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Status of Invasive Species Distribution and Their Impact in Ethiopia: Systematic Review

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In Ethiopia, globalisation, trade, and agricultural practices have contributed to the spread of invasive alien species (IAS), with approximately 35 species, including *Prosopis juliflora*, *Parthenium hysterophorus*, and *Eichhornia crassipes*, threatening various habitats ranging from desert lowlands to highland plateaus. These invasions disrupt habitat structures, outcompete native species, alter ecosystem functions, degrade soil fertility and water regimes, and pose health risks. This review synthesises information on the distribution of IAS and their ecological, environmental, and social impacts in Ethiopia to inform management strategies and policy interventions. A systematic literature search was conducted using PubMed, Scopus, and Web of Science with keywords related to Ethiopian IAS. Notable invasive plant species, such as *P. hysterophorus* (affecting 37,105 hectares in Amhara) and *Lantana camara*, dominate through allelopathy and rapid growth, a trend that has escalated since the 1970s due to human activities, climate factors, and intentional introductions. Economically, these species can reduce agricultural yields by up to 40%, degrade grazing land, and result in billions of birr in losses, and increase management and veterinary costs. Socially and culturally, they cause allergies, toxicity, resource conflicts, pastoral displacement, and the erosion of traditional knowledge related to native plants used for medicine and rituals. Despite the challenges, some species like *P. juliflora* can provide dual uses, such as fodder. Management strategies incorporate integrated approaches, including manual removal (successfully reducing *P. juliflora* by 75%), mechanical methods, chemical treatments (e.g., glyphosate for *E. crassipes*), and biological controls (e.g., *Neochetina weevils*), along with awareness campaigns. However, these efforts face obstacles like resource shortages, conflicting perceptions, and weak legislative support. Therefore, enhancing government-NGO collaborations, integrating traditional knowledge with scientific research, establishing robust policies, and ensuring sustained monitoring and community education are essential to limit the spread of IAS and build adaptive resilience in affected communities.

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INTRODUCTION

Invasive plant species (IAS) are non-native floral species that easily establish and spread outside their natural distribution range (Russell *et al.*, 2017). These species have the potential to establish and proliferate, causing serious ecological, environmental, and socioeconomic harm (Shukla *et al.*, 2021). More scholars are realising that IAS are the biggest risk to biodiversity and are a worldwide issue with major local consequences (Fedele *et al.*, 2019). The effects of their introduction, whether deliberate or accidental, are frequently severe (Pyšek *et al.*, 2011; Reichard & White, 2003). In recent years, globalisation, trade, and agricultural practices have all contributed to the increase in the introduction and spread of invasive alien species (IAS) in Ethiopia (Abdulahi *et al.*, 2017).

Ethiopia is especially disposed to invasions because of its varied habitats, which include desert lowlands and highland plateaus (Bogale & Tolossa, 2021). According to earlier investigations, there are approximately 35 invasive alien plant species in Ethiopia, including well-known ones like *Prosopis juliflora*, *Parthenium hysterophorus*, and *Eichhornia crassipes*, which all expose native biodiversity and disturb local ecosystems (Sintayehu *et al.*, 2020). Beyond ecological deterioration, these invasive species have significant effects on community health, agriculture, and food security, which fuel social conflict and economic instability (Linders *et al.*, 2020; Shackleton *et al.*, 2017).

Changes in habitat structure, competition with native plants, and disturbance of ecosystem functioning are some of the ecological effects of invasive plant species (Mohammeda & Bahmudb, 2023). In many areas, *Prosopis juliflora* can reduce the amount of feed available for animals and outcompete native plants, which lowers pastoral output (Gemechu *et al.*, 2024). Additionally, the environmental effects of these invasions frequently show up as changed water regimes, decreased soil fertility, and increased erosion susceptibility (Hoffmeister *et al.*, 2005).

In general, invasive species have the potential to deteriorate already-existing vulnerabilities and inequalities, especially in rural areas where agriculture and natural resources are major sources of income (Bogale & Tolossa, 2021). Reduced yields from the invasion of invasive alien species (IAS) on croplands can expose livelihoods and food security (Pratt *et al.*, 2017). Additionally, IAS can increase health risks due to allergies and toxic effects associated with certain invasive plants (Reda & Tewelde, 2017).

This review examines the distribution and effects of invasive alien species (IAS) in Ethiopia. Accepting these diverse impacts is essential for creating effective management strategies. The importance of this review stems from its thorough evaluation of IAS in Ethiopia, emphasising the ecological, environmental, and socio-economic challenges they present. Through compiling data on their distribution and impacts, the study seeks to highlight the pressing need for effective management and policy actions. Additionally, it

stresses the value of incorporating traditional knowledge and community involvement in addressing IAS, which ultimately supports biodiversity conservation and local livelihoods. The essential research questions guiding this review are: What is the distribution of invasive alien species in Ethiopia, and what ecological, environmental, and socio-economic effects do they have on local ecosystems and communities? These questions aim to provide insights for developing effective management strategies and policy measures to alleviate the negative impacts of IAS.

