfortably on alkaline to neutral clay soils (Dale, 1981). However, its growth is slow and less prolific on a wide range of other soil types (Adkins et al., 2005; Rezene et al., 2005). Parthenium is a prolific seed producer. For example, in a highly infested field in India, a single plant produced 200, 000 seeds/m² (Joshi, 1991).

The germination process of the weed involves several steps required to change the quiescent embryo to metabolically active embryo (Buhler and Hoffman, 2000). For a seed to germinate adequate water, suitable temperature and composition of gases (O₂/CO₂ ratio) in the atmosphere, and light should be available. Several internal and external factors prevent seed germination. Among the internal factors some of the presence of biochemical inhibitor in the seed and immature embryo. The commonest external factors are soil water content and temperature (Fernandez Q. et al., 1991). The longevity of a seed represents a major mechanism of survival for weed species. It leads to a continuous source of emergency (Carvalho and Favoretto, 1995). However, the longevity of seed in soil varies according to the characteristics, burial depth, and climatic conditions of seeds (Carmona, 1992). Studies conducted on the longevity of *P. hysterophorus* have produced inconsistent results. Butler (1984) came up with a finding that the viability of seed was 66% after one week of burial to 29% after two years.

However, Navie et al. (1998) and Tamado et al. (2002) reported that the viability of seed was greater than 74% after 2 years and showed 50% viability after 26 months of burial in the soil, respectively. This suggests that a potential buildup of a substantial persistence in soil seed bank makes it difficult to eradicate a population of *P. hysterophorus* in a short period of time. The seedlings of it emerged from shallow buried (< 0.5 cm) seeds and none from more than 5 cm depth possibly due to exhaustion of seedling reserves before emergence or an induced dormancy (Tamado et al., 2002). Parthenium seeds do not possess dormancy mechanism (McFadyen, 1994). However, Picman (1984) demonstrated the presence of water soluble germination inhibitors (i.e. parthenium and phenolic acid) in the accessory structure and the seed coat of parthenium seeds. Parthenium has viability greater than 85% (Pandey and Dubey, 1988). Williams and Groves (1980) on their part reported maximum germination (88%) of the seed in dark, under a day/ night temperature regime of 21/16°C. They also noted that the percentage of the germination decreased as the day/night temperature differential was increased. During their work on Indian *Parthenium achenes* in continuous light or dark, Pandey and Dubey (1988) suggested that the weed does not have a strict light requirement for germination. However, they observed that germination was enhanced under the influence of alternating day night temperatures. On the basis of their study, Pandey and Dubey (1988) concluded that 25/20°C day/night temperature regimes were optimum for germination of Parthenium. In Ethiopia, Tamado et al. (2002) reported that germination of Parthenium seed occurred at the mean minimum (10°C) and maximum (25°C) temperatures as well as over a widely range of fluctuating (12/20°C- 35/25°C) temperatures.

2.2. Seed Dispersal

The spread of seeds plus their ability to remain viable in the soil for many years pose one of the most complex problems for control. This fact makes eradication difficult for many seed producing weeds (Monaco et al., 2001). Weed seeds are dispersed by crop seed (hay and straw) wind, water, animals including humans and machinery. Where straw is used for mulching, it is important that the straw be free of viable weed seeds as well as grain seeds. Parthenium achenes are usually transported with crop and pasture seeds or in fodder (Gupta and Sharma, 1977). Weed seeds have special adaptation that helps them spread. Parthenium weed seeds are very small and with short wing like structures (Navie et al, 1996) this helps them to float in wind. Wind transport is usually for a few meters, but whirl winds can carry a large number of light achenes to considerable distance. Weed seeds may move also with

surface water, runoff, in natural streams and rivers, in the irrigation and drainage channels, and in irrigating water from ponds (Monaco et al., 2001). The dispersal of *Parthenium* achenes by water is possible as indicated by large populations of the weed spreading along water ways in central Queensland (Auld et al., 1983). However, scientists have found great variation in length of time the seeds remain viable in fresh water. For example, some seeds can be stored in fresh water for three to five years and still germinate (Monaco et al., 2001).

Animals, including humans, are responsible for scattering *Parthenium* seeds. They may carry the seeds on their feet, cling to their fur or clothes, or internally (ingested seed). In addition, *Parthenium* seed achenes are capable of being transported to long distance in mud and debris (Auld et al., 1983). In most cases, the long distance dispersal of achenes occurs when they are transported on motor vehicles or machinery (Gupta and Sharma, 1977). In general, *Parthenium*, like any other weeds, can be dispersed easily by water, farm machinery, vehicles, movement of livestock, animal dung and grain seeds. Proper cleaning of farm equipment, sowing of uncontaminated seed and a short-term quarantine of livestock in *Parthenium* infested area will reduce the risk of spreading the weed (Tamado, 2001).

2.3. Status and Distribution of *Parthenium* in Ethiopia

In Ethiopia, *parthenium* has become a notorious weed since its discovery in the 1980's. It has been spreading from the eastern route of Ethiopia along the Dire Dawa, Addis Ababa railway presumably between 1974 and 1980. Some believe that the weed might have been transported into the country with imported or donated grain (Seifu, 1990; Fasil, 1994; Frew, 1996; Tamado, 2000). Others hold the belief that the weed entered the country the Ethio-Somali war in 1976/77 through military vehicles (Frew et al., 1996). The presence of *Parthenium* in Kenya and Somalia (Njoroge, 1986) and the capacity of the seed to travel long distance through wind, water, and other means also suggested the possible entry into Ethiopia from these neighboring countries.

In the Amhara region, it is estimated that about 37,105 hectares of land is infested with *parthenium* (Berhe, 2002). It is abundantly found in Gojjam, in south and north Gonder with the potential to spread to agricultural districts of Metama and Setit Humera (Fessehaie, 2004). Furthermore, the weed is well established in many districts of South, north, and central Tigray. In one district alone, Alamata, about 10,000 hectares of the land has been infested

with *Parthenium* (Bezabieh and Araya, 2002). In much of the low lands of Wello, *Parthenium* has become the most dominant weed. In these areas, the weed has been reported in 42 Woredas. The weed is also a serious problem in the Regional State of Oromia although there is no actual survey data on the total area of land infested in the region. Currently, *Parthenium* is spreading at an alarming rate in Eastern Ethiopia; the central rift valley, and neighboring localities of Afar Region, East Shewa, Arsi, Bale and in Southern Ethiopia.

2.4. The Impact of Invasive Weeds

2.4.1. Rangeland productivity and animal production

Weeds are increasingly affecting the utilization of both natural and sown pastures. In Ethiopia, natural pastures constitute the highest portion of the available grazing resources supporting up to 33.08 million heads of cattle (53.7%), 10.41 million goats (13.81%) and 13.46 million sheep (21.86%) (DASP,2005). The major problem facing the pastoral production in Ethiopia is the wide scale degradation of native pasture encroachment by undesirable shrubs like *Acacia sp.*, *Prosopis juliflora* and weeds like *Xanthium* and *Parthenium* (Amaha, 2003; Gemado et al., 2006).

Range and pasture weeds are plants that reduce livestock production through poisoning, reducing stock growth (directly or by competition with preferred plants) or by inflicting mechanical damage. Pasture weed is defined as ‘a species whose presence results in a reduced economic output in a specific system (Auld et al., 1979). Plants may be weeds of pastoral land for a number of reasons. They may be poisonous or unpalatable to livestock or they may be edible, but provide less or poor quality forage when compared to other forage species. Various woody species are widely perceived to reduce the herbage supply through competition. They may inhibit the movements of livestock, reduce their access to water or forage, and make it more difficult to master livestock. Shrubs can also harbor feral animals such as pigs. This may in turn be a problem for livestock enterprise (Auld et al., 1979).

The presence of weeds in rangelands leads to large scale economic losses in the form of reduced level of animal productivity, increased herd mobility rates, more difficult stock handling and management and a considerably reduced property capital values. Weeds in pasture can endanger livestock and lower their products. For instance, they reduce the quality and quantity forage and make them unpalatable or even poisonous to livestock (Kilngman and

Ashton, 1995). For example, plants such as *P. hysterophorus* affect livestock through poisoning. In buffalo calves and crossbred calves fed on Parthenium, the toxic signs were popular erythematous eruptions on body, alopecia and depigmentation of neck and shoulders, and oedema around eyelids and facial muscles (Ahmed et al., 1988).

Adult female Osman Abadi goats that fed on ad libitum aerial parts of parthenium for 12 weeks showed anorexia and dermatitis on either side of thorax, abdomen and neck (Qureshi et al., 1980). A study in India that was conducted on toxicity of the weed to Cattle and Buffalo have shown that a significant amount (10-50%) of the weed in the diet can kill animals within 30 days (Narasimhan et al., 1977). The taints of meat have been detected in a group of sheep given the diet of 30% Parthenium (Tudor et al., 1982).

Evans (1997) indicated that the impact of Parthenium on livestock production is direct as well as indirect. The author revealed that the weed affects grazing land, animal health, Milk, Meat quality, the marketing of pasture seeds, and grain. In Australia, Parthenium could completely dominate grazing land. As a result, up to 80% reduction in stocking rate occurred with a net annual loss of \$ 16.5million (Chippendale and Panneta, 1994). In addition, the presence of Parthenium caused the need for establishment of new improved pasture and production of extra cultivated forage, both of which added to the cost of beef production (Chippendale and Panneta, 1994).

