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Traditional Ecological Farming Practices in the Eastern Himalayan Mountain Environment: Case of a Naga Village, Nagaland (India)

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Abstract
The farming systems practised by the tribal communities in the mountain environment of the North-Eastern region of India are eco-friendly and local climate responsive. These play a significant role in ensuring food security and conserving the local agro-ecological diversity. These farming practices are rooted in the local ecological set up, and they reflect the Indigenous people's response to the environment of the area. The inhabitants of the Khonoma village of Kohima district, Nagaland, the study village, have been traditionally practising unique *Alder* tree-based *jhum* (shifting) cultivation, terrace-based *panikheti* (wet cultivation) and kitchen gardening based on their Indigenous knowledge and skills. They have been practising mixed farming by integrating crops, fish and livestock. The local communities have also evolved some methods for managing the natural settings to sustain their agriculture and livelihoods. This study is an attempt to investigate the methods of traditional farming system of Khonoma, a mountain village in the Eastern Himalayas. This study is based on primary data/ information collected through household survey using semi-structured household survey schedule, participatory rural appraisal (PRA), focus group discussion (FGD), and interviews with key informants and personal field visit in early 2021. The terrace-based *panikheti*, adopted by the people of Khonoma village, has been proved a location specific eco-friendly method for soil and water conservation. The *Alder* tree-based *jhum* practice, as opined by the villagers, is a sustainable livelihood option in the context of the mountain ecological setting and unique cultural values of the people.

Keywords
Ecological farming, Agrobiodiversity; Ethnic community; Mountain environment; Eastern Himalaya

1. Introduction

The ecological farming practices have been gaining popularity as an alternative to the conventional modern farming system due to its minimum environmental impact, ecological adaptability and affinity to cultural values (Deka, 2012; Schoonhoven and Runhaar, 2018). Extensive use of agro-

chemicals, HYV seeds and irrigation in modern agriculture temporarily triggers the productivity of certain crops, but their impact on the ecosystem and peasant society is far reaching (Altieri and Koohafkan, 2008; Conway, 1987). Modern agricultural practices have now proved to be responsible for the degradation of the associated ecology, declining natural fertility of soil, depletion of ground water (Shetty, Ayyappan and Swaminathan, 2013), loss of local crop diversity, and disappearance of agriculture related cultural attributes (Deka and Bhagabati, 2010; Gliessman, 2007). In comparison to diversified cropping and integrated farming, monocropping is given more importance in the modern farming systems. Farmer's choice on agricultural inputs and implements has also been taken over by external agencies and, thus, agriculture has become increasingly capital intensive (Dorin, 2022). Thus the modern agricultural methods, where substantial amount of money is needed for procuring agricultural inputs and implements, have posed a challenge to the farmers, particularly the small and marginal farmers, in the developing countries. These challenges have become more and more acute under the influence of climatic change and other associated phenomena. These are now facing frequent crop loss due to some climate related phenomena like drought, floods and other extreme weather events and certain newly appeared diseases, pests and insects.

Traditional agro-ecosystem in the marginal environment provides various ecosystem goods and services such as regulation of soil and water quality, biological pest control, pollination, support to biodiversity, etc. for sustaining the life and livelihoods of the local communities (Power, 2010; Gauchan *et al.,* 2020; Sharma and Rai, 2012). The diverse agriculture and the associated Indigenous knowledge and skills practised by the Indigenous communities across the world have been reckoned essential climate resilient agriculture (Bisht, 2021; Erisman *et al*., 2016; Mekbib *et al*., 2017). Diversification of agriculture by integrating crops, livestock and fishes is considered as an important strategy to adapt to the climate change risk (Aiman Raza, 2007; Altieri and Koohafkan, 2008; Karki, Burton, and Mackey, 2020). It has been observed that many traditional crop varieties under traditional farming methods have higher productivity, nutritive value and give stable production (Bisht, 2021; DeLonge, Miles and Carlisle, 2016; Maikhuri, Rao and Saxena, 1996.; Khumairoh *et al*., 2021) and resistance to pests and diseases (Mulumba *et al.,* 2012). Moreover, the ecological farming practices are very rich in agrobiodiversity, which ensures stable production and food and nutritional security (Erisman *et al*., 2016; Swaminathan, 1986). Unlike modern agriculture, the traditional farming is based on organic inputs, biological pest management system, local crop varieties, self-seed conservation and locally invented soil and water management systems. Therefore, these farming practices are considered as ecologically sustainable, economically viable and culturally acceptable (Deka, 2012; Sharma and Rai, 2012). It also provides scope for development of agro- and ecotourism as an alternative opportunity for livelihood (Amloy *et al*., 2024; Ba *et al*., 2018). Several studies claimed that the rate of environmental destruction in primitive methods of subsistence farming like shifting cultivation is very limited than the monoculture of plantation farming (Henley, 2011; Morton, Borah and Edwards, 2020). In shifting cultivation, farmers maintain forest cover by a short cropping period and long fallow phase for forest regeneration (Kerkhoff and Sharma, 2006). The long fallow period has high potential for carbon sequestration and

forest recovery (Thong *et al*., 2020) and also helps in maintaining organic carbon and nitrogen stocks in soil (Terefe and Kim, 2020).

