

Fermented Soybean and Resilient Food Systems: A Pathway to Community Growth in Nagaland.

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Abstract

Today, we are faced with challenges as we strive to achieve livelihoods. One particular resource that stands out in Northeast India is fermented soybeans, which holds potential. In the region of Nagaland, fermented soybeans can contribute significantly to both development and ecological balance. The significance of fermented soybeans stems from the region's agrobiodiversity and indigenous knowledge. The traditional practice of fermenting food not only enhances the value of soybeans but also extends their shelf life, thereby ensuring food security. This community-based approach highlights the growing focus on sustainability by minimising impacts while enhancing livelihoods. The cultural heritage of Nagaland is deeply intertwined with its cuisine, presenting an opportunity to preserve traditions while fostering community growth. Fermented soybeans create income-generating opportunities for communities. By combining insights with wisdom, targeted policies that empower stakeholders and facilitate knowledge exchange are vital for research on processing methods and market expansion. This research holds promise for value-added products and increased opportunities. Fermented soybeans have a role in people's lives in Nagaland, Northeast India. They offer benefits regarding nutrition, culture and the environment, making them an excellent choice for improving community nutrition resilience. Foods, especially fermented soybeans, can potentially contribute to socioeconomic development.

Keywords : Sustainable livelihoods, Fermented soybean, Northeast India, Community development, Traditional Food, Indigenous knowledge systems.

Introduction

In the picturesque region of Nagaland, in the northeastern corner of India, the timeless practice of fermenting soybeans transcends the boundaries of tradition. Beyond being a culinary delight, fermented soybeans embody a remarkable convergence of indigenous knowledge, sustainable livelihoods, and community development (Ajungla et al. 2020a). Against this backdrop, this study delves into the intricate web of relationships that arise from the cultivation and consumption of fermented soybeans, with a specific focus on their

environmental implications. We aim to assess the ecological impact of Nagaland's expanding fermented soybean production, scrutinising the intricate dance between agrobiodiversity, land use, and ecological balance. Through a comprehensive analysis, we aim to quantify changes and propose sustainable cultivation practices that guide Nagaland towards a more resilient and harmonious food system.

The cultivation and utilisation of fermented soybeans have gained significant attention in recent years, particularly in Nagaland. This

burgeoning interest stems from recognising the potential contributions of fermented soybeans to various facets of the local landscape, ranging from socioeconomic development to cultural preservation (do Prado et al. 2022). One prominent dimension of this phenomenon that has captured the spotlight is the environmental sustainability of fermented soybean production in Nagaland.

This research paper aims to systematically examine the environmental sustainability of fermented soybean production in Nagaland, specifically emphasising its impact on agrobiodiversity and ecological balance. This study sheds light on the complex interplay between agricultural practices, the environment, and the broader implications for local communities and the ecosystem.

Fermented soybean products have long been a cornerstone of dietary traditions in various parts of the world, especially in regions like Nagaland. With its high protein content, versatility, and numerous health benefits, fermented soybean has become a nutritional staple and a symbol of cultural identity (Ajungla et al. 2020b). As global awareness regarding sustainable and resilient food systems increases, there is growing interest in the potential of fermented foods, like soybeans, to address both food security and environmental sustainability concerns. However, with any agricultural or food production system scaling up, inevitable ecological considerations must be evaluated. To appreciate the significance of this study, it is essential to recognise the multifaceted nature of fermented soybean production in Nagaland. The region's rich agrobiodiversity, deeply rooted indigenous knowledge, and traditional food fermentation practices have contributed to the emergence of fermented soybeans as a pivotal resource. Fermented soybeans are not merely a source of sustenance; they also play a crucial role in the

cultural heritage of Nagaland, providing a unique opportunity to preserve traditions while fostering community growth (Singhal et al. 2021).

