NMHS-Himalayan Institutional Project Grant

NMHS-FINAL TECHNICAL REPORT (FTR)

Demand-Driven Action Research and Demonstrations

NMHS Grant Ref. No.:	GBPNI/NMHS-2019-20/SG	Date of Submission:	d	d	m	m	y	y	y	y

PROJECT TITLE (IN CAPITAL)

"IMPROVING THE TRADITIONAL HOMESTEAD TO A VIABLE AGRO-FORESTRY SYSTEM FOR BIODIVERSITY CONSERVATION AND INCLUSIVE GROWTH OF KHAMPTI TRIBE OF NAMSAI DISTRICT, ARUNACHAL PRADESH"

Project Duration: *from* (**05.09.2019**) *to* (**31.03.2023**).
(3 Years + 06 Months and 27 Days Project Extension)

***Submitted to*:**
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***Submitted by*:**
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GENERAL INSTRUCTIONS:

1. The Final Technical Report (FTR) has to commence from the start date of the Project (as mentioned in the Sanction Order issued by NMHS-PMU) till completion of the project duration. Each detail has to comply with the NMHS Sanction Order.
2. The FTR should be neatly typed (in Arial with font size 11 with 1.5 spacing between the lines) with all details as per the enclosed format for direct reproduction by photo-offset printing. Colored Photographs (high resolution photographs), tables and graphs should be accommodated within the report or annexed with captions. Sketches and diagrammatic illustrations may also be given detailing about the step-by-step methodology adopted for technology development/ transfer and/ or dissemination. Any correction or rewriting should be avoided. Please provide all information under each head in serial order.
3. Any supporting materials like Training/ Capacity Building Manuals (with detailed contents about training programme, technical details and techniques involved) or any such display material related to project activities along with slides, charts, photographs should be brought at the venue of the Annual Monitoring & Evaluation (M&E) Workshop and submitted to the NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora 263643, Uttarakhand. In all Knowledge Products, the Grant/ Fund support of the NMHS should be duly acknowledged.
4. The FTR Format is in sync with many other essential requirements and norms desired by the Govt. of India time-to-time, so each section of the NMHS-FTR needs to be duly filled by the proponent and verified by the Head of the Lead Implementing Organization/ Institution/ University.
5. Five (5) hard-bound copies of the Project Final Technical Report (FTR) and a soft copy of the same should be submitted to the **Nodal Officer, NMHS-PMU, GBP NIHE HQs, Kosi-Katarmal, Almora, Uttarakhand**.

The FTR is to be submitted into following two (02) parts:

Part A – Project Summary Report

Part B –Detailed Project Report

In addition, the Financial and other necessary documents/certificates need to be submitted along with the Final Technical Report (FTR) as follows:

Annexure I	**Consolidated and Audited Utilization Certificate (UC) & Statement of Expenditure (SE)**, including the interest earned for the last Fiscal year and the duly filled GFR-19A (with year-wise break-up).
Annexure II	**Consolidated Interest Earned Certificate**
Annexure III	**Consolidated Assets Certificate** showing the cost of the equipment in Foreign/ Indian currency, Date of Purchase, etc. (with break-up as per the NMHS Sanction Order and year wise).
Annexure IV	**List of all the equipment, assets and peripherals** purchased through the NMHS grant with current status of use, including location of deployment.
Annexure V	**Transfer of Equipment** through Letter of Head of Institution/Department confirming the final status of equipment purchased under the Project.
Annexure VI	**Details, Declaration and Refund of any Unspent Balance transferred through Real-Time Gross System (RTGS)/ PFMS in favor of NMHS GIA General**

NMHS-Final Technical Report (FTR) *template*

Demand-Driven Action Research Project

DSL: Date of Sanction Letter

2	2	0	8	**2**	**0**	**1**	**9**
d	d	m	m	y	y	y	y

Completion

DPC: Date of Project

3	1	0	3	**2**	**0**	**2**	**3**
d	d	m	m	y	y	y	y

Part A: Project Summary Report

1. Project Description

i.	Project Grant Ref. No.:	GBPNI/NMHS-2019-20/SG						
ii.	Project Category:	Small Grant	√	Medium Grant		Large Grant		
iii.	Project Title:	Improving the traditional homestead to a viable agro-forest system for biodiversity conservation and inclusive growth Khampti tribe of Namsai District, Arunachal Pradesh						
iv.	Project Sites (IHR States/ UTs covered) (*Location Maps attached*):	Arunachal Pradesh						
v.	Scale of Project Operation:	Local	√	Regional		Pan-Himalayan		
vi.	Total Budget:	0.412(in Cr)						
vii.	Lead Agency:	ICFRE- Rain Forest Research Institute (RFRI) Jorhat,Assam-785010						

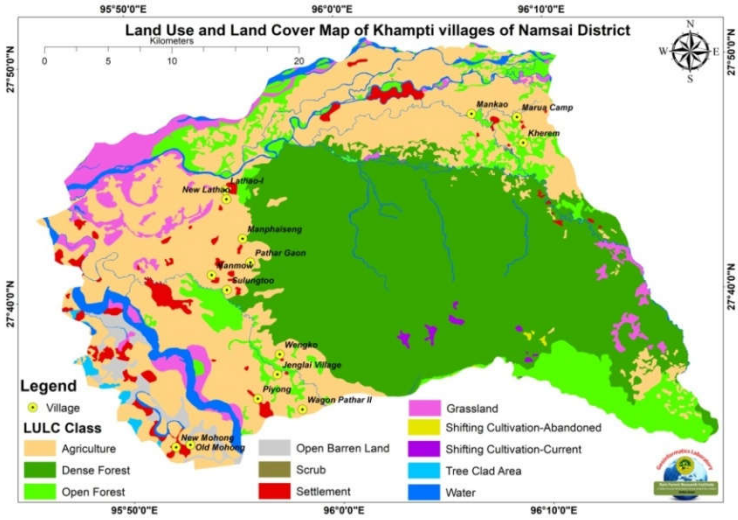


Fig. 1 Location map showing of 15 Khampti villages of Namsai district, Arunachal Pradesh

	Lead PI/ Proponent:	Dr. Prosanta Hazarika ICFRE - Rain Forest Research Institute (RFRI) Jorhat,Assam-785010
	Co-PI/ Proponent:	Shri Protul Hazarika ICFRE- Rain Forest Research Institute (RFRI) Jorhat,Assam-785010
viii.	Implementing Partners:	Arunachal Pali Vidyapith Society, Chowkham, Namsai (NGO)
	Key Persons (Contact Details, Ph. No., E-mail):	Dr. Prosanta Hazarika ICFRE- Rain Forest Research Institute (RFRI) Jorhat,Assam-785010 mobile: 9435352802 e-mail: hazarikapaug08@gmail.com; hazarikap@icfre.org

2. Project Outcomes

2.1. Abstract/ Summary (not more than 250-300 words)

Background

The traditional livelihood options of Khampti tribe of Namsai district, Arunachal Pradesh including agriculture are dated, less productive, unable to sustain the growing demands to the increased population. Consequently, increase in disparity of socio-economy, resource depletion caused livelihood dependency on the forests. Homesteads of Khampti tribes of Namsai are sizable and have the potential to improve their agroforestry system to enhance livelihood.

Objectives/ Aim

The main objective of the project is to support and widen of livelihood options. The other objectives are value addition & skill development to motivate younger generation for self-employment.

Methodology/Approach

PRA, socioeconomic and phytosociological studies were conducted to understand, identify and select productive components of local bioresources to incorporate into the existing traditional homesteads towards a viable agroforestry system. For that, approaches were made for development of 5 agroforestry demo plots in home gardens, conducted trainings for transfer of technologies and skills, value addition of the agroforestry resources.

Results/ Outcomes

A 24 plant species were Identified as viable & productive components for homestead agroforestry. About 44.88% Khampti households were below poverty line and 73.87% land used as agricultural and 25% as homestead land. Phytosociological study documented a total of 311 plant species from homesteads, of which, 105 tree species, 112 species were herb species, 65 shrubs and 26 climbers. Khampti homesteads had the diversity of 150 edibles and 78 medicinal plants. Also conserved 48 RET species.

A numbers of useful plant species were planted in 5 agroforestry models, apart from existing plant species enhancing livelihood and conservation of biodiversity. Economic status was upgraded more than 3 folds due to agroforestry approaches. Fifteen (15) of technology awareness camps were conducted and trained 341 beneficiaries, of which 118 male and 185 female. Also conducted skill & capacity building training for 212 individuals including 117 male and 95 female for nursery establishment, vermicomposting, Bee keeping, floriculture, mushroom cultivation, Japi making, agro based, bamboo products making etc for widening up of self-employment and promote livelihood.

Conclusions

Therefore, introduction of productive components to homestead agroforestry may be a viable alternative for better land management, livelihood, biodiversity and ecosystem services.

Recommendations/Way Forward with Exit Strategy

The agroforestry system that was adopted in the homesteads is productive, replicable, sustainable and viable for extension to the other households to get livelihood and economic benefit. System generated for the aspirant households to obtain guidance from demo plot owners for plantation technology, intercropping and management. With times, fruits bearing plants start production for contributing more economy to the owners too. Apart from that, knowledge and skill trained to the beneficiaries could certainly encourage for value addition of homestead /agroforestry based raw materials.

2.2. Objective-wise Major Achievements

SL	**Objectives**	**Major achievements (*in bullets points*)**
1.	Optimizing land use with	▪ Conducted 5 participatory rural appraisal (PRA) meetings in Old Mohong, Piyong, Parhar Gaon, Mankao and Lathao village

	integration of productive components of local bioresources to existing traditional homesteads to switch into a productive high density agroforestry system.	➢ Chosen productive components such as *Areca catechu* L. (Arecanut), *Acacia catechu* (L.f) Wild.(Khaior), *Aquilaria malaccensis* Lamk. (Sasi), *Bambusa tulda* Roxb. (Jati Banh), *Citrus limon* (L.) Osbeck (Nemu/ Orange), *Cinnamomum zeylenicum* Br. (Dal Cheni); *Cocos nucifera*, *Dalbergia sissoo* Roxb.(Sisoo); *Garcinia lanciefolia* Roxb, *Litchi sinensis* (litchi), *Livistona jenkinsiana* Griff. (Takow pat); *Mangifera indica* (Am); *Moringa oleifera* Lam. (Sojina), *Machilus bombycina* King ex Hook. f., *Zizyphus mauritiana* (Apple Ber) etc for inclusion in agroforestry system. ➢ During PRA also identified intercrop species such as *Brassica nigra* (L.) K.Koch, *Cajanus cajan* (L.) Millsp., *Colocasia esculenta* (L) Schott., *Curcuma longa* L., *Sesamum indicum* L. *Solanum tuberosum* L., *Vigna mungo* (L.) Hepper., *Zingiber officinale* Roscoe and Zea mays L. (Makoi) ▪ Socioeconomic survey revealed that ➢ Landholdings data showed 73.87% of the total land is used as agricultural land and 25% of the land as homestead land. ➢ Livelihood earned by Khampti households mostly agriculture (66.66%), similarly, 20% depend on both agriculture and government job, whereas, 0.44% are dependent only on government jobs and 0.88% on business. ➢ About 44.88% Khampti households were below poverty line and only 23.12 % households had more than Rs 40,000 annual income. ➢ Among the Khampti villages, the literacy rate range Lathao village was lest (16.12%) and highest in Manmow (71.79%).About 50% of the individuals had done their studies up to class 10; 22% had their secondary education (class 12) and few (4.64%) had done post-graduation. ➢ Annual energy consumption was found to be high for LPG (67.55%) than fire wood (17.34 %) and kerosene (15.11%). ▪ Outcome of phyto-sociological study, ➢ Documented a total of 311 plants species from 225 homestead

		gardens of 15 Khampti villages ➢ Of which, 105 tree species, 112 species were herb species, 65 shrub and rest were climber species. ➢ Recorded 93 species of medicinal plant species, 9 spices; 12 fuel-wood species; 5 fodder plant species from homestead gardens. ➢ Also documented 48 ornamental species ➢ A total of 150 edible plant species belongs to 56 families were documented from the homesteads of Khampti villages during the study. ➢ The study documented 48 threatened plant species from their homestead gardens belongs to 35 plant families. ▪ For optimising land use five (5) replicable agroforestry demo plots were developed in 5 Khampti villages i.e. Mankao, Lathao, Pathar Gaon, Old Mohong and Piyaon of Namsai District Arunachal Pradesh. ➢ Plant species such as *Areca catechu*, *Aquilaria malaccensis* (Sasi), *Bambusa tulda* Roxb. (Jati Banh), *Citrus limon* (L.) Osbeck (Nemu/ Orange), *Cinnamomum zeylenicum* Br. (Dal Cheni); *Dalbergia sissoo* Roxb.(Sisoo); *Litchi sinensis* (litchi), *Mangifera indica* (Am); *Machilus bombycina* King ex Hook. f., *Zizyphus mauritiana* (Apple Ber) *Piper nigrum* (black pepper), were planted. ➢ There was a many folds increased in annual return from the intercrops in agroforestry demo plots owners due to cultivation of *Zingiber officinale* (ginger), *Brassica nigra* (mustard), *Curcuma longa* (turmeric), *Cajanus cajan* (arhar), *Colocasia esculenta* (taro),*Sesamum indicum* (sesame), *Solanum tuberosum* (Potato), *Vigna mungo* (black gram) and *Zea mays* (maize). ➢ Data of initial years of agroforestry demo plots could enhance the economic status of the owners more than 3 times. In the year 2022, agroforestry demo plot owner of Mankao (Kherem) had earned a sum of Rs. 96,267.06 (before agroforestry it was Rs. 28,133), owner of Lathao demo plot had earned Rs.2,85,154

		(before agroforestry it was Rs. 19,920), Old Mohong owner had earned Rs. 90,814(before agroforestry it was Rs. 26,800), Pathar Gaon owner had earned Rs.1,22,500.4(before agroforestry it was Rs. 43,946), and the owner of Piyong had earned Rs. 90,576 (before agroforestry it was Rs. 28,487), ➢ Agroforestry plot owner of Lathao village could earn an increment of amount Rs. 2,65,234 in the second (2^{nd}) year which is the highest income being gained after agroforestry plantation, followed by Pathar Gaon with a profit of Rs.78,5544. ➢ The species like *Citrus limon*, *Litchi sinensis, Mangifera indica* and *Zizyphus mauritiana* started fruiting in all the agroforestry demo plots. ➢ Growth and survival rate of the planted seedlings varied for species to species within and among the sites. ➢ Over all tree species survival rate was highest with 80 % for Mankao agroforestry plot followed by Pathar Gaon 78.5 % and Piyong agroforestry plot had 76.34%; Old Mohong 69.55 and Lathao had 68.35 % survival of seedlings. ➢ Improving soil conditions and increased plant diversity.
2.	Value addition & skill development to generate superior products of marketable grade for sustaining livelihood and capacity building.	▪ Skill development training was done on 'Establishment of agroforestry nursery, cutting and bud grafting, and Vermicomposting' for 24 beneficiaries of Khampties. ▪ Five vermicompost (2 chambered) units (size of 14x 5 x 2.5 cft) were established in five demo plots i.e Mankao, Piyong, Lathao, Old Mohong, and Pathar Gaon for capacity building. The technology of vermicomposting and application was transferred to them and now active in production of vermicompost. ▪ Eight technology awareness camps on 'Mushroom cultivation' and 'Vermicomposting' were conducted. ▪ Two on-site technology awareness camps for entrepreneurs on available bioresources for product development were also done. ▪ Prepared three value added product from *Dillenia - Ginger- tea (i.e.* powder *mixture of Dillenia indica* +*Zingiber officinale* (ginger)+

		tea) , Dillenia-Black pepper tea (*Dillenia indica* and *Piper nigrum* (black pepper) powder and *Dillenia indica* and curry powder. ▪ One more value added product (Garcina powder) was prepared from Garcinia pedunculata fruits The process of value addition was transferred to Self help group / beneficiaries. ▪ Training for value addition of agro based products was conducted on '*Establishment of Food Processing Unit'* ▪ Training for value addition of bamboo based products was conducted at RFRI, Jorhat and products were prepared. ▪ Two trainings on value addition of locally available row materials for making Jigat and agarbatti was done ▪ Skill developed to 18 artisans for value addition 'Japi making' from locally available homestead plant *Livistona jenkinsiana* (Toko Patta)
3.	Motivate the younger generation for self-employment exposing with modern technologies.	▪ Provided training and exposure visits to Indian Institute of Entrepreneurship (IIE), Guwahati and Kamdhenu Industries, Basistrachal, Guwahati for motivation of 10 young beneficiaries for self employment establishmenting food processing unit. ▪ Provided training and exposure visits to ICFRE-Rain Forest Research Institute, Jorhat on Bamboo Handicrafts for 12 artisans of Namsai District, Arunachal Pradesh ▪ Motivated 18 artisans for self employment providing skill development training on 'Japi Making' ▪ Provide training to 17 youths for commercial mushroom cultivation and value addition for self-employment ▪ Provide training to 17 youths for vermicomposting and application for organic crop production ▪ Provided trainings to 46 youths for self employment by making Jigat and agarbatti (organic) with locally available row materials ▪ Motivated 24 youths for establishment of nursery for self employment using modern tools and techniques ▪ Developed skills to 23 young farmers for Bee keeping and value addition for self employment ▪ Provided skill development training to 38 youths for self

		employment through floriculture. ▪ Provided training to 24 youths for skill development on composting, vermicomposting and applications.

Note: Further details may be summarized in DPR Part-B, Section-5. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

2.3. Outputs in terms of Quantifiable Deliverables*

S #	Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations, if any, & Remarks thereof:
1	Establishment of agroforestry in homesteads as pilot mode through participatory approach (At least 5 plots)	• Number of Homesteads developed (Nos.)	• 5 homesteads are developed with an objective to have viable agroforestry demo plots one each in Mankao, Lathao, Pathar Gaon, Piyong and Old Mohong of Namsai district, Arunachal Pradesh. • Raising of agroforestry plantation and intercropping were completed.	None
2	Develop the market linkage of value added products (10 Nos.)	Number of value added products are developed (10 Nos.)	▪ 3 value added products were developed from *Dillenia indica, Zingiber officinalis* and *Pepper black gram;* one from *Garcinia pedunculata.* A market local market link given to stakeholder namely 'Namsai Organic Spices and Agricultural Products (*NOSAAP*) Producer Co. Ltd', Namsai. • Also developed 2 value added products i.e. Kiwi Jam and Kiwi Pickle. • Developed a value added product from leaves of *Livistona jenkinsiana*, namely 'Japi' and developed a market link with a trader of Assam namely Pulin Nath, Jorhat.	None

			• Developed four handicrafts products from bamboo and coconut shell namely Leaf Table Clock, Coconut tree with mobile stand, Mushroom Night Lamp and Bamboo flower vase. • Online market link was developed for two products i.e. Ginger and Turmeric with " JA TURMERIC' Link http://mydukan.io/ja33104.	
		• Organize Technology awareness camp (15 Nos.) for sharing knowledge for sustainable utilization of bioresources	▪ A total of fifteen (15) numbers of technology awareness camps were conducted which includes five (5) numbers of Awareness camp cum PRA for bioresources mapping, Four (4) camps on 'Mushroom cultivation' and four (4) camps on 'Vermicomposting'. Two (2) on –site technology awareness camp for entrepreneurs on available bioresources for product development was done. ▪ A total of 341 beneficiaries were participated the technology awareness camps which comprised of 118 male and 185 were female.	None
		• Exposure training to young entrepreneurs (10 Nos.)	Ten (10) numbers of exposure trainings were conducted on- Establishment of Nursery; Cuttings and grafting; Composting, Vermicomposting; Mushroom cultivation; Establishment of Food processing unit; Jigat Production and Agarbatti Making; Bee Keeping; Bamboo products making; Floriculture	None

			and Japi Making	
		• At least 04 Knowledge products: 02 Research publications including journal articles, 01 book chapters, and 01 policy briefs.	• 5 Knowledge products which includes - ➢ Four (4) technical brochures i.e. *Thysanolaena latifolia* (Broom grass), *Schumannianthus dichotomus* (Mutra), *Phrynium capitatum* (Koupat); *Livistona jenkinsiana* (Takow pat) and were distributed as knowledge products among the beneficiaries ➢ A technology manual on 'Substitute Jigat for Agarbathi Industry' published and distributed among the entrepreneurs for Jigat production with locally available 25 plant species ▪ 3 research papers published- ➢ P. Hazarika, Clerissa Handique and Protul Hazarika. (2021). Documentation of Edible Plants in Homesteads of Khampti Tribe, Namsai District, Arunachal Pradesh, India. *Int. J. Adv. Res. Biol. Sci.* 8(7): 64-80. DOI:http://dx.doi.org/10.22192/ijarbs.2021.08.07.008, Impact factor: 4.265 (2020) ➢ P. Hazarika, Clerissa Handique and Protul Hazarika. (2021). Rare, Endangered, Threatened and Endemic (RET & E) plant species in Traditional Khampti homesteads of Namsai district, Arunachal Pradesh.	None

			Life Sciences Leaflets, 139: 1 -12 (NASS rating 3.98,IF: 2.40) ➢ Mayur Suman, Prosanta Hazarika, Malashkiva Kotoky and Protul Hazarika. (2023). Phytosociological vis-a-vis Cultural implications of homestead plant species of Khampti tribe, Arunachal Pradesh. *Int. J. Adv. Res. Biol. Sci*. 10(1): 107-135. DOI:http://dx.doi.org/10.22192/ijarbs.2023.10.01.010 IF 5.51 (2023); NASS Score 3.33 (2020) ▪ An oral presentation was done in Assam Botany Congress (ABC-2) and International Conference on Plant Science on the topic 'Rare, Endangered, Threatened and Endemic (RET and E) plant species in traditional Khampti homesteads of Namsai District, Arunachal' held in Cachar College, Silchar, Assam.	

*As stated in the Sanction Letter issued by the NMHS-PMU.

2.4. **Strategic Steps with respect to Outcomes** (in bullets)

S#	Particulars	Number/ Brief Details	Remarks/ Attachment
1.	New Methodology/ Technology developed, *if any*:	Nil	N/A
2.	New Ground Models/ Process/ Strategy developed, *if any*:	5 Agroforestry models develop	Appendix-I .4 A.
3.	New Species identified, *if any*:	Nil	N/A

S#	Particulars	Number/ Brief Details	Remarks/ Attachment
4.	New Database established, *if any:*	Phytosociological, Socio-economic database developed	Appendix-I B.
5.	New Patent, *if any*:	Nil	N/A
	I. Filed (Indian/ International)		
	II. Technology Transfer, *if any*:	10 technologies were transferred	Appendix-3.
6.	Others, *if any*	1 presentation in Seminar	• An oral presentation was done in Assam Botany Congress (ABC-2) and International Conference on Plant Science on the topic '*Rare, Endangered, Threatened and Endemic (RET and E) plant species in traditional Khampti homesteads of Namsai District, Arunachal Pradesh'* held in Cachar College, Silchar, Assam.

Note: Further details may be summarized in DPR Part-B, Section-5. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

3. New Data Generated over the Baseline Data

S#	New Data Details	Status of Existing Baseline	Addition and Utilisation New data
1.	Edible plant species of Khampti tribes	No published baseline data but Khampti tribe use to take edible plants, New data generated	Evaluated and published in research journal - *Int. J. Adv. Res. Biol. Sci.* 8(7): 64-80
2.	Phyto sociological study of Homegarden plant species of Khampti Tribe of Arunachal Pradesh	No scientific study was existed on Homegarden plant species, new data generated on homesteads plant species	Studied and published in research journal- *Int. J. Adv. Res. Biol. Sci*. 10(1): 107-135.

3.	RET Plant species conserve in Khampti homesteads	No specific baseline data was found on RET species conserved in Khampti homesteads except over all RET plant species found in Arunachal Pradesh; New data generated for 48 RET species	Data generated and published in research journal *Life Sciences Leaflets,* 139: 1 -12
4.	Medicinal Plant conserve in Khampti Homesteads	No specific literature found except plant species used as herbal medicine by Khamptis	New data generated and documented

Note: Further details may be summarized in DPR Part-B. Database files in the requisite formats (Excel) may be enclosed as annexure/ appendix separately to the soft copy of FTR.

