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Traditional knowledge practices of North East India for sustainable agriculture

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Abstract

Indigenous Technical/Traditional Knowledge (ITK) is community, local and rural in origin. In North East India, it is used in weather forecast, for good seed germination, soil fertility management, soil and water management, management of insect pests and diseases of plant and animals, processing, storage and fishing etc. There are several indigenous cultivation practices like wetland rice cultivation of *Apatani* tribe of Arunachal Pradesh, Zabo system of farming and Alder agriculture in Nagaland, large cardamom plantation in Sikkim, Bamboo drip irrigation in Meghalaya, traditional mixed cropping etc. which are still in vogue in organic agriculture in NEH region which are sustainable, eco-friendly, viable and cost effective. North-East India is comprised of eight states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim and supports 50% of India's biodiversity. In addition, this region is also a home of 130 major tribal communities who used to have local medicinal plants for curing their different ailments.

Keywords: traditional knowledge, sustainable, biodiversity, medicinal plants.

Introduction

Indigenous Technical/Traditional Knowledge (ITK) is an accumulated inherited knowledge of farmers environment comprising land, water, tree, plants, animal etc and they have found solutions to manage the problems by taking series of decision and implementing them by allocating resources in efficient manner. This knowledge consists of many facts and helped them to evolve many practices which have been tested over long periods of time and proved beneficial. They depend entirely on locally available resources and knowledge base for maintaining productivity of crops and livestock. In the modern developmental efforts, knowledge of such indigenous practices provide valuable inputs to make efficient use of natural resources. Such components can be incorporated for the development of sustainable farming system and practices. Indigenous Technical/Traditional Knowledge (ITK) is community, local and rural in origin. It is used in weather forecast, for good seed germination, soil fertility management, soil and water management, management of insect pests and diseases of plant and animals, post harvest management etc. There are several indigenous cultivation practices like wetland rice cultivation of *Apatani* tribe of Arunachal Pradesh, Zabo system of farming and Alder agriculture in Nagaland, large cardamom plantation in Sikkim, traditional mixed cropping etc. which are still in vogue in organic agriculture in NEH region which are sustainable, eco-friendly, viable and cost effective ^[1].

ITK used for organic agriculture in North East India

- Cucurbit seeds are kept embedded in fresh cow dung ball which then buried deep in soil for better germination, growth and yield ^[2].
- In Sikkim, rotten forest litter or organic matter rich top soil is used to put into grooves or rock over potato seed or farmers use forest litter as bedding material for compost production. Rice and maize cultivation on terraces are practiced since long time. This method controls surface run off and prevents rill formation and controls the advancement of already existing gullies. The traditional large Cardamom drying kilns (bhutti) do not need the highly specialized skills and foreign input material. The kilns are made of locally available mud and stone masonry walls on four sides.
- In Arunachal Pradesh, farmers protect springs from flooding and encroachment of livestock. They maintain water sources by using locally available materials mainly stone, wood, bamboo, soil etc. In this state, farmers believe that the use of cowdung slurry can protect crops from aphid attack and as repellent to cutting and biting insects and animals. Cattle urine has successfully used against thrips, mites, aphids and caterpillars. Application of extracts prepared from the parts *Sisnu* (*Urtica* spp) and fruits of *Timuz*

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- (*Zanthoxylum armatum*) plants are used to control many kinds of chewing, biting and cutting insects. Leaf and leafy extracts of Chinese berry (*Melia azadirachta*) controls various kinds of insects. *Padam Minyong Adi* society of Arunachal Pradesh observes different rituals when field crop is attracted by insect pests and diseases. The *Adis* of Pasighat area perform another ritual *Irriiwhwn* when young paddy plants just grow up. Likewise, the *Galo-Adi* society performs *Ampu-yolu* ritual for the protection of their crops from pests and diseases. The *Adi* tribes of Basar, West Siang District, Arunachal Pradesh offer four worship during the Kharif season:
 - a. *Dibin*: Worship (Puja) after sowing of paddy for better germination. This worship is done during the months of February-March. During the worship day poultry birds are offered to the Goddess and no one enters the paddy field on that day. It is believed that the person who will enter the field on that day, his crop will not perform better.
 - b. *Tachi*: Worship for control of pests in maize. This is done in the month of May-June. Pigs or poultry birds are sacrificed to Goddess and there is a ban to enter the field on that day.
 - c. *Ampu*: This is an important worship of *Adi* tribes of Arunachal Pradesh. It is done to control the insect-pest problem in Jhum rice as well as wet land rice. It is done for two days. During these two days, no one enter the crop field. Sacrifice of pig is a must in this worship.
 - d. *Mari*: This is the worship of Goddess Laxmi after the harvest of the paddy crop. This is done in the months of November-December. Like *Ampu* sacrifice of pig is compulsory in this puja.
 A part from the above, the *Adi* tribes perform rituals to stop rain, when there is a continuous rain for several days^[3].