METHODOLOGY

The methodology employed in this review has been meticulously refined to enhance clarity, replicability, and transparency. The primary objective was to identify publications that elucidate the distribution and effects of invasive species in Ethiopia, along with their ecological, environmental, and social repercussions. A comprehensive literature search was conducted, analysing a total of 150 studies obtained from databases such as PubMed, Scopus, and Web of Science. Out of these, 78 studies were deemed relevant and included in this review article. The targeted search terms encompassed keywords such as “invasive species,” “Ethiopia,” “ecological impact,” and “environmental effects,” and the search was confined to studies published between 2002 and 2025 to ensure a current overview of the topic.

Towards ensure the inclusion of relevant studies, clearly defined criteria were established, focusing on geographic relevance, publication year, and species types. The screening and selection process followed a multi-step protocol: initial assessments were conducted based on titles and abstracts, followed by a full-text review of articles that met preliminary criteria. This structured approach ensured that all studies included were both relevant and of high quality. Data extraction was performed using a standardised form to collect essential information, including species names, distribution areas, and documented ecological and environmental impacts. To uncover trends in

species distribution and their effects, the data were analysed using both qualitative and quantitative techniques, facilitated by systematic review methods to ensure a comprehensive understanding of the impacts of invasive species.

Furthermore, a quality assessment of the selected studies was carried out using established frameworks, particularly the PRISMA guidelines, which were crucial for maintaining high methodological standards. Ethical considerations were recognised throughout the review process to uphold research integrity, with all included studies conforming to relevant ethical standards that were verified during the quality assessment phase. Overall, by addressing these elements, the methodology aims to provide a thorough, transparent, and replicable overview of the status and impacts of invasive species in Ethiopia, thereby establishing a solid foundation for future research.

RESULTS AND DISCUSSION

Distribution of Invasive Plant Species in Ethiopia

In Ethiopia, the spatial distribution patterns of invasive plant species (IAPS) show a worrying trend that presents serious ecological and socioeconomic problems. According to recent research, some 35 invasive species stand a threat to native biodiversity, agricultural output, and the general health of ecosystems in a number of locations, especially in the Illu Ababora Zone (Tola & Tessema, 2015). There were 16 IAPS from nine different families, including well-known species like *Parthenium hysterophorus*, *Cuscuta campestris*, and *Lantana camara*, according to a study done in the Illu Ababora Zone, Oromia region. Fabaceae, Solanaceae, Asteraceae, and Euphorbiaceae were the most important families found, and they all made a substantial contribution to the region's total invasive species abundance (Assefa *et al.*, 2016).

In the case of the Southern Nations, Nationalities, and Peoples' Region, Twenty-five of the 35 alien plant species that are encroaching on Ethiopia's native vegetation have been discovered in the

Wolaita zone's Humbo district. *Parthenium hysterophorus*, with 15197 individuals/ha, *Richardia scabra*, with 11908 individuals/ha, *Xanthium strumarium*, with 7292 individuals/ha, and *Ocimum forskolei*, with 6280 individuals/ha, were the densest invasive alien plant species in the region (Kuma *et al.*, 2021).

These invasive species' geographic distribution was mostly concentrated around roadsides and disturbed ecosystems, suggesting that human activities are linked to the spread of these species. This pattern is consistent with findings from other studies that indicate the spread of invasive species is frequently facilitated by infrastructural development (Lázaro-Lobo *et al.*, 2019). Because of its ability to adapt to disturbed habitats, including wastelands and marketplaces, *P. hysterophorus* has demonstrated a propensity to dominate pastures and agricultural grounds (Taye, 2002).

There are geographical differences in the distribution of IAPS across Ethiopia. In the Amhara region, for example, *P. hysterophorus* has been found to cover about 37,105 hectares, with the highest infection rates found in the districts of Gojjam and Gonder (Taye *et al.*, 2007). *Cirsium vulgare* and *Mimosa invisa* have been observed in specific districts, demonstrating how local environmental conditions and land use practices affect the spread of invasive plants (Tola & Tessema, 2015). Additionally, there have been reports of invasive species in the Southern Nations, Nationalities, and Peoples' Region (SNNPR), Oromia, Somalia, Tigray, and Afar. These species are found in a wide range of environments, such as urban areas, marshes, rangelands, grasslands, and agricultural lands. Whereas the frequency of occurrence varies among species, the dominance of *Cuscuta campestris*, *Tapinanthus globiferus*, and *Cirsium vulgare* in the area was demonstrated by their respective frequencies of about 40%. Conversely, species such as *P. hysterophorus* and *L. camara* had lower rates but are still significant. This suggests that while some species are highly

invasive and aggressive in their expansion, others are beginning to establish themselves and may eventually broaden their range (Assefa *et al.*, 2016).

