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Plant Composition in Traditional Homegardens of Berung Village, East Siang, Arunachal Pradesh

***Yogesh Kumar*[*1], *Haffis Mohammed*[2], *Aditya Pratap Singh*[3], *Thiyam Jefferson Singh*[4], *Tantulung Tatan*[4], *Kabir K.*[4], *Sagar Tasing*[4], *Telek Yoka*[4] *and Hashim Mohammed S.*[5]**

[1]*Department of Silviculture and Agroforestry, College of Forestry, ACHF, NAU, Navsari, India.*
[2]*Department of Natural Resource Management, College of Forestry, KAU, Thrissur, India.*
[3]*Department of Genetics and Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, (West Bengal), India.*
[4]*Department of Silviculture and Agroforestry, College of Horticulture and Forestry, CHF, CAU, Pasighat*
[5]*Center for the Study of Regional Development, JNU, New Delhi, India.*

(Corresponding author: Yogesh Kumar)*
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ABSTRACT: The present study was carried out in Berung village of Arunachal Pradesh to investigate the species diversity in the traditional homegardens and their traditional uses by the locals. The study revealed that stratification of plant species was common in homegardens, which makes them typical agroforestry systems that are somewhat similar to forests. Based on the average height of the plant species, the study showed four different strata. Of the recorded 80 species, there are 9 categories of plants with different traditional uses based on the products derived from the spp. *viz.*, fruits, vegetables, cereals, medicines and tannin, timber, grasses for thatching and broom making, and fuelwood. Out of the total percentage of plants in the traditional homegardens, 23% were found to be used for vegetable purposes, whereas 20% for medicinal and 19% were fruit-yielding plants.

Keywords: Homegardens, Stratification, Species diversity, Plant uses, Traditional, Survey

I. INTRODUCTION

With escalating deforestation and declining forest cover across the world, the preservation of biodiversity today has become a major concern for scientists and researchers alike. Northeast India, as a part of the Indo-Burma biodiversity hotspot in the world, is blessed with very abundant biodiversity, supporting nearly about 50% of India's biodiversity (Mao and Hynniewta, 2000; Paul *et al*., 2005). Besides declining forest cover in the country, this region has also been witnessing rapid deforestation (Ramakrishnan, 1984; Gupta *et al*., 2005; Reddy *et al*., 2015). Arunachal Pradesh, inhabited by indigenous tribal people, with 26 major ethnic groups and more than 100 sub-tribes, is one the remotest regions of the northeastern Himalayan region of India. The state is hospice to various endemic, rare, and endangered species of flora and fauna. The state has witnessed a significant population growth over the last few decades (Census of India, 2011; Kanwal, 2014), and the forest resources of the state have started to deteriorate along with this growth (Bhuyan *et al*., 2003; Lele and Joshi, 2009; Ravindranath *et al*., 2012), especially due to expanding human settlement, cultivation practices like Jhum cultivation and changing livelihood dependency of people in the region (Lele and Joshi, 2009; Tangjang and Nair, 2016; Tsering *et al*., 2019). In such scenario of deforestation and endemic biodiversity loss, many researchers and conservationists have claimed that agroforestry practices such as homegardens can prove to be an important means of preserving biodiversity.

Homegardens are biodiversity-rich agroforestry practices maintained based on choice, needs and value of plants (Babu *et al.*, 1982). It is a traditional land use practice around a homestead where several plant species are raised and maintained by family members and the products derived are intended primarily for household subsistence (Shrestha *et al.* 2001). Homegarden is generally accepted to be an economically viable, environmentally sound and biologically sustainable agroforestry system (Fernandez and Nair 1986). Homegardens have been getting very popular and are attracting considerable attention from researchers during the past three decades due to broad future possibilities and reasons. The main reasons are:

(i) Homegardens contain characteristics making them interesting models for research and design of sustainable agroecosystems. Some of the futures include effective nutrient cycling, high biodiversity and very less external inputs required and high potential of soil conservation. (Jose and Shanmugaratnam, 1993; Torquebiau, 1992),

(ii) They provide a diverse and sustainable provision of social and economic products and benefits to the families (Christanty, 1990). Compared to other agricultural or horticultural practices, homegardens are diverse in species and well suited for *ex-situ* conservation of many rare, endangered and wild varieties of crops.

