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The Perception of Local Peoples About *Parthenium hysterophorus* Invasion and Its Impacts on Plant Biodiversity in Ginir District, Southeastern Ethiopia

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Abstract: *Parthenium hysterophorus* L. is an alien invasive species plant species belonging to an extremely diverse family Asteraceae. This plant is now a notorious in different part of Ethiopia. Consequently, understanding the impacts of this plant from affected communities' perspectives is crucial to plan sustainable prevention and control strategies. Thus, this investigation was initiated with the aim to generate information about the means and source of its introduction, dispersal, habitats and people's perception towards its impacts on biodiversity in Ginir Woreda, East Bale Zone of the Oromia Regional State of Ethiopia. Semi structured interview, focus group discussions and observations were conducted on people's perception in all study sites involving farmers, cattle grazers, fodder collectors, experts and local residents to see their perception concerning its infestation and impacts on plant biodiversity. Statistical package for social sciences (SPSS) (v. 20) was used for data collection. According to the result of the study most of respondents identified the species, source of introduction, means of dispersal and its impacts on biodiversity. Parthenium was believed to be initially introduced on Ginir district 20 years before near donated food grains are stored and temporarily placed. Parthenium could grow and disseminate whenever adequate soil moisture and rainfall might be available in the soil. Respondents mentioned emergency grain aids, vehicles, animals' movement, water, wind and human activities as dispersal agents and causes of introduction. High infestation of Parthenium were found on abandoned agricultural lands and grazing areas. The high and fast distribution of Parthenium as perceived by respondents was mainly due to its high reproductive ability followed by its ability to out compete native plant species. Respondents' ranked pastoralists and agro-pastoralists as the highly affected group of peoples followed by cattle grazers and fodder collectors. Regarding impacts of Parthenium on plant biodiversity, respondents noticed its impacts on species richness and evenness i.e growth and distribution of other plant species. Furthermore, species composition of grasses, herbs, shrubs and even trees has reduced and replaced by this plant. The result of the study also indicated that Parthenium was found in high disturbed habitats. Yet, much has not been done to aware the local community on its impacts on biodiversity, environment, agriculture and health. It was concluded that, P. hysterophorus was one of the most dominant invasive plant aggressively colonizing different habitats impacting biodiversity. Putting in place strategy and effective planning for the prevention, control and management was recommended to control its further spread and reduce the adverse impacts.

Keywords: Biodiversity, Group of Peoples, Habitats, Infestation, Parthenium

1. Introduction

Invasive Alien Species refer to all categories of living organisms (plants, animals or microorganisms) that are not native occurring outside their adaptive and dispersal ranges [35]. According to [8], invasive alien species are species introduced intentionally or unintentionally outside their origin, where they have the ability to establish themselves, invade, out-compete natives and take over the new environment causing environmental, social and economic problems" [15].

Invasive alien species are the most important notable

drivers behind the current loss of biodiversity. They are identified as one of the major threats to native species and ecosystems around the world [5]. Biological invasions are thus attracting extensive attention among conservationists, ecologists, foresters, policy makers and scientists. Subsequently, they are invading nearly all types of native ecosystems causing hundreds of biological extinctions in the world causing significant impacts on society, economic life, health and national heritage worldwide [2, 18].

In the Africa the impact of invasive species is more critical with serious repercussions on environment, human wellbeing and economic development of societies because Africa is a highly vulnerable continent in the world to climate change. This is due to its climate-sensitive distribution of native flora and fauna [10]. In Ethiopia, the threat posed by invasive align plants to local biodiversity is acknowledged in various policy and strategy documents of the country as biological invasions are recognized both in scientific and political agendas globally [12].

In Ethiopia, there are about 35 invasive alien species identified posing particular problems on agricultural lands, range lands, national parks, water ways, rivers, power dams, roadsides and urban green spaces with great impacts on biodiversity, economic and ecological consequences of the country [7]. *Parthenium hysterophorus* is among the major well known invasive alien species and has been recognized as one of the top five highly targeted weeds in the weed management program of Ethiopia [11].

A few case studies in Ethiopia have indicated that *Parthenium* have gained considerable notoriety as being major threats to native species and ecosystem reducing species diversity. These threaten the survival of many plants and indirectly animals because the competition with native plants for space, nutrients and sunlight [41]. The allelochemicals released from the *Parthenium* or from seed leaching inhibit germination of other plants and the growth of pasture grasses, legumes, cereals, and vegetables, other weeds and even trees [40]. Therefore, the objective of this study aims at documenting the perception of the local communities about *P. hysterophorus* invasion and its impacts on biodiversity in Ginir District of East Bale Zone, Oromia Regional State, Ethiopia.

