Pleione 11(1): 29 - 39. 2017. **ISSN: 0973-9467**

Fruit trees of Poba Reserve Forest in Dhemaji district of Assam, India

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[Received 29.05.2017; Revised 06.06.2017; Accepted 08.06.2017; Published 31.06.2017]

Abstract

Diversity of fruit trees in Poba Reserve Forest and exploitation by fringe communities is discussed. Data collection methods included semi-structured interview, checklist interview, field interview and market survey. This study documented 53 fruit trees distributed in Core area [20 (37.8%)], LZ [12 (22.7%)], TMZ [19 (35.9%)] and SPMZ [16 (30.2%)]. *Rubus buergeri*, *Oldenlandia diffusa*, *Solanum torvum* and *Solanum anguivi* are distributed in all anthropogenic areas LZ, SPMZ and TMZ suggesting ability of these plants to resist perturbations. Further, 36 (67.9%) plants have multiple uses, while 32 (60.4%) species have economic value. Conservation of Poba RF is inevitable for sustained supply of resources. Domestication of indigenous species presents a practical tool for biodiversity conservation and local development.

***Key words*:** Poba RF, wild fruits, phytochemicals, food security, livelihoods, conservation, domestication

INTRODUCTION

Goods and services provided by forest biodiversity is vital for sustenance to indigenous peoples living in or near forests and for them forest is the basis of subsistence, livelihoods and socio-cultural well-being. The continuing loss of primary forests around the world demands concerted efforts on the evaluation of diversity and its utilization by local communities of unexplored forests for proper conservation. Fruit bearing trees are important constituents of forest biodiversity. From the ecological standpoint, the fruits of numerous plants are foraged by animals as source of food and in the process the visitor disperse the fruits and seeds which are critical for forest maintenance, restoration and regeneration. In general, fruits and vegetables are rich repositories of phytochemicals, dietary fibre, minerals, vitamins, and innumerable bioactive compounds which contribute to many health benefits. And for their health benefits, fruits and vegetables are recommended by nutritionists (Giampieri *et al*. 2014; Hoffmann & Schwingshackl 2016). Wild fruits and nuts are exploited as invaluable source of food, medicine and livelihoods. It is loaded with diverse phytochemicals and thus is considered healthy food. In recent times, many studies on the bioactive effects of wild fruits, such as antioxidant, antimicrobial, anti-inflammatory, and anticancer, etc. have suggested that wild fruits could have the potential to prevent and treat many chronic and difficult diseases (Li *et al.* 2016).

Forest resources are exploited by people around the world irrespective of economic status. Particularly in third-world countries, dependence on wild plants for food is

comparatively high (Campbell 1987; Jamir 1995; Lihuan & Ling 1999; Sarma *et al*. 2010; Marwat *et al*. 2011; Mwema *et al.* 2012; Awodoyin *et al.* 2015; Kar *et al.* 2008; Takatemjen *et al.* 2009; Majumdar & Datta 2009; Mozhui *et al.* 2011; Rongsensashi *et al*. 2013; Phangchopi *et al.* 2014; Chothe *et al*. 2014). Indigenous people or forest inhabitants have developed an intricately woven knowledge system, referred as Traditional Knowledge (TK), for optimal and sustainable exploitation of forest resources. Wild fruits are recognized as important non-timber forest products (NTFPs) and its importance to human society can be gauged from the high dependence and outpouring of research and journals incorporating wild fruits. The role of wild fruits in sustainable development is realized by active participation of international organizations such as the Food and Agriculture Organization (FAO), World Bank (WB), Canadian International Development Agency (CIDA), International Development Research Centre (IDRC), Centre for International Forestry Research (CIFOR), International Union for the Conservation of Nature (IUCN) and Biodiversity Support Programme (BSP) in NTFP research including wild fruit resources.

