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Asia's First Green Village: A Micro-Level Study on Community Farming from Nagaland – India

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ABSTRACT

Sustainable agriculture is a system of farming that meets the existing demand for food without dampening the prospects of farming and ecology. Organic farming is one of the fundamental ways to cherish sustainable agriculture. The study analyses alder-based shifting cultivation practised in Khonoma, Nagaland, which was declared India's first "Green Village". It explores the ripples of alder-based shifting cultivation on agricultural sustainability, economic stability, and ecological resilience in Khonoma. It is a study that hinges on a field study. The study emphasizes the efficacy of traditional farming practices merged with contemporary sustainable strategies to tackle climate aberrations, enhance food security, and ameliorate community health outcomes. The alder-based shifting cultivation transforms agricultural sustainability, ecological resilience, and health indicators. The study also establishes that sustainable farming practices have empowered the village to be recognised as a "Green Village" and transformed the village to cherish the pivotal objectives of ecological balance, food security, and health care.

Keywords: Shifting cultivation, climate change, green economy, organic farming, community farming, Indian agriculture.

JEL codes: Q1, Q2, Q3, Q5

I

INTRODUCTION

The World Bank has committed to working with other countries to facilitate climate-smart agriculture, as per the 'Climate Change Exchange Plan 2016-20' and also for the ensuing period, i.e., 2021-25 (World Bank, 2021). Organic farming is one of the fundamental approaches to realizing sustainable agriculture. It is a unique initiative deploying natural inputs, prohibiting synthetic inputs, and mandating soil-building crop rotations. India ranks first in the number of organic farmers, i.e., 13,66,226. It stands at ninth position in terms of the land under organic farming, i.e., 22,99,222 hectares, according to the '*World of Organic Agriculture Report 2021'*. Northeast India has great potential for organic farming. Already, the state of Sikkim has become the first organic state in the world with a total of 74647.31 hectares of land under organic cultivation and an organic production of 443.85 million tonnes for the year 2020-21 (ibid).

Shifting cultivation, a traditional agricultural practice found in diverse stretches across the globe, embodies a harmonious relationship between human societies and nature. Shifting cultivation, also known as "jhum" in the local vernacular, holds cultural gravity in Nagaland and is deeply entrenched in the traditions and practices of indigenous communities (Darlong, 2004). The historical continuity of jhum reflects the

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intimate convergence between humans and the environment, where farm practices are imbued with spiritual and social gleanings. Alder trees, integral to the jhum cycle, epitomise resilience, regeneration, and the cyclical nature of life. Their presence in the landscape is a testament to the sustainable '*land management practices*' developed by Naga tribes over centuries, flagging the adaptive capacity of traditional knowledge systems in navigating dynamic environmental milieu (Krug, 2009). Among its various forms, alder-based shifting cultivation stands out as an exemplar of sustainability deeply rooted in Nagaland.

Green Farming:

Sustainable farming is a formidable system of farming that meets the needs of existing generations while being conscious of the prospects and challenges of future generations. It favours environmentally friendly and ecologically stable cultivation techniques that preserve soil fertility, prevent water pollution, and conserve biodiversity (UC Sustainable Agriculture Research & Education Program, 2021). Sustainable agricultural practices corroborate achieving Sustainable Development Goals (SDGs), including zero hunger. It is economically viable, socially responsible, and ecologically complimentary**.** The greening of the economy with farm initiatives seeks to march forward with an exclusive emphasis on food security (FAO, 2012).

Green Village-Khonoma:

The Government of India and the Government of Nagaland declared the village of Khonoma as India's first green village in 2005 (Papu & Nathani, 2020). A Green village is a village that practices SDGs corresponding to a pollution-free environment, efficient and effective management of the environment and biodiversity, conservation of nonrenewable energy, rainwater harvesting, natural water management, and environment-friendly technology like the use of organic fertilizers and pesticides, cattle rearing, etc. Organic farming is widely practised in the Village of Khonoma. The *Angami* tribe is densely prevalent in the village. They practice terrace farming and alder-based shifting cultivation. Alder trees are planted along with the crops in the jhum fields. The Himalayan Alder tree is a tree that is capable of fixing nitrogen into the soil and nurturing the land for shifting cultivation (Sharma et al., 2008)

This paper analyses the ramifications of alder-based shifting cultivation on agricultural sustainability, economic stability, and ecological resilience in Khonoma, Nagaland. This study also highlights the efficacy of traditional farming practices merged with contemporary sustainable strategies to address climate variability, enhance food security, and increase community health outcomes.

II

METHODOLOGY

Khonoma is a *Naga* village in the Indian state of Nagaland. The village comprises 1,943 people settled across 424 households (Roy et al., 2020). The study is built upon primary data collected through the field study in the village of Khonoma. Purposive sampling has been deployed to carve out the sample. The study deploys a *schedule* method to obtain data from the villagers. The data was collected during October and November 2021. The respondents for the data collection were women farmers who had been actively engaged in farming. The village is further segregated into three *Khels*, i.e., *Thevoma, Semoma, and Merhüma*. Data were collected from 99 farmers, i.e., 33 households from each Khel, out of 424 total farm households. The data pertains to three crops, i.e., Paddy, Chilli, and Garlic, based on their respective production levels for measuring economic, agricultural, ecological sustainability and health benefits. Agricultural sustainability encompasses access to input and output markets, price stability, farmers' perception of profitability, food security perception, income stability of farmers and labour stability. Ecological sustainability is measured using six indicators: soil erosion rate, organic matter content, water quality, water use efficiency, vegetative cover, biodiversity, resilience to climate variability and soil, water, and crop residue levels. Health indicators include factors such as vitamin C and iron levels, dietary fibre and antioxidant content, resistant strains, antibiotic alternatives, chronic cough, respiratory infections, dietary diversity score, annual produce yield, incidence of cardiovascular complications, obesity, asthma and diabetes.