The tribal communities inhabiting the Himalayan mountain environment of North-East India have been practising some Indigenous farming systems (IFS) such as paddy-cum-fish farming of Apatani community of Arunachal Pradesh, bamboo drip irrigation-based farming in Meghalaya, wet rice cultivation in Assam, *Zabo* irrigation-based wet rice cultivation in Nagaland, and so on. Shifting cultivation, locally called *jhum*, is one of the dominant forms of agriculture practiced in the hilly areas of this region. Several studies show that the shifting cultivation practices of North-East India is rich in crop diversity (Asati and Yadav, 2014; Payum *et al*., 2021). *Alder*-based *Jhum* cultivation, terrace-based *Panikheti* and kitchen gardening of Khonoma village in Nagaland are century-old ecological farming practices where the farmers developed unique system for soil, water and agrobiodiversity conservation based on their Indigenous knowledge and skills (KTDB 2009; Roy, Debnath and Nautiyal, 2020).

2. Objective of the Study

This study has been carried out with the following objectives:

1. To investigate nature and types of traditional farming practices and crop cycles developed by the Indigenous communities based on the local climate, ecology and indigenous knowledge system.
2. To study the traditional strategies adopted by the hill farmers for soil conservation and water management in different farming practices.

3. Geographical Background of the Village

This study has been carried out in a typical Naga village called Khonoma, located in Sechü-Zubza sub-division of Kohima district, Nagaland (Figure 1). The village is located at $25^0 39' 21.20''$ N latitude and $94^0 1' 18.27''$ E longitude at a distance of 20 km from Kohima town and around 80 km from Dimapur town. It is surrounded by Jotsoma village on the north, and Mezoma village on the west. Being located at the foothill of the Barail range, the village is a part of the Eastern Himalaya and Indo-Burma Biodiversity Hotspot (Chase and Singh, 2012). The physiography of the village is hilly ranging from gentle slope to steep rugged hillsides. The village is drained by a small stream called Dzüza and its tributary Khurü forming a valley plain with moderate slope. The average elevation of the Khonoma is around 1,455 m from the mean sea level.

The area receives an annual rainfall of 2,000 to 2,500 mm and most of the rainfall occurs during May to September. The area experiences cold and winter season from October to March. Temperature varies from 15^0C to 30^0C during summer and 5^0C to 25^0C during winter. The village is inhabited by the Angami Naga tribe. It has 424 households with a total population of 1,943 as per 2011 Census. The old people reported that the village is about 700 years old. The village is divided into three clans, called *Khel*-Merhüma (M-Khel), Semoma (S-Khel) and Thevoma (T-Khel). Literacy rate is 83.41%, which is higher than state's average (2011 Census). Although the village is rich in forest resources, agriculture is the main source of livelihood of the people.