However, as the popularity and scale of fermented soybean production continue to rise, there is a growing need to assess its environmental implications critically. This study considers the intricate relationship between land use, biodiversity, and overall ecosystem health after increased soybean cultivation. By doing so, it aims to address a significant gap in current knowledge regarding the sustainability of this practice.

Soybeans, a major global crop, have been increasingly recognised for their nutritional value and potential in sustainable agricultural practices. Fermentation of soybeans enhances their nutritional profile, making them a desired food source in many cultures (Anderson et al. 2019). Nagaland, a northeastern state in India, has seen a surge in fermented soybean production due to its cultural significance and increasing market demand. As with many agricultural practices, the intensification and scaling up of production can have profound environmental impacts. Agrobiodiversity, which refers to the variety and variability of plants, animals, and microorganisms used in agriculture, is pivotal in ensuring ecosystem resilience and adaptability (Borsari, 2022). Understanding how scaling up fermented soybean production might affect the intricate balance of Nagaland's unique ecosystem is crucial. While fermented soybean production offers economic and nutritional benefits to the region of Nagaland, there are growing concerns about its environmental sustainability, especially its potential impact on local agrobiodiversity and the broader ecological balance.

Problem Statement: While the advantages of fermented soybean are evident in nutrition and cultural significance, the environmental implications of scaling up its production remain

relatively unexplored. Specifically, how might an increase in soybean fermentation production impact the agrobiodiversity of Nagaland? What potential long-term effects could this practice have on the local ecosystem, especially when considering land use, water resources, and waste management? The challenge lies in balancing the socio-economic benefits of increased production with the preservation and health of the environment.

While much is said about the potential of fermented soybeans in Northeast India, particularly in Nagaland, for their contribution to development, ecological balance, food security, and cultural practice preservation, there appears to be a lack of specific research addressing the sustainability and environmental impact of scaling up fermented soybean production and its integration into local livelihoods. The importance of sustainability is discussed but does not delve into the ecological implications of increased soybean fermentation and its potential long-term effects on agrobiodiversity and the ecosystem. Exploring this aspect and the socioeconomic benefits would be crucial to developing comprehensive strategies for maximising the positive impact of fermented soybeans in the region while minimising potential negative consequences. Therefore, a research gap exists in understanding the broader environmental sustainability considerations and the ecological implications of promoting fermented soybean production and consumption in Northeast India.

Significance: Addressing these concerns is paramount for several reasons. Firstly, understanding the environmental ramifications ensures that Nagaland's rich agrobiodiversity, integral to the region's ecological balance, is not inadvertently compromised. Secondly, for local communities that rely heavily on the land and its resources (Yadav & Sharma, 2019), balancing

economic growth and environmental stewardship is essential to ensuring a sustainable and prosperous future. By proactively assessing and addressing the ecological implications of fermented soybean production, we can pave the way for more informed and sustainable practices that benefit both people and the planet. Besides, global attention is shifting towards sustainable agriculture and conservation (Schattman et al. 2023). So, this kind of study can provide valuable insights and lessons for other regions facing similar challenges.

Research Objectives :

1. To review and synthesise existing literature, theories, and conceptual frameworks related to the following aspects of Nagaland:
 - i. Assessment of land use dynamics for Soybean Cultivation.
 - ii. The impact of increased soybean cultivation on local agrobiodiversity and overall ecosystem health.
2. To propose sustainable cultivation practices that mitigate potential negative environmental consequences while supporting the continued growth of fermented soybean production livelihoods.

The following specific objectives underpin the study:

1 a) Assessment of Land Use Dynamics for Soybean Cultivation

Nagaland, a mosaic of pristine forests and intricate agricultural lands, has undergone transformative land use dynamics over the past few decades, predominantly influenced by shifting cultivation, agricultural intensification, and urban sprawl (Hiese et al. 2020a). These shifts, marked by a move from traditional jhum cultivation systems to more settled farming practices and increasing

urbanisation, are having profound impacts on the state's ecological balance and cultural heritage (Das, 2022, 2022; Debojyoti Das, n.d.; Hiese et al. 2020b; Kumar et al. 2016; M. Longchar, 2013). The land is the essential and inseparable domain of the Naga tribe (Ringkahao Horam, 2018).