The study has been carried forward on a *'5-point Likert scale'* concerning farmers' perceptions of various indicators, i.e., agricultural, ecological and health. The Likert scale responses were standardised to ensure appropriate analogy across various indices. The *mean* and *standard deviation* were calculated for each indicator. The standardized values were computed by subtracting the mean of the indicator and dividing it by the standard deviation for each response from the respondent. This standardization process has ensured comparability across different measures. Once standardized, composite scores for each dependent variable were constructed. The composite score was calculated by averaging the standardized scores of indicators.

The independent variables are the intensity of alder-based cultivation (measured on a continuous scale), farm size (in hectares), farming experience (in years), level of education (index), and access to credit (binary variable). Dependent variables are constructed as composite scores representing three main outcomes: *agricultural sustainability, ecological resilience, and health indicators*. ANOVA is employed to extrapolate the mean difference in the production across three Khels and selected crops. Multiple regression analysis evaluates the relationship between the independent variables and the composite scores for the dependent variables. The models are specified as follows:

Agricultural Sustainability = $\beta_0 + \beta_1 AB + \beta_2 FS + \beta_3 FE + \beta_4 EL + \beta_5 AC + \varepsilon_i$

Ecological Resilience = $\beta_0 + \beta_1 AB + \beta_2 FS + \beta_3 FE + \beta_4 EL + \beta_5 AC + \varepsilon_i$

Health = $\beta_0 + \beta_1 AB + \beta_2 FS + \beta_3 FE + \beta_4 EL + \beta_5 AC + \varepsilon_i$

AB =Alder-based Cultivation
FS = Farm Size
FE = Farm Experience,
AC = Access to Credit,
β_1 to β_5 are the coefficients for the independent variables.

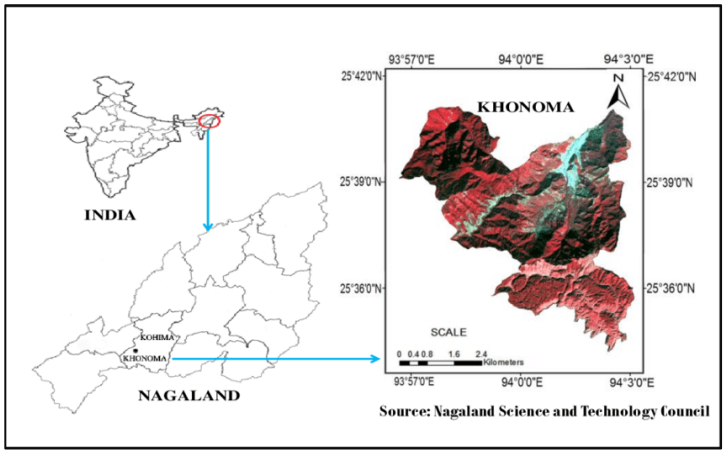

Figure 1: Map of Khonoma

III

RESULTS AND DISCUSSION

The economy of North-east India is highly intertwined with agriculture. Its mountainous topography constrains the extent of land utilized towards settled agriculture. The rugged terrain of the region hampers the nature and scope for industrialization. Limited land has been available for settled farming except for the sizeable areas in Assam's Brahmaputra and Barak valleys (North Eastern Council, 2024). Along with settled farming (e.g., paddy cultivation), the 'Slash-and-burn' method, or *Jhum* cultivation or Shifting cultivation, is more prevalent among the indigenous tribes in Northeast India (Lalrinsangpuii et al., 2016). This method is a congenial method for cultivation in the hilly regions. Jhum is one of the oldest farming techniques closely convoluted to the social and cultural values of the tribal communities.

Other practices, such as *Bun* cultivation method to grow potatoes, have also been practiced in the hilly areas of Meghalaya (Basavaraj et al., 2019). However, this practice could result in soil erosion and mismanagement of water resources (Satapathy & Bujarbaruah, 2006). Settled agriculture is another example of a farm practice that leads to imbalances in biodiversity. Several ecological challenges like loss of biodiversity, soil erosion, and the decline in soil and forest productivity have been identified as the pitfalls of the *'Slash-and-burn method'*. As far as Jhum cultivation is concerned, the *Jhum* cycle has been shortened due to the population explosion (Tripathi & Barik, 2003). This could potentially lead to low crop productivity levels and high environmental degradation. Shifting cultivation continues to be a significant agricultural system in many remote terrains of South and Southeast Asia as well as in Africa, wherein *mixed cropping* remains the best choice for the livelihood sustainability of farmers despite the global trend towards commercial agriculture from subsistence farming (Shaw et al., 2022).

The prohibition of *Jhum* in the North-eastern region was not a successful venture. However, the two North-eastern states, i.e., Tripura and Nagaland, have made remarkable progress in containing the ecological challenges that emanate from shifting cultivation. The 'Forest Department of Tripura' deployed the 'Joint Forest Management Committee' to wean farmers of crop rotation by promoting rubber cultivation across the degraded forest areas. Nagaland Village Development Boards have also adapted the 'Modified Jhum Cultivation Practices,' especially in the village of Khonoma. The farmers over here practice the Alder-based method of Shifting cultivation. This cultivation method could enhance yield levels, lead to sustained soil fertility, reduce input costs, and increase returns to farmers. It has been ascribed as the "resource-conserving, environmentally compatible, socially supportive, and commercially competitive'' practice. Apart from the environmental benefits, it also carries certain health benefits for the people. It prevents various diseases and disorders like *cancers, digestive dysfunctions, headaches, genetic defilements, weakened immune systems, and even premature deaths* (Mie et al., 2017). The practice of Jhum connects with local cultural values very intricately, embodying a holistic approach. Its dynamism is evident in various practices across different regions, demonstrating an adaptive capacity to evolving biophysical and socioeconomic inclinations (Saikia, 2010).