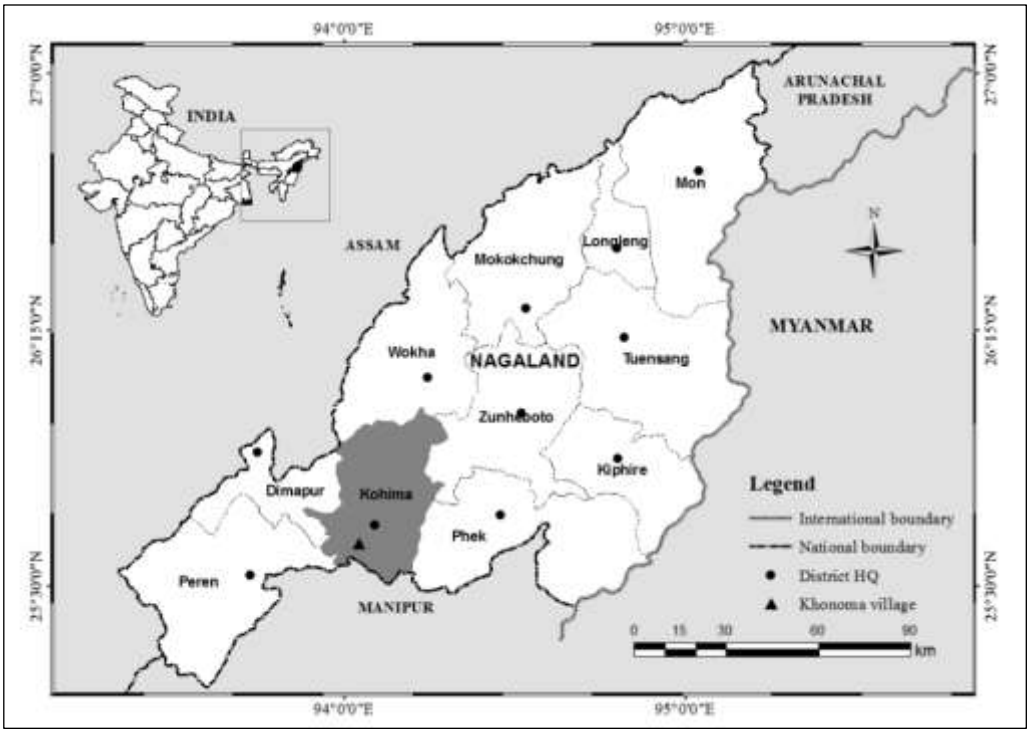

Figure 1: Location of Khonoma village in Nagaland

3. Methods

Descriptive and qualitative methods were followed in conducting this study. Data were collected through purposively designed household survey schedule, intensive field observation, interviews and focus group discussion (FGD) with the local communities following Participatory Rural Appraisal (PRA) approach (Figure 2). Household survey was conducted covering 50 selected households (12% of total households) during the month of February 2021. Simple random sampling procedure was followed for the selection of households. Out of the total respondents, 60% were males and 40% were females. In addition to household survey, several stakeholders, including Secretary of Khonoma Village Development Board (BDV), members of women self-help groups, and members of farmers' club were interviewed.

Participatory resource map of the village has been prepared to understand the agricultural land use pattern of the village and the associated problems. Local people were asked to draw their village map on the ground. They drew the map on the ground using sticks and placed different colour powder (*ranguli*) to indicate agricultural lands (both the terrace fields, *jhum* fields), irrigation canals, kitchen gardens, fish ponds, forests etc. of their village. After the completion of drawing, a stick was handover to a senior participant to explain their village map. A transact walk was performed along with the farmers in order to verify the prepared map with the existing agricultural land use pattern and the associated problems. A small group consisting of 6-7 villagers, including the village headman and women farmers, were asked to participate in the transact walk in order to investigate the Indigenous land use pattern and its relations with the existing irrigation system, soil quality, forest cover and regenerated forest growth after *jhum* (shifting cultivation) cycle completed.

A crop calendar was prepared with the help of villagers to study the seasonal cycle of crop farming and associated agriculture activities in Khonoma. A chart was drawn on the ground with the time scale (month wise) in horizontal direction and the type of agriculture, crops and farming activities on the vertical axis. The participants were asked to place some materials such as stones, stick, etc. on the ground chart as per the activities required during different season for *jhum* cultivation, terrace farming and kitchen gardening different months.

Figure 2: Focus group discussion and interview (Photo Credit: Sourav Saha)

5. Results and Discussion

5.1 Socio-economic Condition of the Village

The household level data on socio-economic background of the farmers, farming types, land size, farm income and food security of the farmers of the village provide an idea about the farming practices and its role on the livelihood sustainability of the villagers. The sample survey shows that only 4% of the total households of the village are engaged in the service sector and the rest 96% is in agriculture. Average family size of the sample households is 6 persons. Among the sample households, as many as 127 members are found to get involved continuously in agriculture where 73 (57.48%) are female farmers clearly indicating the dominant role played by the females in farming. During the off-farm season (January-February), some farmers are engaged in other activities like wage labour (14%), basketry (8%), honey collection (4%), driving (4%), masonry (6%), weaving (10%), gardening (4%) and petty vending (7%). It is also found that 66% of the surveyed households have livestock, mainly piggery and poultry. Table 1 gives a brief description of the methods of farming in Khonoma village.

Table 1: Households involved in different methods of cultivation

Method of cultivation	*No. of households*	*Percentage*
Only alder base *jhum*	2	4%
Only terrace (wet rice) cultivation	16	32%
Both *jhum* and terrace	32	64%
Kitchen garden	34	68%

It has been reported that the majority of the households (86%) of Khonoma village are self-sufficient in food production for the entire year, while 14% households need to purchase rice for some months of the year.

5.2 Agricultural System

The natural landscapes of Khonoma have been used by the villagers through generations based on their Indigenous knowledge and skills; and, as such, they have developed a sustainable land use system (Figure 3). The farming system operated by the villagers facilitated conservation as well as sustainable use of the natural resources. Three distinctive agricultural systems namely, alder based *jhum*, terrace farming and kitchen gardening are observed in the village. The cropping cycle of each of the farming systems is closely associated with the rhythm of monsoonal rain (Figure 4). *Jhum* cultivation begins in winter season (December-January) with the process of slash and burn. Sowing of seeds starts during pre-monsoon period (April-May). The Eastern Himalayan region generally receive good amount of rainfall during the pre-monsoon period, which favours the growth of *jhum* crops. Transplantation of wet rice is done during the month of June-July. Post-monsoon is the season of harvesting when the farmers remain busy in harvesting crops from both the *jhum* and terrace fields. Cropping during the winter season is very limited due to scarcity of water in the hill slopes. Vegetables are grown in the kitchen gardens and some parts of the terrace fields with the help traditional system of irrigation.