4. Demonstrative Skill Development and Capacity Building/ Manpower Trained

S#	Type of Activities	Details with number	Activity Intended for	Participants/Trained			
				SC	**ST**	**Women**	**Total**
1.	Workshops	**5**	Awareness on bioresources mapping & species selection	00	195	85	194
2.	On-Field Trainings	**8**	Technology transfer for livelihood and capacity building	00	112	82	112
3.	Skill Development	**10**	Technology transfer and resource utilization	00	117	95	212
4.	Academic Supports			00	00	00	00
5.	Others (if any)	**2**	Awareness on resource utilization and livelihood	00	34	19	34

Note: Further details may be summarized in DPR Part-B. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

5. Linkages with Regional & National Priorities (SDGs, INDC, etc.)/ Collaborations

S#	Linkages /collaborations	Detail of activities (No. of Events Held)*	No. of Beneficiaries
1.	Sustainable Development Goals (SDGs)	SD Goal 1. No Poverty Goal 5: Gender equality Goal 8: Decent work and economic growth	330 beneficiaries were trained
	Climate Change/ Intended Nationally Determined Contributions (INDC) targets addressed	National Agro-forestry Policy (NAP)	Agroforestry system developed in traditional Kampti home gardens
2.	Any other:		

Note: Further details may be summarized in DPR Part-B, Section-6. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

6. Project Stakeholders/ Beneficiaries and Impacts

S#	Stakeholders	Support Activities	Impacts in terms of income generated/green skills built
1.	Line Agencies/ Gram Panchayats:		
2.	Govt Departments (Agriculture/ Forest/Water):		
3.	Villagers/ Farmers:	Active participation in planning and implementation	Smooth and quick up scaling of the project activities were enabled
4.	SC Community:		
5.	ST Community:	Khampti tribe 100 % participation	Inclusive growth
6.	Women Group:	60% beneficiaries	Gender equality
	Others, *if any*:		

Note: Further details may be summarized in DPR Part-B, Section-6. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

6. Financial Summary (Cumulative)

S. No.	. Financial Position/Budget Head	Funds Received* (Rs)	Expenditure/ Utilized	% of Total cost
I.	Salaries/Manpower cost #	869857.00		
ii.	**Travel**	973274.00		
iii.	Expendables &Consumables			
iv.	Contingencies	171773.00		
v.	Activities & Other Project cost #	1579947.00		
v.	Institutional Charges	**362400.00**		
vi.	Equipments	**00**		
	Total	**385249.20**		
	Interest earned			
	Grand total			

Please attach the consolidated and audited Utilization Certificate (UC) and Year-wise Statement of Expenditure (SE) separately, *ref*. **Annexure I.**

8. Major Equipment/ Peripherals Procured under the Project** (*if any*)

S#	Name of Equipment	Quantity	Cost (INR)	Utilisation of the Equipment after project
1.	Nil	Nil	00	N/A

Details should be provided in details **(*ref.* **Annexure III &IV).**

9. Quantification of Overall Project Progress

S. No.	Parameters	Total (Numeric)	Remarks/ Attachments/ Soft copies of documents
1.	IHR States/ UTs covered:	1	
2.	Project Sites/ Field Stations Developed:	5	Appendix- I .4 A.
3.	Scientific Manpower Developed (PhD/M.Sc./JRF/SRF/ RA):	2	
4.	Livelihood Options promoted	10	Appendix-4
5.	Technical/ Training Manuals prepared	5	Appendix-5
6.	Processing Units established, if any	*5* (attach photos)	Appendix – 1.4 A

			Vermicomposting units
7.	No. of Species Collected, if any	Nil	
8.	No. of New Species identified, if any	Nil	
9.	New Database generated (Types):	3	Appendix 1.1 &1.2
	Others (if any)		

Note: Further details may be summarized in DPR Part-B. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

10. Knowledge Products and Publications:

S#	Publication/ Knowledge Products	*Number*		*Total Impact Factor*	*Remarks/* Enclosures
		National	International		
1.	Journal – Research Articles/ Special Issue:	03	0	5.51 4.265 and 2.40	Appendix-2
2.	Book – Chapter(s)/ Monograph/ Contributed:	nil		Nil	
3.	Technical Reports:	4		Nil	Appendix-5
4.	Training Manual (Skill Development/ Capacity Building):	1		Nil	Appendix-5
5.	Papers presented in Conferences/Seminars:	1		Nil	
6.	Policy Drafts/Papers:	nil			
7.	Others, if any:	nil			

Note: Please append the list of KPs/ publications (with impact factor, DOI, and further details) with due Acknowledgement to NMHS. Supporting materials may be enclosed as annexure/ appendix separately to the FTR.

11. Recommendation on Utility of Project Findings, Replicability and Exit Strategy

Particulars	Recommendations
Utility of the Project Findings:	The project could developed replicable agroforestry system which will help in generating better livelihood opportunities. The technologies skilled to the beneficiaries are inheritable for cultivation, management, production, processing and value addition will also equip and encourage the youth, women and entrepreneurs for self-sustained and self-employment.

Replicability of Project/ Way Forward:	The project established five agroforestry demonstration plots which are replicable to other homesteads of the district for better economic benefits and optimum use of land. However, the approaches used in the project including selection of location specific viable and productive components through PRA may be exercised with utmost care. The training and capacity building, locally available resource based value addition activities pertaining to motivate younger generation for self employment can be easily replicable in different localities of the Indian Himalayan Region (IHR) areas.
Exit Strategy:	Established agroforestry in homesteads in five Khampti villages were handed over to the owners after completion of project tenure. The required technology for plantation, cultivation of intercrops, nutrient and pest management were handed over through training time to time during project period may be handy for future for self sustain. As the agroforestry crops and intercrops benefitted economically the owners are supposed to be able to reproduces their annual crops investing a part of their economic output. As the economic growth of the owner received from the agroforestry and that will be realised by the other villagers of the district, will encourage adopting the same in their homesteads too.

(**PROJECT PROPONENT/ COORDINATOR**)

(Signed and Stamped)

(**HEAD OF THE INSTITUTION**)

(Signed and Stamped)

Place: ……..
Date: …../……/……

PART B: DETAILED PROJECT REPORT

1. EXECUTIVE SUMMARY (not more than 2–3 pages)

The main inhabitants of Namsai district, Arunachal Pradesh are Tai Khampti, Singpho, Deori and Mishing tribes. However Tai-Khampti is the major tribe, their traditional practices on agriculture and other livelihood options mainly reflected on the socioeconomic status of Namsai district. The traditional livelihood options including agriculture are less productive. Therefore, it was observed that Khampti villagers' particularly small landholdings households use to collect timber, fuelwood and edibles from the forests to meet the growing demands of increased population. Consequently, these factors caused resource depletion and then again turn into more livelihood dependency on the forests of the mountain ecosystem.

The project could generate new baseline data on socioeconomic conditions of Khampti tribe of Namsai district, Arunachal Pradesh. The socioeconomic study revealed that 44.88% Khampti households were below poverty line. Out of total land use land cover pattern about 73.87% land used as agricultural and 25.16% as homestead land. The land holding data obtained from the socioeconomic survey also indicated that most of the households having more than 10 bighas of agricultural land, but average annual return from agricultural land was very very low i.e. Rs. 10906.53. Indeed, a Khampti household never use to cultivate entire agricultural lands belongs to the household in a year. Only a part of the agricultural land is used for cultivation of paddy per the family requirement forayear or gives others to cultivate on the system called 'Adhi'. In Adhi system half of the production was given to the owner of the land. Moreover, the size of the Khampti homesteads were varies from 0.1 ha to 7ha but less utilized; average annual income from homesteads was only Rs. 3470.13. From the data of socioeconomic study the total average annual income of the Khampti households was very low only Rs. 28,445.60.

The project also generated new baseline data on phytodiversity of homestead plants of Khampti tribe of Namsai district, Arunachal Pradesh. The phytosociological study documented a total of 311 plant species from homesteads, of which, 105 were tree species, 112 species were herbs, 65 were shrubs and 26 species were climbers. Khampti homesteads had the diversity of 150 edibles and 78 medicinal plants. Also conserved 48 RET species. The common species found all the Khampti villages were *Cocos nucifera* L., *Areca catechu* L., *Livistona jenkinsiana* Griff., *Sapindus mukorossi* Gaertn., *Albizia chinensis* (Osbeck) Merr., *Albizia lucidior* (Steud.) Nielson., B*ambusa tulda* Roxb., *Citrus limon* (L.) Osbeck. in their homesteads.

The diversity of plant species varies in different Khampti villages. For example, tree species diversity was highest in Mankao village and lowest in Manmow village. The species

diversity of shrubs was recorded as highest in Sulungtoo and lowest in Manmow village. On the other hand, the 'Species Richness' for tree species was found highest in Kherem village and lowest in Wengko village. While Species Richness' for shrub species was found highest in New Lathao village and lowest in Old Mohong village. Use value (UV) of the plant species was also determined as an important index of utility and criterion of conservation of the species in their homesteads of Khampti tribes. The highest use value was recorded for *Livistona jenkinsiana* (0.65-0.71) followed by *Areca catechu* (0.58- 0.63), *Bambusa tulda* (0.50-0.52), *Cinnamomum zeylenicum* (0.50-0.57), *Camellia sinensis* (0.45- 0.49), *Citrus limon* (0.44-0.51), *Musa Cavendish* (0.42-0.46), *Murraya koenigii* (0.43- 0.50), *Derris elliptica* (0.39-0.42) and the lowest was observed in *Prunica granatum*. The Khampti tribe is rich in traditional knowledge for utilization of homestead plants and reflected in their strong cultural practices.

The project established in five agroforestry demonstration plots which are replicable to other homesteads of the district for better economic benefits and capable to optimize land use pattern with productive phytodiversity. It is also observed that established agroforestry in the five (5) homesteads i.e. in Mankao, Lathao, Parthar Gaon, Piyong and Old Mohong could generate more than 3 folds annual income for the initial years. This is encouraging for better land management and to enhance livelihood. It also helped in conservation of biodiversity and contributed to promote other ecosystem services too. The main objective of the project was to support livelihood options. To achieve the goal, 24 plant species as productive components of local bioresources/NTFPs were planted in to five (5) existing traditional homesteads towards establishment of a viable agroforestry system. It was observed that land use systems of five agroforestry system introduced in Khampti homesteads under the project were profitable with a variation in benefit cost ratio (BCR) range from 4.44 to 10.45. Whereas, the BCR value more than 1 is considered as profitable land use system.

A total of ten (10) training programmes were conducted for technology intervention, skill & capacity building to 212 individuals. Of which, 117 were male and 95 were female.They were trained for nursery establishment, vermicomposting, Bee keeping, floriculture, mushroom cultivation, Jigat production, Agarbatti making, Japi making, establishment of food processing unit, bamboo products making etc for widening up livelihood and promote self-employment oportunities. These training programmes were instumental to learn modern technologies and skills for resource utilization and value addition, which motivate the younger generation for self-employment. Apart from that a total of fifteen (15) of technology awareness camps were conducted and benefited 341 stack holders, of which 118 male and 185 female. Under these activities provided 8 hands-on trainings on vermicomposting and mushroom cultivation.

Furthermore, four knowledge products (SoPs) namely ‘Patidoi’, ‘Tokopata’, ‘Jaru Bon’ and ‘Kou pat’ and a technical manual on ‘Substitute Jigat for Agarbatti Industry’ were also published and distributed among the beneficiaries.

As the out come of training programmes a total of 12 value added products were produced by the beneficiaries of which 6 were edible products targeting the local markets and other six were non edible. These 12 value added products were prepared by eight (8) entrepreneurs of Namsai district, Arunachal Pradesh. Value addition of NTFPs may not only enhance livelihood but also enabled them to expose with modern technologies, develop skill to generate superior products of marketable grade.

As mentioned the major change was obtained with regards to land utilization system under the introduced agroforestry as demo consequenced as profitable. At the same time, the introduced agroforestry system also offered prevalage to the homestead owners to recycle of organic waste to vermicompost for better organic production. Five vermicomposting units were established under the project and and also provided training for production of vermicompost.Thus they had been given oportunities for application of biofertilizers; production and application of compost and vermicompost.

In addition to the above, 24 productive plant species planted in the five (5) agroforestry demo plots over exsiting phytodiviesity had extended their cortribution in biodiversity. Realizing the change could be brought in economic status through agroforestry in homesteads (which is in their door step in the form of demo agroforestry) may be a most important driver to the small land holders to self-sustain and large landholders for commercialization. Implementation of the training activities under the project were instrumental for value addition of their bioresources and hopefully enabled those in long ran to reduce anthropogenic pressure on nearby forests of the mountain ecosystem of Arunachal Pradesh. Thus, all the activities may be useful to promote livelihood and biodiversity conservation.

As the project had to conclude within the time frame of 3.5 years, there are many scientific observations remain under question mark. However, data of the initial years of agroforestry introduction to their traditional homesteads could rely upon as viable alternative to optimize land use and bioresources utilization in eco-friendly manner. The findings of the project carefully recommended for It’s replication in other homesteads of similar topography of the country for enhancing the productivity & income; promote ecosystem services; and to ensure conservation and sustainable use of biodiversity.

2. INTRODUCTION

2.1. Background (max. 500 words)

Namsai district is situated at the bank of the Dihing river and the other river is Tangapani. It comprises with 178 villages and is the youngest district of Arunachal Pradesh. It was formed on 25th November, 2014, after dividing former Lohit district. The district is located in between latitude 27°30' to 27°55'N and longitude 95° 52' to 96° 20' E with a total geographical area about 1587 sq km. Namsai is sharing border with Lohit and Changlang to the east; Assam to the west; Lohit and Assam to the North, and the south border adjoins Changlang district. The district is divided into 5 administrative circles i.e. Mahadevpur, Namsai, Piyaong, Lathao and Chongkham. It is the inhabitancy of mainly Tai Khampti, Singpho, Deori and Mishing tribes. Other tribes are Adi, Mishmi, idu etc. Namsai is the land of Khampti. The word suggests the syllables 'Khamp' meaning 'Gold' and 'Ti' denoting 'Land', together manifests a “land full of gold”, where they inhabit. The local language Khampti syllables ‘Nam’ and ‘Sai’ meaning the ‘water’ and ‘sand’, together makes Namsai denoting the grace of sand besides the water body of beautiful Dihing river, a tributary of Brahmaputra. Khampti people speak Khampti language which has its own script. Their script is known as “*Lik Tai”* which was originated from the “*Shan”*(Tai) script of Mayanmar. Other communicating languages are Assamese, Hindi and English. Road distance between RFRI, Jorhat and Namsai is almost 260 Km. Tai-Khampti is the major tribes of Namsai district. They migrated from the Moung Khamti in the Irrawadi valley, Myanmar and settled around the Tegapani River, Namsai in the 13th century (Das, 1989; Pandey, 1997; Geyi, 2021). Being Tai-Khampti is the major tribe, their traditional practices on agriculture and other livelihood options mainly governed the socioeconomic status of the district. There are two types of land system in villages of Namsai district i.e. individual and community land (Hazarika *et al*., 2021). It was observed that every household was allotted land for homestead, wet rice field and dry land cultivation on equality principle depending on the population of the family at the time of allotment (Gogoi, 1971). The remaining village land earmarked for pasture and forest land belongs to the community under the customary ownership right of the Chauman (village headman). The emerging trend of privatization of land and prevalent customary rights of ownership of land vested in the Chauman has created inequality in land holdings (Hazarika *et al*., 2021). The homesteads play important role conservation of unique diversity of edible, medicinal and useful plant species to mitigate local needs and commercial important (Dilrukshi *et al*., 2013; Hazarika *et al.*, 2014). As such introduction of viable components into the home garden agroforestry may be a viable alternative for better land management and livelihood. It also helps in conservation of biodiversity and environment too. It was expected to help in

enhancing the household productivity, promote ecosystem services, and ensure conservation & sustainable use of biodiversity.

2.2. Overview of the major issues addressed (max. 500 words)

It is also observed that small land holding families often have to depend on nearby forests for their livelihoods. In the year 2002 to 2020, Namsai lost 37% of the forest cover area (Mondal, 2022). From 2013 to 2021, 100% of tree covers loss in Namsai district occurred within the natural forest. The total loss within the natural forest was equivalent to 781kt of CO_2e emissions. Thus, increasing trend in population pressure and small land holding families caused the biodiversity and natural resource depletion. The Khampti community has their own traditional knowledge with respect to their resource utilization (Das, & Tag, 2006). The people of the area are mainly agricultural depended. The present agricultural system is traditional, less productive and practised mainly by the women. At the same time, their homesteads are said to be less productive. However, Bamboo Toko pata, orange, citrus and pineapple, betel nut and betel vine, black paper are some potential components found in thoer homesteads. They have also practised for sericulture traditionally. The traditional knowledge of herbal medicine Khampti tribe is rich, communal and the knowledge on the use of medicinal plants has been passed on orally from generation to generation without any written document (Namsa *et al.*, 2009).

The population pressure, inequality of land holdings, increased in small landholding families, recurrent flood, migration of non-tribal population, women dependent workforce (Gender inequality), conversion of forest to tea garden and traditional cultivation practice that unable to attract the younger generation toward cultivation. No modern agroforestry system is operational among the people of the district. Every household of Khamptis have their homesteads surrounding their residential house. Size of these home gardens are varies from 0.1 ha to 7ha. Except several instances most of homestead gardens belonging to this tribe was found unused and underutilized. A well-designed homestead rich in biodiversity also acts as a good source of income for the family. The layered canopy configurations and a mixture of compatible species are the most conspicuous characteristics of all home-gardens (Nair, 1993). Homesteads of this tribal community may be upgraded to viable agroforestry system incorporation modern agroforestry components for generation optimum livelihood and land utilization of the mountain ecosystem. Thus, homesteads are important land form of optimum utilisation of growing trees, shrubs and herb.

The project addresses the priority issue of sustainable development goals through management of land and native bio-resources, women empowerment, gender equality as well

as promote livelihood through introduction of agroforestry system. Implementation of the project helped in productivity enhancement, value addition, supplementary livelihood option, conservation and sustainable use of biodiversity, and awareness and capacity building.

(COVID-19 lockdown: The project works were largely affected due to the lockdown & inter states imposed due to COVID-19 pandemic situation.)

2.3. Baseline Data and Project Scope (max. 500 words)

A socioeconomic survey was conducted in collaboration with Arunachal Pali Vidhapith Society, Namsai, new baseline data generated on land holdings and land use pattern, primary livelihood activity, economic condition, education, language, traditions and customs, culture & Lifestyle, energy consumption, livestock profile etc. It was observed that most families were nuclear. More than 50% of the households were kaccha, 32% lived in semi pucca houses and 15% had pucca houses. Average annual income of the households was maximum (25.77%) within the range of Rs 15,000- 20,000; 23.12% households had the annual income more than Rs 40,000; 10.66% households had within Rs 30,000- 40,000; Similarly, 21.34 households had annual income range Rs 20,000-30,000; while 5.3% within the range of Rs 10,000-15,000; 13.77% within 10,000. About 66% of the population depend on agriculture for their livelihood, similarly, 20% depend on both agriculture and government job, whereas, 0.44% are dependent only on government jobs and 0.88% on business. 50% of the individuals had done their studies upto class 10; 22% had their secondary education (class 12) and few (4.64%) had done post-graduation. Landholdings data showed 73.87% of the total land is used as agricultural land and 25% of the land as homestead land. Cow is the highest reared livestock than pig, goat and buffalo. They cultivate Kharif and Rabi crops. Annual energy consumption was found to be high for LPG (67.55%) than fire wood (17.34 %) and kerosene (15.11%).

The phyto-sociological survey was conducted following quadrate method to record tree and shrub species found in 225 homesteads of 15 Khampti villages. A total of 311 plant species were recorded from Khampti homesteads; of which 105 tree species and 65 shrub, 111 herbs and 30 climber species; 150 plant species were edible. Use value (UV) of the plant species was also determined as an important index of utility and criterion of conservation of the species in their homesteads of Khampti tribes. Shanon-Weiner Diversity Index, Margalef's index and Sorenson's Similarity Index were analyzed for determining the biodiversity of the villages. The phyto-sociological survey was conducted to know about the extent of biodiversity that has been traditionally conserved in Khampti homesteads of Namsai district, Arunachal Pradesh. It was

observed that Khampti people also conserved traditionally and culturally a number of plants about to extinct, wild, and other living species of a crop plant in their homesteads.

Participatory Rural Appraisal (PRA) was conducted in Mankao Village, Lathao villge, Pathar Gaon, Piyong and Old Mohong villages collaborating by Arunachal Pali Vidhapith Society, Namsai. Through PRA village resources particularly homesteads plant species were mapped and selected productive components for improving the homesteads into a viable agroforestry system. Secondary data were also collected from existing literatures on migration and history of Khampti tribe, language, traditions and customs, Ethno & folk medicine, culture & Lifestyle etc (Das & Hui, 2006; Nathalang, 2006; Pandey 1972; Kumar, 2022; Komow, 2017; Mondal, 2022; Tripathy & Raha 2018; Geyi, 2021; Ete and Sharma, 2023)

Native potential bioresources were incorporated in 5 agroforestry system. Agroforestry in homesteads enabled to produce products using agroforestry based raw materials to meet local demand. That, in turn, reduces the anthropogenic pressure on the forests, way out mitigate climate change. Trainings, meeting, publication and distribution of leaflets on productive components, organic technology and value addition work were instrumental among the community for capacity building and skill development to the stakeholders. Value addition of bioresources including NTFPs of the proposed agroforestry in to new marketable product/(s) will sustain livelihood and attract the youth, also will alleviate gender equality.

2.4. Project Objectives and Target Deliverables (as per the NMHS-Sanction Order)

The long-term goal of the project is to enhance livelihood by optimum utilization of land incorporating productive components of local bioresources to existing traditional homesteads towards a viable agroforestry system.

Project Objectives	Quantifiable Deliverables	Monitoring Indicators
1. Optimizing land use with integration of productive components of local bioresources to existing traditional homesteads to switch into a productive high density agroforestry system.	• Establishment of agroforestry in homesteads as pilot mode through participatory approach (At least 5 plots)	• Number of Homesteads developed (Nos.)
2. Value addition & skill development to generate superior products of marketable grade for sustaining livelihood and capacity building.	• Develop the market linkage of value added products (10 Nos.)	• Number of value added products are developed (Nos.)

3.Motivate the younger generation for self employment exposing with modern technologies	• Develop the market linkage of value added products (10 Nos.) • Organize Technology awareness camp (15 Nos.) for sharing knowledge for sustainable utilization of bioresources • Exposure training to young entrepreneurs (10 Nos.) • At least 04 Knowledge products: 02 Research publications including journal articles, 01 book chapters, and 01 policy briefs.	• Number of training and awareness programmes conducted (No) • Number of beneficiaries village/ local people (Nos.) • No. of Reports/Research articles/Policy documents prepared and published (Nos.)

3. METHODOLOGIES/STARTEGY/ APPROACH – *supporting documents to be attached.*

3.1 Methodologies used (max. 500 words)

i. Socioeconomic survey was done following randomize purposive sampling method through interview the elderly persons and women with a structured questionnaire. New baseline data were generated on land holdings and land use pattern, primary livelihood activity, economic condition, education, language, traditions and customs, culture & Lifestyle, energy consumption, livestock profile etc (Appendix 1.1).

ii. The phyto-sociological survey was conducted in 225 homesteads of 15 Khampti villages namely Old Mohong, Pathar Gaon, Piyong, Lathao-1. New Lathao, Sulungtoo, Kherem, Marua camp, Mankao, New Mohong, Manphaiseng, Manmow, Wagon Pathar, Jenglai, Wengko (Appendix-1.2.& Appendix 2). Recorded homestead plant species following quadrate method to enrich database on local bioresources for livelihood options and ecological sustainability. Quadrates laid $10m^2$ for trees, 5 m^2 for shrubs and $1m^2$ for herb species. Data were analysed for relative frequency, relative dominance and relative density (Trivedy *et al*., 1987), Importance Value Index (Curtis, 1959). The species diversity within a community was determined by using the Shanon-Weiner

Index (Rajasekaran, et al., 2017), Species Richness (Rajasekaran et al., 2017), and Use Value (Dossou et al., 2012; Khatib et al., 2021). Also documentation of tree, shrubs, herbs, medicinal, edibles, fuel wood, timber plants, RET species etc were done and published 3 research paper in peer reviewed journals (Appendix- 2).

iii. Five (5) participatory rural appraisals (PRA) were conducted with SWOT analysis in Old Mohong, Piyong, Mankao, Pathar Gaon and Lathao village to select viable and productive components for agroforestry species based on local priority and conditions of bioresources (Appendix-1.3). The beneficiaries for homestead agroforestry demo plots were also selected in the PRA meetings (Appendix 1.3).

iv. As per selection of name of the 5 beneficiaries by the PRA meetings, five(5) agroforestry demo plots in pilot mode were established in homesteads of Old Mohong, Piyong, Pathar Gaon, Mankao and Lathao villages. A lay out plan along with plant species and intercrops was designed and implemented (Appendix-1.4. A)

v. A total of 21 plant species were identified by the peoples in the PRA meetings and were planted in 5 different agroforestry plots (Appendix-1.4. A). The details of species planted in agroforestry plots are presented in table 2.

vi. The MoUs were signed between homesteads owners and ICFRE-Rain Forest Research Institute, Jorhat (Appendix-1.4.B).

vii. Technologies were transferred for nursery seedlings production, plantation techniques, production and application of vermicompost, use of phyto-pesticides to control pest and diseases, sustainable harvesting, processing & curing etc (Appendix-3.C).

viii. Soil physicochemical characteristics were studied following standard methods such as available phosphorous (Bray and Kurtz, 1945), nitrogen & potassium (Page *et al.* 1982), percent organic carbon (Walkley and Black,1934), pH(1:2;soil: water); EC by Calomel Electrode method to evaluate status due to agroforestry(Appendix-1.4 A;Table 4).

ix. The details of 10 numbers training conducted for capacity and skill development, value addition are presented in appendix-3.C.

x. The details 15 technology awareness camps/ meetings organised for motivation and self employment are presented in appendix -3. D.

An NGO namely **'**Arunachal Pali Vidyapith Society (AVPS)', Chongkham, Arunachal Pradesh was engaged as implementing partners of RFRI which actually act as service provider by providing manpower and also guiding in community participatory activities & assist in organizing of training camps etc. on payment basis.

3.2 Data collected and Equipments utilized (max. 500 words)

A structured questionnaire was used for collection of socioeconomic survey; A format was also used to collect data for PRAs. Phytosociological data were collected by following quadrate method. A 10 m^2 quadrates was used to record tree species ; 5m^2 quadrates was used to record the shrub species and 1m^2 quadrate was laid to record the herb species from homesteads. Apart from these a numbers of basic equipments for collecting data to conduct PRAs, Socioeconomic and phytosociological survey of Khampti tribe, Namsai district of Arunachal Pradesh are as follows:

1. GPS: It was used to locate the project site such as latitude and longitude, altitude, etc.
2. Measuring scale/tape: It was used to measure the dimension of the handloom and handicraft products.
3. PowerPoint projector: It was used for conducting an awareness program at the village level.
4. Digital camera: The camera was used for photography of the project sites, plant species and various products of indigenous knowledge systems such as pickle products, handicraft items, agricultural produces, etc.
5. Digital caliper: The measurement of diameter, length, etc. of plant species was done.
6. Soil samples collected time to time from agroforestry demo plots were analyzed using pH & EC meter, available nitrogen using Kjeldal apparatus, available phosphorus using spectrophotometer and potassium by flame photometer etc.

3.3. Details of Field Survey conducted, if any (max 500 words)

The socioeconomic and phytosociological surveys were conducted in Namsai district of Arunachal Pradesh during 2019-2020. A structured questionnaire was used for socioeconomic data collection from 15 randomly chosen rural households of 15 Khampti villages viz., Old Mohong, Pathargaon, Piyong, Lathao-1, New Lathao, Sulungtoo, Kherem, Marua camp, Mankao, New Mohong, Manphaiseng, Manmow, Wagon Pathar, Jenglai, Wengko of 5 administrative Circles of the Namsai district. Multistage purposive randomized sampling technique was exercised to collect the socio-economic data, biodiversity, socio- cultural relationship with the plant species present in homesteads of 15 Khampti villages distributed of Arunachal Pradesh. A total of 225 homesteads were surveyed for socioeconomic and elderly

persons were interviewed to document socioeconomic status at household level. Prior permission was taken from the owners of the homesteads while conducting the survey.