The traditional jhum, slash-and-burn agriculture, has been integral to Nagaland's agrarian identity for generations. However, the increasing pressure to meet food and economic demands has prompted many to abandon this cyclic and sustainable practice in favour of permanent cultivation, often leading to deforestation and loss of biodiversity (A. Singh, 2019; Karim & Mansor, 2011; Longshibeni N Kithan, 2015).

Simultaneously, Nagaland's urban areas, with Kohima and Dimapur at the forefront, are expanding at an unprecedented rate. This urbanisation has led to land being repurposed for infrastructural developments, often at the expense of vital green spaces and indigenous habitats (Jamir, 2021).

The resultant changes in the land-use mosaic are not just environmental. The societal implications, particularly for indigenous communities whose lives and livelihoods are deeply intertwined with the land, are profound. The challenge for Nagaland now lies in harmonising its developmental aspirations with the pressing need for environmental stewardship and cultural preservation (Hiese et al. 2020c; Lawrence et al. 2019).

1 b) Assessment of The Impact of Increased Soybean Cultivation on Local Agrobiodiversity and Overall Ecosystem Health in Nagaland.

Nagaland, an ecologically rich state in Northeast India, is currently facing ecological and

agricultural shifts due to the increased cultivation of soybeans. While soybeans serve as a pivotal crop for economic and nutritional purposes in the region, their burgeoning cultivation is raising significant concerns regarding the preservation of local agrobiodiversity and the health of the broader ecosystem (Hiese et al. 2020d; Rodrigues & Miranda, 2021a; Solo & Kikhi, 2021).

Nagaland's inherent agrobiodiversity, characterised by its diverse indigenous crops, is a testament to its rich ecological tapestry. However, the emphasis on soybean monoculture threatens this rich diversity. With more land dedicated to soybean cultivation, there is a palpable reduction in the variety of indigenous crops, which can threaten plant diversity and the myriad of organisms dependent on these native plant species. In the long run, this shift can affect pollinators, certain insect species, and specific bird populations integral to the local ecological chain (Jones et al. 2021). As mentioned above, this paper highlights the potential threat to Nagaland's agrobiodiversity due to the emphasis on soybean monoculture.

The monoculture practice used in cultivating genetically modified crops can increase the risk of herbicide tolerance and insecticide resistance, potentially impacting the food web and biodiversity (Chaurasia et al. 2020). The underutilisation of agrobiodiversity in national food systems is emphasised, indicating a need to prioritise diverse crop cultivation (Jones et al. 2021). These findings suggest that the shift towards soybean monoculture in Nagaland may threaten the region's rich agrobiodiversity and the organisms dependent on native plant species.

The study shows that increased soybean cultivation contributes to deforestation and habitat fragmentation, leading to ecological consequences. A great example is the soybean expansion in South

America, particularly in the Brazilian Amazon and Cerrado, which has resulted in significant forest loss (Song et al. 2021). It focuses on the example of the municipality of Sorriso in Brazil and finds a strong inverse relationship between soybean cultivation and forest cover (Rodrigues & Miranda, 2021b). These findings highlight the detrimental impact of soybean cultivation on forests and emphasise the need for sustainable land use practices to mitigate deforestation and its ecological consequences.

So, we can understand from these data that deforestation and habitat fragmentation are additional ecological consequences of increased soybean cultivation. We see regularly large swathes of forests in Nagaland are cleared to meet the growing demand for agricultural land. These forest clearances not only disrupt the habitats of myriad species but also affect watershed areas, leading to water scarcity and reduced quality of freshwater sources (Sarma & Kalita, 2021).