- *Adi* tribes of Basar put five wooden / bamboo sticks randomly in the rice field during flowering stage and place dead frog / dry salted fish / crabs on the stick to attack adult Gandhi bugs.
- Sun drying has been found effective in protecting grain from insect infestation. The *Adi* tribes of Arunachal Pradesh build massive house for their residence as they can be heated properly. In Arunachal Pradesh, the majority of farmer keep food grains and meat near the kitchen where the smoke of burning firewood penetrates. They also use leaves of neem or tulsi on the top of the storage structure to keep free insect-pest infestation. A traditional system of rat proof storage locally called *Nahu* (granary) can be seen at the one corner of a village of *Adi* tribes in Arunachal Pradesh. The ground below the *Nahu* is used to store fuel wood. The locally available Toke leaf, bamboo, wooden planks and cane are the major raw material for the construction of *Nahu*.
- *Nishi* tribe of Arunachal Pradesh use rat trap called 'Gurung'. The trap is made of tauk (thin bamboo) with long internode. Garo tribes of Meghalaya use grain storage structures made up of thatch grass, bamboo and wooden poles.
- Fishing is an exotic origin among *Adis* of Arunachal Pradesh^[4]. There are altogether 32 different fishing techniques adopted by tribes only. Out of them, *Hib Rinam* is more harmful to aquatic life. *Rilen Minnam*, *Hibok Pena*, *Hill Monam* and *Hibok Tumnam* are harmful and *Likam Panam*, *Liru Hinam*, *Ngou Paanam* and *Ngoi*

Tumnam are harmful. Other techniques are completely harmless to aquatic life. Common indigenous tools used by Galo tribes are *Takom*: It is a long conical basket placed in the gaps of stone after river, *Raju* : A conical basket used by females placed in between two legs while hands move the stones, *Edir* : A well designed basket with a valve used after draining the river to catch running fish, *Chirido*: A cylindrical basket used to cover the stone pill before removing stones, *Ekar*: A fishing rood/line and hooks used during angling, *Ehap*: A fishing net thrown from distance to cover the fish, *Mohap*: A long stick fitted with iron tip at the kill the fish outside water, *Saptor*: a small sized net, fitted with four sticks used to catch fish by spreading it on the floor of river, *Mojkali*: A iron cap fitted arrows to shoot big fish, *Ir*: A bow used to shoot fish, *Orok*: Swords used to shoot fish and *Taomomi*: Thorny basket in which big fishes are driven to it.

- In most of the fishing techniques, herbal poisons are used as they have short lived effects in comparison to chemical. Some of the herbal poisons are *Tam*: It is a herbal poison; *Talik*: Bark of the tree; *Tanir*: Bark of the tree; *Ramil*: Bark of *Acacia pinnata*; *Takh*: Bark of *Gynocardia odorata*; *Ripik*: Bark of *Millietis pachycarpa*; *Mute*: Fruits of tree. *Onyur*: Fruits of tree; *Dikotamo*: Whole plant of *Polygonum hydropiper*; *Rukdik* : Whole plant; *Satamo/ Pagmo*: Fruits of tree.
- In the hills, natural perennial streams are the main source of water for domestic and irrigation uses. The drip irrigation using bamboo is practiced by farmers in jaintia hills of Meghalaya to irrigate arecanut and betel vine grown on steep hill slope with bouldary soil. The khasis (Meghalaya) cure the arecanut in the flowing water.
- *Apong* in *Adi* (Arunachal Pradesh), *Zumai* in *Bado* and *Zutuiling* in *Mizo* tribe are traditionally prepared fermented beverages of the North East. *Apong* is prepared from cooked rice after fermentation. In this process materials like bamboo funnel called Popur, banana leaves etc. are used.

Traditional farming systems of North East India

Farming system involves an appropriate combination of farm enterprises like cropping systems, livestock, fisheries, forestry, poultry and the ways available to the farmers to raise them for profitability. Diversified Farming System is an important tool for enhancement of agricultural growth by promoting food and nutritional security, income and employment generation, poverty alleviation, judicious use of natural resources and ecological environments. To develop and adopt a sustainable farming systems the factors such as soil, climate, availability of resources, land, water, labour and capital, economic return and managerial skill to be considered^[1].

Jhum cultivation: It is practiced by the hill farmers to utilize the most of available natural resources to get maximum possible output and to minimize the risks involved in the cultivation by slashing, clearing and burning systems from January-March^[5]. Crops grown by the jhum farmers include cereals (rice, maize, millets), legumes (beans, pigeon pea, rice bean, pea, soybean, cow pea), oilseeds(ground nut mustard), root crops (cassava, potato, colocassia, yam, sweet potato), cucurbits (bottle gourd, snake gourd, pumpkin, cucumber, bitter gourd, melons, ridge gourds etc.), seeded vegetables (okra, chilli, brinjal, tomato), fruits (banana, papaya, citrus,

grapes, local fruits), cash crops (coffee, areca nut) and spices (cardamom, black pepper, large cardamom).

Field Crop production: In hill region, an alternative form of shifting cultivation can be adopted for cultivation of crops such as pulses, upland rice, vegetables, tuber and root crops. Crops like cassava, maize intercropped with soybean, pigeon pea, finger millet, sesame etc. can be grown in upper portion of sloppy land while lower portion can be used for growing rice for production maximization.

Double cropping of rice: In NEH region, a pre-kharif rice can be grown with proper adjustment of date of sowing and selection of early varieties like Vivek Dhan-82, Megha Rice-1, VL Dhan 61 before the main crop of rice.