Collected data were classified into social and economic categories. The social factors included- name and age of the respondent, type of family- nuclear or joint, family size- no. of female and male, type of house- kaccha, semi pucca & pucca; educational status; lifestyle and dresses; culture & rituals; livelihood activities- agriculture, service, self-employed, business etc of the household; rate of acquaintance with agroforestry systems. Economic questions included average monthly income of family, earning from primary livelihood activities, monthly energy consumption, land holdings – income from agricultural and homestead land, livestock profile and agricultural production. The economic gain of different land uses - such as homestead and homestead agroforestry (5 agroforestry demo plots) was evaluated for two consecutive years on the annual income. The collected data were analyzed and presented in tables and figures.

Similarly, homestead plant species from 15 randomly selected homesteads of each 15 Khampti villages were recorded by random quadrate sampling method. Relative frequency, relative dencity and relative dominance were calculated out to obtain importance value index (IVI) of the plant species available in the homesteads. The plant species recorded in the survey were classified as trees shrubs and herbs. Also plant species were categorized according the use by the villagers such as edible (fruits, vegetables, spices) medicinal, fodder, timber, fuel wood, ornamental, sacred etc. Importance Value Index (IVI), Species richness and species diversity has been calculated in the 15 quadrates of each Khampti village. The height and collar diameter/ DBH of the plant species were measured. Use value of most important plant species commonly found in all the homesteads was also evaluated.

Apart from these, the field surveys were conducted in the demo agroforestry plots situated in Mankao, Lathao, Pathar Gaon, Piyong and Old Mohong villages time to time to record seedlings survival and growth of seedlings of plant species those were planted in 5 homesteads agroforestry demo plots established. Surveys were also done to record yield of intercrops harvested time to time in different seasons of the year those were cultivated in 5 agroforestry demo plots. The data of the field surveys were analyzed, documented and also a few of them were published in peer reviewed Journals.

3.4 Strategic Planning for each activity with time frame (max. 200 words)

Activities	1st year				2nd year				3rd year			
	1	2	3	4	5	6	7	8	9	10	11	12
Activity-1.1. Socioeconomic status	√	√	√	√	√	√						
Activity-1.2. Phyto-sociological study	√	√	√									
Activity-1.3. Selection of species through PRAs		√	√									
Activity-1.4. Selection of beneficiaries & develop AF			√	√	√	√	√	√	√	√	√	√
Activity-2.1. Value addition & Skill development				√	√	√	√					
Activity-2.2. Technology Awareness camps							√	√	√	√		
Activity-2.3. Value addition of potential bioresources									√	√	√	
Activity-2.4 Need based training		√	√	√	√	√	√	√	√			
Activity-3.1Demonstration of cultivation practices							√	√	√	√		
Activity-3.2 Motivate the younger generation & exposure training				√					√			
Activity-3.4. Writing of FTR												√

4. KEY FINDINGS AND RESULTS – *supporting documents to be attached.*

4.1 Major Activities/ Findings (max. 500 words)

Activity1: Optimizing land use with integration of productive components

Activity-1.1

- Socioeconomic status of Khampti tribe was evaluated by a survey of 225 households in 15 Khampti villages.
- Structured questioner was prepared for interview the elderly persons, data were recorded and analysed.
- Details of the findings are presented in appendix 1.1.

Activity-1.2

- Phytosociological study was conducted following quadrate methods in 225 homesteads of Khampti tribes during 2019-2020.
- Data were recorded and evaluated for relative frequency, relative density, relative dominance, IVI, Species richness, species evenness, use value etc. and published in peer reviewed research journal (Appendix 2. Phytosociological vis-a-vis Cultural implications of homestead plant species of Khampti tribe, Arunachal Pradesh. *Int. J. Adv. Res. Biol. Sci.* 10(1): 107-135.)
- Documented plant species found in the homesteads of Khampti villages in different

categories such as edible, fodder, medicinal, spices, timber, fuel wood, ornamental etc and presented in appendix 1.4.

- 150 plant species were documented as edible found in Khampti homesteads and published in peer reviewed journal- *Int. J. Adv. Res. Biol. Sci.* 8(7): 64-80. DOI: http://dx.doi.org/10.22192/ijarbs.2021.08.07.008 (Appendix 2).
- 48 rare, endangered and threatened (RET) plant were also found to conserved in the homesteads of Khampti tribe and findings were published in a research paper of a peer reviewed journal- *Life Sciences Leaflets,* 139: 1 -12 (Appendix 2).

Activity-1.3

- Five (5) PRAs were conducted on 05/12/2019 in Old Mohong village, on 28.12.2019 in Mankao Village, on 30. 12.2019 in Pathar Gaon, on 10.01.2020 in Lathao village, on 12.01.2020 in Piyong village. (**Appendix-1.3**)
- The resources were mapped, identified priority livelihood options and created awareness for application of modern technologies.
- SWOT analysis was done and identified land and resources as strength; poor education and technology skills as weakness; human resource, rich biodiversity, tribal tradition and culture as opportunity; lack of awareness, incompetency in resource generation and utilization as major threats for the tribe.
- Identified 24 plant species as viable and productive components for agroforestry during PRAs as priority species by the villagers those took part in the programmes.

Activity-1.4

- Selected one beneficiary from each of the five villages i.e. Mankao, Pathar Gaon, Lathao, Piyong and Old Mohong Villages in consultation with and agreed by the gathering of PRA meetings (Table 11 in appendix 1.4 A).
- 5 agroforestry plots were established incorporating 24 plant species as productive components (Fig 11);
- Technologies were transferred for establishment and management of nursery; plantation management; vermicomposting and application (Appendix 3.C.1,3 &4)
- Five (5) concrete structured vermicompost units were established for capacity building in organic fertilizer production and application (Fig 9 in appendix 1.4 A).

Activity-2. Value addition & skill development to generate superior products

Activity 2.1

- Technology awareness camps (15) were organized to share knowledge, skill development and motivation for sustainable utilization NTFPs (**Appendix-1.3**).
- Technology demonstrations, distribution brochures were done focusing livelihood

(Appendix -2 & 3).

Activity 2.2

- Beneficiaries were trained to produce 10 value added products such as Japi from toko pata, Jigat, hand rolled agarbatti, agro based products from curcuma, zinger, Kiwi, elephant fruit, bamboo articles etc Technology experts were engaged for conducting the trainings (Appendix 4).

Activity 2.3

- Training was organized & trained 10 entrepreneurs at IIE, Guwahati for production, preservation, packeting, storage of agro based value added products (Appendix 3).
- Involved local NGO for market linkage.

Activity2.4

- Demonstration of cultivation practices was done for collection of propagules, production of seedlings and planting of seedlings and cuttings, organic fertilizers and after care for selected bioresources.
- Trainings on mushroom cultivation; bee keeping, floriculture etc were conducted.

Activity-3. Motivate the younger generation for self employment

Activity3.1

- Provided technology guidance to the SHG, young entrepreneurs and progressive farmers for development of infrastructure & self employment (Appendix 3).
- Trained a few as master trainers for agro-products, mushroom cultivation and vermicomposting (Appendix 3).

Activity-3.2

- Provided exposure trainings (10) to young and able entrepreneurs for setting up of NTFPs based industry including making of Japi, bamboo items, Jigat, agarbatti, Agro-based production like pickles, jam, jelly sauce, squash etc (Appendix 3).

4.2 Key Results (max. 500 words in bullets covering all activities)

- Out of total landholdings by Khampti households 73.87% was used for agricultural purpose and 25% of the land as homestead land.
- Livelihood earned by Khampti households mostly agriculture (66.66%), similarly, 20% depend on both agriculture and government job, whereas, 0.44% are dependent only on government jobs and 0.88% on business.
- About 44.88% Khampti households were below poverty line and only 23.12 % households had more than Rs 40,000 annual income.
- Among the Khampti villages, the literacy rate range Lathao village was lest (16.12%) and highest in Manmow (71.79%).About 50% of the individuals had done their studies up to

class 10; 22% had their secondary education (class 12) and few (4.64%) had done post-graduation.

- Annual energy consumption was found to be high for LPG (67.55%) than fire wood (17.34 %) and kerosene (15.11%).
- Documented a total of 311 plants species from Khampti villages
- Of which, 105 tree species, 112 species were herb species, 65 shrub and rest were climber species.
- Recorded 93 species of medicinal plant species, 9 spices; 12 fuel-wood species; 5 fodder plant species from homestead gardens.
- Also documented 48 ornamental species
- A total of 150 edible plant species belongs to 56 families were documented from the homesteads of Khampti villages during the study.
- Documented 48 RET plant species from the homestead gardens belongs to 35 plant families.
- 24 plant species were selected through 5 PRA meetings as identified as productive component for homestead agroforestry.
- Five (5) replicable agroforestry demo plots were developed in 5 Khampti villages to optimising land use in Mankao, Lathao, Pathar Gaon, Old Mohong and Piyaon of Namsai district, Arunachal Pradesh.
- There was a 3 folds increased in annual return from the intercrops in agroforestry demo plots owners due to cultivation of *Zingiber officinale* (ginger), *Brassica nigra* (mustard), *Curcuma longa* (turmeric), *Cajanus cajan* (arhar), *Colocasia esculenta* (taro),*Sesamum indicum* (sesame), *Solanum tuberosum* (Potato), *Vigna mungo* (black gram) and *Zea mays* (maize) (Table 3).
- Agroforestry plot owner of Lathao village could earn an increment of amount Rs. 2,65,234 in the second (2^{nd}) year which is the highest income being gained after agroforestry plantation, followed by Pathar Gaon with a profit of Rs.78,5544.
- The species like *Citrus limon*, *Litchi sinensis, Mangifera indica* and *Zizyphus mauritiana* started fruiting in all the agroforestry demo plots.
- Growth and survival rate of the planted seedlings varied for species to species within and among the sites.
- Over all tree species survival rate was highest with 80 % for Mankao agroforestry plot followed by Pathar Gaon 78.5 % and Piyong agroforestry plot had 76.34%; Old Mohong 69.55 and Lathao had 68.35 % survival of seedlings.

- Agroforestry interventions could improve soil conditions and increased plant diversity.
- Out of 24 beneficiaries were trained for 'Establishment of agroforestry nursery, cutting and bud grafting, one in Pathar Gaon produce seedlings in nursery.
- Five vermicomposting units were producing vermicompost and vermiwash.
- Cultivation of edible Mushrooms in Pathar Gaon, Piyong and Lathao villages by individuals and SHG were observed and production was sold in local market.
- Value added products were prepared by Pathargaon beneficiary from *Dillenia - Ginger- tea (i.e.* powder *mixture of Dillenia indica +Zingiber officinale* (ginger) + tea) , Dillenia-Black pepper tea (*Dillenia indica* and *Piper nigrum* (black pepper) powder; *Dillenia* curry powder and Garcinia powder.

4.3 Conclusion of the study (max. 500 words in bullets)

- The established five (5) homestead agroforestry systems are replicable to other households of the district and also viable to mitigate initial financial constraint.
- Analysis of benefit-cost ratio (BCR) of agroforestry practices coming upto 10.49 from intercrops in initial years. And also realized more than 3 folds increased in annual income to the households of demo plot owners.
- The project also becomes successful in creating awareness among farmers/ beneficiaries about the benefits of agroforestry systems and self sustain through 15 awareness programmes.
- The project also provided ample advantages for linking the knowledge partners and experts with the stakeholders/ beneficiaries though its various training programmes.
- The project made attempt for providing markets linkage of agroforestry products although the state do not have declared minimum support prices (MSP) and also value added products.
- The project while implemented carefully chosen the productive components to achieve self sustained food and non-food sources of the household considering the sustainability issues.
- The implemented activities of the project also included production of vermicompost and application techniques considering for improvement of soil health providing the nutrient safety net and organic production of agroforestry crops.
- While implemented the agroforestry systems enough care was taken to enhance functional biodiversity of the landscape.
- Ultimately, the adopted homestead agroforestry systems expected to help to increase overall farm productivity and higher income to the farmers in a long run.

- Apart from the agroforestry interventions the project held 15 awareness meetings and provided 10 exposure cum skill development trainings to the project beneficiaries for widen up of livelihood options.
- Considering short duration of the project (3 years) the homestead agroforestry owners were trained to acquire need base technology know how for establishment of nursery, vermicomposting for nutrient management, biofertilizers application, plantation management and value addition etc to develop a self sustained system.

Consequently, the adopted agroforestry in Khampti homesteads are to be viable to fulfill the objectives of food security and economic return, nutritional security, environmental sustainability, and positive climatic action.

5. OVERALL ACHIEVEMENTS – *supporting documents to be attached.*

5.1. Achievement on Project Objectives/ Target Deliverables (max. 500 words)]

Objective 1 Achievements

- Optimisation of land use was done by establishing 5 homestead agroforestry demo plots in Old Mohong, Piyong, Pathar Gaon, Lathao and Mankao Khampti villages with integration of 24 plant species including 9 intercrop species, 4 spices and as productive components of local bioresources to existing traditional homesteads to switch into a productive high density agroforestry system (Table 3).
- Documented socioeconomic status of Khampti tribes of Namsai district Arunachal Pradesh (Appendix 1.1).
- Documented phytosociological status of plant species conserved in the homesteads of Khampti tribes (Appendix 1.2) and published two papers(Appendix 2)

Objective 2 Achievements

- Ten(10) skill development trainings were conducted (Appendix 3)
- Ten (10) value added products were generated using skill earned through trainings by the beneficiaries for sustaining livelihood and capacity building (Appendix 4).

Objective 3 Achievements

- Four (4) onsite demonstration programmes on mushroom cultivation and spawn production were held at Piyong, Old Mohong, Pathar Gaon and Lathao villages.
- Fifteen technology awareness programmes were held to motivate the younger generation for self employment exposing with modern technologies
- Organized exposure training on 'Establishment and Management of Nursery; Establishment of Food Processing Unit ; Mushroom Cultivation and Vermicomposting; Skill Development training on Bamboo Handicrafts; Skill Development Training on Jigat

Production and Agarbatti Making; Bee Keeping; Bamboo products making; Floriculture and plantation management; Japi Making etc.

5.2. Interventions (max. 500 words)

Agroforestry interventions were taken up for demo plots established in Mankao, Lataho, Piyong, Pathar Gaon and Old Mohong villages per layout plant described in appendix-I.4 A. Provided a need based training on 'Establishment and Management of Nursery' to become self sustain to fulfil the seedlings demand of viable components of agroforestry crops. Field preparation, pit digging, planting of seedlings, application of fertilizers including biofertilizers and vermicompost were done during year 2020 by engaging daily wage labours in close monitoring of the plot owners and the project staff. Growth and survival of the seedlings planted were recorded. Regular monitoring was done by the project leader and also visited the director, RFRI Jorhat to the sites. Almost 40 per cent causality was filled by replanting the seedlings in the succeeding years up to 3rd year. Time to time technical guidance for weeding, fertilization and disease management was also provided to the plot owners. For production of organic crop and to mitigate the fertilizer demand for application to seedlings and intercrop species trainings were provided for production of compost, vermicompost and application too. As capacity building activity five (5) numbers of vermicompost units were established and technology for vermicomposting and application in crops of agroforestry was transferred to the plot owners (Appendix- 1.4 D). The agroforestry demo plantation plots established under the project were presented in fig.2 to fig. 6.

Intercrop species such as *Brassica nigra* (L.) K.Koch, *Cajanus cajan*, *Curcuma longa* L., *Solanum tuberosum* L., *Sesamum indicum* L., *Vigna mungo* (L.) Hepper, *Zingiber officinale* Roscoe.,and *Zea mays* L. cultivated during 1st two years in the demo plots were harvested time to time and economic output was evaluated (Table-3). Socioeconomic status was evaluated before the agroforestry interventions in 15 Khampti villages of 225 households including the 5 households selected as demo plot beneficiaries. These data were compared for the economic enhancement of the demo plot beneficiaries (Table 3). Soil samples were collected before agroforestry interventions in the year 2020 and after agroforestry intervention in 2021 and 2022. The samples were analysed for pH, EC, % Organic Carbon, Available Potassium, Available Nitrogen content and Available Phosphorous. Compared the yearly data for status of improvement of soil conditions due to agroforestry intervention and data were presented in table-4.

Homestead of Piyong before agroforestry

Homestead of Piyong 3 years after agroforestry

Intercrop with Arecanut-Sisham- Apple ber -Banana

Arecanut-Citrus-apple ber 3rd year plantation

Aquileia- Livistona-Citrus- vegetable

Arecanut- Mango –Apple ber- Livistona

Arecanut- Apple ber- Cinamomum etc.

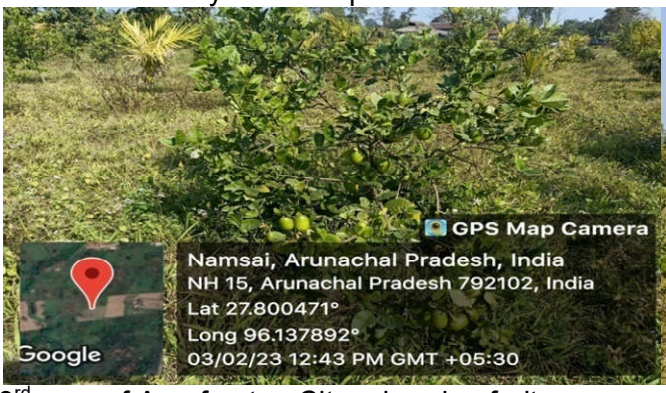
Arecanut-coconut-citrus- Apple ber etc in 3rd yr.

Fig. 2 Agroforestry demo plot of Piyong village, Namsai district, Arunachal Pradesh showing status of before and after plantation along with a few productive components.

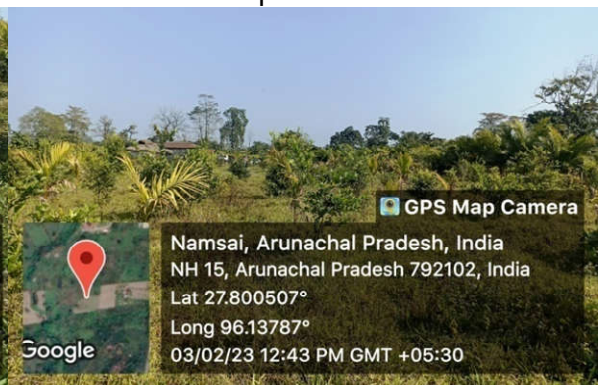

Homestead of Mankao village at initial stage of agroforestry plantation

1 year after plantation

Intercrop with sesame



3rd year of Agrofrestry: Citrus bearing fruits



Homestead of Mankao after 3 year of agroforestry

Shri A.S. Rawat, IFS &DG, ICFRE visited Mankao Agroforestry plot in December 2022

Fig: 3 Agroforestry demo plot of Mankao village, Namsai district, Arunachal Pradesh showing status of before and after plantation along with a few productive components

Before agroforestry in Pathar Gaon

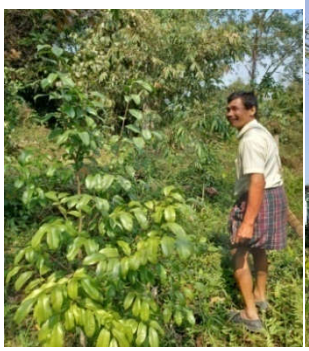
After plantation of 2 months

6 months after agroforestry plantation

Intercrop :Arecanut- Arahar- Zinger-Colocasia

A part of plantation in agroforestry Pothar Gaon

A part of plantation with Arecanut – Litchi-Lemon



Aqularia (Agarwood)

Bambusa tulda

Lemon-Arecanut- Apple ber with Aqulalria

Fig 4. Agroforestry demo plot of Pothargaon village, Namsai district, Arunachal Pradesh showing status of before and after plantation along with a few productive components.

Homestead of Lathao before agroforestry

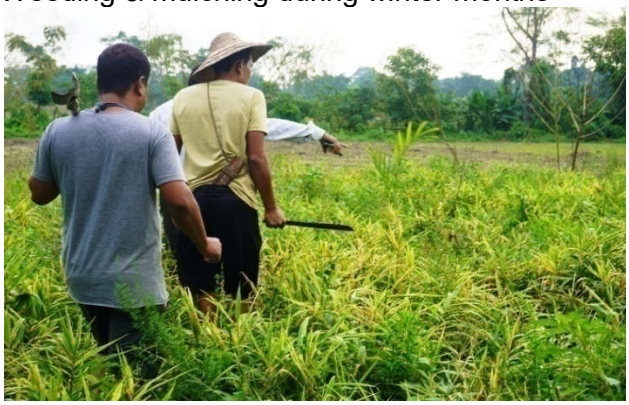
Homestead 2 months after plantation

1 year after plantation

Weeding of plantation area Lathao demo plot

Weeding & mulching during winter months

A part of site after weeding



Intercrop of Zinger in Agroforestry Lathao

A part of plantation after 3 years in Lathao

Fig 5. Agroforestry demo plot of Lathao village, Namsai district, Arunachal Pradesh showing status of before and after plantation along with a few productive components.

Fig 6. Agroforestry demo plot of Old Mohong village, Namsai district, Arunachal Pradesh showing status of before and after plantation along with a few productive components.

Trainings conducted for the other beneficiaries and technology awareness meetings held time to time during the project period. Detailed information is presented in Appendix 3. Technical manual for production of 'substitute jigat for agarbatti industry' was published and other 4 brochures (SOPs) on *Thysanolaena latifolia* (Broom grass), *Schumannianthus dichotomus* (Mutra), *Phrynium capitatum* (Koupat); *Livistona jenkinsiana* (Takow pat) were published and distributed among the beneficiaries as knowledge products time to time (Appendix-5). Apart from these a total of 10 numbers of trainings were given to a total of 212 beneficiaries for capacity building, skill development, self-employment and widening up of livelihood options. Details are described in appendix-1 and appendix-3.

5.3. On-field Demonstration and Value-addition of Products, if any (max. 500 words)

A total of four (4) field demonstration programmes on 'Vermicomposting and Application' were conducted in Lathao on 06.04.2021, Pathar Gaon on 19.02.2021, Old Mohong on 16.02.2021and Piyong on18.02.2021 on site demo plots where the respective vermicomposting unit developed. The farmers not less than 15 from each of the above villages were demonstrated the technology for vermicomposting starting from collection, processing and decomposing the organic garbage including agricultural residues; filling of vermicompost pit ; source and addition of earthworm (Vermi) to the pit, aftercare; collection vermicompost from pit; sieving, processing, packeting, storage and application in different crops in homestead agroforestry by two resource persons namely Dr. Prosanta Hazarika and Shri Rajarshi Bhattacharyya of RFRI, Jorhat (Appendix-3 D(i)).

Another four (4) onsite demonstration programmes on 'Mushroom Cultivation and value addition' were conducted to the SHGs in Lathao on 08.03.2021, Pathar Gaon on 20.02.2021, Old Mohong on 15.02.2021and Piyong village on 17.02.2021. Dr. Prosanta Hazarika, P.I. of the project demonstrated on collection of rice straw, cutting, boiling, enriching, filling of substrate after enriching, inoculation with spawn, aftercare, darkroom condition for cultivation, harvesting for the oyster mushroom cultivation and value addition by drying and powder making, packaging etc (Appendix-3.D(ii)).

Three (3) value added products were developed from *Dillenia indica, Zingiber officinalis* and *Pepper black gram;* one (1) from *Garcinia pedunculata.* Also developed 2 value added products i.e. Dellenia pickle and Mango pickle; Kiwi Jam and Kiwi Pickle (Appendix 4).

A value added product namely 'Substitute Jigat' was made using leaves & twigs of *Manihot esculenta* (Simolu alu), *Hibiscus rosa sinensis* and *Corchorus olitorius* (Mora pat).

A market local market link was given to stakeholders namely 'Namsai Organic Spices and Agricultural Products (*NOSAAP*) Producer Co. Ltd', Namsai for these agro products.

Developed a value added product from leaves of *Livistona jenkinsiana*, namely 'Japi' and developed a market link with a trader of Assam namely Pulin Nath, Jorhat.

Developed four (4) handicrafts products from bamboo and coconut shell namely Leaf Table Clock, Coconut tree with mobile stand, Mushroom Night Lamp and Bamboo flower vase (Appendix 4).

Online market link was developed for two Agro products i.e. Ginger and Turmeric with " JA TURMERIC' Link http://mydukan.io/ja33104.

5.4. Green Skills developed in State/ UT (max. 500 words)

Establishment of viable and replicable demonstrative model of homestead agroforestry in 5 homesteads of 5 Khampti villages of Namsai district, Arunachal Pradesh are now exposed to the villagers for the agroforestry interventions to acquire green skills staring from nursery seedlings production, plantation and management. Technology for production and application of Composting and Vermicomposting were also trained to 23 beneficiaries of the Namsai district. Four onsite demonstration programmes were also conducted in Old Mohong, Piyong, Pathar Gaon and Lathao villages to transfer green technology on 'Vermicomposting and Application' to a total of 53 beneficiaries were trained including 14 men and 39 women. People of the Khampti tribe are also use mushrooms as their dietary items. The technology of spawn production and cultivation of edible mushrooms was transferred to 59 beneficiaries of the district including 14 men and 43 women. *Livistona jenkinsiana* (Toko Pat) is one of the very common a viable component available in the Khampti homesteads. Therefore value addition of toko pat was trained by making Japi to 18 artisans of Namsai district, Arunachal Pradesh. Similar green skill development training was also conducted to 12 artisans for making of value added products from bamboos. During socioeconomic survey it was observed that Khampti woman were use to involve in flower culture in their homesteads and therefore the floriculture technology was transferred to 38 beneficiaries of which 10 men and 28 woman participants. Keeping on the view of homestead production of edibles a 12 days training programme was also organized for 12 entrepreneurs on 'Establishment of Food Processing Unit' for value addition of edibles and self employment. Bee keeping is one of the potential livelihood options in the state because there are huge cultivation of mustered plant and plenty of flowering plants in wild too. For that a training programme was conducted namely 'Skill Development Training on Bee-keeping, Value Addition and Entrepreneurship' and trained 23 beneficiaries including 14 men and 9 women.