The contribution of fruits and nuts from forests and other natural ecosystems is wide-ranging encompassing all aspects of human society. Primary use of such fruits is for subsistence and nutrition and food security (Ogle & Grivetti 1995; Eromosele *et al*. 1991; Maikhuri *et al*. 1994; Grivetti & Ogle 2000; Muok *et al*. 2001; Deshmukh & Waghmode 2011; Mwema *et al*. 2012; Phangchopi *et al.* 2014). Wild fruits are also integral part of traditional medicines (Hazarika *et al*. 2012; Rajkumari *et al*. 2013; Phangchopi *et al*. 2014) and investigations on the bioactive compounds present in them is gaining momentum (Judprasong *et al.* 2013). The potential of livelihood opportunities for marginalized population and poor families has attracted attention of researchers and various agencies (Narendran *et al*. 2001; Muok *et al.* 2001; Scherr *et al.* 2004; Ndoye *et al.* 2004; Fisher 2004; Belcher *et al*. 2005; Kar & Borthakur 2007; Mahapatra & Panda 2012; Mwema *et al.* 2012; Shaffiq *et al*. 2013; Medhi & Borthakur 2013; Mabaya *et al.* 2014; Makdoh *et al.* 2014; Medhi *et al*. 2014; Phangchopi *et al*. 2014). NTFP, that also includes wild fruits, as a paradigm for sustainable development and conservation has been increasingly felt since the publication of an article by CM Peters and his colleagues in *Nature* where they claimed that, more money could be earned from tropical forests by collecting these products than from logging (Peters *et al.* 1989). The present report deals with the diversity of wild fruits in Poba Reserve Forest and their exploitation by the communities living in the forest fringe areas. The term 'tree' is used here to refer any fruit bearing plant of ethnobotanical importance and not strictly for the habit of the species.

MATERIAL AND METHODS

Study site

The study area, Poba Reserve Forest (PRF), is located in Jonai subdivision, Dhemaji district, Assam and with the central location at 27°50'11"N and 95°17'45"E covering an area of 22,548 hectares (Fig. 1). It is bounded by Daying Ering Wildlife Sanctuary, NH-52 and foot-hills of Arunachal Pradesh in the North, Dibru-Saikhowa National Park and the Siang, Dibang and Lohit rivers in the East, Laly River (referred as Brahmaputra downstream) in the South, and a few revenue villages to the West. PRF is an important elephant corridor linking the Daying Ering Wildlife Sanctuary in Arunachal Pradesh with Dibru Saikhowa National Park in Assam *via* the proposed Kobu Chapori Reserve Forest, on an island of the river Brahmaputra. The forest receives annual rainfall between 3600 mm to 4000 mm and gifted with diverse habitats and vegetation for herbs, shrubs, climbers, lianas, trees, epiphytes and parasites of evergreen traits. Highest temperature recorded till date is 35^0 C in summer and lowest 7^0 C in winter. It is pertinent to mention that, at present Poba is the only Reserve Forest or

Protected Area in the entire Jonai subdivisional area; other three forests have been encroached and rendered to oblivion (**Table 1**).

Table 1. Reserve Forests in Jonai subdivision of the Dhemaji district and their status

Reserve Forest	Area (Hectares)	Status
Gali Reserve Forest	10,562	Completely encroached
Poba Reserve Forest	10,221	**Existing**
Jamjing Reserve Forest	9060	Completely encroached
Sengajan Reserve Forest	1,619	Completely encroached
Kobu Chapori Reserve Forest (proposed)	9,400	**Existing**