There is no use of modern agricultural inputs and implements in farming carried out in the village. Human labour provided by the family members is the most important input. The seeds come from the previous year's stock. The villagers have their own method of seed conservation. Only a small section of the farmers is found to purchase seeds of certain crops such as potato, carrot, cabbage, etc. from the market. The villagers follow a unique land tenure system. Lands used both for terrace and *jhumming* are owned individually. The farmers have no land records and they do not follow any standard land measurement. Most of the farmers have agricultural land both for *jhumming* and terracing. Every household on an average have 3.3 terraced plots and 2.4 *jhum* plots. The size of plots in terracing is very small as compared to the *jhum* fields. It is noteworthy here that the decision for selection of land for *jhum* cultivation, irrigation management, etc. is taken by the people collectively.

Figure 3: Pattern of Land use and land cover of the study village

5.3 Alder-Based jhum *Farming*

The Himalayan Alder tree (*Alnus nepalensis*) naturally grows throughout the Himalayan countries such as Afghanistan, Pakistan, Nepal, Bhutan, India, Myanmar and China (Kehie, Khamu and Kehie, 2017). Several studies have shown that the *A. nepalensis* has been widely used in traditional agroforestry system for hill slope land management and soil conservation (Huber, Matiu, and Hülsbergen, 2018; Rana *et al*., 2018). This tree hosts nitrogen-fixing bacteria, which help in enhancing soil fertility (Kehie, Khamu and Kehie, 2017; Rana *et al*., 2018; Rathore, Karunakaran, and Prakash, 2010; Sharma *et al.,* 2008). Alder tree-based agroforestry, mixed with various commercial crops like

cardamom, oranges, tea, etc., has been found economically helpful for the farmers (Mortimer *et al*., 2015; Sharma *et al.,* 2002). The Himalayan Alder is also a native plant to Khonoma village, which grows at an elevation of above 1,000 metres. The luxuriant growth of Alder trees in the mountains provides necessary base for the development of a unique system of shifting cultivation. Unlike the traditional *jhum* cultivation of North-East India, the villagers of Khonoma practise *jhum* cultivation in a different way. They cultivate a number of crops integrating with the Alder tree (Cairns, Keitzar and Yaden, 2010).