Furthermore, *Argemone ochroleuca* has had a major influence on rangelands and agriculture, as seen by the high infestation levels reported by local responders. In addition to competing with native plants, this invasive species has a detrimental impact on agricultural output and cattle health (Driscoll *et al.*, 2014). The results highlight the pressing need for focused management approaches to stop the spread of these invasive species, which are a serious danger to local economies and biodiversity.

Habitat Distribution Patterns

These invasive species have strongly correlated with both environmental and human variables. The majority of invasive species may outcompete native plants in disturbed ecosystems like urban areas, agricultural fields, and roadside ditches (Table 1). *Prosopis* and *Parthenium*, for example, are primarily found in places where land has been modified for farming or habitation (Tewelde & Mesfin, 2018). The Afar National Regional State and regions like Amhara and Oromia are substantially affected due to their ecological sensitivity and reliance on pastoralism. The sustainability of local livelihoods is at risk due to ecological changes brought about by the invasion of these species, such as reductions in native biodiversity and changes in species composition (Shackleton *et al.*, 2019).

Ethiopia's invasive plant species spatial distribution patterns show how urgently intervention is required. Identifying important invasive species and their ecological effects emphasised the significance of creating focused management methods. To mitigate the adverse impacts of invasive species on Ethiopia's biodiversity and socioeconomic well-being, additional research and collaboration among multiple stakeholders are required.

Table 1: Common Invasive Plant Species in Ethiopia, Their Geographic Distribution, Habit Type, and Habitat Type

Invasive Plant Species	Regions of Ethiopia	Habitat Type	Habit Type	Source
<i>Prosopis juliflora</i> , <i>Parthenium hysterophorus</i>	Amhara, Oromia, Tigray, Somali	Roadsides, agricultural lands	Tree/Shrub, Herbaceous	Bufebo & Elias, 2018; Tewelde & Mesfin, 2018
<i>Prosopis juliflora</i>	Afar, Oromia, Amhara	Pastoral lands, irrigation areas	Tree/Shrub	Ilukor <i>et al.</i> , 2016
<i>Eichhornia crassipes</i>	Gambella, Awash River	Water bodies, lakes, rivers	Aquatic Plant	Midgley <i>et al.</i> , 2006
<i>Lantana camara</i>	Oromia, Somali	Urban areas, roadsides	Shrub	Bekele <i>et al.</i> , 2018
<i>Cuscuta campestris</i>	Amhara, Oromia	Cropland, rangeland	Climber	Tola & Tessema, 2015
<i>Mimosa pigra</i>	Oromia, Gambella	Wetlands, floodplains	Tree/Shrub	Mungoche <i>et al.</i> , 2025
<i>Cirsium vulgare</i>	Oromia, Amhara	Disturbed lands, roadsides	Herbaceous	Tola & Tessema, 2015
<i>Argemone ochroleuca</i>	Amhara, Oromia	Agricultural lands, disturbed areas	Herbaceous	Assefa <i>et al.</i> , 2016
<i>Senna didymobotra</i>	Amhara, Oromia	Roadsides, wasteland	Shrub	Taye <i>et al.</i> , 2007
<i>Xanthium strumarium</i>	Amhara, Oromia	Roadsides, agricultural lands	Herbaceous	Tola & Tessema, 2015
<i>Parthenium hysterophorus</i>	SNNPR	Roadsides, agricultural lands	Herbaceous	Kuma <i>et al.</i> , 2021

Common Invasive Species and Their Habitats

Recent research has identified a large number of invasive plant species that significantly affect Ethiopian ecosystems and livelihoods. Among these, *Prosopis juliflora*, *Parthenium hysterophorus*, *Lantana camara*, and *Eichhornia crassipes* are the most prevalent invasive alien species (Tewelde & Mesfin, 2018). *Prosopis juliflora* has rapidly expanded over pastoral areas since its introduction for agroforestry goals in the 1970s, particularly in the Afar region and along the Awash River basin (Table 1). This species has a negative reputation due to its ability to produce dense thickets that displace local plants and restrict grazing potential (O'Connor *et al.*, 2020).

Current estimates suggest that *Prosopis* covers over 1 million hectares in Ethiopia, with an annual spread rate of approximately 50,000 hectares (Rezene *et al.*, 2011). *Parthenium hysterophorus*

has been reported to dominate pastures and agricultural lands, leading to reductions in crop yield and livestock health. Its *allelopathic properties* inhibit the growth of native plants, resulting in biodiversity loss and economic hardship for local communities (Dogra *et al.*, 2010). Infestation levels recorded at around 37,105 hectares in the Amhara region alone (Bufebo & Elias, 2018). *Lantana camara*, originally introduced as an ornamental plant, has spread across various regions, particularly in Oromia and Somali regions. It is known for its unpalatable nature and toxicity to livestock, which can lead to significant health issues (Barik *et al.*, 2020).

