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Research Article

Participatory Communal Management Strategy and Response Campaign of *Lantana camara* Infested Rangeland at Babille District, Eastern Ethiopia

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Abstract

L.camara is one of the world's worst weeds that threaten the native biodiversity of rangeland and forest ecosystems of Ethiopia. This action was designed to appraise and scale up lessons, findings, and outcomes of participatory communal management strategy and response campaign of *L. camara* early infested rangeland around Babille district, Oromia region, Eastern Ethiopia. Consequently, twenty hectares of *L. camara* early infested site was investigated 13 km distance south of Babille City. The site was nominated based on the level of infestation, forage diversity, socioeconomic importance of the communal land, and availability of infrastructure. The cover-abundance and, distribution of *L. Camara* were estimated visually to guess the amount of human power desired during the intervention. Manual uprooting was the preferred management strategy based on the feasibility of tactics, species disturbance level, and availability of technologies. A reaction campaign were designed and implemented via participating 120 trained farmers to up-root the infested site. Voluntary communal participation, adoption of farmer's knowledge, attainment of consensus between different stalk holders, sustaining chain of command between stalk holders, and creating commitment among local farmers were some of the lessons and experiences learned from the campaign. Manual uprooting of *L. camara* is labor-intensive, and costly. Conversely, it is the preferred intervention mechanism applicable via reducing disturbance in the nearby vegetation that contributes to maintaining diversity and connectivity between ecosystems. Sharing and scaling up practical findings, and lessons, customizing local knowledge and the participatory response tactics are essential that contribute to suppress *L. camara* dominance.

Keywords: Restoration; Manual Uprooting; Response Campaign; Realistic Approach; Rangeland

Introduction

The deliberate or accidental introduction of non-indigenous species to new habitats has become an increasingly important aspect of global environmental change [8,19]. The invasion of habitats by exotic species is a global phenomenon with ecological, economic, and social consequences [16,18,21]. It is considered the second most widespread threat to global biodiversity next to habitat destruction of natural ecosystems worldwide [1,11,13,14]. The impacts of alien species are enormous. They cause alteration in ecosystem processes and community structure, the decline in abundance, and the richness of native flora [11,21].

L. camara is one of the Verbenaceae family species and the genus Lantana. It is native to tropical America but now has spread to many countries in Asia, Africa, and Australia [1,5,22]. The diverse and broad geographic distributions of the species beyond its native range are the reflection of its wide ecological tolerance, ability to conquer diverse habitats, and success in a variety of soil types [5,6].

It is now a cosmopolitan exotic invader and has been declared a noxious weed in many parts of the world [3,10,17]. Its stems are four-angled when young, rounded when mature, with numerous Leaves that are bright green above, paler beneath, about 6 cm long,

with slightly rounded-toothed margins, strongly veined, aromatic when crushed short prickles. The flowers are mainly pink, yellow, orange, and red, in compact heads 2.5 cm wide. Fruits are fleshy, rounded, glossy, and purplish-black when ripe and Seed dispersed by songbirds [2].

L. camara was introduced to Ethiopia as an ornamental plant due to its beautiful aromatic flowers [2,16,19]. However, because of prolific seed production and easy dispersal, it escaped cultivation, and become a pest in the social, ecological, and economic concerns. Presently, it has dispersed almost all over the country, but still; it is not much perceived as a chronic environmental problem, except in a few parts of Ethiopia, such as Oromia and Somali regions [16,19]. *L. camara* invasion has greatly affected herbaceous species diversity and altered soil physiochemical properties of Babile district. Its invasiveness was confirmed and its negative impact on biodiversity demand, proper control, and management actions to be undertaken by the government and different stakeholders [9].