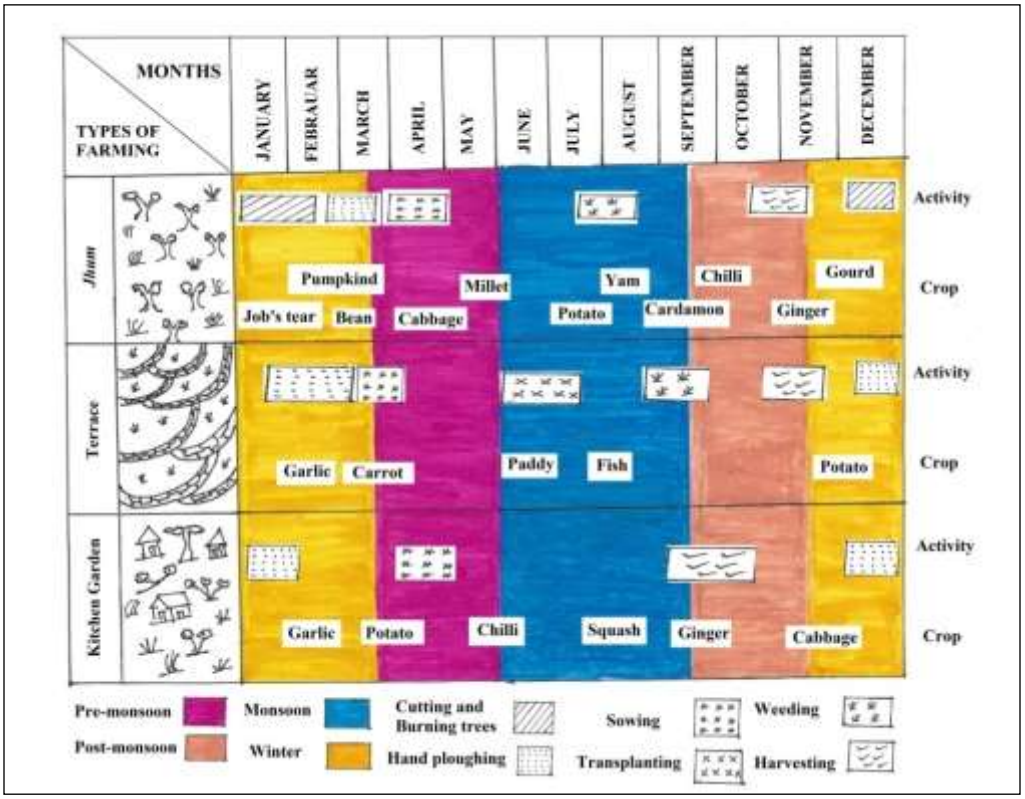

Figure 4: Farming cycle in Khonoma village

Before or after the slash and burn operation, the Alder trees are pollarded at the height of 2 meters from the ground. The vertical growth of the tree is restricted by pollarding the main trunk, leaving only few branches for apical growth. This practice not only keeps the crops underneath the trees from being shaded but also provides the benefit of fuel wood and organic manure. They use the pollarded branches as firewood and timber and the leaves and ashes of small tree branches as manure. As the growth of Alder tree is very fast, the branches become mature enough for *jhumming* within 5-6 years from the time of pollarding. Therefore, the farmers of this village can manage their *jhum* cycle within 5-6 sites of the forest patches without destroying the new forest lands. It is estimated that more than 80% of the firewood requirement of the village is met from the trees obtained from the *jhum* fields, which greatly reduces the pressure on the natural forest for firewood. Thus, the Alder-based *jhum* cultivation in Khonoma village sets a unique instance of ecological farming which, unlike the common *jhum* practice, does not cause forest loss and ecological imbalance in the mountain landscape of the Eastern Himalayas.

The villagers usually follow 5-6 years *jhum* cycle. After the pollardition and clearance of forests, they cultivate the land for two consecutive years. During this time, the growth of pollarded tree branches is restricted by cutting them carefully, and then for the next 3-4 years these are allowed to grow freely during the fallow period (Figure 5). Thus, the tree branches get enough time to grow and produce wood within the 5-6 years of *jhum* cycle. The farmers of Nagaland have also been practising various Indigenous soil conservation techniques for *jhum* land management (Singh, Devi and Singh, 2016). Usually during the rainy season, top soil of *jhum* fields, which contain enormous nutrients, gets eroded by the surface runoff (Yadav *et al*., 2006). To check such top soil erosion the villagers of Khonoma adopt the technique of contour bund using locally available natural materials such as stones, tree branches, log, bamboo, etc. The series of parallel as well as random bunds constructed by them across the hill slope minimize the speed of surface runoff and thus help in soil conservation.

The process of *jhum* cultivation begins with the clearing of forests by pollarding the Alder tree branches in the months of December and January. In January, they collect the dried branches for firewood and burn the slash (Figure 5). The activities such as digging of land for ploughing, mixing of ash and final preparation for sowing seeds are done in February and in the month of March generally seeds are sown. A number of crops such as potato, maize, bean, yam, pumpkin, cabbage, gourd, cucumber, etc. are grown together as mix-cropping. Job's tear (*Coix lacryma-jobi* L.) is sown in the month of April. Thus, the farmers apply intercropping methods in *jhumming*. July-August is the main harvesting season. In the second year, the same fields are used for cultivation of various cereal crops such as millet, sesame, etc. At present, farmers of the village have started cultivating large cardamom in some selected *jhum* fields

5.4 Terrace Farming

Like other communities of Nagaland, the Angami Naga farmers of Khnoma village have also some specific terraces for wet rice cultivation. Based on their Indigenous ecological knowledge and skills they have developed the terrace landscape in the valleys of the Dzüza and Khurü streams. These valleys are surrounded by hills and forests playing a significant role in the terrace farming. Besides these main streams, there are several small streams and springs originating from these hills, which provide necessary water to the fields. The soil characteristics and water quality of the terrace fields of the village are largely influenced by the natural forests around. Residual ash and other organic materials from *jhum* fields of the surrounding hills are drained to the valley to enhance the soil fertility. Therefore, the terrace fields adjacent to the hills have rich humus content that favours luxuriant growth of the crops. Based on the location the terrace fields of the village are divided into 14 units and each unit is identified with specific name like Ketsazhu, Keyafa Phi, Kenofú, Kelizü, Tehuphi, Chadaphi, Jüpfüzhu, Rülie liezú, Kerükhú, Nyúzekú, Púcha, Púgú, Mechakha, and Sikha liezú. Among these fields, Ketsazhu, Kerükhú, Chadaphi and Kenofú are the cold water fields, meaning the water of these fields remain cool as these are shadowed by the forests of the hills. Wet terraced paddy is the major crop of the village. The farmers cultivate various traditional rice varieties depending upon the suitability land (Table 2). In the cold-water fields, they plant the varieties suitable for cold-water environment. Similarly, the fields where the surface water becomes relatively hot due to direct sunshine insolation the

villagers cultivate certain rice varieties that can tolerate warm water. Thus, the farmers of the Khonoma have been preserving several traditional rice varieties through generations. Each rice variety has unique aromatic and morphological characteristics. In Khonoma village, as many as 20 local varieties of rice have been in use. The farmers are very sincere in conserving the seeds of the local rice varieties. The farmers also collect seeds from other farmers of the village or the neighbouring villages in exchange to their seeds. They do not use any kind of chemical fertilizer and pesticides. Cow dung, pig dung, chicken privy, rice husk and ash are mainly used in the terrace fields as manure.