With the global population expected to rocket over 9 billion individuals by 2050, there is an ever-increasing need to increase food production and secure stocks. In this context, countries across the globe, especially developing countries where food insecurity and food insecurity are rampant, are resorting to different counter strategies to address growing needs and to avoid food

shortages and famines (Shrivastava and Heinen, 2005). Over the past few year there has been growing interest in nourishing and intensifying local food production to alleviate the negative impacts of global food shocks and food prices (Khatoon *et al.*, 2012). Therefore, home gardens are widely considered as a strategy to improve food security and nutrition at home.

Homegardens are being practiced as a part of an age-old tradition in Arunachal Pradesh, in which trees are, incorporated into the agricultural crops and livestock production systems as per local agro-climatic and other on-field conditions. Homegardens were managed in traditional ways, using knowledge and techniques that have evolved through farmers through trial and error for a long time (Leakey *et al.*, 1996). Farmers often plant trees in their fields to achieve their livelihoods to generate income, risk management, food security at home and for the efficient use of available land, labor and money. A variety of species yielding a diversity of end products like grain crops, rhizomes and tubers and vegetables are grown with several fruit yielding and other trees in the traditional systems, which are useful in the subsistence of the farmers (Yumnam *et al.*, 2011).

The East Siang district of Arunachal Pradesh, northeast of India (Eastern Himalayas), also usually called the gateway to Arunachal Pradesh, where the present research has been carried derives its name from the mighty Siang River (Das, 1986). The region lies between 27º43' to 29º20'N latitudes and 94º42' to 95º35' E longitudes covering 4005 km^2 geographical area of the state and characterized by undulating topography. The district evaluation ranges from 130 m ASL at Bilat, sub-division to 752 m ASL at Riga, Boleng sub-division.

Extensive altitudinal differences along with physiographic variations contribute to erratic climatic conditions in East Siang district. The climate of the major part of the district falls under humid sub-tropical with wet summer and winter and the other remaining part falls under tropical condition. The mean maximum and minimum temperatures of the district are 28 and 18ºC, respectively. The year may be divided into different seasons i.e., winter (January to February), pre-monsoon (March to May), monsoon (June to September) and post-monsoon (October to December). The mean annual rainfall of the district is about 4168 mm. The soils of the hills and suburbs are rocky, sandy, loam or mixed, and are alluvial clays rich in organic matter (Das and Das, 2005).

Like any tribal communities globally, the tribal population in Arunachal Pradesh have also been known to collect diverse local tree products from adjoining forests for their subsistence and daily livelihood (Gangwar and Ramakrishnan, 1990; Tangjang and Arunachalam, 2009; Singh *et al*., 2010; Fentahun and Hager, 2010; Kumar *et al*., 2015). The Adi is one of the major tribes in this district which has been documented to harbor rich Indigenous knowledge on the use of various indigenous floras and tree species (Das, 2003).

The Berung community has immense traditional knowledge of using the locally available resources. The community is dependent on farming mainly and has customary laws that are in line with social and cultural patterns, land tenure system and farming practices. In the past, local people have been collecting their daily necessities from the wild, but over time, they have evolved several traditional methods which can help in meeting their daily basic needs. Traditional Homegardens are one of such practices that can help in achieving higher net sustainable productivity standards for the traditional farmers belonging to the community (Arnold and Devees, 1999). A variety of traditional crops are cultivated in the homegardens, which find utility in the everyday life of the farmers', as they provide a greater variety of food and nutrition along with medicines and also act as a good source of commercial benefits in addition to household subsistence (Kabir and Webb, 2008).

Traditional homegardens of Berung community also contribute to the socio-economic upliftment at the local level as homegardens avail a variety of market goods such as food, firewood and timber, spices and fodder and various non-market goods and services like soil and biodiversity conservation, air and water quality improvement and aesthetic beauty. Homegardens have proven to be well supportive in generating better returns for the farmers of Berung community, especially during fallow periods.