Multiple Cropping based Production System: It is common in shifting cultivation where farmers grow 8-35 species on a small plot of 2 to 2.5 ha with simultaneous sowing and sequential harvesting. The crop mixture provides crop cover against loss of nutrients, optimizes resources, facilities recycling of biomass and nutrients and improves soil characteristics. In Arunachal Pradesh, mixed cropping of rice + maize, rice + cucurbits, rice + banana, rice + citrus and maize + French bean are sown in Jhum areas.

Bun system of cultivation: This system of cultivation is practiced mainly in the state of Meghalaya. Under this system, the crops are grown on a series of raised beds locally referred to as "Bun" formed along the slope of the hills. Presently, most of the farmers grow crops consecutively for two years in Bun field. In first year, generally tuber crops like ginger, turmeric, potato, sweet potato etc. and vegetables followed by upland paddy are grown.

Rice-fish system of Apatani plateau: It is a multi-purpose water management system, which integrates land, water and farming system by protecting soil erosion, conserving water for irrigation and paddy-cum-fish culture. It has been practiced in a flat land of about 30 km² located at an altitude of about 1,525 mete rns. In the humid tropic climate of Lower Subansiri district of Arunachal Pradesh. Local tribe "Apatani" which develop this system dominates the area. In Manipur and Nagaland Paddy-cum-fish culture is practiced in terraced fields where a small pond is dug in the middle or corner for harvesting of fish during the harvest of paddy. Two crops of fish and one crop of paddy is commonly harvested conserving water throughout the year. Technology intervention of Common Carp found most suitable in the higher altitudes grown with improved rice varieties. In the system, Grass carp is another competent fish commonly grown with rice as pre-kharif crop in the plain of Manipur [6, 7].

Bamboo drip irrigation system: The tribal farmers in Muktapur, Jaintia hills district of Meghalaya have developed the indigenous technique of bamboo drip irrigation. Betel vines planted with areca nuts the supporting tree are irrigated with this system, in which water trickles or drips drop at the base of crop. In this system, water from the natural streams located at higher elevation is conveyed with the use of bamboo channels, supports to the site of plantation through gravity flow [8].

Alder based agriculture in Nagaland: In some pockets of Nagaland the farmers use *Alnus nepalensis* (Alder) tree for agriculture. In this system the Alder seedlings are planted on the sloppy land intended for cultivation and the alder grows fast till attain six to ten years old. At this stage initially the trees are pollarded, the leaves and twigs are burnt and ash is mixed with soil to prepare it for raising crops such as maize, millets, potato, barley, wheat, chilli, pumpkin, taro etc. [9]. Subsequently also pollarding is done once every four to six years. Under this process coppice are cut except five to six on top of the main trunk and crop schedule is followed including fallow period of two to four years. The bigger branches stripped of leaves are used for fire wood, while the root of the tree develop nodules (colonies of Frankia) responsible for fertility improvement whereas spreading nature of the roots helps in preventing soil erosion in slopes.

ZABO system: "Zabo" is an indigenous farming system of Nagaland. The word "Zabo" means impounding of water [10]. It has a combination of forest, agriculture and animal husbandry with well founded soil and water conservation base. It has protected forest land towards the top of hill, water harvesting tanks in the middle and cattle yard and paddy fields for storage for the crops as well as for irrigation during the crop period. Special techniques for seepage control in the paddy plots are followed. Paddy husk is used on shoulder bunds and puddling is done thoroughly.

Large Cardamom Plantation in Sikkim

The indigenous tribes i.e. *Lepcha* and *Limbu* used to collect large cardamom from natural forests and domesticate under shade trees like alder. Farmers have evolved a tree cutting schedule to get continuous supply of forest wood and fodder without affecting the shade requirements of large cardamom plants. This tree management system is also helpful in preventing lifting of large cardamom clumps due to thick subsurface spreading roots of old trees. Otherwise, lifting of clumps result into low productivity of large cardamom [11].

Diversified Hill Horticulture

The varied agroclimate and topography of the Eastern Himalayan Range provides suitable environment for development of horticulture dominated farming system [12] (Table 1).

Table 1: Fruit and vegetable crops suitable for cultivation in Arunachal Pradesh

Horticulture Zone	Fruit crops
Foot hills and valley (170-915 m)	Mandarin, Acidlime, Assam Lemon, Aonla, Pineapple, Jackfruit, Papaya, Beans, cucurbits, potato.
Mild hills (915-1803 m)	Peach, Plum, Apricot, Pear, Pomegranate, Grapes, Low chilling Apple, Persimmon, Kiwi, off season vegetable, Potato.
High hills (>1803 m)	Apple, Cherry, Chestnut, Kiwi, off season vegetables.

Suitable land use systems such as Agrihorti, Agri-horti-silvi pastoral, mixed horti, pure horti, horti-silvi-pastoral and multi-tier horticulture system should be developed based on

agroclimate zones, crop priority, topography and socio-economical factors.

(a) Agri-horticulture land use system

- 2/3rd area (upper side) is covered under horticultural crops (mandarin, guava)
- 1/3rd area under cereals
- Fruit trees are planted in half moon terraces on contour (Triangular system)
- Pineapple should be planted to protect the contour bunds
- Interspaces in contour should be utilized for intercropping

(b) Agri-horti-silvi-pastoral (model land use)

- Middle 1/3rd area for horticultural crops (mandarin, guava)
- Upper 1/3rd for fodder trees
- Lower 1/3rd for growing cereals and fodder crops
- Terrace risers are used for growing fodder grass like golden timothy grass, dallis grass etc.

