Tradition in transition: the transformation of traditional agriculture in Arunachal Pradesh, North East India

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It has been observed recently that the majority of farmers in North East India have shifted their attention towards traditional agroforestry practices owing to their economic and ecological values. We conducted an extensive survey in three districts of Arunachal Pradesh, India, namely, Kra Daadi, Lower Subansiri and Papum Pare. The study focused on the imperative of agroforestry practices in terms of socio-economy, livelihood, food security and the existing constraints hampering the development of agroforestry practices. The traditional agroforestry has replaced the old way of jhumming that registered a decline of at least 70%–80% during the last 15 years. The practice of traditional agroforestry in this region displayed several social, environmental and economic benefits leading to the growth of adoption for sustainable development.

Keywords: Jhum cultivation, livelihood, socio-economy, sustainable development, traditional agroforestry.

JHUM is a traditional land-use system in which a patch of the forest is removed for agricultural cultivation for a few years, which is then shifted to a new site for the next cycle. The procedure entails clearing a forest tract, crop cultivation for 1–3 years, and then a fallow period during which cultivation is stopped to allow the soil to recover its fertility[1]. It contributes significantly to biodiversity protection, soil and water conservation, and climate change mitigation[2]. The practice of shifting cultivation is widely prevalent in North East India (NEI)[3]. This custom is considered to have developed as part of the culture of those who live in the hills and is intimately linked to socio-cultural practices and religious beliefs[4]. NEI is one of the world's biodiversity hotspots, the Indo-Burma biodiversity hotspot, and is located at the crossroads of the Indo-Chinese, Indo-Malayan and Indian biogeographical worlds[5].

Shifting cultivation remains an important system for food production in the hilly terrains of NEI because it was found to be best suited for the climatic, edaphic, topographic and socio-economic milieu of that region. However, soil erosion, nutrient loss and other problems related to the ecosystem resulting from the short fallow period, are causing deterioration in the soil health, low crop yield leading to poverty and the food insecurity among the farmers[6]. Shifting cultivation is a subsistence farming method that is inefficient, damages soil quality, destroys biodiversity and forests; hence its practice has to be ceased.

Almost all the indigenous mountain communities in NEI region utilize a variety of traditional agroforestry (TAF) methods, which are popularly regarded as sustainable land management approaches[7]. The most tested land-use solution to curbing the practice of slash-and-burn cropping has been the establishment of site-specific and sustainable agroforestry models[8]. According to Tscharntke *et al.*[9], the practical benefits of agriculture in the form of fuel, fodder, lumber, fruits and medicines assist farming communities in generating revenue and alleviating poverty.

Different indigenous communities residing in different parts of Arunachal Pradesh, NEI, have been practicing this agriculture since time-immemorial. Agroforestry, in general, is the integration of tree species with crop plants to derive more economic benefits. One of the major differences of this practice is that, like the pure jhum practice, the plot of cultivated area need not be shifted periodically. It is practised in a particular piece of land for a long time, where different trees and crops are grown. The recent boom in the cultivation of cardamom on a large scale has changed the scenario of traditional agricultural practices especially in Kra Daadi and Lower Subansiri districts of Arunachal Pradesh. Farmers in the Eastern Himalayas have modified their traditional practice of crop rotation in accordance with the different environmental factors and agronomic requirements to counter the dangers to soil health posed by shifting agriculture, firewood and timber collection. These practices are mostly sustainable from the ecological point of view[10].

Materials and methods

Study area

Arunachal Pradesh is the largest (area ~84,000 sq. km) among the eight NE Indian states and is popularly known

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Figure 1. Map of Arunachal Pradesh, North East India, showing the study areas (Papum Pare, Lower Subansiri and Kra Daadi districts).