The most common locally adopted methods used around Babille district for the management of *L. Camara* are hand pulling, slashing/chopping of the stems, and in some cases burning. In Ethiopia, there is no reliable and agreed practical intervention or management procedure, tactics, and methods designed to control invasive alien species in general and particularly for *L. Camara*. This action is therefore designed, to evaluate the effectiveness and limitation of participatory communal management and the response campaign of the IAS *L. camara* early infested rangeland using locally adopted physical control method (Uprooting by available tools and locally adopted knowledge by deploying manpower to dismantle the root system of *L. camara*. It is an experimental designed management package formulated based on the behavior of the plant, farmers interest, environmental factors (landscape, plantation, temperature, rainfall and etc), available technologies, and manpower around Babille District, Eastern Hararghe, Oromia Region, Ethiopia (Figure 1).

Methodology of the management Campaign

Site description

Babille is one the most priority districts where the infestation of *L. camara* is high. It is found in the Eastern part of Ethiopia located in Eastern Harerghe Zone of the Oromia Region, 30 km East of Harar [25]. A participatory Rural Appraisal following [15] was conducted from 20 to 25 May 2016 around different area of Babille villages to select an early infested experimental rangeland and to document available traditional knowledge for invasive species management. Accordingly, 13 Km south to Babille, twenty (20) hectares of *L. Camara* early infested rangeland was selected for the response campaign site based on the level of infestation, forage diversity, socioeconomic importance of the communal land, and availability of infrastructure (road, transportation, and water).

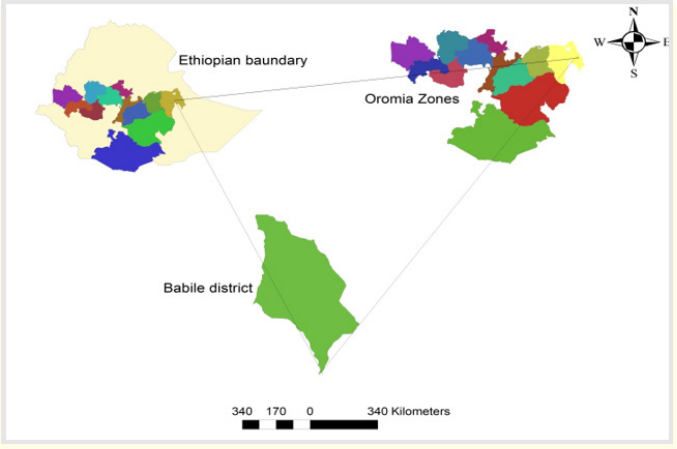

Figure 1: Maps of Babile District.

Human power determination

To determine the required amount of manpower in the management campaign, inventory data projection of five plots was done. Consequently, a total of one hundred twenty individuals were needed to participate in the response campaign. Available technologies and farmers' knowledge were registered prior to the campaign and designed as a method or step-wise control package for *L. camara* early infestation in consideration of diverse physical and environmental factors.

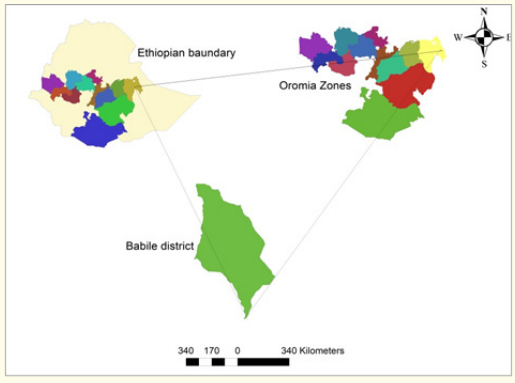

Plate 1: A: Site inspection and investigation (Photo by Edeget Merawi, 2016) B. Figure 1. Map of Babile district.

Plate 2: Stakeholder Consultation; Photo by Edeget Merawi, 2016.

Plate 3: Mini hearing session on site; Photo by (Edeget Merawi, 2016.

Stakeholder Identification

Prior to the field trip, multi-stakeholders were identified by consulting Harar Biodiversity Center, Babile district, and, village administration officers. Based on the information shared between officers and respective leaders of the governmental sectors at the district, village, Harar Biodiversity Center, and Ethiopian Biodiversity Institute, 120 voluntarily local farmers that were involved in the consecutive participatory management strategy and response campaign program were selected.