The phytosociological survey revealed that there are available plant resources for Jigat production for making Agarbatti in the homesteads of Khampti village. Imoprtantly India has to import Jigat powder from other county like Vietnam and China every year. Agarbatii are widely used by the Khampti tribe in different religious occasions and day to day customs. Therefore, two training programmes were conducted in Piyong and Pathar Gaon villages on 'Jigat production and agarbatti making and the technology of production' to 46 beneficiaries. Moreover, a local NGO namely 'Arunachal Pali Vidyapith Society', Chongkham was involved as partner to perform certain project activities.

5.5. Addressing Cross-cutting Issues (max. 200 words)

The project activities also addressed certain cross cutting issues like protection of ecosystem, biodiversity, gender equality, empowerment of women and youth etc.

- All the agroforestry interventions that were performed in the project site including establishment agroforestry plantation incorporating productive components, application of biofertilizers instead of chemical fertilizers, production and application of vermicompost etc had the positive impact on ecosystem protection, improvement of soil health and enhancement of biodiversity.
- Biodiversity of the homesteads was enabled to increase due to introduction of high density multiple cropping agroforestry system with scientific management without disturbing the pre-existing vegetation of the homesteads.
- The project activities like skill development and technology demonstration programmes a total of 552 beneficiaries were involved of which 280 were women. Therefore, while implementing the project activities due focus was given on gender equality too.
- Similarly due weightage was given for empowerment of women and youth at the time of selection of training for skill development and technology demonstration, also involved during socioeconomic survey too.
- Up scaling of income was also possible for those who adopted agroforestry in their homesteads. Thus it could address inclusive growth and poverty alleviation (by creating self employment opportunities) of the tribe.

6. PROJECT'S IMPACTS IN IHR – *supporting documents to be attached.*

6.1. Socio-Economic impact (max. 500 words)

The project findings indicated that improvement of economic status of a household/farmer of Khampti tribe is possible through the adoption of agroforestry

practices (Table 3). The initial high adoption costs of agroforestry system because of out sourcing of the seedlings could be self sustained by producing seedlings requires for raising agroforestry plantation at their own nurseries. The other issue of requirement of economic investment for fertilization of the planted seedlings and intercrop agriculture also addressed by the project activity by providing training to the beneficiaries on composting, vermicomposting and application (Appendix 3 A). Most importantly, few vermicompost units were established and technology demonstration was also conducted in mass scale among the villagers (Appendix 3 [B]). For that beneficiaries were trained tp establish and management of nursery including modern technologies such as cutting, grafting, layering and stump planting etc (Appendix 3 A). Technology demonstration and awareness camps were conducted for the farmers/ beneficiaries on the full benefits of agroforestry systems (Appendix 3 [B])

This project dealt with the issue of inclusive growth. As such, widening of livelihood option, capacity and skill developments were addressed for agroforestry-based products. For that first hand data on socioeconomic status were recorded through a survey undergoing purposive sampling method in Kampti villages and recorded household income, education, primary livelihood activity, monthly energy consumption, land holdings – agricultural and homestead land, livestock profile, agricultural production etc. These data were helped in identifying the gaps between resources & regeneration of resources; methods of utilization and utilization pattern; and linking to economic activities with skill already they have and need to be provided for widen up of livelihood option and self employment generation to the tribe. For example the socioeconomic study

The phytosociological study helped in identifying productive components in the homesteads and to choose the most appropriate strategy for poverty reduction ensuring availability of food, fuel, fodder and employment opportunity encompass in homestead agroforestry especially for the Khampti tribe and also to other local communities in general. For example phytosociological study

Implementation of agroforestry in 5 selected homesteads of the tribe was found effective in up scaling of infrastructures, skill, capacity building and most importantly contribution to household economy. For example, in the initial years of agroforestry intervention like intercropping give a boost in household economy more than 3 folds (Table 3). Thus the activities of the project also make aware of their bioresources, methods of regeneration and also earned skills for value addition of their produces into products. It was also observed that a few

products have been developed out of their locally available bioresources (Appendix 4. and fig.) and thus foundation has been built by the project for future upliftment.

6.2. Impact on of Natural Resources/ Environment (max. 500 words)

Agroforestry of any kind are most self sustained and productive system over any kind of agricultural system. Again, next to the forest, homesteads are said to be biodiversity rich area where human beings generation after generations tend to assemblage need based flora in the same piece of land. As such project interventions for improving such traditional homesteads to a viable agroforestry system have direct and positive impact on natural resources of the region. Incorporation of productive components such as plant species, vermicompost production units, mushroom cultivation, value addition of homestead raw materials etc not only helped in enhancement of land productivity, income and thus enabled to generate a self sustained ecosystem. As per assessment even in the initial years homestead agroforestry land could earn more than 3 folds of annual income that before they practize the agroforestry. Introduction of agroforestry system enabled to promoted diverse crop production before than ever. Thus the agroforestry owners along with learned skills through trainings and technology demonstration could certainly help in reduction of resource lost by step forward for value addition of their produces. By these activities there is a possibility of reduction the threat to the wild natural resources of the forest area. In long run the plant species in the agroforestry system produce edibles, fire wood, fodder, medicine, timber and also provided ecosystem services for better environment. If the threats on natural forest could reduced there may be positive impact on the natural resources.

6.3. **Conservation of Biodiversity/ Land Rehabilitation in IHR (max. 500 words)**

Plant diversity of homesteads has an extensive socio-economic and agro-ecological contribution including food production and planty of other products. Although most of the Khampti homesteads are sizable but they have lack of knowledge to how to confine the productive components in the same pieces of land for land productivity and economy enhancement. The project interventions that were implemented in the homesteads for a viable, replicable agroforestry system have a continuous support towards conservation of biodiversity by identifying, accumulation all the productive components in the same piece of land. It is to be mentioned that although most of the components were identified from the local bioresources especially from the homesteads, however, these bioresources were found scattered and the people did not know/ aware of the benefit of such assemblage. Establishment of five (5) demo agroforestry plots in five different Khampti villages exposed to

the villagers about process and products of homestead agroforestry for widening the livelihood and enriching the biodiversity. Moreover, the intervention like training to the beneficiaries on 'establishment and management of nursery' including vegetative means of propagation like cutting, grafting, layering, Rhizome planting and stamp planting had encouraged the beneficiaries for raising plantation and conservation of even RET species. It is to be mentioned that the Khampti homesteads recorded to conserve 48 RET species (Appendix-2, paper 3). Besides also the people are exposed to the green technologies such as composting, vermicomposting, biofertilizers and their applications in the crops for better production and land management. Additionally, activity of vermicomposting and application in their crops and land had the impact on improvement of land quality and rehabilitation too. The agroforestry has direct relation to land, therefore, the activity was assessed in agroforestry demo plots for soil improvement and the results were presented in table-4 of Appendix 1.4. The study revealed that there was an increasing trend in soil physicochemical parameters such as pH, EC, NPK and soil organic carbon etc. even in the initial years of agroforestry plantation. For example, available phosphorous in the soil of Old Mohong homestead before agroforestry was 28.46 ±2.29 Kg/ha and after two years of agroforestry interventions it raised up to 53.2 ±1.47 Kg/ha. Similarly Soil organic carbon was 1.13 ±0.16 % before the agroforestry intervention and after two years of agroforestry it enriched to 1.86±0.40%.

6.4. Developing Mountain Infrastructures (max. 200 words)

The agroforestry system developed in five homesteads on Namsai district are situated in Indian Himalayan region of Northeast India and contributed to SDGs 6–9, development of infrastructures. In general agroforestry can provide direct benefits derived from timber, fruit, fodder, livestock, non-timber forest products (NTFPs), and food from agricultural crops. Thus it could contribute towards SDGs 13– 15, green infrastructures (Category 4). Agroforestry interventions also helped the farmers to improve their productivity and livelihoods options (Category 3 SDGs 10–12, sustainable production and consumption). The established agroforestry in the Namsai district under this project is viable to generate raw materials for small-scale enterprises such as agro based industries, saw mills, carpentry, wood carving, Japi and hat making, basket-making, handmade-paper, medicinal plants, essential oils, and bio-briquette. Also open up additional option of food security by cultivation of edible mushroom and could address the issues of SDGs 1–5, poverty dimension (Category 1) by enhancing annual income.

6.5. Strengthening Networking in State/ UT (max. 200 words)

There is a general tendency of any individual/group or institution etc to build up a network system for strengthening the input output system to continue their exercises. As such, the project had taken up such activities to strengthen the network system for sharing knowledge & technologies between the partner institutions and beneficiaries such as ICFRE- Rain Forest Research Institute, Jorhat, Indian Institute of Entrepreunership, Guathati; Krishi Vigyan Kendra (KVK), Tinsukia, KVK Namsai. Apart from these, there is build a keen relationship between experts and beneficiaries at the time of skill development and technology transfer trainings those were conducted time to time. Moreover, interventions were carried out to build up a networking system among the agroforestry producers and local markets of the state and also provisioning online marketing system through "JA TURMERIC' Link http://mydukan.io/ja33104. Besides, the activities such as socioeconomic survey, distribution of seedlings among the villagers, awareness meetings etc built up relationships to strengthen networks.

7. EXIT STRATEGY AND SUSTAINABILITY – *supporting documents to be attached.*

7.1. Utility of project findings (max. 500 words)

The developed agroforestry systems in five homesteads of the Khampti households could be adapted by other homesteads owners of the district or the state to improve income and organic production for self sustain. The agroforestry system also able to enhance annual return to the homestead owners by promoting more than 3 folds income (Table 13). The data on the soil nutrient status of the agroforestry systems showed a gradual improvement in NPK, soil organic carbon and pH value which ultimately contributed for enhancing the productivity of the land (Table 14). The activities such as capacity building and skill development trainings would be helpful in widen up livelihood options, livelihood promotion and sustainable utilization of resources. The entire activities of the project targeted to self sustain in food and non-food components, value addition for sustainable utilization and reduce lose of production. Thus, this project provides scope in poverty alleviation by creating self employment opportunities. The project contributed for scientific advancement to the stake holders through technology inputs for skill development. The capacity building activities implanted in adopted homesteads agroforestry systems are capable in resource utilization and economy. Almost 21 plant species which are selected for plantation out of 24 plant species were new to the new to the homesteads where agroforestry intervention were taken

up. Thus, by this action of agroforestry increases the biodiversity of the homesteads, also prospect for better ecosystem services and scoping mitigation of climate change.

In addition to these, the project generated and documented first hand data on the socioeconomic status of Khampti tribes which may be handy for use by the researchers. The project also studied and documented the phytosociological data of homesteads plant species of Khampti tribes which was never studied earlier. This study also documented the edibles, fuel wood, timber, medicinal, fodder, aesthetic and RET plant species those were conserved in the Khampti homesteads. Both the sets of data are new contribution on the Khampti tribe and research which could be utilized in future.

7.2. Other Gap Areas (max. 200 words)

- During the project period it was observed that the owners of agroforestry have to suffer due to ups and downs of rate for their produces such as ginger , termaric, musterd, arahar, maize, sesham etc due to lack of minimum support price (MSP). Interstingly, rice is the main agricultural produce for which also does not have MSP.
- There are limited financial Institutions in the state for granting assistance to set up production units. It was also observed such shortcomings regulated improper exposures to encourage for start up business with strong mobilization activities to the youths and entrepreuners from financial institutions.
- There is a need to undertake more confidence building activities towards on setting up and run of production unit at financial and marketing level.
- Time tenure of the project like agroforestry activities may be more than even five years to complete all scientific observations about the economic impact, to standardize plant –intercrop relationship with time for continuous return, management practices such as standardization of application of fertilizer dose to the crops with time, post harvest management, value addition etc for continuous return.
- Most importantly State Forest Department of Arunachal Pradesh may take up similar initiative for agroforestry interventions in the homesteads which is almost nil approach so far.

7.3. Major Recommendations/ Way Forward (max. 200 words)

- The agroforestry system introduced in the Khampti homesteads are economically viable so far and may be extended to other homesteads with careful selection of production

components and intercrop species launching self regulatatory nutrient management system.

- A continuous approach may be acertained for application of compost, vermicompost, and biofertilizers for self sustained nutrient management of agroforestry crops.
- Approaches of value addition enable to reduce lose of production and widen up of livelihood.
- Khampti homesteads resident of 150 edible species and 87 medicinal plant species along with their indigenous technical knowledge for utilization for nurshiment and welbeing, treatment of various diseases or aliaments locally. Extensive scientific works may be taken up for upscaling, conserve and utilization of these resources and tribal traditional knowledge towards strengthening the natural drug recovery and therapy system.
- The awareness programmes, skill development and technology transfer traininings have positively impacted on the livelihood of indigenous people that need to be continued in the coming years by sanctioning more such projects.
- The Khampti tribe and other indigenous communities may be provided more technical support even after completing the project through online or offline mode by concerned PI and Co-PIs/ experts of local KVKs & MSME, Spice Board etc with the initiative of State Forest Department.

7.4. Replication/ Upscaling/ Post-Project Sustainability of Interventions (max. 500 words)

Agroforestry system that were introduced in homesteads of Namsai district of Khampti villages are viable in improveing income of the households and also contributed in improvement of soil quality as well. It is therefore quite relavent to replicate such interventions to other homesteads for reciveing the benefit of agroforestry system as evident in the initial years of the project findings. Trainings for technology transfer and upscaling of skills for value addition also enhanced knowledge, minimize the gaps and encouraged the younger generation for adopting more livelihood options for resource mobilization and self employment. In the introduced agroforestry system in homesteds of Namsai district there are three components of agroforestry crops such as short/ seasonal crop production, medium / annual crop production and long duration crop. The recurrent cost of cropping and management during post project period could be met from the income generated from short/ seasonal crop production through the agroforestry system as per performance showed in the intial years. The same trend is expected

to be continued by intercropping of seasonal crops. Apart from that, more economic out put expected to add in the upcoming years from medium / annual crop production such as the yield from fruit crops that were introducted in the agroforestry plots. At the time of introduction of agroforestry application of PGPR biofertilizers was done along with vermicompost. These interventions proven in improvement of soil quality including soil organic matter that step up the yield and income and also help in generating a self sustained nutrient management system as the beneficiaries were trained for production and application of compost and vermicompost too. Moreover, post project sustainability may be achived for maintainance and production of propagues of the crops as they were trained for seedlings production techniques including, cutting, grafting, layering etc. Although there is no MSP, however, there are enough scopes for saleing of agroforestry produces in local markets as the tradered from out side the state are observed to come regularly to procure these commudities. Apart from that intervations and training for value addition of agroforestry produces also reduce production loses may cause due to excess production and boost the livelihood option and self employment.

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9. ACKNOWLEDGEMENTS

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APPENDICES

Appendix 1 – Details of Technical Activities

Appendix 1.1 Socioeconomic status of Khampti tribe, Namsai district of Arunachal Pradesh

A survey was carried out in 225 households of 15 villages to know the socioeconomic status of the Khampti tribe of Namsai, Arunachal Pradesh during 2019-2020. The household owners were interviewed with the help of questionnaire for socioeconomic, life style and livelihood, education qualifications, primary livelihood activity, land holdings and land use pattern, energy consumption, livestock profile etc. To compare the profitability of different land uses, the annual profit was calculated for livestock and homestead.

Survey Method

To collect the first-hand data, questionnaires were prepared and distributed among 15 random chosen rural households of 15 villages viz., Old Mohong, Pathargaon, Piyong, Lathao-1, New Lathao, Sulungtoo, Kherem, Marua camp, Mankao, New Mohong, Manphaiseng, Manmow, Wagon Pathar, Jenglai, Wengko of Namsai. The homesteads owners (with pre-consent) were interviewed and information were recorded. Collected data were classified into social and economic categories. The social factors included- name and age of the respondent, type of family- nuclear or joint, family size- no. of female and male, type of house- kaccha, semi pucca and pucca, educational status, livelihood activity of the household, rate of acquaintance with agroforestry systems. Economic questions included average monthly income of family, primary livelihood activity, monthly energy consumption, land holdings – agricultural and homestead land, livestock profile and agricultural production. To compare the profitability of different land uses, the annual profit was calculated for two consecutive years after practicing agroforestry. The collected data were analyzed and presented in tabular form and graphs were plot.

Social status

Type of family was categorized as nuclear or joint based on the number of family members in each of the families. House type was surveyed whether houses are kaccha, semi pucca or pucca. Social status of the Khampti people were evaluated based on religion, caste, festive occasions, customs or rituals and their marriage system.

Economic status

The monthly income of the families was grouped as- Rs.5,000 to 10,000 rupees; Rs.10,000 to 15,000; Rs.15,000 to 20,000; Rs.20,000 to 30,000; Rs.30,000 to 40,000; more than 40,000.

Life style and livelihood

Lifestyle was evaluated based on their clothes and dresses. Options of livelihood were analyzed under three categories- agriculture, service holder and business. Service holders were categorized whether they are school teacher, college teacher, state govt. employee, job in private companies or daily wage labor. Business was categorized as one having grocery shop, stationary shop, agribusiness, fuel wood/timber business, cottage industry, MSME/ other industry or any other business.

Education

Literacy is considered as a vital factor for socio-economic progress of a society. Status of education and their literacy rate was evaluated in 15 Khampti villages in 4 different groups i.e secondary (10^{th} standard), higher secondary (12^{th} standard), graduation and post-graduation.

Landholdings and Land use Pattern

Households have their landholdings which are divided into homestead and agricultural land. Some has own landholdings while others borrow for cultivation. Total area under agriculture, total area under homestead and area under other plant species were evaluated. Usually, the agricultural land covers the maximum area with smaller homesteads. Soil type of the land and crop cycle period were also noted. Major agricultural crops and homestead plant species were listed.

Livestock profile

Apart from plant resources, Khampti people of Namsai district were observed to rear livestock in their homesteads. Some of them consider the livestock as secondary livelihood. Livestock profile was checked for cow, buffalo, bulls, goat, pigs and poultry. Sources of fodder was surveyed whether they are collected from forest, trees outside forest, agricultural land, or purchase, or from homestead.

Energy consumption

Energy consumption type i.e., fuel wood, kerosene, LPG or others and their annual consumption quantity were analyzed. Sources of fuel wood were also surveyed.

Economic outcome from homesteads and livestock

The average annual income and the income from the homesteads along from their livestock were analyzed.

Findings of socioeconomic survey

Social status

It was observed that, most of the families were nuclear families i.e., families having an average of 5 members with a range of 2 to 7 individuals and the rest were joint. Similarly, the

average size of the joint families were 8 members with a range from 5-15 individuals. 164 families out of 225 families were nuclear and the rest 6 were joint families (Fig 11). They mostly live in 'Sang Ghar', 'Kaccha' house i.e., made of wood and bamboo with the roof made of 'tokow pat'(*Livistona jenkinsiana*) or 'Semipucca' i.e., the houses made of concrete post with wooden 'sang' and tin roof. Few live in 'pucca' houses which are of two kinds; one is similar to 'sang ghar' but made of concrete materials with tin pat roof and the other is general concrete house. As per the records, 117 households were having kaccha houses, 73 families have semi pucca houses and 35 families lived in pucca houses (Fig 8).

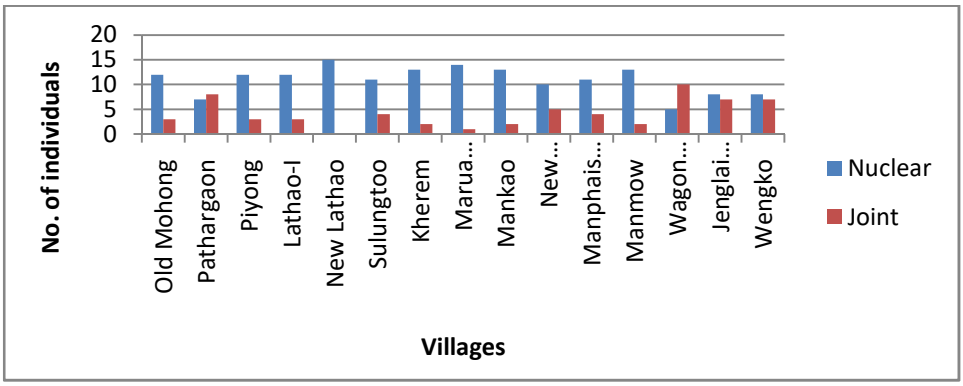


Fig 7: Showing family type of 15 Khampti villages of Namsai

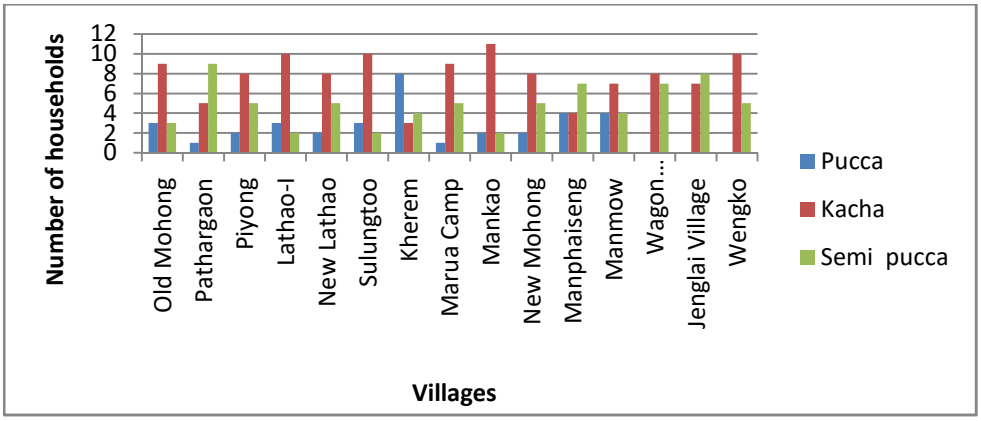


Fig 8: Showing house types of 15 Khampti villages of Namsai

The Khamptis are follower of Buddhism. Every household has a prayer room, where they perform prayers every morning and evening by offering flowers (*nam taw yongli).* The community worship place is called as 'Pagoda'. The religious guru/ priests are known as 'Monk' and 'Bhante'. The 'Bhante' is not only the religious priest but also traditional healer or medicine man. Two types of traditional treatments were followed by 'Bhantes' i.e., by means of 'Mantras' or with herbal medicines. The treatment procedures are still available with the 'Bhantes' in the form of 'hand written book' in Tai language.

The Khamptis have their unique cultural heritage and their language script is similar as Thai. The festivals that are being observed are Poi Pee Maw (New Year festival), Panchong (Mela), Kamphai, Potuwa, Sangken, Maikosomphai (Religion based). Sangken is the main festival of Khampti people which is celebrated on 14th April every year and Poi-pee-Mau is the Khampti New Year (Phukan, M. 2019) They have their own customary laws. Marriage within the caste and inter caste marriage is also frequent among them.

Table 1: Average annual income of 15 Khampti villages of Namsai district, Arunachal Pradesh

Name of Village	5000-10000 (Rs.)	10,000-15,000 (Rs.)	15,000-20,000 (Rs.)	20,000-30,000 (Rs.)	30,000-40,000 (Rs.)	More than 40,000 (Rs.)	Total Household
Old Mohong	0	0	5	7	1	2	15
Pathar Gaon	0	0	1	1	0	13	15
Piyong	2	6	1	2	1	3	15
Lathao 1	6	1	3	5	0	0	15
New Lathao	3	0	8	4	0	0	15
Sulungtoo	0	0	11	4	0	0	15
Kherem	0	1	8	1	1	4	15
Marua camp	5	2	8	0	0	0	15
New Mohong	6	0	4	3	2	0	15
Mankao	0	1	1	3	5	5	15
Manphaiseng	0	0	2	2	3	8	15
Manmow	0	1	1	4	1	8	15
Wagon Pathar	4	0	0	4	5	2	15
Jenglai	5	0	2	2	0	6	15
Wengko	0	0	3	6	5	1	15
Total	31	12	58	48	24	52	225
Parcentage	13.77	5.34	25.77	21.34	10.66	23.12	

Economic status

Average annual income of each of the Khampti villages were analyzed and presented in Table 1. Out of 225 households surveyed for 15 Khampti villages, a total of 31households (13.77%) irrespective of their villages were came under the income group of Rs 5000-10,000 per annum; 12 households (5.34%) came under the income group of Rs. 10,000-15,000. Similarly, a total of 58 households (25.77%) were grouped under the income group of Rs. 15,000-20,000 and 48 households (21.34%) came under the income group of Rs. 20,000-30,000. However, annual income within Rs 30,000- 40,000 was enumerated for 24 households (10.66%) and more than Rs. 40,000 were found for 52 families (23.12 %). Lathao 1 and New Mohong were recorded to have the least income families (6 each) with average

annual income of Rs 5,000-10,000, followed by Marua camp and Jenglai with 5 families each. While Pathar Gaon was recorded as the rich village having 13 households with more than Rs. 40,000 of annual income followed by Manphaiseng and Manmow with 8 households having more than Rs. 40,000 (table 1).

Lifestyle and livelihood

The traditional dress for male is 'Khampti Lungi' and dresses for female are 'Rheha', 'Mekhela' and 'Longpat'. Apart from these Khampti males use to wear full-sleeved cotton shirt called 'siu pachoi' and multi colored lungi/sarong called 'phanoi'. Women wear long sleeve shirt called 'siu pasao', deep coloured mekhela called 'sinn' and silk scarf called 'phamai'. The married women wear unique green colored cloth covering the middle part of the body. Women are traditionally skilled in weaving and they weave their traditional dresses in their handloom. It was found that the villagers are mainly engage in agricultural activities as their livelihood source. Further it was notice that 150 individuals are dependent on agriculture, 45 individuals are engage both in agriculture and government job whereas 24 of them are engage both in agriculture and business. Only 1 individual do govt. service and 2 are dependent on business as their livelihood source which is being presented in a pie (Fig 9).