2.4.2. Impact on forage production

Parthenium hysterophorus reduces pasture carrying capacity and forage productivity (Fessehaie et al 2005). In addition, the weed makes land infertile and weakens the quality of grazing land (Fessehayie et al 2005, Ayele 2007). The pastoralists in Jijiga (Ethiopia) also reported that some of the preferred grass species such as: *Chrysopogon aucheri*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Aristida adscensionis*, *Panicum coloratum*, *Tragus berteronianus*, *Cenchrus ciliaris* and *Bothriochloa insculpta* have shown signs of serious decline in terms of biomass production and area coverage (Ayele 2007). Similarly, Ahmed (2003) indicated that due to this invader in the area, most of the valuable species are disappearing as a consequence that there was forage scarcity

2.5. Methods of Control of Parthenium Weed

2.5.1. Use of competitive plants

Competition is one of the several types of interference among species or population. Interference refers to any type of positive and negative interactions between species. Interference may involve physical factors like Space, Light, Moisture, Nutrients, and Atmosphere. It may also be a type of chemical interaction (Monaco et al., 2001). Competition between weeds and crops are generally associated with negative interference. Such a competition involves physical factors that decrease growth in both type of plant due to the absence of an insufficient supply of a necessary growth factor. Competition can be either within the same species (intra), that is when two or more plants of the same species co-exist in time and space or between different species (inter), that is when two or more different species co-exist. For example, allelopathy is a negative type of interference between plants that occurs in the form of chemical influence (Monaco et al., 2001).

Under the biological methods, use of plants with allelopathic effect is an important component of biological control of Parthenium. Generally, two approaches are followed to control Parthenium through bio agents. One is through maintaining naturally occurring biodiversity and the other is through planting selected plant species in target areas (Wahab, 2005). A recent botanical survey across India has shown that species such as *Cassia sericea*, *Cassia tora*, *Cassia auriculata*, *Croton bonplandianum*, *Amaranthus spinosus*, *Tephrosia purpurea*, *Hyptis suaveolens*, *Sida spinosa*, and *Mirabilis jalapa* are capable of effectively suppressing Parthenium in natural habitats (Wahab, 2005). Another study in India revealed that *Cassia sericea* reduces the accumulation of Parthenium by 70% and Parthenium population by 52.5% (Kandasamy and Sankaran 1997). And yet another studies showed that aqueous extracts from *Imperata cylindrical*, *Desmastachya bipinnata*, *Otcantium annulatum*, and *Sorghum halepense* markedly suppressed seedling growth and germination of Parthenium (Anjum and Bajwa, 2005).

In USA, there are a large number of plants that compete with Parthenuim for resource and space. Studies confirmed that Parthenium could be a weak competitor in the face of other native and non-native plants such as Johnson grass (*Sorghum halepense*), Congongrass (*Imperata cylindrica*), barnyardgrass (*Echinochloa crusgalli*), *Senna obtusifolia*, etc (Bryson,

2003). The occurrence of allelopathy has been widely reported in grasses like *Desmostachya bipinnata*, *Imperata cylindrica*, *Eragrostis poaioides*, *Cenchrus ciliaris*, *Panicum antidotale* (Bajwa et al., 1998; Hussain and Abidi, 1991).

Many other grasses have also been reported to exhibit allelopathy to preclude the associated species through reducing their regeneration, growth and yield. A survey in Pakistan revealed that in *Parthenium* infested areas there was a marked reduction in the density of *Parthenium*, particularly at *Imperata cylindrical* and *Desmostachya bipinnata* dominated localities, when compared to the infested nearby grasses. The conclusion drawn from the study was that this low density of *Parthenium* could be due to allelopathic nature of these grasses (Anjum and Bajwa, 2005). In similar manner, a greenhouse study in Australia indicated that grasses like *Bothriochloa insculpta*, *Dichanthium aristatum* and *Cenchrus ciliaris* out compete *Parthenium* and that among the legumes that were tested butterfly pea (*Clitoria ternatea*) competed strongly with *Parthenium* (O'Donnel and Adkins, 2005).

2.5.2. Pasture and grazing management

2.5.2.1. Understanding grazing pressure

According to Harper (1977), herbivore animals can decrease growth and fecundity, stimulate compensatory re-growth or in severe cases cause mortality of plants. In similar way, Crawley (1987) and Louda (1989) believed that the herbivore influence the competitive interactions among plants as they reduce the ability of grazed individuals to acquire resources or as they prevent individuals from becoming competitors altogether. Grazing pressure indicates how heavily a pasture is grazed. Grazing pressure is measured by how much the pasture animals have grazed compared with how much pasture was produced in that season. In set-stocked paddocks, grazing pressure must obviously vary with season. Therefore, when grazing pressure is high and prolonged, the competitiveness of desirable, perennial and productive grass declines.

This occurs mainly because grass root systems contract. Normally, grasses with diminishing roots cannot properly use rainfall. When pasture competition decreases, *parthenium* weed gain the room to colonize and begin seed production, rapidly increasing its soil seed bank. When a grass species fails to set seed, its grass soil seed bank can become very low. Usually, a sensible grazing pressure takes into account the 'amount of feed' available rather than the

traditional ‘acres per animal’ stocking rate and ensures that animals do not overgraze, desirable grasses are setting seed each season, and pasture use matches seasonal grass production (Mount morgan, 2006).

2.5.2.2. Monitoring pasture condition

Pasture condition is a statement about grasses that make up a pasture. It is an assessment of the health, yield and ground cover of grasses. The desirable, perennial and productive grasses must dominate and produce seed to maintain good condition. Monitoring assesses the current health of pastures, picks up trends in pasture condition and indicates whether pasture condition is improving or declining. It also allows fine-tuning of grazing management before the competitive edge is lost and before animal production declines. Animal performance slips long after pasture condition starts declining (Mount morgan, 2006). The worst infestation of parthenium occurs in areas that have lost native vegetation or where there has been continued disturbance particularly from heavy grazing (McFadyen, 1992). There is a marked inverse relationship between existing plant cover and weed density.

2.5.2.3. Spelling paddocks

Proper grazing in pasture and in rangelands maximizes the growth environment for desirable species by minimizing the growth of yield-reducing weeds (Monaco et al., 2001). The rest periods are planned to suit the needs of pasture plants (not just the animals). Spelling encourages to improve the condition of pastures and to re-establish competition. Again, grasses will redevelop root systems, set seed and finally replenish depleted soil seed banks. Grass tussocks can also build up plant reserves, which are essential for vigorous growth. The first six to eight weeks of the growing season provide the most effective spelling opportunity. Grasses draw on stored reserves for new growth, which also needs time to replenish those plant reserves. After this, the grass roots start reactivating and seedlings establishing. However, native grasses establish poorly where there is parthenium. Using herbicide to control parthenium will encourage pasture re-establishment during a rest period (Mount morgan, 2006).

2.5.2.4. Managing watering points

The distance from watering point has a significant impact on soil nutrients and, consequently on the spatial distribution of herbaceous species and rangeland conditions. As the proximity to

the watering point increases, the score of range condition decreases. This implies that watering point contributes to the range deterioration (Gemedo, 2004). In similar way, heavy grazing can change the composition of plant communities (Landsberg et al., 2002). Lange (1969) argued that the interaction between animals and watering points leads to the development of distinct ecological units called biospheres. As they are usually found at the immediate vicinities of livestock watering points, biospheres are areas of high use. Thus, biospheres are defined as patterns that reflect the concentricity of stocking pressure around water points (Andrew and Longe, 1986).

Stock waters are points of constant and high grazing pressure generally characterized by low ground cover, numbers of grass tussocks, and poor pasture competition. One major feature of water points are that they are highly susceptible to parthenium and often become seed dispersal areas. Therefore, to overcome high grazing pressure one needs to establish several stock waters per paddock and rotate stock by alternating the water points in use (Mountmorgan, 2006). Some studies have shown that overgrazing by domestic livestock is major degrading factor as it changes the structure and composition of vegetation. As a result, some species increase in abundance while others decrease (Yates et al., 2000).

2.5.2.5. Fencing different land types

Fencing different land type can achieve better grazing management. Pasture composition is determined by land type. Palatability differences within paddocks lead to uneven grazing pressures. Livestock are able to selectively graze a small proportion of the available palatable herbage and ignore the undesirable ones. Studies have suggested that the most palatable species are selected first and closely defoliated. Decline in the quality and productivity of the rangeland occurs, when the grazing pressure is high (Coupland, 1979; Cossins and Upton, 1985). This in turn creates potential weed-susceptible patches. The vulnerability of areas can be affected by the physical situation of the areas. For example, flooded areas are highly prone to parthenium as grass is often killed by floodwaters which may contain parthenium seed. Therefore, the flooded pastures need adequate rest from grazing to regain their competitive edge. It is also advisable if the cattle are not allowed to graze in the affected areas as doing that would prevent the spread of parthenium seed (Mountmorgan, 2006).

2.5.2.6. Manual and mechanical control

Hand weeding of parthenium is not advisable as the weed causes contact dermatitis, asthma and fever to human beings. In addition, hand weeding is laborious as it requires frequent work following the emergence pattern of the weed. Hoeing can also be used to get rid of parthenium, but repeated operation is needed as long as there is the seed of the weed in the soil. Manually removing parthenium is the most ideal method. However, it is effective as a method only in limited areas such as residential colonies and agricultural fields. It is not a suitable or economical method to deal with the weed that has infested pasture and wastelands of wider areas. According to Gupta and Sharma (1977), cutting parthenium from base using metal blades or swards is seldom effective because it usually facilitates rapid regeneration of plants from crown buds. The authors suggested that the weed should be uprooted to prevent its regeneration from the remaining lateral shoots and that the uprooting should be done before its flowering period and when the soil is moist enough to facilitate easy removal. Who should do the removal of the weed should also need careful decision. For example, Mahadevappa (1997) and Bahn et al. (1997) recommended that only a person insensitive to parthenium allergy should be engaged.

2.5.3. Using herbicides

Using herbicides to control parthenium weed is not environmentally sound and economical feasible for small holder farmers and pastoralists in Ethiopia. However, under special situations spraying pasture with herbicides can be a useful way of eliminating the weed. However, parthenium should be sprayed early before it has set seed. Again, small and isolated infestation should be treated immediately. Usually, herbicide control will involve a knockdown herbicide to kill plants that are present. Residual herbicide, on the other hand, is applied to control future germination. Repeated spraying may be required even within one growing season to prevent future seed productions. However, to overcome excessive infestation one should carry out herbicide treatment in conjunction with pasture management (Mountmorgan, 2006). A field trial undertaken in Assam, India, indicated that Metribuzin 0.2% solution effectively controlled Parthenium.