Consultation and hearing

A mini participatory group consultation and hearing with stalk holders particularly with the main involved actors "farmers' were conducted. The consent of all those listed parties were taken and consensuses were reached during the participatory consultation and hearing programs. During this special session, available technologies, adopted knowledge, experiences, and cultures associated with biodiversity conservation and sustainable utilization as well *L. camara* management interventions were documented. The overall Programs of the participatory management strategy and response campaign were discussed in detail and more or less comparative consensuses between the trained farmers were grown.

Documentation prior to the campaign [experiences, lessons, failures, and success stories raised during consultation]

A total of 120 local people were involved during the mini-workshop session (plate 3). The local people were discussed on the home-grown method used to manage *L. camara* early-infested areas. During the stakeholder consultation or hearing session, farmers described Chopping the stem as the most serviceable technique in controlling the spread of *L. camara.* Conversely, they evaluated their previous trial had little effect in managing the spread of *L. camara* infestation. The local people also evaluated chopping method as an operative managing technique even though the underground left part of the plant regenerate soon. Fencing the right and left sides of *L. camara* growing areas specifically on the edge of farmlands and houses that obstruct the running nature of the plant was raised as preventive management tactic. Seedling uprooting, planting competitive fodder trees, utilization of the plant for alternative use value, and cutting, burning, and or burying underground before flowering were the major local knowledge raised, documented and discussed on their effectiveness, and weakness. Finally, the technical team and farmers designed a participatory management strategy and response campaign.

Participatory management strategy and response Campaign designed.

Scholars recommended using a scientific approach for tackling IAS is vital. According to [16,25] the major component of weed management consist of the steps; understanding of the overall objectives/strategies of WM, Step-by-step procedure for dealing with an individual weed problem and realistic appraisal of the limitations and potentials of individual available technologies [16] also

noticed that the overall weed management strategy programs are prevention, Control, and eradication. Consequently, controlling particularly manpower uprooting is the main program selected for this experiment since the selected site is early-infested rangeland; it is a feasible strategy in which a substantial amount of *L. camara* plants and their parts biomass elimination. Physical removal specifically uprooting using a localized tool called "Mencha" [short-handled cutter made from iron] followed by Rehabilitation and/or restoration of the cleaned site using forage grasses, shrubs, and trees was designed as a response tactics.

Participatory management strategy of L. camara early infested rangeland

The participatory management strategy particularly designed for the investigated site was consists of seven steps; site inspection, preliminary survey (reconnaissance survey), conducting inventory (estimating the cover-abundance of *L. camara*), identifying multi stakeholders, identifying available technologies , dealing with multi-stakeholders and execution of the specific and designed response campaign (Figure 2).

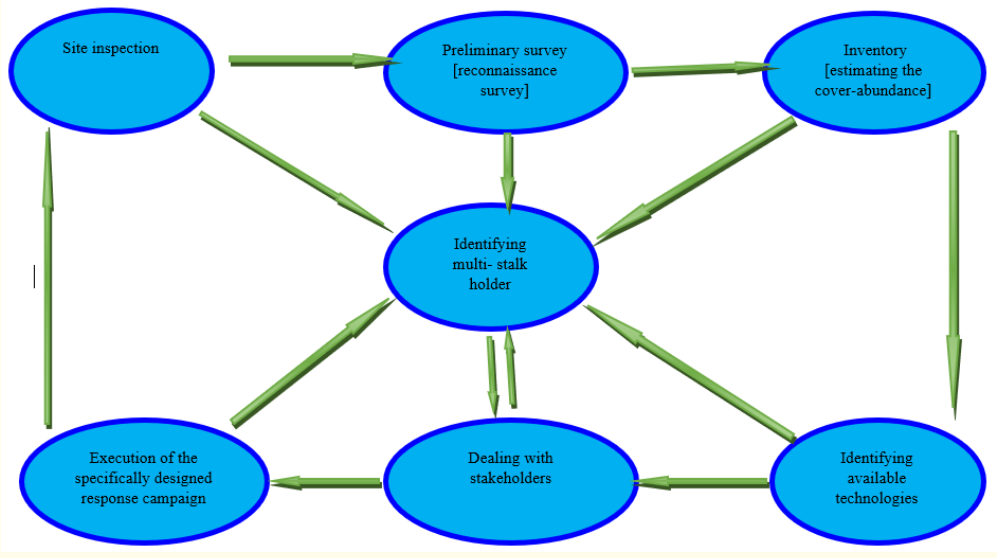

Figure 2: Schematic representation of theoretical framework of participatory management strategy of *L. camara* early infested rangeland at Babile district, Oromia region, Eastern Ethiopia (own formulation based on the available technologies, time, environmental factors, litrature and capacity].