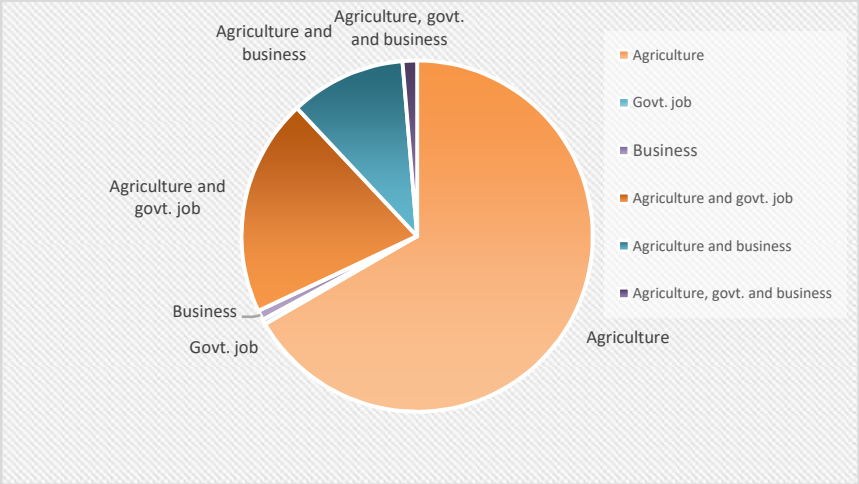


Fig 9: Primary livelihood sources of the households in Namsai

Educational status

The educational status of the respondents in 15 villages is presented in table 2. Out of the total population (1318) surveyed of 15 villages in 225 households, it was found that 206 individuals have completed secondary, 76 had completed higher secondary, whereas, 83 were graduates and 19 completed post-graduation. Among the villages, Manmow has

the highest youth literacy rate of 71.79% followed by Jenglai (45.16%) and Lathao has the least youth literacy rate (16.12%).

Table 2: Village wise educational status of Khampti villages of Namsai district, Arunachal Pradesh

Name of village	10th	12th	Graduate	Post graduate	Total	Literacy rate (%)
Old Mohong	13	10	7	0	30/50	37.50
Pathar Gaon	6	4	4	2	16/98	16.32
Piyong Khampti	14	4	13	2	33/83	39.75
Lathao	6	4	4	1	15/93	16.12
New Lathao	6	5	5	0	16/82	19.51
Sulungtoo	12	11	6	1	40/98	40.81
Kherem	7	5	5	3	20/102	19.60
Marua camp	5	4	4	1	14/86	16.27
New Mohong	19	3	3	0	25/98	25.51
Mankao	16	9	5	1	31/91	34.06
Manphaiseng	21	0	0	0	21/89	23.59
Manmow	28	12	12	4	56/78	71.79
Wagon Pathar	11	4	4	0	19/78	24.35
Jenglai	27	4	8	3	42/93	45.16
Wengko	15	12	3	1	31/99	31.31
Total	206	91	83	19	409/1318	

Landholdings and Land use Pattern

The village economy is predominantly an agricultural based economy. Although, most of the households having more than 10 bighas of land, they do not cultivate the entire agricultural land in a year. Indeed, they cultivate a part of the land as per their requirement for the year or give others to cultivate on the system called 'Adhi'. In Adhi system half of the production is given to the owner of the land. As an average of 800 kg rice is produced per bigha of land. The market value of per 100 kg rice is Rs 500-700. Apart from the paddy they used to cultivate maize, mustard, sorghum and potato in their farmland/agricultural lands. Out of 225 households, 9 households were recorded to have small tea gardens in homesteads or other than homestead area. No proper organized agroforestry cropping system was found in the Khampti villages of Namsai.

From the survey, it was observed that Lathao 1 village (average of 30.93 bighas/ household) has the highest landholdings. New Lathao has the lowest landholdings (average of 9.5 bighas/ household) followed by Old Mohong (average of 12.9 bighas/ household). The

survey revealed that 73.87% of the landholdings are utilized for agriculture and 25.16% of the landholdings as homestead garden.

Out of 225 households surveyed, 75 households have agricultural land within the range of 0-9.9 bighas, followed by 68 households with a range of 10-19.9 bighas, 44 households have 20-29.9 bighas, 4 households within the range of 30-39.9 bighas range, whereas 10 households have 40-49.9 bighas and only 1 household has 50-59.9 bighas of agricultural land and the other one has 60-69.9 bighas of agricultural land.

Similarly, out of 225 households, 179 households have homestead within the range of 0-9.9 bighas, 16 households have homesteads within the range 10-19.9 bighas, followed by 8 households with 20-29.9 bighas range and only 1 household from Kherem village with 30-40 bighas of homestead garden. Sulungtoo village have 138 bighas of land largest under home gardens with an average of 9.2 bighas. While households of New Lathao occupied 37 bighas of homestead land which is the lowest land under homesteads (average home garden area/ family 2.46 bighas). Old Mohong have small home garden with an average of 2.6 bighas per households followed by Kherem 2.9 bighas and Lathao-I with 3.4 bighas. Average land area of homesteads occupied by other villages are recorded as 3.8 Bighas in Wengko, 4.23 bighas in Pathar Gaon, 4.46 hectare (ha) in Marua Camp, 4.86 ha in Manmow, 5.4 ha in both Mankao and Piyong Khampti, 5.27 ha in New Mohong, 6.66 ha in Manphaiseng, 7.96 ha in Wagon Pathar and 8.57 ha in Jenglai Village. An overall analyzed data of land use pattern of 15 villages which is divided into agricultural and homestead land is being represented in Fig 10.

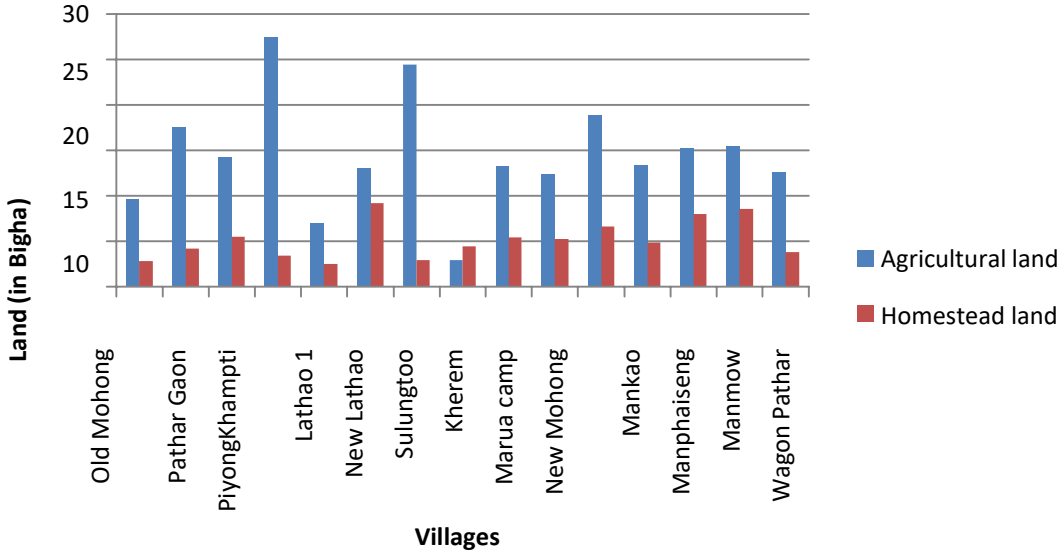


Fig 10: Land use Pattern of the villages in Namsai

Soil type of the agricultural field was analyzed for the 15 villages. It was observed that these villages have varying soil type. Old Mohong, Pathar Gaon, Piyong, Lathao, Sulungtoo, Marua Camp have clay soil. Whereas New Lathao, Wengko, Jenglai, Wagon Pathar, Mankao and New Mohong have sandy loam soil. Manphaiseng and Manmow were found to have clayey loam soil. On the other hand, sandy clay was found only in Kherem. Two crop cycle were found, one is from April or May (kharif season) and the other is from September or October (rabi season).

Table 3 List of seasonal crops growing in the traditional homesteads of Khampti villages of Namsai district.

Annual & cash crop	Kharif season (April and May)	Rabi season (September and October)
Colocasia esculenta L.	*Zea mayze* L	*Phaseolus vulgaris* L.
Zingiber officinale Roscoe	*Colocasia esculenta* L.	*Brassica juncea* (L.) Czern.
Curcuma longa L.	*Lagenaria siceraria* (Molina) Standl.	*Brassica oleracea var. capitata*
Ananas comosus (L.) Merr.	*Benincasa hispida* (Thunb.) Cogn	*Brassica oleracea var. botrytis*
	Capsicum annum L.	*Brassica nigra*, *Brassica napus* L.
	Cucumis sativus L.	*Solanum tuberosum* L
	Solanum melongena L.	*Sesamum indicum* L.
	Solanum myriancanthum	*Raphanus sativus* (L.) Domin
	Cucurbita pepo L.	*Coriandrum sativum* L.
	Luffa cyclindrica M. Roem	*Allium cepa* L.
	Corchorus olitorius L.	*Allium sativum* L
		Lycopersicon esculenta L.

People of all the villages raise one crop in a year in their agriculture fields. They use to cultivate their traditional and native variety of rice i.e., 'Khampti Lahi', Bordhan, Ranjeet and Boradhan. Tea is also grown in their homesteads and in farm lands too. The home gardens comprise of trees, shrubs, herbs, aesthetic plant and fruits and vegetable trees. The plant species for livelihood in homesteads are *Areca catechu, Livistona jenkinsiana, Piper betel, Cinnamomum tamala, Citrus limon, Elettaria cardomomum, Curcuma longa, Ananus comosus, Zingiber officinale, Phyllanthus embilica, Phyrinum capitatum, Terminalia chebula, Calamus tenuis, Citrus sinensis, Cymbopogon nardus, Musa sp., Piper nigrum, Citrus grandis, Lawsonia inermis, Phrynium capitatum* and *Averrhoa carambola.* (Hazarika, P., *et al.* 2021) It was observed that almost all the homesteads were laying without seasonal crops and

vegetables except a few. Seasonal crop recorded to grow in the homestead gardens are presented in the table 3.

Livestock status

Table 4: Livestock status of Khampti villages in Namsai district, Arunachal Pradesh

Name of Village	Number of livestock				
	Cow	Buffalo	Goat	Pig	Poultry
Old Mohong	20	0	16	9	68
Pathar Gaon	71	17	7	14	26
Piyong Khampti	40	0	10	9	57
Lathao 1	45	0	7	5	28
New Lathao	29	0	6	6	55
Sulungtoo	33	0	6	0	38
Kherem	32	0	0	5	50
Marua camp	11	0	0	3	39
New Mohong	10	2	13	8	61
Mankao	32	4	0	0	55
Manphaiseng	16	11	0	0	70
Manmow	32	4	0	0	55
Wagon Pathar	49	2	10	9	54
Jenglai	53	4	2	1	74
Wengko	58	0	1	15	60
Total	**635**	**40**	**79**	**76**	**722**

Out of 225 households, 114 were not preferred to rear any live stocks due to some reasons. Among them, cow and poultry are being reared most. Other livestock were goat, pig and buffalo. It was also observed that out of 225 families, 123 families reared cow, 72 reared poultry, 38 families were found brear pig, 22 families reared goat and only 12 families found to keep buffalo. cow and buffalo were kept for milk and plough. It has been found that they get the fodder mostly from their homestead or agricultural land. Livestock status of Khampti villages in Namsai district is presented in table 4. From the data, it was found that in the 15 Khampti villages have 635 cows, 79 goats, 76 pigs, 40 buffaloes and 722 poultry.

Energy consumption

The study revealed that Khamptis used fuel wood, L.P.G cylinders and kerosene to meet their energy needs. Of which, LPG cylinders were used mostly for cooking. They collected fuel woods either from homesteads or from agricultural fields. sometimes they used to purchase the fuelwoods from the local markets also. Data showed that out of 225 households, 197 households (87.55%) uses L.P.G. as their energy source and 34 households (15.11%) depends

on kerosene. moreover all the households uses fuelwood. Number of households using different energy sources annually in 15 villages was evaluated and presented in table 5.

Table 5: Number of households using different energy sources annually in 15 villages of Namsai

Village	Fuel wood	LPG	Kerosene (L)
Old Mohong	15	12	3
Pathargaon	15	15	6
Piyong	15	14	3
Lathao-I	15	15	2
New Lathao	15	15	0
Sulungtoo	15	15	1
Kherem	15	15	1
Marua Camp	15	15	1
Mankao	15	15	0
New Mohong	15	13	3
Manphaiseng	15	14	8
Manmow	15	13	1
Wagon Pathar II	15	4	5
Jenglai Village	15	7	0
Wengko	15	15	0
Total	225	197	34
Percentage (%)	100	87.55	15.11

Economic return from all the sources

The Khampti people were use to take meat which are available in their local markets. Price of broiler chicken was Rs. 200/kg and local chicken was Rs. 300/kg. Likewise, pig was recorded to sold at Rs 400/ kg and goat at Rs 400/kg. They rear cow and buffaloes for milk and other dairy products. Milk is sold at Rs. 60 to 70 per litre in the market. Table 7 represent the village wise average annual earning of the household and their earnings from homestead, livestock and service or business. Average annual income of each of the village (15 household each village) including homestead, agricultural income, income from livestock and income from govt. or business were evaluated for 15 villages and presented in table 6. The survey revealed the avarage annual income of a household of Khampti tribe from all the sources was Rs. 28,445.60 with a range of minimum Rs.19033.3 and maximum avarage annual income of Rs. 43946.6

Table 6 Different sources of annual income obtained from agriculture, livestock and service/business in respect to their households' income of Khampti tribe, Namsai district, Arunachal Pradesh.

Villages	Average annual income of each household					Range of household income
	Agriculture (Rs)	Livestock and poultry (Rs.)	Homestead (Rs.)	Govt. service/business (Rs.)	Total Household income (Rs.)	
Old Mohong	11400	9313	3566.6	6433.3	30712.9	20000-30000
Pathar Gaon	13166.6	17580	6600	6600	43946.6	30000- 40000
Piyong Khampti	10213	9520	2120	6633.3	28486.3	20000- 30000
Lathao	8433	7220	2333.3	1933.3	19919.6	10000-20000
New Lathao	10000	7727	3300	17000	38027	10000-20000
Sulungtoo	4133.3	6253	4133.3	1666.6	16186.2	10000-20000
Kherem	16200	5433	2900	3600	28133	20000- 30000
Marua camp	7800	2340	3493.3	533.3	14166.6	10000-20000
New Mohong	14046	5026.6	3433.3	1193.3	23699.2	30000-40000
Mankao	9433	4167	3833.3	1600	19033.3	10000-20000
Manphaiseng	12866.6	5800	2533.3	16400	37599.9	30000-40000
Manmow	10900	7000	3500	16366.6	37766.6	30000-40000
Wagon Pathar	10653	10707	2966.6	5466.6	29793.2	30000- 40000
Jenglai	11247	8227	3406.6	5333.3	28213.9	30000- 40000
Wengko	13106.6	10826.6	3933.3	3133.3	30999.8	30000- 40000
Total	163598.1	117140.2	52052.9	93892.9	426684.1	
Average income	10906.53	7809.33	3470.13	6259.46	28,445.60	

From the data it was observed that average annual income earned from agriculture by the households was Rs. 10906.53; average household income from homesteads of was Rs. 3470.13; average annual earning from livestock and poultry is Rs 7809.33 and average annual earning of the households from govt. job or business is Rs. 6259.46.

The survey revealed that 164 families out of 225 families were nuclear and the rest 6 were joint families. 117 households were having kaccha houses, 73 families had semi pucca houses and 35 families lived in pucca houses. The annual income of the households ranges from Rs. 13.500 to Rs. 310,000. Their main primary livelihood is agriculture and about 70% of the people were engaged. The Khampti people follow Buddhism and they celebrate various Khampti occasions. People were not well educated. A very few had done their higher studies which eventually decrease their literacy rate. Literacy rate was found within the range of 20.27% to 54.05%. The landholdings utilized by each of the households for agriculture was more as compared to homestead garden. Seasonal crops (vegetables) were recorded to grow in the homestead gardens such as *Zea mays, Colocasia esculenta, Solanum tuberosum melongena, etc.*in Kharif season and *Sesamum indicum, Phaseolus vulgaris, Solanum tuberosum, etc*., in Rabi seasons. Cow was reared most and other livestock were goat, buffalo, and poultry. L.P.G. cylinders were mostly consumed as the source of energy. Women are actively engage in selling goods in the local markets along with their traditional role which was a positive sign towards development. Although, Khampti homesteads are sizable, due to lack of proper agroforestry planning, their profitability was less, hence agroforestry demo plots were introduced to project profitablility of the agroforestry system under the project activity. Integrated cultivation of multi-crops and multiple use of land was found to have higher economic gain than the monoculture system (Bijarpas *et al*., 2015).

Higher level of education and income, large size of land holdings, modified houses, business and government jobs are found positively related to traditional elite families. It was analyzed from the recorded data that the income from homesteads is negatively related with the land holding size of the households. Hence demo plots were selected to improve income through agroforestry.

Summary of socioeconomic study of Khampti tribe

It was observed that most families were nuclear. More than 50% of the households were kaccha, 32% live in semi pucca houses and about 15% have pucca houses. Average annual income of the households was maximum (25%) within the range of Rs 15,000- 20,000; 23% incomes more than Rs 40,000; while 5.3% within the range of Rs 10,000- 15,000. About 66% of

the population depend on agriculture for their livelihood, similarly, 20% depend on both agriculture and government job, whereas, 0.44% are dependent only on government jobs and 0.88% on business. 50% of the individuals had done their studies upto class 10; 22% had their secondary education (class 12) and few (4.64%) had done post-graduation. Landholdings data showed 73.87% of the total land is used as agricultural land and 25% of the land as homestead land. Cow is the highest reared livestock than pig, goat and buffalo. They cultivate Kharif and Rabi crops. Annual energy consumption was found to be high for LPG (67.55%) than fire wood (17.34 %) and kerosene (15.11%). Further, it was noticed that there was no proper agroforestry planning in the villages to optimize land use, increase profitability and widening livelihood options.

Appendix 1.2 Phytosociological study of homesteads plant species of Khampti tribe

Phytosociological study was done to find out extent of phytodiversity that was conserved in their homesteads by the Khampti tribe and to document them as per their type of utilization. The other purpose of this study was to select the productive phyto components in their homesteads which are directly link with the livelihood, culture and are suitable to include in the proposed agroforestry system trials. Apart from that it was also intended to know about the extent of biodiversity that has been traditionally conserved in Khampti homesteads of Namsai district, Arunachal Pradesh.

The details methodologies followed for the phytosociological study and the findings are presented in Appendix -2 (paper 1 to 3). Phytosociological data were collected following multistage purposive randomized sampling technique was exercised to select the samples for the study to determine the biodiversity, socio-cultural relationship with the plant species present in homesteads of 15 Khampti villages distributed in 5 administrative Circles of the Namsai district of Arunachal Pradesh. The species recorded in the survey were classified as trees and shrubs. Prior permission was taken from the owners of the homesteads while conducting the survey. The survey was done in 225 homesteads to document plant species following quadrate method from 15 randomly selected homesteads of each of the 15 Khampti villages. For tree species the size of the quadrate was 10 m × 10 m and for shrub species the size of the quadrate was 5 m × 5 m. Interviews were also done with the locals with the help of a questionnaire for documenting the use of different plant species in their cultural and traditional practices. Following equations were used for determining the biodiversity of the different homesteads.

Apart from those, a few other findings i.e. 12 species of fuel wood (Table 7), 9 spice yielding species (Table 8), 87 species of medicinal plants (Table 9), 5 fodder plant species (Table 10) were also documented from their homesteads.

Table 7 Fuel wood species recorded from Khampti homesteads of Namsai district, Arunachal Pradesh

Sl	Species Name	Khampti/ Local name	Family	Habit
1	*Alangium chinense* (Lour.) Harms.	Sikamorolia	Alangiaceae	Shrub/wild
2	*Albizia chinensis* (Osbeck) Merr.	Sagur enka Shaw Koroi	Fabaceae	Tree/wild
3	*Albizia lucidior* (Steud.) Nielson.	Moj	Fabaceae	Tree/ wild
4	*Azadirachta indica A..Juss.*	Mahaneem	Meliaceae	Tree/ planted
5	*Balakata baccata (Roxb.) Esser*	Seleng	Euphorbiaceae	Tree/ wild
6	*Ficus religiosa* L	Anhot	Moraceae	Tree/planted
7	*Grewia asiatica* L.	Kukur huta	Tiliaceae	Shrub/ wild
8	*Litsea monopelata* Roxb.	Sualu	Lauraceae	tree/ wild
9	*Mallotus paniculatus* (Lam.) Mull.Arg.	Morolia	Euphorbiaceae	Tree/ wild
10	*Mallotus tetracoccus* (Roxb.), Kurz	Bor Morolia	Euphorbiaceae	Tree/ wild
11	*Melia azedirach* L.	Ghora neem	Meliaceae	Tree/ planted
12	*Premna latifolia* Roxb.	Gohora	Verbenaceae	Tree/wild

Table 8 Spice species recorded from Khampti homesteads of Namsai district, Arunachal Pradesh

Species Name	Khampti /Local name	Family	Habit/ habitat
Amomum subulatum Roxb.	Elachi	Zingiberaceae	Herb/cultivated
Cinnamomum zeylenicum Br.	Dalcheni	Lauraceae	small tree/ planted
Coriandrum sativum L.	Pikki/ Pi kiDhania	Apiaceae	Herb/ cultivated
Curcuma longa L.	Khow main, Halodhi	Zingiberaceae	Herb/ cultivated
Eryngium foetidum L.	Man dhania	Apiaceae	Herb/ wild
Murraya koenigii (L.) Sprenge	Hom, Narasingha	Rutaceae	Shrub/ wild/planted
Zanthoxylum armatum DC.	Mekat, Masala pat	Rutaceae	Shrub / planted
Polygonum pangianum (G.D.Pal & Maiti) R.C.Srivast.		Polygonaceae	Herb/ planted
Piper nigrum L.	Imphitlom, Jaluk	Piperaceae	climber/ cultivated

Table 9 Medicinal plant species recorded from Khampti homesteads of Namsai district, Arunachal Pradesh

Sl	Species Name	Khampti/Local name	Family	Habit/ ststus	Parts & used for
1	*Acacia fernasiana* L.	Torua-kadam	Fabaceae	Sh/ LR/C	Fr- Toothache
2	*Achyranthes aspera* L.	Kungra/Ban-sath, Pak	Amaranthaceae	H/W /LR	A- piles and chest pain
3	*Acorus calamus* L	Sam pu/Bos	Acoraceae	H/C/VU	Rh- asthma and bronchitis
4	*Adhatoda zeylanica* Medic.	Bahak tita	Acanthaceae	Sh/C/LR	L, B, R- antimalarial, jaundice
5	*Adiantum capillus-veneris* L.	Pukut/Chuli Dhekia	Adiantaceae	Cl/W/ LR	WP- cold and cough
6	*Ageratum conyzoides* L.	Manpung/ padribha	Asteraceae	H/W/LR	L- Woundhealing, R- pneumenia
7	*Aloe vera* (L.) Burm.f.	Sal Kuwori	Xanthorrhoeaceae	H/ C/ LR	A-Cosmetic, antidiabetic, Antiseptic
8	*Alpinia galanga* (L.) Willd.	KingPang/Gandhatora	Zingiberaceae	H/ W/LR	Rh-Skin allergy
9	*Alstonia scholaris* (L.) R.Br	Mai tang /Sotiana	Apocynaceae	T/W/ LR	B-malaria
10	*Alternanthera denticulata* R. Boown.	Bisoilyakoroni	Amaranthaceae	H/C/LR	A- wound healing
11	*Amomum subulatum* Roxb.	Elachi	Zingiberaceae	H/C/LR	Rh- Skin allergy, wound
12	*Andrographis paniculata* Wall.ex. Nees	Hirota/Kalmegh	Acanthaceae	H/ C/ NT	WP- Malaria, jaundice, liver tonic,
13	*Argyreia nervosa* (Burm. f.) Bojer	Motaimon/Bih dharak	Convolvulaceae	Cl/ W/LR	L- skin diseases
14	*Asparagus racemosa* Willd	Sottish sora/ Satmul	Liliaceae	Cl/ C /NT	T- impotency,stomach problem
15	*Asplenium nidus* Linn.	Ya hang kaa	Aspleniaceae	Epi/ LR	L- healing fractured bone
16	*Bidens pilosa* L	Mutkein	Asteraceae	H/W /LR	A- urinary tract infection
17	*Blumea balsamifera* (L.) D.C	Yanang	Asteraceae	H/ W /VU	L- dysentery, diarrhoea , diabetes, body pain
18	*Buddleja asiatica* Lour.	Bana /Pisola	Scrorphulariaceae	Sh/ W/ E	Fl- skin diseases
19	*Caesalpinia bonduc* (L) Roxb.	Leta guti	Fabaceae	Sh/ W/LR	S- intestinal worms, colic pain
20	*Calotropis gigantea* L.	Akon-Asing/Akon	Asclepidaceae	Sh/ W/LR	Latex- skin ulcer
21	*Cannabis sativa* Linn	Vijaya/Bhang	Cannabinaceae	H/ W/	Fl-Stomach disorder
22	*Centella asiatica* (L.) Urb.	Panang lung/ Bor-manimuni	Apiaceae	H/ W/	WP- Chonic dysenty, high blood pressure
23	*Cassia tora* Linn.	Hakboo/Medeluwa	Fabaceae	H/ W/LR	L- relief rheumatic pain
24	*Cheilocostus speciosus* (J.Koenig)	Saru Jamlakhuti	Zingiberaceae	H/ W/NT	Rh-pain during mesual cycle, white