The experiment revealed also that the native grass species were not affected and re-growth of parthenium was not observed up to three months (Rajkhawa et al., 2005). One should not,

however, that when the amount of metribuzin exceeds 0.2%, it destroys all plants (Sharma, 2003). Glyphosate 1.5kg/ha, paraquat 0.5kg/ha and 2, 4-D 1.0kg/ha were also able to control parthenium. Their side effect was that they killed the other vegetation. This suggested that they are effective and less harmful only when they are sprayed on road side, rail way tracts, industrial sites and dwelling habitats. However, re-growth of parthenium was noticed after 30 days of spray of these herbicides (Singh et al., 2003; Rajkhowa et al., 2005).

In none crop areas (i.e. along rail ways, road sides and waste land); spraying common salt solution at 15-20% during the active growth stage of the weed will effectively control it (De and Mukhopadhyay, 1983; Ramamoorthy et al., 2003). High concentration of common salt brings about plasmolysis which in turn leads to desiccation of the treated parthenium plants. After this, the weed is burned to prevent its regeneration. An experiment carried out in New Delhi on a fallow land that was heavily and uniformly infested with natural population of Parthenium revealed that Metribuzin at 1 and 1.5kg/ha resulted in 100% control of flowered as well as non-flowered parthenium plants, followed by 50-60% of glyphosate at 1.0 and 1.5 kg/ha. The experiment suggested again that are the

Vegetatively active growing plants were comparatively more sensitive to these herbicides than the flowered plants. For example, 2, 4-D Ethyl Ester at 1.0kg/ha resulted in 40% more mortality of non-flowered Parthenium plant than 2, 4 D Na salts. It also suggested that Chlorimuron ethyl was inferior to other herbicide treatments in reducing the growth of Parthenium (Sharma, 2003). On its part, an experiment conducted in Werer Agricultural Research Center in Ethiopia on sorghum fields that were infested naturally by Parthenium revealed that both Gesaprium Combi (5.5 L/ha and Primextra TZ 500 FW (5.5 L/ha) were found to be most effective in controlling Parthenium for a prolonged period of time after application (Kassahun et al., 1999).

3. MATERIALS AND METHODS

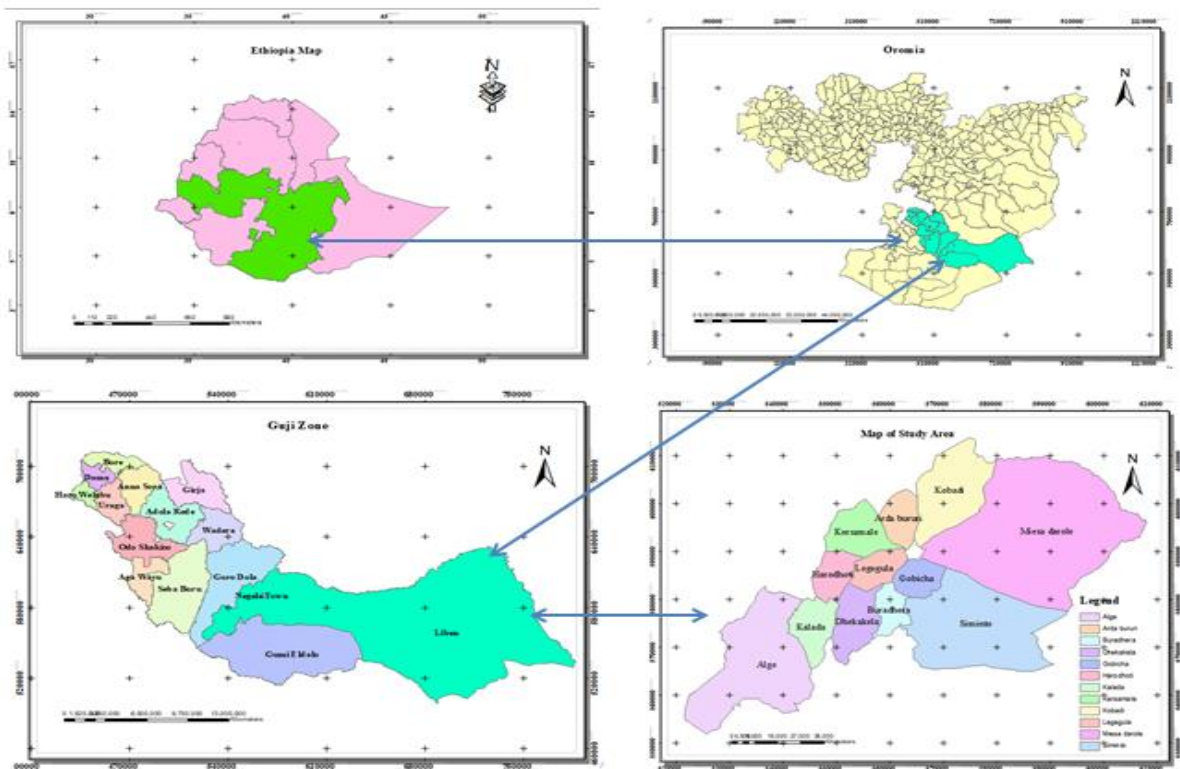
3.1. Description of the Study Area

This study was conducted in Ethiopia, Oromia Region, Guji Zone, Liban District, it is located between 4-6°N and 36-42°E, in Oromia regional state, Ethiopia. The Guji zone borders on the North with the Gedeo zone and the Sidama zone, on the South with the Somali regional state, on the East with the Bale zone, and on the West with Borana zone. The total land area of the zone is 18,577.05 square kilometers. The zone has 14 District, out of these five were categorized as pastoral and agro-pastoral District. The town of Guji Zone is Negele Borena. While Liben district is found in Guji Zone of Oromia national regional state.

3.1.1. Altitude and Climate

The climate of the pastoral and agro-pastoral regions of the Guji zone is mostly arid and semi-arid. The inter-annual rainfall was varied with an average annual rainfall of 526.75 mm. The rainfall pattern is bimodal the major season (Ganna) which extend from March to May and received 60% of the annual rainfall, the minor season (Hagayya), which extend from September and November received 40% of the annual rainfall. The mean annual temperature range is 24–30°C (Guji zone administration report, 2020). The Guji zone is estimated lies within the altitude range of 700 - 3500 meters above sea level (m.a.s.l). The altitude of Liban District ranges from 1120 to 1600 m.a.s.l. Rivers include the Awata. State forests include the Genale, Dawa and Hara Kalo. The Guji Oromo are the dominant ethnic group in the study area and Borena, Arsi, and Somale are ethnic groups living in peaceful coexistence. In the Liban district, Borena Oromo are numerically the dominant ethnic group. The livelihoods of the community are predominantly dependent on livestock production and in some area's agriculture. They are predominantly pastoralists, agro pastoralists, and farmers. The Guji and Borana communities have a well-established indigenous system in the management of grazing rangelands and other natural resources as well as an organized social institution like the „Gada“ system.

Map 1 location of study area



3.1.2. Topography and Demography

The Guji landscape, the landscape slopes gently from the north-west to the south-east, between altitudes of 1500 and 1000m above sea level. Guji rangeland is located between 4 - 6°N and 36-42°E (Guji zone administration report,., 2020). Guji_Liban rangeland is bordered by Borena administrative zone in the north and north east, Somali regional state in the east. Population, Based on the 2007 Census conducted by the central statistics agency of Ethiopia (CSA), this Zone has a total population of 1,389,800, of whom 702,580 are men and 687,220 women; with an area of 18,577.05 square kilometres, Guji has a population density of 74.81. While 129,852 or 14.31% are urban inhabitants, a further 5,315 or 0.38% are pastoralists. A total of 269,440 households were counted in this Zone, which results in an average of 5.16 persons to a household, and 258,540 housing units. The four largest ethnic groups reported in Guji were the Oromo (78.57%), the Gedeo (14.33%), the Amhara (2.59%), and the Somali (1.59%); all other ethnic groups made up 2.92% of the population. Oromiffa was spoken as a first language by 77.91%, 14.16% spoke Gedeogna, 4.31% spoke Amharic and 1.61% spoke Somali; the remaining 2.01% spoke all other primary languages reported. The majority of the inhabitants professed Protestantism with 56.14% of the population having reported they

prospected that belief, while 14.8% of the population were Muslim 11.32% of the population said they held traditional beliefs, 7.49 % professed Ethiopia Orthodox Christianity and 2.12% were Catholic (Guji zone administration report 2020).

3.1.3. Economy Level and Production Systems

Economic Activities and Livelihoods are Animal husbandry is the commonly practice old age economic system as ecological settings of Liban rangeland is more suitable for animal rearing on pastureland. Liban pastoralists keep various stock types such as cattle, goats, sheep, camel, and equines. Cereals include corn, wheat, barley, and sorghum; sugar cane, banana and papaya are other important crops. Cattle keeping are the most favored one as cattle, besides serving as a source of livelihood, is associated with some social values as well. Liban district data estimates the total livestock population. The total livestock population is 364,652 of which Cattle-118,896; Goats-118,058; Sheep 78,339; Camels-8,267; Equines-7,562; Hens-33,532. The rainfall condition is not sufficient for livestock rearing and agriculture (Guji zone administration report, 2020).

3.1.4. Infrastructure and Social Facilities

In the Guji zone, basic social services such as education, health, water, roads and communication infrastructure are still underdeveloped due to past political, social, and economic marginalization. Industry in the Liban district includes 20 grain mills. There were 7 Farmers Associations and 5 Farmers Service Cooperatives. Liben has 51 kilometres of dry weather and 198 all-weather road, for an average road density of 20 kilometres per 1000 square kilometres. About 7.2% of the rural and 32.2% of the urban population has access to drinking water (Guji zone administration report, 2020).