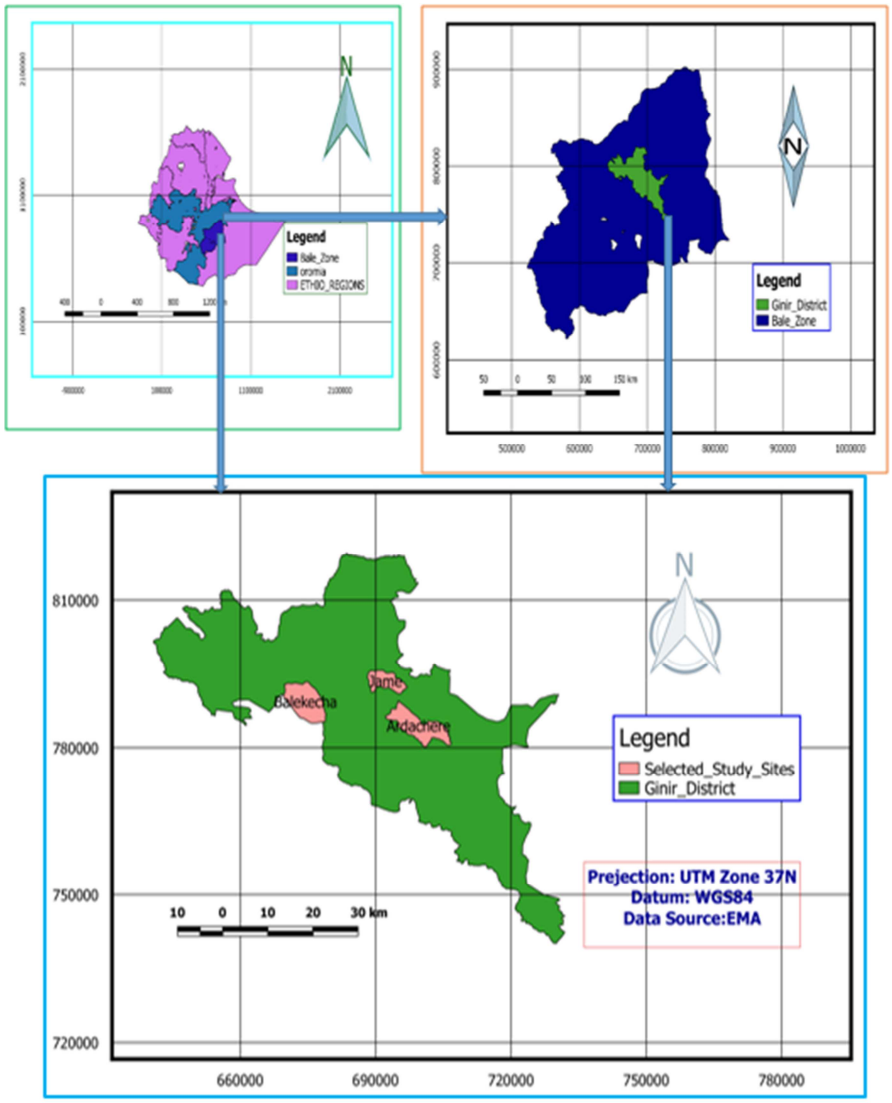

Figure 1. *Location map of the study area.*

2. Materials and Methods

2.1. Description of the Study Area

The study area, Ginir district is found in East Bale zone, Oromia Regional State, Southeast Ethiopia (Figure 1). It is one of the administrative units among 7 districts of East Bale zone with an area of about 2,384 square kilometers. The administrative center of the district is Ginir town, which is located at distance of 136 km from Bale Zone capital Robe town and 566 km from country Capital, Addis Ababa.

Geographically the district is located between 6° 40' 23"N to 7° 25' 32"N and 40° 15' 24" to 41° 6' 39"E. The district is bordered by Gololcha and Gasera districts in North, Rayitu and Sawena districts in East, Dawe Kachen in South and Goro and Sinana districts in West. Administratively the district is sub divided into 28 rural and 3 urban administration Kebeles (the smallest administrative unit).

According to 2013 Central Statistical Agency's population projection, total population of the district by year 2017 was 184,314 (93,804 male and 90,510 female). Among which 151,722 (82.32%) are rural and 32,592 (17.68%) are urban dwellers. Topography of the district falls within altitudinal range of 1200-2406m above mean sea level. The soil type of the district is categorized under pellic vertisols. The Northern and North Western part of the district is relatively characterized with highland mountainous. Whereas Eastern and South Eastern parts of the district is dominated by lowland. The southern part of the district is dominated by undulated value and broken escarpment [14].

According to 2020 data from Bale Zone metrological station, the mean annual temperature of Ginir district is 22.0°C. Its mean maximum temperature reaches 29.0°C in March and the mean minimum temperature is 15.0°C in November. Ginir district falls within two agro-climatic zones namely 25% midland (Woyinadega) and 75% lowland (kola). The area receives mean annual rainfall of about 700mm, whereas the minimum and maximum rainfall is 200 and 1200mm respectively. The district has bimodal rainfall pattern (two major cropping seasons) this are; Belg (autumn) season (March to May) and Tsedey (spring) season (September to November). Bega (winter) season (December to February) is the driest season in the area. In the district the highest rainfall amounts recorded in months of April, May and October and the lowest amount recorded in months of January and February.

2.2. Surveys on Peoples' Perception on the Impacts of Parthenium

2.2.1. Sampling Technique

Ginir district was purposively selected for the study from other districts of Bale zone, Southeast of Ethiopia, based on the aggressive infestation of *Parthenium*. In order to achieve the objective of the study, three kebeles of Ginir district was selected using purposive random sampling technique due to problems and high expansion of *Parthenium* to different land use types.