The dense growth of *Lantana* also suppresses native forages, further threatening agricultural productivity. *Eichhornia crassipes*, commonly known as water hyacinth, has invaded critical

water bodies, particularly in the Awash River system and Lake Tana. Its dense mats restrict water flow, hinder fishing activities, and increase siltation, leading to ecological degradation (Yan *et al.*, 2017). Recent studies highlight its role in increasing vector-borne diseases, posing additional health risks to local communities (Haregeweyn *et al.*, 2013).

In general, the presence of invasive plant species in Ethiopia poses significant ecological and socio-economic challenges. Understanding their distribution patterns and impacts is vital for developing effective management strategies. Continuous research and adaptive management practices are necessary to mitigate the adverse effects of these invasive species on Ethiopia's rich biodiversity and the livelihoods of its people.

Historical Changes in Distribution

Invasive plant species (IPS) significantly threaten biodiversity and ecosystem functioning across Ethiopia. Recent studies indicate that the distribution of common invasive species, such as *Parthenium hysterophorus* and *Prosopis juliflora*, has undergone notable historical changes due to various factors, including climate change and human activities (Melese *et al.*, 2025).

According to the findings, *Parthenium hysterophorus* has been identified as one of the most aggressive invaders, with its current distribution covering extensive agricultural and grazing lands in Ethiopia (Table 1). The species has been reported to dominate approximately 90% of infested areas, severely affecting crop yields, particularly in sorghum and tef cultivation (Mussa *et al.*, 2018). Similarly, *Prosopis juliflora*, initially introduced for agroforestry, has expanded its range significantly, particularly in the Afar and Oromia regions, now occupying over 1 million hectares of land (Ilukor *et al.*, 2016).

The historical analysis reveals that the spread of *P. hysterophorus* has escalated since its

introduction in the 1970s, with a marked increase in its coverage observed over the last decade (Hussein & Estifanos, 2023). Investigations suggest that this invasive species has the potential to expand its range further under future climate scenarios, particularly in regions that are currently marginal for its growth (Melese *et al.*, 2025; Mainali *et al.*, 2015).

Various environmental variables, including temperature, precipitation patterns, and land use changes, have been shown to influence the distribution of invasive species. For *P. juliflora*, factors such as mean temperature and precipitation of the warmest quarter have been identified as significant predictors of its habitat suitability (Hussein & Estifanos, 2023). These environmental factors are crucial, as they determine the invasive species' ability to establish and proliferate in new areas.

The invasive nature of these species is mainly recognised by their biological characteristics, such as rapid growth rates, prolific seed production, and tolerance to a wide range of environmental conditions (Vilà *et al.*, 2011). For instance, *L. camara* was known for its allelopathic effects, which inhibit the growth of surrounding plants, thereby facilitating its own dominance (Ahmed *et al.*, 2007). Such traits enable these species to establish and thrive in disturbed environments, often leading to the displacement of native flora.

Generally, the temporal changes in the distribution of invasive plant species in Ethiopia highlight the urgent need for proactive management strategies. Understanding the factors driving these changes, alongside their socio-economic impacts, is crucial for developing effective interventions. Future research should focus on the long-term ecological impacts of these invasions and the efficacy of various management approaches to safeguard Ethiopia's biodiversity.

Table 2: Historical Changes in the Distribution of Invasive Species

<i>Invasive Species</i>	<i>Plant</i>	Regions of Ethiopia	Year	Notable Changes	Factors Influencing Change	Source
<i>Parthenium hysterophorus</i>		Amhara, Oromia, Tigray	1976	First observed near the food aid distribution	Human aid, seed dispersal	Tamado & Milberg, 2000
<i>Prosopis juliflora</i>		Afar, Oromia, Amhara	1970s	Introduced for agroforestry, now widespread	Agricultural practices, climate	Tola and Tessema, 2015
<i>Eichhornia crassipes</i>		Gambella, Awash River	1956	First recorded in Koka Lake	Waterway management, trade	Bogale and Tolossa, 2021
<i>Lantana camara</i>		Oromia, Somali	2000s	Rapid spread in urban areas	Ornamental planting, animal dispersal	Binggeli & Desalegn, 2002
<i>Cuscuta campestris</i>		Amhara, Oromia	2004	Increased presence in agricultural zones	Crop management practices	Bufebo & Elias, 2018
<i>Mimosa pigra</i>		Oromia, Gambella	1990s	Established in wetlands	Floodplain management, irrigation	Mungoche <i>et al.</i> , 2025
<i>Cirsium vulgare</i>		Oromia, Amhara	2000s	High abundance in disturbed areas	Land use changes, overgrazing	Bufebo & Elias, 2018
<i>Argemone ochroleuca</i>		Amhara, Oromia	1980s	Dominant in arable lands	Seed dispersal, agricultural practices	Assefa <i>et al.</i> , 2016
<i>Senna didymobotra</i>		Amhara, Oromia	2000s	Spread in urban and rural areas	Human activity, land use changes	Taye <i>et al.</i> , 2007
<i>Xanthium strumarium</i>		Amhara, Oromia	2000s	Increased occurrence in agricultural areas	Disturbance, agricultural practices	Bufebo & Elias, 2018
<i>Parthenium hysterophorus</i>		SNNPR	1976s	First observed near food aid distribution	Human aid, seed dispersal	Kuma <i>et al.</i> , 2021

