

# Major dominant invasive alien plant species, land uses types and their management practice in Shashemene district, Ethiopia

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## Research Article

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# Abstract

## Background

Even though Ethiopia has great geographic diversity, macro and micro-climatic variability, invasive alien species are deliberately or unintentionally introduced outside their natural habitat and establish themselves, invade, out-compete natives and take over the new environment and threatening to biodiversity, ecosystem services, social, ecological and economical impacts of the country.

## Materials and methods

Primary data were generated and collected comprehensive assessment technique from preliminary survey, interview and observations were used for the primary data collection which conducted from June 6, 2021 to April 10, 2022 in three rounds to collect basic information and observation of invasive species. Fifteen representative sites were selected using purposive sampling techniques. Descriptive statistics and Microsoft-Excel spread sheet were used for data presentation and analysis.

## Results

*Parthenium hysterophorus*, *Lantana camara*, *Argemone ochroleuca*, was the most dominant invasive species. Invasive species differently distributed over land use types, non-cultivated land roadside and grazing land were the most dominantly affected land use type in the woreda.

## Conclusion

Invasive alien plant species invaded in the district, they are highly intensive on non-cultivated, crazing land and road side type on land use types and affecting natural resource, human and livestock health problem.

## 1. Introduction

### 1.1 Background and Justification

Ethiopia has great geographic diversity, and macro and micro-climatic variability. However, there are threats its biodiversity by habitat conversion, invasive species, unsustainable utilization of biodiversity resources, replacement of local varieties and breeds, climate change and pollution, demographic change, poverty, and lack of awareness and coordination (EBI, 2014).

**Invasive alien species (IAS):** an alien species which threatens ecosystems, habitats or species. (1) Alien species that escape from human control go beyond the intended physical boundaries and cause

environmental damage (2) Covers alien species that remain under human control but damage native ecosystems. Such damage is linked to species being alien, but not to invasiveness. **Native invasive (or) local invasive:** species that get into modified habitats by their own means and then go through population explosions, loss to biodiversity and economics (Shiferaw, Demissew and Bekele, 2018).

## 1.2 Historical perspectives of invasive alien plant species (IAPS)

Plant invasion is a strong threat to the species diversity around the world during the 21<sup>st</sup> century after habitat loss. Large number species of invasive alien plants are introduced to native country in the world and few of these become problematic, they are introduced in to a country either through human or natural (e.g. winds, birds, animals, water) (Dogra *et al.*, 2009; Kapla *et al.*, 2014) Thousands of plant species have been transported by humans to areas far from their natural habitats; accidentally or intentionally (e.g. agro-forestry, horticulture, forestry, and animal husbandry purposes). However, invasions by IAPS are one of the largest threats to the ecosystems of the earth, and the services.

Invasive plant species, introduced deliberately or accidentally to different parts of the world, can cause important economic, environmental and social losses (Anderson, 2005), and they recognized as one of the major threats to native species and ecosystems around the world (Kathiresan, 2004; Kathiresan et al., 2005).

According to UNEP, 2003 report, Ethiopia is rich in biodiversity and is one of the 12 Vavilovian centers of origin. The country has a long history of introduction of alien species of plants and animals, especially those which were found to be productive elsewhere and offered potential economic benefits to the country intentionally and unintentionally, more than 35 invasive alien plant species are posing negative impacts on native biodiversity, agricultural lands, range lands, national parks, water ways, lakes, rivers, power dams, road sides, urban green spaces with great economy and social consequences ( Rezene Fessehaie and Taye Tessema; 2009)

Among 35 identified and listed invasive alien plant species in Ethiopia, the top-20 includes: *Prosopis juliflora* (Sw.) DC., *Parthenium hysterophorus* L., *Eichhornia crassipes* (Mart.) Solms, *Lantana camara* L., *Opuntia ficus-indica* (L.) Miller, *Opuntia stricta* (Haworth) Haworth, *Argemone mexicana* Sweet, *Ageratum conyzoides* L., *Senna occidentalis* (L.) Link, *Datura stramonium* L., *Mimosa diplotricha* C. Wright, *M. pigra* L., *Cryptostegia grandiflora* (Roxb.) R. Br, *Acacia saligna* (Labill.) H.L. Wendl., *Nicotiana glauca* Graham, *Xanthium strumarium* L., *Caesalpinia decapetala* (Roth) Alston, *Pistia stratiotes*, *Cirsium vulgare* (Savi) Ten, and *Xanthium spinosum* L. (Boy & Witt, 2013).

## 1.3 Geographical distribution and sensitive ecosystems for IAPS

In Ethiopia; disturbed ecosystems, along road sides, agricultural lands, and grass lands, in Vegetation ecosystems: Desert and semi-desert, Acacia-Commiphora woodland and bush land, freshwater lakes, lake shores, marshes, swamps and flood plain vegetation, dry Evergreen Afro-montane forest and grassland complex, and Acacia wooded grassland of the central rift are under threat of IAPS (IBC, 2005)

According to CBD (2001), invasive alien species are deliberately or unintentionally introduced outside their natural habitat, where they have the ability to establish themselves, invade, out-compete natives and take over the new environment. Apart from their threat to biodiversity and ecosystem services, invasive species have significant social, ecological and economical impacts. They reduce agricultural yields, irrigated crop lands, grazing areas, water availabilities, and contribute to spread of vector born diseases. According to Raghubanshi et al. (2005), alien invasive species have unique characteristics over the native ones. They do not need special environmental requirement for seed germination, have rapid seedling growth and produce seeds for longer period of time as long as environmental condition permit, they are also highly tolerant to climatic and edaphic variations and have an ability to compete and drive off other species from their habitat.

EBI report in 2015 revealed that invasive species have been threatening local biodiversity and ecosystem services. Being one of invasive alien plant species distribution area in Ethiopia, Shashemene district were affected by invading plant species. Early detection and identification of invasive plants, facilitated through mapping efforts, is critical for rapid response and effective monitoring strategies. For this reason, this study intended to carry out on dominant invasive alien species, affected land uses type and their management practice regarding the impact on the biodiversity in district. Since this is first study, is baseline to plan on dominant invasive alien species eradication and controlling methods and to conduct further studies in the district. This study was initiated with the following objectives(s):

## **2. General Objective(S)**

- To assess major dominant invasive alien plant species, identifying land uses type invaded and assessing management practice IAPS.

### **Specific objectives**

- To identify the type of major dominant invasive species found in study site
- To assess the awareness of local community about invasive plant species.
- To identify major invaded land uses types by invasive alien plant species.
- To pin out management practice taken to control and eradicate invading species

## **3. Materials And Methods**

### **3.1 Description of Study site**

Located at **38° 56' N, 7° 23' E**, with an average altitude of 2002 m.a.s.l. The rainfall pattern of the district is characterized by bimodal distribution with small rainy season belg (March-June) and main rainy seasons Meher and Shashemene town is capital of West Arsi Zone, Oromia regional state of Ethiopia. The town lies on the Trans-African Highway 4 Cairo-Cape Town, about 250 km from the capital of Addis Ababa to southern direction.

Specifically, **fifteen** representative kebeles were selected based on researcher observation following recommendation from wereda agricultural experts. For survey and field work, specific site/ kebeles were selected following main road and sub road by taking the city as bench mark.

Table 1  
specifically selected kebeles in the study site.