3.1.5. Soil and Vegetation types

As FAO (2007) definition the term land use has the following meaning “land use is the arrangements activities and inputs people undertake in a certain land cover type to produce, change or maintain it.” FAO illustrated that grass land is one of the land cover class whereas rangeland, tennis court as well as recreation area was same example of land use terms, land use mean exploitation of land for agriculture, industrial, residential, recreational or other purpose. Soil; the major soils in the Guji Zone are chromic, orthic, luvisols, ortnic,

acrisolscalcic and eutricfluvisols and chromic eutric and calcic combisols are the major ones. While, the major soil types in the Liban district are chromic and orphic liaisons (45%), calcaric and eutricregosols (15.3%) and lithosols together with humic, mollic vitric and osols (39.7%) (Guji zone administration report, 2020). Majority of Liban rangeland is covered by with short and scattered thorny bush. Liban rangelands constitute the bush lands, which cover major parts of Liban

3.1.6. Data Sources

Both primary and secondary data sources were used to carry out this study. The quantitative data was gathered through semi-structured respondents' interviews from pastoral household and focus group discussion with selected member of the 3 kebeles; whereas the qualitative data were collected through key informant interviews, focus group discussions, direct observation and vegetation survey. In addition, secondary data was obtained from review of documents and published works, including government office and policy documents as well as works produced by international agencies. Relevant online website sources are accessed for more secondary data.

3.1.7. Survey of the pastoralist' perception on the effects of Parthenium weed

The study was conducted in the rangeland of Liben districts of the Guji zone. The districts were selected based on the aggressive invasiveness of the parthenium weed and the rangeland potential of the area. A single visit informal survey was conducted before the commencement of the actual research work. Purposive sampling procedure was followed to identify and select the pastoralists. A total of 120 pastoralists from three kabeles 40 per site with an average age of 44 years (ranging 30-84) was selected based on their awareness about the aggressive colonization of parthenium weed the rangeland and its impact on their livestock and on themselves. A structured questionnaire was prepared to collect adequate information regarding the overall impact of the parthenium. A pretest of the prepared questionnaire was practiced before the start of the actual survey to achieve effective communication of the needed information by the selected pastoralists and questionnaire was translated in to local language (Afaan Oromo) by BA Degree graduated teacher. A single visit formal survey method (ILCA, 1990) was used to gather primary and secondary data on the impact of parthenium on range land and on livestock productivity. The survey was also meant to understand the impact of parthenium weed on livestock and to trace the dispersal agents,

cause of aggressiveness and the suitable seasons for the distribution of this weed in the rangeland.

Group discussions were held with three groups from Siminto, Lagagula, and kobadi kebeles that contains milk collector females, elders, cattle keeper youth to gather information of weed on livestock products mostly on milk production, milk quality, livestock health problems and how can it decreases important range plant composition and controlling mechanisms.

Key informant interview with selected kebeles development agents and district officials. Furthermore, observations were made in all kebales of the district to see the distribution of weed as well as infestation level and infested land types. The households (HHs) or respondents was interviewed by using structured questioner by trained data collectors under the close supervision of the researcher to collect the information of effect of parthenium weed on livestock production. The primary and secondary information/data was collected from the district office and/or from development agents (DAs) and focus group discussion with selected member of the three kebeles that contains 8-12 members.

3.1.8. Sampling of vegetation

To measure effects of parthenium weed on aboveground herbaceous vegetation cover from 12 kebeles of Liben districts (3) Three kebeles were selected based on degree of infestation1 kebele from high infestation of parthenium weed, 1 kebele from medium infestation and 1 kebele from low infestation. The field study was undertaken between October 15 and December 15 2020 when the rangeland vegetation was to a larger extent at full flowering and vigorous growth. Road Transect survey method (Greig-Smith, 1983; Wittenberg et al., 2004) was employed in the rangeland located in the Liben districts kebeles namely Siminto, koba adi and lagagula. Two inverted 'M' patterned 100 m long transects, 1 km apart from each other, and each containing 9 evenly spaced sample quadrats was established to assess the impact of parthenium on aboveground herbaceous vegetation cover. A total of 160 quadrats in 3 sample sites 27 quadrants each measuring 20m*20m in each quadrants there are five small quadrants in each measures 1m x 1m (1m²) sample quadrat was laid. The samples were taken at the interval of 500 m. The quadrats will be then delineated using polyethylene strings around four wooden pegs inserted in to the soil at four corners. 15 sample quadrats was taken from each sample site, and coded by the numbers and the local PA names. The majority of the

plant species collected from the quadrats was identified and recorded in local name and in scientific name by plant botanist.

The cover abundance (the proportion of individual species) of the plant species are cut at animal grazing level and encounter in each of quadrats (1m²) was record using the procedure documented in Wittenberg et al. (2004) in order to investigate the abundance and composition of the herbaceous vegetation as impacted by parthenium. This method has been found to be appropriate for areas in which an invasion is spatially patchy (Greig-Smith, 1983; Wittenberg et al., 2004). The method involves a total estimate based on abundance and cover of the species. The total estimate scale (abundance plus coverage) is summarized in the following ways. A plant species covers a small area given the point (+), cover small (1), less or equal to 5% area coverage (2), 6-25% area coverage (3), 26-50% area coverage (4), 51-75% area coverage (5) and 76-100% area coverage (6). Following the methods suggested by Chellamuthu et al.(2005), the sample sites was categorized into three parthenium infestation levels: low (11-25%), moderate (26-50%) and high (> 50%) of the total precent area coverage of parthenium weed. The importance value index (IVI) that indicates the importance of species in an ecosystem is calculated as follows (Kent and Coker, 1992):

$$\text{Relative density} = \frac{\text{Number of individuals of species}}{\text{Total number of individuals}} \times 100$$

$$\text{Relative abundance} = \frac{\text{Total No of species A}}{\text{Total No of individual of all species recorded}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Frequency of species}}{\text{Frequency of all species}} \times 100$$

The importance value index for each plant species is the sum of its relative abundance; relative dominance and relative frequency were used to evaluate the importance of plant species. The invasive plant species ratio (IPSR) was compute to assess whether A. parthenium weed is an invasive species or not. The ratio is defined as the density of species regarded as invasive divided by others regarded as non-invasive (i.e. a ratio of > 1.0 is an indication of a high invasive threat, while < 1.0 represents a lesser threat of encroachment) (Angassa and Oba, 2008). Percent using diagrams, tables, matrices and photographs to look further the relationship between variables for the triangulation of data in order to increase accuracy and validity of the data. Diversity of the species for the vegetation data from the sample sites in

the study areas were compared using Shannon Diversity Index. This index accounts both for the abundance and the evenness of the species in natural environment as shown by the equation below (Shannon and Wiener, 1949). It is also used to assess the impact of parthenium on the diversity of herbaceous plant species. The higher value of index of diversity indicates the variability in the type of species and heterogeneity in the community where as the lesser values point to the homogeneity in the community.

$$H' = - \sum_{i=1}^S P_i \ln P_i$$

Where H' = Shannon diversity index; P_i = the importance value of the i th species; S = total number of species in the sample quadrat. The evenness of species will be calculated as proposed by (Hill, 1973):

$$E = \frac{\exp(H')}{S} \text{ Or } \frac{1}{\sum_{i=1}^S P_i \ln P_i / \ln S}$$

3.2. Data Analysis

Data collected were systematically coded and analysed using descriptive statistics for qualitative data by employing Statistical Packages for Social Sciences (SPSS, 2011) version 20 and ranked data was analyzed based on Friedman rank test and quantitative variables was analysed using one way analysis of variance using frequency, mean and standard deviation was used to compare categorical variables between surveyed peasant association.

4. RESULT AND DISCUSSION

4.1. Sex and Age composition of the Households (HHs) in the study area

Sex and Age distribution of respondent in the study area presented in Table 1, accordingly the Male household heads are 77.5% and the females are 22.5%. A household was defined as a person or group of related and unrelated persons who live together in the same dwelling unit(s) or in connected premises, who acknowledge one adult member as head of the household, and who have common arrangements for cooking and eating their food. Households in Ethiopia are predominantly male headed, a common feature of most African countries. Less than one-fourth of households are headed by females with the proportion of female-headed households higher in urban areas than in rural areas (CSA, 2006). Majority (42.5%) of the respondents ages fall between 41 and 50 years, 25.8% of the respondents were aged above 51 years, while 23.3% of them were aged between 31 and 40 years, followed by those between 21 and 30 years and under 20 years accounts 5.83% and 2.5 % respectively. From the results depicted in Figure 1, the respondents were well distributed in terms of age and that they are active in advancements and productivity and hence can contribute constructively in this study on the effects of Parthenium weed on their locality and livestock production. The involvement of respondents with higher age group that means 68.3 % above 41 age is seen as good chance in the study area due to their experience to collect a good information about the status of the range land.

Table1: Sex and Age compositions of households in the study area (N = 120)

Sex	Resident kebele			Total (N)	percentage (%)
	Lagagula	Kobadi	Siminto		
Male	29	32	32	93	77.5
Female	11	8	8	27	22.5
Total	40	40	40	120	100
Age of HH					
Under 20	0	3	0	3	2.5
21-30	3	2	2	7	5.83
31-40	15	10	3	29	23.3
41-50	17	21	13	51	42.5
Above 51	5	4	22	30	25.8
Total	40	40	40	120	100

4.1.1. Marital Status

Based on the information collected from the respondents, the about 73.3 % of the households were married. While, the remaining 2.5 % was not married and 14.2% was divorced and 10% of them were lost their husbands during boundary conflict (Table 2)

Table 2. Marital status of the households in the study area

Marital Status	Resident kebele			Frequency (n)	Percentage (%)
	Lagagula	Kobadi	Siminto		
Single	1	2	0	3	2.5
Married	29	28	32	88	73.3
Divorced	6	7	4	17	14.2
Widowed	4	3	4	12	10.0
Total	40	40	40	120	100.0

4.1.2. Major livelihood activities of the respondents

As presented in Table 3; Livelihood activities of the households in the area falls under livestock rearing, crop production and mixed livestock and crop production. the mentioned two activities compared with other have significant contribution, but pit trade, wage labour are rarely practiced. Therefore; Majority (56.6%) of respondents are engaged in mixed livelihood activity of livestock rearing and crop farming, while 25.8% were engaged on livestock rearing and 7.5% were producing crop and the remaining 10% are pastoral traders and wage labourers. As concluded from the information collected from the respondents agro-pastoralism is the major means of livelihood for households and livestock and crop production as means of income in the study area.