Peoples' perception about *Parthenium* problem on biodiversity and its infestation was assessed by interviewing a total of 105 respondents using purposive sampling method. The interview was targeted for farmers and pastoralists, agricultural and environmental experts and common people throughout the study area. Farmers working in agriculture land, animal herders, and common people near in road side and the sampling sites were interviewed. Among the 105 respondents 90 of them were farmers, pastoralists and common people of the three sampling kebeles (30 per each kebele) and the other 15 were experts (5 per each kebele). Thus, from each study kebele 35 respondents were interviewed.

2.2.2. Data Collection Methods

The primary data were generated from preliminary survey, field work, and the responses of the local people and agricultural experts who are involved directly or indirectly with the problems of *Parthenium*. In order to get adequate information on the overall impact of *Parthenium* in the study area, semi-structured interview questions were prepared. The surveys on peoples' perception were conducted in all study sites involving farmers, cattle grazers, fodder collectors, experts and local residents to understand the public opinions. Furthermore, observations, interview, and focus group discussions was made with development agents and agricultural experts of each study sites.

The interviews was targeted at understanding the impacts of *Parthenium* invasion on plant biodiversity and its infestation on woodland vegetation, abandoned agricultural lands, grazing (pasture) lands and along the main road sides. A semi-structured questionnaire that includes both close and open-ended was designed and employed to generate quantitative data from respondents. The questionnaire was prepared in English language and translated to local language (Afaan Oromo). By this particular method, a total of 105, respondents were considered and interviewed as research subject.

Pretesting of questionnaire was conducted to see about inclusiveness, its validity, relevance and comprehensiveness. Based on the pre-testing feedback, final questionnaire was prepared and administered accordingly [28]. During key informant interviews, key informants having long standing knowledge and spending their extended time in the local area was purposefully selected. These informants were mainly elders of local communities, administrators and development workers. Key informant interviews were conducted with these knowledgeable community representatives. For the key informants' interview, a total of 5 individuals were included in the study from each selected kebele. The selection of these key informants was carried out using snowball method.

Focus group discussion (FGD) was also the other most important research method to get varieties of information from different segments of the community for qualitative data which were conducted to get general information about the impacts of invasive plant species. FGD with key informants containing 5 individuals were conducted in each Kebeles. A check-list was prepared for key informants'

interview and an open kind of discussion was held. The information obtained were analyzed and checked with those obtained by other methods for triangulation.

Field observation method was used during the whole period of field work activities by informally discussing with the people; observed by different activities carried out by the community to control the impacts of the invasive plant species. During observation, field note was taken and issues had been raised during FGDs and key informants interview to get insight about the issue under investigation. Secondary data sources were both hard copies and online materials such as published articles, unpublished documents, proceedings and project reports.

2.2.3. Data Analysis

Both descriptive (frequency and percentage) and inferential statistics were used for data presentation, analysis and interpretation. The data collected from respondents concerning the impacts of *Parthenium* on native biodiversity were arranged and analyzed by using "Microsoft office excels". The responses of sample respondents from the questionnaires were tabulated. The tabulated responses were analyzed using different statistical tools with the help of SPSS (statistical program for social sciences) v.20 software.

3. Results

3.1. Perception on the Infestation of P. hysterophorus

According to information gathered about respondents, the average age of the overall sample respondents were 55 years ranging from 35 to 75. The majority of respondents 65% were elders (>45 years old), the other respondents 35% were found between the age 35 to 45. The data collected form respondents indicated that most of the study participants were males (74.3%) and the remaining (25.7%) were females. On the other hand, majority of the respondent of the study area (32.4%) were agro-pastoralists, while the other respondents were farmers (22.9%), pastoralists (26.7%), concerned experts of the district (14.3%) and other (3.8%) respondents like merchants and daily laborers respectively.

Table 1. *Age and occupation of respondents.*

No.		Number of respondents	Percent	Cumulative Percent
1.	Age of respondents			
	35-45	37	35.2	35.2
	45-55	28	26.7	61.9
	55-65	33	31.4	93.3
	65-75	7	6.7	100.0
	Total	105	100.0	
2.	Occupation			
	Farmer	24	22.9	22.9
	Pastoralist	28	26.7	49.5
	Agro-pastoralist	34	32.4	81.9
	Expert	15	14.3	96.2
	Other	4	3.8	100.0
	Total	105	100.0	

The educational level of respondents extends from those that cannot read and write up to the secondary educational level where others hold level III to Bachelor Science degree. From College/University. The results of respondents' educational status showed that 51.4% of the overall sample respondents were not able to read and write, while the remaining 48.6% of the overall sample respondents were able to read and write. Accordingly most respondents employed in the government offices has worked over 6 years and had experiential knowledge.

Table 2. *Education level of respondents.*

No.	Education level	Number of respondents	Percent	Cumulative Percent
1.	Cannot read and write	54	51.4	51.4
2.	Elementary	23	21.9	73.3
3.	High school	12	11.5	84.8
4.	Diploma and above	16	15.2	100.0
	Total		100.0	

3.1.1. Perceptions on the Time of Introduction and Habitat Infested by Parthenium

Among the total respondents, 89.5% of the respondents noticed and knew the name of this invasive species before this study and were able to identify it from other species by its physical form or morphology. The other 10.5% of respondents are not familiar with the name of *Parthenium* however they observed it invading different land use types of the study district. Regarding the initial introduction of *Parthenium*, 76.2% of the sample respondents believe that initial *Parthenium* infestation on Ginir district begin 20 years before, while some of the respondents 21% have the perception that *Parthenium* dominated the study area in last 10-20 years and very few respondents 2.8% of them observed this invasive species in the last ten years nevertheless most respondents agreed its rapid and aggressive spread was noticed from the last 5-10 years.