Response campaign of *L. camara* early infested rangeland

The early infested rangeland at Babile district response campaign particularly designed for the investigated site consists of seven steps; consultation, hearing and awareness creation, documentation of local knowledge and cultures, multi stalk holder enrollment and man power determination, attainment of consensus between multi stakeholders and devising schedules of execution, uprooting using available tools, restoration and or rehabilitation and monitoring and follow up were designed as a response campaign (Figure 3).

Available technologies and tools

The tactics to eliminate *L. camara* determine the technology and tools. Locally adopted technology called Uprooting using locally available tools were used. Chopping tools were used to remove substantial biomass of the root system. Some of the tools used are meter, rope, axe or splitter, knife and farmer sticks were used for different purpose by the coordinators and farmers involved during the campaign.

Estimation of *L. camara* Cover abundance.

Three imaginary transect lines were laid systematically to guess the cover abundance of *L. camara***.** Five representative 20m x 20m plots from the four directions and one center plot were laid and count result was used for human power determination. Based on the count result of the five plots, a simple mathematical projection of the remaining site per hectare was done and the average cover abundance of lantana was determined. The overall experimental site (20 hectare) divided in to 500 quadrates of 20m x 20m. On average, one individual stand of *L. camara* per quadrates was con-

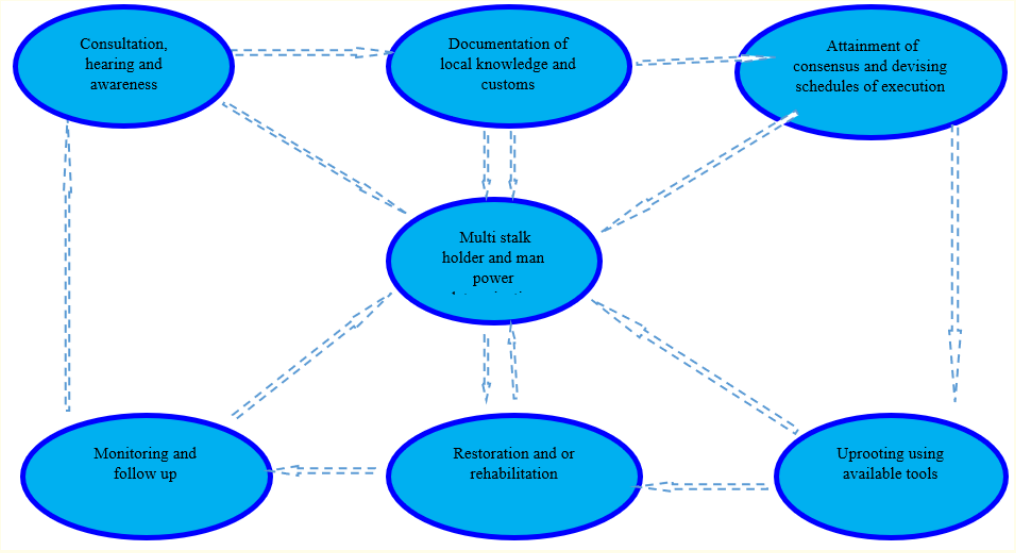

Figure 3: Schematic representation of the theoretical framework of response campaign of L. camara early infested rangeland at Babile district, Oromia region, Eastern Ethiopia (own formulation based on the available technologies, time, environmental factors, literature and capacity].

sidered (projected following the five plot count result). The stand cover abundance of *L. camara* is approximately 500 individual per hectare that brings the total stand cover abundance 10,000 individual. Each individual involving in the campaign uproots approximately 83 individual stand of *L. camara* within 3 hours.

