THE MULTIFUNCTIONAL ROLE OF STINGING AND DEAD NETTLES IN SUSTAINABLE AGROECOSYSTEMS

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REVIEW

Abstract

Stinging nettle (Urtica dioica) and dead nettle (Lamium spp.) has exhibited significant potential in sustainable agriculture, yet their roles remain underexplored in scientific literature. Our research study investigates how nettles will contribute to these aspects of agriculture and hypothesize that these plants provide multifunctional benefits to agriculture that will enhance sustainability. Through a comparative search we determine that between Urtica dioica and Lamium spp. they have noticeable differences and similarities in their habitat preference, soil requirements and climatic adaptability establishing them as valuable indicators species. The practical applications of nettle in organic farming and agroforestry, particularly in permaculture and regenerative agricultural practices are assessed and the production of all natural fertilizers and biostimulants from nettles is evaluated currently. Furthermore, the effects of medicinal and nutritional values of nettles in sustainable agricultural contexts are also examined within the current research. The aim of this study is to investigate the contributions of stinging nettle and dead nettle to soil health, biodiversity and eco-friendly farming practices. Through doing so this study will seek to provide evidence-based insight into how these plants can act as key components of sustainable agricultural systems that will potentially lead to novel concept to be introduced into crop management, soil fertility and biodiversity conservation within agroecosystems.

Keywords: foods of the future, bio-fertilizers, natural bio-stimulants, ecological indicators

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INTRODUCTION

Agriculture has greatly expanded due to technological progress and supportive government policies, enhancing efficiency but also prompting worries about excessive resource use and environmental damage. As a result, there's a strong focus on sustainable agriculture, aiming to balance environmental care, economic stability, and social fairness to maintain resources for future generations (Gamage et. al., 2024).

Sustainable agriculture plays a crucial role in ensuring that everyone has steady access to enough nutritious and safe food, not just now but also economically stable for the future (Muhie, 2022).

Sustainable agriculture stands at the forefront of global efforts to devise farming practices that are ecologically sound, economically viable, and socially equitable. Within this context, stinging nettle (*Urtica dioica*) and dead nettle (*Lamium spp.*) emerge as not merely botanical curiosities but as pivotal components of agroecological research. These plants, historically overlooked, are now recognized for their robust adaptability and minimal cultivation requirements, positioning them as ideal candidates for sustainable agricultural practices.

Stinging nettle and dead nettle play a crucial role in promoting sustainable farming. They help improve soil quality, support more diverse plant and animal life, and lessen the need for chemical fertilizers and pesticides. This makes it really important to explore their benefits further (Pimentel, 1997, Power, 2010).

It is crucial that we promote sustainable agriculture to address big challenges that currently threaten standard farming practices and the health of ecosystems globally. One of the central issues is soil degradation: conventional farming methods strongly detriment soil health and productivity. Old-style farming, relying heavily on tiling and relying too much on chemicals, exacerbates this problem. Tilling displaces the delicate balance of soil life and results in erosion and loss of important nutrients very often (Earth org, n.d.)

The simplification of landscapes and reliance on one crop alone strips agricultural

lands of essential natural diversity, impeding important ecological actions such as pollination and pest control. Farmers further miss resilience against pests and changes in weather. This undermines crop stability and health as well as the health of our farming ecosystems (My Good Planet, n.d.).

The heavy financial burden presses small farmers who often lack means to switch to newer techniques that are more sustainable. This situation underlines the crucial need to make a move towards practices that are both more sustainable and also economical, reducing costs and thriving through changes in market and climate. (Terán-Samaniego et al., 2025).

Given breadth of challenges, there is powerful scholarly and practical rationale for adopting sustainable farming methods. These strategies not only reduce present environmental and economic stress but also assure long term food and viability in farming communities (Sithole et al., 2024).

Recent signs point to nettles as attractive for sustainable farming as these plants offer ecological benefits and light maintenance (Venter de Villiers et al., 2024).

The ecological versatility of nettles extends beyond their traditional uses; they are renowned for their bioactive compounds, which have utility in diverse sectors such as medicine, textiles, and sustainable bioeconomy's. Particularly, stinging nettles are noted for their ability to enhance soil fertility through dynamic nutrient cycling and for fostering biodiversity by providing essential habitat and resources for a multitude of beneficial insects (James at al., 2015).

The aim of the study is to assess stinging nettle and dead nettle contributions to enhancing soil health, supporting biodiversity, and promoting eco-friendly farming practices. By examining their utility in organic farming, as natural fertilizers and bio-stimulants, and their medicinal and nutritional benefits. The research seeks to validate the potential of nettles to aid in the development of climate-resilient and sustainable agricultural systems and answers to the main questions: what is the contribution of both stinging and dead nettles to agro-ecosystem sustainability and do they have multifunction ability as plants of the future?