No	Selected specific site in the district(kebeles)	Location/wereda	Zone
1	Kuyera, Bute filicha, Awasho(from Northern)	Shashemene	West arsi
2	Bura borama, koreborjota, Tatesa, Dalati,Toga(fromsouthern)	Shashemene	West arsi
3	Alelu illu, Cabie dida(from western)	Shashemene	West arsi
4	Sole, Hurso Simbo, Abaro, Mararo( from Eastern)	Shashemene	West arsi

## 3.2 Source and collection methods of field data

Reconnaissance survey was carried out as first round from June 6 to 10 in 2021. Important basic information was collected by researchers' observation, survey in the second round which conducted from January 12 to 21 2021 and third round conducted from April 4 to 10 in 2022. The primary data was generated and collected through semi-structured interview, field observation and survey. Secondary source of data was obtained from the agricultural office of the districts, from different books, journal and research article.

**3.3. Field observation:** was carried out to identify, to collect specimen, to observe physiological and morphological characteristic of invasive species and invaded land use type. Identification of dominant invasive species was made in the field by using a dichotomous key and compared with specimen collected in Shashemene botanical garden (SBG) herbarium and stored in SBG herbarium.

**3.4. Data Analysis:** Descriptive statistics and SPSS 25 (statistical package for social sciences) tools were used for data presentation and analysis. MS-Excel was also used for drawing bar graph and charts. The results were presented by tables and figures.

## 4. Results And Discussions

### 4.1 Types of major dominant alien invasive plant Species

In the survey, field observation, Shashemene district was invaded by invasive alien plant species and they are causing production loss, disease (skin allergy), being a great challenge for food security and food self-sufficiency directly and indirectly. In this study, it is addressed the current status of alien invasive plant species in the district. It is observed that, they are competing, dominating, suppressing, invading natural resource, crops, and exposing farmer additional cost for farming (invasive clearance cost and labor cost. Example to clear *Argemone ochroleuca*) from farm land and to weed *Parthenium hysterophorus* from their crop land) it also seen that, invasive plant beside of damaging biodiversity, they

are causing great damage to animal grazing land, milk product and cow meat contamination, they are causing an allergy and asthma disease to human when they weed by hand. It also informed that the infestation and their problems were increasing time to time and expectation of new invasive introduced with construction material of High way passing through the district.

In this study, invasive plant species can directly or indirectly affect the food security of local resident. In areas where they spread, invasive can destroy natural pasture, displace native trees, and reduce grazing potential of rangelands. They compete for and reduce productivity farming lands. According to local people *Parthenium hysterophorus* recently became a major crop weed in the district and Heavy infestation of *Parthenium hysterophorus* was observed. *Argemone ochroleuca* entered farm fields after harvesting crops in the winter season and abundantly infest in the farm land

Major dominant invasive alien plant species invading in Shashemene district including in the city were: *Parthenium (Parthenium hysterophorus)*, *Lantana camara*, *Argemone ochroleuca* *Argemone Mexicana*, *Senna occidentalis*, *Xanthium strumarium*, *Nicotiana glauca* and *Xanthium spinosu*, *Senna didymobotrya* (Table 2).

#### 4.2. Floristic Classification of Dominant Invasive Species:

The result of the study revealed that, nine most frequently dominant invasive alien plant species (IAPS) that heavily invade large area of different land use type and belongs to five families were identified from 15specifically selected kebeles in the district (Table 2).

Table-2 Major dominant invasive alien plant species in Shashemene district

No	Scientific Name	Family	Local name(§)	Habit
1	<i>Parthenium hysterophorus</i> L.	Asteraceae	Farame	Herb
2	<i>Lantana camara</i> (SW.)DC	Verbenaceae	Qorso simbira	Shrub
3	<i>Argemone ochroleuca</i>	Papaveraceae	Dalacho	Herb
4	<i>Senna occidentalis</i> L.	Fabaceae	Qorcha bofa	Shrub
5	<i>Xanthium strumarium</i> L	Asteraceae	Bandoo	Herb
6	<i>Xanthium spinosum</i> L	Asteraceae	Yesetmelas(amh)	Herb
7	<i>Nicotiana glauca</i> Graham	Solanaceae	Tambo	Shrub
8	<i>Acacia saligna</i> (Labill.) Wendl.	Fabaceae	Saligna	Tree
9	<i>Senna didymobotrya</i> (Fresen.)	Fabaceae	Shuna	Shrub
§ Orm- Afan oromo, amh- Amharic language				

Based on life form or habit of invasive alien plant species, invasive plants of herb habits are highly distributed and dominating account higher number 45% and followed by shrubs species which account 44% and remaining small percentage of dominating species were tree species 11 % (**Figure 2**)

### 4.3. Distribution and Invaded Land Use types

Distribution and land invaded by Invasive alien plant species were differ across the specific site and accordingly differ across the district. *Parthenium* weed dominant invasive species in the district and has been rapidly invading grazing land, wastelands and cultivated areas, roadsides, recreation areas, and flood plains in the district. *Parthenium hysterophorus* weed was also known to defectively distress crop production, biodiversity, animal husbandry, human health and even ecosystem integrity. Although the invasion of this weed was not new to the local community, the status of being its invasion was not controlled as required. Frequently available and dominating species across all kebeles but highly invading in Dalati, koreborjota, Tatesa, Bora borama, sole, mararo, hurso, kuyera and Alelu illu (**Table 3**).

*Lantana camara* is one of major dominant invasive Succeeding *Parthenium* weed found in all kebeles but highly dominating in Dalati kebele, koreborjota around Toga kebele including many part of the city and highly covering grazing land, roadside, forest adjacent of Gara jama forest, gara calaleqa site, gara ifa indigenous restoration site (Gara ifa). Peoples in the district intentionally, cultivating ad propagating those species in their home garden and in there farming area for decoration, fencing and for flood protection (*Lantana camara*). *Argemone ochroleuca* is also dominant invasive plants found in all kebeles and their distribution is differ and heavily invading in Kore borjota, kuyera, around Toga, Alelu illu, cabie dano, Faji gole, qararu, goba kebeles and infested on farm site of all kebeles especially after crop were harvested in winter season (**Table 3**).

Forest area, agricultural land, non- cultivated land, degraded land, rural village, urban open areas including home garden for decoration, recreation site, botanical garden and grazing land were the invaded land use types dominated by invasive alien plant species in the study site. (**Table 3**)

Table 3 Distribution status of Invasive Plants Species on land use type in the district

N <sup>o</sup>	Invasive Plants	Distribution on land use types §		Distribution and dominance rank
		Land use types	Infestation status	
1	<i>Parthenium hysterophorus</i>	1,2,3,4,5,6	Very High	1
2	<i>Lantana camara</i>	2,3,4,5,8	high	2
3	<i>Argemone ochroleuca</i>	12,3,4	High	3
4	<i>Senna occidentalis</i>	1,2,3	Moderate	4
5	<i>Senna didymobotrya</i>	2,3,4	Moderate	5
6	<i>Xanthium spinosum</i>	1,2,4	Low	5
7	<i>xanthium strumarium</i>	1,2,4	Low	5
8	<i>Acacia saligna</i>	3,4,8	Low	5
9	<i>Nicotiana glauca</i>	2,3,4	Low	6
§ 1 = Cultivated land, 2 = Road side 3 = Grazing areas 4 = Non-cultivated land 5 = Rural villages 6 = urban areas 7 = Riverside 8 = Forest areas				

Major dominant species invade land use system at different rate and parthenium hysterophorus account (19%) which is the highest infestation, Lantana camara (15%) Argemone ochroleuca (12%) and Senna occidentalis, Xanthium spinosum, xanthium strumarium, Acacia saligna and Nicotiana glauca have all most similar infestation which is (9%) in percentage (**Figure 3**).

In the field observation and survey, Invasive alien plant species were differently infested on different land use types. From those land use type in the district, non-cultivated land, roadside and grazing areas (including open area or waste land in the city) were the highly affected land use type in the district (**Figure 4**).