Figure 5: Alder based *jhum* farming practices at Khonoma village (Photo Credit: Sourav Saha)

Note: **A**-Alder tree in fallow *jhum* field; **B**- Burning after pollarding; **C**-Soil protection bund suing stone; **D**- Tree branches lying on hill slope to minimize flow speed and top soil erosion; **E**- Branches growing out after pollarding; **F**-Mixed crop in *jhum* field

The farmers begin the process of field preparation in the months of December and January by ploughing the lands, which thereafter involve different stages of cultivation (Table 3). During February and March, they level the surface of the field by breaking the large pieces of soil called *Chickro* and then keep the field fallow until the arrival of monsoon. In the meantime, during January-February, the seedlings are raised in the fields over adjacent high lands adjacent. Irrigation canals are cleared with the onset of monsoon and water is drained to the fields during April-May. The sides of the plots are plastered with

soil paste to prevent water leakage except for the outlet point. The surface soil is turned and mixed so that the weeds get decomposed. Then the soil is levelled and bunds are plastered finally. During June-July, the rice seedlings are transplanted. Weeding is done after two-three weeks of transplantation. In October, again weeding is done before harvesting the crops. Some paddy fields are used for cultivation of potato, garlic and other vegetables during the *rabi* (December-March) season (Figure 6). However, large parts of the terrace fields remain fallow during this period due to scarcity of water.

Table 2: Traditional rice varieties cultivated in Khonoma village

Variety (Vernacular name)	*Morphological characteristics*	*Field condition*	*Uses*
1. Thevürü	Small, red,	Warm water	Food
2. Thevürü	Medium, round, white	Both cold and warm water	Food
3. Thevürü	Round and long, little tail, white	Both cold and warm water	Food
4. Ngoba	White	Warm and excess water	Food
5. Ngoba	Red	Warm and excess water	Suitable for eating
6. Ngodi	Red	Excess water	
7. Üisevolhunya		Cold water	Food, local beer
8. Rheninya	White	Cold water	Snakes and local beer
9. Krumiavinya	White	Cold water	Snakes and local beer
10. Dzükounya	Less production (cultivate only in one or two plots)	Cold water	Snakes and local beer
11. Kenonya		Warm water	Food
12. Shünino	Less cultivated now	Warm water	Food
13. Tsorenyü	White	Warm water	Food
14. Tekhwerü	White	Warm water	Food
15. Abor	White	Both cold and warm water	Food
16. Rosholha	White	Warm water	Food
17. Akaülha	White		Local beer
18. Mekrielha	Red, small, sticky	Both cold and warm water	Food
19. Mekrielha	White, long, less sticky	Both cold and warm water	Food
20. Mekrielha	White, long, long stem, high productive	Warm water	Food

Source: Focus group discussion with the farmers of Khonoma, 24 February 2021

Table 3: Works involved in terrace paddy field

Process	*Period*	*Work*
Tekhuhi	December-January	Digging soil/ plough the field
Niekrovü	February-March	Break the large pieces of soil into small size
Tekhunie	April	Watering the field first time through canal water and plastering the raised bund of plots
Sepuhu	May	To mix soil and to hide the grasses bellow the soil
Khopone	May	Final plastering the terrace *khupo* (bund) for water storage and flow
Tekhuse	June-July	Transplanting of paddy
Dzüva	August	Release water from the field and keep the field dry for 20 days to a month; weeding; shake the rice plant and scratch the roots so that the plant gets stronger and healthier
Khuporhe	August	Remove the grass from the border of the field and ensure the free flow of water (mainly do by women flock)
Thiphiviü	September	Remove the dry paddy leaves
Liekhro	October	Bind the paddy plants in bundles so that rice can be harvest easily
Liere	October	Harvest