Although considered ecologically and economically important, still there is a lack of information on the traditional homegardens of East Siang District, Arunachal Pradesh. Therefore, there is a need to study the Homegarden structure and utilization pattern in Berung village and to establish how threatened and economically important species are conserved in traditional homegardens. There is also a vital demand for greater diversification of techniques of management and utilization of homegarden species, which warrants further research commitment. Keeping the above points in view the study was conducted with the following objectives:

(i) To study the species composition of the homegardens in Berung Village

(ii) To study the traditional uses of different plants in the homegarden.

II. MATERIAL AND METHODS

The study was carried out in traditional homegardens in Berung village of East Siang district in Arunachal Pradesh (Fig. 1). More than 20 homegardens were selected for collecting the plant information. The reason for incorporation of different plants in the Homegardens and their uses were collected with the help of standard questionnaires and through interviews of veteran owners of the homegardens. Standard methods of botanical collection and herbarium techniques have been followed for the documentation of plant species in the homegardens (Jain, 1977).

Name of village: Berung
Name of Panchayat: Berung Kebang
Name of District: East Siang
Name of State: Arunachal Pradesh
Latitude: 27°58′ 44.73″N
Longitude: 95°20′ 47.05″E
Altitude: 149m
Language spoken: Adi, Hindi

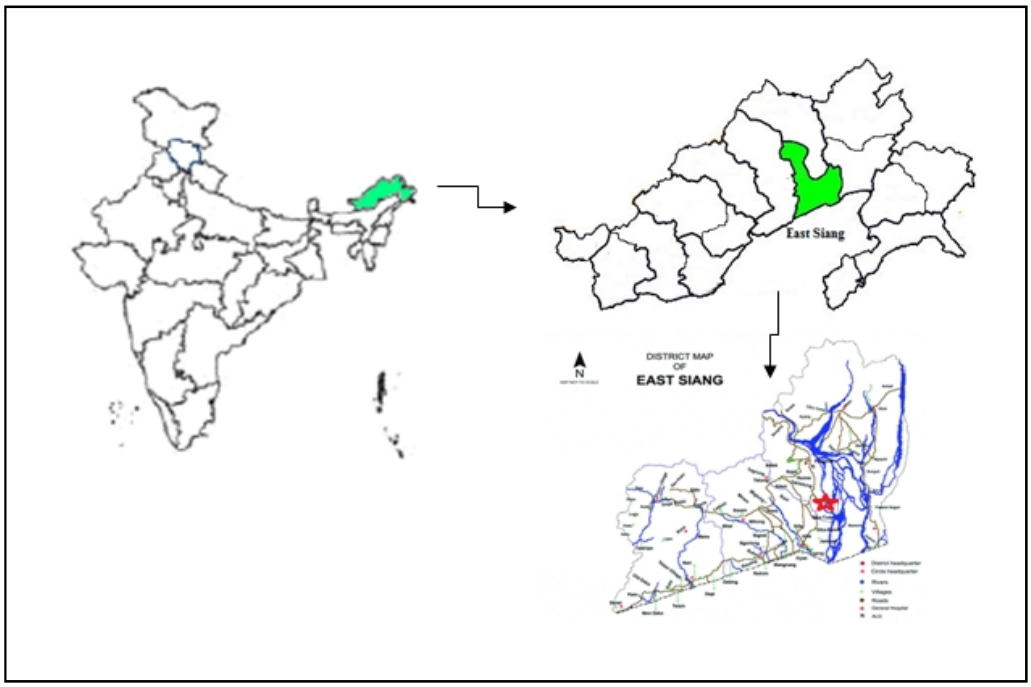


Fig. 1. Map of the studied area.