Integrating Tradition and Sustainability in Khonoma:

The farmers of Khonoma practice a cropping system with a distinct feature, i.e., Alder-based *Jhum* cultivation, which is sustainable and eco-friendly. The villagers of Khonoma have been practising alder-based farming for generations. The salient feature of the Alder tree (a legume) is that its '*root nodules*' can absorb the atmospheric nitrogen in the soil. As a result, the Alder trees assist in retaining soil fertility (Giri et al., 2018). Several regions across Northeast India have been practising the 'slash and

burn' method of shifting cultivation. In this method, trees are burnt to clear the vast stretches of the forest so that cultivation can be carried forward for a few years. However, in Khonoma, Jhum cultivation has been practised by pollarding alder trees at a certain height, i.e., 500-300 meters above the 'Mean Sea Level (MSL)'. The maximum height of the alder tree is 30 metres, and the diameter is 60 centimetres. It is a 'pioneer species' of degraded land that needs preferably permeable soil, moisture, and a cool climate with a mean temperature of 13-26°C (Sharma et al., 2020). Alder-based farming in Khonoma combines Terrace Farming (up to 1000 metres from MSL) and Alder-based Jhuming (up to 1000-1500 meters above MSL). Our study area has a forest coverage of 1500-3000 meters above MSL (Priyadarshni et al., 2021). Under *Jhum* cultivation, the crops are grown with the Alder tree as an intercrop. In the first year of Jhuming, i.e., during the November and December seasons, the Alder trees are pollarded. The first pollarding phase occurs when the scab becomes rough and fissured. The minimum age for pollarding alder trees is 7–10 years when their height reaches 10 metres and diameter stretches up to 70–80 centimetres. The trees are pollarded two metres above the ground level to allow robust sprouts and avoid damage by the cattle.

Fresh mud is applied on top to protect the portion from desiccation. A stone is also placed above the chopped portion to protect the trees from frost damage and ensure that coppices sprout from the sides (Cairns & Brookfield, 2011). The fallow period between the phases of pollarding is approximately five years, i.e., the first phase post-pollarding. The second phase kicks off when Alder trees reach the age of 12-15 years. During the fallow period, farmers allow the thicket stumps of the alder trees to grow till the harvesting season. Alder trees can grow freely post-harvesting, leaving four to six shoots equally stretched around the top of the stump. The shoots are then allowed to grow till the next Jhum cycle. This has been the process of pollarding Alder trees for shifting cultivation, and the same process has been repeated consistently for generations (ibid).

The village of Khonoma endorses the Alder-based (environment-friendly) method of farming. The villagers of Khonoma do not consider shifting cultivation to be the cause of deforestation and other environmental devastation, thus contributing to climate change. The dedication of the village to maintaining a pollution-free environment is discernible through adopting eco-friendly practices such as rainwater harvesting and natural water management (Saikia et al., 2024). Innovative ideas regarding technology, pesticides, insecticides, etc., have spearheaded sustainable agriculture. The farmers of Khonoma apply their indigenous technology for sowing and harvesting. They utilize the spade *(Kezhü)*, paddy mat *(Zopie)*, and Naga basket *(Mekhuo)* in their agricultural activities. They use only organic pesticides and fertilizers instead of chemical ones. All these organic practices have transformed Khonoma into a sustainable village. Our study finds that all the households apply organic fertilizers and pesticides. The paddy fields are irrigated through the streams that flow across the hills. The village community toils collectively to erect water channels that lead the water up to all the fields located downstream.

Contribution to Food and Feed:

It is perceived from the field observation that the village of Khonoma has an agro-based economy that has been sustained for generations. In the evolution of developmental strategies in the country, there has also been a transition in the economy of Khonoma village. Our study shows that farming activity shifted in favour of cash crops and other allied occupations (Ray et al., 2021). The village is located on a hilltop. The geographical terrain is not so flat; therefore, the farmers are left with few viable options. They cultivate in the tiny little plots. This is also done to consistently retain the water in the farm, flowing from the top of the hill to the basement. Under Terrace Farming, the villagers predominantly cultivate *Paddy* and Garlic. They also cultivate Chilli and maize under the Shifting Cultivation (Saikia & Nookathoti, 2023).

TABLE 1. FOOD AND FEED INDICATORS
(UNIT: PRODUCTION = Q; HOUSEHOLD CONSUMPTION AND FEED – per cent)

Thevoma				
Farming System	Crops	Production	Domestic Consumption	Animal Feed
Terrace farming	Paddy	15	75	25
	Garlic	2.30	56	_
Alder-based Shifting Cultivation	Chilli	2.40	60	_
Semoma				
Terrace farming	Paddy	13.18	75	25
	Garlic	3.20	56	_
Alder-based Shifting Cultivation	Chilli	1.30	60	_
Merhüma				
Terrace farming	Paddy	12.01	75	25
	Garlic	5.20	56	_
Alder-based Shifting Cultivation	Chilli	1.10	60	_

Source: Author's Calculation.
Note: "_" means no direct contribution

It is evident from the discussion with the villagers that the differences in production among the three Khels correspond to the holding size. In terrace farming, Thevoma leads in paddy production, followed by Semoma, with Merhüma producing the least. Despite these differences in production volume, all three khels allocate a consistent portion of their paddy harvest for domestic consumption and animal feed. Merhüma significantly outperforms the other two Khels in garlic yield, while Thevoma produces the least, and Semoma falls in between. In the context of alder-based shifting cultivation, Thevoma again takes the lead in chilli production, with both Semoma and Merhüma producing equal but lesser amounts. While there are notable differences in the quantities of crops produced, the distribution between domestic consumption and animal feed remains remarkably consistent within each crop type. The consistent distribution of crops between domestic consumption and animal feed across Thevoma, Semoma, and Merhüma stems from the shared cultural practices, nutritional needs, livestock management priorities and economic considerations.

In Khonoma, traditional farming practices reflect deeply ingrained cultural values and a sustainable agriculture approach. Terrace farming, prominent in this

region, has been practised for growing paddy, which is not sold commercially but kept mainly for domestic consumption. A significant portion of the paddy produce has been utilized to manufacture local 'rice beer,' an integral part of the community's social and cultural life. The brewing of local rice beer has been served/consumed during religious rituals, festivals, and other social ceremonies (Nath et al., 2019). The remaining produce is consumed domestically or shared across the family clan, fostering strong community bondage and ensuring food security. The cultivation of garlic is also significant in terrace farming. Apart from selling in the open market, most garlic yield is reserved for household consumption, emphasizing its gravity in local culinary traditions. By nourishing garlic and paddy together, farmers in Khonoma demonstrate efficient use of terrace farming systems, maximizing the output of essential crops that support their nutritional needs and social customs (Nanda, 1984).