Table 3. Major livelihood Activities of the respondents

Livelihood	Resident kebele			Frequency (N)	Percentage (%)
	Lagagula	Kobadi	Siminto		
Pastoralism	8	11	12	31	25.5
Crop Farming	4	3	2	9	7.5
Agro pastoralist	23	20	25	68	56.6
Pit trade, Wage labour	5	6	1	12	10
Total	40	40	40	120	100

4.1.3. Livestock number and composition in the district

Pastoralism is the major means of livelihood for pastoralist households and plays an important role and it is the major asset. The study area, Liban District is favourable for rearing of animals like cattle, sheep, goat, Camel and others. The survey result shows that 30.8 % households in the study area practice rearing of all livestock, 12.5% respondent rear cattle only and camel only, 19.16 % household are cattle and goat, 8.3% respondent have only Sheep and goats, 10 %camel and goat and 6.6% respondents rear cattle and camel. The average cattle holding of HH in the study area was 9.89 ± 8.46 when the highest cattle number was recorded in low infestation kebeles 11.53 ± 10.15 , followed by moderate infestation sites 10.40 ± 7.88 and 7.64 ± 6.31 in high infestation kebeles. There was significant difference in Cow holding per HH among three kebeles at ($P > 0.05$) the average of cow per HH was 18.91 ± 15.67 , while the high mean number of Cows 22.07 ± 18.25 was recorded in low infestation kebeles and the lower Cows number was 14.46 ± 12.65 it records in high infestation kebeles. The average sheep and goat holding of HH in the study area was 35.81 ± 39.22 varied significantly at ($P > 0.05$) the high number of sheep and goat was 40.12 ± 40.09 show in low infestation kebeles, the lower mean number was in high infestation kebeles which is 27.82 ± 38.04 . The difference showed that number of livestock holding and livestock diversity differs among location depending on the resources they have in the area. This study is similar to the study of (Devendra and Thomas, 2002) indicated that cattle production systems and livestock holding differ markedly due to differences in resource endowments, climate, human population, disease incidences and level of economic development.

The overall mean cattle holding was 9.89 ± 8.46 heads/HH and this was higher than cattle holdings in most highland areas of the country such as in Mekele, 8.01 heads/HH reported by (Seid Guyo, 2012) and Awassa area, 6.85 heads/HH reported by (Ike, 2002). However, the current finding was lower than the holdings in Metema woreda (15.5 ± 0.7) heads per household reported by (Seid Guyo, 2012). Availability of vast communal grazing land may account to higher cattle holdings than other areas. The result indicated that cattle were the largest species of livestock reared by the smallholder producers. This proportion and the response of respondents reflected that cattle rearing were important husbandry practices and almost all HHs depends on cattle.

Table.4. Livestock number and composition in the study district (Mean + SD)

Types of livestock	Residence kebales				sign
	Siminto Mean± SD.	Kobadi Mean± SD.	Lagagula Mean± SD.	Overall Mean± SD.	
Cows	22.07 ± 18.25	20.00 ± 14.65	14.46 ± 12.65	18.91 ± 15.67	0.081
Oxen and bulls	6.68 ± 7.76	5.80 ± 3.91	4.41 ± 2.90	5.65 ± 5.37	0.164
Heifers	10.76 ± 9.83	9.40 ± 6.71	7.13 ± 5.90	9.12 ± 7.78	0.110
Calf	6.63 ± 4.78	6.43 ± 6.05	4.56 ± 3.81	5.89 ± 5.02	0.130
Total mean of cattle	11.51 ± 9.43	10.42 ± 9.88	7.63 ± 6.96	9.85 ± 8.71	
Sheep and goats	40.12 ± 40.90	39.43 ± 39.75	27.82 ± 38.04	35.89 ± 39.67	0.304
Camel	28.24± 27.97	21.65 ± 17.84	22.59 ± 22.83	24.21 ± 21.12	0.317
Equines	3.07 ± 3.19	2.66 ± 2.32	1.51 ± 1.76	2.41 ± 2.42	0.004
Poultry	4.27 ± 4.09	4.80 ± 5.62	3.33 ± 3.39	4.14 ± 4.61	0.363

4.2. Distribution of Parthenium weed in the study district

Distribution of Parthenium weed in different parts of habitats in Liben district was presented in Table 5. According to the finding of this study 51.7% of the respondents revealed that *P. hysterophorus* weed was highly distributed on farming Land, followed by along the Road side (27.5 %), Water point area (16.7%) and (4.2%) was on Grazing Land .Similarly (Tefera, 2002) also shown that Parthenium weed spreads rapidly in all parts of a range land; especially along roads and railways in grazing areas and arable land.

Table 5.Distribution of Parthenium weed in the study area (N = 120)

Distribution area	Frequency	Percent (%)
Arable Land	62	51.7
Grazing Land	5	4.2
Water Point Area	20	16.7
Road Side	33	27.5
Total	120	100.0

Parthenium has been observed to grow in a wide variety of habitats throughout the world including the vast area of waste lands and pastures (Pandey and Dubey, 1988), cleared lands

(Holman, 1981), all types of crops orchards (Pandey and Dubey,1991), forest nurseries, public lawns, open spaces in town, the sides of the rail way tracks (Jayacchandra, 1971), road sides, new construction sites and along streams and rivers (Maheshwri and Pandey, 1971; Holman, 1981). According to the key informants interview the *Parthenium* weed was introduced in Liben district since 20 years by the means of food aid. But the appearance of *Parthenium* weed in all kebeles or pastoral areas (PAs) of the District was not at the same time, firstly the weed was appear in the kebeles/PAs located around Nagele Borena town such as; Kersamale, Lagagula, Gobicha and Arda bururi then it transmitted to the kebeles/PAs near to the high way.

4.2.1. *Parthenium* weed distribution agent and suitable season

The *Parthenium hysterophorus* is distributed everywhere in Liben woreda at this time. This may be due to different distribution agents as indicated on (Table 6), According to the responses of respondents, 69.2% of the *Parthenium* weed distribution was caused by Water and Wind followed by (17.5%) Livestock movement and (9.2%) respondents stated that Human activities. Shashie A, (2007), indicated that; water and wind is the main seed dispersal agent followed by animal movement human activities and vehicles. Each agent might contribute to its wide range of dispersal. *Parthenium* weed benefits from the frequency of the extreme climate events such as flooding. Therefore, such a climate facilitates seed dispersal and provides bare ground which favours germination and seedling establishment (Navie et al., 2005). Similarly several studies on *Partheinum* have revealed that the weed could spread unintentionally through Flooding, Animal dung, Wind and Animal movement (Gupta and Sharma, 1977, Auld et al., 1983; Abraham and Girija, 2005, Navie et al., 2005; Mountmorgan, 2006).

Table 6. Distribution agent and favourable season for *Parthenium* weed distribution (N = 120)

Distribution agents	Frequency	Percentage (%)
Livestock movement	21	17.5
Water and wind	83	69.2
Vehicle	2	1.7
Human factor	11	9.2
Other factor	2	1.7
Total	119	99.2
Distribution Season		
Summer	84	70.2
Winter	17	14.1
Spring	15	12.5
Outman	4	3.3
Total	120	100

The favourable season for *P. hysterophorus* weed distribution is presented in Table 6. Therefore; most of the respondents (70.2%) revealed that the favourable season for *P. hysterophorus* distribution was in Summer and some (14%) were in Winter and followed by (12.4%) in spring, although *Parthenium hysterophorus* is an annual weed; its infestation or distribution is greatly dominated in summer; this is due to the germination mostly occurred during wet season when it gets favourable condition; such as moisture and nutrients. The pastoralists in the study districts explained that parthenium has been observed to germinate at the beginning of the rainy season i.e. balgi (March to April) and Kiremt (July to September) and to set seeds at the onset of the dry season. They further elaborated that seed the germination of this weed could happen at any time of the year as long as adequate soil moisture and rainfall might be available. It has been reported elsewhere that *Parthenium* would grow and reproduce at any time of the year and four or five successive generations and seedlings can emerge at the same site during a good growing season (Prasanta et al., 2005).

4.2.2. Causes of aggressiveness of *parthenium* weed

Causes of aggressiveness for *Parthenium* weed infestation is presented on Table 7. According to the finding of this study (77.5 %) of the pastoralists revealed that overgrazing was the main cause of *Parthenium* weed infestation and about 17.5% was drought and the remaining 5.0% of the respondents said that; toxic nature of the *Parthenium* weed is a good chance for wide spread over other plant. Ahmed's (2003) study on rangeland of Jijiga also indicated that

in bad years when the grasses were grazed and above ground part exhausted, the underground part were uprooted to feed livestock which resulted in reduced regeneration of plants in the future. High grazing pressure caused by high stock number or the prevailing drought might lead to a decrease in the vigor and competitiveness of the pasture and thereby allowing the entry and spread of Parthenium (Mountmorgan, 2006).

Table 7, Causes of aggressiveness for infestation of Parthenium weed

Cause of aggressiveness	Frequency (n)	Percentage (%)
Over grazing	93	77.5
Toxicity over other plant	6	5.0
Drought	21	17.5
Total	120	100.0

As a result of this study, the competition from palatable pasture species decreased and Parthenium weed would gain advantage to colonize and produce seeds. With prolonged high grazing pressure, the desirable perennial components declined, grass root system contracted and grasses with a diminished root system could not use the maximum rainfall. Livestock grazing could also have a profound effect on vegetation change (Illius and O'Connor, 1999). It has been known that undesirable species increase at the expense of desirable species. Several other studies also showed that the grazing intensity increased the herbaceous composition change from high palatable to less palatable species (Illius and O'Connor, 1999; Amsalu, 2000).

4.3. Effects of Parthenium weed on range land plants

Effects of Parthenium weed on range land plants in the study area (Table 8). The survey result shown that most of (35.8%) interviewed pastoralists revealed that Parthenium weed is highly compete with other neighbouring plants , 29.2% of Households stated that the weed decrease species composition, 10% respondents was states decrease plant density and about 25.0 % of respondents was states that decrease availability of forage plant and causes feed shortage. The area coverage of grasses and other important range plants has decreased and unknown invasive weeds and bushes were introduced and distributed rapidly on large area.