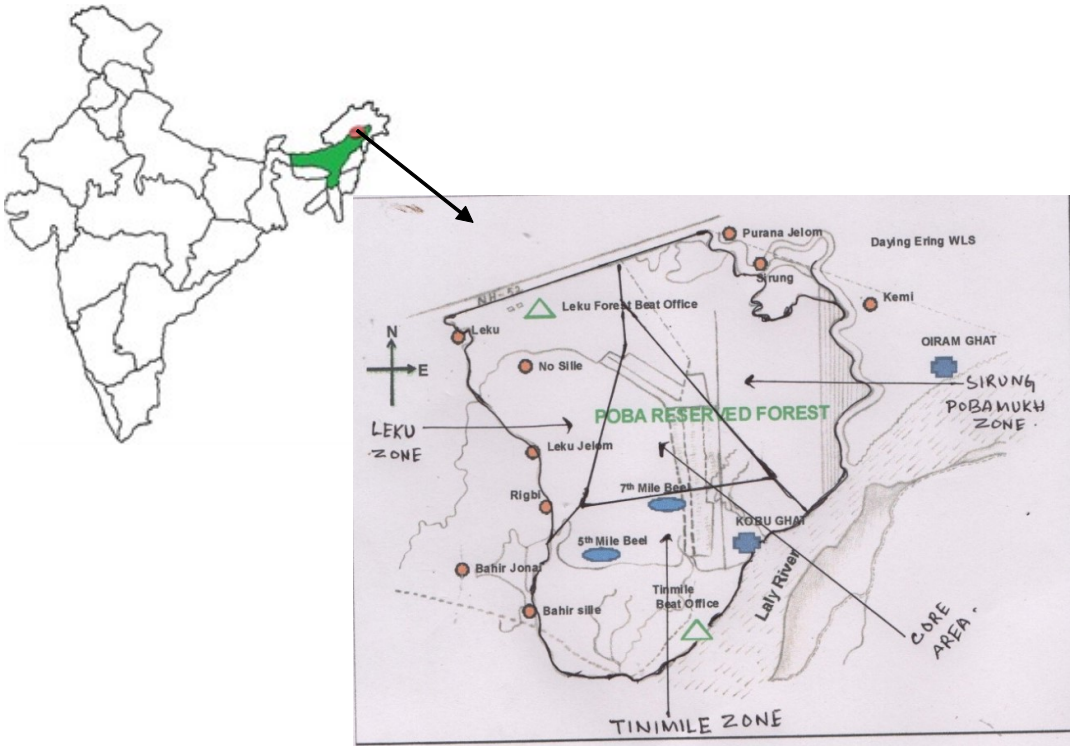

Fig. 1: Map of Poba Reserve Forest showing fringe villages and different zones/areas of the forest.

PRF is under intense anthropogenic pressure with 22 villages (Kemi, Oiramghat, Purona Jelom, Leku, Sirung, Nahor Jelom, Leku Jelom, Rigbi, Bahir Sille, Malbug, Nahor Sile, Santipur, Hajong Bosti, Urang Bosti, Rabha Kathoni, Sonowal Kathoni, Berachapori, Beramilon, Beramajgoan, Taribosti, Luhijan and Bahirjonai (Fig. 1) being distributed in the fringe areas. The inhabitants of these villages are largely dependent of the forest resources for their all

requirements (Pegu *et al*. 2013a,b, 2014b). The forest also suffers from large scale encroachment and collection pressures for which human-wildlife conflict has become a pertinent issue (Pegu *et al.* 2014a). For the convenience of understanding and discussion, the forest has been divided into some zones or areas based on disturbance pressure: Sirung Pobamukh Zone (SPMZ), Luku Zone (LZ), Tinimile Zone (TMZ) and Core area (Fig. 1**)**. Except Core area, other areas or zones being adjacent to human settlement are largely frequented by people for the collection of different types of forest produces. The Core area occupies central portion of the forest and so is least frequented by the villagers. This area has comparatively more vegetation and form the feeding ground of elephants and the preferred house for many other animals.

Data collection

Field study was undertaken during the years 2012 to 2015 among fringe communities of PRF. Ethnobotanical information on wild fruits and its utilization was gathered following the methods of Alexiades (1996), Cunningham (2001) and Martin (1995) which is briefly described for larger audience. The research design included obtaining permission from local forest department, survey of fringe villagers and interview of informants, visit to PRF and market survey. Consent of community elders and informants was obtained in accordance with ethics of ethnobiological research (ISE 2006).

Data was collected through Semi-structured interview from 443 informants, including household elders and people engaged in gathering resources from the Poba forest. Questions included plant resources collected from PRF and pattern of utilization. However, information relating to wild fruits only was considered for the present analysis and discussion. Plant interview was performed after collecting fruits from the forest and recording its identity and uses with the help of village elders. Pictures of the plant species were also shown to them for the ease of identification in local dialect. For adequate sampling of fruit plants, we also employed Checklist interview and a preliminary checklist of fruit plants with local names and uses was compiled through Group discussion. Ethnobotanical inventory or Field interview included walking in the forest with informants and/or forest officials, listening to them about plants and collecting and taking notes on the morphology and their uses. Photographic information of the plants was collected using a digital camera. Survey of Jonia daily and weekly markets was also undertaken and wild fruits sold were recorded along with local names and price. This method enabled us to assess the dependence of fringe communities on PRF, livelihood practices and plants having economic value. Market survey also provides opportunity to assess collection pressure and threats to wild plant population and conservation priorities. Plants were identified with the help of available floras (Hooker 1875-1897; Kanjilal et al. 1934 - 1940; Rao & Verma 1972, 1973; Balakrishnan 1981 & 1983) Nomenclature of plants followed the online database *www.theplantlist.org*.