(c) Mixed horticultural land use

- Only different horticultural crops are grown
- The upper 2/3rd area is planted with fruit crops
- The lower 1/3rd terraced area is planted with vegetable crops

(d) Pure horticultural land use (Fruit crops only)

- If the available land is more
- Suitable for fruit growing
- The land collectively acquired/cooperative land can be used for this purpose

(e) Horti-silvi-pastoral system

The horti-silvi-pastoral system has great potential to provide a sustainable land use system, which would maintain an acceptable level of production of fruits, vegetables, fuel wood, timber, fodder etc. and at the same time, conserve the basic resources (mainly soil) on which production depends. This system was found economically viable and socially acceptable alternative to *jhuming* in this region.

(f) Multi-tier horticultural system

1. Horti-horti three-tier system: arecanut + black pepper +Ginger / turmeric / pineapple / Assam lemon
2. Silvi-horti three-tier system: MPT + black pepper + ginger/turmeric/pineapple
3. Silvi-horti two-tier system (Parkia and pineapple or subabool and pineapple)
4. Alder based farming system of Nagaland (alder and vegetables like potato, cole crops or alder and cereals like maize, rice etc.

Rattan Cultivation as a Part of Shifting Cultivation

Incorporation of rattan in Jhum Kheti is an indigenous system in Kalimantan, Indonesia. This can be exploited in Jhum areas of Arunachal Pradesh state. These plants are popular as raw materials for furniture industry throughout the world. Arunachal Pradesh alone accounts for 4 genera and 17 species. The genus *Calamus* has the largest number of 12 species followed by *Plectomia*, *Daemonorops* and *Zalacca* [13].

Agroforestry Based Production System

This is common in tribal of India. In certain agroforestry based systems, the trees and certain plants are consciously maintained on farm lands. In Arunachal Pradesh, planting of *Terminalia myriocarpa* and *Morus lavigata* highly valued

timber species are very common. In Meghalaya, thinned pine tree + ginger and planting in pineapple field or boundary line are worth to be noticed. In Mizoram, contour trench farming is practiced in Jhum area. In this model land use system, top portion is undisturbed forest, middle portion is with horticulture crops and down the hills terraced rice is cultivated with contour trenches planted with pineapple or grasses [14].

Traditional medicinal practices of North East India

North-East India supports 50% of India's biodiversity. Meghalaya is endowed with 850 medicinal plants, of which 377 species are used by majority of people for their primary health care needs. In Assam, herbal plants are used at the household level in a self-help mode by the rural community. Arunachal Pradesh, the treasure house of biological and socio-cultural diversity in the Eastern Himalayan Region of India. A number of underutilized minor edible fruits have been identified in the Imphal valley (excluding Jiribam subdivision, Imphal East) of Manipur. The rich flora of Sikkim has a number of raw drugs described in Ayurvedic texts. There are about 420 plants are used by the tribal people for various diseases in Sikkim Himalayas region. A total of 25 of medicinal plants are recorded from the medicine men and aged villagers of various villages from Tripura.

Arunachal Pradesh: Arunachal Pradesh is the treasure house of biological and socio-cultural diversity in the Eastern Himalayan Region of India. The state has 26 major tribes and over 110 subtribes who maintain a close relationship with the nature. The local inhabitants of the state have their own customs, tradition and medicinal system who mainly depended on forests and forest products for their day to day lives. Seeds, barks, rhizomes, leaves, flowers etc, of different medicinal plants like *Acorus calamus* Linn, *Ageratum conyzoides* Linn, *Allium cepa* Linn, *Allium hookeri* Thwaites, *Artemisia indica* Willd., *Berberis wallichiana* DC, *Cardamine hirsuta* Linn., *Centella asiatica* Linn., *Clerodendrum colebrookianum* Walp., *Eleusine coracana* (Linn.) Gaertn, *Gynostemma pedata* Blume. *Gynura cusimbua* (D. Don) S. Moore, *Houttuynia cordata* Thunb., *Hydrocotyle javanica* Thunb. *Litsea cubeba* (Lour.) Pers., *Mahonia napaulensis* DC., *Michelia champaca* Linn, *Mikania micrantha* Kunth, *Oenanthe javanica* (Blume) DC., *Oxalis corniculata* Linn., *Paederia foetida* Linn., *Plantago erosa* Wall. ex Roxb., *Plectranthus japonicas* (Burm.f.) Koidz., *Pteridium revolutum* (Blume), *Rhus javanica* Linn., *Solanum nigrum* Linn., *Solanum xanthocarpum* Schrad. & Wendl. *Spilanthes paniculata* Wall. Ex DC., *Swertia chirayita* (Roxb. ex Fleming) Karsten, *Taxus wallichiana* Zucc., *Valeriana jatamonsii* Jones, *Zingiber officinale* Roscoe are used by tribals of this state for treatment of various ailments [15].

