Biodiversity Conservation And Socioecological Significance In Community Of Ukhrul Districts Of Manipur: A Case Study

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Abstract
Traditional communities around the world are confronting a variety of issues as a result of declining per capita land availability and a developing market economy. This has resulted in a shift in land usage in which polyculture of a variety of traditional crops is gradually being replaced by a market-driven monoculture system of agriculture to suit market needs on one side and maximise production on the other. As a result, traditional homegarden crops are under threat in many regions. To examine the impact of such change in terms of crop species and their socioecological significance, a study on conservation of traditional crops in homegardens in Tangkhul community in Ukhrul District of Manipur, India was conducted. In homegardens, 73 plant species with economic, social, and cultural significance from 27 families were identified. The findings of this study reveal that the Tangk hul traditional population possesses extensive indigenous knowledge of biodiversity protection in their small homegarden locations. Understanding traditional knowledge about HGs and how it influences species selection in the local community should aid in the development of improved techniques for the sustainable management of traditional homegardens. Traditional groups should be encouraged to conserve such rich biodiversity, and the government should offer adequate support so that they can withstand market-driven pressure.

Keywords: Crops, homegarden, Northeast India, Tangkhul, traditional community

1. Introduction

Natural ecosystems are undergoing extraordinary changes due to habitat loss, fragmentation, and conversion to agriculture (Laurance 2007). All of these changes have resulted in biodiversity loss, increased poverty, and increased greenhouse gas (GHG) emissions (Baral et al. 2014; Costanza et al . 2014: Liang & Liu 2017). The Conference of the Parties to the Convention on Biological Diversity has set a goal of reducing the rate of biodiversity loss by 2010. One of the promising options for meeting this goal is home gardening (HG) (Teklay et al. 2013). Homegardens, also known as compound farms, homesteads, or mixed gardens, are historically significant agro-ecosystems practised and managed by successive human societies around the world (Kumar & Nair 2004). There is mounting evidence that, due to their close resemblance to natural forests in structure and function, traditional homegardens would be an effective option for contributing to biodiversity loss reduction (Gardner et al. 2009; Teklay et al. 2013), as well as supplementing food production and livelihood opportunities for farmers (Brandt et al. 2012).

Homegardening is a traditional conservation agro-ecosystem where some native crop species are produced all over the world (Galluzzi et al. 2010). Various research on HGs have been conducted to understand their potential as a site for biodiversity conservation as well as how HGs can be used to reduce poverty through a complete and interdisciplinary assessment of their agrobiodiversity (Fraser et al. 2011; Reyes- Garcia et al. 2010; Salako et al. 2014). The significance of HG has been studied in South-East Asia (Wiersum 1982), Central Mexico (Ortiz-Sanchez et al. 2015), and West African countries (Salako et al. 2014). However, investigations on the important functions of HG in biodiversity conservation and food security of traditional communities have been few and far between in Northeast India's culturally rich Tangkhul group.

Peyre et al. (2006) investigated the dynamics of HGs in Kerala and discovered that the decline in species mix of trees and shrubs was caused by HG modernization. Thangjam and Arunachalam (2009) investigated traditional HG and its function in biodiversity conservation in three agricultural communities in Arunachal Pradesh, Northeast India, and found that HG includes a socio-religious dimension in addition to traditional dietary supplements. According to Kumar and Nair (2004), tropical HGs from peninsular India offer 70 to 84 percent of commercial timber requirements to local populations in addition to food supplements.

Although HGs are one of the most significant components of the traditional village ecology in Northeast India, research on their function in conservation, food security, and management methods is limited. Because crop species selection and cultivation are dependent on their availability (Gilmore et al. 2013), we can expect crop species use in HG to differ. People tend to retain native genetic resources around as readily available for food supplements and medicinal uses (Achigan-Dako et al. 2011; Horn et al. 2012), but we expect HG species will be used for a variety of purposes other than food and medicine. Traditional communities around the world have recently faced a number of issues as a result of declining per capita land availability and a developing market economy. This has resulted in a shift in land usage, with