III. RESULT AND DISCUSSION

A. Structure of Homegarden

There was no planting pattern observable in the Homegarden. Stratification of plant species was common in homegardens, which makes them typical agroforestry systems that are somewhat similar to forests. Based on the average height of the plant species, the study showed four different strata (Table 1). These were Upper (>10m), Medium (>4m - <10m), Lower (>2m - <4m) and Ground (<2m)

The studied homegardens of *Berung* community are multi-storied with the top storey occupied by *Albizia lucidor*, *Areca catechu*, *Artocarpus heterophyllus*, *Elaeocarpus floribundus*, *Mangifera indica*, *Livistona jenkensiana* etc. Papaya, guava, Litchi and citrus are some of the commonly observed middle- storey species. Generally, fruit and timber yielding trees were common in most of the homegardens. The pre-dominant floor species in the Homegarden was *Ananas comosus* and vegetable crops. Among the weedy species, the most extensive ones are those belonging to the family Asteraceae (e.g., *Spilanthes* sp, *Ageratum conyzoides*).

The detailed survey of traditional homegardens recorded 80 species of traditional use, representing 65 genera and 38 families. There are 9 categories of plants with different traditional uses characterized based on the products in the traditional homegardens viz., fruit plant, vegetables, cereals, medicinal, timber, thatching, broom making (Fig. 2e), house building and fuel-wood (Table 1).

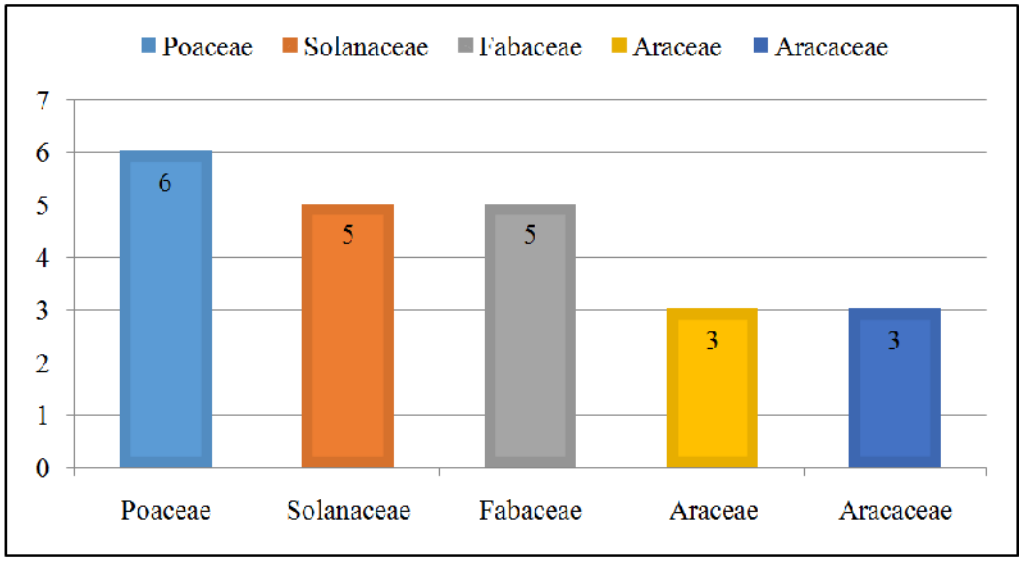
Out of the total plants, 23% were found to be used as vegetables, whereas 20% were medicinal and 19% were fruit-yielding plants in the traditional homegardens. The family Poaceae recorded the highest (6) species numbers followed by Solanaceae (5), Fabaceace (5), Araceae and Arecaceae (3 species each) *(Graph I)*. The plants from Poaceae and Lamiaceae family were found to be utilized for most extensive purposes like for cereals, broom making (Fig. 2e) and house construction, whereas maximum plants from the family Solanaceae were found to be used as vegetables and plants representing family Mimosaceae were found suitable for fire-wood purposes (Fig. 2d). Herbs represented the maximum percentage (43%) in ethno-botanical uses, whereas trees and shrubs represent 35% and 22%, respectively of the total ethno-botanical uses of traditional homegardens (Graph II).

Table 1: Plant height categories in the homegardens.