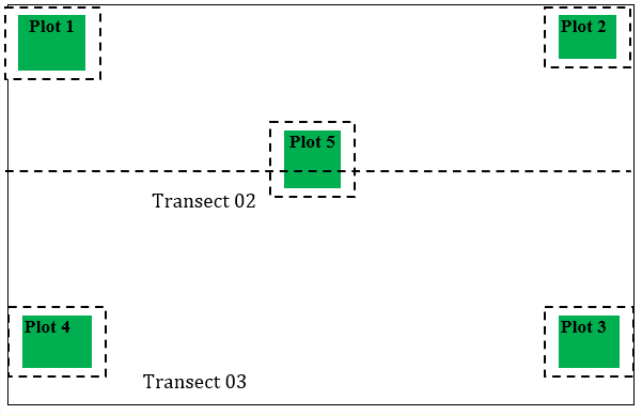

Figure 4: Schematic representation of plots.

The three hour [3Hr] manual uprooting intervention [Report]

Except a few of the trained farmers, they were found at site based on the agreed appointment time. The date and time of the campaign was on 25 May 2016 at 10 pm. The farmers were grouped in to 10 mini groups in which each working groups consists of twelve individuals. Coordinator was assigned for each groups for reporting, follow up and mentorship. All of the groups were competing each other to finalize their blocks and to handover the cleaned site. Uprooting and collecting the plant parts of *L. camara* at some point were continued for about three hours. It was very interesting commitment. At the late morning the site was totally free from *L. camara* stand cover and around ten big collections of *L. camara* plant parts were clearly observed. Since the intervention was started at mid night of Ethiopian time the photographs and videos taken were dark. After the 3Hr intervention programs, all of the stalk holder were meet again and sharing information's and the way forward specifically issues associated with rehabilitation and or restoration campaign steps and the role of each party on the restoration, monitoring and follow up duties.

Discussion

The result of this action come up with participatory communal management strategy and response campaign of *L. camara* has required mas participation of man power intervention supplemented with prior local knowledge, designed proper intervention tactics, sharing and scale up practical findings, and consecutive follow up which are suggested to be common to the local experiences, customs, traditional knowledge and values of the community around Babile District, Eastern Harerge, Ethiopia. Major actions like designing reaction campaign and management strategy, Human power determination, stalk holder identification, consultation

and hearing, documentation of local knowledge, identifying available technologies and tools, estimation of *L. camara* cover abundance, and manual uprooting interventions were done to clean the early infested site of *L. camara*. Voluntary communal participation, adoption of farmer's knowledge, attainment of consensus between different stalk holders, sustaining chain of command between stalk holders, and creating commitment among local farmers were some of the lessons and experiences learned from the campaign.

The major task done during cleaning of early infested lands were general awareness creation about Invasive alien species, restoration through prior indigenous plant, and continuous follow up strategy implementation [25]. *L. camara* has not fully effective control techniques currently available. In many areas, the sheer size of the infestations coupled with low land values makes conventional control not feasible. However mechanical clearing and hand pulling are suitable for small areas and fire can be used over large areas [5]. Manual removal of plants minimizes disturbance to nearby vegetation and is effective in killing the plants, especially those in small, isolated clumps growing along fence lines or in public parks. Manual uprooting of lantana plants is labor intensive and costly but is often the only method available to farmers in developing countries [5,12].

Studies showed that an increase in both abundance and richness of native species regeneration following Lantana removal [4,12,26]. Many years of work can be wasted if follow-up does not occur for at least two years following the last seeding. Together with its higher monetary and labor costs, uprooting is a recommended Lantana removal method. Cutting and burning, on the other hand, is comparatively feasible and practical from a management perspective, and is widely used where land is of low value, as also in open pastures [5]. There is also evidence that burning reduces the number of Lantana seeds in the soil seed bank [27]. In fact, a recent study from Australia has recommended the use of frequent fires for *L. camara* control in fire tolerant ecosystems [28].