Table 1. Literacy rate and population/family size of the interviewed farmers of Papum Pare, Lower Subansiri and Kra Daadi districts, Arunachal Pradesh, North East India

Size	Literacy rate (%)	Average family size	Male/female ratio
Small	76.47	6.43	1.80 : 1
Medium	75.5	6.44	2.33 : 1
Large	75.9	6.19	1.66 : 1

Table 2. Land size allocation or landholding or farming unit of Papum Pare, Lower Subansiri and Kra Daadi districts of Arunachal Pradesh

District	Small (%)	Medium (%)	Large (%)
Papum Pare	46.66	20	33.33
Lower Subansiri	21.33	24	54.66
Kra Daadi	16	21.33	62.66

as the 'Land of the Rising Sun'. It is located at 26°28′–29°30′N and 91°30′–97°30′E and is predominantly hilly and mountainous. The state is notable for its diverse flora and fauna and is recognized as one of the world's 200 most important ecoregions[11].

The present study was carried out in three districts of Arunachal Pradesh, namely Kra Daadi, Lower Subansiri and Papum Pare, during 2019–2020 (Figure 1). The Kra Daadi district lies between 27°38′–27°43′N lat. and 93°42′ to 93°37′E long., with elevations ranging from 1080 to 2060 m amsl. Between 92°40′–94°21′E long. and 26°55′ and 28°21′ N lat. is the Lower Subansiri district. The Papum Pare district spans 26°55′–28°40′N lat. and 92°40′–94°21′E long.

Local farming households were approached with verbal consent and a structured questionnaire. The objectives of the study were explained to ensure the proper collection of information. Three complementary approaches were adopted to obtain information, which included formal interviews targeting local experienced persons (aged between 30 and 65 years), field visits and interactions usually involving more than two members of the farming households through a structured questionnaire. The food insecurity assessment was followed using the method of Food and Agriculture Organization (FAO)[12].

Results

Socio-economic status

The study sites recorded the highest literacy rate among the small-scale agriculture practitioners (76.47%), followed by large-scale (75.9%) and medium-scale (75.5%) farm holders. The average family size was recorded highest in medium-scale farmers (6.44), followed by small- and large-scale farmers. The male–female ratio (interviewed persons) was found to be higher among the medium-scale farmers (2.33 : 1) followed by small-scale (1.80 : 1) and large-scale (1.66 : 1 farmers) (Table 1).

Small-scale farmers of Papum Pare district allocated most of their landholdings to agriculture (46.66%), while it was the least in Kra Daadi district (16%). Among the medium-scale farmers, it was highest in Lower Subansiri (24%), followed by Kra Daadi (21.33%) and Papum Pare (20%). In the large-scale farming sector, farmers of Kra Daadi district allocated most of their landholding to agriculture (62.66%), followed by Lower Subansiri (54.66%) and Papum Pare (33.33%) districts. Forest farming in the Kra Daadi district occupied most landholdings allocated for cultivation purposes (Table 2).

Table 3. Land-use pattern in Papum Pare, Lower Subansiri and Kra Daadi districts of Arunachal Pradesh

Size (total no.)	Wet rice cultivation (%)	Private forests (%)	Land under traditional agroforestry systems (%)	Jhum land (%)
Small (63)	23.80	33.33	15.87	26.98
Medium (49)	22.44	32.65	22.44	22.44
Large (113)	25.66	23.00	23.89	27.45

Table 4. Tree–crop combination in traditional agroforestry systems in Papum pare, Lower Subansiri and Kra Daadi districts of Arunachal Pradesh