conventional crop farming gradually being supplanted by market demands on one side and production maximisation on the other.
Ukhrul District is one of the highest districts in Manipur state, in northeastern India, and is home to the Tangkhul traditional community. The district is rich in biodiversity due to its location at the crossroads of the Eastern Himalaya and the Indo-Burma biodiversity hotspots. Many endemic and endangered flora and wildlife can be found in this area. The tremendous biodiversity of the woodlands is mirrored in the HG. Furthermore, HGs are traditionally cherished by these cultures, not just as a source of food supplements, but also for their diverse social and cultural characteristics. Such tribal community traditional knowledge must be understood in perspective of the function of HG in biodiversity conservation, food security, and problems posed by a changing global scenario. This study attempted to explore the function of traditional HG in biodiversity conservation as well as how the Tangkhul community managed to preserve such biodiversity in the face of a global changing scenario.

2. Biodiversity Conservation of Ukhrul Districts of Manipur

Biodiversity covers both biotic and abiotic variables that are necessary for human survival, such as temperature, food supply, species, and so on. There are approximately 8.1 billion species on Earth with different ecosystems, and another 1.4 million species with no defined ecology. It is a complete set of life, and the phrase biodiversity refers to the many different types of life on Earth. It refers to the species in the ecosystem. Individual species in our ecosystem have been developing over time. Species extinction has a significant impact on the remaining species in this framework.

The terrestrial environment and ecosystems are maintained by biodiversity. It aids in the preservation of the food chain, the control of environmental contamination, the preservation of healthy land, the provision of essentials to humans, and the generating of money. It serves a social, cultural, and economic purpose. However, because of changes in altitude, there is an unequal distribution of biodiversity from pole to equator. India ranks 15th in the world in terms of biodiversity heritage. According to the India Biodiversity Portal, we have about 58.1K species, accounting for 7% of global biodiversity. In recent estimate by CBD & IBPES, it is speculated that around 20% of the world plant species will be lost by 2025 if the current rate of plant genetic erosion continues. Over 1/4th of the entire species on earth may go extinct in the next 30 years.

Biodiversity conservation refers to the protection, management, regeneration, and preservation of genetic variety, species, and ecosystems. Extinction is a natural rule in which some species evolve while others become extinct. However, as a result of human activity, this has increased at an alarming rate. The primary causes of biodiversity loss are large-scale deforestation, forest fires, mining, building, and climate change. Overexploitation and unlawful hunting result in the extinction of species. Overpopulation creates more needs, which leads to an overuse of natural resources. Another element contributing to biodiversity loss is resource exploitation and urbanisation. Currently, one of the primary goals of institutions around the world is biodiversity conservation, which includes saving lives, preserving species, maintaining ecosystems, and creating a healthy environment for future generations. According to the biodiversity conservation programme, there are two types of conservation: in situ conservation and ex situ conservation. The former is the conservation of species in their natural habitats, whereas the latter is a created ecosystem condition to conserve species. Based on our culture, human resources, and financial situation, in situ conservation is acceptable in our scenario.

The forest is critical to the ecosystem's survival. The forest ecosystem determines the climate of a location and its inhabitants. To avert habitat loss, deforestation must be reduced. The total area of the Ukhrul district is 4,544 square kilometres including Kamjong District as per Global Forest Watch tool analysis. In 2010, Ukhrul had 380 Kha (Kilo hectare) of natural forest, extending over 86% of its land area. In 2020 alone, Ukhrul lost 2.89 Kha of natural forest, equivalent to 1.21 Mt of CO_2 of emissions. From 2001 to 2020, It lost 37.9 Kha of tree cover, equivalent to a 10% decrease in tree cover since 2000, and 16.0 Mt of CO_2 emissions. It adversely affects the water balance and reduces water retention capacity. With the loss of forest, water for the household also gets lost, consequently severe water scarcity in Ukhrul (Global Forest Watch).