Table 3. *Time of the plant seen.*

No.	Time of the plant seen	Number of respondents	Percent	Cumulative Percent
1.	<10 years	3	2.8	2.8
2.	10-20 years	22	21.0	23.8
3.	>20 years	80	76.2	**100.0**
	Total	105	100.0	

Additionally, key informants and experts expressed that *Parthenium* first appeared in specific localities of Ginir district, near food-aid distribution centers and where donated food grain is stored and temporarily placed. According to the respondents, the seeds of this plant may have arrived with introduced grain and vehicles that carry them. Thus highest number of the respondents ranked that *Parthenium* first appeared in abandoned agricultural land (25.7%) and grazing areas (22.9%), while about 16.2% of the respondents indicated that *Parthenium* first appeared on road side. There are also other few respondents who mention woodland and bush land vegetation (13.3%), uncultivated (6.7%), around home side (6.7%), construction (4.8%) and cultivated (3. 8%) areas as a place where *Parthenium* species initially observed in there locality.

Table 4. *Area where Parthenium first appear.*

No.	Area where *Parthenium* first appear	Number of respondents	Percent	Cumulative Percent
1.	Grazing areas	27	22.9	22.9
2.	Abandoned agricultural land	24	25.7	48.6
3.	Road sides	17	16.2	64.8
4.	Woodland and bush land vegetation	14	13.3	78.1
5.	Uncultivated areas	7	6.7	84.8
6.	Around home side	7	6.7	91.5
7.	Construction areas	5	4.8	96.3
8.	Cultivated areas	4	3.8	100.0
	Total	105	100.0	

3.1.2. Agents of Seed Dispersal and Suitable Season for Parthenium Infestation

According to the interview made, the infestation and distribution of *Parthenium* was through different dispersal agents as vehicles, animals' movement, water current, wind and human activities. As depicted below in the table, the survey data analysis on the initial introduction of *Parthenium* showed most of the respondents (40%) mentioned grain aids as the main seed dispersal agent followed by vehicles crossing the area (29.5%). Other few respondents also pointed cattle or animals movement (10.5%), climate events such as wind (10.5%), erosion by flood (6.7%), and intentionally through human activities (2.9%).

Table 5. *Causes and distribution of Parthenium in the study area.*

No.	Causes of introduction	Number of Respondents	Percent	Cumulative Percent
1.	Through emergency grain aids	42	40.0	40
2.	Through vehicles crossing the area	31	29.5	69.5
3.	Through wind	11	10.5	80
4.	Through cattle or animals	11	10.5	90.5
5.	through water (erosion or flood)	7	6.7	97.2
6.	Intentionally by humans activities	3	2.9	100.0
	Total	105	100.0	

As depicted in the table below, it can be seen that**,** most of the respondents (65.7%) in *Parthenium* infested areas observed that *Parthenium* could grow and disseminate at any time of the year as long as sufficient soil moisture and rainfall might be accessible in the soil. Moreover, some (32.4%) of the sample respondents perceived *Parthenium* has been observed in the field germinating and growing during wet season or at the beginning of the rainy season and set seeds at the onset of the dry season. Very few respondents 1.9% also consider dry season as a season that could help *Parthenium* to grow.

Table 6. *Seasons those favor the growth of Parthenium.*

No.	Seasons	Number of respondents	Percent	Cumulative Percent
1.	Any time of the year	69	65.7	65.7
2.	Wet season	34	32.4	98.1
3.	Dry season	2	1.9	100.0
	Total	105	100.0	

3.1.3. Infestation Level of Parthenium in Different Land Use Types

As indicated below in the table, *Parthenium* was observed in the district to grow on road sides, Acacia woodland and bush land vegetation, grazing areas, abandoned agricultural land, around home yards, cultivated and uncultivated areas. According to the respondents in the district, abandoned agricultural land and grazing land are the two highly infested habitats. Twenty eight point six (28.6%) of the interviewed respondents ranked *Parthenium* infestation to be the highest in the abandoned agricultural land followed by grazing areas (21.9%), road sides (19%) and woodland and bush land vegetation (12.4%). Regarding the abundance of *Parthenium,* respondents of the study area noted that from the four main selected land use types *Parthenium* was sparsely populated in woodland and bush land vegetation area. On the contrary, respondents found *Parthenium* densely populated in abandoned agricultural land, grazing areas and road sides respectively.