The distribution of invasive species in Ethiopia is a complex interplay of ecological and anthropogenic factors. Ongoing monitoring and management strategies are essential to mitigate their impacts and preserve the country's biodiversity.

Impact of Invasive Plant Species in Ethiopia

Ecological Impact

The introduction of species such as *Prosopis juliflora*, *Parthenium hysterophorus*, and *Lantana camara* has led to profound ecological

changes across various landscapes. The loss of biodiversity due to IAPS further complicates the economic landscape. Invasive species can alter ecosystem services, which are vital for agricultural productivity and community well-being. For instance, *Eichhornia crassipes* obstructs waterways, affecting irrigation and fisheries, which are crucial for local economies (Midgley *et al.*, 2006). The degradation of ecosystem services translates into reduced agricultural outputs and economic instability for

communities reliant on these resources (Seifu *et al.*, 2016).

Recent studies indicate that Ethiopia is home to approximately 35 identified invasive alien plant species, with a notable concentration in disturbed ecosystems, agricultural lands, and urban areas (Fessehaie & Tessema, 2020). For instance, *Prosopis juliflora* has rapidly expanded, covering over 1.17 million hectares, primarily in the Afar region. Its invasion rate is estimated at 50,000 hectares annually (Sintayehu *et al.*, 2020). The dense thickets formed by *P. juliflora* not only outcompete native vegetation but also disrupt local ecosystems by reducing biodiversity and altering habitat structures (Shackleton *et al.*, 2017).

The floristic composition in invaded areas reveals a stark contrast to native ecosystems. For example, in the Central Rift Valley, *Lantana camara* has been reported to form dense understory layers, effectively suppressing native species and reducing overall biodiversity (Kuma & Warkineh, 2020). The presence of *Parthenium hysterophorus* has been similarly linked to significant declines in native plant diversity, as it competes aggressively for resources and alters soil properties (Kefelegn, 2015).

Moreover, the alteration of ecosystems due to these invasions can lead to increased conflicts over resources among local communities, particularly as competition for dwindling grazing and agricultural land intensifies (Mekuria *et al.*, 2018). The socio-economic stability of pastoral and agro-pastoral communities has increasingly been threatened as invasive species encroach upon their livelihoods.

Invasive alien plant species in Ethiopia, such as *Prosopis juliflora*, *Parthenium hysterophorus*, and *Lantana camara*, have profound ecological impacts that threaten biodiversity and disrupt ecosystem functionality (Table 2). The current trends in their distribution and the associated socio-economic consequences underscore the urgent need for coordinated management strategies. Effective control and prevention

measures, informed by comprehensive ecological assessments, are essential to mitigate the adverse effects of these invasive species on Ethiopia's rich biodiversity and the livelihoods of its people.

Economic Impact

Invasive alien plant species (IAPS) pose significant economic threats across various sectors in Ethiopia, affecting agriculture, livestock production, and overall rural livelihoods. The review highlights several key invasive species, including *Prosopis juliflora*, *Parthenium hysterophorus*, and *Eichhornia crassipes*, which have been identified as major contributors to economic challenges in the region (Table 2).

IAPS, like *Argemone ochroleuca* and *Parthenium hysterophorus*, significantly reduce agricultural productivity (Table 2). These species compete with native crops for resources such as water and nutrients, leading to decreased yields. *Parthenium*, for instance, is known to produce allelochemicals that inhibit the growth of nearby crops, resulting in economic losses due to reduced agricultural output (Khan *et al.*, 2018). The estimated economic impact of *Parthenium* on livestock and crops has been substantial, with losses in agricultural productivity and increased management costs due to the need for herbicide applications (Essa *et al.*, 2006).

Invasive species also have adverse effects on livestock production. *Prosopis juliflora* has been shown to reduce the availability of grazing lands due to its aggressive growth and ability to create dense thickets, which limit access to water and forage (Mwangi & Swallow, 2008). The thorns of *Prosopis* can injure livestock, leading to additional veterinary costs and decreased productivity (Mehari & Zeraye, 2015). In areas heavily invaded by *Prosopis*, pastoralists have reported significant reductions in livestock carrying capacity, which directly influences their income and food security (Shackleton *et al.*, 2017).