According to the state forest report, Manipur has 77.2 percent forest cover, of which 23.95 percent is protected forest and 9.42 percent is reserve forest. Such forest mapping is critical in our region, which is primarily in non-protected areas, to keep the forest in check. To assess our forest structure, a controlled integration of protected and non-protected areas will be carried out. Forests housed both living and non-living natural resources, and they were a key source of food, wood, and a wide range of other items. Manipur is home to two of India's 34 biodiversity hotspots: the Indo-Burma Biodiversity Hotspot and the Himalaya Hotspot. The state is home to many endangered species, including Shirui lily (Lilium mackliniae), Sangai (Rucervus eldii eldii), Blythe's tragopan (Tragopan blythii), Assamese macaque, Hibbon, Rhododendron spp., Taxus spp., wuyawon (Caulokaempferia secund

Crop failure owing to climate change, frequent forest fires, increased occurrence of landslides, scarcity of water, and river floods due to rapid water burst have all occurred in recent years. The present epidemic is strongly linked to

biodiversity loss. These issues are becoming more prevalent in nearby villages. The government has taken attempts to alleviate the situation, and there has been some success in some places. For example, the Kyoto Protocols on Carbon Emission Reduction are a global Act that is being implemented in various parts of the world. There are a few other Acts to conserve biodiversity, such as the Convention on Biological Diversity of 2002, the India Forest Acts of 1972, and others, which emphasise the preservation, conservation, regeneration, and management of natural resources, as well as empowerment of the local population. Local communities and their practises are becoming increasingly important for global climate mitigation. They lend weight to a local action with global implications.

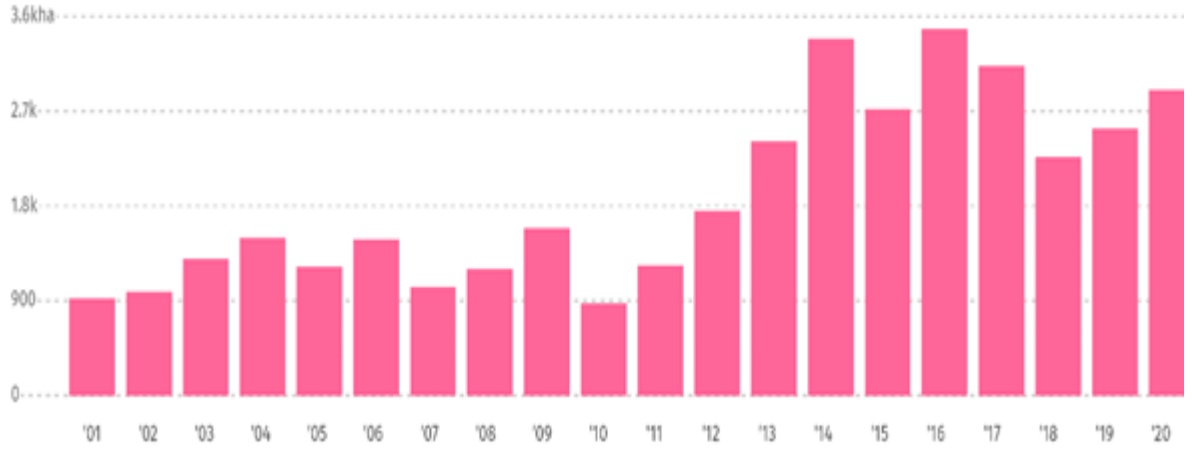

Figure 1: Tree cover loss in Ukhrul, Manipur estimated using Global Forest Watch.

From 2001 to 2020, Ukhrul lost 37.9 kha of tree cover, equivalent to a 10% decrease in tree cover since 2000, and 16.0Mt of CO_2 emissions. Y-axis indicates the tree cover extend in thousand hectares, and X-axis indicates the year from 2001-2020. (These estimates do not take tree cover gain into account).

There is a need to protect biodiversity, yet it is fraught with difficulty. Ex situ biodiversity conservation is expensive and requires resources. There are numerous unidentified species, making it difficult to keep track of everything. We live in an era when biodiversity loss is at an all-time high, fueled by a sedentary lifestyle and a greedy mindset. Given the enormous value of biodiversity loss, several initiatives are being conducted to restore it. Humans are the primary threats to the problems, as well as the only ones who can solve them. The amount of flora and fauna that exists is always a marvel, but while utilising these resources, prudent and sustainable approaches should be the primary focus.