Table 7. *Respondents view on Parthenium invaded land use types.*

No.	Invaded land use types	Number of Respondents	Percent	Cumulative Percent
1.	Road sides	20	19.0	19.0
2.	Acacia woodland & Bush land vegetation	13	12.4	31.4
3.	Grazing areas	23	21.9	53.3
4.	Abandoned agricultural land	30	28.6	81.9
5.	Uncultivated areas	8	7.6	89.5
6.	Cultivated areas	5	4.8	94.3
7.	Around home sides	6	5.7	100.0
	Total	105	100.0	

3.1.4. Causes of Aggressiveness of Parthenium

Most respondents mentioned that the high and fast desperation of *Parthenium* was mainly due to its high reproductive and regenerative ability (28.6%) through producing large amount of Parthenium seeds at its seed pods followed by its ability to out compete other surrounding plants (24.8%) dominating the area, its ability to spread in many ways (17.1%) through various agents at different land use types, the ability of the seed to stay in the soil seed bank for many years (11.4%) and adapted to grow in different soil types (12.4%) enabling it to germinate at any time of the year everywhere and its ability to resist impacts of drought (5.7%) which supports this invasive plant to survive scarcity of water.

Table 8. *Main causes for high and fast distribution of Parthenium.*

No.	Main causes of infestation	Number of respondents	Percent	Cumulative Percent
1.	Ability of the seed to stay longer in soil seed bank	12	11.4	11.4
2.	Its ability to withstand drought	6	5.7	17.1
3.	Its ability to out compete native plant species	26	24.8	41.9
4.	Its ability to spread in many ways	18	17.1	59.0
5.	Its high reproductive ability	30	28.6	87.6
6.	Its ability to grow in different soil types (habitats)	13	12.4	100.0
	Total	105	100.0	

The result showed that different group of peoples from the society are affected due to invasion of *Parthenium*. According to respondents' rank pastoralists and agro-pastoralists (41%) are the highly affected group of peoples in the society followed by cattle grazers and fodder collectors (30.5%), foresters and community forest users' (25.7%) and concerned sector offices (2.9%).

Table 9. *Groups of society more affected.*

No.	Groups of society	Number of respondents	Percent	Cumulative Percent
1.	Cattle grazers & fodder collectors	32	30.5	30.5
2.	Foresters and community forest users'	27	25.7	56.2
3.	Concerned sector offices	3	2.9	59.0
4.	Pastoralists and Agro-pastoralists	43	41.0	100.0
	Total	105	100.0	

3.2. Perception on Impacts of P. hysterophorus on Biodiversity

As pointed out by respondents, *Parthenium* has invaded and affected vegetations found in abandoned agricultural areas, roadsides, grazing areas, woodland and bush land forest areas and cultivated and uncultivated areas. Most of the sample interviewees (85.7%) noticed its impacts in infested areas on the growth and distribution of the surrounding plants. Other few respondents (10.5%) believe the impact of *Parthenium* is not yet known to them now, however it will have an effect on biodiversity of other native plant species in the near future. Still, very few respondents (3.8%) didn't perceive the concept that *Parthenium* affects the growth and distribution native plant species.

Table 10. *Effect of Parthenium on growth and distribution.*

No.	Effect of Parth. on growth and distribution	Number of respondents	Percent	Cumulative Percent
1.	Yes	90	85.7	85.7
2.	No	4	3.8	89.5
3.	Not Yet Known	11	10.5	100.0
	Total	105	100.0	

Table 11. *Rate of impact on plant richness and evenness.*

No.	Rate of impact	Number of respondents	Percent	Cumulative Percent
1.	Very high	18	17.1	17.1
2.	High	36	34.3	51.4
3.	Average	31	29.5	81.0
4.	Low	14	13.3	94.3
5.	Very low	6	5.7	100.0
	Total	105	100.0	

Concerning the rate of impacts of *Parthenium* on plant richness and evenness respondents vary on their perception. Majority of the respondents 34.3% perceived that, the impact *Parthenium* on other native plant species richness and evenness was high. Whereas, some other respondents supposed and ranked the effect of *Parthenium* on other plant species richness

and evenness as average (29.5%) followed by very high (17.1%), low (13.3%) and very low (5.7%) respectively.

On the subject of events observed, most of the respondents revealed that the species composition of grasses, herbs, shrubs and even trees has reduced and replaced by *Parthenium*. With regard to the impact of *Parthenium* in the grazing lands, different views were submitted. Most valuable grass species which were essential for animals fodder/grazing has decreased both in the type and quality of grasses. Among the interviewed respondents majority of them 51.4% perceived that *Parthenium* has increased on grazing lands of the study area from time to time. With related to this, 25.7% of the respondents said that *Parthenium* has decreased the types of grasses found in grazing areas, while 22.9% of the respondents argued that the quality of grass has decreased frequently due to invasion of *Parthenium* in grazing areas.

Table 12. *Events observed in the grazing lands.*

No.	Where Parthenium first appear	Number of respondents	Percent	Cumulative Percent
1.	Parthenium has increased	54	51.4	51.4
2.	Types of grasses has decreased	27	25.7	77.1
3.	Quality of grasses has decreased	24	22.9	100.0
	Total	105	100.0	

The extent of awareness regarding negative impacts of *Parthenium* on biological diversity was low. Majority of the respondents (51.4%) acknowledged that, they weren't properly aware or just had low awareness. Some other respondents (21.9%) in contrary had sufficient awareness in its impacts on biodiversity. While 15.2% of them were admitted high awareness, few of the respondents (11.4%) have no awareness concerning negative impacts.