MATERIAL AND METHOD

In order to answer the questions of the present study were analyzed more than 100 research papers as well as the European and USA databases, the most important data were selected.

RESULTS AND DISCUSSIONS

Urtica dioica, often known as stinging nettle or common nettle, is a versatile herb with a long history of use as a wild green and for therapeutic purposes. Originally from Eurasia, this species has expanded across a wide range of habitats, including North Africa, North America, Europe, and various parts of Asia (Klimešová, 1995).

Lamium spp., often designated as dead nettles, constitute a genus of flowering plants distinguished by their misleading resemblance to stinging nettles, albeit devoid of the typical sting. These plants flourish in temperate zones globally, like North Africa, Europe and Asia and are esteemed for their aesthetic qualities (Wieczorkowska et al., 2022).

To present the differences and similarities between *Urtica dioica* and *Lamium spp*., was created Table 1, which reviews the main aspects related to: habitat, reproduction, pollinators, soil requirements and health effects, climatic adaptability, use in organic farming and permaculture, use in agroforestry, production of natural fertilizers, production of biostimulants, medicinal and nutritional value, biodiversity contribution, ecosystem stability, environmental impact, nutrient composition, traditional uses in food, medicinal properties and common uses in medicine.

Table 1

Similarities and differences between *Urtica dioica* and *Lamium spp*.

Particularity	Stinging Nettle (*Urtica dioica*)	Dead Nettle (*Lamium spp.*)
Growth Habit	Perennial herb (Kregiel et al., 2018)	Perennial/Annual herb (Salehi et al., 2019)
Reproduction	Rhizomes and seeds (Kregiel et al., 2018)	Seeds and vegetative distribution (Rudy et al., 2004)
Pollinators	Wind-pollinated (Tiotiu et al., 2016)	Insect-pollinated (Sulborska et al., 2014)
Habitat Preference	Moist, fertile soils, woodlands, riverbanks (Maričić et al. 2021)	Moist, fertile and unfertile soils, shaded, pastures, gardens (Mohler et al., 2021)
Soil Requirements	Fertile, rich in nitrogen and well-drained (Kregiel et al., 2018)	Fertile, loamy, moist as well as drained soil (Mohler et al., 2021)
Soil Health Effects	Enhances microbial activity, improves soil structure (Kregiel et al., 2018)	May lead to soil acidification and loss of biodiversity (Rudy et al., 2004)
Climatic Adaptability	From temperate to mild-cold climates (Opačić et al., 2024)	Temperate to mild climates (Wieczorkowska et al., 2022)
Use in Organic Farming	Natural pest control and composting (Baraa, 2022)	Potential ground cover and prevention of soil erosion (Rudy et al., 2004)
Use in Permaculture	Increases soil health, providing mulch and maintaining soil moisture (Garmendia et al., 2018)	Potential soil nitrogen conservation, due to the colored flowers a recommended pollinator (Rudy et al., 2004)
Use in Agroforestry	Improves soil health, promotes attraction of beneficial insects(James et al., 2015)	Improves soil health and provides nectar for beneficial insects (Rudy et al., 2004)
Production of Natural Fertilizers	Used for compost and traditional liquid fertilizers in many countries (Garmendia et al., 2018)	Unused as fertilizer, even so possible one (Salehi et al., 2019)
Production of Bio-stimulants	Stimulates plant growth, intensivists resilience (Maričić et al. 2021)	Mild stimulant properties, aids soil retention and health(Rudy et al., 2004)
Medicinal Value	High in antioxidants, anti-inflammatory properties (Bhusal et al., 2022)	Traditionally used in herbal medicine for hypertension or inflammation (Akkol et al., 2008)
Nutritional Value	Abundant in vitamins (A, C, K), minerals (iron, calcium) (Bhusal et al., 2022)	Rich in flavonoids, insufficient studied nutritional value (Salehi et al., 2019)
Biodiversity Contribution	Supports insects, birds, and pollinators, contributes to ecosystem stability (James et al., 2015)	Excellent for attracting bees and butterflies, improving ecosystem stability (Rudy et al., 2004)
Ecosystem Stability	Enhances soil quality, prevents erosion(Garmendia et al., 2018)	Provides ground cover, prevents soil compaction (Plantura, n.d., Dead Nettles section)
Environmental Impact	Eco-friendly, biodegradable(Garmendia et al., 2018)	Can cause water pollution, soil degradation (Plantura, n.d., Dead Nettles section)
Common Uses in Food	Utilized in soups, teas, and as a leafy vegetable (Shonte et al., 2017)	Used in teas, salads, and herbal remedies (Teklehaymanot, 2010)
Medicinal Properties	Anti-inflammatory, diuretic, antihistamine(Kregiel et al., 2018)	Slight astringent, anti-inflammatory (Akkol et al., 2008)
Common Uses in Medicine	Treats arthritis, allergies, and urinary tract issues (Kregiel et al., 2018)	Traditionally used for wound healing and mild infections (Salehi et al., 2019)