2. Methodology

Study site

Ukhrul District is in northeastern Manipur, bordered by Mynmar in the east, Nagaland in the north, Imphal east and Chandel Districts in the south, and Senapati and Kangpokpi Districts in the west (Fig. 1). The district's geographical coordinates are 24°N-25.41°N and 94°E -94.47°E. The geography of the area is hilly, with elevations ranging from 913 to 3114 m amsl. The district's climate is pleasant most of the year, with temperatures ranging from 3 °C (lowest) to 33 °C (highest) (maximum). The average annual rainfall is approximately 85.31 cm (Feroze 2014). Five villages; Peh, Paorei, Phungcham, Lunghar and Hunphun (Ukhrul) were selected to carry out this study. All these villages are located in the northern part of Ukhrul District, Manipur.

These settlements are home to the traditional Tangkhul population, which is one of India's scheduled tribes. The owners were questioned about the crops they farm, cattle, management procedures, the significance of the HGs, and the manufacture of a variety of products from them. This set of communities has been sustaining HGs for a variety of reasons, including: I food production, (ii) ethnomedicinal plant production, (iii) livestock integration with agricultural crops, and (iv) conservation of traditional crop types (and/or foreign species).

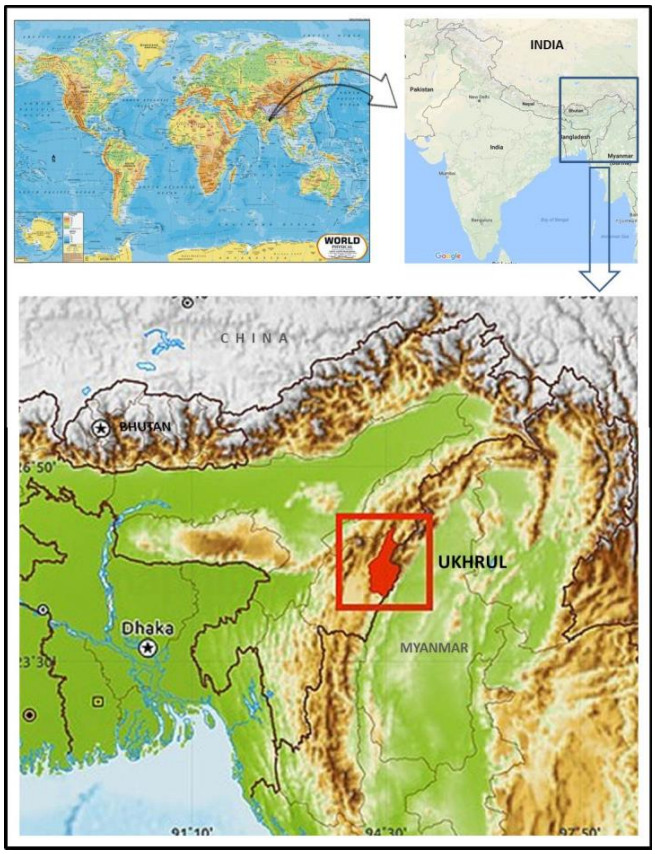

Figure 2: Study Site Ukhrul District, Manipur

Data collection and sampling

Ten plots (HGs) ranging in size from 0.75 ha to 2 ha were chosen at random from each hamlet, followed by identification of their owners for a focused interview. Semi-structured interviews (SSIs) were done in each hamlet with 20 participants (10 women and 10 men) ranging in age from 15 to 60 years. The purpose of the interview was to gain a more in-depth understanding of: I how homegardening is practised, (ii) what germplasms are used in HG, (iii) what roles male and female members of the family play, what are the economic benefits of HG, (v) what are the challenges in HG, and (vi) what are the changes in HG. From the data attempt was made to explore opportunities and mechanisms to accommodate the interests of women and men in homegardens and gain better control over homegardening and nutrition activities.

Focus Group Discussions (FGDs) were done with more knowledgeable individuals who have been practising homegardening for at least five years. Farmers who are married and whose main occupation is farming with their HG of at least one hectare in size are more knowledgeable in this area. The FGDs aimed to gather collective perspectives on how home gardens fit into men's and women's livelihood objectives and aspirations, as well as how home gardening might address nutrition inadequacies of household members in ways that empower women. The majority of the plant species were identified in the field as a result of published articles and reports. Herbarium sheets were created for those species that could not be recognised in the field, together with a record of the local name and uses. Photographs of such species were also taken in the hopes of identifying them in the future. Local and institutional taxonomists were consulted, and the prepared herbarium specimens were compared to published articles and specimens for identification.