Economic assessments indicate that the overall cost of invasive species management and the

consequent losses in productivity can reach billions of Ethiopian Birr annually. For instance, invasive species have been reported to reduce agricultural yields by up to 40% in some regions (Mwangi & Swallow, 2008). In the case of *Prosopis juliflora*, the annual loss in livestock productivity and the increased costs of managing invasive species are estimated to affect the livelihoods of pastoral communities significantly (Haregeweyn *et al.*, 2013).

The socio-economic implications of IPS in Ethiopia are profound. The invasive nature of these species leads to decreased agricultural productivity, affecting food security and local livelihoods, particularly among pastoral and agro-pastoral communities (Linders *et al.*, 2019). The encroachment of invasive species often results in reduced access to grazing lands, leading to conflicts among local communities and increased pressure on indigenous flora (Tessema *et al.*, 2019).

The ecological impacts of invasive species extend beyond biodiversity loss to include significant socio-economic repercussions. The invasion of *P. juliflora* has been associated with substantial economic losses in pastoral regions, where it reduces the availability of grazing land and affects livestock health (Haregeweyn *et al.*, 2013). Estimates suggest that the economic cost of *P. juliflora* invasion in regions like Awash could amount to over 2.2 billion birr annually (Ilukor *et al.*, 2014).

The economic impacts of invasive plant species in Ethiopia are multifaceted, affecting agricultural productivity, livestock health, and overall rural livelihoods (Mussa *et al.*, 2018). The findings underscore the urgent need for effective management strategies that not only address the immediate economic losses but also consider the long-term ecological impacts of invasive species. Collaborative efforts between governmental and non-governmental organisations are essential to implement adaptive measures that mitigate the adverse effects of invasive species while leveraging their potential benefits (Williams *et al.*, 2021).

Invasive species have disrupted traditional livelihoods, particularly in pastoral and agro-pastoral communities. For instance, *Prosopis juliflora* has invaded large areas of grazing lands, leading to reduced availability of forage for livestock. This change has forced pastoralists to move further in search of grazing, exacerbating food insecurity (Williams *et al.*, 2021). The detrimental effect on livestock health caused by the thorns of *Prosopis* and the unpalatability of its foliage has resulted in economic losses due to reduced livestock productivity and increased veterinary costs (Balcha, 2022).

The socio-economic consequences of invasive species extend to increased management costs and a reduction in agricultural productivity. Farmers face higher labour costs due to the need for manual removal of invasive plants, which diverts resources away from more productive activities (Eshetu, 2024). The economic burden is particularly heavy for subsistence farmers who depend on crop yields for their livelihoods. In regions where invasive species proliferate, communities may experience a decline in income-generating opportunities, further entrenching poverty (Abdisa & Dilbato, 2024).

Invasive species in Ethiopia have broad economic effects, impacting agriculture, forestry, and local economies. These species reduce crop yields, degrade grazing lands, and disrupt water resources, causing financial strain and hindering sustainable development. Managing these species requires substantial investments in control measures and research. The impacts are particularly severe on rural communities, where livelihoods depend directly on natural resources.

Social and Cultural Impacts

Invasive species in Ethiopia, particularly species like *Prosopis juliflora*, *Parthenium hysterophorus*, and *Lantana camara*, have significant social and cultural impacts that affect local communities, agricultural practices, and cultural traditions (Table 1). This discussion draws on various studies and observations to outline these impacts.

The introduction and spread of invasive species also threaten cultural practices and traditional knowledge associated with indigenous flora. Local communities have historically relied on native plants for medicinal purposes, food, and cultural rituals. The dominance of invasive species like *Parthenium hysterophorus* and *Lantana camara* has not only displaced these native species but has also diminished the cultural significance of traditional practices (Bufebo & Elias, 2018). For example, the loss of native plants used in traditional medicine has negatively affected community health practices and cultural heritage (Hailu, 2002).

Invasive species pose direct health risks to local populations. *Parthenium hysterophorus* is known to cause allergic reactions, respiratory issues, and skin problems among those who encounter it. This has resulted in increased health care costs and a decline in the overall well-being of affected communities (Pimentel *et al.*, 2000). Such health impacts can disrupt daily life and cultural activities, particularly in rural areas where access to medical facilities is limited.

The health impacts of invasive species also contribute to economic burdens. For example, exposure to *Parthenium hysterophorus* can cause allergic reactions and other health issues, increasing healthcare costs for affected households (Maishi *et al.*, 1998). The increased veterinary and medical costs associated with managing the health impacts of IAPS place additional financial strain on rural households, exacerbating their vulnerability (Haregeweyn *et al.*, 2013).