Most of the chilli crop is consumed within the household, reflecting its prominent role in local cuisine. The sale of organic Chilli (bhut jolokia) provides farmers' livelihoods. Alder trees enrich the soil through nitrogen fixation (Kehie et al., 2017; Rana et al., 2018; Rathore et al., 2010; Sharma et al., 2008; Kandpal & Bhowmik, 2017). It helps mitigate erosion, creating a sustainable environment for chilli cultivation. This practice aligns with the community's commitment to sustainable agriculture, which leverages local knowledge to balance ecological stewardship with crop productivity. The farm practices of the village embody the harmonious bond among the land, people, and customs.

Being a fast-growing plant, Alders also provide timber and fodder to the villagers, especially during those bleak and dry spells. Alder trees in Khonoma are highly priced for their wood, which is known for its quality and ease of work. It enables them to craft beautiful wood products, including furniture and intricate carvings, which are in high demand locally. The smoothness and softness of the wood make it suitable for high-quality timber products. By engaging with sustainable harvesting practices, the community can ensure a steady supply of alder wood and, hence, a reliable income source. The Alder trees also fulfil the firewood requirements of the villagers, especially during the winter and dry seasons. These products are essential for daily cuisine and other kitchen specifications. They can also be sold to generate additional revenue. Further, it significantly contributes to local economies (Mortimer et al., 2015; Sharma et al., 2002).

The analysis of paddy, garlic, and chilli production among the different Khel groups shows highly significant divergence. For paddy production, the deviations between the groups are much larger than those within the groups. It harbingers a significant difference in the production levels among the Khel groups. Similarly, garlic production also shows a significant difference among the groups. Chilli production reflects the same pattern of significant differences. *Post hoc* tests for Khel comparisons reveal that the difference in mean production between Merhuma and Semoma is not statistically significant. However, the differences between Merhuma and Thevoma, as well as between Semoma and Thevoma, are statistically significant. This indicates that

there are significant variations in the production among these groups. The ANOVA results for paddy, garlic, and chilli production show significant differences across the Khel groups. Post hoc tests reveal that Merhüma and Semoma do not differ significantly. Both Merhuma vs. Thevoma and Semoma vs. Thevoma show significant differences. This suggests that the Khels substantially impact the production of these crops, and the differences between certain Khels are statistically significant.

TABLE 2. RESULTS OF ANOVA

PANEL (A): PADDY PRODUCTION

(1)	Sum of Squares (2)	Df (3)	Mean Square (4)	F (5)	P (6)
Khel	45.43	2	22.713	91.7	<.001
Residuals	6.69	96	0.0697		

Source: Authors' Calculation

PANEL (B): GARLIC PRODUCTION

	Sum of Squares	df	Mean Square	F	p
Khel	44.07	2	22.033	112	<.001
Residuals	5.30	96	0.0552		

Source: Authors' Calculation

PANEL (C): CHILLI PRODUCTION

	Sum of Squares	df	Mean Square	F	p
Khel	9.80	2	4.900	24.5	<.001
Residuals	5.40	96	0.0563		

Source: Authors' Calculation

TABLE 3. RESULTS OF POST-HOC TESTS - KHEL-WISE

Comparison							
Khel		Khel	Mean Difference	SE	df	t	p_{tukey}
Merhuma	-	Semoma	-0.200	0.200	96	-1.00	0.583
	-	Thevoma	-1.300	0.200	96	-6.50	<.001
Semoma	-	Thevoma	-1.100	0.200	96	-5.50	<.001

Source: Authors' calculation.

It is evident from the field study that their commitment to green practices is a communal effort. It leads to a consistent ecological perspective across farmers across three khels. Collective decision-making ensures efficiency in land use and environmental practices. The shared knowledge and communal monitoring adherence

to sustainable methods. Cultural and traditional values emphasizing respect for nature guide the community's approach. Joint initiatives promote coordinated action. Village-level education and awareness programs inform all members about ecological benefits, and economic interdependence encourages a collective commitment to ecologically and economically beneficial practices. Community leaders inspire and maintain this unified perspective. Therefore, the following section will provide an overall perspective of the farmers on the ecological, economic, and health impact assessment of alder-based shifting cultivation.

Table 4 shows that alder-based cultivation significantly impacts agricultural sustainability, i.e., access to input and output markets, price stability, farmers' perception of profitability, food security perception, income stability, and labour stability. Farm size also impacts agricultural sustainability quite positively. Farming experience and the level of education also show a significant positive effect. Access to credit is another significant positive factor.

TABLE 4. REGRESSION RESULTS OF AGRICULTURAL SUSTAINABILITY

Variable (1)	Coefficient (2)	Std. Error (3)	t-value (4)
Constant	-0.0327	0.102	-0.319
Alder-based Cultivation	1.4825	0.100	14.826***
Farm Size	0.5106	0.101	5.055***
Farming Experience	0.4511	0.101	4.466***
Education Level	0.4730	0.101	4.693***
Access to Credit	0.5091	0.100	5.086***

Source: Authors' Calculation
*Note: *** $p < 0.01$*

While farmers can procure essential inputs and market their produce, improved transportation and cooperative market initiatives could enhance this access and increase farmers' opportunities for selling produce at remunerative prices (Villar et al., 2023). Price stability in the village is linked to varying market demand, changing weather patterns, and transportation hindrances. Despite these challenges, the relatively stable prices suggest that farmers can still zoom their income to some extent. Farmers' perception of profitability is driven by community-oriented farming, where sharing resources and knowledge strongly contributes to collective success. However, further strengthening market access and stabilizing prices could increase farmers' profitability and stability.