RESULTS AND DISCUSSION

Fruits and nuts form important plant resource and were collected regularly from PRF by fringe communities for food, medicine and livelihoods. This study documented 53 species of fruit tress belonging to 37 genera under 22 families (Table 2); the Phyllanthaceae has the highest representation with 6 species. Distribution of these plants in the forest, however, is not homogeneous (Table 2). Of the 53 fruit plants, 20 (37.8 %) are concentrated in the core area, 12 (22.7 %) are distributed in the LZ, 19 (35.9 %) in the TMZ and 16 (30.2 %) in the SPMZ. From Table 1, it is also evident that some plants can be found in more than one zone. Four plants namely *Rubus buergeri*, *Oldenlandia diffusa*, *Solanum torvum* and *Solanum anguivi*, are distributed in all anthropogenic areas of LZ, SPMZ and TMZ suggesting ability

of these plants to resist perturbations. *Pegia nitida*, *Colocasia esculenta*, *Piper longum* and *Citrus medica* are distributed in LZ and TMZ. *Terminalia chebula*, *Caesalpinia crista*, *Ficus racemosa*, *Phyllanthus virgatus* and *Neonauclea purpurea* have been reported from LZ and SPMZ. While, *Dillenia indica*, *Phyllanthus emblica*, *Ziziphus mauritiana* and *Z. rogusa* have distribution in the SPMZ of the forest.

Table 2. Inventory of edible fruits in Poba Reserved Forest, Jonai, Dhemaji district, Assam [Sirung Pobamukh Zone: **SPZM**; Luku Zone: **LZ**; Tinimile Zone: **TMZ**]

Botanical name	Parts of fruit eaten	Other uses	Economic value	Availab-ility	Distribution in the forest
ANACARDIACEAE					
Mangifera sylvatica Roxb.	Pulp	Wood for furniture	Yes	Jun - Oct	LZ
Pegia nitida Colebr.	Whole fruit	Tender shoots & leaves in medicine	No	Whole year	TMZ, LZ
Spondias pinnata ((L. *f*) Kurz	Pulp	Tender leaves in medicine	Yes	Oct - Feb	SPMZ
ARACEAE					
Colocasia esculanta (L.) Schott	Pulp	Aerial parts in medicine	Yes	Jul - Oct	TMZ, LZ
ARECACEAE					
Caryota urens L.	Whole fruit	Wood as shaft of plough	Yes	Whole year	Core area
Calamus rotang L.	Whole fruit	Stem as cordage	Yes	Whole year	Core area
CLUSIACEAE					
Garcinia lanceifolia Roxb.	Whole fruit	Pulp in medicine	Yes	Jan - May	Core area
Garcinia cowa Roxb. *ex* Choisy	Whole fruit	Pulp in medicine	Yes	Jan - May	Core area
Garcinia morella (Gaertn.) Desr.	Whole fruit	Pulp in medicine	Yes	Jun - Sep	Core area
Garcinia pedunculata Roxb. *ex* Buch.-Ham.	Whole fruit	Pulp in medicine and rituals	Yes	Jun - Sep	Core area
COMBRETACEAE					
Terminalia bellirica (Gaertn.) Roxb.	Pulp	Pulp in medicine; wood as timber	Yes	Aug - Jan	LZ
Terminalia chebula Retz.	Pulp	Pulp in medicine; wood as timber	Yes	Mar - Jul	LZ, SPMZ
Hodgsonia macrocarpa (Blume) Cogn.	Pulp	-	No	Jun - Aug	Core area
DILLENIACEAE					
Dillenia indica L.	Pulp	Leaves and pulp in medicine; wood for timber	Yes	Whole year	SPMZ, TMZ
FABACEAE					
Caesalpinia crista L.	Seed	Leaves and seeds in medicine	No	Apr - Nov	LZ, SPMZ
Vigna vexillata (L.) A.Rich.	Seed	-	No	Jan - May	TMZ
Mucuna pruriens (L.) DC.	Seed	-	No	May - Aug	Core area
LYTHRACEAE					
Trapa natans L.	Seed	-	No	May - Aug	TMZ
Trapa natans var***. bispinosa*** (Roxb.) Makino	Seed	-	No	May - Aug	TMZ
MALVACEAE					
Bombax ceiba L.	Pulp of ripe fruits	Leaves in medicine; tender	Yes	Feb - May	TMZ