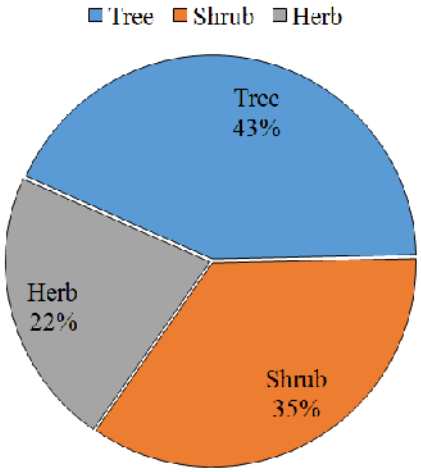
Storeys	Name of the species
Upper (>10m)	*Artocarpus heterophyllus, Castanopsis indica, Litsea cubeba,Morus laevigaeta, Gmelina arborea, Terminalia myriocarpa*
Medium(>4m- <10m)	*Mangifera indica, Elaeocarpus floribundus, Psidium guajava, Syzgium fruticosum, Zizyphus jujuba, Moringa oleifera, Dillenia indica, Erythrina indica, Alstonia scholaris, Mesua ferrea, Calamus*spp, *Michelia champaca, Carica papaya, Livistona jenkensiana*
Lower (>2m - <4m)	*Citrus reticulata, Clerodendron viscosum, Musa sapientum, Citrus limon, Zanthoxylum armatum,*
Ground (<2m)	*Ananus comosus, Abelmoschus esculentus, Alocasia indica, Amaranthus* sp, *Capsicum annum, Ipomoea batatas, Lycopersicum esculentum, Momordica charantia, Solanum torvum, Solanummelongena, Cassia alata,*

Table 2: Categorization of different plant species of homegardens based on their uses.

Category	Plant species
Fruits	*Ananus comosus* Merr. *Artocarpus heterophyllus* Lam., *Carica papaya* Linn. *Castanopsis indica* (Roxb.) A. DC., *Citrus reticulata* Blanco., *Citrus limon* (L) Burm., *Dillenia indica* Linn., *Elaeocarpus floribundus* Blume., *Litsea cubeba* (Lour) Pers., *Mangifera indica* Linn., *Morus laevigaeta* Linn., *Musa sapientum* Linn., *Psidium guajava* Linn., *Syzgium fruticosum* DC., *Zizyphus jujube* Lamk.
Vegetables	*Abelmoschus esculentus* (Linn) Moench., *Alocasia indica* (Roxb.) Schott., *Amaranthus* sp., *Capsicum annum* Linn., *Clerodendron viscosum* Vent., *Colocasia* sp *Capsicum annum* Linn., *Dioscorea* sp, *Ipomoea batatas* (L) Laurk., *Lycopersicum esculentum* Linn., *Manihot esculenta* Crantz., *Momordica charantia* Linn, *Moringa oleifera* Cam., *Polygonum* sp, *Solanum torvum* Swartz., *S. melongena* Linn., *S. nigrum* Linn., *S. kurzii* Brace ex Prain., *Zanthoxylum armatum* DC.
Cereals	*Eleusine coracana* (L) Gaertn, *Zea mays*Linn.
Medicinals	*Areca catechu* Linn, *Ageratum conyzoides* L, *Alstonia scholaris* (L.) R. Br, *Artemesia nilagirica* Pamp., *Bauhinia variegata* Linn., *Cassia alata* L., *Centella asiatica* (L), Urban, *Clerodendron viscosum* Vent., *Colocasia esculenta* (L) Merr., *Curcuma longa* L., *Dillenia indica* L., *Erythrina indica*, *Moringa oleifera* Cam., *Piper betel* Linn., *Solanum khasianum* Cl., *Spilanthes acmella* Merr., *Terminalia myriocarpa* Heurek and Muell, *Zingiber officinale* Rosc.
Timber	*Gmelina arborea* Linn, *Mesua ferrea*. *Michelia champaca*., *Terminalia myriocarpa* Heurek. and Muell.
Thatching	*Areca catechu* Linn, *Imperata cylindrica* Linn., *Livistona jenkensiana* Griff.
Broom making	*Calamus* sp ,*Dendrocalamus* sp, *Imperata cylindrica* Linn., *Livistona jenkensiana* Griff., *Saccharum spontaneum* Linn., *Sida acuta* Burm.
House building	*Bambusa tulda* Roxb., *Bambusa pallida* Munro., *Calamus* sp, *Dendrocalamus hamiltonii* Neeset Arn., *Dipterocarpus* sp, *Gmelina arborea*, *Livistona jenkensiana* Griff., *Mesua ferrea* Linn.
Fuelwood	*Albizzia lebbeck* Benth., *Albizzia procera* Benth., *Bauhinia variegate* Linn.