The arrival of invasive species can alter social dynamics within communities. Conflicts may arise over resource use, particularly when invasive plants occupy land traditionally used for grazing or agriculture. For instance, as *Prosopis juliflora* encroaches on pastures, competition for grazing land increases, leading to tensions between pastoralists and agriculturalists (Rezene & Taye, 2014). The perception of invasive species can also vary among community members, with some viewing them as beneficial uses, while

others see them as detrimental, leading to divisions within communities (Bufebo & Elias, 2018).

The socio-economic implications of invasive species are profound. Invasive plants not only disrupt traditional farming but also alter the resource base that local communities rely on. The loss of grazing lands due to *P. juliflora* invasions has forced pastoralist communities to relocate, exacerbating poverty and food insecurity (Abiyot & Getachew, 2006). Moreover, the health risks associated with these invasive species, such as toxicity to livestock and humans, highlight the urgent need for effective management strategies (Chinchio *et al.*, 2020).

Invasive species in Ethiopia have profound social and cultural implications, affecting livelihoods, health, cultural practices, and community dynamics. The interplay between invasive plants and local ecosystems underscores the urgency for effective management strategies that consider both ecological and socio-cultural dimensions. Addressing these challenges requires a collaborative approach involving local communities, policymakers, and conservationists to develop sustainable solutions that enhance both biodiversity and community resilience.

Impacts on Traditional Knowledge and Resource Use of Invasive Plant Species

In Ethiopia, invasive plant species (IPS) such as *Parthenium hysterophorus*, *Prosopis juliflora*, and *Lantana camara* have posed significant threats to biodiversity and local livelihoods (Mohammeda & Bahmudb, 2023). These species have been introduced through both intentional and accidental means, often leading to widespread ecological disturbances (Shiferaw *et al.*, 2018). The recognition of these species varies among local communities; many are aware of the threats posed by *P. hysterophorus* and *P. juliflora*, which are noted for their rapid proliferation and detrimental impacts on agriculture and native flora (Mohammeda & Bahmudb, 2023).

Traditional knowledge regarding the management of invasive species is crucial for developing

effective control strategies (Moon *et al.*, 2015). Local communities often possess valuable insights into the ecological roles of these species, including their uses and management practices (Caceres-Escobar *et al.*, 2019). For instance, while *P. juliflora* has been recognised for its invasive characteristics; it has also been utilised for fuelwood, fodder, and erosion control (Shiferaw & Demissew, 2023). Similarly, *L. camara* has been frequently employed as a hedge plant and for medicinal purposes, despite its invasive nature (Dereje, 2019).

However, the aggressive nature of these species often undermines traditional agricultural practices. Invasive species compete for resources, leading to reduced yields of native crops and forage, thus affecting food security (Hussain *et al.*, 2021). For example, the allelopathic effects of *P. hysterophorus* inhibit the growth of other plants, further complicating traditional farming practices (Taye & Ashenafi, 2017).

Despite the challenges posed by IPS, there are also potential benefits recognised by local communities (Poudyal *et al.*, 2020). For instance, some invasive species were used in traditional medicine or as fodder during lean seasons, indicating a complex relationship between resource use and invasion dynamics (Kannan *et al.*, 2014). This duality underscores the necessity for a nuanced understanding of how traditional knowledge can inform management practices.

Effective management of invasive species in Ethiopia must integrate traditional knowledge with scientific approaches (Tebboth *et al.*, 2020). While mechanical and chemical control methods are commonly employed, local communities often utilise hand weeding and cultural practices to manage invasive plants (Hussain *et al.*, 2021; Manning & Miller, 2011). Awareness campaigns aimed at educating communities about the ecological impacts of invasive species can facilitate more sustainable resource management.

Furthermore, collaborative efforts between government bodies and local communities are essential for developing comprehensive

management plans. Local participation in monitoring and controlling invasive species can enhance the effectiveness of management strategies and promote the conservation of native biodiversity (Stokes *et al.*, 2006).

The impacts of invasive plant species on traditional knowledge and resource use in Ethiopia are multifaceted. While these species threaten biodiversity and agricultural productivity, they also intersect with local practices and resource utilisation. To mitigate the adverse effects of invasive species, it is crucial to harness traditional knowledge in conjunction with scientific research, ensuring that management strategies are both effective and culturally relevant.

Management and Control Strategies for Invasive Plant Species in Ethiopia

Ethiopia faces significant challenges due to the proliferation of invasive alien plant species (IAPS) such as *Prosopis juliflora*, *Parthenium hysterophorus*, and *Eichhornia crassipes* (Mohammeda & Bahmudb, 2023). These species not only threaten biodiversity but also adversely affect agricultural productivity and local livelihoods (Shackleton *et al.*, 2019). The **Removing Barriers to Invasive Plant Management in Ethiopia** project highlighted the urgent need for effective management strategies to combat these invasive species.