Recent signs point to nettles as attractive for sustainable farming as these plants offer ecological benefits and light maintenance (Venter de Villiers et al., 2024).

There are significant ecological and economic motivations for cultivating *Urtica dioica* and *Lamium spp* due to its broad spectrum of potential applications and its crucial role in sustaining local plant and animal life. Among the species of the genus *Urtica*, this perennial herb stands out for its significant contributions to both environmental conservation and human benefits (Jaiswal, V., & Lee, H. J. 2022; Salehi et al., 2019).

Urtica dioica (stinging nettle) and *Lamium spp*. (dead nettles), while sharing common morphological features such as toothed, heart-shaped leaves and square stems, presenting significant botanical distinctions and differing impacts upon human contact. *Urtica dioica*, part of the *Urticaceae* family, is characterized by its fine hairs that inject irritants, causing a stinging sensation, whereas *Lamium spp*., belonging to the *Lamiaceae* family, lacks such attributes,

rendering it harmless (Ensikat et al., 2021; Salehi et al., 2019).

In terms of floral characteristics, *Urtica dioica* produces inconspicuous greenish or brownish flowers. Contrarily, *Lamium spp*. exhibits more visually appealing flowers that are typically pink, white, or purple, aligning with aesthetic features commonly found in the mint family. The root system of *Urtica dioica* is notably more aggressive, contributing to its rapid spread and potential invasiveness, a stark contrast to the less aggressive nature of *Lamium spp*., which is often favored in garden settings for ground cover (Taylor, 2009; New York Botanical Garden, 2018).

Both *Urtica dioica* and *Lamium spp*. demonstrate a preference for moist, fertile soils, yet they differ in their specific ecological niches and soil nutrient requirements. *Urtica dioica* is typically found in nitrogen-rich soils close to human activity areas, such as waste grounds and waterways (Kregiel et al., 2018).

On the other hand, *Lamium spp.* flourishes in shaded environments, indicative of its adaptability to woodland and shaded garden habitats (Rudy, 2004).

Climatically, *Urtica dioica* is robust, capable of thriving across a broad temperature range and diverse environmental conditions, which speaks to its widespread distribution in temperate zones globally (Opačić et al., 2024). *Lamium spp*., while also temperate, prefers somewhat warmer and more stable temperature conditions (Rudy 2004).

Stinging nettles reproduce through rhizomes and spread and disperse seeds (Kregiel et al., 2018). Dead nettles reproduces in the same manner: by dispersing seeds and vegetatively too but only locally (Rudy et al., 2004).

Urtica dioica are pollinated by the wind, typically blooming from April through October (Tiotiu et al. 2016). *Lamium Spp*. depends on insects for pollination, has to interact with animal pollinators (Sulborska et al., 2014).

Maričić, et al. in 2021 showed the effectiveness of nettle extract in enhancing soil fertility, stating that leaf fertilization with it was effective in improving plant growth parameters. Additionally, aqueous nettle extracts had a beneficial impact on the accumulation of iron in the leaves (Maričić et al. 2021).

Stinging nettles and dead nettles hold significant potential for integration into organic farming and agroforestry systems, recognized for their multifunctional roles in enhancing agricultural sustainability (Baraa, 2022; Gallandt, 2014).

Stinging nettles are a potent source of essential nutrients, notably nitrogen, phosphorus, and potassium, which are crucial for plant growth (Bhusal et al., 2022). The practice of fermenting nettles to create a nutrient-rich liquid fertilizer is well-used. This organic fertilizer provides a cost-effective alternative to synthetic inputs, enriching soil fertility and promoting robust plant health (Garmendia et al., 2018).

Using nettle aligns with sustainable practices by utilizing overlooked resources. Aqueous nettle extract, which is abundant in nitrogen, phosphorus, calcium, magnesium, and iron, fosters plant development and can be employed as fertilizers or pesticides, thus integrating into sustainable organic farming (Nygaard et al. 2011).

Dead nettles having a ground cover option can help in decrease of soil erosion (Rudy et al, 2004).