#### 4.4 Management practices of Invasive alien plant species.

Even though several methods are applied to eradicate or control invasive alien plant species like biological, mechanical, chemical, mechanical or physical eradication is commonly applied in the district. Farmers in the district eradicate invasive plant species like *Lantana camara*, *Parthenium hysterophorus*, *Argemone ochroleuca* through mechanical or physical ways, including uprooting, weeding, cutting, stick raking, ploughing, blurring and grubbing. But also local community utilizes invasive species in their daily life, for example, *lantana camara* can be utilized as a potential source of fire wood and medicine for tooth disease.

Invading Invasive alien species was identified and controlling measure was taken by mobilizing community by awareness of its effect on natural resources and biological diversity. *Lantana camara*



highly invaded the bottom side of the mountain gara ifa in dalati kebele, even many emerging sapling were suppressed or invaded and liberated after eradication of the invasive, an event that one *Lantana camara* suppressed three indigenous and medicinal sapling of *Olea aeuropa*, *Clutina abyssinica*, *Maytenus senegalensis*. Methods of eradication used were, Physical uprooting, cutting before flowering and seeding, after cutting and uprooting they collect and burned in one place.

#### **4.5. Informant's profile and their different perception on IAPS**

##### **4.5.1 Household's profile**

In this study, seven persons (five male and two female) across 15 kebele were selected and a total of 105 peoples out of which 75 male and 30 female were participated this is due to the general fact prevailed in Ethiopia as where males are considered as the head of the household or the owner of the land while female mostly participate/work at home and local culture is the main reason for large number of male participants. Regarding their age, majority of respondents 38% ranges from (40-60) and followed by 33% ranged from (15-25) which is due to student joined school at higher age and 29% account the age from (25- 40).

Different perception of informants was evaluated to know their attribute and aspect towards IAPS. Regarding their educational background level majority of 38% were at Illiterates, 33% at primary, 22% at secondary and 7 % were at tertiary school level complete (**figure-6**). 71% of the informants were male and 29% were females. Assessment in job category of the respondents indicated that all most all of respondents were found to be farmers or family of farmers (student), and live since birth.

##### **4.5.2 Respondents Estimate on the perceptual Status of IAPS**

Most of the respondents (92%) reported the high level of invasive alien plant species and 6% and 2 % of them reported its level invasion as intermediate and lower level respectively (**Figure 7**). As field observation and from the respondents report, the level of invasion was very high in the study area particularly around non-cultivated, grazing and roadside. From field observation and as the respondents reported the most dominant invasive alien species in the study area were *Parthenium hysterophores*, *Lantana camara* and *Argemone ochroleuca*. Moreover, all most 100% of the respondents in the area were familiar with invasive species Almost all of the respondents (100%) believe that there is currently a much more increase in the spread of Invasive plant species in the study area when compared to the previous time in number and types of invasive species (**Figure-8**).

##### **4.5.4 Respondents estimate on entry of IAPS in the district**

As shown on figure 9, majority of respondents (57%) informed the time of entry is not so much far years ago is about before 10 years ago and introduced in their locality with construction, birds and seeds and but 19 % of informant confirmed the time of entry was before 20 years ago. 14% mentioned they don't remember the entry time but believe as it entered with agricultural seeds and charity imported seeds.

small respondents of 10% mentioned the time of entry was before 5 years ago with expansion of Shashemene city

#### 4.5.5 Negative impact of IAPS on Biodiversity in the study area

As summarized on below figure-10, Regarding their impact on biodiversity, most of the respondents 86% of informants were well informed as IAPS having an inclusive impact on biodiversity, as having no impact on biodiversity (3%) and 11% of respondents have no idea

#### 4.5.6 Future impact assessment of IAPS in the district

From the summarized graph below, on the future impacts assessment of IAPS, majority of the respondents (90%) reported that IAPS as cause high impact in the future, 9% reported moderate impact and 1% reported that the impact of invasive in the future to be low.

#### 4.5.7 Socio-Economic effect of IAPS

As shown on the figure 12 below, 43% of the respondents reported that IAPS having direct effect on the economy, 31% having indirect effect, 2% as having no effect, and 24% as having both direct and indirect effect on the economy. To the detailed harm of IAPS, respondents stated that IAPS as causing human disease like allergy asthma and animal disease like milk color and odor change, meat toxicity, affecting biodiversity and suppressing Indigenous tree, grass, blocking grazing land to cows. Thus, they have been caused so many problems to the society and biodiversity at large.

#### 4.5.8 The Management Practices to Control IAPS

As shown in the figure 13, the organization that has been working on control of IAPS is summarized and almost all of the Respondents (93%) confirmed that there was no organization that has been working on control of Invasive alien plant species, 7% of the respondents told that there was some organization that has been working on control of IAPS such as Ethiopian biodiversity Institute/ Shashemene botanical garden and West Arsi zone forest and climate change trying to eradicate invasive species by mobilizing community.

All most all respondents (95%) reported that IAPS has having no benefit even though five respondents (5%) reported as they are benefit like *Lantana camara* used for Tooth disease, ornament, fence, flood prevention and used as fire wood.

**4.5.9 Morphological Description of top dominating Invasive plants Species:** *Parthenium hysterophorus* L belongs to Asteraceae family and called Faramsisa/famee (Oromiffaa) which growth of Erect, perennial herb, up to 60 cm high. Stem repeatedly branched, grey-green, striate-sulcate. Leaves alternate, pinnate to bipinnate, grey-green, petiole narrowly winged, up to 2.5 cm long. Habitat grows along roadside ditches, in abandoned air fields, margins of farmland and causing a series problems in the district. *Lantana camara* belongs to Verbenaceae family, is a shrub growth up to 5m and erect and scan dent.

Locally called Qorso simbira/oromic language and yewof kolo due of dispersed by eating birds (data source from natural data base for Africa (NDA) version 2.0 released in 2011). In the field observation and survey the image of some dominant invasive alien plant species were collected by researcher and displayed in the figure below(Figure 14)

## Conclusion

*Parthenium* (*Parthenium hysterophorus*), *Lantana camara*, *Argemone ochroleuca*, were the major dominant invasive alien plant species invading in Shashemene district and they highly intensive on non-cultivated, crazing land and road side type on land use types. Local people were not aware even though they are familiar with them but recently some activities were started to eradicate by uprooting and cutting and after uprooted collect in one place and burn it which is physical or mechanical methods. There should be strong government support, comprehensive community awareness programmes, effective law or policy and commitment for eradication and managements. Invasive species should be a current issue of government and included in water shade conservation management practice checklist.

## Declarations

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### AUTHORS' CONTRIBUTIONS

The authors have made substantive intellectual contributions to this original research work in primary data collection, organization of the data, analysis, interpretation of results as well as preparation of the manuscript and proof reading. All authors read and approved the final manuscript.

### SUPPLEMENTARY INFORMATION

There is no additional supplementary information for this paper.