Graph I: Major Plant families in homegardens of Berung village.



Graph II: Categories of plants available in homegardens of Berung village.

A variety of different traditional crops are grown in the homegardens, which are valuable in the everyday life of the farmers, as they provide a greater diversity of food and also acts as a good source of commercial income sources in addition to household consumption. Plant species such as *Zizyphus jujuba*, *Dillenia indica*, *Elaeocarpus floribundus*, *Syzgium fruticosum*, *Litsea cubeba*, *Castanopsis indica* are edible fruits that provide supplementary food especially during drought (Saikia *et al.*, 2012).

The local inhabitants also use some plants as food for cooking. Some of them are rhizome/tubers of *Discorea*, *Abelmoschus esculentus*, *Alocasia indica*, *Amaranthus* sp, *Brassica oleracea*, *Capsicum annum*, *Clerodendron viscosum*, *Colocasia* sp, *Cucurbita moschata*, *Cucurmis sativus*, *Dioscorea* sp, *Solanum* sp. They also sell some vegetables in the marketplaces for getting some financial returns.

Fig. 2a. Bamboo basket (Aeber).

Fig. 2b. Phrynium pubinerve Blume (Ekam).

Fig. 2c. Pandanus leaves for mat making.

Fig. 2d. Fire wood collected from homegarden.

Fig. 2e. Broom made from *Sida acuta.*

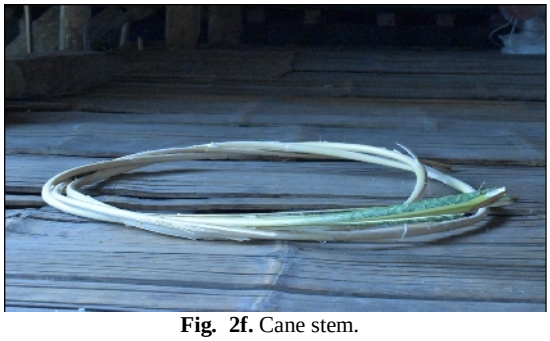


Fig. 2f. Cane stem.

Fig. 2. Various products obtained from homegardens.

Among other useful plants recorded in the study area were different bamboo species, *Calamus* spp, *Areca catechu* and *Livistona jenkensiana* which had a variety of end uses (Fig. 2a- 2f). Major uses were for fencing, house construction, mat making, various day-to-day necessities as bamboo used as water pipes, for hats, bows and arrows and traditional worshipping also as they are associated with ancestral sacrifices (Fig. 2c).

IV. CONCLUSION

Homegardens are the major sites where variety of plants and trees grows in the human-dominated landscapes as reported by various researchers, and it is fact-based that tribal communities from this region, like any tribal communities worldwide, have immense Indigenous knowledge on the utilization of various local plant and tree species as is apparent by various studies (Murtem, 2000; Sarmah, 2010; Jha, 2015; Kumar et al., 2015; Chaudhry and Murtem, 2017). Most of the homegardens in our study area, however, looked like any other common homegardens in other regions of northeast India, packed with wild and exotic edible and ornamental trees. The present study revealed that homegardens of Berung village are depositories of diverse plant resources of both economic and ecological significance. Local people of Berung village have used these traditional components derived from Homegardens; *i.e.*, ethno-medicinal and other ethno-botanical plants and also passed on this information through verbal traditions to the younger generation. Most of the plants used by these tribes are unconventional and not known by mainland people residing outside. The interest in the traditional wisdom of use of these plants for various purposes is slowly fading away from the younger generation as a result of which both species richness and plant uses have decreased. This generation differences coupled with the advancement of agricultural practices, have led to a significant deterioration of biological diversity and indigenous knowledge, practices and skills among local people. Accordingly, there is an urgent need to capture the local knowledge, practice, related management and utilization of plants before these are lost forever.