District	Agroforestry system	Preferred tree-crop combination
Kra Daadi	Forest farming	Hollock + bamboo + *Litsea cubeba* + cardamom
		Saurauia sp. + *Bauhinia variegata* + bamboo + cardamom + colocasia
	Farm forestry	Cardamom + orange + pineapple + *Livistona jenkinsiana* + *Phoebe* sp. + hollock
	Agrisilviculture	Mustard + sesamum + cardamom + *Phoebe* sp. + *Litsea cubeba* + *Pandanus* sp.
		Rice + millet + *Phoebe* sp. + guava + pear
		Tea + guava + *Pandanus* sp. + jackfruit + bamboo + *Magnolia champaca*
	Silviagriculture	Hollock + *Phoebe cooperiana* + bamboo + cardamom + mustard + cabbage + potato + Ladies finger
	Agrihorticulture	Ginger + *Curcuma longa* + pineapple + banana + orange
		Colocasia sp. + guava + bamboo + orange + banana + *Litsea cubeba*
	Hortisilviculture	Orange + banana + pineapple + *Phoebe cooperiana* + *Litsea cubeba*
		Pineapple + Banana + Guava + *Phoebe* sp. + hollock + *Magnolia* sp.
	Agrisilvifishery	Vegetable crops + multipurpose trees around or near fish ponds
Lower Subansiri	Agrifishery	Rice + fish farming
		Rice + maize + beans on the bunds of rice fields
	Agrihorticulture	Mustard + cabbage + kiwi + strawberry
		Maize + beans + pumpkin + mustard + apple + plum
		Soybean + mustard + kiwi + strawberry
	Hortiagriculture	Apple + pear + plum + mustard + beans + cabbage
		Pear + strawberry + tomato + cabbage + chilli
		Plum + cabbage + chilli + tomato + cucumber
		Strawberry + beans + *Citrus* sp.
		Jackfruit + peach + chilli + colocasia + beans
	Farm forestry	Bamboo + pine tree
Papum Pare	Agrihorticulture	Rice + cococnut + pineapple + black pepper + arecanut
		Potato + beans + colocasia + pineapple + mango
		Maize + *Livistona jenkinsiana* + black pepper + arecanut
		Mustard + cucumber + pumpkin + arecanut + coconut
	Agrisilviculture	Chilli + tomato + lemon + arecanut + *Elaeocarpus floribundus*

The area under forest occupied most of the landholdings of the farming communities in the studied areas. It was recorded that large-scale farmers allocated 23.89% of the landholdings towards the development of TAF and 27.45% for jhum cultivation (Table 3).

Agroforestry systems and tree-crop composition

Different types of agroforestry systems were recorded in all the three studied districts. The most common were agrihorticulture and Agrisilviculture. The tree-crop combination of the agroforestry systems varied from place to place depending upon elevation, climate, soil and socio-cultural factors. Table 4 presents the most commonly seen tree-crop combination of the agroforestry systems of the three studied districts.

Status of jhum and TAF

The Lower Subansiri district showed the highest number of farmers practising TAF (73%), followed by Papum Pare (50%) and Kra Daadi (49%). Jhum cultivation was mostly practised in Kra Daadi district (25%), followed by Papum Pare (18%) and Lower Subansiri (12%) (Figure 2).

There has been a progressive advancement in the adoption of TAF over jhum cultivation in recent decades owing to various factors such as soil fertility and growing food demand due to the increase in population (Figure 3). Among the farmers of the studied areas, Kra Daadi district had the highest number of jhum practitioners (81%), followed by Papum Pare (71%) and Lower Subansiri (31%) before 2010, which declined sharply after 2010.

The Lower Subansiri district had the highest record of TAF adopted by farmers (88%), followed by Papum Pare (82%) and Kra Daadi (75%). It has been observed that the adoption of TAF has been rapidly increasing in Kra Daadi compared to the other two districts after 2010.

Jhum cultivation has been practiced by the tribal communities of the three studied districts for generations with different perspectives (Figure 4). The Kra Daadi district (49%) had the highest number of farmers adopting jhum as subsistence farming, followed by Papum Pare (42%) and Lower Subansiri (38%). Jhum for income generation was highest in Papum Pare district (35%), followed by Lower Subansiri (33%) and Kra Daadi (30%) district. The Kra Daadi district was also the highest in adopting jhum for traditional and cultural purposes (29%), followed by Papum Pare (23%) and Lower Subansiri (21%) districts.

Food security

The food insecurity survey in the three districts revealed the highest food security status (C1) in Lower Subansiri district (79%) and the least in Kra Daadi district (20%). The highest mildly food insecure status (C2) was recorded in Kra Daadi (40%), followed by Papum Pare (31%) and Lower Subansiri (17%) districts. Moderate food insecure status (C3) was highest in Kra Daadi (34%), followed by Papum Pare (18%) and Lower Subansiri (4%) district. The Lower Subansiri district recorded negligible in severely food insecure status (C4) (Figure 5).