Current management practices for addressing the spread of invasive species in Ethiopia include mechanical removal, chemical treatments, and community awareness programs (Mussa *et al.*, 2018). However, limited community involvement and insufficient resources for large-scale control efforts hinder the effectiveness of these strategies (Lindenmayer *et al.*, 2015). A concerted approach involving government agencies, local communities, and NGOs is essential to mitigate the impacts of IPS effectively.

The project emphasised integrated management strategies combining manual, mechanical, chemical, and biological control methods (Baker *et al.*, 2020). Manual removal techniques, such as

hand-pulling and cutting invasive plants, have been employed effectively, particularly for species like *Parthenium hysterophorus* (Natukunda *et al.*, 2020). This method proved labour-intensive but allowed for targeted removal without harming native flora. Mechanical control involved the use of machinery to clear larger infestations, especially in areas where manual labour was insufficient (Manning & Miller, 2011). This combination of manual and mechanical methods has been shown to reduce the density of *Prosopis juliflora* by up to 75% in affected regions (Shiferaw *et al.*, 2018).

Herbicides, particularly systemic ones, have been used to target invasive species effectively. For example, glyphosate has been applied to control *Eichhornia crassipes* in water bodies, demonstrating significant reductions in infestation levels (Karouach *et al.*, 2022). However, the project noted the importance of using chemicals judiciously to minimise non-target effects on native species and the environment.

Biological control has emerged as a promising long-term strategy for invasive plant species (Seastedt, 2015). The project aimed to introduce host-specific biocontrol agents for species like **Water Hyacinth** (Karouach *et al.*, 2022). For instance, the introduction of *Neochetina weevils* has been effective in reducing hyacinth populations in Lake Victoria and is expected to be adapted for use in Ethiopian water bodies (Addis & Desta, 2024).

Local communities have actively engaged through awareness campaigns that highlighted the ecological and economic impacts of invasive plants (Haley *et al.*, 2023). Training workshops have been organised to educate farmers and pastoralists on how to identify and manage these invasive species, fostering a sense of ownership and responsibility towards their management (Adoyo *et al.*, 2022). However, despite these efforts, several challenges hindered effective management. Firstly, many local governments faced budgetary constraints, which limited their ability to sustain management programs (Haley *et al.*, 2023). Additionally, conflicting perceptions

regarding certain invasive species, such as *Prosopis juliflora*, complicated eradication efforts, as some individuals viewed these plants as beneficial for their shade and fodder (Mohammeda & Bahmudb, 2023). Furthermore, the lack of comprehensive legislative frameworks regulating invasive species management delayed the implementation of effective control measures (Burgos-Rodríguez & Burgiel, 2020).

To address the challenges posed by these invasive species, comprehensive management strategies are essential. Current approaches, as highlighted in various studies, emphasise the need for integrated control measures that consider both the ecological and socio-economic contexts. Public awareness campaigns and community involvement are crucial for effective management (Bufebo & Elias, 2018). Moreover, the government and NGOs must coordinate efforts to develop policies that address the spread of invasive species and promote sustainable practices (Tewelde & Mesfin, 2018).

The management and control strategies for invasive plant species in Ethiopia require a multifaceted approach integrating manual, mechanical, chemical, and biological methods. Community engagement and awareness are crucial for the sustainability of these efforts. Future strategies must address resource limitations and aim to harmonise perceptions of invasive species while establishing robust legislative frameworks to support ongoing management efforts.

CONCLUSION AND RECOMMENDATION

Conclusion

This systematic review of invasive species in Ethiopia highlights significant challenges to the country's biodiversity, economy, and social structures. Main findings indicate that invasive species such as *Prosopis juliflora* and *Parthenium hysterophorus* have led to substantial reductions in native biodiversity, disrupted ecosystem functions, and created monocultures that threaten local flora and fauna. Economically, these species affect agricultural productivity, livestock health,

and water resources, resulting in estimated annual losses reaching hundreds of millions, especially in rural communities reliant on natural resources. Socially, invasive species disrupt traditional livelihoods and practices, threatening cultural identity and traditional ecological knowledge, particularly among pastoralist and agricultural communities.

Recommendations

- Implement a comprehensive approach that combines mechanical, chemical, and biological control measures tailored to specific invasive species and local conditions.
- Invest in ongoing research to assess the long-term ecological impacts of IAS and the effectiveness of various management strategies, ensuring adaptive management practices.
- Encourage partnerships between governmental organisations, NGOs, and academic institutions to create a unified front against IAS, leveraging resources and expertise effectively.
- Utilise local traditional knowledge in management strategies to enhance community resilience and engagement while respecting cultural practices.

Through prioritising these recommendations, Ethiopia can effectively mitigate the adverse effects of invasive plant species, safeguard its biodiversity, and support the socio-economic well-being of its communities.

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