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REFERENCES

Arnold, J.E., and Dewees, P.A. (1999). Trees in managed landscapes: factors in farmer decision making. *Agriculture in Sustainable Agricultural Systems*, 277-294.

Babu, K.S., Jose, D., and Gokulapalan, C. (1982). Species diversity in a Kerala home garden. *Agroforestry Today*, *4*(3), 15.

Bhuyan, P., Khan M.L., and Tripathi R.S. (2003). Tree diversity and population structure in undisturbed and human-impacted stands of tropical wet evergreen forest in Arunachal Pradesh, Eastern Himalayas, India. *Biodiversity and Conservation*, *12*: 1753–1773.

Census of India (2011). Provisional population total. *Directorate of census operations*, Arunachal Pradesh.

Chaudhry P., and Murtem G. (2017). An ethno botanical note of the plant species used by local tribes for dwelling purposes in the Eastern Himalaya of India and some forest management related pressing issues. *Ecological Questions*, *27*(3): 53–64.

Christanty, L. (1990). Homegardens in Tropical Asia, with special reference to Indonesia. Homegardens in tropical America: a review‖ a Tropical Homegardens (Landauer K., Brazil, M., eds.).

Das, A.K. (1986). *Ethnobotany of East Siang district of Arunachal Pradesh*, PhD Thesis (Gauhati University, Guwahati)

Das, A.K. (2003). Some notes on the folk medicines of the *Adis* of Arunachal Pradesh, In: *Ethnomedicine of the tribes of Arunachal Pradesh*, edited by Mibang T.

Das, T. and Das A.K. (2005). Inventorying plant biodiversity in home gardens: A case study in Barak Valley, Assam, North East India. *Current Science*, *89*(1): 155

Fentahun M., and Hager H. (2010). Integration of indigenous wild woody perennial edible fruit bearing species in the agricultural landscapes of Amhara region Ethiopia. *Agroforestry Systems*, *78*(1): 79–95.

Fernandez, E.C.M., and P.K.R. Nair. (1986). An evaluation of the structure and functions of tropical homegardens. *Agroforestry Systems*, 21: 279-310.

Gangwar A.K., and Ramakrishnan P.S. (1990). Ethnobiological Notes on Some Tribes of Arunachal Pradesh, Northeastern India. *Economic Botany*, 44(1): 94–105.

Jain, S. K. (1977). Handbook of field and herbarium methods.

Jha K.K. (2015). Non-timber Forest Products, Their Vulnerability and Conservation in a designated UNESCO Heritage Site of Arunachal Pradesh, India. *Notulae Scientia Biologicae*, *7*(4): 444–455.

Jose, D., and Shanmugaratnam, N. (1993). Traditional homegardens of Kerala: a sustainable human ecosystem. *Agroforestry systems*, 24(2), 203-213.

Kabir, M. E. and E. L. Webb. (2008). Can homegardens conserve biodiversity in Bangladesh?. *Biotropica*, *40*: 95-103.

Kanwal, K.S. (2014). Non timber forest products (NTFP) as a tool for sustainable socio-economic development of community. *Arunachal Times*, 26: 58.

Khatoon, R., Singh, P. K., Das, A. K., and Dutta, B. K. (2012). Indigenous wild edible fruits for Kom tribe in Manipur, India. *Pleione*, *6*: 268-272.

Kumar N., Kumar S., Singh B., Mishra B.P., Singh B., and Singh V. (2015). Traditional practices of utilization and conservation of non-wood forest products by Adi tribes of Arunachal Pradesh. *Journal of Applied and Natural Science*, *7*(1): 111–118.