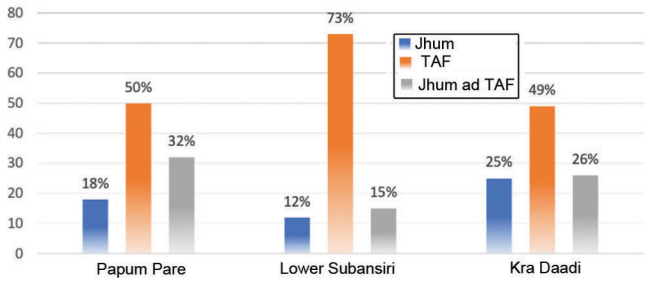


Figure 2. Households practising jhum, traditional agroforestry (TAF) and both TAFs and jhum in Papum Pare, Lower Subansiri and Kra Daadi districts, Arunachal Pradesh.

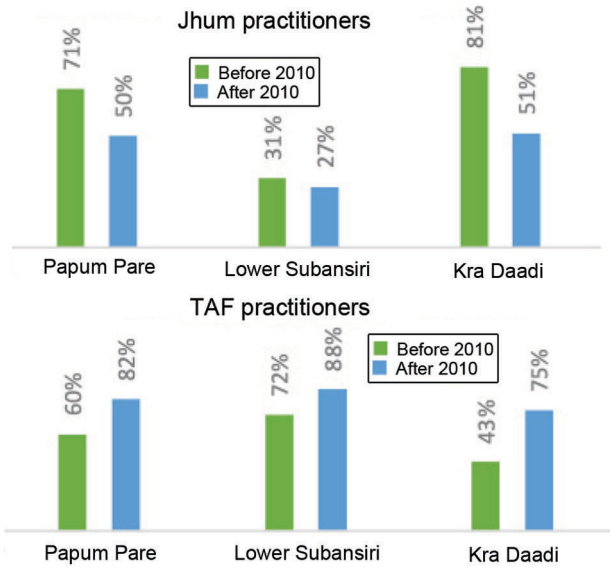


Figure 3. Advancement in the adoption of agroforestry in the recent decade (before and after 2010) in the studied areas.

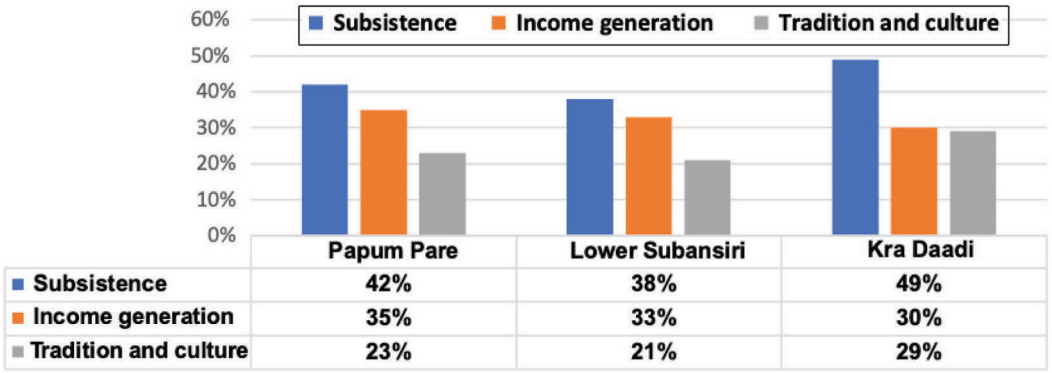
Discussion

Many tribal societies in tropical and subtropical areas have traditional knowledge for conserving natural ecosystems and biodiversity[13,14], as it has the potential to develop agroforestry systems for more efficient livelihood and income generation. Farming communities of the hill tribes, however, are associated with jhum cultivation which has been the mainstay of rural livelihood for decades. Although jhum cultivation has many pros and cons, its popularity has sharply decreased with the adoption of more ecologically and economically efficient agroforestry systems in recent decade.