	C.D. Specht				discharge
25	*Chromolaena odorata* (L.)R.M.King and H.Rob.	Mikam/Jarmani bon	Euphorbiaceae	H/ W/LR	L- wound healing
26	*Cinnamomum zeylenicum* Br.	Dalcheni	Lauraceae	ST/ C/LR	B- Flu, indigestion
27	*Cleome gynandra* L.	Bhutmala	Cleomaceae	H / W/LR	A- diarrhoea
28	*Clerodendron colebrookianum* Walp .	Patak khai /Nefafu	Verbenaceae	Sh/ W/VU	L- blood presser
29	*Clerodendrum infortunatum* L.	Dhapat tita	Verbenaceae	Sh/ W/	L- Antidandruff, malaria
30	*Clitoria ternatea* L.	Aparajita	Fabaceae	Cl / C/	R- juice for white discharge female, relief mensural pain
31	*Coleus forskohlii* Briq.	Moyamuksii	Lamiaceae	H/ W/	A- paste for knee joint pain
32	*Costus speciousus* (Koeing) Sm.	Mantung/Jamlakhuti	Zingiberaceae	H/ W/LR	R,St- Jundice
33	*Crassocephalum crepidioides* (Benth.) S.Moore	Yamen/Bonkopah	Asteraceae	H/ W/	WP-Anti malarial,
34	*Crinum latifolium* L.	Dheki phul	Amaryllidaceae	H/W/LR	Bulb- rheumatism
35	*Croton roxburghii* Bolar.	Hongkii/Gos mahudi	Euphorbiaceae	ST/ W/	R- root paste for bone pain
36	*Croton tiglium* L.	Saklang /Koni bih	Euphorbiaceae	Sh/W/LR	Fr- chronic malarial fever.
37	*Curcuma caesia* Roxb.	Khingnak/keturihalodhi	Zingiberaceae	H/ W / T	Rh-snack bite and scorpion bite
38	*Curcuma longa* L.	Khow main/ Halodhi	Zingiberaceae	H/ C/	Rh-anti bacterial , relief swalling muscular wound
39	*Datura innoxia* Mill.	Pukumii/ Datura	Solanaceae	Sh/ W/	L, Fr- dog bite. burnt skin
40	*Derris elliptica* (wall.) Benth.	Etam chali	Fabaceae	Sh/ C/	B- leprosy
41	*Dillenia indica* L.	Makchan/ outenga	Dilleniaceae	T/W/LR	antidiabetes,congestion,antidiarrhoea
42	*Drymaria cordata* (L.) Willd. Ex Schult	Yatikhoi/Laijabori	Caryophyllaceae	H/ W/LR	WP- paralysis, skin disease
43	*Eryngium foetidum* L.	Man dhania	Apiaceae	H/ W /LR	A-fever, arthritis
44	*Euphorbia hirta* L	Dud boon	Euphorbiaceae	H/W/	TT- worm killing in children
45	*Euphorbia neriifolia* Linn.	Sepak/Siju	Euphorbiaceae	H/ C/	St- bone fracture
46	*Garcinia pendunculata* Roxb. ex Buch.Ham	Mhahau /Bor thekera	Clusieaceae	T/C/NT	F- drypulp in blood dysentry
47	*Gaultheria fragrantissima* Wall.	Gandapura	Ericaceae	Sh/C/	B/ L- rheumatism, scabies
48	*Gynocardia odorata* R.Br.	Makampo/ Lemtem	Flacourtiaceae	T/W/NT	Fr- leprosy, skin diseases
49	*Heliotropium indicum* L.	Sankieng/ Hatishuria	Heliotropiaceae	H/ W/LR	L- paste for breathlessness

50		bon			R- Gum bleeding, mild cough.
51	*Hibiscus syriacus* L.	Nongnang tibe	Malvaceae	Sh/C/	Flb- regularize menseual cycle
52	*Houttuynia cordata Thunb.*	Punkyo/ mossandori	Saururaceae	H/W/	A-pneumonia, bronchitis
53	*Hydnocarpas kurzii*(King) Warb.	Makhapong/ Sal mugra	Achariaceae	T/W/CR	B- juice to improve health, skin disease
54	*Kaemferia galanga* Linn.	Wan hom/ Gathion	Zingiberaceae	H/W/ CR	Rh- anti vomiting, brain stimulant
55	*Kalanchoe pinnata* (Lam.) Pers	Yapong /Dupor tenga	Crassulaceae	H/ C/NT	L-feaver , unination, kidney stone
56	Lannea coromandelica (Houtt.) Merr.	Jia-poma	Anacardiaceae	T/ W/LR	L- Boils, skin eruption.
57					Fr/ L /B-
58	*Litsea cubeba* (Lour). Pers.	Rukmeer/ Mejankori	Lauraceae	T /W/LR	stimulant, anti-inflammatory
59	*Litsea gluctinosa* (Lour) Robinson	Baghnala	Lauraceae	T/ W/NT	B- boils
60	*Melastoma malabathricum* L.	Mohapatta/Phutuka	Melastomataceae	Shr / W/LR	Ts-Diabetes
61	*Mirabilis jalapa* L.	Ar-atukkhuan /Godhuli gopal	Nyctaginaceae	Sh/C/LR	R- piles
62	*Ocimum canum* L.	Pisimkhim/ Kolia tulosi	Lamiaceae	H/ C/LR	L- cough, bronchytis
63	*Oroxylum indicum* (L.) Benth. Ex Kurz	Bhatgila/ Bhat Ghilla	Bignoniaceae	T/W/NT	R-diarrhoea,fever
64	*Paederia foetida* L.	Sankar/Bhedai lota	Rubiaceae	Cl/ W/LR	L-gastritis, indigestion
65	*Perilla frustescens* (L.) Britt	Nga khaw/ Sukloti	Lamiaceae	H/C/	Ts- fever, stomach trouble
66	*Physalis minima* L.	pokmou	Solanaceae	H/ W/	WP-Gastric trouble
67	*Picrorhiza kurroa* Royle	Kutki	Scrophulariaceae	H/ W /EN	R- malaria
68	*Psidium guajava* L.	Mantaka /Modhuri	Myrtaceae	T/ C/LR	TT- diarrhoea
69	*Plantago major* L	Sevinyuri/Singapat	Plantaginaceae	H/W/ LR	A-Constipation, indigestion
70	*Plumbago indica* L	Kensumi/ Agechita	Plumbaginaceae	H/ C/LR	R- mouth ulcer
71	*Pogostemon benghalensis* (Burm. f.) O. Kuntze	Ya kin phit/ Suklati	Lamiaceae	H/ C/ DD	L- stomach ulcer, food poison
72	*Pouzolzia bennetiana* Wight.	Borali-bokua	Urticaceae	H /W/ LR	L- constipation
73	*Rhychostylis retsuss* (L.) Blume	Kopu phul	Orchidaceae	Epi/ C/LR	L- in rickettsia
74	*Ricinus communis* L.	Ton kong/era	Euphorbiaceae	Sh/ C/ NT	L-Body pain
75	*Sapindus mukorossi* Gaertn.	Mak sak/Monisal	Sapindaceae	T/ C/LR	Fr- antidendruf
76	*Scoparia dulcis* L	Meeta boon/Bon tulsi	Scrophulariaceae	H/ W/	WP- Jaundice, fever,

77	*Solanum torvum* Sw.	Mehengchang/Vekuri	Solanaceae	H/W /	Fr- malaria stomach pain
78	*Spilanthes paniculata* Wall ex.DC	Yakheomong/Piroja	Asteraceae	H /W	Fl;-toothache, mouth ulcer
79	*Stellaria media* (Linn.) Vill.	Morolia sak	Caryophyllaceae	H/ W /LR	WP- Paste use to stop bleeding
80	*Stephania japonica* Miers.	Bhimraj/Tubuki lota	Menispermaceae	Cl /W/LR	T- malaria
81	*Sterculia villosa* Roxb.	Iswarai/Odal	Sterculiaceae	T/ W/ LR	B- burnt and inflamed skin
82	*Syzygium cumini* (L.) Skeels.	Jamuk	Myrtaceae	ST/ W/LR	S- anti diabetes
83	*Terminalia arjuna* Roxb.	Arjun gose/Ariun	Combretaceae	T/ C/LR	B & Fr- heart disease, stimulant
84	*Terminalia chebula* Retz.	Manaa/ Silikha	Combretaceae	Tree/ C/VU	Fr-constipation, indigestion
85	*Tinospora cordifolia* (Willd.)Miers	Hakyungha/ Amor lota	Menispermaceae	Cl/ W/CR / VU	ST- gastaritis, stimulant, immunity
86	*Zanthoxylum armatum* DC.	Mekat/ Masala pat	Rutaceae	Sh / C/ NT	S - stomach disorder
87	*Zingiber officinalis* Roscoe.	Hing/Khingn/ Ada	Zingiberaceae	H/ NT/ C	Rh- cough , Stomach pain

Habit: Herb= H, Shrub=Sh, Tree= T, Climber = Cl, Small tree = ST, Epiphyte = Epi
Status: **C**-cultivated/ planted, **CR**-critically endangered , **DD**-data deficient, **E**-endemic to NE India, **EN**-endangered, **EW**-extinct in wild, **I**-invasive, **IN**-introduced & naturalized, **LR**-lower risk/conservation dependent, **NT**-near threatened (includes lower risk/near threatened), **VU**-vulnerable, **W**-wild,

Parts Used: A-aerial parts, B-bark, St- Stem, Br-branches, Bu-buds, F-flowers, Fr-fruit, L-leaves, R-roots, Rh-rhizomes, , S-seeds, Sa-sap, SC-seed coat, Sh-shoot, So-seed oil, Sp-spadix, St-stem, T- Tuber, TT- Tender plant tip, W-wood, WP- whole plant

Table 10 Fodder species recorded from Kampti homesteads ofNamsai district, Arinachal Pradesh

Species Name	Khampti / Local name	Family	Habit/ ststus	Use	part used
Bauhinia variegata (L.) Benth.	Sekang, kanchan Manau	Fabaceae	small tree/ planted	ornamental/ fodder	flower
Ficus auriculata Lour.	Athua-dimoru	Moraceae	small tree/ planted	fodder	leaves
*Ficus hispida*L.f.	Mukanpong/ Mawa Dimoru	Moraceae	small tree/ planted	fodder	leaves
Ficus religiosa L	Anhot	Moraceae	Tree/planted	fuel wood/ fodder	wood
Schumannianthus dichotomus (Roxb.) Gannep.	Patidoi/ pong	Marantaceae	Herb/ wild	mat making/ fodder	stem

Appendix –I 3 A. Establishment of Five (5) Agroforestry Demo Plots

Fig .11 Maps showing GPS locations of 5 homesteads agroforestry demo plantation area

Five (5) homesteads (plots) of 5 Khampti villages were selected for improving to agroforestry system. The size of homestead agroforestry demo plots varies from 1.5 ha to 5 ha.

Selection of demo plots was done considering the criteria of distribution of one from each of the five circles of Namsai district Arunachal Pradesh. Name of selected Villages, administrative Circle and name of the beneficiaries (homestead owners) is presented in table 11 and GPS maps in fig.1 to 5.

Table 11 Name of the selected Homestead owner (beneficiary), Villages, Administrative Circle, GPS points of Namsai district, Arunachal Pradesh.

Sl. No	Name of Homestead owner	Village	Circle	Lat	Long
1	Chow Makang Manong	Old Mohong	Mahadevpur	27°48″02.2″N	96°08’22.3″E
2.	Chow Newata Mannaw	Lathao	Lathao	27°44′36.5″N	95°54′41.1″E
3.	Chow Peng Moungleng	Pathar Gaon	Namsai	27°41’17.7″N	95°55’29.3″E
4.	Chow Ayoka Manlong	Mankao	Chongkham	27°33’28.4″N	95°92’38.8″E
5.	Chow Mutuwom Manchey	Piyong	Piyong	27°35′45.5″N	95°55′57.7″E

Plantation Layout of Agroforestry crops

1. **Layout of plan of Agroforestry demonstration plot, Mankao village**

Size of plantation: 5 ha

i. Boundary plantation : *Aquilaria malacensis*, *Bambusa tulda* and *Cinnamomum zylenicacum*

ii. Upper story plantation: *Areca catechu, Acacia catechu*, *Cocos nucifera*, *Dalabergia sisso* and *Mangifera indica,*

iii. Middle story plantation : *Citus limon, Garcinia lanciefolia, Litchii sinensis* and *Zizyphus mauritiana*

iv. Lower story intercrop: *Colocasia esculenta*, *Zingibar officinalis*, *Solanum tuberosum, Sesamum indicum*, *Brassica juncea* and vegetables

2. **Layout of plan of Agroforestry demonstration plot, Old Mohong village**

Size of plantation: 1.5 ha

i. Boundary plantation : *Aquilaria malacensis*, *Bambusa tulda, Cinnamomum zylenicacum* and *Livistona jenkinsiana*

ii. Upper story plantation: *Areca catechu*, *Cocos nucifera*, *Dalbergia sissoo*, *Mangifera indica*

iii. Middle story plantation : *Citus limon, Garcinia lanciefolia, Litchii sinensis*, *Piper nigram* and *Zizyphus mauritiana*

iv. Lower story intercrop: *Colocasia esculenta*, *Zingibar officinalis*, *Solanum tuberosum, Sesamum indicum*, *Brassica juncea* and vegetables

3. **Layout of plan of Agroforestry demonstration plot, Pathar Gaon**

Size of plantation: <5 ha

i. Boundary plantation : *Aquilaria malacensis*, *Bambusa tulda, Cinnamomum zylenicacum* and *Livistona jenkinsiana*

ii. Upper story plantation: *Areca catechu, Dalbergia sisso*, *Cocos nucifera,* and *Mangifera indica*

iii. Middle story plantation : *Citus limon, Cinamomum zylenica, Garcinia lanciefolia, Litchii sinensis*, *Piper nigram* and *Zizyphus mauritiana*

iv. Lower story intercrop: *Phaseolus mungo*, *Cajanas cajan*, *Colocasia esculenta*, *Zingibar officinalis*, *Solanum tuberosum, Sesamum indicum* , *Brassica juncea* and vegetables

4. **Layout of plan of Agroforestry demonstration plot, Lathao village**

Size of plantation: 1.5 ha

i. Boundary plantation : *Aquilaria malacensis*, *Bambusa tulda Cinnamomum zylenicacum* and *Livistona jenkinsiana*

ii. Upper story plantation: *Areca catechu, Acacia catechu*, *Cocos nucifera, Dalabergia sisso* and *Mangifera indica*

iii. Middle story plantation : *Citus limon, Garcinia lanciefolia, Litchii sinensis,* and *Zizyphus mauritiana*

iv. Lower story intercrop: *Colocasia esculenta*, *Zingibar officinalis*, *Solanum tuberosum, Sesamum indicum* , *Brassica juncea* and vegetables

5. **Layout of plan of Agroforestry demonstration plot, Piyong village**

Size of plantation: 1.5 ha

v. Boundary plantation: *Aquilaria malacensis*, *Bambusa tulda, Cinnamomum zylenicacum* , *Dalabergia sisso* and *Livistona jenkinsiana*

vi. Upper story plantation: *Areca catechu, Cocos nucifera,* and *Mangifera indica*

vii. Middle story plantation : *Citus limon, Garcinia lanciefolia, Litchii sinensis, Piper nigram* and *Zizyphus mauritiana*

viii. Lower story intercrop: *Colocasia esculenta*, *Curcuma longa*, *Solanum tuberosum, Sesamum indicum* , *Brassica juncea* and vegetables

Spacing

Spacing for Boundary plantation: *Cocos nucifera & Cinnamomum zylenicacum* 12m x 12 m; *Aquilaria malacensis* : 2.5m x 2.5m and *Bamusa tulda* 5m x5m; *Livistona jenkinsiana* @ spacing of 5m x5m

Spacing for Block plantation

Areca catechu: 5m x 5m; planting in between *Areca catechu* was done with *Citrus limon*: 2.5m x 2.5 m in same row;

Acacia catechu*:* 10m x 10m planting in between was done with *Citrus limon* : 2.5m x 2.5 and *Areca catechu* 10m x10m in same row

Zizyphus mauritiana: 10m x10 m; row planting in between *Zizyphus mauritiana* was done with *Citrus limon* : 2.5m x 2.5 m in same row;

Mangifera indica: 10m x 10m; planting in between *Mangifera indica* was done with *Areca catechu* @ spacing of 10m x 10 m in same row;

Areca catechu 10m x 10m; planting in between *Areca catechu* was done with *Litchii sinensis*: 10.0 m x 10.0 m and *Citrus limon* : 2.5m x 2.5 m in same row

Dalabergia sisso 5m x 5m; planting in between *Dalabergia sisso* was done with *Citrus limon* : 2.5m x 2.5m and Areca catechu 10m x10m in same row.

Other middle story species: 5m x 5m; planting in between other species in the same row.

Row to row spacing: 10m x 10m (Within this spacing farmers use to cultivate lower story annual crops including vegetables for household consumption)

Planting

Pits size 1x1x1 ft and were filled with 10 kg of FYM/ cow dung + 20 kg soil + 30 g Aldrin or BHC or Methyl parathion powder + 50 g Urea + 30 gm super phosphate + 30 g MoP well mixed before 15 days

Planting time: April – Aug.

Pits were dug one month before planting

Application of Fertilizers / plant at the time of planting

FYM: 10 kg or Vermicompost: 1 kg

Urea: 50 g

Super phosphate: 30 g or PGPR biofertilizers: 5 g

Potash (K_2O)/ MoP : 30 g

Below is an example for layout plantation *Areca catechu- Zizyphus mauritiana- Cinnamomum zylenicacum* based Agroforestry system

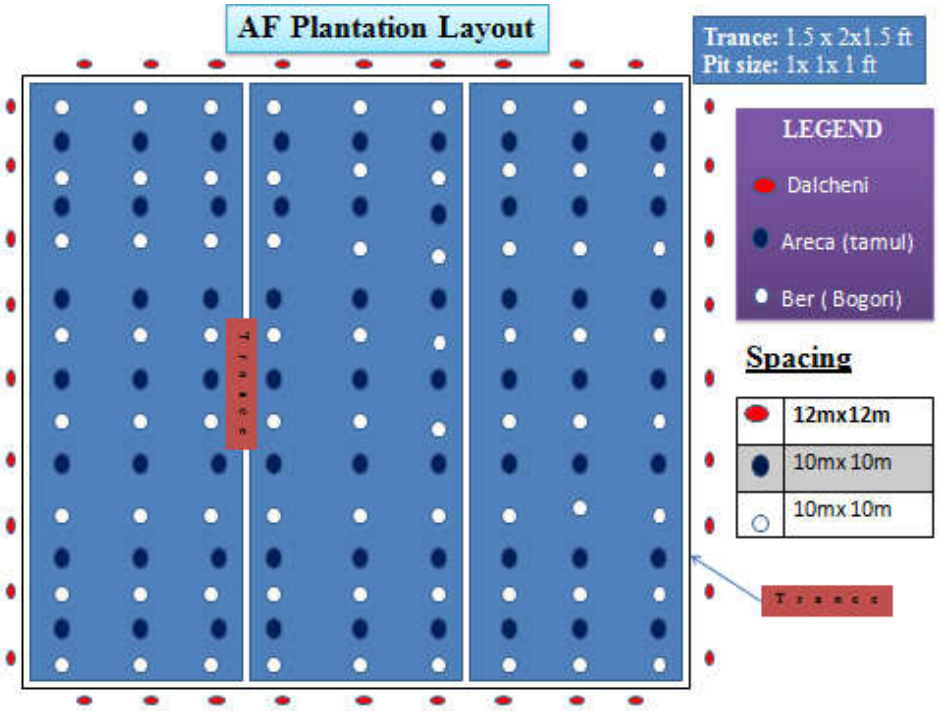


Fig 12 Depicted a sketch map of AF plantation layout of *Cinnamomum zylenicacum* as boundary plantation and block plantation with *Areca catechu* and *Zizyphus mauritiana*. Between row spacing *Citrus limon* was planted

Application of Fertilizers / plant after six months of planting

FYM: 20 kg or Vermicompost : 2 kg

Urea: 50 gm

Super phosphate: 30 gm or PGPR biofertilizers: 5 g

Potash (K_2O)/ MoP: 30 gm

Establishment of vermicompost Units

Vermicompost units established in Mankao, Piyong Khampti, Lathao, Pathar Gaon and Old Mohong village are presented in fig 13. As a part of capacity building activities and to self sustain in production and application of organic source of fertilizer five (5) vermicompost (2 chambered) units (size of 14x5x2.5 cft) were established in homestead agroforestry demo plots of agroforestry plantation during Oct- Dec., 2020. This was done also to disseminate the technology to other villagers too. Farmers were also trained by onsite demonstration programmes of these villages. Initially, earthworm species *Eisenia fotida* was given to each of the unit owners and they have been trained to multiply the earthworm. Presently they have produced vermicompost to fertilize the crops and seedlings in agroforestry area. Also they used to apply vermiwash too.

Vermicompost unit in Old Mohong Village

Vermicompost unit in Pathargaon Village

Vermicompost unit in Piyong Village

Vermicompost unit in Mankao Village

Vermicompost unit in Lathao Village

Varmiwash collection from pit

Fig 13 Vermicompost units established in different villages of Namsai District, Arunachal Pradesh

Raising agroforestry plantation in demo plots

Seedlings planted in 5 different demo plots are presented in table 2. Plantation were done in three consecutive years along with filling up of causality of seedlings. *Areca catechu, Aquilaria malacensis*, *Bambusa tulda*, *Cinnamomum zeylenicum, Cocos nucifera, Dalbergia sissoo*, *Garcinia lanciefolia, Litchi chinensis, Livistona jenkinsiana, Magnifera indica* and

Zizyphus mauritiana were planted in each of the five demo plots. In two plots Lathao and Mankow seedlings of *Acacia catechu* were also planted. *Machilus bombycina* was also planted except Piyong demo plot. Intercropped *Zingiber officinale* (Ginger), *Cucuma longa* (turmeric), *Cajanus cajan* (L.) Millsp, *Colocasia esculenta* (L.Schott, *Sesamum indicum* (til), *Solanum tuberosum* L., *Vigna mungo* (black mung) Zea *mays* (maize), in the demo plots. Fruit trees such as *Areca catechu* (Tamul), *Citrus limon* (lemon), *Zizyphus mauritiana* (apple ber), *Mangifera indica* (mango), *Litchi sinensis* (litchi), and *Garcinia lanceifolia* were planted. Spice species - *Cinnamomum zylenicum* (cinnamon), *Piper nigrum* (black pepper),) etc. were also planted in the demo plots.

Table 12 Planted species in 5 Agroforestry Demo plots developed in Khampti homesteads of Namsai district Arunachal Pradesh

Name of plant species	[A] Number of seedlings planted in 5 Agroforestry demo plantation in Namsai district				
	Pathar Gaon	Piyong	Mankao	Lathao	Old Mohong
Acacia catechu (L.f.) Willd.	00	00	500	100	00
Aquilaria malaccensis Lam.	2040	540	1040	540	540
Areca catechu L.	400	400	1400	400	400
Bambusa tulda Roxb.	10	10	10	10	10
Cinnamomum zeylenicum Br.	25	25	100	100	100
Citrus limon (L.) Osbeck	200	100	200	100	2000
Cocos nucifera L.	15	20	12	10	15
Dalbergia sissoo Roxb.	100	140	100	100	100
Garcinia lanciefolia Roxb.	25	125	100	50	100
Litchi chinensis Sonn.	250	250	250	250	250
Livistona jenkinsiana Griff.	45	55	42	30	25
Magnifera indica L.	50	50	50	50	50
Piper nigrum L.	40	160	00	00	160
Zizyphus mauritiana Lam.	300	200	200	200	200
Machilus bombycina King ex Hook. f.	20	00	20	50	20
	[B] Intercrop species (Propagules given for intercrop (in Kg))				
Brassica nigra (L.) K.Koch	20	00	20	20	20
Cajanus cajan (L.) Millsp.	50	00	00	00	00
Colocasia esculenta(L.)Schott	00	00	100	00	100
Curcuma longa L.	00	300	200	00	00
Sesamum indicum L.	10	10	10	10	10
Solanum tuberosum L.	200	200	200	200	200
Vigna mungo (L.) Hepper *Zea mays* L	10	10	10	10	10
Zingiber officinale Roscoe.	200	00	120	120	120

Determination of Gross income

The total income of each agroforestry systems was calculated by multiplying the total yield of agroforestry produces (intercrops etc) with their market price.

Gross income = Total yield × Market price

Determination of net income

The net income of each agroforestry systems were calculated by subtracting the total cost of agroforestry components from the total income or gross income.

Net income = Total income – Total cost of production

Table 13: Comparison of income before and after agroforestry intercrop in Homestead Agroforestry Plots, Namsai District

Sl	Demo plots			Annual return/ha from intercrops in initial years of Agroforestry interventions in the homesteads (in Rs)									
		Year 2020 (Before Agroforestry plantation) Income (Rs)		2020-2021 (1st year return from agroforestry intercrop)					2021-2022 (2nd year return from agroforestry intercrop)				
				Cost of production/ input (Rs)			Gross income/ out put (Rs)	Net Income (output-input) (Rs)	Cost of production/ input (Rs)			Gross income/ out put (Rs)	Net Income (output-input) (Rs)
				Land preparation + propagules	Labour + Management	Total Cost			Land preparation + propagules	Labour+ Management	Total Cost		
1	AM	28,133		10,800	9,500	20300	96,500	76,200	7,150	11,730	18880	1,15,167	96,267
2	NM	19,920		11,750	10,300	22050	1,19,050	97,000	7,750	11,750	19500	2,04,654	1,85,154
3	MM	26,800		10,550	7,200	17750	1,22,750	1,05,000	7,500	12,550	20050	1,30,864	110,814
4	PM	43,946		10,550	9,750	20300	1,15,300	95,000	8,500	11,000	19500	1,42,000	1,22,500
5	MUM	28,487		11,550	10,200	21750	96,750	75,000	8,100	10,800	18900	1,09,476	90,576

AM**=** Chow Ayoka Manlong (Mankao); NM=Chow Newata Mannaw (Lathao); MM= Chow Makang Manlong (Old Mohong); PM=Chow Peng Mounlang (Pathar Gaon); MUM= Chow Mutuwom Manchey (Piyong)

Calculation of benefit-cost ratio (BCR)

The benefit-cost ratio was calculated by using the following formula

Benefit-cost ratio (BCR) = Gross income ÷ Cost of production

Table 14 Benefit cost ratio of homestead agroforestry systems of Namsai district, Arunachal Pradesh

Sl.	Demo plots	Year 2020-2021			Year 2021-2022		
		Total production cost (Rs)	Gross income (Rs)	BCR	Total production cost (Rs)	Gross income (Rs)	BCR
1	AM	20300	96,500	4.75	18880	1,15,167	6.09
2	NM	22050	1,19,050	5.40	19500	2,04,654	10.49
3	MM	17750	1,22,750	6.91	20050	1,30,864	6.50
4	PM	20300	1,15,300	5.70	19500	1,42,000	7.28
5	MUM	21750	96,750	4.44	18900	1,09,476	5.79

AM= Chow Ayoka Manlong (Mankao); NM=Chow Newata Mannaw (Lathao); MM= Chow Makang Manlong (Old Mohong); PM =Chow Peng Mounlang (Pathar Gaon); MUM= Chow Mutuwom Manchey (Piyong)

Economic contribution from homestead agroforestry

Economic return from the annual/intercrops was calculated for the year 2021 and 2022 based on the local market value of the harvested crops. A comparative study was done on the income before and after agroforestry plantation in the homesteads and presented in table 13. As per the assessment, in the year 2020-2021 agroforestry demo plot of Chow Newata Mannaw (Lathao) had earned Rs. 97,000/, Chow Makang Manlong (Old Mohong) had earned Rs. 1,05,000/-, owner of Chow Peng Manlong (Pathar Gaon) had earned Rs. 95,000/-, Chow Ayoka Manlong (Mankao) had earned Rs. 76,200/- and Chow Mutuwom Manchey (Piyong) had earned Rs. 75,000/- from their annual crop. There was a slight increased in net income in the year 2021-2022 for all the agroforestry plots of the district. Accordingly, agroforestry demo plot owner of Mankao had earned net income of a sum of Rs. 96,267.06, owner of Lathao demo plot had earned net income Rs.1,85,154, Old Mohong owner had earned net income Rs. 90,814, Pathar Gaon owner had earned net income Rs.1,22,500.4 and the owner of Piyong had earned net income Rs. 90,576 from the annual harvest (Table 13). The data revealed that Lathao demo plot owner had obtained highest net income of the amount Rs. 1,85,154 followed by Pathar Gaon with net income of Rs. 1,22,500 in the second (2^{nd}) year .