The village can meet its food needs. This perception aligns with Khonoma's sustainable farming practices that prioritize local consumption. Diverse cropping systems and a balanced allocation between human and animal feed contribute to this sense of security. Their diversified farming systems, including terrace and shifting cultivation, provide a buffer against fluctuations. Khonoma maintains a strong agricultural workforce (Prakash et al., 2017). This is due to community cooperation and a cultural emphasis on agriculture. The family members, especially the women,

participated in agricultural labour. This has been functional in the village of Khonoma due to the tiny size of the land holding. The community participation to assist villagers has been identified as strong and active. Hence, as a part of their farm festival, different age groups render labour in each member's fields. During peak demand for labour, labourers working in the fields of others revert to their fields. Wage labour is also frequently observed amongst the relatively affluent households who hire labour in their fields. The least prosperous labourers often have very little land, and some lack the means to rent land. Paying the labour and land rent rests on mutual understanding and community participation. High labour availability enables the village to consistently maintain intensive farming practices and produce quality yields. The sustainability assessment reflects Khonoma's foundation for agricultural development, supported by a motivated workforce, diversified farming practices, and a strong sense of community.

Ecological Benefits:

Khonoma Nature Conservation & Tragopan Sanctuary (KNCTS) won the India Biodiversity Award 2021 for "Sustainable Use of Biological Resources", announced during the virtual celebration of International Day for Biological Diversity. The awards are a collaborative effort between the Ministry of Environment, Forest and Climate Change, the National Biodiversity Authority, and the United Nations Development Programme (The Morung Express, 2021). Khonoma's agricultural practices reflect sustainability and a commitment to living harmoniously with nature. Khonoma's alder-based farming systems have evolved to balance the region's ecological landscape. The environmental benefits reflect the sustainable farming methods and consequent impact on soil health, water quality, and biodiversity. The village has accomplished commendable results in reducing soil erosion, maintaining high organic matter in the soil, and ensuring water quality. These outcomes are primarily due to the integration of alder-based shifting cultivation. The villagers practice effective soil conservation practices. Terrace farming, commonly practised in the region, is designed to reduce erosion by stabilizing soil through multiple layers and strategic vegetation. This method is reinforced by the alder trees planted through the shifting cultivation system.

Table 5 shows the regression results of ecological resilience. The results indicate that alder-based cultivation exerts a positive footprint. Farm size, farming experience, level of education and access to credit have a significant and positive lineage. The soil's high organic matter content reaffirms Khonoma's organic farming traditions. Natural fertilisers like compost and manure are regularly used. These practices help maintain the soil's nutrient balance, promoting healthy crop growth. Alder trees in Khonoma enhance soil fertility by fixing atmospheric nitrogen through their symbiotic relationship with root nodules bacteria. This natural process enriches the soil, reduces the need for chemical fertilizers, and promotes eco-friendly farming practices. Apart from the absorption of atmospheric Nitrogen in the Jhum fields, the roots of Alder trees naturally hold the soil together, thereby reducing soil erosion. Farmers in Nagaland employ various indigenous soil conservation techniques for managing jhum lands

(Singh et al., 2016). During the rainy season, the nutrient-rich upper layer of the soil in jhum fields is prone to erosion due to surface runoff (Yadav et al., 2006). To mitigate this, the villagers of Khonoma utilize contour bunding, employing locally sourced natural materials such as stones, tree branches, logs, and bamboo. These bunds arranged both parallel and randomly across hill slopes, could effectively reduce the velocity of surface runoff, thereby aiding in soil conservation.

TABLE 5. REGRESSION RESULTS OF ECOLOGICAL RESILIENCE

Variable	Coefficient	Std. Error	t-value
Constant	-0.0262	0.089	-0.295
Alder-based Cultivation	1.4568	0.087	16.774***
Farm Size	0.4811	0.089	5.392***
Farming Experience	0.4892	0.089	5.503***
Education Level	0.4753	0.089	5.336***
Access to Credit	0.4862	0.087	5.589***

Source: Authors' Calculation
*Note: *** $p < 0.01$*

Their sustainable land use ensures that harmful agrochemicals do not leach into water flow. Water use efficiency is also high due to the meticulous management by the villagers (Saha et al., 2023). Irrigation techniques that conserve water and minimise wastage are preferred. Dense vegetative cover is another indication of Khonoma's farming systems, where mixed cropping, agroforestry, and the preservation of natural forests contribute to plant growth. It facilitates vegetation recovery during the fallow periods (Fox, 2000). The high biodiversity is the region's commitment to maintaining a diverse range of crops and local flora and fauna. During the cultivation phase, lands under shifting cultivation fall under farming. However, the same lands are considered under forests during the fallow phase (Tiwari, 2017). The biodiversity of the village is remarkable. This encompasses a wide range of flora and fauna, as documented by the Khonoma Tourism Development Board (KTDB) in 2004. This includes over 70 species of plants that have been utilized for medicinal purposes, 84 species of wild fruits, 116 species of wild vegetables, nine species of mushrooms, and five different species of natural dyes.

Additionally, there are 204 species of trees, 45 species of orchids, 11 species of cane, 19 species of bamboo, 25 species of snakes, six species of lizards, 11 species of amphibians, 196 species of birds, and 72 species of wild animals (KTDB, 2004). Traditional farming systems like jhum support biodiversity by enabling farmers to cultivate different crops in varying cycles. The surrounding forests provide a natural habitat for wildlife. Alder trees are vital in agroforestry systems that regulate light and retain soil moisture, benefiting planted crops. This integration of forestry and agriculture allows farmers to harvest timber and agricultural produce from the same land simultaneously, leading to diversification and stimulating their income sources. Additionally, alder trees support local biodiversity by providing habitats and food for

various species, enhancing the ecological balance. This contributes to a more resilient and productive environment for farming.