Stinging nettles improve soil health by providing mulch and also they help retain soil moisture (Kregiel et al., 2018). Dead nettles retain soil nitrogen too and it attracts pollinators owing colorful flowers (Mohler et al., 2021).

Stinging nettle is particularly known for strengthening microbial activity and improving soil texture (Kregiel et al., 2018). On the other hand, dead nettles has the potential to lead to acidic soil which can result in loss of biodiversity (Rudy et al., 2004).

According to Bhusal et al., 2022 *Urtica dioica*, exhibits properties that are antioxidative, antimicrobial, and beneficial to health in its roots, stems, and leaves (Bhusal et al., 2022).

According to Wieczorkowska et al., 2022, dead nettles was used for treating menstrual dysfunction and inflammation (Wieczorkowska et al., 2022). *Lamium spp* have been used for treating high blood pressure (Akkol et al., 2008).

Stinging nettle is abundant in important nutrients like vitamins A, C, K and minerals: calcium, magnesium, iron (Bhusal et al., 2022). Dead nettles contain flavonoids, anthocyanins, and phenylpropanoids, still under-researched in terms of nutritional value (Salehi et al., 2019).

The incorporation of stinging nettles can serve as a biocontrol strategy, leveraging their strong odor to repel harmful pests while attracting beneficial insects. This natural pest

management aligns with organic farming principles, reducing reliance on chemical pesticides and enhancing biodiversity (James et al., 2015).

The floral characteristics of *Lamium spp*. are particularly attractive to bees and other pollinators, which are vital for the pollination of many agricultural crops. Enhancing pollinator presence helps increase crop yields and is crucial for the sustainability of food production systems (Rudy et al., 2004).

A quantitative study on consumer attitudes towards stinging nettle, known locally as "Samma," was carried out in Ethiopia. Stinging nettles are favored by local communities for their multiple uses, including food, medicinal benefits, livestock feed, and the environmental services they offer (Shonte et al., 2017).

It's important to note that the use of dead nettles as a food resource is an essential aspect of the traditions of indigenous communities living in the rainforests of Africa and South America (Teklehaymanot, 2010).

Urtica dioica leaves contain histamine, which might seem unsuitable for allergy treatment. However, histamine has already been used to manage severe allergy symptoms (Kregiel et al., 2018). *Lamium spp*. showed impressive anti-inflammatory and pain-relieving properties (Akkol et al., 2008).

The most recognized health benefit of using *Urtica dioica* is activity against Benign Prostatic Hyperplasia (BPH), as well as urinary tract infections. Herb extract of Urtica plants is useful for bladder disorders, reduces postoperative blood loss, and prevents hemorrhagic and purulent inflammation following adenectomy (Kregiel et al., 2018).

Lamium spp. have been traditionally employed worldwide in traditional medicine to treat various conditions such as fractures, hypertension, gynecological disorders, and respiratory issues. Additionally, preparations from *Lamium* plants exhibit a broad spectrum of activities, including anti-inflammatory, antihypertensive, wound healing, expectorant, and analgesic effects (Salehi et al., 2019).

Cultivation of medicinal plants today is not only a promising alternative to wild harvesting, but it also constitutes a significant economic sector providing raw materials for the pharmaceutical, cosmetic, and food industries. The economic viability of cultivating medicinal plants is competitive with the profits achievable from standard field crops (Dajic-Stevanovic et al., 2015). Nettle, in particular, offers economic benefits and substantial commercial potential due to its minimal input requirements and various uses within a single harvest, making it an appealing crop for farmers (Sadik, 2019). It demands low agronomic input, making it highly suitable for organic farming. As a perennial crop, it helps in reducing soil erosion and, as a nitrophilous species, it aids in restoring over-fertilized soils (Bacci et al., 2011).

CONCLUSIONS

Sustainable agriculture is crucial to balancing ecological health, economic stability and social equity, ensuring resources for future generations. Essential for ensuring constant access to nutritious and safe food and maintaining long-term economic stability.

Both stinging nettle (*Urtica dioica*) and dead nettle (*Lamium spp*.) are integral to sustainable agriculture due to their resilience, adaptability and minimal cultivation requirements. Stinging nettle and dead nettle have numerous benefits in agricultural practices: they improve soil quality and biodiversity; reduce dependence on chemical fertilizers and pesticides; provide essential nutrients, promote microbial activity and prevent soil erosion; serve as natural pest control, compost, bio-stimulants and enhance pollination and ecological stability.

Nettles contribute significantly to environmental conservation and provide multiple economic benefits by requiring minimal agronomic inputs. They can serve as profitable crops due to their diverse applications in medicine, food, textiles, and as bioactive substances.

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