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# A Review of the Long-Term Effects of Invasive Plant Species on Native Plant Community Structure and Ecosystem Functioning

**[1]Manshi Yadav, [2]Avshesh Kumar and [3]Rajkumar Yadav**

*[1,2,3]Department Of Botany ,T .D .P .G . College ,Jaunpur Affiliated To VBSP University ,Jaunpur (U.P.)222002.*

**ABSTRACT**

Globally, invasive plant species (IPS) are a major cause of ecological degradation and biodiversity loss. By altering vegetation structure, soil characteristics, nitrogen cycling, microbial diversity, and hydrological processes, they modify native plant groups and impair ecosystem resilience. Invasive plants inhibit native species and interfere with vital ecosystem services like carbon sequestration, soil fertility, pollination, and water management through resource competition, allelopathy, and habitat change. The long-term effects of invasive plant species on native vegetation and ecosystem functioning are examined in this article. It discusses the impact of climate change on invasion dynamics while highlighting the main mechanisms of invasion, such as competitive superiority, enemy release, and plant–soil feedbacks. In order to preserve biodiversity and sustain ecosystem functioning, the review highlights the significance of integrated management and ecological restoration.

**KEYWORDS**
Plant-soil feedback, allelopathy, nutrient cycling, biological invasion, native vegetation, invasive plant species, biodiversity loss, ecosystem services, and restoration ecology.

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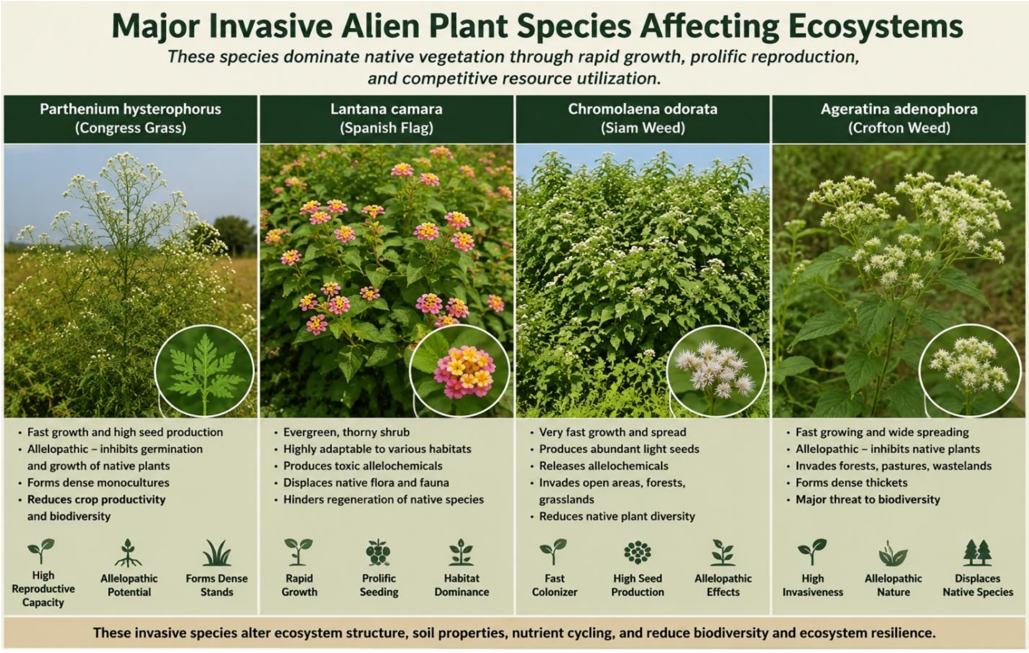
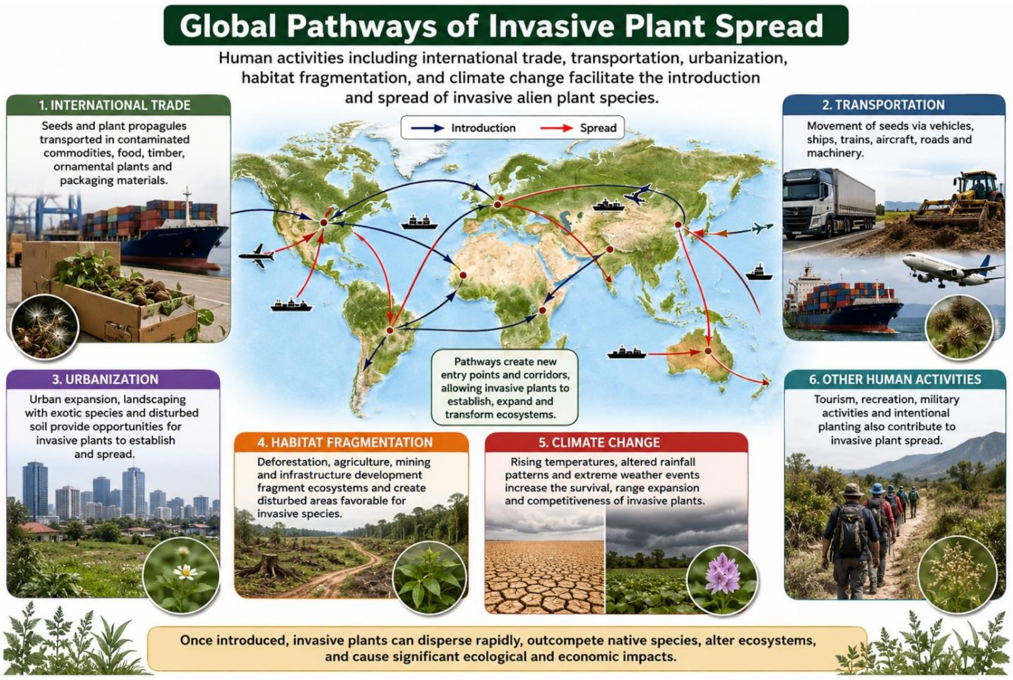
## 1. Introduction