The integration of several factors like irrigation schemes, training programmes, seed subsidies, proper technical inputs and creating links to better agricultural market places has resulted in a multifold increase in the adoption of settled agriculture in various states of NEI[15]. The present study shows the diversity of agroforestry systems in practice along with TAF in Arunachal Pradesh. The tree-crop combination of different agroforestry systems varied in all the three studied districts according to the elevation, climatic conditions, soil, and edaphic factors as well as socio-cultural factors. More crops were grown using TAF than jhum cultivation. This can be linked to the constraints of crop management in remote hilly terrain. From the farmers' perspective, altitudinal fluctuation is crucial in determining which tree–crop combinations are the most profitable. The primary tree–crop combination in the Kra Daadi district was cardamom and orange along with various multipurpose trees (MPTs) like *Phoebe cooperiana*, *Terminalia myriocarpa*, etc. Both farm forestry and forest farming were prevalent in the Kra Daadi district. Most of the allocated landholding of farmers for cultivation was confined to forest farming of *Ammomum subulatum* (black cardamom). In the three studied districts, agrihorticulture and agrisilviculture were prevalent. The most commonly grown commercial crops included orange and cardamom. In Ziro Valley, Arunachal Pradesh, largely inhabited by the Apatani community, kiwi was grown on a commercial scale. The most common crops and vegetables grown in home gardens included cabbage, tomato, chilli, etc., which were generally intercropped with fruit trees such as pear, plum, peach, apple, etc. Orange trees intercropped with pineapple were dominant in the farmlands of the Lower Subansiri district. Farm forestry was also a popular practice,

Table 5. Crops grown in jhum fields and traditional agroforestry systems in Papum Pare, Kra Daadi, Lower Subansiri districts of Arunachal Pradesh

Traditional farming system	Crops
Jhum	*Colocasia* sp., *Cucurbita maxima*, *Cucumis sativus*, *Glycine max*, *Lycopersicum esculentum*, *Zingiber officinale*, *Brassica rapa*, *Zea mays*, *Capsicum chinensis*, *Capsicum annum*, *Solanum melongena*, *Phoebe* sp., *Allium sativum*, *Pisum sativum*, *Solanum tuberosum*, *Curcuma longa*, *Allium cepa*, *Eleusine coracana*, *Musa* sp., *Clerodendrum coolebrookianum*, *Solanum torvum* and *Solanum nigrum*
Traditional agroforestry	*Ammomum subulatum*, *Citrus limon*, *Musa* sp., *Actinidia deliciosa*, *Citrus sinensis*, *Diospyros* sp., *Juglans regia*, *Malus domestica*, *Prunus communis*, *Prunus domestica*, *Prunus persica*, *Psidium guajava*, *Mangifera indica*, *Mangifera sylvatica*, *Brassica juncea*, *Brassica oleracea* var. *botrytis*, *Brassica oleracea* var. *capitata*, *Brassica oleracea* var. *italica*, *Brassica rapa*, *Capsicum annuum*, *Cucumis sativus*, *Cucurbita maxima*, *Daucus carota*, *Glycine max*, *Hibiscus esculentus*, *Lycopersicum esculentum*, *Momordica charantia*, *Phaseolus vulgaris*, *Pisum sativum*, *Raphanus sativus*, *Solanum tuberosum*, *Solanum melongena*, *Spinacea oleracea, Vigna umbellata*, *Allium cepa*, *Allium sativum*, *Coriandrum sativum*, *Curcuma longa*, *Zingiber officinale*, *Eleusine coracona*, *Fagopyrum esculentum*, *Hordeum vulgare*, *Zea mays*, *Acer laevigatum*, *Alnus nepalensis*, *Castanopsis* sp., *Abies* sp., *Pinus longifolia*, *Pinus roxburghii*, *Quercus* sp, *Dendrocalamus hamiltonii* and *Phoebe* sp.



	Papum Pare	Lower Subansiri	Kra Daadi
Subsistence	42%	38%	49%
Income generation	35%	33%	30%
Tradition and culture	23%	21%	29%

Figure 4. Number of households practising jhum for various purposes in Papum Pare, Lower Subansiri and Kra Daadi districts, Arunachal Pradesh.