However, the village is still susceptible to climate exigencies like irregular rainfall patterns, drought, etc. (Nongbri et al., 2016). This poses a herculean challenge to future agricultural productivity. Soil and water residue levels show minimal pesticide residues. This coincides with Khonoma's inclination toward organic farming techniques and the limited use of synthetic pesticides. Similarly, crop residues carry very low pesticide residues, confirming that organic farming practices successfully minimize chemical inputs. These indicators collectively reflect the importance of Khonoma's sustainable agricultural practices. Khonoma has successfully balanced traditional knowledge with sustainable practices. Diversifying cropping patterns, integrating climate-resistant varieties, and implementing water management systems for variable rainfall are instrumental in mitigating climatic risks (Abbass et al., 2022). Combining its strong foundation for sustainable agriculture with innovative climate adaptation measures, Khonoma can continue to thrive as a model for ecological balance and agricultural ingenuity.

Human Health Benefits:

Nutrient-rich produce is a staple food across Khonoma, with high vitamin C, iron, dietary fibre, and antioxidants (Shaw et al., 2022). The diverse, organic farming systems help cultivate various nutrient-dense crops. These nutrients develop strong immune systems and lead to better health outcomes. This indicates that the local diet is naturally balanced and nutritious.

Table 6 shows the regression results of health indicators. Alder-based cultivation significantly impacts various health outcomes. Farm size, farming experience, level of education, and access to credit are significant factors that register indelible impressions on health outcomes.

TABLE 6. REGRESSION RESULTS OF HEALTH

Variable (1)	Coefficient (2)	Std. Error (3)	t-value (4)
Constant	-0.0507	0.109	-0.466
Alder-based Cultivation	1.4993	0.106	14.136***
Farm Size	0.4724	0.108	4.371***
Farming Experience	0.4575	0.108	4.236***
Education Level	0.4599	0.108	4.275***
Access to Credit	0.4691	0.106	4.425***

Source: Authors' Calculation
Note: *** $p < 0.01$

The high percentage of farmers not using antibiotics demonstrates that Khonoma residents are aware of the probable apprehensions of over-utilizing antibiotics. They rely heavily on traditional remedies and herbal sources, which enable the spread of

resistance (Chase & Singh, 2013). Improved respiratory health is evident as the residents of Khonoma moved away from chronic cough, respiratory infections, and asthma incidents, which were recorded at low levels. In Khonoma, the surrounding forests and sustainable farming practices limit air pollution and reduce exposure to harmful particulates. Enhanced food security is reflected in high dietary diversity and crop annual produce yields. The diverse cropping systems, agroforestry practices, and the variety of food groups ensure that the community is self-sufficient. Khonoma's residents confront a very low risk of chronic diseases like *cardiac complaints, diabetes, and obesity complications*. The emphasis on nutrient-rich and fresh produce, combined with physical activity in farming, keeps people active and minimises the risk of lifestyle-related health complications. Lastly, the community-oriented lifestyle, strong social bondage networks, and residing proxy to nature promote sound mental well-being. Thus, Khonoma's sustainable and traditional farming systems contribute significantly to the community's physical and psychological health.

Community Initiatives:

The *Communitization of Public Institutions and Service* (NCPIS) Act of 2002 significantly broadens communities' involvement in the development and welfare initiatives in Nagaland. This legislation encourages community participation in various sectors, including education, health, power, and rural tourism, by delegating management responsibilities to local communities. This approach aims to enhance the performance of public services through active community involvement. A significant challenge under this framework is the expansion of horticulture in tribal areas as a sustainable alternative to shifting cultivation, also known as jhumming. The strategy for this transition emphasizes the importance of voluntary adoption by the tribal communities, facilitated by the benefits of horticulture practices. Communitization fosters community engagement in developmental projects and aligns with traditional practices in Nagaland, making it a vital component of regional development strategies. An example of successful communitization is the *North Eastern Community Resource Management Project* (NERCORMP), sponsored by the North Eastern Council (NEC), involving the *International Fund for Agricultural Development* (IFAD). This project operates across Assam, Meghalaya, and Manipur. This is recognised as a significant achievement in rural social livelihood enhancement and has attracted interest from the World Bank for further expansion (NER 2020).

Additionally, village councils in the northeastern states have launched initiatives to develop sustainable forms, such as shifting agriculture. One such initiative is the community-led biodiversity conservation project in Khonoma village, Nagaland, which is an integral part of the communitisation programme. Moreover, the Nagaland Empowerment of People through Economic Development program, formerly known as the Nagaland Environmental Protection and Economic Development (NEPED), has encouraged farmers to augment their incomes by cultivating cash crops on jhum fields

(Chawii, 2007). This approach promotes economic development and contributes to environmental sustainability (Roy et al., 2020).

There is a tradition of transferring traditional agricultural knowledge and new techniques from generation to generation. The participation in Knowledge exchange appears to be high. Farmers actively engage in learning from one another. The strong participation reflects a community that values collective growth. The inclination for collaboration among villagers is particularly strong. Farmers often work together, sharing resources, labour, and knowledge to ensure the success of their collective agricultural efforts. This spirit of cooperation helps reduce individual risk and ensures the knowledge is disseminated effectively, reinforcing the entire agrarian network. The strength of the farm organization is also significant in Khonoma. Cooperative structures and informal farmer networks are well-established and enable farmers to negotiate better regarding market access, advocate for fair pricing, and share resources efficiently. This organizational strength enhances their resilience and bargaining power.

Women in Khonoma play an active role in farming activities and decision-making (Shaw et al., 2022). Their involvement emphasizes the community's progressive values, as women contribute equally to the agricultural economy. This inclusiveness helps in decision-making and a well-rounded understanding of farming challenges. The quality of wildlife habitats remains strong, reflecting the community's sustainable practices that respect and protect the natural environment. Khonoma's agricultural landscape is thoughtfully managed to balance farming and conservation. This approach maintains the integrity of local wildlife habitats. This enhances biodiversity and preserves the region's ecological health. These socio-economic, climatic, and demographic indicators demonstrate that Khonoma maintains a socially inclusive and environmentally conscious agricultural community. By valuing knowledge exchange, collaboration, and sustainable practices, the village sets a powerful example of how social structures can support prosperous and resilient agriculture.