One of the biggest environmental problems of the twenty-first century is acknowledged to be biological invasions. Invasive alien plant species (IAPS) are a major danger to agricultural productivity, environmental stability, biodiversity, and sustainable use of natural resources. Globalization, international trade, urbanization, habitat fragmentation, and climate change are examples of human actions that have expedited the introduction and global spread of invasive plant species. Once established, these species can dominate native ecosystems for extended periods of time due to their rapid growth, high reproductive capacity, phenotypic plasticity, and effective resource consumption.

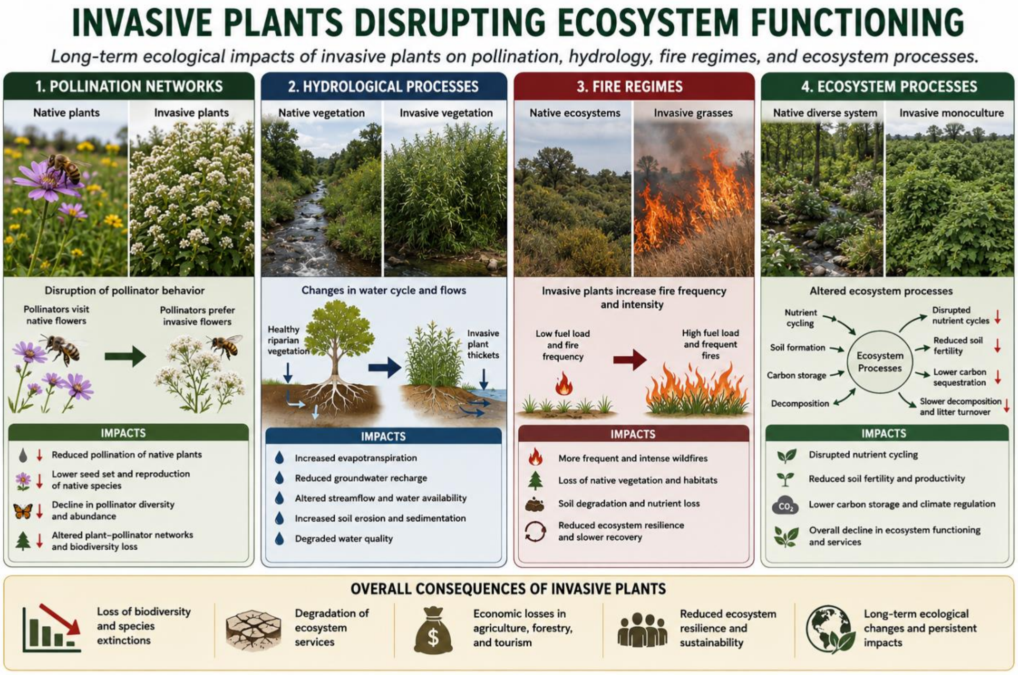



Invasive plant species cause long-lasting ecological changes that go beyond direct competition with native plants, in contrast to transient environmental disturbances. They change the hydrological processes, microbial populations, soil physicochemical characteristics, vegetation composition, ecosystem structure, nutrient cycling, and species interactions. As a result, invasive plants are acknowledged as one of the five main causes of biodiversity loss worldwide, along with pollution, habitat destruction, climate change, and overuse of natural resources (Pyšek et al., 2020; IPBES, 2023).

By preserving biodiversity, promoting wildlife habitats, controlling nutrient cycling, preserving soil fertility, halting erosion, and maintaining ecosystem productivity, native plant communities serve as the ecological cornerstone of terrestrial ecosystems (Tilman, 1999). However, invasive plants frequently create dense monospecific stands in place of varied native vegetation, which lowers ecological resilience and habitat diversity. Even once invasive species are eliminated, these structural alterations may last for decades, making ecosystem regeneration more challenging (Ehrenfeld, 2010).



The astonishing success of invasive plant species can be explained by a number of ecological theories. According to the Enemy Release Hypothesis, invading plants can devote more resources to growth and reproduction after escaping their native herbivores and pathogens (Keane & Crawley, 2002). The Novel Weapons Hypothesis, which postulates that invasive species produce allelochemicals that are foreign to native plants, is another generally accepted theory. According to Callaway and Ridenour (2004), these substances facilitate invasion success by inhibiting plant growth, suppressing seed germination, and lowering the competitiveness of native vegetation. Another significant way that invasive plants subjugate native communities is through competition for vital resources like sunshine, water, nutrients, and space. Numerous invasive species have large root systems, quick growth rates, excellent nitrogen uptake, and great photosynthetic efficiency. According to Levine et al. (2003), these traits limit native plants' access to resources, which lowers their chances of survival, reproduction, and species richness. Furthermore, allelopathic substances released by invasive species such Parthenium hysterophorus, Lantana camara, Ageratina adenophora, and Chromolaena odorata prevent native plant establishment and produce long-lasting plant-soil feedbacks that encourage additional invasion (Inderjit & Duke, 2003).




Long-term incursions also drastically alter subterranean ecological processes and soil characteristics. Nutrient cycling and microbial activity are impacted by variations in litter quality, soil pH, organic carbon content, moisture, nitrogen availability, and phosphorus dynamics. By altering root exudates and litter inputs, invasive plants often modify bacterial, fungal, and mycorrhizal communities, resulting in soil conditions that favor invasive species while decreasing native plant performance (Ehrenfeld, 2003; van der Putten et al., 2007). These interactions between plants and soil increase the persistence of invasions and decrease the chance for ecosystem recovery. Invasive plants alter hydrological regimes, fire frequency, pollination networks, and trophic interactions, all of which have an impact on ecosystem functioning beyond soil processes. Dense invasive vegetation can alter streamflow, increase soil erosion, decrease groundwater recharge, and increase evapotranspiration. While invasive floral plants alter pollinator behavior by drawing pollinators away from native species, hence decreasing native plant reproduction and biodiversity, some invasive grasses encourage more frequent and intense wildfires (Brooks et al., 2004; Morales & Traveset, 2009).