Botanical name	Parts of fruit eaten	Other uses	Economic value	Availab-ility	Distribution in the forest
		vegetable; wood for plywood			
Grewia hirsuta Vahl	Whole ripe fruit	-	No	Mar - Jun	Core area
Grewia sapida Roxb. *ex* DC.	Whole ripe fruit	-	No	Feb - May	Core area
MORACEAE					
Artocarpus chama Buch.-Ham.	Pulp of ripe fruits	Wood as timber; Furniture	Yes	Apr - Aug	Core area
Artocarpus lacucha Buch.-Ham.	Pulp of ripe fruit	Wood for timber; bark as masticatory	Yes	Apr - Aug	Core area
Ficus auriculata Lour.	Pulp of ripe fruit	Leaves as vegetable	Yes	Whole year	LZ
Ficus semicordata Buch.-Ham. *ex* Sm.	Pulp of ripe fruit	Leaves as vegetable	Yes	Whole year	LZ
Ficus racemosa L.	Pulp	Leaves as vegetable	Yes	Whole year	LZ, SPMZ
MUSACEAE					
Musa velutina H.Wendl. & Drude	Pulp of ripe fruit	Spadix in medicine and ritual ceremony	Yes	May - Aug	Core area
MYRICACEAE					
Myrica esculenta Buch.-Ham. *ex* D.Don	Pulp of ripe fruit	-	Yes	Jul - Sep	Core area
MYRISINACEAE					
Ardisia sp.	Pulp of ripe fruit	-		Jul-Nov	LZ
MYRTACEAE					
Psidium guajava L.	Pulp of ripe fruit	Leaves in medicine	Yes	Jun - Oct	TMZ
Syzygium cuminii (L.) Skeels	Whole ripe fruit	Ripe pericarp in medicine	Yes	Jun - Oct	Core area
Syzygium fruticosum DC.	Whole ripe fruit	Whole ripe fruit in medicine	Yes	Jun - Oct	Core area
Syzygium kurzii (Duthie) N.P.Balakr.	Whole ripe fruit	Whole ripe fruit in medicine	No	Jul - Nov	SPMZ
NYMPHAEACEAE					
Nymphaea nouchali Burm.f.	Whole ripe fruit	-	No	Oct - Dec	TMZ
Nymphaea rubra Roxb. *ex* Andrews	Whole ripe fruit	-	No	Oct - Dec	TMZ
PHYLLANTHACEAE					
Antidesma bunius (L.) Spreng.	Whole ripe fruit	-	Yes	Jul - Aug	Core area
Antidesma ghaesembilla Gaertn.	Whole ripe fruit	Whole ripe fruit in medicine	Yes	Jul - Aug	Core area
Baccaurea ramiflora Lour.	Pulp of the ripe fruit	Whole fruit in medicine	Yes	Jul - Sep	Core area
Bischofia javanica Blume	Whole ripe fruit	Wood in construction	No	Jul - Dec	LZ

Botanical name	Parts of fruit eaten	Other uses	Economic value	Availab-ility	Distribution in the forest
Phyllanthus emblica L.	Pulp of ripe fruit	Fruit in medicine	Yes	Jun - Dec	SPMZ, TMZ
Phyllanthus amarus Schumach. & Thonn.	Whole ripe fruit	Shoots and fruits in medicine	Yes	Feb - Jul	SPMZ, LZ
PIPERACEAE					
Piper longum L.	Whole ripe fruit	Leaves and fruit in medicine	Yes	Sep - Dec	TMZ, LZ
RHAMNACEAE					
Ziziphus jujuba Mill.	Pulp	-	Yes	May - Dec	SPMZ, TMZ
Ziziphus rugosa Lam.	Pulp	-	Yes	May - Dec	SPMZ, TMZ
ROSACEAE					
Duchesnea indica (Jacks.) Focke	Whole ripe fruit	-		Feb - Jun	SPMZ
Prunus jenkinsii Hook.f. & Thomson	Pulp of ripe fruit	-	No	May-Aug	Core area
Rubus buergeri Miq.	Whole ripe fruit	Leaves in medicine	No	Whole year	LZ, SPMZ, TMZ
RUBIACEAE					
Neonauclea purpurea (Roxb.) Merr.	Pulp	-	No	Mar - Aug	LZ, SPMZ
Oldenlandia diffusa (Willd.) Roxb.	Whole ripe fruit	Fruits in medicine	No	Mar - Sep	LZ, SPMZ, TMZ
RUTACEAE					
Citrus medica L.	Pulp	Leaves & fruits in medicine and rituals	Yes	Feb - Aug	LZ, TMZ
SOLANACEAE					
Solanum torvum Sw.	Whole fruit	-	No	Jan - Aug	SPMZ, LZ, TMZ
Solanum anguivi Lam.	Whole fruit	Leaves & fruit in medicine	Yes	Jan - Aug	SPMZ, LZ, TMZ