Leakey, R.R.B., Temu, A.B., Melnyk, M., and Vantomme, P. (1996). Domestication and commercialization of non-timber forest products. *Non-Wood Forest Products Series*, *9*.

Lele N., and Joshi P.K. (2009). Analyzing deforestation rates, spatial forest cover changes and identifying critical areas of forest cover changes in North-East India during 1972–1999. *Environmental Monitoring and Assessment*, *156*: 159–170.

Mao A.A., and Hynniewta T.M. (2000). Floristic diversity of North East India. *Journal of Assam Science Society*, *41*(4): 255–266.

Murtem G. (2000). Common wild vegetables of Nyishi tribe of Arunachal Pradesh. *Arunachal Forest News*, *18*(1/2): 66–77.

Paul A., Khan M.L., Arunachalam A., and Arunachalam K. (2005). Biodiversity and conservation of *Rhododendrons* in Arunachal Pradesh in the Indo-Burma Biodiversity hotspot. *Current science*, *89*(4): 623–634.

Ramakrishnan P.S. (1984). Problems and prospects of conservation of plant resources eastern hill region of India, [in:] S.K. Jain, K.L. Mehra (eds.), Conservation of plant resources. Botanical Survey of India, Howrah, p. 172–180.

Ravindranath N.H., Srivastava N., Murthy I.K., Malaviya S., Munsi M., and Sharma N. (2012). Deforestation and forest degradation in India – implications for REDD+. *Current Science*, 102(8): 25.

Reddy C.S., Jha C.S., Dadhwal V.K., Krishna P.H., Pasha S.V., Satish K.V., Dutta K., Saranya K.R.L., Rakesh F., Rajashekar G., and Diwakar P.G. (2015). Quantification and monitoring of deforestation in India over eight decades (1930-2013). *Biodiversity and Conservation*, *25*: 93–116.

Sarmah R. (2010). Commonly used non-timber forest products (NTFPs) by the Lisu tribe in Changlang district of Arunachal Pradesh, India. *SIBCOLTEJO*, *05*: 68–77.

Saikia, P., Choudhury, B.I., and Khan, M.L. (2012). Floristic composition and plant utilization pattern in homegardens of Upper Assam, India. *Tropical Ecology*, *53*(1): 105-118.

Shrestha, P., Gautam, R., Rana, R.B., and Sthapit, B.R. (2001). Home gardens in Nepal: status and scope for research and development. *Home gardens and in situ conservation of plant genetic resources in farming systems*, 17-19.

Shrivastava, R. J. and J. T. Heinen. (2005). Migration and home gardens in the Brahmaputra valley, Assam, India.*Journal of Ecological Anthropology*, *9*: 20-34.

Singh R.K., Pretty J., and Pilgrim S. (2010), Traditional knowledge and bio-cultural diversity: learning from tribal communities for sustainable development in northeast India. *Journal of Environmental Planning and Management*, *53*(4): 511–533.

Tangjang S., and Arunachalam A. (2009). Role of traditional homegarden systems in Northeast India. *Indian Journal of Traditional Knowledge*, *8*(1): 47–50.

Tangjang S., and Nair R.P.K. (2016). Integrated bamboo + pine homegardens: A unique agroforestry system in Ziro Valley of Arunachal Pradesh, India. *International Journal of Environmental and Agriculture Research*, *2*(2): 25–34.

Torquebiau, E. (1992). Are tropical agroforestry home gardens sustainable?. *Agriculture, ecosystems and environment*, 41(2), 189-207.

Tsering G., Nimasow G., and Singh N.C. (2019). Impact of population growth on forest cover in Tawang District of Arunachal Pradesh, India. *International Journal of Current Sciences*, *22*(10): 1–10.

Yumnam, J.Y., Bhuyan, S.I., Khan, M.L., and Tripathi, O.P. (2011). Agro-diversity of East Siang-Arunachal Pradesh, Eastern Himalaya. *Asian Journal of Agricultural Sciences*, *3*(4): 317-326.