IV

CONCLUSION

The community of ‘Angami’ has an intense and unique effort of Alder-based farming in the hilly areas. Indigenous community participation in green agriculture transforms the village into an ideal model for other communities worldwide. Climate change would further lead to increased temperatures, shifting the boundaries of the agroecosystem, frequent extreme weather events…etc. Climate variability also adversely impacts crop yields and significantly lowers livestock productivity. Substantial investments are mandated to maintain current yields and meet the food demand in quantity and quality. On the other hand, agriculture also contributes significantly to climate change worldwide through chlorofluorocarbon (CFC) emissions. Appropriate policies and human interventions are the need of the hour to

address the food security challenges and perils of climate change. In this context, sustainable agriculture can deliver staunch positive externalities that can mitigate the ill effects of climate change. In this context, the village of Khonoma is moving in the right direction, which can be emulated nationwide.

The issues related to biodiversity in the Northeastern region are complex due to the diverse geographical terrain. The conservation issues vary from state to state. Apart from restoring soil fertility, an alder-based system could transform the farmers towards income augmentation through the marketing of firewood. An alder-based agricultural system was disseminated in almost all parts of Nagaland under the 'Nagaland Empowerment of People through Economic Development (NEPED)' project. Although 'Alder' grows in an alleviation range between 1200 to 1700 meters, the farmers could correlate the concept to the trees that could be grown in their locality and yield similar results. Thus, farmers nationwide can also be invited to this village to gain exposure to the sustainable farming system.

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REFERENCES

Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures, *Environmental Science and Pollution Research*, 29 (42539-42559). https://doi.org/10.1007/s11356-022-19718-6.

Basavaraj, S., Choudhury, B. U., & Rangappa, K. (2019). Nur bun cultivation and soil health: An indigenous way of farming in hilly ecosystem of Meghalaya, *Indian Farming*, 69 (2).

Cairns, M., & Brookfield, H. (2011). Composite farming systems in an era of change: Nagaland, Northeast India, *Asia Pacific Viewpoint*, 52(1), 56–84. https://doi.org/10.1111/j.1467-8373.2010.01435.x

Chase, P., & Singh, O. P. (2013). Ethnomedicinal plants used by the Angami tribe of Nagaland, *India. Indian Journal of Tropical Biodiversity*, 21(1&2), 29–42.

Chawii L (2007). Community initiative in biodiversity conservation: Khonoma, Nagaland (Appendix-E), in Background Paper no. 14. Natural resource-based income and livelihood improvement initiatives in Northeast India.

Darlong, V.T. (2004). To jhum or not to jhum: Policy perspectives on shifting cultivation. Guwahati: The missing link (TML).

Food and Agriculture Organization of the United Nations (2012). Greening the economy with agriculture. https://www.fao.org/3/i2745e/i2745e00.pdf.

Fox, J. (2000). How blaming 'slash and burn' farmers is deforesting mainland Southeast Asia. Asia Pacific Issues, 47: 1–8.

Giri, K., Mishra, G., Jayaraj, R. S. C., & Kumar, R. (2018). Agrobio-cultural diversity of alder based shifting cultivation practiced by Angami tribes in Khonoma village, Kohima, Nagaland, *Current Science.* 115(4), 598–599. https://doi.org/10.18520/cs/v115/i4/598-599.

Kandpal, B. K. and S. N. Bhowmik. (2017). Shifting cultivation in Tripura: Challenges, prospects and alternatives, in Jhum improvement for sustaining farm livelihood and natural resource conservation in north eastern hill region: vistas and frontiers. Indian Council of Agricultural Research, ICAR Complex for NEH Region, Meghalaya.

Kehie, M., Khamu, S. and Kehie, P. (2017). Indigenous alder based farming practices in Nagaland, India: A sustainable agricultural model, *Journal of Traditional Folk Practices*, 5(2), 82-152.

Khonoma Tourism Development Board. (2004). Environmental impact assessment report – Khonoma green village project report, Khonoma village.

KTDB (Khonoma Tourism Development Board) (2009). Environmental impact assessment report with reference to eco-tourism development, natural resource management and social capital for the village community of Khonoma, Nagaland. Khonoma Tourism Development Board, Khonoma, Nagaland, India.

Krug, M (2009). Shifting cultivation and forest resources in Nagaland, N.-E. India, Dissertation presented to the Faculty of organic agricultural sciences / Department of organic plant production and agro ecosystems research in the tropics and subtropics, University of Kassel.

Mie, A., Andersen, H. R., Gunnarsson, S., Kahl, J., Kesse-Guyot, E., Rembiałkowska, E., Quaglio, G., & Grandjean, P. (2017). Human health implications of organic food and organic agriculture: a comprehensive review. *Environmental Health*, 16(1), 111. https://doi.org/10.1186/s12940-017-0315-4.

Mortimer, P.E., Gui, H., Xu, J., Zhang, C., Barrios, E. and Hyde, K.D. (2015). Alder trees enhance crop productivity and soil microbial biomass in tea plantations. *Applied Soil Ecology*, 96, 25-32.

Nanda, S. (1984). Cultural anthropology. California: Wadsworth Publishing Company.

Nath, N., Ghosh, S., Rahaman, L., Kaipeng, D. L., & Sharma, B. K. (2019). An overview of traditional rice beer of North-east India: ethnic preparation, challenges and prospects. Indian Journal of Traditional Knowledge, 18(4), 744–757.

Nekro T (2009). Traditional agricultural practices and sustainable livelihood, A thematic report, GOI - UNDP PROJECT-Strengthening state plans for human development, Department of planning and coordination, Government of Nagaland, Nagaland - Kohima 797 001.

Nongbri, B., Feroze, S. M., Ray, L. I. P., & Devarani, L. (2016). Assessment of risk due to exposure to drought: A study of farm households of Nagaland, *Indian Journal of Agricultural Economics*, 71(3), 351-365.