Source: Focus group discussion with the farmers, February 2021

The farmers have traditionally developed a type of irrigation and water management system in their terraced wet paddy fields, which they call *Panikheti*. They channelize the hill stream water by constructing earthen canals and irrigate the terrace fields. The excess amount of water is transferred from one plot to another plot through specific outlets made in the fields' margin *khupo* (bunds). Bamboo pipes are commonly used for inter-field water supply. It is found that about 1/3rd of the terraced plots receive irrigation water throughout the year and remained wet, while other plots remained dry during the winter season. The plots, which receive water throughout the year, are more productive than the other plots. Ponds/ fisheries are most common in the terrace fields of the village. The farmers keep one or two *lha* (plot) of their wet plots as a pond for rearing fish and irrigating crops in the dry season (Figure 7). During June-July, the farmers release fish fingerlings in some paddy fields and harvest during October-November after the harvest of paddy. The farmers get extra benefits from the integration of fish farming in the paddy fields. It increases the soil fertility (adding nitrogen) and provides additional benefit to the farmers (Halwart, 1998; Saikia and Das, 2008). Some studies show that the rice yield is higher in fish-cum-paddy fields than the normal paddy fields (Lu and Li, 2006; Tsuruta *et al.*, 2011). In addition to pisciculture, the practice of apiculture (rearing of bee) is very common in the terrace fields of Khonoma. The farmers of Khonoma have skill of making beehives boxes by using tree trunks. They keep the beehive boxes on the *bunds* of terrace

fields for honeybee and, thus, get honey as an additional product. Thus, the farmers have skilfully used the *bunds* of the terrace fields for productive purposes.

Figure 6: Terrace fields during *kharif* (A,B) and *rabi* (C,D) season (Photo Credit: Sourav Saha)

Figure 7: Dry and wet terrace fields (A), beehives (B) and fisheries (C & D) in the terrace fields (Photo Credit: Sourav Saha)

Figure 8: Kitchen gardens backside the residential plots (Photo Credit: Sourav Saha)

5.5 Kitchen Garden

Kitchen gardening is also very common among the people of Khonoma village. Besides *jhum* and terrace fields, the vegetable farming is done in the small kitchen gardens located close to the residential areas. Average size of the kitchen gardens varies from 0.012-0.017 acre. As the agricultural fields, both *jhum* fields and terraces are far from the residential area, the villagers cultivate various vegetables for their daily consumption (Figure 8).

The villagers cultivate different season vegetables such as cabbage, king chilli, tomato, chayote, spinach, mustard leaf, ginger, garlic, onion, eggplant, potato, yam, pumpkin, etc. in their kitchen gardens. Like *jhum* and terrace fields, the farming methods in kitchen gardens are purely organic. Fire wood ash of their kitchen, pig dung and poultry's excreta are used as manure in these gardens. Kitchen gardens are mostly rain fed and sometime they irrigated from their households. The women are mostly taking care about the kitchen gardens. As the plots are tiny and much closed to residential area, they can nurture more intensely.

6. Conclusion

From the above discussion, it can be concluded that the indigenous Angami Naga tribal community of Khonoma village of Nagaland has successfully adopted micro-level location specific strategies for farming and maintaining sustainable agriculture practices. Their farming practices are not only ecologically adaptive but also economically sustainable. Except manual labour, capital investment for other input budgets are very negligible. The villagers do not use any chemical fertilizers and pesticides in their farmland.

The Alder-based shifting cultivation of the village demonstrates the effective use and conservation of forest and soil by limiting the process of deforestation. The practice of integrated pisciculture and apiculture in the wet terrace paddy fields of the village is a sustainable and effective for land and water management in the hilly environment. All the farming practices of the village are cost effective and the farmers are self-sufficient in terms of seeds, manure, etc. Maintenance of crop diversity through their age-old farming practices not only helps in conservation of agrobiodiversity but also provide scope for adaptation and development of climate resilient agriculture.

In the present context of climate change, rapid environmental degradation and forest cover loss, the traditional farming system practiced by the ethnic communities of the ecologically sensitive mountain areas of the Eastern

Himalayas set a good example of sustainable agro-ecosystem evolved locally by the people of the area. The traditional agricultural knowledge and skills of the Indigenous communities that they developed through generations have, of late, attracted attention of the ecologists, agricultural scientists and environmentalists because of the negative effect of the modern agriculture on the environment. This Alder based *jhum* and terraced paddy cultivation if diffused to other parts of the Eastern Himalayan region, may help in mitigating the problem of environmental degradation on the one hand and ensuring the livelihood sustainability of the mountain-dwellers on the other.

7. Acknowledgement

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	*Author 1*	*Author 2*	*Author 3*	*Author 4*	*Author 5*
Conceived and designed the research or analysis	Yes	Yes			
Collected the data	Yes	No			
Contributed to data analysis and interpretation	Yes	Yes			
Wrote the article/paper	Yes	No			
Critical revision of the article/paper	Yes	Yes			
Editing of the article/paper	Yes	Yes			
Supervision	Yes	Yes			
Project Administration	Yes	No			
Funding Acquisition	No	No			
Overall Contribution Proportion (%)	70	30			

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Research involving human bodies or organs or tissues (Helsinki Declaration)
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not a clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)
The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge
The author(s) solemnly declare(s) that this research has involved Indigenous Peoples as participants or respondents. The contexts of Indigenous Peoples or Indigenous Knowledge were also indirectly covered through literature review. Therefore, copy of a Consent Form and a Self-Declaration in this regard are appended along with this article.