### CONFLICT OF INTEREST

The Authors declares there is no Conflict of interest

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## Figures

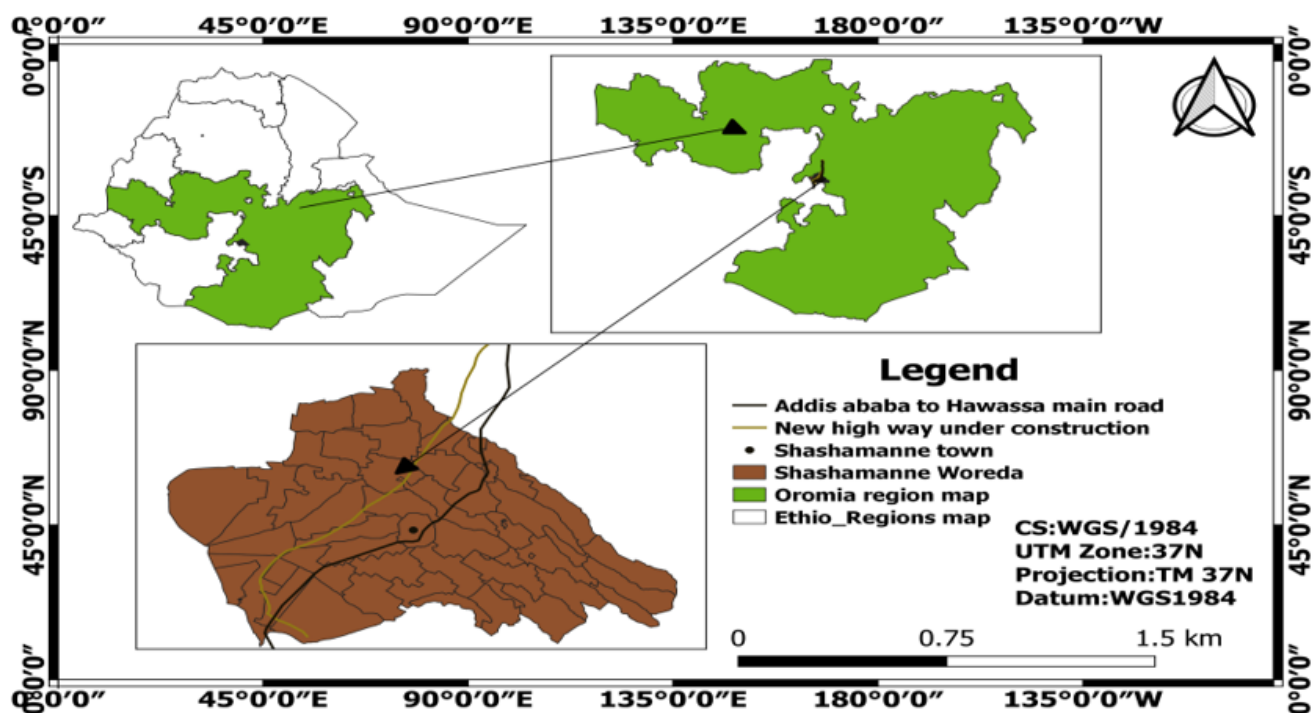


Figure 1

Map of study site /Shashemene wereda

# Growth form

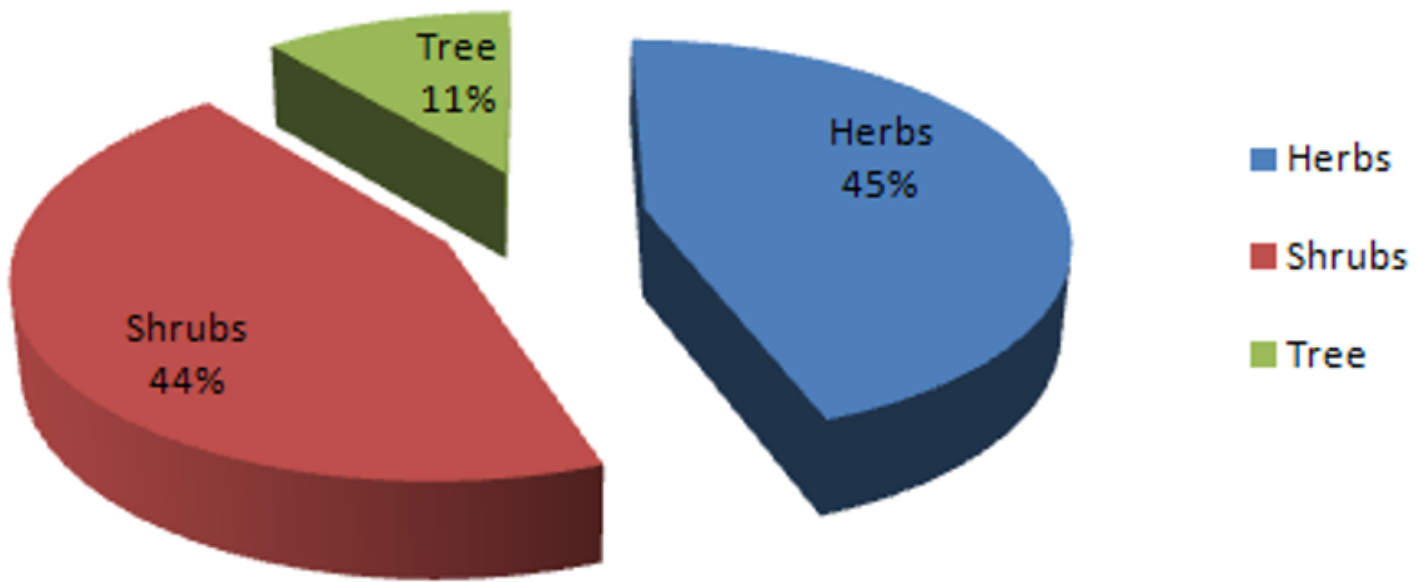


Figure 2

Dominant invasive species Life form in the district

## land uses type vs IAPS

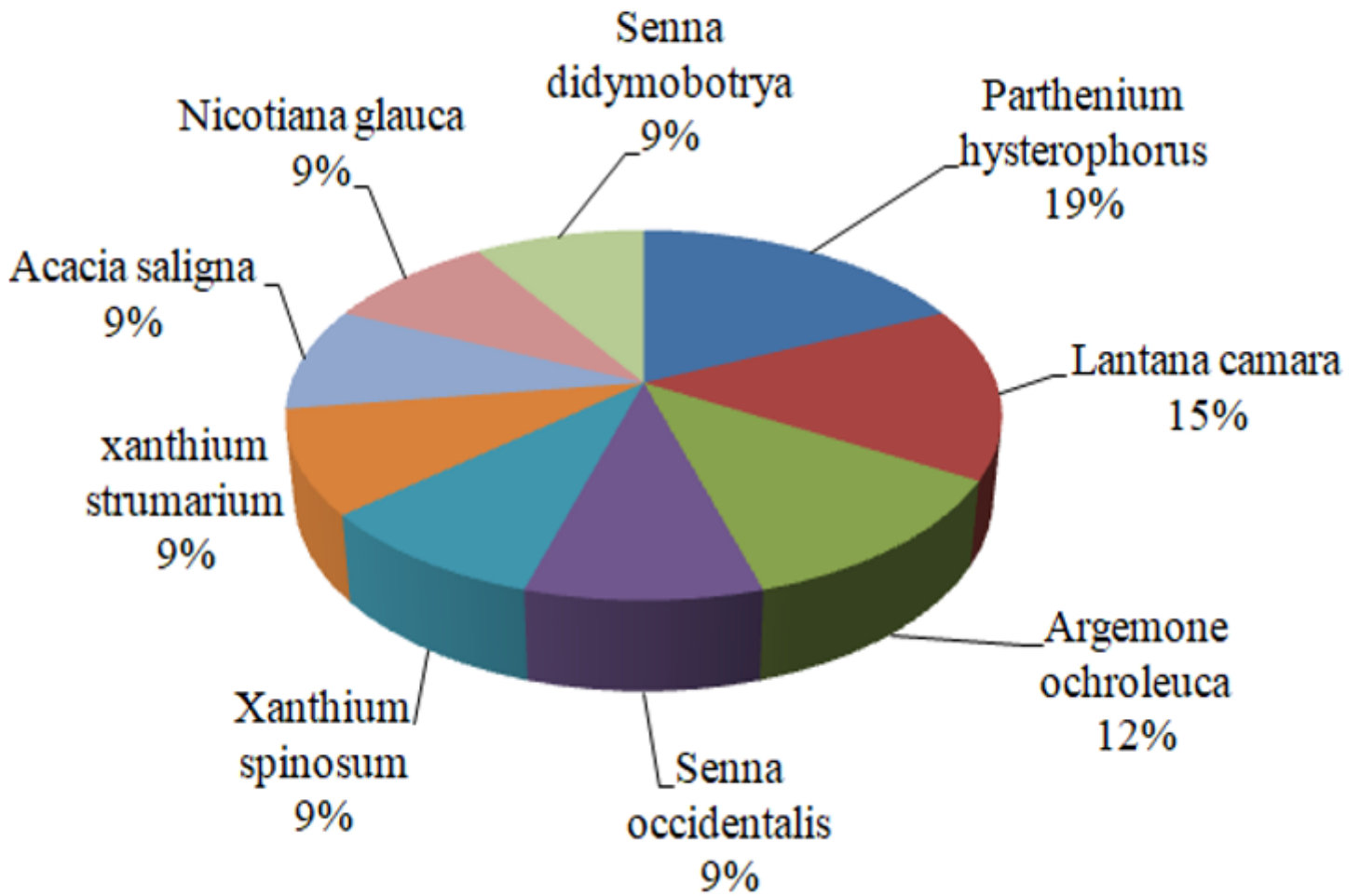