North Eastern Council (2024). Agriculture and allied. Retrieved from https://necouncil.gov.in/nec-project-sector/agriculture-and-allied.

Papu, S., & Nathani, N. (2020). India's first green village —Khonoma, *International Journal of Environmental Science and Development*, 11(1),21–25. https://doi.org/10.18178/ijesd.2020.11.1.1220.

Prakash, N., Roy, S. S., Ansari, M. A., Sharma, S. K., Punitha, P., Sailo, B., & Singh, I. M. (2017). Jhum improvement for sustaining farm livelihood and natural resource conservation in North Eastern hill region: Vistas and frontiers. ICAR Research Complex for NEH Region.

Priyadarshni, P., Padaria, R. N., Burman, R. R., Singh, R., & Bandyopadhyay, S. (n.d.). Development and validation of knowledge test on indigenous alder-based jhum cultivation and mechanism for knowledge dissemination, *Indian Journal of Extension Education*, 57(1), 1–7.

Rana, S.K., Rana, H.K., Shrestha, K.K., Sujakhu, S. & Ranjitkar, S. (2018). Determining bioclimatic space of Himalayan alder for agroforestry systems in Nepal, *Plant Diversity*, 40(1), 1-18. DOI: https://doi.org/10.1016/j.pld.2017.11.002.

Rathore, S.S., Karunakaran, K. and Prakash, B. (2010). Alder based farming system a traditional farming practices in Nagaland for amelioration of jhum land, *Indian Journal of Traditional Knowledge*, 4, 677-680.

Roy, N., Roychoudhury, S., Nautiyal, S., Sunil, Agarwal, K., & Baksi, S. (2020). Livelihood strategies and agricultural practices in Khonoma village of Nagaland, India: Observation from a field visit. *Environmental Science Socio-economic and Eco-biological Dimensions in Resource Use and Conservation Strategies for Sustainability*. http://www.springer.com/series/3234.

Saha, S., Hussain, S., Deka, N., Mahanta, R., & Bhagabati, A. K. (2023). Traditional ecological farming practices in the eastern Himalayan mountain environment: Case of a naga village, Nagaland (India). *Agrobiodiversity and Agroecology*, 3(2).

Saikia, A. (2010). Innovation dynamics in shifting cultivation: The case of jhum in Nagaland, Doctoral Theses, Centre for Studies in Science Policy, School Of Social Sciences, Jawaharlal Nehru University, New Delhi.

Saikia, B & Nookathoti, T. (2023). Rural innovation and sustainable agriculture: Insights from Nagaland. *Aarthika Charche*, 8(1). 53-62.

Saikia, B., Nookathoti, T. & Hiremath, C. (2024). Alder-based shifting cultivation in Nagaland -A theoretical perspective, *Journal of Climate Change*, 10(2), 19-26. DOI 10.3233/JCC240011.

Satapathy, K.K. & K.M. Bujarbaruah (2006). Slash and burn agriculture: Its practice, effect, and problem of development, in *Agroforestry in North East India: Opportunities and challenges*, ICAR Research Complex for NEH Region, 1-14.

Sharma, I. P., Kanta, C., Dwivedi, T., & Rani, R. (2020). Indigenous agricultural practices: A supreme key to maintaining biodiversity, 91–112). https://doi.org/10.1007/978-981-15-1902-4_6.

Sharma, E., Sharma, R., Sharma, G., Rai, S. C., Sharma, P., & Chettri, N. (2008). Values and Services of Nitrogen-Fixing Alder-Based Cardamom Agroforestry Systems in the Eastern Himalayas. ICIMOD. Retrieved from https://lib.icimod.org/record/8808.

Sharma, G., Sharma, E., Sharma, R., & Singh, K.K. (2002). Performance of an age series of alnus cardamom plantations in the Sikkim Himalaya productivity, energetics, and efficiencies. *Annals of Botany*, 89(3), 261–272.

Shaw A K, Natori Y, and Edake S. (2022). A tradition in transition: Understanding the role of shifting cultivation for sustainable development of North East India. TERI, New Delhi.

Singh, L.K., Devi, S.R. & Singh, H.J. (2016). Modified echo as an option for low cost soil conservation measures for settle agriculture in Wokha, Nagaland - A Case Study. *The Bioscan*, 11(4), 2487-2491.

The Morung Express. (2021, May 22). Khonoma Nature Conservation & Tragopan Sanctuary wins India Biodiversity Awards 2021. The Morung Express. Retrieved May 13, 2024, from http://www.morungexpress.com/khonoma-nature-conservation-tragopan-sanctuary-wins-india-biodiversity-awards-2021.

Tiwari, B.K, R. Kumar, L. Thakur, & A. Salve. (2017). Agroforestry for sustainable rural livelihood: A review. *International Journal of Pure and Applied Biosciences*, 5(1), 299–309.

Tripathi, R.S. & S.K. Barik (2003). Shifting cultivation in North East India, in B.P. Bhatt, K.M. Bujarbaruah, Y.P. Sharma and Patiram (Eds.) (2003), Proc. approaches for increasing agricultural productivity in hills and mountain ecosystem, ICAR Research Complex for NEH Region, Umiam, Meghalaya, 317–322.

UC Sustainable Agriculture Research and Education Program (2021). What is sustainable agriculture? UC agriculture and natural resources. Retrieved from https://sarep.ucdavis.edu/sustainable-ag.

Villar, P. F., Kozakiewicz, T., Bachina, V., Young, S., & Shisler, S. (2023). PROTOCOL: The effects of agricultural output market access interventions on agricultural, socio-economic and food and nutrition security outcomes in low- and middle-income countries: A systematic review, *Campbell Systematic Reviews*, 19, e1348. https://doi.org/10.1002/cl2.1348.

World Bank (2021). Climate change exchange plan 2021-25. World Bank Group.

Yadav, R.K., Yadav, D.S., Rai, N. and Sanwal, S.K. (2006). Soil and water conservation through horticultural intervention in hilly areas, *ENVIS Bulletin Himalayan Ecology*, 14(1), 4-13.