Assam: In Assam, herbal plants are used at the household level in a self-help mode by the rural community. The rural people of Assam also consume many herbs as nutritional diet used in Indian system of medicine viz. *Bacopa monnieri* L. Penn., *Centella asiatica* L., *Dioscorea bulbifera* Linn., *Emblica officinalis* Gaertn, *Eryngium foetidum* Linn., *Terminalia chebula* Retz., *Zanthoxylum alatum* Roxb., *Mentha spicata* Linn., *Ocimum sanctum* Linn., *Terminalia bellerica* (Gaertn.) Roxb., *Paederia foetida* Linn., *Euryale ferox* Salisb., *Solanum nigrum* Linn., *Piper longum* Linn., *Garcinia cowa* Roxb. Ex D.C., *Garcinia morella* (Gaertn.) Desr., *Garcinia pedunculata* Roxb., *Dillenia indica* Linn.,

Calamus rotang Linn., *Parkia roxburghii* G. Don., *Alpinia allughas* Rosc., *Clerodendrum glandulosum* Lindl., etc. This shows that people in this region are adopting the use of herbal plants in their day to day life which help in keeping their body healthy preventing ailments. With its vast hills and forests, Assam is the home to a variety of medicinal herbs and plants such as eg. Sarpagandha (*Rauvolfia serpentina* (Benth) ex.Kurz.), Pippali (*Piper longum* Linn), Amlakhi (*Embllica officinalis* Gaertn), Hilikha (*Terminalia chebula* Retz.), Bhomora (*Terminalia bellerica* (Gaertn.) Roxb.), Arjuna (*Terminalia arjuna* Wight & Arn.), Vaividang (*Embelia ribes* Burm.f.), Chaulmoodgra (*Hydnocarpus kurzii* King.), Mezankori (*Litsea citrata* Blume.), etc. About 900 species of medicinal herbs and plants are known to exist in abundance in the forest area of the state with the Brahmaputra valley itself having 50 species of herbs and plants of commercial value [16]. It has been found that the people apply their traditional knowledge of different medicinal plants to cure simple and common diseases as cold and fever but also deadly ones, as complicated as cancer. It is interesting to note that the roots and leaves of *Catharanthus roseus* are used as a carcinogenic medicine. Other major ailments for which there are trade of medicinal plants include leprosy, jaundice, dropsy, pneumonia, asthma, elephantiasis, piles, hysteria, malaria, calculi both gall-bladder and kidney, bronchitis, pharyngitis and rheumatism. Highest numbers of plants are found to be used against snakebite. Several parts of a plant such as roots, leaves, flowers, seeds, tubers, stems, fruits are used as medicine. Among the different parts of the documented plants they utilise the leaves mostly (43%), followed by roots (28%), sometimes the whole plant (17%), seeds (4%), flowers (4%), stems (2%), tubers (1%) and fruits (1%).

Manipur: The state has a central valley (Imphal Valley) inhabited by the *Meitei* and *Meitei pangal* whereas the hilly

areas are inhabited by 30 different tribes of *Naga* and *kuki* tribes. The North – Eastern region of India including Manipur is part of both Himalaya as well as Indo-Burma biodiversity hotspots in the world supporting about 50% of the total India's biodiversity but represent only 8% of the total geographical area of India. The therapeutic application of 39 underutilized edible fruits comprising 29 genera and 23 families are used as medicine by the Meitei community. These plants are used for a wide range of common ailments like diuretic, laxative, jaundice, diabetes, diarrhoea, dysentery etc. Fruits and leaves are the major plant parts used for the preparation of medicine having 52% and 22%. *Aegle marmelos* (Heiri- khagok), *Annona reticulata* (Ramphal), *Artocarpus heterophyllus* (Theibong), *Averrhoa carambola* (Heinoujom), *Baccaurea ramiflora* (Moktok hei), *Citrus grandis* (Nobab), *Citrus macroptera* (Heiribob), *Elaegnis umbellata* (Heiyai), *Euphoria longan* (Nongang hei), *Ficus auriculata* (Heirit), *Ficus glomerata* (Heibong), *Flacourtia jangomas* (Heitroi), *Garcinia pedunculata* (Heibung), *Juglans regia* (Heijuga), *Olea ferruginea* (Chorphon), *Phyllanthus acidulous* (Kihori), *Rhus chinensis* (Heimang), *Rubus ellipticus* (Heijampet), *Spondias pinnata* (Heining), *Terminalia chebula* (Manahi) are popular amongst them [17].

Meghalaya: Meghalaya is rich in its floral diversity and contributes about 18% of total flora of country. There are about 3128 species of flowering plants in the state of which 40% of total flora of state is endemic. Meghalaya is endowed with 850 medicinal plants, of which 377 species are used by majority of people for their primary health care needs. The indigenous people have vast knowledge of their plant resources as medicines and have been using over the years [18] (Table 2).