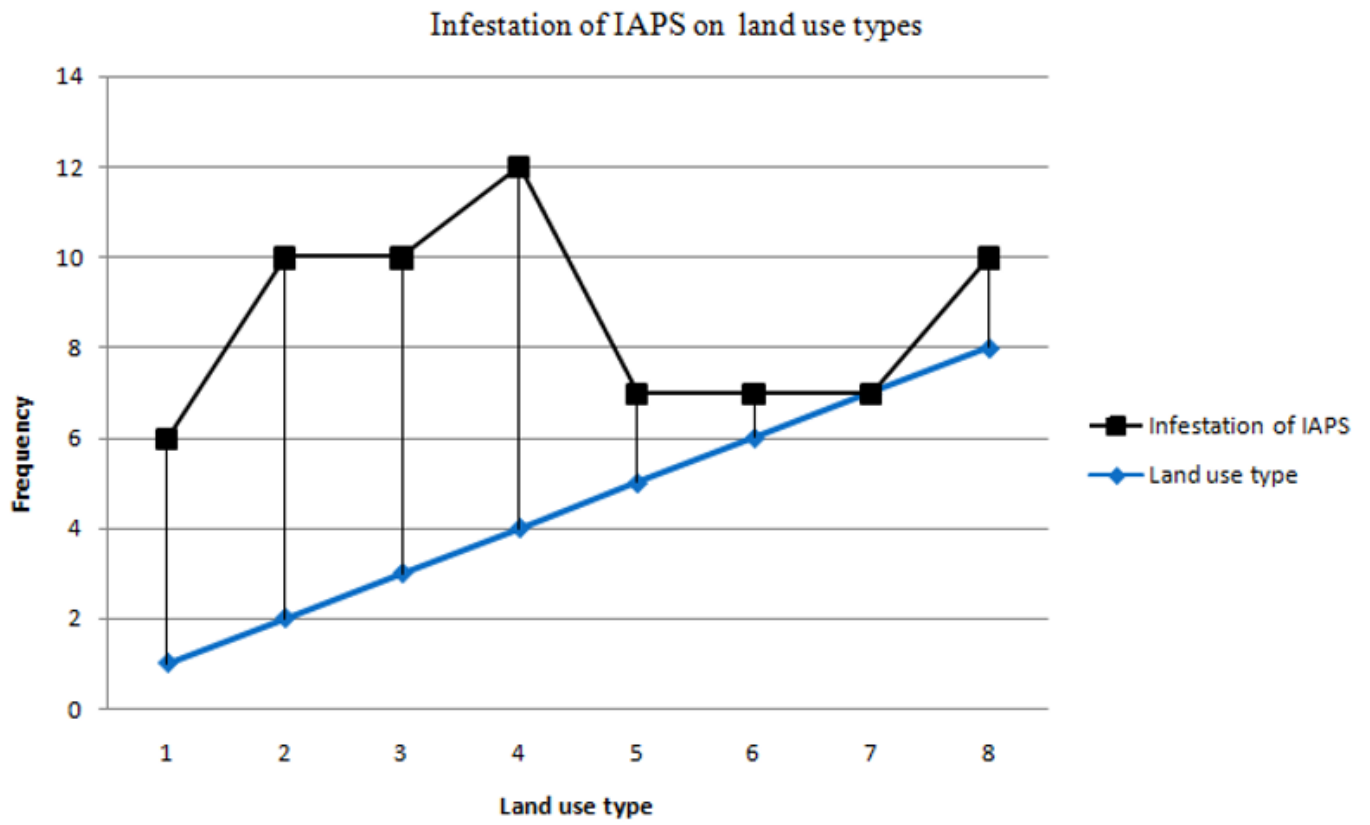


Figure 3

Distribution and invaded land uses type by invasive species in the district.



**Figure 4**

infestation of IAPS on land use system

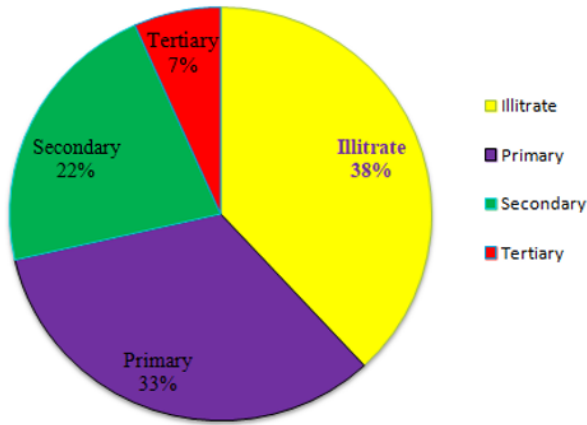




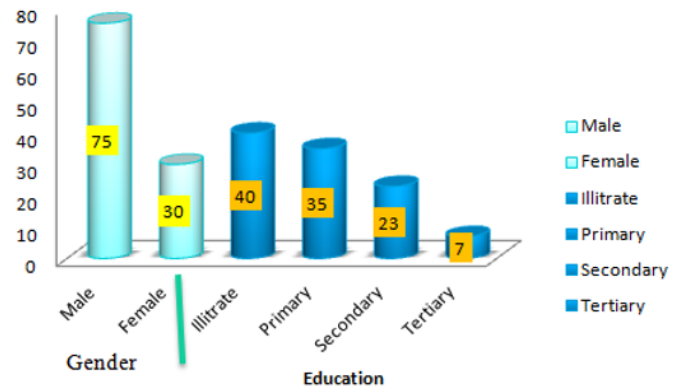
**Figure 5**

management practices by local peoples/ the fight with *Lantana camara*- photo taken in dalati kebele in the field observation