Soil health, another critical aspect of the ecosystem, is adversely affected by intensive soybean cultivation. Continuous cultivation can result in the depletion of vital soil nutrients and erosion, threatening crop yield and the land's future agricultural potential. Furthermore, the excessive use of fertilisers daily in soybean farming can lead to soil acidification and affect local water bodies, causing disturbances in aquatic ecosystems (M. Tahat et al. 2020). The study highlights the ecological challenges associated with pesticide use in soybean cultivation. It emphasises the critical role of pesticides in increasing crop yields. It discusses their adverse effects on the natural environment, including harm to non-target organisms and contamination of air, water, soil, and crops (Tudi et al. 2021).

In sum, while the burgeoning soybean cultivation in Nagaland offers economic

opportunities and addresses nutritional demands, it does not come without ecological consequences. The challenge for Nagaland and similar regions globally is to strike a balance - ensuring that the economic benefits of soybean cultivation do not come at the expense of the region's rich agrobiodiversity and overall ecosystem health.

2. Proposal for Sustainable Cultivation Practices in Nagaland's Fermented Soybean Sector.

Cultivating fermented soybean, a linchpin of Nagaland's agricultural and cultural landscape stands at an environmental crossroads due to intensified farming practices (Chishi & Jahanara, 2022). To ensure that this crucial livelihood continues to thrive without detriment to the region's rich biodiversity and ecological health, there is an imperative need for sustainable cultivation practices that coalesce modern agricultural techniques with indigenous knowledge. (Arora et al. 2022; Chhabra & Sinha, 2020; Myllemngap, 2021; Sharma et al. 2020, 2020; Smriti Singh et al. 2019).

The critical components of this proposal include:

1. **Agroforestry Integration:** The social, economic, and environmental contributions of traditional agroforestry systems, including increased soil fertility and the provision of various resources, are critical components (Wondimenh, 2023) which can be quickly adopted in Nagaland. The role of agroforestry in climate change adaptation and mitigation and its potential for enhancing livelihoods and food security is also needed (Taye Gifawesen et al. 2020).
2. **Crop Rotation and Polyculture:** Varietal mixtures, a form of polyculture, can support insect pest control and increase crop

productivity (Snyder et al. 2020). The long-term benefits of legume-based cropping systems on soil health and productivity are also emphasised (Ananda et al. 2022). Moreover, the importance of legume-rhizobia and legume-arbuscular mycorrhizal fungi symbioses in nutrient acquisition and sustainable agriculture has been clearly shown (Liu et al. 2020).

3. **Organic Farming Techniques:** Organic farming focuses on preventive pest and disease management measures, promoting ecosystem health and plant resistance (Saha & Baudh, 2020). Additionally, organic agriculture significantly reduces pesticide use compared to conventional farming, lowering dietary risks and promoting public health (Benbrook et al. 2021).
4. **Water Management:** It has been found that indigenous rainwater harvesting techniques can significantly increase runoff retention, double infiltration, and mitigate soil water stress, leading to extended growing seasons and enhanced crop yields (Tamagnone et al. 2020). Implementing sustainable irrigation practices, such as pressurised and deficit irrigation systems, is essential in water-scarce regions (Nikolaou et al. 2020).
5. **Community Engagement and Education:** Appropriate agricultural practices in implementing sustainable agriculture and identifying factors influencing farmers' adoption of these practices are essential (Tiefigue Coulibaly et al. 2021).
6. **Market Incentives for Sustainable Products:** This study provides insights into market incentives for promoting sustainable agricultural practices. The importance of sustainable agriculture in mitigating adverse

environmental impacts caused by conventional farming practices is highly emphasised (Coulibaly et al. 2021).

If implemented in collaboration with local communities, agricultural experts, and policymakers, this proposal can usher in an era of sustainable soybean cultivation in Nagaland that honours its rich traditions while looking ahead to a sustainable future.