Table 2: Medicinal plant species used by tribal people of Meghalaya

Scientific name	Local name	Family	Parts used	Application
<i>Aegle marmelos</i> (Linn.) Corr	Sempri	Rutaceae	Leaves, Bark	Gastric problem, dysentery
<i>Allbizia odoratissima</i> (Linn. f.) Benth	Siso	Fabaceae	Bark	Headache, dizziness
<i>Alstonia scholaris</i> (Linn.) R. Br.	Sokson	Apocynaceae	Leaves, Bark	Fever, epilepsy and respiratory diseases
<i>Anacardium occidentale</i> Linn.	Cashewnut	Anacardiaceae	Bark, Fruit and Leaves	Inflammation, urinary disorder
<i>Annona squamosa</i> L.	Ata bol	Anonaceae	Bark, Leaves, Roots, Unripe fruits and seed	Indigestion
<i>Antidesma acidum</i> Retz.	Arobakh	Euphorbiaceae	Leaves	Blood pressure
<i>Aristolochia clematitis</i> L.	Esamul	Aristolochiaceae	Leaves and roots	Snake bite
<i>Artocarpus gomezianus</i> Wall. Ex.Trecul	Armum	Moraceae	Bark	Headache, dizziness
<i>Bauhinia variegata</i> L.	Megong	Fabaceae	Leaves	Blood pressure
<i>Bombax ceiba</i> L.	Bolchu	Bombacaceae	Leaves	Diarrhoea
<i>Bridelia retusa</i> Spreng.	Khasi	Euphorbiaceae	Bark, fruit juice	Wound healing, earache
<i>Calotropis procera</i> (Linn.) R. Br.	Memangtebrong	Apocynaceae	Bark, Leaves, Roots, Latex and Flower	Paralysis, leprosy, skin diseases and cough
<i>Carica papaya</i> L.	Modipol	Caricaceae	Root, latex and seed	Dogbite, earache
<i>Cassia fistula</i> L.	Snaru	Fabaceae	Bark	Stomach pain
<i>Cestrum nocturnum</i> L.	Gamini	Solanaceae	Bark, leaves	Toothache, headache
<i>Cinnamomum tamala</i> Fr. Nees	Tejpata	Lauraceae	Bark	Urinary disorder
<i>Cissus quadrangularis</i> L.	Haljora	Vitaceae	Whole plant	Sprain and piles
<i>Clerodendrum glandulosum</i> Coleb.	Dongam	Verbenaceae	Leaves	Blood pressure
<i>Crataeva nurvala</i> Buch. Ham.	Jongchia	Oleaceae	Bark, leaves	Skin diseases, toothache
<i>Cuscuta reflexa</i> Roxb.	Dodimit	Convolvulaceae	Leafless stem	Jaundice, headache
<i>Crypteronia paniculata</i> Blume	Mosuginsep	Crypteroniaceae	Leaves	Snake bite and wound Healing
<i>Derris robusta</i> (Roxb. Ex DC.) Benth.	Kakharu	Fabaceae	Leaves	Headache

<i>Dillenia indica</i> Linn.	Tedike	Dilleniaceae	Bark, leaves	Diarrhoea
<i>Dillenia scabrella</i> Roxb.	Agatchi	Dilleniaceae	Bark	Snakebite
<i>Drimycarpus racemosus</i> (Roxb.) Hk. f.	Babari	Anacardiaceae	Bark, leaves	Skin diseases
<i>Duabanga grandiflora</i> (Roxb.ex DC) Walp.	Bolchim	Lythraceae	Bark, leaves, root and flower	Headache, epilepsy
<i>Erythrina stricta</i> Linn.	Mandal	Fabaceae	Leaves, root	Asthma, epilepsy
<i>Ficus hispida</i> L	Thiwek	Moraceae	Root	Dysentery
<i>Firminia colorata</i> (Roxb.)R. Br.	Walgem	Sterculiaceae	Bark, leaves	Wound healing
<i>Gmelina arborea</i> Roxb.	Gambal	Verbanaceae	Bark, leaves	Cough, snakebite
<i>Grevillea robusta</i> A. Cunn.	Silver oak	Proteaceae	Bark, Leaves	Headache, dizziness
<i>Hibiscus rosa-sinensis</i> word L	Jova	Malvaceae	Flower	Headache, abortion
<i>Jatropha curcas</i> L.	Banglagash	Euphorbiaceae	Stem	Burn
<i>Jatropha gossypifolia</i> L.	Banglagash	Euphorbiaceae	Latex	Dysentery
<i>Justicia gendarussa</i> Linn.	Dojagipe	Acanthaceae	Whole Plant	Cough,throat infection and sprain
<i>Lagerstroemia parviflora</i> Roxb.	Sidai	Lythraceae	Bark, Leaves	Skin diseases
<i>Lagerstroemia speciosa</i> L. Pers.	Asari	Lythraceae	Bark, root	Dysentery, jaundice
<i>Litchi chinensis</i> Sonn. T	Letchu	Sapindaceae	Bark, Root, Seed	Stomach and throat pain
<i>Lygodium japonium</i> Thunb. Ex Murr.	Ruatip	Lygodiaceae	Whole Plant	Wound healing
<i>Mangifera indica</i> L. Tree	Tekatchu	Anacardiaceae	Bark, seed	Jaundice and itching
<i>Macropanax undulatus</i> (Wall ex D. Don)	Sambrong	Araliaceae	Leaves	Headache
<i>Melia azedarach</i> L.	Neem	Meliaceae	Leaves	Fever and stomach pain
<i>Mikania micrantha</i> H. B. K	Sampangguri	Asteraceae	Leaves	Wound healing
<i>Mussaenda glabra</i> Vahl.	Sonarupa	Rubiaceae	Flower, Leaves, Root	Jaundice, leprosy and fever
<i>Oryza sativa</i> L.	Minil	Poaceae	Stem	Gall bladder stone and urinary disorder
<i>Oroxylum indicum</i> (Linn.) Vent. B Tree Fever and jaundice	Khiring	Bignoniaceae	Bark, Flower, Root, leaves and seed	Fever and jaundice
<i>Phlogacanthus thyrsoiflorus</i> (Roxb.)Nees	Ellot	Acanthaceae	Bark and Leaves	Cough, fever, jaundice and gastric problem
<i>Piper betel</i> Linn.	Pan	Piperaceae	Leaves	Dysentery
<i>Piper longum</i> L.	Golmoris	Piperaceae	Fruit	Fever and cough
<i>Plumbago indica</i> L.	Achitragitchak	Plumbaginaceae	Leaves, Root	Headache
<i>Premna latifolia</i> Roxb.	Dukhemi	Verbinaceae	Leaves, Bark	Diabetes
<i>Prunus persica</i> Linn.	Biispol	Rosaceae	Leaves	Skin diseases
<i>Sabia lanceolata</i> Colebr.	Madri	Sabiaceae	Bark, leaves, root	Epilepsy
<i>Sida acuta</i> Burm.	Chirotha	Malvaceae	Bark, Leaves	Malaria
<i>Spilanthes acmella</i> Murr.	Sonapul	Asteraceae	Stem, leaves, flower	Toothache
<i>Spondias pinnata</i> (L.F.) Kurz	Ambarerongtong	Anacardiaceae	Bark	Nasal bleeding
<i>Sterculia villosa</i> Roxb.	Olmak	Sterculiaceae	Bark	Throat pain
<i>Tamarindus indica</i> L.	Cheeng	Fabaceae	Leaves, Roots	Skin diseases
<i>Thevetia peruviana</i> (Pers.) K. Schum.	Ceiling bol	Apocynaceae	Latex	Cough
<i>Terminalia bellerica</i> (Gaerth.) Roxb.	Chirore	Combretaceae	Bark, Fruit, Root, Seed	Headache, Jaundice and gastric problem
<i>Terminalia chebula</i> Retz.	Arithak	Combretaceae	Bark, Fruit	Dysentery
<i>Terminalia myriocarpa</i> Heurck. AndMuell.	Rakseng	Combretaceae	Bark, Root	Urinary disorder, heart problem
<i>Tinospora cordifolia</i> (Willd.) Miers	Dumandal	Menispermaceae	Stem	Urinary disorder
<i>Vitex glabrata</i> R. Br.	Bandi-kuri	Verbanaceae	Bark, Leaves	Inflammation
<i>Ziziphus jujuba</i> Lam.	Kangkil	Rhamanaceae	Bark	Cough, tuberculosis