During the community based intervention of alien weeds; Diagnosing the real problem, realistic appraisal of the situation, understanding the overall problem, exploring potential technologies, setting plan of action, execution of the planned action and follow up were mentioned as a strategy to remove the early infested rangeland [25]. Mechanical removal like uprooting using local available tools and restoration of the cleaned site using forage grasses, shrubs and trees were used tactics in different literatures [5,12,25]. Post-removal management has been stressed as significant in all conventional control methods [5]. Post-removal planting of species is recommended that can pre-empt Lantana re-colonization, and respond positively to disturbances like fire and grazing, that are known to promote Lantana's spread [12].

Lessons learned and the way forward.

Major lessons like voluntarily mass participation, adoption of farmer's knowledge, attainment of consensus between different stalk holders, sustaining chain of command between stalk holders, creating commitment on local farmers, devising appropriate response campaign and intervention strategy, establishing monitoring and follow up mechanism (post removal management; and compiling seasonal data are crucial to alleviate the effect of early infested *L. camara* on native biodiversity. Manpower uprooting followed by restoration and consecutive monitoring and follow up has to be in place to defend the regeneration of long live buried soil seed bank and left regeneration potential parts of *L. camara*. Similar research have reported that following *L. camara* removal, an increase in both abundance and richness of native species regeneration [4,12]. Physical intervention or management (uprooting, grafting the floral and leaf part before fruiting, destruction of seeds and area enclosure until restoration and rehabilitation successive monitoring and follow up might decline the reproduction of early infested *L. camara* that enable diversified plant composition.

Conclusion

In this intervention we observed that manual uprooting of *L. camara* is labor intensive and costly. Conversely, it is the preferred intervention mechanism applicable via minimizing disturbance in the nearby vegetation that contribute to diversity and maintaining the relationship between ecosystems. Sharing and scale up practical findings, lessons, customizing local knowledge associated with IAS management and communal participation recommended as suppressive measures of *L. camara* early infestation. The regrowth of manual uprooting could be highly assisted by post-harvest follow up and monitoring particularly prior restoration of species at the ecosystem.

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Ethics Approval and Consent Participate

Permission to perform the action was obtained from the district and village respective administrative office of the study area. The purpose of the intervention was explained to all participants, and they agreed to provide information and to participate in the inter-

ventions. All photographs were taken up on the oral consent of individuals or owners.

Authors' Contributions

Edeget. M. and Abebe. W. Girma. E. and Girum. F. designed the actions, performed the actions, and verified the analytical methods of the action. All authors discussed the results and contributed to the final manuscript.

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Availability of Data and Materials

The datasets related to this article can be accessed from the Corresponding author on reasonable request.

Competing Interests

The authors declare that we have no conflict of interest.

Bibliography

1. Binggeli P. "Verbenaceae, Lantana camara. The Natural History of Madagascar". SM Goodman and JP Benstead (eds.) (2003): 415-417.

2. Binggeli P and Desissa D. "Lantana camara-the invasive shrub that threatens to drive people out of their land". *Newsletter of the Ethiopian Wildlife and Natural History Society* (2002): 4-6.

3. Binggeli P., *et al*. "An overview of invasive woody plants in the tropics". An overview of invasive woody plants in the tropics 13 (1998).

4. Cummings J., *et al*. "Experimental manipulation of restoration barriers in abandoned eucalypt plantations". *Restoration Ecology* 15.1 (2007): 156-167.

5. Day MD., *et al*. "Lantana: current management status and future prospects (2003).

6. ECZ. "Implementation of Invasive Plant Prevention and Control Programmes in Zambia". Report Submitted to the CAB International Africa Regional Centre under the PDF-B Phase of the UNEP/GEF Project: Environmental Council of Zambia, Lusaka, Zambia (2004).

7. Fessehaie R and Tessema T. "Alien plant species invasions in Ethiopia: challenges and responses". In Proceedings of the International Workshop on Parthenium Weed in Ethiopia (2014).