Benefit cost ratio (BCR) of homestead agroforestry systems of Namsai district, Arunachal Pradesh were calculated and presented in table 14. It was said when BCR value greater than 1, the land-use system can be termed as profitable (Hasan et al, 2020). Calculated value of BCR indicated that ratio increased with time of the agroferstry system and also grater

than 1. Therefore, all of the five agroforestry land use systems established in the Khampti homesteads were profitable. Among the agroforestry land use systems profitability was highest (6.91) in the year 2020-21 obtained by Chow Makang Manlong (Old Mohong) and lowest was 4.44 obtained by Chow Mutuwom Manchey (Piyong). In the second year i.e. 2021-22 BCR is slightly increased but there was a jump maximum upto 10.49, obtained by Chow Newata Mannaw (Lathao). The data of BCR revealed that agroforestry land use system is profitable and can be extended to other area with aceptible reason of ability for income generation.

Improvement in soil physicochemical parameters due to agroforestry interventions

After analysis of soil samples of agroforestry plots, it is observed that there was a gradual improvement in soil physicochemical properties such as pH, EC, Per cent organic carbon, available phosphorus, available nitrogen and potassium in the soils of agroforestry demo plots recorded for the year 2020, 2021 and 2022. The data of soil samples analysed are presented in table 15. The said improving trend was evidient within the agroforestry plots and among the agroforestry plots too with an exception in Piyong for available potassium. Available phosphorus of the soils before agroforestry interventions for Piyong homestead was revealed highest value with 57.26 ±0.68 Kg/ha, followed by Pathar Gaon i.e. 49.24 ±1.16 kg/ha, there by in Lathao 45.2±1.70 kg/ha and Old Mohong available phosphorus in the soil before agroforestry plantation was recorded as 28.46±2.29 kg/ha. Available phosphorus was lowest (27.34±2.14 kg/ha) in Mankao homestead among all 5 homesteads before agroforestry interventions. However, after the agroforestry intervention of 2nd and 3rd year of plantation the values of soil available phosphorus were recorded to improve. For example, plot wise percent increase in available phosphorus in the 3rd year (2021-22) was 55.79 % for Piyong; in Pothar Gaon was 33.26 %; for Old Mohong it was highest 86.92 %; for Lathao it was 84.18% and percent increase in available phosphorus in Mankao agroforestry plots was 65.43%. Similar treand was also revealed for available nitrogen and % organic carbon contents among the plots.

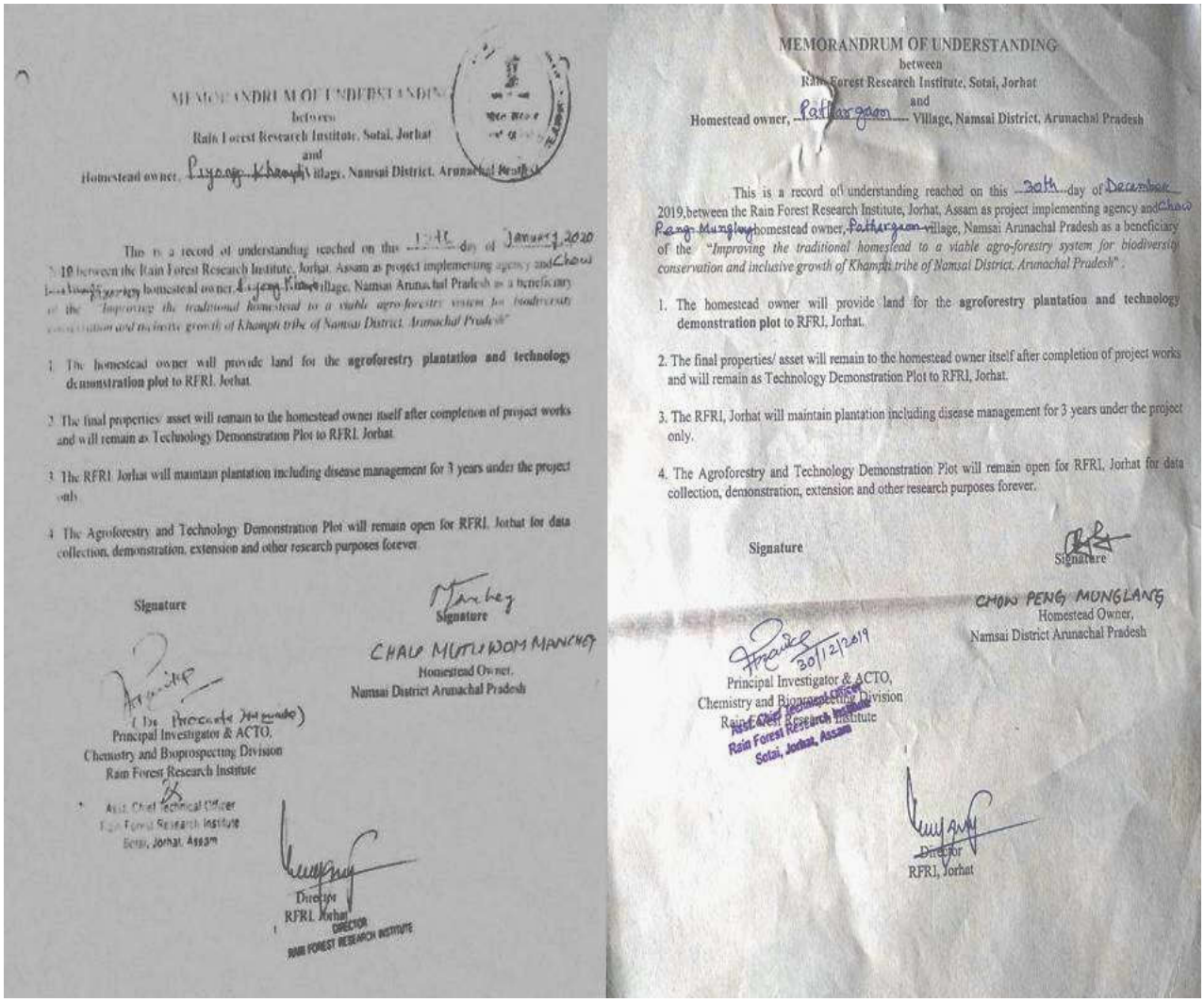
The soil of Northeastern region of India is acidic. As such, the pH vaule of the soils of homesteads of Namsai district ranged from 4.1 to 5.3 as recorded for the soils before the agroforestry interventions. pH value of the soils of 5 agroforestry plots were also analysed for succeeding years after agroforestry plantation and revealed in improvement of soil pH with high values up to 6.2. The EC of the soil also found to improve due to agroforestry intervations.

Table 15: Data showing (mean value ±SD) of soil parameters of due to agroforestry interventions in 5 demo-plots of Namsai district, Arunachal Pradesh

Village		Available Phosphorous (Kg/ha)			Available Nitrogen content (Kg/ha)			Available Potassium (Kg/ha)			% Organic Carbon			pH			EC		
		Year			Year			Year			Year			Year			Year		
		2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022
Mankao		27.34 ±2.14	36.27 ±1.98	45.23 ±0.60	238.33±0.86	275.97±1.07	376.32±0.88	139.13±1.02	205.32±1.17	304.6±1.43	1.41±0.35	1.78±0.14	1.8±0.20	5.3 ±0.65	6.1 ±0.3	6.1±1.33	59±3.37	75±2.92	180±2.52
Lathao		45.2 ±1.70	79.12 ±1.41	83.25 ±2.37	326.14±0.19	413.95±1.66	501.76±1.72	101.31±1.10	181.68±0.70	295.15±0.76	0.99±0.49	1.59±0.30	1.92±0.36	5±o.34	6.2 ±0.43	6.2±0.70	48±4.33	114±2.77	192±3.43
Old Mohong		28.46 ±2.29	35.7 ±0.78	53.2 ±1.47	200.7 ±0.70	301.05±o.57	451.58±0.85	214.77±1.61	304.6 ±0.77	309.33±0.81	1.13 ±0.16	1.23±0.57	1.86±0.40	4.1±0.41	5.6 ±0.45	6±0.5	88±4.41	72±3.33	143±3.90
Pathar Gaon		49.24 ±1.16	57.48 ±1.09	65.62 ±0.89	351.23±1.54	388.86±1.15	413.95±1.5	233.69±1.41	257.32±1.18	370.79±1.12	1.29±0.5	1.76±0.20	2.26±0.40	4.7±0.50	5.5±0.40	5.5 ±0.29	47±2.32	69±3.54	126±3.65
Piyong		57.26 ±0.68	87.61 ±1.40	89.21 ±1.71	326.14±0.86	388.86±1.73	451.58±0.68	129.68±0.65	217.2 ±0.76	337.7±0.72	1.36±0.53	1.73±0.40	1.91±0.20	4.8±0.70	5.9 ±0.60	5.5 ±1.11	65±3.66	78±3.23	141±2.78

Appdndix-1.3. [B] MoUs between homesteads owners and ICFRE-Rain Forest Research Institute, Jorhat

Five (5) MoUs were signed between homestead owners (beneficiaries) of Namsai district, Arunachal Pradesh and ICFRE- Rain Forest Research Institute, Jorhat, Assam for improving the homesteads in to agroforestry system. That was done by selecting the beneficiary in each PRA meetings in consultation with the respective villagers. Copies of the MoUs are –



MEMORANDUM OF UNDERSTANDING
between
Rain Forest Research Institute, Sotai, Jorhat
and
Homestead owner, Pathargaon Village, Namsai District, Arunachal Pradesh

This is a record of understanding reached on this 30th day of December 2019, between the Rain Forest Research Institute, Jorhat, Assam as project implementing agency and Chow Peng Munglang homestead owner, Pathargaon village, Namsai Arunachal Pradesh as a beneficiary of the *"Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh"*.

1. The homestead owner will provide land for the **agroforestry plantation and technology demonstration plot** to RFRI, Jorhat.
2. The final properties/ asset will remain to the homestead owner itself after completion of project works and will remain as Technology Demonstration Plot to RFRI, Jorhat.
3. The RFRI, Jorhat will maintain plantation including disease management for 3 years under the project only.
4. The Agroforestry and Technology Demonstration Plot will remain open for RFRI, Jorhat for data collection, demonstration, extension and other research purposes forever.

Signature
Signature
CHOW PENG MUNGLANG
Homestead Owner,
Namsai District Arunachal Pradesh

30/12/2019
Principal Investigator & ACTO,
Chemistry and Bioprospecting Division
Rain Forest Research Institute
Sotai, Jorhat, Assam

Director
RFRI, Jorhat

MEMORANDRUM OF UNDERSTANDING
between
Rain Forest Research Institute, Sotai, Jorhat
and
Homestead owner, Old Mahong Village, Namsai District, Arunachal Pradesh

This is a record of understanding reached on this 08 th day of January 2019 between the Rain Forest Research Institute, Jorhat, Assam as project implementing agency and Chow Makang Manlong homestead owner, Old Mahong village, Namsai Arunachal Pradesh as a beneficiary of the *"Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh"*.

1. The homestead owner will provide land for the **agroforestry plantation and technology demonstration plot** to RFRI, Jorhat.
2. The final properties/ asset will remain to the **homestead** owner itself after completion of project works and will remain as Technology Demonstration Plot to RFRI, Jorhat.
3. The RFRI, Jorhat will maintain plantation including disease management for 3 years under the project only.
4. The Agroforestry and Technology Demonstration Plot will remain open for RFRI, Jorhat for data collection, demonstration, extension and other research purposes forever.

Signature

Principal Investigator & ACTO,
Chemistry and Bioprospecting Division
Rain Forest Research Institute

Asst. Chief Technical Officer
Rain Forest Research Institute
Sotai, Jorhat, Assam

Signature
Homestead Owner,
Namsai District Arunachal Pradesh
(CHOW MAKANG MANLONG)

Director
RFRI, Jorhat
DIRECTOR
RAIN FOREST RESEARCH INSTITUTE

MEMORANDRUM OF UNDERSTANDING
between
Rain Forest Research Institute, Sotai, Jorhat
and
Homestead owner, Mankao Village, Namsai District, Arunachal Pradesh

This is a record of understanding reached on this 28th day of December 2019 between the Rain Forest Research Institute, Jorhat Assam as project implementing agency and Chow Ayoka Manlong homestead owner, Mankao village, Namsai Arunachal Pradesh as a beneficiary of the *Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh*

1 The homestead owner will provide land for the **agroforestry plantation and technology demonstration plot** to RFRI, Jorhat
2 The final properties asset will remain to the homestead owner itself after completion of project works and will remain as Technology Demonstration Plot to RFRI, Jorhat
3 The RFRI, Jorhat will maintain plantation including disease management for 3 years under the project only
4 The Agroforestry and Technology Demonstration Plot will remain open for RFRI, Jorhat for data collection, demonstration, extension and other research purposes forever

Signature

Signature
CHOW AYOKA MANLONG
Homestead Owner,
Namsai District Arunachal Pradesh

Principal Investigator & ACTO,
Chemistry and Bioprospecting Division
Rain Forest Research Institute
28/12/2019
Asst. Chief Technical Officer
Rain Forest Research Institute
Sotai, Jorhat, Assam

Director
RFRI, Jorhat
DIRECTOR
RAIN FOREST RESEARCH INSTITUTE

MEMORANDRUM OF UNDERSTANDING
between
Rain Forest Research Institute, Sotai, Jorhat
and
Homestead owner, Lalhao Village, Namsai District, Arunachal Pradesh

This is a record of understanding reached on the 10th day of January 2020 between the Rain Forest Research Institute, Jorhat Assam as project implementing agency and Chau Nenata Mannow homestead owner, Lalhao village, Namsai Arunachal Pradesh as a beneficiary of the *Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh*

1. The homestead owner will provide land for the **agroforestry plantation and technology demonstration plot** to RFRI, Jorhat
2. The final properties asset will remain to the homestead owner itself after completion of project works and will remain as Technology Demonstration Plot to RFRI, Jorhat
3. The RFRI, Jorhat will maintain plantation including disease management for 3 years under the project only
4. The Agroforestry and Technology Demonstration Plot will remain open for RFRI, Jorhat for data collection, demonstration, extension and other research purposes forever

Signature

Signature
CHAU NENATA MANNOW
Homestead Owner,
Namsai District Arunachal Pradesh

Principal Investigator & ACTO,
Chemistry and Bioprospecting Division
Rain Forest Research Institute
Sotai, Jorhat, Assam

Director
RFRI, Jorhat
DIRECTOR
RAIN FOREST RESEARCH INSTITUTE

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Documentation of Edible Plants in Homesteads of Khampti Tribe, Namsai District, Arunachal Pradesh, India

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Abstract

A study was conducted to document edible plant species present in homesteads of Khampti tribe of Namsai district, Arunachal Pradesh during November 2019 to February 2021. Randomly selected 225 homesteads of 15 Khampti villages were surveyed for edible plant species, taken photographs, collected samples for identification. Further, the homesteads owners (with pre-consent) were interviewed with semi-structured questionnaire and record information such as local name of the plant, category of the plant (i.e. cultivated, planted and wild), edible plant parts, mode of consumption etc. A total of 150 edible plant species belongs to 56 families were documented from the homesteads of Khampti villages during the study. Of which, 47 edible plant species were planted in their homesteads from the wild, 44 were wild and natural invaders and 59 were cultivated. The study revealed that Khampties were consumed fruits of 72 plant species, whole plant used as vegetables of 21 herb species, tender shoots of 19 plant species used as vegetables, 9 tubers,7 rhizome, seeds of 7 plant species and leaves 6 species. They used to consume 47 plant parts as raw, 77 after cooked, 15 as pickle, 9 as chutney, 7 as spice and another 7 consumed by extracting juice etc. The study could document a considerable extent of edible plant species from Khampti homestead gardens. It indicates that Khampti homesteads were safe shelter edible plant diversity and thus they are being conserved with time and in turn provide the community needs.

Keywords: Khampti, homesteads, edible plant species, documentation

Introduction

It is a known fact that edible plants are domesticated in past from the wild habitat. Thereafter, these plant species are either cultivated in field or planted in the homesteads. It was also said that domestication of plant took place mainly in mountainous regions more or less within or near the tropics (Vavilov, 1935). Food habit of a community confined in particular locality has been build up with time and was governed mainly by two factors such as resource availability of edible plant species and ecological factors. Further, it has governed with local ethno botanical knowledge (LEK) and traditional ecological knowledge (TEK) at community level (Hazarika *et al.*, 2015; Turreira-García *et al.*, 2015). The human population used to collect different edible plants or plant parts i.e. fruits, nuts, roots etc from the forests since nomadic stage.

Subsequently, with the progress of settled and civic nature of nomadic tribes, they domesticated plants and animals (Schaal, 2019). Use of fire and agriculture altered the food habit of human beings by and large (Zucoloto, 2011). The food habit is also influenced by some other factors such as development of indigenous knowledge, cultivation, culture, economic, social, nutritional, health status etc (Downs *et al*., 2020; Gartaula *et al*., 2020; Singh *et al*., 2020; Singh *et al*., 2010). Thus, it is assumed that within a community or a tribe with time a gradual change in food habit is build up and shaped. Accordingly people use to domesticate the plant species in their settled habitat and thereafter in homesteads. Researchers also observed that there is number of different environmental factors and socioeconomic factors such as sex, age gender, education, proximity to the market and distance to the urban areas can influence the knowledge and use of wild food plants by the local people (Bortolotto *et al*., 2015; Ojelel *et al*., 2015; Toledo *et al*., 2007).

A number of scientific studies document over 27,400 plant species as edible in the world either cultivated or from wild (Garn and Leonard, 1989; French, 2019). It is estimated that, in India about 1,403 species of 184 families are consumed as food plants (Ray and Sreevidya, 2020), while in north east (NE) India is around 300 (Deka *et al*., 2012; Murtem and Chaudhry, 2016). Even after having highest natural plant diversity and tribal communities in NE India the figure of edible plant diversity is merely low and it indicates that lots of works need to be done.

Arunachal Pradesh is hotspot of natural plant resources and rich in ethnicity as the state is an inhabitance of 28 major tribes (Khongsai *et al*., 2011). It was also recorded that the edible plants which are found in NE India occur in Arunachal Pradesh (Ray and Sreevidya, 2020; Dutta *et al*., 2017; Haridasan *et al*., 1990). A good number of research studies were reported from Arunachal Pradesh at different community level on wild edible plants (Angami et al , 2006; Moyong *et al*., 2019; Murtem and Chaudhry 2016; Tsering *et al*., 2017; Tag and Das, 2004; Shankar *et al*., 2016; Lungphi *et al*., 2018; Khongsai *et al*., 2011, Namsa *et al*., 2011). The homesteads play important role conservation of unique diversity of edible and useful plant species to mitigate local needs and commercial important (Dilrukshi *et al*., 2013; Hazarika *et al*., 2014). There has been no systematic study on the edible plant species of the homesteads that are consumed by Khampti tribe of Namsai district, Arunachal Pradesh. Therefore, this study was conducted for generation of the database on edible plant species, recorded edible plant parts, mode of use etc. The study also emphasizes on the extent conservation of edible plant species by the Khampti community in their homesteads.

Materials and Methods

Study Area

The study was conducted on Khampti tribe in Namsai district, Arunachal Pradesh during November 2019 to February 2021. The district is located in between latitude 27°30' to 27°55'N and longitude 95° 52' to 96° 20' E and sharing border with Lohit and Changlang towards the east; Assam to the West; Lohit and Assam towards the North, and the south border adjoins Changlang district (Fig.1). The climate is warm and temperate. The rainfall in summers has much more than the winter. The average annual temperature is 22.8°C. Average annual precipitation is 2728 mm. High quantity of rainfall (750-800 mm) is recorded during July-August with a relative humidity of 80%. Maximum and minimum winter temperatures are 25° C and 10° C, respectively.

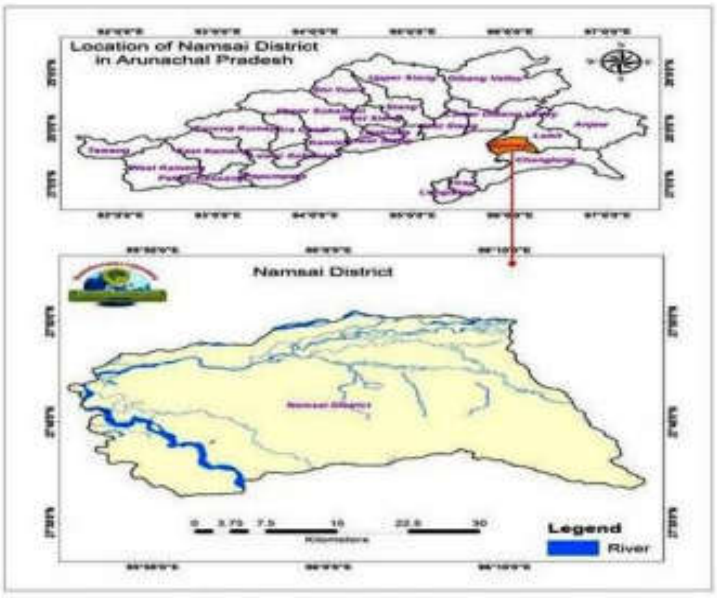

Fig 1 Location Map of Namsai district, Arunachal Pradesh

Data collection

A total of 225 Khampti homesteads form 15 Khampti villages were surveyed randomly i.e. Old Mohong, New Mohong, Lathao, New Lathao, Sulungtoo, Pathar Gaon, Piyong II, Kherem, Mankao, Marua Camp, Manphaiseng, Manmow, Wagon Pathar, Jenglai, and Wenko. Randomly selected 15 homesteads of each of the 15 Khampti villages were visited and objective of the study was clearly explained to the homesteads owner. Information of edible plant species, parts used as food, mode of use , the associated indigenous knowledge etc were collected with the interview by a semi structured questionnaire with prior informed consent (PIC) from the homestead owner. The edible plant species were also photographed along with the edible parts.

The edible plant species of their homesteads were taxonomically authenticated with the help of standard Flora of Assam (Kanjilal et al., 1934 – 1940) and Flora of Arunachal Pradesh (Hajra et al., 1996; Giri et al., 2008; Chowdhery et al., 2009), and Flora of Lower Subansiri (Pal, 1993). The accepted scientific names were verified in the website www.theplantlist.org and www.plantsoftheworldonline.org.

Results

A major plant species recorded from homesteads of Khampti villages of Namsai district were edible. There were 106 edible plant species documented from Khampti homesteads, of which, 59 were cultivated and 47 were planted and are presented in Table 1. Planted species are basically domesticated from the wild habitat as they are useful. Apart from that 44 wild species were also recorded from the homesteads of Khampti villages and are presented in Table 2. In both the tables incorporated information such as their local name, family, edible parts, mode of use etc. The survey could record a total of 149 plant species from their homesteads were edible either in raw or cooked or in other processed product form (Table 1 & 2). They belongs to 56 plant families (Fig 2.), of which Solanaceae represented with maximum 13 species, followed by Rutaceae with 10 species, 7 species belong to Cucurbitaceae and Arecaceae; Araceae and Brassicaceae with 6 plant species each; 5 species by Zingiberaceae. Other plant families such as Amaranthaceae, Apiaceae, Fabaceae, Lamiaceae, Musaceae, Rosaceae and Rubiaceae were observed to have 4 edible species each in different Khampti homesteads. Likewise, Anacardiaceae, Asteraceae,

Clusieaceae, Euphorbiaceae, Myrtaceae Polygonaceae and Piperaceae were 7 plant families found to occur 3 edible species each in the homesteads of Khampti villages. Importantly, other 11 plant families were found to have 2 edible plant species in the homesteads of different Khampti villages i.e. Alliaceae, Caryophyllaceae, Chenopodiaceae, Dioscoreaceae, Lauraceae, Oxalidaceae, Passifloraceae, Phyllanthaceae, Rhamnaceae, Sapindaceae, and Malvaceae. Only single edible plant species were detected from another 24 plant families i.e. Acantaceae, Annonaceae, Bambusaceae, Bromeliaceae, Caricaceae, Convolvulaceae, Dilleniaceae, Eleocapaceae, Eleagnaceae, Lythraceae, Melastomataceae, Myricaceae, Moraceae, Moringaceae, Pedaliaceae, Poaceae, Portulacaceae, Saururaceae, Woodsiaceae, Theaceae, Tiliaceae, Urticaceae ,Verbenaceae and Vitiaceae. There was a variation in parts used within a species or among the edible plant species and are presented in fig 3. More than one part of a plant species was also recorded for a few edible plant species. Accordingly, bark. *Cinnamomum zeylenicum* was used for preparing spice. The bark of *Glyscosmis pentaphylla* was used treat Pneumonia and ripe fruit is eaten (Table 2). The flower of three plant species i.e. *Brassica oleracea* var.*botrytis*, *Phlogachanthus thyrsiflorus* and *Sesbania grandiflora* were recorded as edible after cooked. Fruits of 72 plant species were recorded as edible which were grown in their homesteads of which 22 were taken when ripped. The other fruit were recorded to take either in raw or after cooked. Likewise 6 plant species were recorded as edible their leaves (Table 1 & 2).