**Eduactional level of respondant in percentage**



**Informant profile**



**Figure 6**

Educational levels and gender of informants

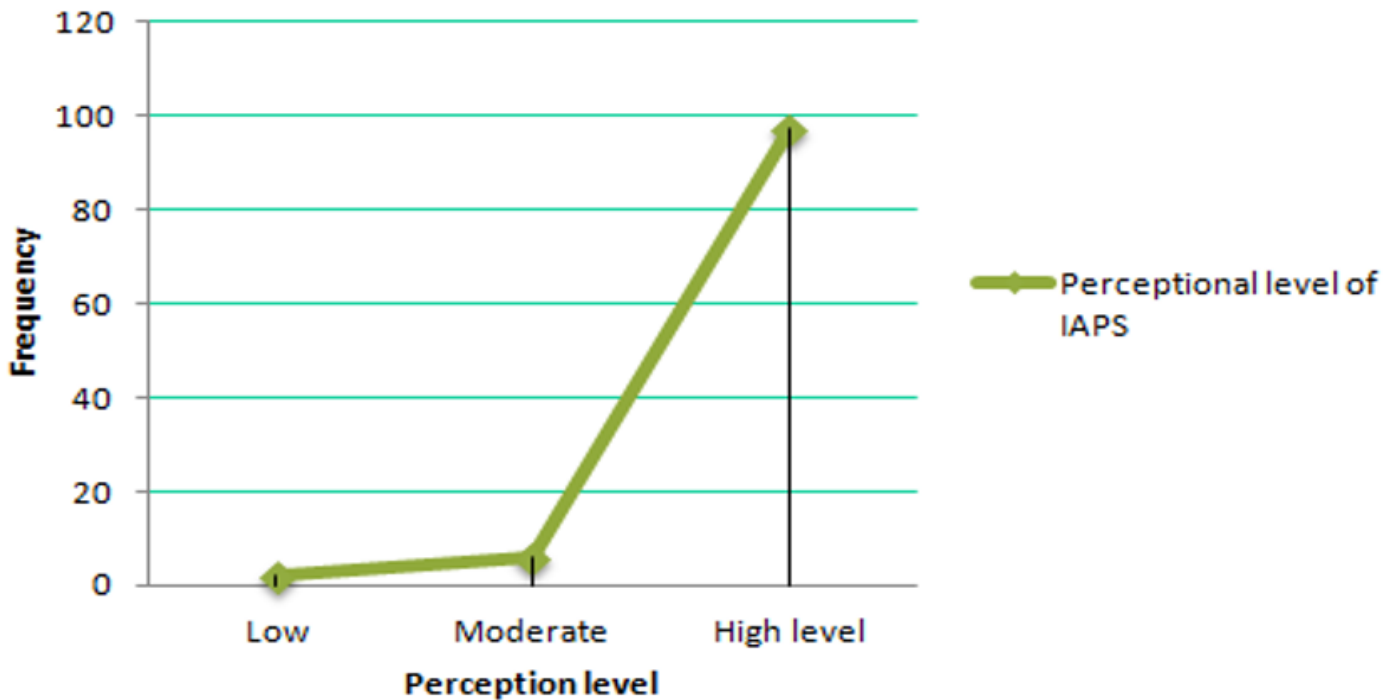


Figure 7

Respondent perceptions on the status of IAPS

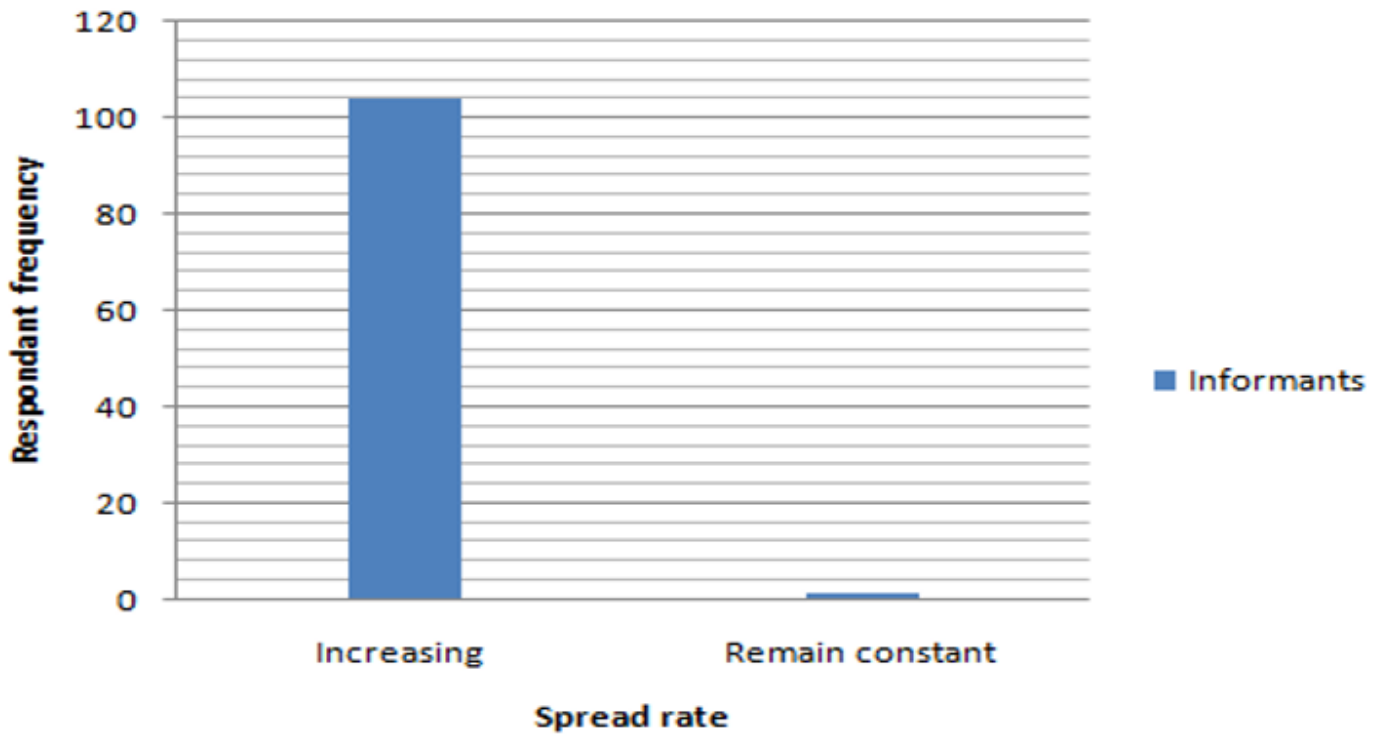
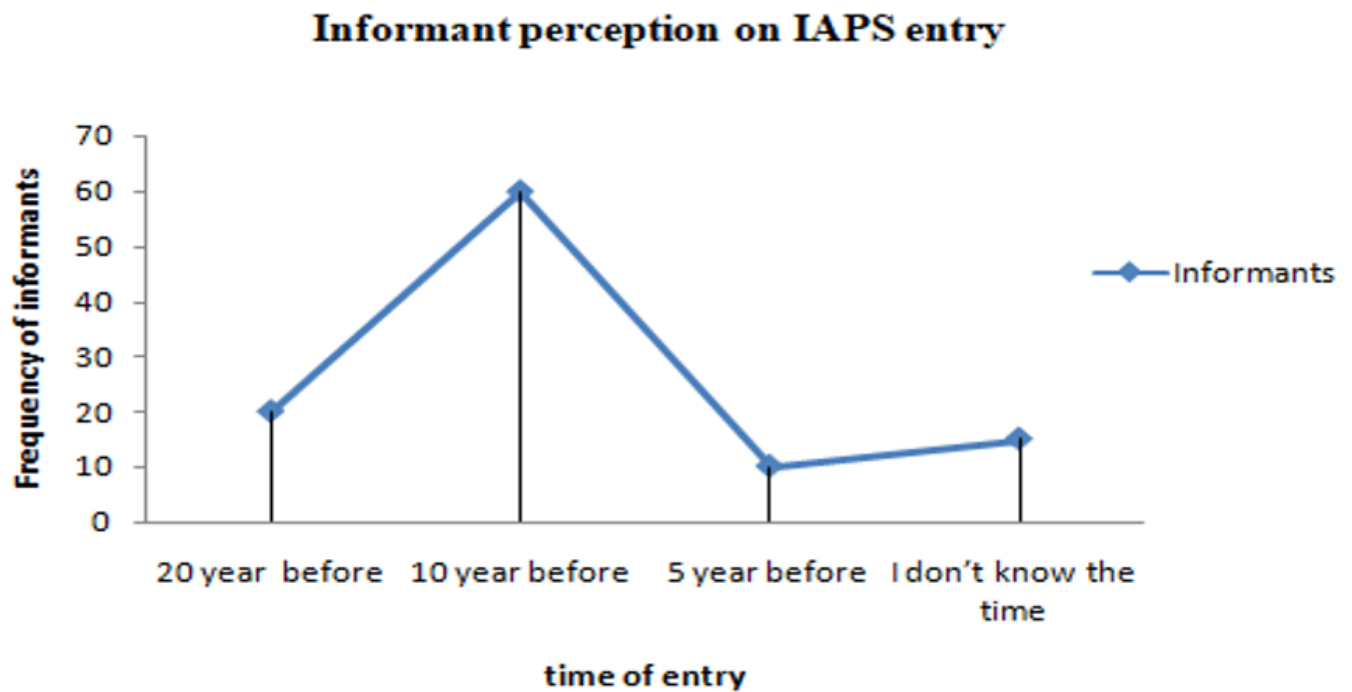