Sikkim: The unique geographical position and wide range of topography, high fertile soil, sufficient rainfall and presence of large number of perennial stream makes the state of Sikkim one of the treasure house of bio-diversity in the country. Sikkim has vast reserve of medicinal plants and rich culture of folk medicine. The rich flora of Sikkim has a number of raw drugs described in Ayurvedic texts. There are about 420 plants are used by the tribal people for various diseases in Sikkim Himalayas region and Bikh (*Aconitum ferrox* Wall.), Ghewkumari (*Aloe barbadensis* Mill), Khomog (*Angelica archangelica* Linn.), Tetaypati (*Artemisia vulgaris* L.), Satmuli (*Asparagus racemosus* Willd.), Pakhanbheda (*Bergenia lingulata* Har.), Runglim (*Celastrus paniculatus* Willd.), Betlaure (*Costus speciosus*), Sonahkiri (*Dendrobium nobile* Lindl.), Kapur kacheri (*Hedychium spicatum* Ham Ex. Smith), Totola (*Oroxylum indicum* Vent.), Beriara (*Paederia*

foetida), Kutki (*Picrorhiza kurroa* Royle ex. Benth), Panchpatey (*Podophyllum hexandrum* Royal), Manjitho (*Rubia cordifolia* Linn), Brahma kamal (*Saussuria lappa* C.B.Cl), Kukur (*Smilax lanceifolia* Roxb.), Dhengresalla (*Texus baccata* Linn.), Tumuru (*Zanthoxylum alatum* Roxb.) are the commonly used medicinal plants of the state^[19].

Tripura: The tribal people of Tripura are accustomed to a wide variety of medicinal plants used in their herbal medicinal practices (Table 3). A total of 25 of such plants are reported were from the medicine men and aged villagers of various villages. Some important plants include *Oroxylum indicum*, *Euphorbia nerifolia*, *Scoparia dulcis*, *Jatropha curcas* and *Kaempferia rotunda*^[20].