Research involving Plants
The author(s) solemnly declare(s) that this research has involved the plants for experiment or field studies. Some contexts of plants are also indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

Research Involving Local Community Participants (Non-Indigenous) or Children
The author(s) solemnly declare(s) that this research has directly involved local community participants or respondents belonging to non-Indigenous peoples. However, this study did not involve any child in any form directly. The contexts of different humans, people, populations, men/women/children and ethnic people are also indirectly covered through literature review. A sample copy of the Consent Form implying prior informed consent (PIC) of the respondents is appended.

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

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INFORMATION AND CONSENT FORM FROM RESPONDENTS
(Non-Indigenous or Indigenous Respondents)
This form was translated into local language for the respondents

Title of the Research: Traditional Ecological Farming Practices in the Eastern Himalayan Mountain Environment: Case of a Naga Village, Nagaland (India)

Principal Researcher: Dr. Sourav Saha, Department of Geography, Mahapurusha Srimanta Sankaradeva Viswavidyalaya, Nagaon-782001, Assam (India)

Research Supervisor: Dr. Ratul Mahanta, Dr. Nityanana Deka and Dr. Abani Kumar Bhagabati Gauhati University, Guhahati-782001

A) INFORMATION TO PARTICIPANTS

1. Objectives of the research

The objectives of this study were to investigate the nature and investigate nature and types of traditional farming practices and crop cycles developed by the indigenous communities based on the local climate, ecology and indigenous knowledge system.

2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

4. Advantanges and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute nature and types of traditional farming practices and crop cycles developed by the indigenous communities

5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to opt out of the research, please contact the researcher at the telephone number or email listed below. At your request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

B) CONSENT

Declaration of the participant

- ⇨ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇨ I can ask the research team questions and ask for satisfactory answers.
- ⇨ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇨ I have read this information and consent form and agree to participate in the research project.
- ⇨ I agree that the interviews be recorded in written form by the researcher: Yes ( ) No ( )

Signature of the participant : _____ Date : _____21.07.2023_____

Surname : _____ _____ First name : _____ _____

Researcher engagement

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher : Date : 22-07-2023

Surname: Saha First name: Sourav

- ⇨ Should you have any questions regarding this study, or to withdraw from the research, please contact Dr. Sourav Saha by e-mail sourav.saha626@gmail.com
- ⇨ If you have any concerns about your rights or about the responsabilités of researchers concerning your participation in this project, you can contact the Dr. Ratul Mahanta, Department of Economics, Gauhati University, Guwahati-781014 Assam, by email rmeco@gauhati.ac.in

SELF-DECLARATION FORM

Research on Indigenous Peoples and/or Traditional Knowledge

1. Conditions of the Research

1.1 Was or will the research (be) conducted on (an) Indigenous land, including reserve, settlement, and land governed under a self-government rule/agreement or?

Yes

1.2 Did/does any of the criteria for participation include membership in an Indigenous community, group of communities, or organization, including urban Indigenous populations?

No

1.3 Did/does the research seek inputs from participants (members of the Indigenous community) regarding a community's cultural heritage, artifacts, traditional knowledge, biocultural or biological resources or unique characteristics/practices?

Yes

1.4 Did/will Aboriginal identity or membership in an Indigenous community used or be used as a variable for the purposes of analysis?

No

2. Community Engagement

2.1 If you answered "Yes" to questions 1.1, 1.2, 1.3 or 1.4, have you initiated or do you intend to initiate an engagement process with the Indigenous collective, community or communities for this study?

Yes

2.2 If you answered "Yes" to question 2.1, describe the process that you have followed or will follow with to community engagement. Include any documentation of consultations (*i.e., formal research agreement, letter of approval, PIC, email communications, etc*.) and the role or position of those consulted, including their names if appropriate:

First of all, the village headman of the local community was approached and consulted about the purpose of the study. Then with his help the other community members respondents were approached for a PRA meting and group discussions. They were consulted during the meeting. Verbal agreement was done for information use and analysis.

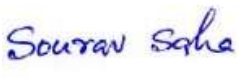
3. No Community Consultation or Engagement

If you answered "No" to question 2.1, briefly describe why community engagement will not be sought and how you can conduct a study that respects Aboriginal/ Indigenous communities and participants in the absence of community engagement.

Not Applicable

⇨ Name of Principal Researcher: Dr. Sourav Saha

⇨ Affiliation of Principal Researcher: Department of Geography, Mahapurusha Srimanta Sankaradeva Viswavidyalaya, Nagaon-782001, Assam (India)

Signature: 

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