4. Results and discussion

Location, content and size

Homegardens are an important land use in the Tangkhul people in Northeast India. Home gardens in all villages share several characteristics, including size, species composition, location, and even management strategies. The following characteristics were shared by all: I they were located adjacent (proximal/attached) to dwellings, (ii) soil fertility was maintained through nutrient supply from household organic waste, (iii) crops were in various vertical canopy layers, (iv) production was primarily for household consumption but surplus was sold, and (v) cropping was practised all year.

Table 1: Family-wise distribution of homegardens crops

Family	No. of species	Family	No. of species
Amaranthaceae	3	Musaceae	2
Amaryllidaceae	6	Myrtaceae	1
Apiaceae	6	Passifloraceae	1
Araceae	2	Pedaliaceae	1
Asteraceae	1	Plantaginaceae	2
Brassicaceae	2	Poaceae	3
Caesalpiniaceae	1	Polygonaceae	4
Caricaceae	1	Portulacaceae	1
Convolvulaceae	1	Rosaceae	4
Cucurbitaceae	8	Rutaceae	1
Fabaceae	7	Saururaceae	1
Lamiaceae	5	Solanaceae	9
Lythraceae	1	Zingiberaceae	6
Malvaceae	1		

Traditional HGs in the Ukhrul District range in size from 100 to 3000 m2. However, garden size does not equate to crop diversification because a wide range of crops can be cultivated in tiny sections of homegarden. This implies that, in addition to its manufacturing function, HG has social and cultural implications.

Biodiversity in homegardens

In total, 73 plant species with economic, social, and cultural importance from 27 families were identified in the research region (Table S1). One species has yet to be recognised, however its local names have been provided. All of the species can be classified according to their uses, which are I vegetables, (ii) spices, (iii) fruits, (iv) medicinal plants, opportunistic wild vegetables; not intentionally grown but useful, and (vi) others; used as juice (Saccharum officinarum), pigfeed (Portulaca oleracea), Tobacco (Nicotiana tobacum), and multipurpose plant (Bambusa nutans). Solanaceae has the most species with nine, followed by Cucurbitaceae with eight, Fabaceae with seven, and Zingiberaceae with six apiece (Table 1). There were twelve families which were represented by single species. Vegetable was the largest category with 34 species followed by spices with 13 species, fruit crop with 12 species, medicinal plants and opportunistic wild crops with 10 species each and others with 4 species, respectively (Fig. 3).