Infestation of Parthenium weed can degrade natural ecosystem; because it has a very high invasive capacity and allelopathic properties which has the potential to disrupt any type of natural ecosystem (Kumar, 2014). Ahmed (2003) and Belaynesh (2006) indicated that due to this new invader in the area, most of the valuable species are disappearing; as a consequence it was caused forage scarcity in the area.

Table 8, Effects of Parthenium weed on range land plants (N = 120)

Effects of weed on range land	Frequency	Percent (%)
Decrease species composition	35	29.2
Competition over other plants	43	35.8
Decrease plant density	12	10.0
Feed shortage	30	25
Total	120	100

In some kabeles like (Lagagula, karsamale, Gobicha, Hardot and bururi) of the study districts most of important range plant species have totally disappeared and as a consequence the pasture production has become inadequate. They have the fear that the problem might lead utilize Parthenium and other weeds as feed for their livestock. The valuable species in the areas which were essential for grazing animals have already disappeared due to the continued increase of the invasion of Parthenium weed. In the above listed kabeles *P. hysterophorus* could completely dominate grazing land, resulting in a weed monoculture and reduced stocking rate. Similar problem was reported from the pastoral areas of central Queensland where Parthenium was the dominant species under certain conditions by producing negative effects on the growth and performance of the associated beneficial forage plant species.

The monoculture of the none-nutritious vegetation matter might make it impossible to sustain grazing animals. As a consequence, a dramatic drop in the productivity of the pasture could reach below the carrying capacity of the rangeland (Chippendale and Panetta, 1994). According to group discussion some of the preferred grass species which have shown signs of serious decline in terms of composition and area coverage. These include: *Aristida kenyensis* L, *Chloris radiata* (L.) *Dactyloctenium aegyptium*, *Chrysopogon aucheri*, *Eleusine indica*, *Gaertn Sporobolus pellucidus*, *Cenchrus ciliaris*, and *Bothriochloa insculpta*.

4.4. Effects of Parthenium Weed on Milk production and quality

P. hysterophorus weed was recently introduced weed and its impacts on animal productivity are well known and observed by pastoralist community in study area about 42.5% of respondent was stated that bitter or trait tastes, 22.5 % pastoralist was stated that reduces milk fat, about 20 % of respondents was believe that Parthenium weed is reduces cow's milk production and about 15 % of them was mentioned the bad odor of milk (Table 9). The effect of *P. hysterophorus* on livestock production is similarly diverse, affecting grazing land, animal health, milk and meat quality. The current study reported a perceived decline in livestock production and quality of milk and meat .The pastoralists or respondents expressed their views concerning the quality of animal products and their marketability during the group discussion. They added that the meat quality is deteriorated and has bad odor from livestock that fed on Parthenium weed. They further elaborated that when animals were allowed to graze only on Parthenium weed; nobody would like to drink the milk. However, when Parthenium is offered as a supplement to other forages the taste might slightly improve. The hepatotoxic allelochemical Parthenium adversely affects animal health, and the quality of milk (taste bitter) and meat (Shashie, 2007; Kaba, 2008). Although Parthenium is usually not grazed by cattle as it is not palatable due to its irritating odor, bad taste and presence of trichomes, stray cattle, however, are often forced to feed on this weed during periods of fodder scarcity, thereby resulting in impairment of both quality and quantity of milk (Kumar, 2014).

Table 9, Effects of *Parthenium* weed on cow Milk production and quality (N=120)

Variables	Frequency	Percent (%)
Bitter or traint taste milk	51	42.5
Bad odour milk	18	15.0
Reduces milk production	24	20.0
Reduces milk fat	27	22.5
Total	120	100.0

In general, conversely, goats and sheep have been found browsing the plant (Mekonnen, 2017). However, leaves of Parthenium, whenever eaten, can result in tainted sheep (Masum et al., 2013; Kumar, 2014) and goat meat (Mekonnen, 2017) and make diary milk unpalatable due to its irritating odor (Masum et al., 2013; Kumar, 2014; Mekonnen, 2017). Besides, like the case with cattle, the weed can also reduce milk yield of the caprine animals (Mekonnen,

2017). Adkins and Shabbir (2014) elaborated that *Parthenium* weed contains a number of potential allelochemicals which are not only poisonous to livestock, but also can alter the microbial composition of the rumen of the dairy cattle, which consequently can impart bitter taste to the milk and the meat.

4.5. Impact of *Parthenium* weed on Animal health

According to the finding of this study, about 45.8% of the respondents were stated that Diarrhoea is the main animal health problem caused by *Parthenium* weed, 30 % of the respondents were said Cough and the rest 15.8 % were mentioned the Dermatitis (Table 10). As to the Veterinarians involved in the present study, allergic skin reactions, anorexia, pruritus, dermatitis and diarrhoea were the prevalent animal health problems in the study area. *Parthenium* is poisonous to livestock when it is consumed or repeatedly in contact with the weed. Every plant parts of *Parthenium* at any stage of growth are toxic to livestock. *Parthenium* toxicity to livestock entails allergic skin reactions, Alopecia, dermatitis, anorexia, Pruritus, diarrhea (Knox and Paul, 2013, Masum et al., 2013, Kaur et al, 2014, Kumar, 2014; Tafese, 2015, Mekonnen, 2017)

Table 10, Diseases caused by *Parthenium* weed and most affected Animals (N = 120)

Diseases	Frequency	Percent
Diarrhoea	55	45.8
Cough	36	30.0
Dermatitis	19	15.8
no problem	10	8.3
Total	120	100.0
Most affected animal	Frequency (n)	Percentage
Cattle	95	79.2
Goat	11	9.2
Sheep	4	3.3
Camel	9	7.5
Total	119	99.2

This can be attributed to the fact that *P. hysterophorus* releases chemicals that inhibit the germination and growth of pasture grasses and other plants (Dalip et al., 2013) thus reduces feed supply for animals. In addition, *P. hysterophorus* weed causes reduction in milk Gnanavel (2013) and reduces milk quality by tainting it with parthenium toxin (Chippendale

and Panetta, 1994). This research is also in agreement with a study by Muli (2014) who reported a decline in milk production in Nyando Sub-County of Kisumu County.

Toxic substances found in *Parthenium* are lethal to human beings and animals (Singh et al., 2002). It is considered to be a cause of allergic respiratory problems, contact dermatitis, mutagenicity in human and livestock. The impact of *P. hysterophorus* on animal health was also reported by Kololgi et al. (1997) where it causes respiratory disease like bronchitis. Dermatitis this study was similar with Nisar Ahmed et al. (1988) reported that animals fed on *P. hysterophorus* developed dermatitis with pronounced skin lesions, became highly emaciated and eventually died due to the rupture of tissues and haemorrhages in their internal organs.

According to (79.2%) respondents were stated that most affected animals by *Parthenium* weed are Cattle, Goats (9.2%) Camel (7.5) and Sheep are (3.3 %). (Show table) The result shown that in Liban area cattle are the most vulnerable livestock; as the study result indicated from India on the toxicity of the weed on cattle and buffaloes have shown that (10-50%) of the weed in the diet can kill these animals within 30 days (Narasimhan et al., 1977, 1980; More et al., 1982). In Australia, Chippendale and Panneta (1994) stated that cattle grazing in *P. hysterophorus* invaded pastures were marketed with a lower weight compared to those from weed free areas, accounting for more losses to the producer. Vartak (1968)

4.3.1. Management practices of *Parthenium* weed

The result of this study indicated in Table 11 there has been some management practices used to curb the infestation of *Parthenium* weed in the study districts. About 46.6 % respondents practiced burning to get rid off the weed when it occurs in the rangelands, 45.8% of the respondents using herbicide and 5% were used hand weeding to control *Parthenium* weed infestation over range land

Table.11. *Parthenium* weed management practices in study area (N=120)

Mechanisms	Frequency(N)	Percentage (%)
Hand weeding	7	5
Using herbicide	55	45.8
Burning	56	46.6
Not use any mechanism	2	1.7
Total	120	100

Various methods, namely physical, chemical, bio-herbicidal, and integrated, are being practiced to manage *Parthenium* weed across the globe (Kaur et al., 2014). In agreement with the present study, Hundessa and Belachew (2016) found that tillage and hand weeding were the most practiced control methods used against *Parthenium*. Likewise, farmers in *Parthenium* infested areas of Ethiopia often try to maintain their lands free of the weed through hand hoeing, hand weeding (Tessema et al., 2010; Seta et al., 2013; Beyene and Tessema, 2015; Mekonnen, 2017), herbicides (Hundessa and Belachew, 2016), burning (Seta et al., 2013; Beyene and Tessema, 2015), intensive cultivation, and inter-cropping (Tessema et al., 2010),

In croplands, Mekonnen (2017) suggested that hand hoeing and weeding before the plant blooms should be done, which should be repeated 3 to 4 times in a season to check for all the flushes. Kaur et al. (2014) also stated that manual uprooting of *Parthenium* before flowering and seed setting is the most effective method; uprooting the weed after seed setting will increase the area of infestation. Besides, such physical control like hand weeding involves a time consuming and unpleasant job, made worse by the health hazards involved with handling *Parthenium* weed (Kaur et al., 2014).