Results and Discussion

The study unveiled multifaceted changes in the land-use patterns of Nagaland, driven primarily by increasing soybean cultivation and developmental pressures. Notably, these changes are not merely ecological but have profound socio-cultural implications. The indigenous communities, which have an ancestral bond with the land, face challenges as their traditional landscapes transform. Soybean cultivation, while bringing economic gains and meeting nutritional needs, is altering the ecological fabric of the region. There is an evident tension between the developmental trajectory and the region's environmental and cultural integrity.

Our investigation into the impact of increasing soybean cultivation on Nagaland's land-use patterns and its socio-cultural implications revealed a complex interplay between economic development and preserving environmental and cultural integrity.

i. Relevance Emphasized

In considering the multifaceted changes observed, it is imperative to underscore the relevance of the findings. The transformation in land-use patterns, driven by the surge in soybean cultivation, extends beyond ecological shifts; it directly impacts the socio-cultural fabric of Nagaland. The implications of these changes are deeply rooted in the ancestral

connection indigenous communities have with the land.

ii. Socio-Cultural Challenges Highlighted

The challenges these communities face in transforming landscapes is not merely practical; they extend to the core of their cultural identity. As soybean cultivation brings economic gains and nutritional benefits, it concurrently poses challenges to the traditional landscapes, creating a tension that demands careful consideration.

iii. Balancing Economic Gains and Environmental/Cultural Integrity:

The tension identified between the developmental trajectory and the environmental and cultural integrity of the region calls for a nuanced discussion. It is evident that while soybean cultivation contributes to economic growth and nutritional security, it also raises concerns about its ecological impact. This necessitates carefully examining the trade-offs in achieving economic aspirations without compromising the region's vibrant agrobiodiversity and the holistic well-being of its ecosystems.

iv. Impact of Fermented Soybean Products

Beyond the cultivation aspect, our study delves deeper into the impact of fermented soybean products on the communities of Nagaland. Fermentation not only enhances the economic value of soybeans but also plays a crucial role in meeting nutritional needs. The extended shelf life resulting from fermentation contributes significantly to food security, a vital aspect of the resilience of communities, particularly in challenging ecological and economic contexts.

v. Cultural and Nutritional Significance

Fermented soybean products, deeply ingrained

in the cultural heritage of Nagaland, offer more than just economic gains. They become a means of preserving traditions while fostering community growth. The study highlights how these products, rich in nutrition, become a cornerstone for improving community nutrition resilience. The cultural heritage of Nagaland, closely tied to its cuisine, provides a unique opportunity to leverage fermented soybeans for economic and nutritional well-being.

vi. Integrating Traditional Wisdom for Sustainable Progress:

Our findings underscore the need for a balanced approach to address this tension. Sustainable progress in Nagaland requires the integration of modern agricultural practices with traditional wisdom. Collaborative efforts are essential to formulate strategies that preserve the region's environmental ethos and cultural heritage. Such an approach ensures that economic growth does not overshadow the intrinsic values that define the resilience and uniqueness of the communities of Nagaland.

Conclusion

Like several biodiverse-rich regions globally, Nagaland is at an inflexion point where economic aspirations intersect with environmental and cultural considerations. The surge in soybean cultivation, though economically promising and nutritionally fulfilling, raises ecological concerns. For Nagaland to progress sustainably, a balanced approach is vital—one that embraces economic growth without undermining the region's vibrant agrobiodiversity and the holistic well-being of its ecosystems. This necessitates a joint effort, integrating modern agricultural practices with traditional wisdom, ensuring that development

does not overshadow the region's environmental ethos and cultural heritage.

In conclusion, our study emphasises that the path to community growth through fermented soybeans and resilient food systems in Nagaland demands a holistic understanding. By embracing the challenges and complexities highlighted in this

research, stakeholders can work collaboratively to forge a sustainable future that harmonises economic development with the preservation of the region's cultural and environmental heritage, with a particular focus on the impactful role of fermented soybean products in shaping this narrative.

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