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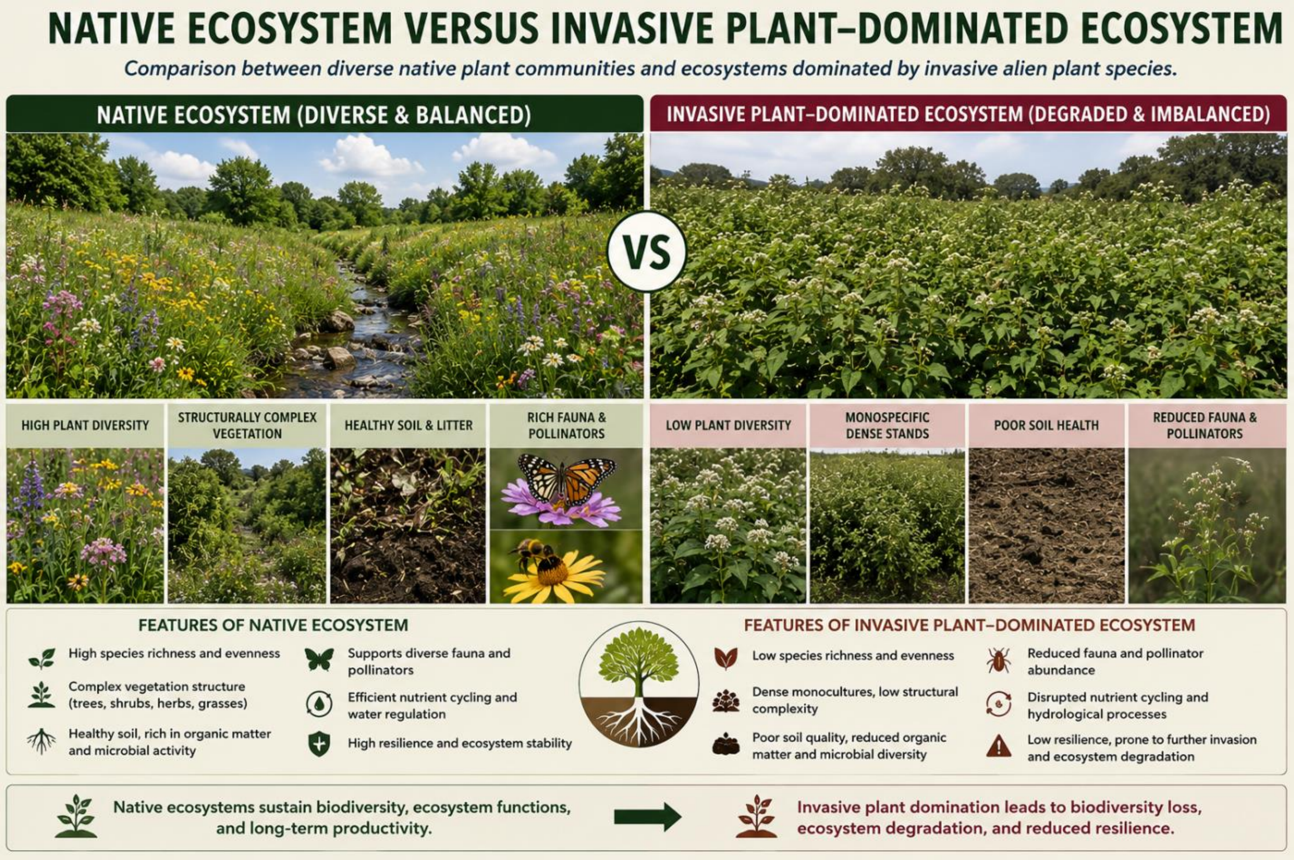
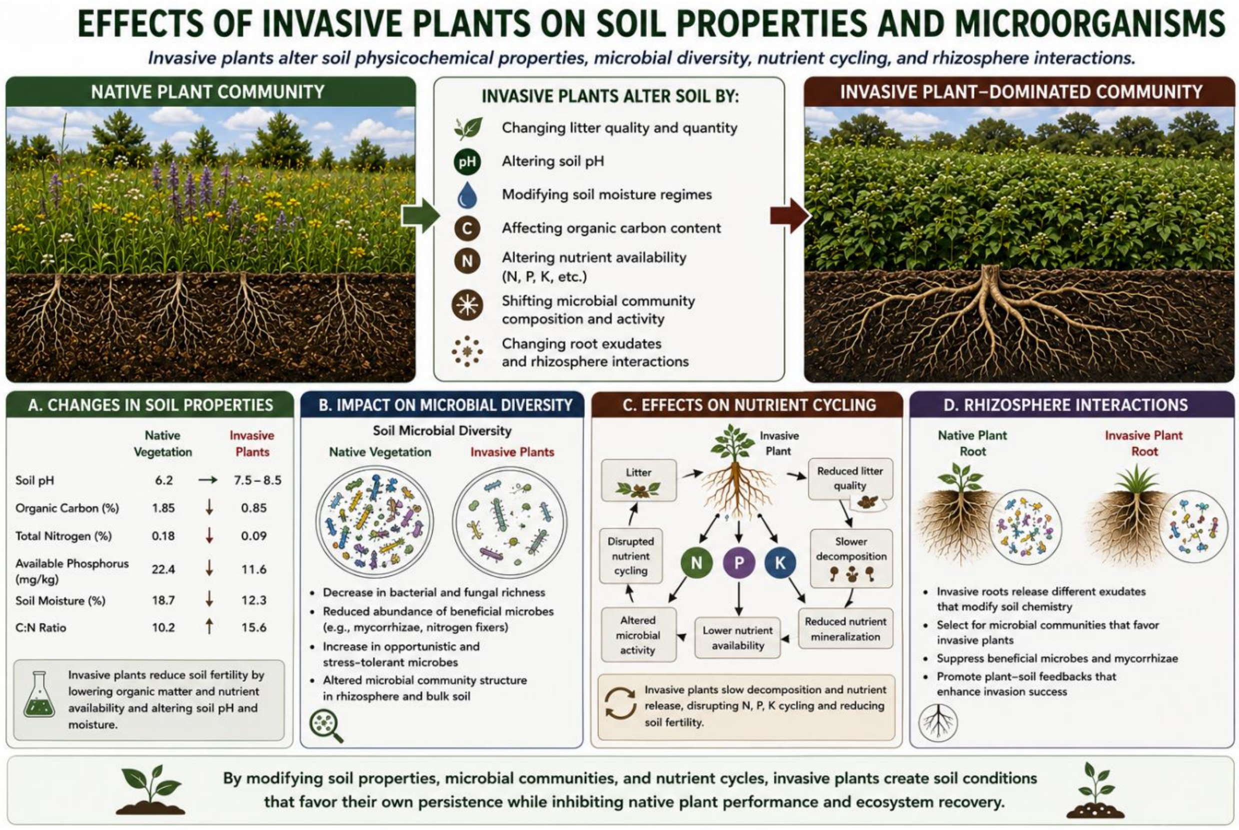