Table 13. *Extent of awareness on negative impact of Parthenium on biodiversity.*

No.	Extent of awareness	Number of respondents	Percent	Cumulative Percent
1.	Highly aware	16	15.2	15.2
2.	Lowly aware	54	51.4	66.7
3.	Sufficiently aware	23	21.9	88.6
4.	Have no awareness	12	11.4	100.0
	Total	105	100.0	

Regarding the growing form of *Parthenium,* majority of the respondents (51.4%) described that the growing form of *Parthenium* has an effect on growth and distribution of other native plants, which successively affects ecosystem and biodiversity.

Table 14. *Situation of growing form.*

No.	Situation of growing form	Number of respondents	Percent	Cumulative Percent
1.	Growing form	54	51.4	51.4
2.	Dried form	10	9.5	61.0
3.	Both forms	41	39.0	100.0
	Total	105	100.0	

Nevertheless, 39.0% of the sample respondents expressed that both growing and dried forms affect the growth of other plants, while very few respondents (9.5%) mentioned that dried form of this invasive plant also has an impacts on growth and distribution of other native plants.

Most sample respondents stated that, the presence of *Parthenium* highly affected the growth and distribution of different groups of plants. According to respondents the groups of plants affected due to invasion of *Parthenium* was ranked sequentially. As stated and ranked by informants grasses and herbs are the highly affected group of plants (41.9%) followed by crop plants (20%), small bushes (20%), tree plants (11.4%) and vegetables (6.7%), from seriously damaged to slightly affected.

Table 15. *Groups of plants affected.*

No.	Groups of plants	Number of respondents	Percent	Cumulative Percent
1.	Grass and herbs	44	41.9	41.9
2.	Small bushes	21	20.0	61.9
3.	Tree plants	12	11.4	73.3
4.	Crop plants	21	20.0	93.3
5.	Vegetables	7	6.7	100.0
	Total	105	100.0	

Concerning the positive impacts of *P. hysterophorus*, most of the respondents 64.8% were unaware about the good effect of *Parthenium* invasive species for humans and biodiversity. However, 15.2% of the respondents and interviewed experts expressed their view that *Parthenium* may have its own benefits to the ecosystem which is not yet known. Conversely,

very few respondents 20% mention control of soil erosion (7.6%), soil improvement (3.8%) and its use for animal's fodder (8.6%) during lack of forage or during dry seasons as its positive impacts.

Table 16. *Current use of Parthenium humans or biodiversity.*

No.		Number of respondents	Percent	Cumulative Percent
1.	Usefulness of *Parth.* to humans or biodiversity			
	Yes	21	20.0	20.0
	No	68	64.8	84.8
	Not Yet Known	16	15.2	100.0
	Total	105	100.0	
2.	Current use of *Parthenium*			
	As fodder for animals	9	8.6	8.6
	Control soil erosion	8	7.6	16.2
	Increase soil fertility	4	3.8	20.0
	Nothing	84	80.0	100.0
	Total	105	100.0	

The result of questioners and the survey made discovered 3 major invasive species that were widespread and associated with *Parthenium hysterophorus*. Among the tree major invasive species, two of them were ranked by respondents as most troublesome *i.e. P. hysterophorus* and *Argemone mexicana* which are the most dominant and aggressively distributed species within a short period of time since their introduction. The table below also shows the percentages of the respondents rank was *Parthenum hysterophorus* (63.8%) at the top followed by *A. mexicana* (23.8%) and *Xanthium strumarium* (12.4%) in terms of area coverage and fast distribution.

Table 17. *Major invasive alien species.*

No.	IAS	Number of respondents	Percent	Cumulative Percent
1.	*Parthenium hysterophorus*	67	63.8	63.8
2.	*Argemone mexicana*	25	23.8	87.6
3.	*Xanthium strumarium*	13	12.4	100.0
	Total	105	100.0	

Accordingly, respondents considered *Parthenium* and the remaining observed *A. mexicana* and *X. strumarium* respectively as factors affecting herbaceous, shrubs and trees of the study area. As they reported, *Parthenium* occupied large area resulting decreased plant species richness and other regenerating species. Furthermore, respondents ranked these invasive align species in terms of plant species richness and regeneration of other understory plants that have suffered due to the impacts of invasive plant species.

As informants stated, the influence of disturbances like over grazing and browsing, cutting (removal) of plant materials, presences of other invasive plants and forest fire besides the influence of *Parthenium* infestation has become severe in the study sites. As a result, respondents ranked the level of disturbances in different land use types of the study area.

Table 18. *Level of disturbances.*

No.	Level of disturbances	Number of respondents	Percent	Cumulative Percent
1.	Undisturbed	8	7.6	7.6
2.	Slightly disturbed	54	51.4	59.0
3.	Highly disturbed	34	32.4	91.4
4.	Very highly disturbed	9	8.6	100.0
	Total	105	100.0	

Thus majority of respondents 51.4% perceived that *P. hysterophorus* are abundantly seen in slightly disturbed plots followed by highly disturbed (32.4%), very highly disturbed (8.6%), and undisturbed (7.6%) areas of the study sites.

4. Discussion

4.1. Invasion of P. hysterophorus as Perceived by Respondents

Age and education status were the key components to be considered which affects the distribution of the invasive plants and adoption of new technologies**.** Even though most of the informants can't read and write, they are generally considered as an essential repository of ingenious knowledge and wisdom. In addition, they know the area very well than the younger generation. With reference to [31], age is necessary tool to examine at which *Parthenium* was first introduced and to note the problems and impacts before and after its introduction. Education is also important element to recognize the newly emerging problems and thinking over adoptions of new technologies [31].