4.4. Effects of *Parthenium* weed on other Species composition in the study area

Name of species	Low infestation Kebale	Moderate infestation kebales	High infestation kebales	Life form
<i>Themeda triandra</i>	5.42	0.00	0.00	A/H
<i>Aristida kenyensis</i> L.	0.00	4.29	0.00	A/H
<i>Bothriochloa insculpta</i>	0.00	0.00	0.00	P/H
<i>Cenchrus ciliaris</i> L.	5.86	0.00	0.00	P/H
<i>Chloris radiata</i> (L.) Sw	1.00	0.00	0.00	A/H
<i>Chloris roxburghiana</i>	6.79	4.97	0.00	P/H
<i>Chrysopogon aucheri</i>	5.7	5.31	2.95	p/H
<i>Cynodon dactylon</i> Pers.	6.87	4.86	8.62	P/H
<i>Dactyloctenium aegyptium</i>	0.00	4.52	4.20	A/H
<i>Digitaria milaniana</i>	0.00	5.54	2.5	P/H
<i>Digitaria neghellensis</i>	8.44	0.00	1.70	P/H
<i>Eleusine indica</i> Gaertn	9.64	0.00	0.00	A/H
<i>Eragrostis capitulifera</i>	0.00	6.44	0.00	A/H
<i>Eragrostis papposa</i>	2.00	6.56	2.15	A/H
<i>Harpachne schimperii</i>	2.13	0.00	3.63	A/H

Heteropogon contortus	0.00	0.00	2.61	P/H
Leptothriuh senegalense	0.00	3.50	1.33	P/H
Loudetia flavida	4.70	0.00	4.09	A/H
Melinis repens	1.00	0.00	0.00	A/H
Panicum maximum L.	2.33	4.01	0.00	P/H
Pennisetum mezianum.	2.00	0.00	0.00	A/H
Sporobolus discosporus	1.13	0.00	0.00	A/H
Sporobolus pellucidus	0.00	0.00	0.00	P/H
Sum of grass	64.06	50.05	30.90	
NON GRASS PLANT				
Abutilan species	0.00	2.31	0.00	P/H
Abutilon hirtum	1.92	0.62	0.00	A/H
Amaranthus hybridus L	0.72	0.50	1.25	A/H
Amaranthus spp	0.60	0.56	0.00	A/H
Bidens pilosa L.	0.64	2.54	0.00	A/H
Chlorophytum gallobatense	2.97	3.56	2.27	A/H
Commelina Africana	2.97	4.01	1.47	A/H
Datura stramonium L	2.13	1.80	2.72	
Dyschoriste hidebrandti	2.13	2.54	0.00	P/H
Euphorbia heterophylla L	1.80	2.65	0.00	A/H
Galinsoga parvifolia	2.37	2.03	0.00	A/H
Galium spurium	0.92	0.79	1.25	A/H
Guizotia scabra	0.00	1.75	0.00	A/H
Helichrysum glumaceum	0.00	0.00	2.5	A/H
Indigafera voikensi	0.20	0.00	2.50	P/H
Lantana rhodesiensis	1.12	0.11	0.00	P/H
Leucas martinicensis Ait.	0.00	0.00	0.00	P/H
Oxygonum sinuatum	1.40	0.00	0.00	P/H
Oxygonum tinuatum	0.00	0.00	0.00	A/H
Psydnax schimperiana	2.25	3.50	0.00	A/H
rgemone mexicana L.	0.00	0.00	5.56	A/H
Rhynchosia ferruginea	2.25	3.45	0.00	A/H
Solanum samalense	0.00	0.00	4.65	P/
Tagetes minuta L	0.00	1.52	0.34	A/H
Togates minuta	3.73	1.75	0.22	A/H
Xanthium strumarium L.	0.00	0.16	0.56	A/H
Sum of non-grass	29.26	36.25	25.56	
Parthenium	6.67	13.74	43.52	
hydrosporus				A/H

Table 12.Parthenium weed effects on other species composition

Life form: A/H= Annual Herbaceous, P/H= Perennial Herbaceous, P/T Perennial Tree, P/S= Perennial shrub.

In the study sites, a total of 52 taxa belonging to 1 plant families were recorded (Table 12). The most frequent families based on the number species were Poaceae (23), Asteraceae (8) Fabaceae 8. Tamado and Milberg (2000) also reported high frequency of these two families in south Ethiopia as they are very rich in species composition. Annuals were more common (30 taxa) than perennials (22 taxa). The cover abundance averaged over the three *Parthenium* weed infestation levels was 15.42% for *P. hysterophorus*, 53.56% for grass and 28.11% for non-grass species (Table 12). At the low parthenium weed infested sites, grasses were more dominant accounting for 64.06% of the total cover percentage while non-grass species accounted for 29.26% and Parthenium weed were 6.6 %. In Moderate infestation kabeles grasses were accounting for 50.06 % total cover 36.25% for non-grasses and 13.74 % for *P. hysterophorus* weed. In high weed infestation site Parthenium weed were cover about 43.52% of area coverage grasses were 30.9% and 25.56% for non-grasses.

Among grasses, the most dominant species were *Digitaria neghellensis*, *Eleusine indica* Gaertn, *Cynodon dactylon* Pers and *Chloris roxburghiana* accounting for 9.64, 8.44, 6.87 and 6.79 % of the total area cover, respectively, averaged over the three parthenium weed infestation levels. Among the non-grass species, *Asystasia schimperi* (Acanthaceae), *Ocimum basilicum* (Lamiaceae) and *Indigofera amorphoides* (Fabaceae) were more dominant accounting for 5.5, 4.6 and 4.01% of the total cover, respectively, averaged over the three parthenium infestation levels. In line with this study, Belaynesh (2006) also recorded the highest frequency of *Chrysopogon aucheri*, *Eragrostis* spp, *Indigofera* spp and *Ocimum* spp. in the aboveground vegetation of rangelands of Jijiga

The current study showed that the number of desirable species declined in the highly infested sites. Such a reduction could be attributed to the increasing abundance of partheinum in the sites. It is clear in Table 12 that the total percentage coverage of partheinum was found to escalate from 6.6 in low infestation to 43.52% in high infestation kebales. Species composition was significantly decline in number with in three different infestation sites from 31 species number low infestation site to 29 and 22 species in medium infestation to high infestation site respectively. The present finding supports Kohli et al.'s (2004) study in which they reported that in high infested sites of Lower Himalaya (India) the number of species were reduced from 25 to 12 species from NIS to HIS

.

4.5. Impact of Parthenium weed on herbaceous species diversity, richness and evenness in three different infested area

There was a significant negative relationship between density of *P. hysterophorus* weed and species richness ($r = 0.048$, $p < 0.05$). This implied that an increase in the density of *P. hysterophorus* weed led to the decrease in the number of other plant species in the sampling areas, hence the negative correlation values. Sites which had low density of *P. hysterophorus* had more herbaceous plant species.

Table 13 Species richness (r), Evenness (E) and Diversity (H'). In infested PAs (Mean + SD)

PAs	Richness (r)	Evenness (E)	Diversity (H)
LIS Siminto	10.0 ± 8.40	0.85±0.0	2.88±0.05
MIS Kobadi	5.28±3.62	0.98±0.03	2.57±0.05
HIS Lagagula	3.30±3.22	0.72±0.0	2.31±0.06
Over all mean	6.19 ±5.08	0.85±0.01	2.58±0.053
Sign.	0.048	.000	0.98

LIS = Low infestation site MIS = Moderate infestation site HIS = High infestation site
PAs=pastoralist association

Species Evenness (E) was varied significantly ($P < 0.05$) among different infestation level Parthenium weed in the study area as result indicates on table 13 shown the significant difference, therefore, the highest (0.98 ± 0.03) evenness value was recorded in medium infestation kebeles or kobadi while the least (0.72 ± 0.0). Value was recorded in low infestation kebele or Lagagula Species diversity (H) was not varied ($P > 0.05$) among three different infestation kebeles. Globally, several studies have revealed the aggressiveness of *P. hysterophorus* weed. Similar trend was observed in the current study where species diversity, richness and density decreased significantly with the increase in *P. hysterophorus* density. For instance, sites which recorded higher density of the weed had the lowest plant species diversity and richness. Similarly, sites which had lower number of *P. hysterophorus* recorded higher plant species diversity and richness. This can be attributed to the fact that *P. hysterophorus* weed grows faster, has a short life cycle, greater reproductive ability, competitive ability and allelopathy that makes it a successful invader of non-native habitats (Grice, 2006). This is in line with findings by Dalip et al., (2013) who indicated that *P. hysterophorus* weed easily occupied new locations and often substituted native plant species resulting in a serious damage to biodiversity.

In Ethiopia, Ayana et al. (2011) noted that within a few years of introduction of *P. hysterophorus* weed into Awash National Park, there was a decline of 69% in stand density of herbaceous species. The reduction of species richness and diversity with increasing density of *P. hysterophorus* has been well elaborated by Navie et al. (1996). The same author also reported that *P. hysterophorus* takes the form of a rosette during the early stages and requires suitable area to establish. The rosette spreads rapidly near the ground and interferes with the emergence of other seedlings through allelopathy. The stem elongates later and branches at the apex. Together with its high growth rate, the weed becomes competitive and develops the ability to exclude the growth of other species (Navie et al., 1996).

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The difference showed that number of livestock holding and livestock diversity differs among location and depending on the resources they have in the area. Cattle production systems and livestock holding differ markedly due to differences in resource endowments, climate, human population, disease incidences and level of economic development. Availability of vast communal grazing land may account to higher cattle holdings than other areas. The result indicated that cattle were the largest species of livestock reared by the smallholder producers. This proportion and the response of respondents reflected that cattle rearing were important husbandry practices and almost all HHs depends on cattle. Livelihood activities of the households in the area falls under livestock rearing, crop production and mixed livestock and crop production. The mentioned two activities compared with other have significant contribution, but pit trade and wage labour are rarely practiced. Agro-pastoralism is the major means of livelihood for households and livestock and crop production as means of income in the study area. The *Parthenium hysterophorus* is distributed everywhere in Liben woreda at this time. This may be due to different distribution agents: mainly Water and Wind, livestock movement and human factors are most important agents.

The distribution season of *P. hysterophorus*, was majorly in summer and some are in winter, Most of the valuable species in the areas which were essential for grazing animals have already disappeared due to the continued increase of the invasion of Parthenium weed and livestock selection pressure.