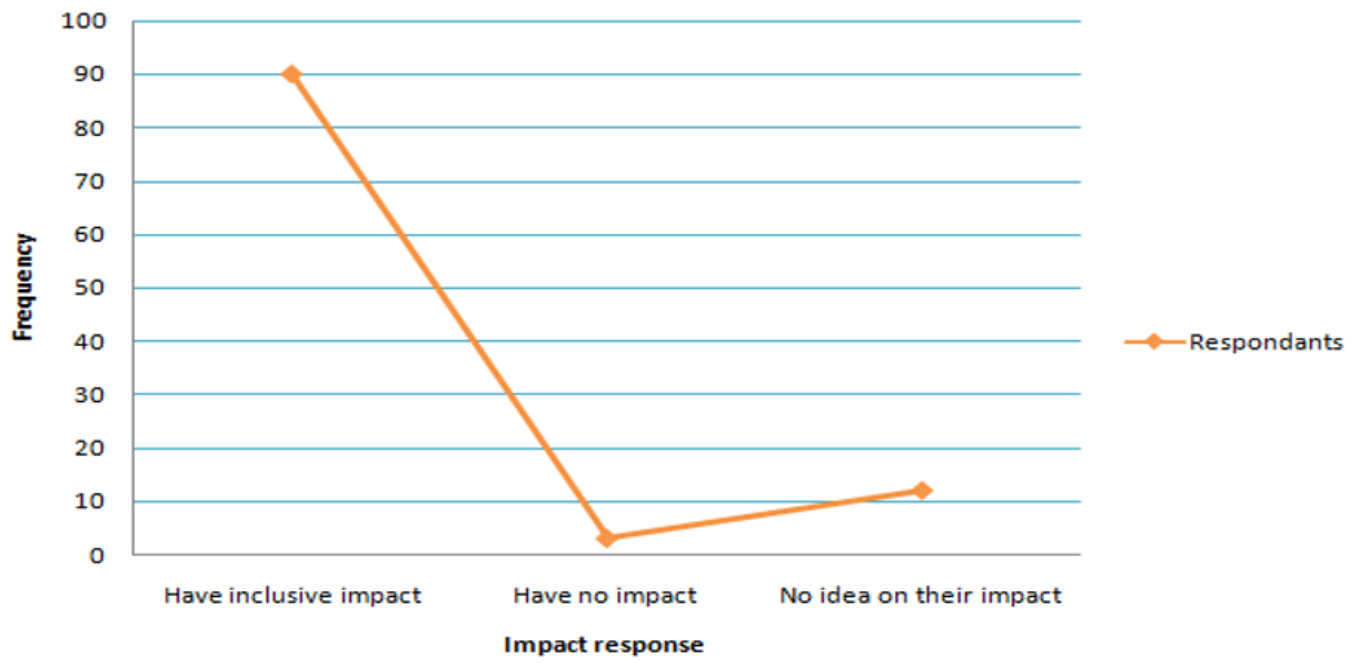
Figure 8

previous and current comparison of IAPS spread



**Figure 9**

Entry estimations of IAPS in the district



**Figure 10**

Negative impacts of IAPS on biodiversity

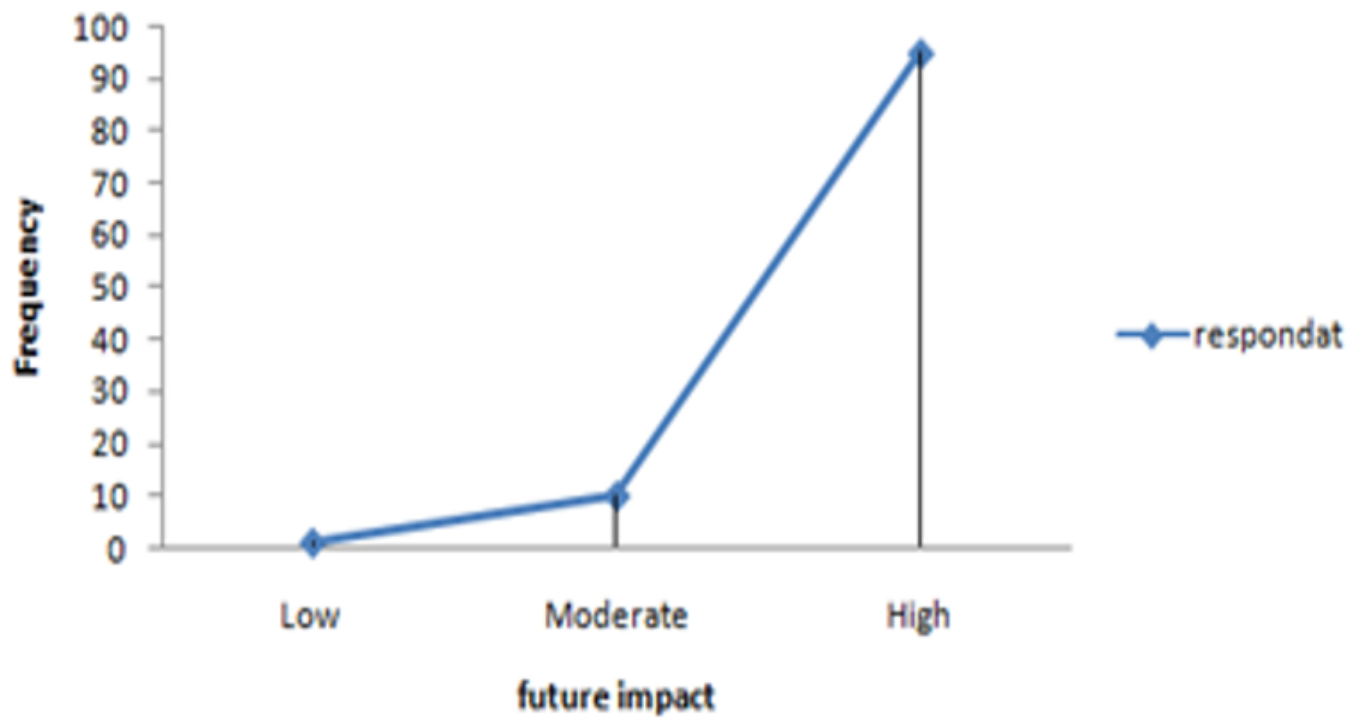


Figure 11

Evaluation of the negative impact of IAPS in the future

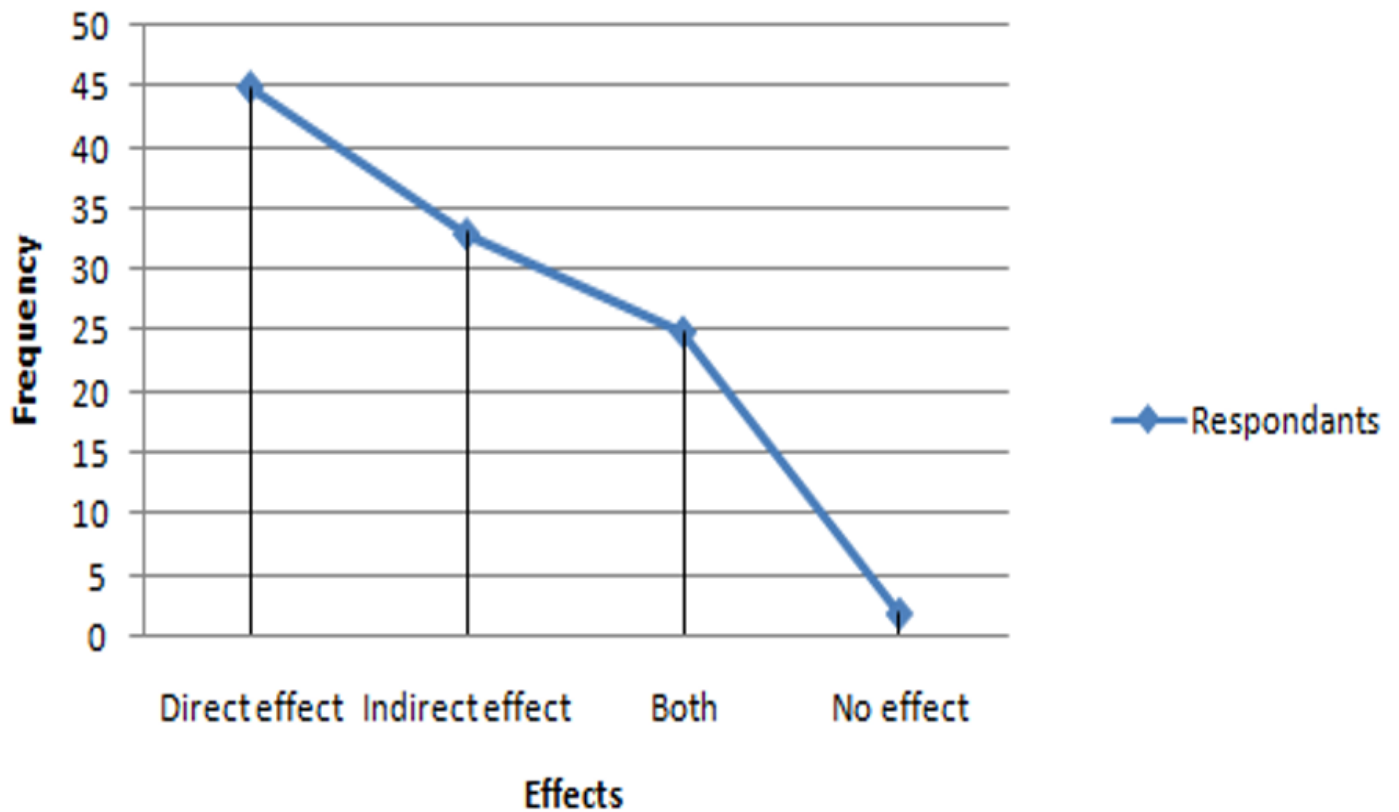


Figure 12

Effect of IAPS on socio-economy in the district

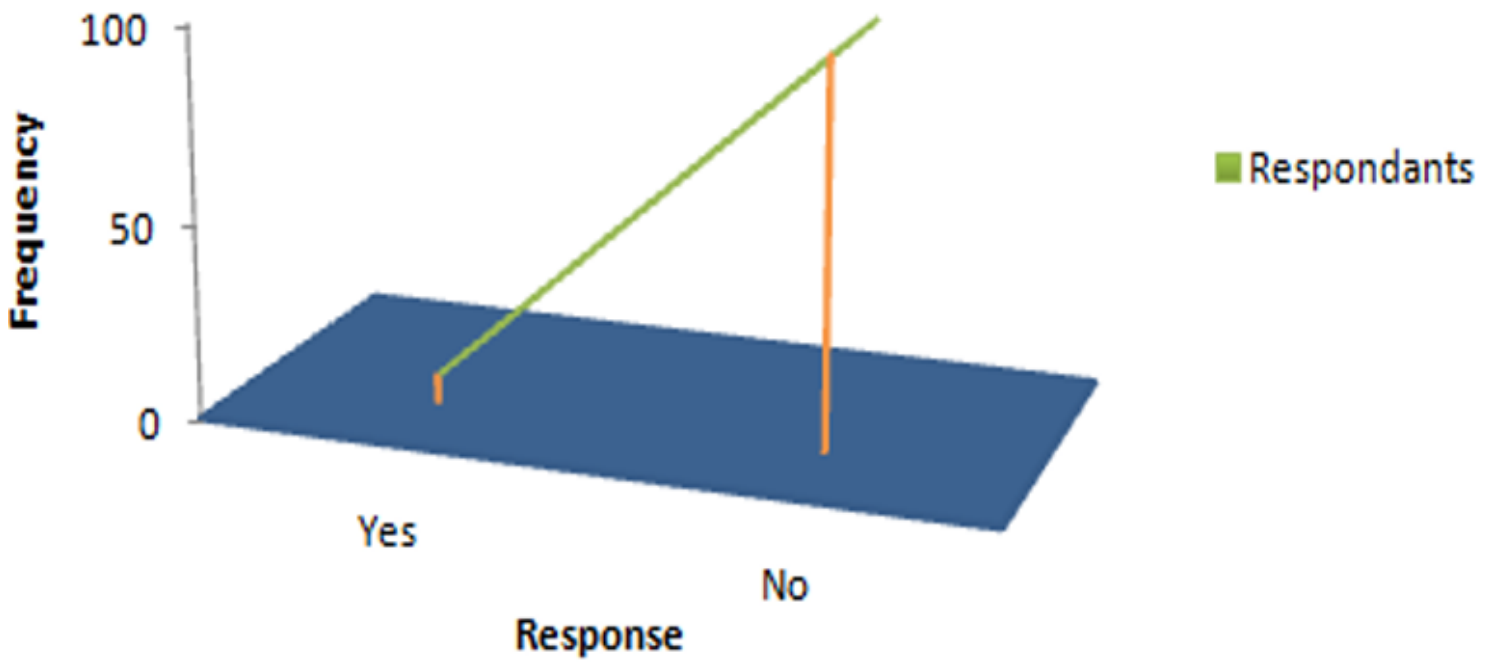


Figure 13

Management practice perception of respondent in the district

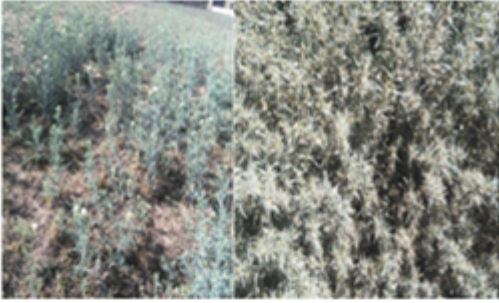


Figure 1 *Arzemonia ochroleuca* invade farmland in the district



Figure 2 *Paspalum hysterophyrum* at the road side in the district



Figure 3 *Nicotiana glauca* infestation in the district



Figure 4 *Xanthium strumarium* infest in the district



Figure 3 *Lantana camara* invasion in the district/dalati kebele

## Figure 14

morphological and physical features of some invasive alien plant species in the study site