8. Genovesi P and Shine C. "European strategy on invasive alien species: Convention on the Conservation of European Wildlife and Habitats (Bern Convention) (No. 18-137)". Council of Europe (2004).

9. Getye Ytagesu K and Workeneh D. "Impact of *Lantana camara* L. on herbaceous species diversity and soil characteristics in babile district, eastern ethiopia (Doctoral dissertation, Haramaya University)" (2020).

10. Goulson D and Derwent LC. "Synergistic interactions between an exotic honeybee and an exotic weed: pollination of Lantana camara in Australia". *Weed Research* 44.3 (2004): 195-202.

11. Grice AC. "The impacts of invasive plant species on the biodiversity of Australian rangelands". *The Rangeland Journal* 28.1 (2006): 27-35.

12. Hiremath AJ., *et al*. "Restoring Lantana camara invaded tropical deciduous forest: the response of native plant regeneration to two common Lantana removal practices". *Indian Forester* 144.6 (2018): 545-552.

13. IUCN. "Implementation of Invasive Plant Prevention and Control Programmes in Zambia". *Removing Barriers to Invasive Plant Management in Africa* 38 (2004): 681.

14. Malik RN and Husain SZ. "Broussonetia papyrifera (L.) L'hér. Ex Vent: an environmental constraint on the himalayan foothills vegetation". *Pakistan Journal of Botany* 39.4 (2007): 1045.

15. Martin GJ. "Ethno botany: A conservation manual London" (1995).

16. McNeely JA. "Global strategy on invasive alien species". IUCN (2000).

17. Morton JF. "Lantana, or red sage (*Lantana camara* L., [Verbenaceae]), notorious weed and popular garden flower; some cases of poisoning in Florida". *Economic Botany* 48.3 (2003): 259-270.

18. Nigatu L., *et al*. "Impact of Parthenium hysterophorus on grazing land communities in north-eastern Ethiopia". *Weed Biology and Management* 10.3 (2010): 143-152.

19. Solomon CA and Adane AT. "Impact of invasion: A case study on the ecological and socioeconomic impact of Lantana camara (L.) in Abay Millennium Park (AMP), Bahir Dar, Ethiopia". *Journal of Ecology and the Natural Environment* 7.5 (2015): 132-145.

20. Stohlgren TJ., *et al*. "Patterns of plant invasions: a case example in native species hotspots and rare habitats". *Biological Invasions* 3.1 (2001): 37-50.

21. Tessema T., *et al*. "Invasive alien plant species in Ethiopia: Impact, challenges and responses (2009).

22. Tola J and Tessema T. "Abundance and Distribution of Invasive Alien Plant Species in Illu Ababora Zone of Oromia National Regional State, Ethiopia". *Journal of Agricultural Science and Food Technology* 1.7 (2015): 94-100.

23. Wardle DA., *et al*. "Terrestrial ecosystem responses to species gains and losses". *Science* 332.6035 (2011): 1273-1277.

24. Wise RM., *et al*. "Costs, benefits and management options for an invasive alien tree species: the case of mesquite in the Northern Cape, South Africa". *Journal of Arid Environments* 84 (2012): 80-90.

25. Yeneayehu fentahun and Girma Eshetu. "Community based eradication strategy and response tactics of the IAS *Prosopis juliflora* early infested nursery site in babile worked, Erer bada Kebele Eastern Hararghe, Ethiopia: Case Study". *International Journal of Botany Studies* 2.1 (2018): 70-73.

26. Gooden B., *et al*. "Invasion and management of a woody plant, *Lantana camara L*., alters vegetation diversity within wet sclerophyll forest in southeastern Australia". *Forest Ecology and Management* 257 (2009): 960-967.

27. Hiremath AJ and Sundaram B. "Invasive plant species in Indian protected areas: conserving biodiversity in cultural landscapes". *Plant invasions in protected areas: Patterns, problems and challenges* (2013): 241-266.

28. Debuse VJ and Lewis T. "Long-term repeated burning reduces *Lantana camara* regeneration in a dry eucalypt forest". *Biological Invasions* 16 (2014): 2697-2711.