Among the total respondents, most of them (93%) identified *Parthenium* invasive alien species in their

surroundings. Analogous situation has been stated from Uttar Pradesh India that around 80% of the farmers covered by their survey could identify the morphology of *Parthenium* [19]. A study conducted in Gedeo of Ethiopia also showed that 73% of the respondents heard about *Parthenium* and had some information about its impact [36]. However, most of the respondents of the study sites didn't know the negative impacts of the species on environment and health. Similar finding was revealed in a survey conducted around Ambo of Ethiopia that the awareness level of the farmers towards *Parthenium* impact was low [29].

Regarding means of introduction, respondents believe that *Parthenium* first outspread mainly with emergency grain aid and vehicles crossing the area. So it is likely that imported wheat grain and grain carrying trucks was contaminated with its seeds. Similarly, [13] reported that *Parthenium* was first seen nearby food-aid distribution centers in 1980s in Ethiopia. In addition, local dispersal of *Parthenium* seeds occurs by climate events like wind and water (flooding). [30] documented similar situation that it was benefited from the intense climate events such as flooding which helps for dispersion of seed. Whereas, motor vehicles, machinery and livestock movements, crop and pasture seed also contributes for long distance dispersal. This is because, its seeds are light, small and black in color and they can spread with air, water and animals from one place to other [19].

Unrestricted movement of animals and equipment's from invaded to non-invaded areas might contribute to its wide range of dispersal and provides bare ground which favors germination and seedling establishment. It was also accepted that seeds of many invasive plants could pass through the digestive tract of animals. This happened when animals graze in *Parthenium* invaded areas and moved to non-invaded sites carrying the seeds in their hooves and drop their dung. Few days latter, when the seed of *Parthenium* gets moisture it starts to grow in new areas. This may be attributed to water and wind because of the very fine nature of *Parthenium* seeds. [1] stated that flooding and vehicle took the lead for fast rate of distribution and its easy dissemination of *Parthenium* seed from place to place.

Respondents revealed that *Parthenium* had been spread in an alarming rate to almost all kebeles and neighboring districts, along the main roadsides, abandoned agricultural areas, grazing lands and woodland and bush land areas of the district. It is also observed that this invasive plant grows in the fallow period in agricultural fields where only one or few crop is grown in a year. This content matchs with the idea forwarded by [34] which expressed *Parthenium* as a weed along roadsides, grassland area and wastelands in certain cropping season affecting agricultural production and native plant species.

In the same way, *Parthenium* were found densely populated on abandoned agricultural land, grazing areas, road sides and Acacia woodland and bush land habitats mainly. In agreement with this, those uncultivated and left barren were found to be invaded greatly by *Parthenium* plant. Among these, roadsides where movements of vehicles were also high, was found densely populated by this invasive plant. It might be due to the high seed dispersion by the movement of vehicles and abandonment of land [20]. Study conducted in rain fed areas of the province of Punjab, North Western Frontier Province and Kashmir, Pakistan, shows that this invasive species is also spreading rapidly in wastelands and grazing lands and replacing the local flora [16].

Most of respondents indicated that *Parthenium* first seen on abandoned agricultural areas and roadsides and then dispersed to other habitats. In areas where weeding is done rarely and inconsistently, it is very common to see dense stands of *Parthenium*. This finding indicated that *Parthenium* was found to be severe in disturbed habitat. This is in line with [41], which expressed that this invasive plant population was high in areas where soils are disturbed perpetually. This was for purposes of buildings, road construction and waterways for irrigation channels. Hence, large density of *Parthenium* along roadsides might be due to disturbance like transportation of sands and gravels from *Parthenium* invaded to non-invaded areas.

Most of the respondents noticed that *Parthenium* could germinate at any season and everywhere. The same condition has been reported 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 [33]. This might be due to its relative low moisture requirement for germination and its drought resistance capacity thereby suppressing other plant species [39]. Besides, they stated that *Parthenium* is an aggressive colonizer and they also noticed its capacity to disseminate easily to different land use types from year to year. Many factors like its wider adaptation, resistance to drought and photo insensitivity are pointed as reason for its competitive nature by respondents. Similarly, [38] and [3] mentioned the ability of the species to adapt over a wide range of photoperiods and climates (high moisture and high temperature) and its adaptability to various soil types.

Since the introduction of this invasive species, it expanded at an alarming rate in different land use types (habitats) and new areas. This may be because of the allelopathic nature of *Parthenium* and its impacts on plant diversity. That may be due to allelo-chemicals released from *Parthenium*, viz. sesquiterpene lactones and phenolics, which affect many plant species [25]. As a consequence the grazing land production for instance has become inadequate and some other indigenous plants are colonized by this invasive species. Due to a dramatic drop in the productivity of grazing land the respondents described their fear that the problem might lead them to use *Parthenium* and other invasive species as feed for their livestock. The same condition are described by [6] that due to this new invader, grazing lands are becoming insufficient to sustain grazing animals since the beneficial species are disappearing or becoming endangered.