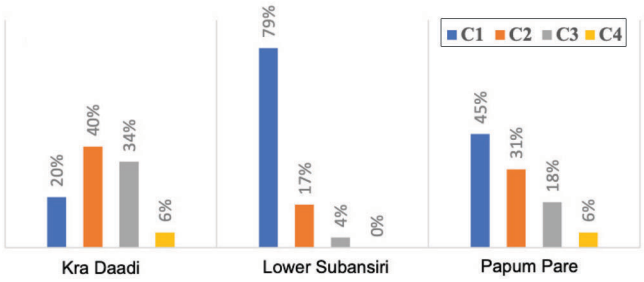


Figure 5. Food insecurity status of Kra Daadi, Lower Subansiri and Papum Pare districts, Arunachal Pradesh. C1, Food secure access; C2, Mildly food insecure access; C3, Moderately food insecure access; C4, Severely food insecure access.

where pine trees were grown along with bamboo and other MPT.

Studies have emphasized the integration of indigenous fruit trees (IFTs) with crops in southern Africa[16]. The hazards of monoculture farming systems of staple food crops, such as pest and disease susceptibility and soil nutrient depletion, have been proven to be mitigated by tree-and-crop production methods[17].

The unique traditional paddy-cum-fish farming practice of Ziro valley provides a stable seasonal income for the farmers. Palm and areca nut were the most dominant components of home gardens with a large diversity of crops in the Papum Pare district. Agri-piscicultural system was found in all three districts, where fish ponds were maintained within or near agricultural farms.

The present study suggests increased adoption and establishment of TAF and homestead agroforestry system, replacing the old jhum farming culture. Farming households nowadays consider socio-economy, productivity (quality and quantity) and labour as the main factors in the change of farming culture from jhum to TAFs. The survey data in Figure 3 depict the total number of jhum practitioners in all the three studied districts before and after 2010. It can be observed that there is a significant reduction in the number of jhum practitioners in all the three districts. Kra Daadi had the highest number of jhum practitioners and Lower Subansiri had the least number before 2010. After 2010, Lower Subansiri had the maximum number of TAF practitioners, followed by Papum Pare and Kra Daadi districts.

This study reveals that a few farming households still practise shifting cultivation. This old farming system has been practiced for various reasons, including subsistence, income generation, and also for conserving tradition and

culture. Most of the rural households practiced jhum for subsistence and minimal income generation. Few of them practiced it as a part of their tradition and culture since jhum linked them to their roots. The fallow period usually involves a cycle of three years. However, during this gap, there is regeneration of new plants which becomes a grazing ground for domesticated animals like cows and goats, mithun (semi-domesticated) and other wild animals. This is one of the major advantages of jhum practice. Moreover, more than 20 crops are grown annually, which makes a farming family food secure and economically stable. Even though the practice of shifting cultivation has been one of the major systems contributing to the livelihood of the hill people, there is a progressive decline in its practice.

The food security status clearly shows that the farming population in Lower Subansiri was the least food insecure, followed by those in Papum Pare and Kra Daadi. This can be linked to the highest adoption of economically efficient agroforestry systems by the tribal communities of the Lower Subansiri district.

Conclusion

Jhum cultivation has been the mainstay of survival for many tribal communities for ages. However, there is a sharp decline in the practice of jhum cultivation which is related to low fertility and low yield due to a shorter fallow period leading to less income generation, which does not fulfil the basic needs of marginal farmers. Although jhum cultivation is a centuries-old technique, it is expensive and lacks a systematic approach. Another significant reason for its decline is the lack of proper transportation facilities and poor road conditions due to torrential rainfall in these areas. With the expanding population and demand for food among the tribal communities, there is a need to adopt a new farming strategy that may provide consistent year-round income. This has gradually led to the adoption of TAF, which is less intensive than modern agroforestry systems. TAF in Arunachal Pradesh is found to be a more efficient food-producing subsistence farming system than jhum, which provides ample opportunities to improve the livelihood of farming households, along with ecological as well as economic stability. Therefore, the TAF can be regarded as a substitute for jhum cultivation to promote sustainable livelihood in the hilly regions of Arunachal Pradesh.

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