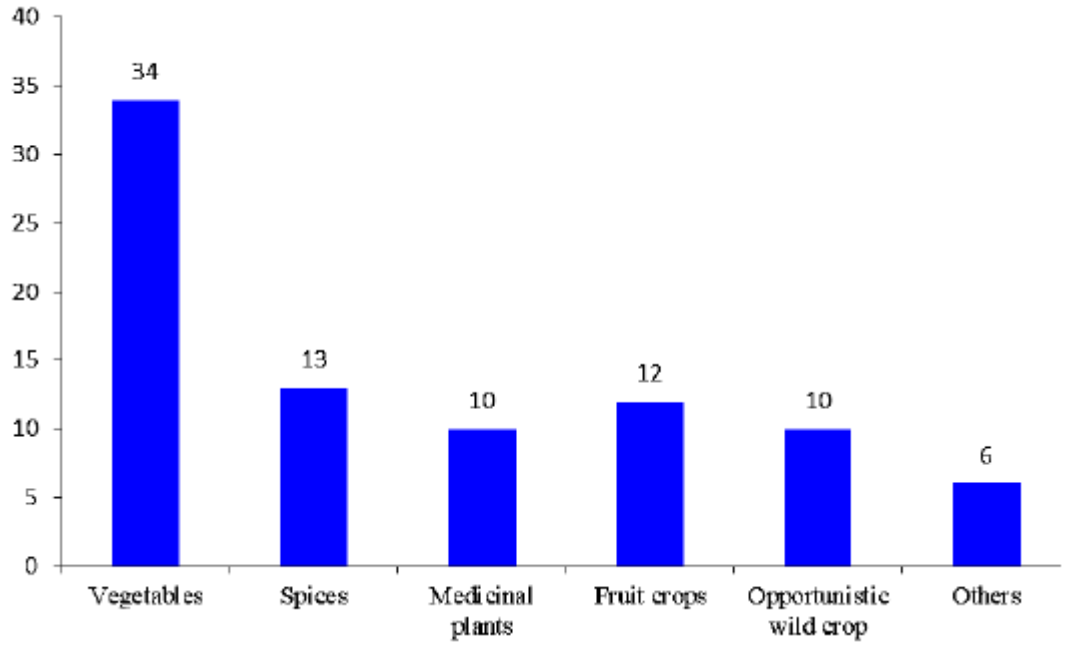

Figure 3: Distribution of crops on the basis of uses

Salako et al. (2014) discovered 285 species in three contrasting climatic zones of Benin, Africa, although these crops were mostly eaten as food and medicinal herbs. Crops were often sown in the gardens by farmers, although in some

HGs, crops regenerated naturally from seeds shed by the preceding generation. Such crops were planted in the garden as opportunistic crops, and their growth was aided by proper weeding and care. Like any other traditional HG of Northeast India, there was vertical stratification with a random mix of trees, shrubs, and herbs (Table 2).

Table 2: Distribution of species in different vertical canopy

First canopy	**Second canopy**		**Third canopy**	**Climbers**
Apium nodiflorum	*Abelmoschus esculentus*		*Parkia roxburghii*	*Benincasa hispita*
Brassica juncea	*Alocasia macrorrhiza/ A*	*locasia indica/*	*Carica papaya*	*Cucumis sativus*
Centella asiatica	*Alpinia galanga*		*Citrus jambhiri*	*Cucurbita ficifolia*
Daucus carota	*Brassica oleracea*		*Musa acuminata*	*Cucurbita pepo*
Lactuca sativa	*Capsicum annum*		*Prunus domestica*	*Ipomoea batatas*
Spinacia ol eracea	*Colocasis esculenta*		*Prunus persica*	*Momortica charantia*
Allium hookeri	*Lablab purpureus*		*Prunus rufa*	*Phaseolus vulgaris*
Allium sativum *Allium tuberosum*	*Perilla frutescens* *Sesamum orientale*		*Psidium guajava* *Punica granatum*	*Phaseolus* spp. *Pisum sati vum*
Apium graveolens *Coriandrum sativa*	*Solanum aethiopicum* *Solanum lycopersicum*		*Pyrus* sp. *Musa nagalandiana*	*Sechium edule* *Vigna species*
Curcumma longa	*Solanum melongena*			*Passiflora edulis*
Houttuynia cordata	*Solanum tuberosum*			*Cyclanthera pedata*
Menth a spicata	*Vicia faba*			
Plantago major	*Capsicum chinense X Capsicum frutescens*			
Eryngium foetidum	*Ocimum citriodorum*			
Momortica charantia	*Zingiber officinale*			
Centella asiatica	*Alpinia galanga*			
Fagopyrum acutatum	*Saccharum officinarum*			
F. cymosum	*Zea mays*			
Plantago major	*Amarunthus viridis*			
Polygonum chinense	*Chenopodium album*			
	Persicaria wallichii			
	Clerodendrum colebrookianum			
	Unidentified species			

But all the species are not scattered uniformly in the HG. Most of the top canopy species were usually located at peripheral areas. Trees such as *Prunus rufa* , *Pyrus, Bauhinia purpurea,* bamboo, *Passiflora edulis* and *Musa* species were grown at the periphery of the gardens while others such as *Carica papaya, Citrus jambhiri, Prunus domestica, Prunus persica, Psidium guajava* and *Punica granatum* were grown at the interior. The protection of such rich biodiversity in such a tiny area can be linked to the repositioning of extensive traditional ecological knowledge among local populations, which is part of the local community's cultural patterns. The intentional arrangement of crops in vertical and horizontal structures in the HG has been observed as an ecologically sound practise because such arrangements have many advantages such as I efficient utilisation of nutrients by different species, (ii) barrier for pests and insects, (iii) control of soil erosion by larger roots, and (iv) ensuring minimum loss during natural calamities such as landslide, hailstorm, winds, and physiological stress.