According to the respondents and field observation, *Parthenium* was determined to grow at any season of the year

in different stages. These are shattering stage, flowering and seedling stages [1]. *Parthenium* has been also observed in the field and perceived by respondents setting seeds, germinating and growing even during dry periods with one or two showers or as long as adequate soil moisture and rainfall might be available in the soil. This implies that any intervention intending to control *Parthenium* should take into consideration of the ability of *Parthenium* to grow everywhere at every season of the year.

In spite of its many harmful effects, some respondents of the study area point out some specific properties that make it useful. Some of the interviewed respondents identified soil improvement, control of soil erosion and its use as animals fodder during lack of forage or/and dry seasons as its helpful impacts. [26] reported that *Parthenium* weed is used as an animal feed due to high potash, oxalic acids and protein content. Supporting the view of the respondents, few literatures which attempts to focus on the positive impact of this noxious invasive plant species stated its use as a green manure to enhance soil fertility and crop growth [17]. Similarly, [22] identified the use of *Parthenium* as compost, green manure for maize and mung bean production.

4.2. Impacts of P. hysterophorus on Biodiversity

According to the result from informants survey *Parthenium* had impacts on the biodiversity of the study sites. In roadsides, grazing lands and abandoned agricultural lands, one can easily observe dominance of *Parthenium* over other species. This is because, *Parthenium* rapidly invaded new surroundings and often replace the indigenous species and poses a serious threat to biodiversity. [24] confirmed that *Parthenium* causes total habitat change in native Australian grasslands, open woodlands, river banks and flood plains. Consequently, most of the sample respondents from infestation area replied that grasses species used for livestock feeding for instance has reduced (disappeared) because of *Parthenium* invasive plant. Similar results were found by [37] in Ethiopia.

According to most respondents, in *Parthenium* infested areas, growing form of *Parthenium* has greately affected the growth and distribution of other neighbouring plants. The growing form of *Parthenium* is when it is currently viable and grows in the invaded areas. Conversely, the dried form is accumulated and died bodies of this plant in infested areas. The growth form of *Parthenium* contended with other surrounding plants for resources. In *Parthenium* infested areas its growth form can causes lack of resources or nutrients. Besides it also results shading effect on plants that grow below it. These situations later inhibit the growth and distribution of native species which in turn affects ecosystem and biodiversity [4, 23].

According to respondents, *Parthenium* infested areas experiences common disturbances by humans and livestock *i.e.* over grazing and browsing, cutting (removal) of plant materials, presences of other invasive plants and forest fire. As informants speculated, the study area has been mostly overgrazed and competitive pasture plants have already diminished. Similar finding was designated in a study conducted in Australia, which stated that larger invasion of *Parthenium* occurs in areas where native vegetation are cleared or frequent disturbance due to heavy grazing are taken place [27].

As reported by respondents, the removal of plant and soil materials due to animal grazing, browsing, the actual presence of animals, their trails and droppings, and movement among others is an indication of disturbances. Furthermore, in the woodland vegetation there was illegal cutting of trees for expansion of farming area, firewood, construction and animal fodder. Moreover, respondents describe that due to the continued increase of *Parthenium* and other invasive weeds, and other related man-made and natural disturbances, the growth and regeneration of different native plant species was reduced. This pointed that there was past disturbances in the area which created an open spaces for the fast invasion of *Parthenium*. Correspondingly, the colonizing nature of this invasive species where were common at very disturbed areas [9].

According to responses from questionnaires, another reason for high and fast distribution *Parthenium* in the study area is lack prevention, control and removal measures by the local peoples and concerned stakeholders. In this case, integrated approaches are warranted to restrict the invasion by developing more than one effective prevention and control strategies [21]. Thus, unless effective measures will not take place by creating awareness about the effects of *Parthenium* to all concerned bodies, the ecosystem will be disturbed. According to [32], to address this problem, public awareness has to be developed and participatory approach should be adopted to control this invasive weed.

5. Conclusion

The outspread of invasive alien plant species is acknowledged as one of the greatest threats to biodiversity and well-being of the planet. *Parthenium hysterophorus* L. is an invasive alien species that existed and distributed at an alarming rate in various habitats including grazing areas, abandoned agricultural land, road sides, woodland and bush land vegetation, uncultivated areas, around home side, construction areas and cultivated areas of the study area. This was due to its reproductive and competitive ability, effective adaptability to varying climatic conditions and absences of their natural enemies. This invasive plant is dispersed by dispersal agents as vehicles, animals' movement, water current, wind and human activities. The finding of study revealed that *Parthenium* causes significant negative impacts on biodiversity and ecosystems, such as species composition of grasses, herbs, shrubs and even trees has decreased and is being replaced by *Parthenium*. Supported with the results found, the following recommendations were drawn: Findings of this study can be used as a baseline information in managing the threat posed by of this plant; A systematically designed and planned

programme that promote the participation of all stakeholders considering universities, government and non-governmental organizations, research centers and individual researchers is vital to develop strategies for controlling its further dispersion; consistent efforts could be taken over *P. hysterophorus* till the complete seed bank is consumed as an integrated package; creating awareness on how to control and prevent its further dispersion; scientific information with basic tools need to be provided to policymakers and resource conservationist which might help to enact well-informed decisions.

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