The result also showed high dependence by fringe communities on Poba forest for subsistence and food security. This can be envisaged from dietary use of all fruits recorded available to them during different seasons of the year. This is obvious for the fact that agricultural land is scarce in fringe areas and the only source of food and nutritional security available to fringe villagers is the forest resources. Of significant piece of information is 8 (15 %) plants namely *Pegia nitida*, *Caryota urens*, *Calamus rotang*, *Dillenia indica*, *Ficus auriculata*, *F. semicordata*, *F. racemosa* and *Rubus buergeri* are harvested round the year and such plants hold advantage over other species for large scale exploitation (Table 2). Further, 36 (67.9 %) fruit plants have important uses other than dietary engagement; fruits and other parts of the plants are used in traditional medicine, construction, crafts, rituals, etc. This presents a case for additional studies on the potentials of wild fruits for meeting basic human needs of food security and healthcare. Another significant output of the present study is the potential of wild fruits as source of livelihoods and household income. Of the 53 fruit plants, 32 (60.4 %) species have economic value that constitutes common items sold in local markets. This also indicates people's preference for these fruits and scope for cultivation of these species. Commercialization of some of these fruits can alleviate poverty to certain level. It also reflects the degree of collection pressure and reminds us of the need for maintaining a balance between exploitation and conservation.

The above results present good indicators of dependence of fringe communities on resources of PRF in general and wild fruits in particular for overall household well being. The level of collection pressure and sustainability of harvesting may be crucial for regeneration of the species. Despite similar landscape, uneven distribution of fruit plants is a cause of conservation concern and contribution of the aforementioned factors cannot be neglected. The confinement of some fruit species in the core area supplements this view. This area has high domination of elephants throughout the year which acted as deterrent for human interference. In other words, commercial exploitation may have rendered some plant resources beyond their regeneration capacity. Conservation of biodiversity for sustained supply of resources is thus, inevitable. In this context, disturbance tolerable species has advantage of regeneration over other species. Domestication presents a viable tool for conservation of important species. Fringe villages share same landscape and environmental gradients with the forest area so cultivation of fruit plants and other species with economic value in home gardens will augment food production on one hand and conservation of genetic resources on the other hand. This strategy can lessen collection pressure on Poba forest and also human-wildlife conflicts (Pegu *et al.* 2014a). Urgency for conservation of PRF also emanates from the ecological role of the forest (Pegu *et al.* 2013a). The forest forms natural barrier between Jonai Subdivisional Township and the Laly River in the south. Deforestation will only accelerate erosion and if not checked, the time is not far when Jonai and adjoining areas would turn into a flood plain. Wetlands in PRF forms breeding grounds for fresh water fishes and any catastrophe will not only destroy fish diversity but also deprive local populace who rely on fish resources of the forest for livelihoods. All these present pressing need for conservation of biodiversity of PRF and prioritization of species for conservation for exploitation of local entailments.

CONCLUSION

Human pressure on biodiversity of Poba forest will increase with the increase of dependent human population and collection pressure for subsistence and commercial purposes. A strategy that helps in maintenance of local biodiversity and cater local demand for resources may be a viable option. Studies have already revealed the prospective of non-timber forest produce in sustainable development and wild forest fruits can make valuable contribution to biodiversity conservation and sustainable development. Poor families around the world have been exploiting wild fruits as source of livelihoods and for alleviating poverty. The use of wild fruits needs to be encouraged beyond dietary needs for the fact that these fruits are stuffed with phytochemicals for human health and even source of novel biocompounds. More studies, however, are necessary to establish the link between consumption of underutilized wild fruits and health benefits. Indigenous plants are well adapted to local environment and their nurturing will bring dividends to local people. In the present context of discussion relating to PRF, domestication presents a practical tool for biodiversity conservation and local development. Home gardens in fringe villages already has some floristic elements of PRF; continuation and development of the practice on carefully selected species can help in augmenting production and gradually minimize dependence on Poba forest.

Acknowledgements

Authors are thankful to esteemed informants who participated in this study and for sharing their valuable knowledge. They are also grateful to local forest department for granting permission for the present study and accompanying us during visits to Poba Reserve Forest. Authors are thankful to Institutional Biotech Hub (DBT, Govt. of India), Diphu Campus for infrastructural support

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