High densities of *P. hysterophorus* were recorded from arable land, pasture land, road side and residential areas. *P. hysterophorus* was affects species richness, diversity and density of other herbaceous flora and reduced in the quality and quantity of milk and it also causes livestock disease like Diarrhoea, Cough and Dermatitis. The number of desirable species declined in the highly infested sites. Such a reduction could be attributed to the increasing abundance of partheinum in the sites. Species Evenness (E) was varied among different infestation level Parthenium weed

5.2. Recommendations

First and foremost, conservations of pasture through proper grazing management need to be given priority since there is a definite relationship between the invasion of parthenium and the vigor of the pasture. the pastoral communities must be advised and trained on how they control the weed and carry out rangeland improvement measures such as proper grazing management through reducing stock numbers. Land managers need to be particularly vigilant in monitoring areas close to Parthenium infestation and be proactive in adoptions of best management techniques to minimize incursion of Parthenium in to clean areas. It is much cheaper and more efficient to cure small infestation than to wait until Parthenium has caused a huge impact on the indigenous vegetation cover

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APPENDIX 2

QUESTIONNAIRE WILL BE USED TO COLLECT INFORMATION FROM STUDY
DISYRICT

PART 1 Personal Information of Respondents

1, Name _____

2, PAs _____

3, Sex A) Male
 B) Female

4, Age

A) Under 20 B) 21-30 C) 31-40 D) 41-50
E) Above 51

5, marital status

A) Single B) Married C) Divorced
D) Widowed

6, Religion

A, Wakefata B, Muslim C, Protestant D, Orthodox

7, Educational background

A, Not attended B) 1-4 C) 5-8
D) Secondary school E) College and university

PART TWO Livestock production system and feed resources

1. What your is occupation

A, Pastoralism B) Crop production C) Agro-pastoralist D) Others

2. Did you produce livestock?

A, Yes B, No

3. If your answer is yes on question No 2 which kind of livestock did you produce?

A, Cattle B) Camel C) Shoots D) other

4. . How many heads of the following livestock do you have?

Livestock	Number	Livestock	Number
Cows		Sheep and goats	
Oxen and bulls		Equines	
Heifers		Camel	
Calf		Poultry	

8) Did you know about parthenium weed?

A) Yes

B) No

9, Did you know first time of introducing parthenium weed in this area?

A) Since 5 years B) Since 10 years C) Since 15 years d) Before 20 years

10) As you think what is the reason for introduction of this weed in your area

A) Food aid B) Vehicles C) Animal Movement D) Water and Wind E)
construction of road and other infrastructure

11) Did you recognize any effects of this weed on animal and environment?

A) Yes B) No

12) If yes on question no 11 what is the effects of parthenium weed on livestock feed source or pasture? list

13. what is the effects of parthenium weed on range plant?

14) What are the effects of parthenium weed on livestock production?

15. which livestock types are highly affected by parthenium weed?

16) What are other effects of parthenium weed on other organism including human?

17) Did you recognize that what are the means for fast distribution for these weed in your area?

A) Livestock movement B) Water and Wind C) vehicles D) Human E) other factors

18) In which area highly infested by parthenium weed?

A) Arable land B) Pasture land C) Water point area D) Road side E) Other area

19) What is the degree of infestation of these weed in your locality?

20) what are the reason for aggressiveness of parthenium weed in your area?

21. What is your traditional controlling mechanism for these weed?

APPENDIX 2

Appendix1. List of plant species recorded from the study sites along infestation level

	Plant name	Local name	Species	Life form
1	Themeda triandra	Gaaguro	grasses (graminoids)	A
2	Aristida kenyanensis L.	Biilaa gaara	grasses (graminoids)	A
3	Bothriochloa insculpta	Luucocolee	grasses (graminoids)	A
4	Cenchrus ciliaris L.	Matguddeesaa	grasses (graminoids)	A
5	Chloris radiata (L.) Sw		grasses (graminoids)	A
6	Chloris roxburghiana	Hiddoo luucocolee	grasses (graminoids)	A
7	Chrysopogon aucheri	Alalo	grasses (graminoids)	A
8	Cynodon dactylon Pers.	Sardo	grasses (graminoids)	A
9	Dactyloctenium aegyptium	Ardaa	grasses (graminoids)	A
10	Digitaria milaniana	Hiddoo	grasses (graminoids)	A
11	Digitaria neghellensis	Ilmogorii	grasses (graminoids)	A
12	Eleusine indica Gaertn		grasses (graminoids)	A
13	Eragrostis capitulifera	Biilaa	grasses (graminoids)	A
14	Eragrostis papposa	Samphilee	grasses (graminoids)	A
15	Harpachne schimperi	Biilaa	grasses (graminoids)	A
17	Heteropogon contortus	Seericha	grasses (graminoids)	A
18	Leptothrium senegalense	Biilaa diidaa	grasses (graminoids)	A
19	Loudetia flavida	Seericha gaaraa	grasses (graminoids)	A
20	Melinis repens	Buuyyoo xirooftu	grasses (graminoids)	A
22	Panicum maximum L.	Loloqaa/ laabeessa	grasses (graminoids)	A
23	Pennisetum mezianum.	Ogoondhichoo	grasses (graminoids)	A
24	Sporobolus discosporus	Saamphillee kootichaa	grasses (graminoids)	A
25	Sporobolus pellucidus	Salaqoo	grasses (graminoids)	A
26	Abutilon species	Gurbii re'ee		
27	Abutilon hirtum	Gurbi daalattii		
28	Amaranthus hybridus L	raafu diima	Forbs	P
29	Amaranthus spp	Raafu	Forbs	A
30	Bidens pilosa L.	Chigogot	Forbs	A
31	Chlorophytum gallobatense	Miirtu		A
32	Chenopodium album	amedmado; adala	Forbs	A
33	Commelina Africana	Qaayyoo	Forbs	A
34	Datura stramonium L	Manji(banji)	Forbs	A

35	Dyschoriste hidebrandti	Gurbii gaalaa		P
36	Euphorbia heterophylla L	Gurii		P
37	Galinsoga parviflora	Aba Tabo	Forbs	A
38	Galium spurium	ashikit;metene/	Forbs	A
39	Galinsogaparviflora/	Balcha	Forbs	A
40	Guizotia scabra	Hada		P
41	Helichrysum glumaceum	Darguu		A
42	Indigafera voikensi	Gurbii Hoolaa		P
43	Lantana rhodesiensis	Midhaan durbaa	Forbs	A
44	Leucas martinicensis Ait.			P
45	Oxygonum sinuatum	Rafu hare/Sog	Forbs	P
46	Oxygonum sinuatum	Mogorree	Forbs	A
47	Psydax schimperiana	Gaalee	Legumes	A
48	rgemone mexicana L.		Forbs	A
49	Rhynchosia ferruginea	Kalaalaa		
50	Solanum samalense	Hiddii gaagaa		P
51	Tagetes minuta L	shiitoo haaree	Forbs	A
52	Togates minuta	Sunkii	Forbs	A
53	Xanthium strumarium L.	Obbaa gurrachaa	Forbs	A
54	Parthenium hydrosporus	Farrame	Forbs	P

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
species Abundance * species composition	Between Groups	(Combined)	169727.758	2	84863.879	41.379	.000
	Within Groups		164072.483	80	2050.906		
	Total		333800.241	82			

ANOVA

Appendix 2. ANOVA for diversity index of the sample sites along infestation levels

Source

Source	Sum of Squares	Df	Mean Square	F	Sig.
Trt	.001	2	.000	.104	.902
Rep	.276	77	.004		
Total	.277	79			

ANOVA

Evenness

Source	Sum of Squares	Df	Mean Square	F	Sig.
Trt	.018	2	.009	3.176	.048
Rep	.202	72	.003		
Total	.220	74			

ANOVA

Abundance

Source	Sum of Squares	Df	Mean Square	F	Sig.
Trt	<u>641.467</u>	<u>2</u>	<u>320.733</u>	<u>9.754</u>	<u>.000</u>
Rep	<u>2597.698</u>	<u>79</u>	<u>32.882</u>		
Total	<u>3239.165</u>	<u>81</u>			

Appendix 3 ANOVA Livestock holding of HH in study area

ANOVA Table							
		Sum of Squares		df	Mean Square	F	Sig.
cows * kebeles	Between Groups	(Combine d)	1229.519	2	614.759	2.567	.081
	Within Groups		28024.473	117	239.525		
	Total		29253.992	119			
bull and ox * kebeles	Between Groups	(Combine d)	104.586	2	52.293	1.838	.164
	Within Groups		3328.714	117	28.451		
	Total		3433.300	119			
hieffer * kebeles	Between Groups	(Combine d)	267.605	2	133.803	2.252	.110
	Within Groups		6951.520	117	59.415		
	Total		7219.125	119			
calf * kebeles	Between Groups	(Combine d)	102.715	2	51.357	2.074	.130
	Within Groups		2896.877	117	24.760		
	Total		2999.592	119			
camel * kebeles	Between Groups	(Combine d)	1031.695	2	515.847	1.159	.317
	Within Groups		52076.097	117	445.095		
	Total		53107.792	119			
sheep goat * kebeles	Between Groups	(Combine d)	3773.683	2	1886.841	1.203	.304
	Within Groups		183549.909	117	1568.803		
	Total		187323.592	119			
equines * kebeles	Between Groups	(Combine d)	51.701	2	25.850	5.798	.004
	Within Groups		521.624	117	4.458		
	Total		573.325	119			
poultry * kebeles	Between Groups	(Combine d)	43.476	2	21.738	1.023	.363
	Within Groups		2485.115	117	21.240		
	Total		2528.592	119			

Appendix 3.1 mean and SD Livestock holding of HH in study area

Report									
Kebeles		cows	bull and oxe	hieffer	calf	camel	sheep goat	equines	poultry
Lagagula	Mean	14.46	4.41	7.13	4.56	22.59	27.82	1.51	3.33
	Std. Deviation	12.65 3	2.908	5.904	3.810	22.835	38.047	1.467	3.909
kobadi	Mean	20.00	5.80	9.40	6.43	21.65	39.43	2.65	4.80
	Std. Deviation	14.86 0	3.917	6.717	6.051	17.845	39.752	1.805	5.626
siminto	Mean	22.07	6.68	10.76	6.63	28.24	40.12	3.07	4.27
	Std. Deviation	18.25 4	7.760	9.833	4.789	22.272	40.901	2.796	4.093
Total	Mean	18.91	5.65	9.12	5.89	24.21	35.89	2.43	4.14
	Std. Deviation	15.67 9	5.371	7.789	5.021	21.125	39.676	2.195	4.610

Image 1 different infestation range land
High infestation site



Low infestation site



medium infestation site

Image 2 vegetation data collection



Image 3 species identification