Traditional HGs of neighbouring communities such as *Nyishis* of Arunachal Pradesh were also rich in biological diversity harbouring many local crop species including the medicinal plants (Thangjam & Arunachalam 2009). But unlike the study area, the HGs in those areas were located primarily on low fertility soils that involve intercropping of cereals such as *Oryza sativa, Setaria italica* , *Zea mays, Manihot esculenta* , *Colocasia* sp,, *Solanum tuberosum, Dioscorea* sp., *Capsicum* sp. and *Solanum melongena* were common vegetable crops. Farmers in Northeast India's tribal communities could describe plant species that they have cultivated in their HGs and have direct management knowledge of, indicating their rich ecological knowledge that is largely practised in and along nature and is influenced by the interactive effects of ecological and socio-economic constraints. This study's Tangkhul traditional community has well created and maintained HG as an important ethno-agricultural land use system. Such significant diversification of crops maintained in HGs in limited areas demonstrates the type of traditional knowledge in efficient biodiversity management. The rich biodiversity of crops (73 species) retained in HG in this community is even greater than that maintained in a neighbouring state of Arunachal Pradesh's shifting agriculturalfield (Shimrah 2017). Van der Wal and Bongers (2013)

divided HGs in rural Mexico into three size categories: I small (less than 1,000 m2), (ii) intermediate (1,000 to 2,000 m2), and (iii) large (more than 2,000 m2). They observed that cultivating so diverse crops in such a small space requires strategies for optimising the use of space and resources such as light, nutrients, and water, which is true in the case of the Tangkhul village. Keeping such significant area under HG by every individual farmer indicates the socioecological significant roles of HGs in this community.

Agriculture is an ever-changing process. In the history of mankind, there has been ongoing improvement, transformation, and conversion. Vandermeer and Perfecto (2012) proposed that socio-ecological systems inside society drive agricultural productivity transformation. Changes in agricultural regimes in traditional communities are driven either outside or domestically. Changes in agricultural production regimes are caused by both external influences (such as market demands, availability of technology, chemicals, and global climate change) and internal ones (lack of labour, loss of soil fertility, commercial crops to fulfil farmers' requirements and lifestyle). Changes in grain production and conservation in HGs might have been easily implemented in traditional societies such as the Tangkhul community as a result of any of these influences. However, the fact that they have remained resilient in the face of such pressure demonstrates that there is a deep-rooted socioecological commitment to withstanding such forces. Such ecological information should be valued and encouraged by policymakers. The current study demonstrates that (1) the HG occupies a small area of the landscape, (2) all families have HG, (3) the garden contains a high diversity of plants, (4) the garden contains rich nutrient s in a sustainable manner through natural cycling and also supplement from kitchen organic waste, and (5) crops are planted densely and occupied most of the year, thus mimicking an HG as a mini-forest.

5. Conclusion

Although homegardens are a supplementary agroecosystem land use, they are an important feature of traditional societies. It provides fresh green veggies and fruits, as well as a conventional healthcare system. There is a repository of traditional ecological knowledge in such communities that goes unreported or is understudied due to their remoteness. The protection of such rich biodiversity must be valued, and government incentives for storing vast indigenous germplasms as well as traditional knowledge must be offered. Healthy relationships and collaborative conservation initiatives between scientific communities and traditional societies should be encouraged so that such rich native biodiversity does not suffer as a result of global change. Because local communities are biodiversity stakeholders, any policy that is enacted should involve them. A community-based conservation initiative should be recognised, and policy concerning biodiversity protection at the local level should be accepted directly from local communities. More research is needed on the role of homegardens as food supplements and adaptability to climate change, as well as assessing their economic worth, nutrition, economic growth, and gender concerns in traditional societies. Although HGs are used to supplement crop production in most parts of the world, its importance in the Tangkhul community has been diverse in terms of traditional healthcare, nutritional value, management, and recycling of organic household wastes, as all of the nutrients in HG come from kitchen wastes. Furthermore, the protection of such abundant biodiversity inside the village environment is noteworthy and ought to be recognised in the scientific community.

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