By fostering the growth of invasive species, climate change exacerbates biological invasions. Many invasive species are more likely to establish and spread when native ecosystems are more vulnerable due to rising temperatures, changing rainfall patterns, increased atmospheric carbon dioxide concentrations, and an increase in the frequency of extreme weather events (Bellard et al., 2013). In addition to their negative effects on the environment, invasive plant species have significant financial implications due to decreased agricultural output, higher management costs, deterioration of ecosystem services, and losses in grazing and forestry systems (Diagne et al., 2021). Because invasive plants leave behind permanent ecological legacies, such as altered soil characteristics, transformed microbial populations, and long-lived seed banks that promote reinvasion, restoring invaded habitats is frequently difficult.




The knowledge and tracking of biological invasions have been significantly enhanced by recent developments in molecular ecology, remote sensing, ecological modeling, and environmental DNA. However, there are still a lot of unanswered questions about how invasive plants, soil microbes, climate change, and ecosystem multifunctionality interact over the long run. With an emphasis on the mechanisms of invasion, ecological ramifications, and future research priorities for successful biodiversity conservation and sustainable ecosystem management, this review attempts to summarize the most recent scientific data on the long-term effects of invasive plant species on native plant community structure and ecosystem functioning.

## Conclusion

Long-term alterations in native plant communities and ecosystem functioning are caused by invasive plant species, which are significant contributors to biodiversity loss and environmental degradation. Invasive plants decrease native species diversity, ecosystem resilience, and vital ecosystem services through resource competition, allelopathy, changes in soil characteristics, microbial communities, and nutrient cycling (Ehrenfeld, 2010; van der Putten et al., 2007). Additionally, they have an impact on pollination, carbon storage, water control, and ecological stability; their expansion and effects are predicted to worsen due to climate change (Bellard et al., 2013).

Early discovery, ongoing observation, integrated control strategies, native vegetation restoration, and ecosystem rehabilitation are all necessary for effective management. In order to better control invasive species, future research should concentrate on long-term ecological monitoring, plant–soil interactions, the consequences of climate change, and cutting-edge technologies like remote sensing, GIS, and environmental DNA (eDNA). To preserve biodiversity and guarantee sustainable ecosystem functioning, cooperative conservation efforts are crucial.

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