Table 3: Medicinal plant species used by village people of Tripura

Scientific name	Local name	Family	Parts used	Application
<i>Aegle marmelos</i> Correa	Bael	Rutaceae	Leaves, gum from fruit, ripe fruit	Leaves pounded to paste with equal quantities of leaves of <i>Cajanus cajan</i> and a little water and 1 cupful extract taken in the morning in empty stomach in combination with molasses in jaundice. Fruit pulp as medicine and for prevention of dysentery.
<i>Ageratum conyzoides</i> Linn.	Shyamtulsi	Asteraceae	Leaves and twigs	Fresh leaf extract used as anti hemorrhagic. Juice used as an expectorant.
<i>Ananas comosus</i> (L.) Merrill	Gihom	Bromeliaceae	Leaves	Leaf extract with milk and sugar candy in rheumatic swellings. Extract of leaf base is taken 1 teaspoon thrice daily in diarrhoea.
<i>Azadirachta indica</i> A. Juss.	Neem	Meliaceae	Leaves and stem bark	Leaves boiled in water to bathe patient with malaria and chicken pox. Smoke produced by burning leaves is used as mosquito repellent.
<i>Cajanus cajan</i> (L.) Millsp.	Arail	Fabaceae	Leaves and twigs	Mature seeds are cooked as a pulse and given in weakness. Leaf and twig paste is applied throughout the body during jaundice.
<i>Carica papaya</i> L.	Paypay	Caricaceae	Root and fruit	Unripe fruits are cooked as a vegetable, ripe fruit, eaten raw. Fruits are considered to be stomachic.
<i>Centella asiatica</i> (Linn.) Urban	Thunmankuni	Apiaceae	Leaves and entire shoot	Eaten either as paste or cooked as a vegetable for dysentery and diarrhea.
<i>Clerodendrum viscosum</i> Vent.	Bhati pataa	Verbenaceae	Leaves and root	Extract is used as expectorant. Decoction of the leaves is used to check high blood pressure. Root extract is as febrifuge.
<i>Cynodon dactylon</i> (L.) Persoon	Doob pataa	Poaceae	Shoot and roots	Shoot extract is anti-haemorrhagic.
<i>Euphorbia nerifolia</i> Linn.	Sairapal	Euphorbiaceae	Leaves	Vapour is inhaled as medicine during fever. Oven heated leaves are placed on the chest to control cough
<i>Jatropha curcas</i> Linn.	Girogaachh	Euphorbiaceae	Branches	The sap is applied locally in gum infections. Raw leaves are used in high blood pressure.
<i>Kaempferia rotunda</i> Linn.	Bhojoraphul	Zingiberaceae	Flower and rhizome	Flower decoction is used to bathe patient with skin infections. Aqueous decoction of rhizome used in jaundice.
<i>Kalanchoe pinnata</i> Pers.	Khurajot	Crassulaceae	Leaves	Chewed raw with sugar to control dysentery and diarrhoea. Juice is administered in jaundice. Leaf paste is applied on skin infections and pimples.
<i>Leucas aspera</i> Spreng.	Doron pushpa	Laminaceae	Leaves and twigs	Extract is taken for cough and jaundice.
<i>Marsilea quadrifolia</i> Linn.	Susni	Marsileaceae	Leaves	Used in jaundice, brain tonic
<i>Mimosa pudica</i> Linn.	Dugjat lajari	Mimosaceae	Entire plant	Leaf paste is applied on the acne and pimples. Extract is used in equal proportion by weight along with bark extract of <i>Urena lobata</i> as a combination medicine against jaundice.
<i>Momordica charantia</i> Linn	Gangrauk	Cucurbitaceae	Fruits and twigs	Fruits is cooked as a vegetable and considered to be anthelmintic. Extract of twigs is used against dyspepsia.
<i>Musa paradisiaca</i> Roxb	Mot	Musaceae	Flower and stolon	Juice of flowers is used in dysmenorrhoea and menorrhagia. Extract of the stolon is administered in dysentery and diarrhoea.
<i>Oroxylum indicum</i> (L.) Vent.	Taukharun	Bignoniaceae	Stem bark and immature fruits	Soup is used as stomachic and anthelmintic.
<i>Ocimum sanctum</i> L.	Tulsi	Laminaceae	Leaves	Extract is used as expectorant and jaundice
<i>Phlogacanthus thyrsoiflorus</i>	Basokpata	Acanthaceae	Leaves	Leaf juice is used as an expectorant.
<i>Psidium guajava</i> L.	Sapri	Myrtaceae	Fruits and twigs	Young twigs is chewed in empty stomach every morning in dysentery and diarrhoea. Fruit is used in anaemia.
<i>Scoparia dulcis</i> L.	Naipungchewk	Scrophulariaceae	Leaves and twigs	Anthelmintic and used in jaundice.
<i>Spilanthes paniculata</i> Wallich ex. DC.	Ansha	Asteraceae	Leaves	Boiled leaves are used with rice in stomach troubles and liver problems.
<i>Terminalia chebula</i> Retzius	Bukhala buthai	Combretaceae	Dried fruit	Extract is used in stomachic and jaundice

Conclusions

Indigenous Technical Practices (IKP) are highly effective and viable for organic cultivation in North East India where use of inorganic fertilizers are used in limited quantities and organic inputs are available in plenty. Traditional Farming System is an important tool for enhancement of agricultural growth by promoting food and nutritional security, income and employment generation, poverty alleviation, judicious use of natural resources and ecological environments for tribals of North East India. Diversified Hill Farming Systems can conserve the indigenous culture, social relationships, habits

and genetic resources of the region and enhance the productivity and profitability of the farmers. In region, herbal plants are used at the household level in a self-help mode by the rural community. The local inhabitants of the region have their own customs, tradition and medicinal system who mainly depended on forests and forest products for their day to day lives. Seeds, barks, rhizomes, leaves, flowers of different native medicinal plants are used by tribals of North East states for treatment of various ailments.

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