Apart from leaves entire plant of 21 herb species were recorded as edible. They are *Alternanthera sessilis*, *Amaranthus hybridus*, *Brassica juncea*, *Brassica napus*, *Brassica olracea var capitata*, *Brassica pekinensis*, *Celosia argentea*, *Centella asiatica*, *Chenopodium album*, *Coriandrum sativum*, *Drymaria cordata*, *Ecliptica prostrata*, *Eryngium foetidum*, *Hedyotis scandens*, *Houttuynia cordata*, *Hydrocotyl sibthorpioides*, *Malva verticiliata*, *Oxalis corniculata*, *Rumex vasicarius*, *Spinacia oleracea* and *Stellaria media*. Of which, *Amaranthus hybridus*, *Brassica juncea*, *Brassica napus*, *Brassica olracea var capitata*, *Brassica pekinensis*, *Coriandrum sativum*, *Malva verticiliata*, *Rumex vasicarius* and *Spinacia oleracea* were recorded as cultivated vegetables in their homesteads and the others are wild herb and come naturally in their growing season.

The tender shoots of 21 plant species were recorded as edible by the Khampti tribe, of which two were cultivated in their homesteads i. e. *Mentha piperata* and *Hibiscus subdarifa*. Other 14 were grown naturally in homesteads (Table 1&2). Moreover *Raphanus sativus* is cultivated to eat root.

The survey also recorded that seeds of 7 plant species found in Khampti homesteads were cultivated for edible purposes (Fig 3). The Khampti are also practicing to take rhizome of the plant species as food. Seven such plant species found in their homesteads were *Alpinia galanga*, *Colocasia affinis*, *Colocassia esculenta*, *Colocasia antiquorum*, *Curcuma longa*, *Homalonema aromatica* and *Zingiber officinalis*. Of which, *Curcuma longa* and *Zingiber officinalis* are popular spice among them.

Mode of consumption these edible plants as food was also evaluated during the survey and presented in the table 1 and 2. Accordingly, five plant parts were consumed after boiling, nine plant species were recorded to intake as chutney, 77 plant parts/ plants were taken as cooked vegetables,4 plant were consumed after dry; Juice of 7 plants were taken and 1 plant used as beverage. Apart from that 15 plant parts were utilized as pickle, 3 of them are use as medicine, seven were as spice and 47 plant species parts were recorded to take as raw (Fig 4). Photographs of few plants species and market product of Khampti homesteads of Namsai district presented in Fig 5.

Table 1 Planted/Cultivated edible plant species recorded in the homesteads of Khampti villages of Namsai district, Arunachal Pradesh

Sl No	Species Name & Family	Khampti Local name	Time of availability	Habit/ Habitat	part used	Mode of use
1	*Aegle marmelos* (L.) Corrêa (Rutaceae)	Bel	April to May	Tree/ planted	Ripe fruit	Raw
2	*Alium cepa* L. (Alliaceae)	Plumuh/Piaj	Nov.-Dec.	Herb/ cultivated	Tuber	Raw/ cooked as vegetable
3	*Allium sativum* L. (Alliaceae)	Plosing /Naharu	Nov.-Dec.	Herb/ cultivated	Tuber	Raw/ Cooked as vegetable
4	*Alocasia macrorrhizos* (L.) Schott.(Araceae)	Panam mon/ Bor man Kasu	Sept to January	Herb/cultivated	Leaves / corm	Cooked /boiled
5	*Amomum subulatum* Roxb. (Zingiberaceae)	Bor Elachi	September-October.	Herb/cultivated	Seed	Spice
6	*Amaranthus hybridus* L. (Amaranthaceae)	Pu-hom lung/ Morisa sag	March to August	Herb/ cultivated	Whole plant	Cooked as vegetable
7	*Ananus comosus* (L.) Merr. (Bromeliaceae)	Mati kathal	May-August.	Herb/ cultivated	Ripe Fruit	Raw
8	*Andrographis paniculata* Wall.ex. Nees (Acanthaceae)	Hirota /Kalmegh	September	Herb/ cultivated	Whole plant	Medicinal
9	*Annona squamosa* L. (Annonaceae)	King hom/ Atlos	September to Novembe	Tree/ planted	Ripe Fruit	Raw
10	*Areca catechu* L. (Arecaceae)	Mak mow/ Tamul	June – December	Tree/ planted	Fruit	Raw
11	*Artocarpus heterophylla* Lamk (Moraceae)	Maalang/ Kothal	July-August	Tree/ planted	Ripe friut	Raw
12	*Averrhoa carambola* L. (Oxalidaceae)	Me phung/ Kordoi	June to February	Tree/ planted	Ripe Fruit	Raw
13	*Baccaurea ramiflora* Lour. (Euphorbiaceae)	Ma phai/ Leteku	July to August	Tree/ planted	Ripe Fruit	Raw
14	*Benincasa hispida* (Thunb.) Cog. (Cucurbitaceae)	Kumura	August to November	climber/ cultivated	Fruit	Cooked as vegetable
15	*Brassica juncea*(L.) Czern. (Brassicaceae)	Hariuh/ Sarioh	November	Herb / cultivated	Leaves	Leaves are cooked as vegetable
16	*Brassica napus* L. (Brassicaceae)	Khow hariuh/ Boga sariah	November	Herb/ cultivated	Plant	Cooked as vegetable
17	*Brassica oleracea var.botrytis* (Brassicaceae)	Phul kobi	November-February	Herb/ cultivated	Flower	Cooked as vegetable
18	*Brassica olracea var capitata* (Brassicaceae)	Bondha Kobi	November-March	Herb/ cultivated	Plant	Cooked as vegetable

19	*Brassica pekinensis* (Lour.) Rupr. (Brassicaceae)	Pakkat/ Pa kag/ Lai Sag	November-February	Herb/ cultivated	Plant	Cooked as vegetable
20	*Camellia sinensis* (L.) Kuntze(Theaceae)	Toon neng/ Sah	Whole year	Shrub/ planted	Tender leaves	Leaf extract used as beverage
21	*Capsicum annum* L. (Solanaceae)	Me fit/Jalokia	Whole year	Herb/ cultivated	Fruit	Raw/ cooked
22	*Capsicum chinensis* Jacq. (Solanaceae)	Me fit- kong/ Bhut jalokia	Whole year	Herb/ cultivated	Fruit	Raw /cooked
23	*Capsicum fructescens* L. (Solanaceae)	Me fit khow/ Boga jolokia	Whole year	Herb/ cultivated	Fruit	Raw / cooked
24	*Carica papaya* L. (Caricaceae)	Mak saan phow/ Amita	Whole year	small tree/ cultivated	Fruit	Raw /cooked
25	*Cinnamomum zeylenicum* Br. (Lauraceae)	Dalcheni	May and again in November	small tree/ planted	Bark	Spice
26	*Citrus limon* (L.) Osbeck (Rutaceae)	Hattal/ Kaghzi-nemu	July-September	Shrub/ planted	Fruit	Raw/pickle / juice
27	*Citrus maxima* (Burm) Meer (Rutaceae)	Mak lung/ Bortenga	November-January.	Shrub/ planted	Fruit	Raw juice
28	*Citrus medica* L. (Rutaceae)	Mak sa neng/ Robab Tenga	November-January.	Shrub/ planted	Fruit	Raw juice
29	*Citrus reticulata* Blanco (Rutaceae)	Mak mighi/ Komolatenga (1)	November-January.	Shrub/ planted	Fruit	Raw/ juice
30	*Citrus x sinensis* (L.) Osbeck (Rutaceae)	Mingi/ Komolatenga	November-January.	Shrub/ planted	Fruit	Raw/ juice
31	*Cocos nucifera* L. (Arecaceae)	Mowon/ Narikol	Whole year	Tree/ planted	Fruit	Raw
32	*Colocasia affinis* Schot. (Araceae)	pi pok	November-January	Herb/ cultivated	Tuber	Cooked as vegetable
33	*Colocassia esculenta* (L.) Schott (Araceae)	Phewk/ Kala-kochu	November-December	Herb/ cultivated	Tuber	Cooked as vegetable
34	*Corchorus olitorius* L. (Tiliaceae)	pi seng/Chbang /Mora pat	April- May	Herb/ cultivated	Tender plant	Cooked as vegetable
35	*Coriandrum sativum* L. (Apiaceae)	Pi ki/ Dhania	January-February	Herb/ cultivated	plant/ seed	Chutney /Cooked
36	*Cucumis sativis* Linn. (Cucurbitaceae)	Teng/Tianh	Whole year	Climber/ cultivated	Fruit	Chutney/ cooked as vegetable

37	*Cucurbita pepo* L. (Cucurbitaceae)	Ma pak kham/ Rongalau	August - December	climber/ cultivated	Fruit	Cooked as vegetable
38	*Curcuma longa* L. (Zingiberaceae)	Khow main/ Halodhi	December-January	Herb/ cultivated	Rhizome	Spice
39	*Dendrocalamus hamiltonii* (Bambusaceae)	Kako Banh	April to June	Cultivated	Rhizome	Cooked/pickle
40	*Dillenia indica* L. (Dilleniaceae)	Makchan/Outenga	July- Feb	Tree/ planted	Fruit	Cooked/pickle
41	*Dioscorea pentaphylla* L. (Dioscoreaceae)	Kuan mung/ Panchpotia Alu	Dec-Jan	Climber/ cultivated	Tuber	Boiled as vegetable
42	*Dioscoria alata* L. (Dioscoreaceae)	Malang/Kath alu	December	climber/ cultivated	Tuber	Boiled as vegetable
43	*Dimocarpus longan* Lour. (Sapindaceae)	Nagalitchu	July- Oct.	Small tree/ planted	Fruits	Raw
44	*Elaeis guineensis* Jacq. (Arecaceae)	Plam oil	June-August	Tree/ exotic	Fruit	Ripe fruit eaten raw
45	*Elaeocarpus floribundus* Blume. (Elaeocarpaceae)	Jalphai	August to October.	Tree/ planted	Fruit	Raw / pickle
46	*Eleagnus latifolia* L. (Eleagnaceae)	Mu lot Mirika Tenga	August to October.	Climbing Shrub/planted	Fruit	Pickle
47	*Emblica officinalis* L, (Euphorbiaceae)	Amlokhi	August to October.	tree/planted	Fruit	Raw /pickle
48	*Garcinia cowa* Roxb. (Clusieaceae)	Kuji thekera	July-September	Tree /planted	Fruit	Pickle/ dry
49	*Garcinia lanceifolia* Roxb. (Clusieaceae)	Rupohi Thekera	July-September	Shrub/planted	Fruit	Chutney/ pickle
50	*Garcinia pendunculata* Roxb. ex Buch._ Ham (Clusieaceae)	Mannang Bor thekera	April to August	Tree/ planted	Fruit	Chutney/ pickle/ dry
51	*Hibiscus subdarifa* L. (Malvaceae)	Tenga mora	April to August	Herb/cultivated	Tender shoot	Cooked as vegetable
52	*Houttuynia cordata* Thunb. Saururaceae	Punkyo/ Masandari	Whole year	Herb/cultivated	whole plant	Cooked as vegetable
53	*Ipomoea batatas* (L.) Lamk. (Convolvulaceae)	Mitha alu	June-January	climber/ cultivated	tuber	Cooked as vegetable
54	*Lagenaria siceraria* (Molina) Standl. (Cucurbitaceae)	Jatilau	Throughout the year	Climber/cultivated	fruit	Cooked as vegetable
55	*Livistona jenkinsiana* Griff. (Arecaceae)	Tongko/ Tokow	Dec-January	Tree/ planted/En	Nut	Raw
56	*Litchi chinensis* Sonn. (Sapindaceae)	Lichu	May and June.	Tree/ planted	Ripe fruit	Raw

57	*Luffa cylindrica* M.Roem. (Cucurbitaceae)	Jika	June to October	Climber/ cultivated	Fruit	Cooked as vegetable
58	*Lycopersicon esculenta* L. (Solanaceae)	Bor bilahi	October-February	Herb/ cultivated	Fruit	Raw /cooked
59	*Lycopersicum pimpinifolium* (L.)Mill (Solanaceae)	Konbilahi	October-February	Herb/ cultivated	Fruit	cooked
60	*Magnifera indica* L. (Anacardiaceae)	Momung/ Aam	June-August	Tree/ planted	Ripe Fruit	Raw
61	*Malva verticiliata* L. (Malvaceae)	Lofa saag	October-February	Herb/ cultivated	Whole plant	Cooked as vegetable
62	*Manihot esculenta* Crantz. (Euphorbiaceae)	Simolu Alu	October-February	Shrub/ cultivated	Tuber	Cooked as vegetable
63	*Mentha piperata* Linn (Lamiaceae)	Piche hun/ Pudina	March to August	Herb/ cultivated	Tender shoot	Chutney
64	*Momordica charantia* Linn. (Cucurbitaceae)	Makhaie Khum/ Tita kerela	March to August	climber/ cultivated	Fruit	Cooked as vegetable
65	*Moringa oleifera* Lam. (Moringaceae)	Sajina	February to May	Tree/ planted	Pod	Cooked as vegetable
66	*Musa acuminata* Colla. (Musaceae)	Koi/ Mem-Jatikol	Whole year	Tree/ cultivated	Ripe Fruit	Raw
67	*Musa balbisiana* Colla. (Musaceae)	Bhim kol	Whole year	Tree/ planted	Ripe Fruit	Raw
68	*Musa cavendish* Lamb. (Musaceae)	Jahaji	Whole year	Tree/ planted	Ripe Fruit	Raw
69	*Musa paradisiaca* L. (Musaceae)	Koi athia/ Kach kol	Whole year	Tree/ planted	Ripe Fruit	Cooked as vegetable
70	*Myrica esculenta* Ham. (Myricaceae)	Noga tenga	September -October.	Tree/ planted	Ripe Fruit	Pickle/ raw
71	*Passiflora edulis* Sims. (Passifloraceae)	Rasna	September -October.	climber/ cultivated	Fruit	Fruit Juice
72	*Passiflora quadrangularis.* L. (Passifloraceae)	Lota bel	May to November	climber/ cultivated	Fruit	Cooked as vegetable
73	*Phaseolus vulgaris* L. (Fabaceae)	Tho nin/ Mati mah	December	climber/ cultivated	Seed	Raw /cooked
74	*Phlogachanthus thyrsiflorus* Nees. (Rubiaceae)	Mochomkhum / Titaphul	May to Auguest	Climber/ planted	Flower	Cooked as vegetable
75	*Phoenix dactylifera* L. (Arecaceae)	Khejur	June or early July.	Tree/ planted	Fruit	Raw
76	*Pogostemon benghalensis* (Burm. f.) O. Kuntze (Lamiaceae)	Ya kin phit /Suklati	Whole year	Herb/ planted/ escapices	Tender shoot	Cooked as vegetable
77	*Polygonum pangianum* (G.D.Pal & Maiti)R.C.Srivast. (Polygonaceae)	--	Whole year	Herb/ planted	Tender shoot	Spice

78	*Phyllanthus embilica* L. (Phyllanthaceae)	Makhaam/ Amlokhi	October-November	Tree/ planted	Fruit	Raw/ pickle/ dry
79	*Phyllantus acidus* (L.) Skeels. (Phyllanthaceae)	Por Amlokhi	October-November	Tree/ planted	Fruit	Raw/ pickle
80	*Piper betel* L. Piperaceae	Pan	Whole year	climber/ cultivated	Leaves	Raw
81	*Piper nigrum* L. (Piperaceae)	Imphitlom Jaluk	November to February	climber/ cultivated	Seed	Spice
82	*Pisum sativum* L. (Fabaceae)	Mantaka/ Motormah	May to August	Climber/cultivated	Seed	Raw
83	*Prunica granatum* L. (Lythraceae)	Dalim	April-September	Shrub/planted	Fruit	Raw
84	*Prunus persica* (L.) Batsch Rosaceae	Nara Bogori	October-November	small tree/planted	Fruit	Raw
85	*Psidium guajava* L. (Myrtaceae)	Mantaka/ Modhuri	November-December	Tree/ cultivated	Tender shoot	Cooked as vegetable
86	*Pyrus communis* L. (Rosaceae)	Naspoti(1)	October-November	Tree/ planted	Ripe Fruit	Raw
87	*Pyrus pyriflora* (Burm.) Nak. (Rosaceae)	Naspoti (2)	October-November	Tree/planted	Fruit	Raw
88	*Raphanus sativus* (L.)Domin (Brassicaceae)	Mula	November to January	Herb/ cultivated	Root	Raw chutney/ cooked as vegetable
89	*Rumex vasicarius* L. (Polygonaceae)	Suka sag	November -January	Herb/ cultivated	Whole plant	Cooked as vegetable
90	*Saccharum officinarum* L. (Poaceae)	Oei/ Kuhiyar	November to January	Herb/ cultivated	Whole plant	Juice/ Molasses
91	*Seasamum indicum* L (Pedaliaceae)	Till	December	Herb / cultivated	Seed	Spice
92	*Sesbania grandiflora* (L.) Poir. (Fabaceae)	Bog phul	November to February	Shrub/ planted	Flower	Cooked as vegetable
94	*Solanum intregrifolium* L (Solanaceae)	garden egg plant	February to July	Herb/ cultivated	Fruit	Cooked as vegetable
95	*Solanum lycopersicum*L. (Solanaceae)	Bilahi	November to February	Herb / cultivated	Fruit	Cooked as vegetable
96	*Solanum melongena* L. (Solanaceae)	Makhw/ Bengena	February to July	Herb/ cultivated	Fruit	Cooked as vegetable

97	*Solanum tuberosum* L. (Solanaceae)	Mangkla/ Alu	December - January	Herb/ cultivated	Tuber	Cooked as vegetable
98	*Spinacia oleracea* L. (Chenopodiaceae)	Paleng	December to February	Herb/ cultivated	Whole plant	Chutney/ cooked
99	*Spondias pinnata* (L.f.) Kurz (Anacardiaceae)	Mokog Amora	August–September	Tree/ planted	Fruit	Pickle/ raw
100	*Syzygium cumini* (L.) Skeels. (Myrtaceae)	Jamuk Kolajamu	June- July	Tree /planted	Ripe Fruit	Raw
101	*Syzygium jambos* (L.) Alston (Myrtaceae)	Golapi Jamun	May- June	small tree/ planted	Ripe Fruit	Raw
102	*Tamarindus indica* L. (Fabaceae)	Mekeng Teteli	March-April	Tree/ planted	Ripe fruit	Raw
103	*Zanthoxylum armatum* DC. (Rutaceae)	Mekat Masala pat	Whole year	Shrub / planted	Leaves	Spice/ chutney
105	*Zingiber officinalis* Roscoe. (Zingiberaceae)	Hing/Khing Ada	Dec-January	Herb/ cultivated	Rhizome	Spice
106	*Zizyphus mauritiana* Lam. (Rhamnaceae)	Mokho Apple Bogori	Nov-January	small tree/ cultivated	Ripe Fruit	Raw

Table 2 Wild edible plant species recorded in the homesteads of Khampti villages of Namsai district, Arunachal Pradesh

Sl No	Species Name & Family	Khampti Local name	Time of availability	Habit/ Habitat	part used	Mode of use
1	*Alpinia galanga (* L.) Willd. (Zingiberaceae)	King Pang/ Khing pang/ Gandha Tota	Oct. to March	Herb/ wild	Rhizome	Cooked as vegetable
2	*Alpinia nigra* (Gaertn.) B.L.Burtt (Zingiberaceae)	Monhioo/ Tora gajali	Oct. to March	Herb/wild	tender shoot	Cooked as vegetable
3	*Alternanthera sessilis* (L). RBr. Ex DC (Amaranthaceae)	Yachnung/ Mati kaduri	March to October	Herb/ wild	Whole plant	Cooked as vegetable
4	*Alternanthera aquatica* (Parodi) Chodat. (Amaranthaceae)	Leheti sak	March- June	Herb/ Wild	Tender shoot	Cooked as vegetable
5	*Amaranthus spinosus* L. (Amaranthaceae)	Po hom nam/ Hati Khutora	March- Oct	Herb/wild	Tender shoot	Cooked as vegetable
6	*Blumea lanceolaria* (Wall. ex Roxb.) Druce. (Asteraceae)	Yanang	Whole year	Herb/wild	Tender plant	Cooked as vegetable
7	*Caryota urens* L. (Arecaceae)	Kunhang/ Sewa Tamul	Dec- Feb	Tree/ wild	Fruit	Raw

8	*Centella asiatica* (L.) Urb. (Apiaceae)	Panang lung Bor-manimuni	March - Sept	Herb/wild	Whole plant	Cooked as vegetable
9	*Chenopodium album* L. (Chenopodiaceae)	Puku/ Polom Jilmilsak	Dec - March	Herb/ wild	Tender shoot	Cooked as vegetable
10	*Clerodendron colebrookianum* Walp . (Verbenaceae)	Patak khai /Helle Yasak/ Nefafu	March- Oct	Shurb/ wild	Tender shoot	Cooked as vegetable
11	*Coccinea grandis* (L) Voight. (Cucurbitaceae)	Lok khoi kang wan/ Belipoka	Mar- Sept.	Climber/ wild	Fruit	Cooked as vegetable
12	*Colocasia antiquorum* Schott Melet(Araceae)	Mon-lai/ Adolia Kosu	Feb to Sept	Herb/ wild	Stem	Cooked as vegetable
13	*Diplazium esculentum* (Retz.) Sw. (Woodsiaceae)	Pu kut Dhekia	April- Nov.	Herb/ wild	Tender shoot	Cooked as vegetable
14	*Drymaria cordata* (L.) Willd. Ex Schult (Caryophyllaceae)	Laijabori	March - Oct	Herb/ wild	Whole plant	Cooked as vegetable/ medicine
15	*Ecliptica prostrata* L. (Asteraceae)	Kanraj /Kehraj	March - Sept	herb/wild	Tender plant	Cooked as vegetable
16	*Eryngium foetidum* L. (Apiaceae)	Man dhania	March - Sept	Herb/ wild	Plant	Chutney
17	*Glyscosmis pentaphylla* (Retz.) DC (Rutaceae)	Chauldhuwa Hengena poka	July – August	Shrub/wild	Bark/Ripe fruits	Medicine/ Raw
18	*Hedyotis scandens* Roxb. (Rubiaceae)	Kanjaua/ Bonjaluk	April to Sept	Herb/wild	whole plant	Cooked as vegetable
19	*Homalonema aromatica* Roxb. (Araceae)	Suanpa/ Gandha kosu	Entire year	Herb/wild	Rhizome	Cooked as vegetable
20	*Hedyotis scandens* Roxb. (Rubiaceae)	Kanjaua /Bonjaluk	Entire year	Herb/wild	Whole plant	Cooked as vegetable
21	*Hydrocotyl sibthorpioides* Lam. (Apiaceae)	Panang on/ Saru manimuni	Entire year	Herb/wild	whole plant	Cooked
22	*Lasia spinosa* L. (Araceae)	Sengmora	Entire year	Herb/ wild	Tender shoot	Cooked as vegetable
23	*Leucas aspera* (Willd.) Link . (Lamiaceae)	Dulon bon/ Durun	Entire year	Herb/ wild	Tender shoot	Cooked
24	*Litsea cubeba* (Lour). Pers. (Lauraceae)	Rukmeer/ Mejankori	April to July	Tree / wild	Fruit	Cooked
25	*Mangifera sylvetica* L (Anacardiaceae)	Momung/ Bon Aam	April to July	Tree/ wild/ En	Ripe Fruit	Raw
26	*Melastoma malabathricum* L. (Melastomataceae)	Mohapatta Phutuka	Throughout the year	Shrub / wild	Ripe Fruit	Raw
27	*Murraya koenigii* (L.) Sprenge (Rutaceae)	Hom/ Narasingha	Whole year	Shrub/ wild	Leaf	Chutney
28	*Oxalis corniculata* L. (Oxalidaceae)	Yasompi/ Tengesi	Whole year	Herb/ wild	whole plant	Cooked

29	*Paederia foetida* L. (Rubiaceae)	Sankar/ Bhedai lota	Whole year	Climber/ wild	Leaves	Cooked
30	*Perilla frustescens* (L.)Britt (Lamiaceae)	Nga khaw/ Naga Machala	Whole year	Lamiaceae	Herb/cultivated/ escapist	
31	*Physalis minima* L. (Solanaceae)	Pokmou	April to Aug.	Herb/ wild	Fruit	Raw/ cooked
32	*Pinanga gracilis* Bl. (Arecaceae)	Gerugatamul	September-October	Shrub/ wild	Fruit	Raw
33	*Piper mullesua* D. Don (Piperaceae)	Imphitlom thon/ Pipoli	Whole year	Climber/ wild	Spike	Raw / spice
34	*Portulaca oleracea* L. (Portulacaceae)	Yayinu/ Malbhug Khutara	Sept to June	herb/wild	Whole plant	Cooked as vegetable
35	*Rubus ellipticus* Sm. (Rosaceae)	Jetulipoka	February and April.	Climber/ wild	Fruit	Eaten ripe fruit
36	*Sarcochlamys pulcherrima* (Roxb.) Gaud.	Bon-tejpat, Mesaki	Whole year	Shrub/Wild	Leaves	Cooked
37	*Solanum aculeatissimum* Jacq. (Solanaceae)	Miyangkom/ Tita bekuri	May to sept	Herb/ wild	Fruit	Cooked
38	*Solanum myriacanthum* Dunal. (Solanaceae)	Kutahi-benegna	May to sept	Herb/ wild	Fruit	Cooked
39	*Solanum nigrum* Linn. (Solanaceae)	Hor/ Rambengena	March to Nov.	Herb/ wild	Fruit	Raw
40	*Stellaria media* (Linn.) Vill. (Caryophyllaceae)	Morolia sak	April to Oct.	Herb/ wild	Whole plant	Cooked
41	*Tetrastigma thomsonianum* Planch (Vitaceae)	Nol- tenga	Whole year	Climber/ wild	Tender shoot	Cooked as vegetable
42	*Xanthium strumarium* Linn Asteraceae	Agora	December-February	Herb/Wild	Tender plant	Cooked as vegetable
43	*Zanthoxyllum oxyphyllum* Edgew. (Rutaceae)	Mezenga	Whole year	Climber/ wild	Tender shoot	Cooked as vegetable
44	*Zizyphus oenoplia* L. (Rhamnaceae)	Mokho on Bogori	Nov- Dec	small tree/ wild/ cultivated	Ripe Fruit	Raw

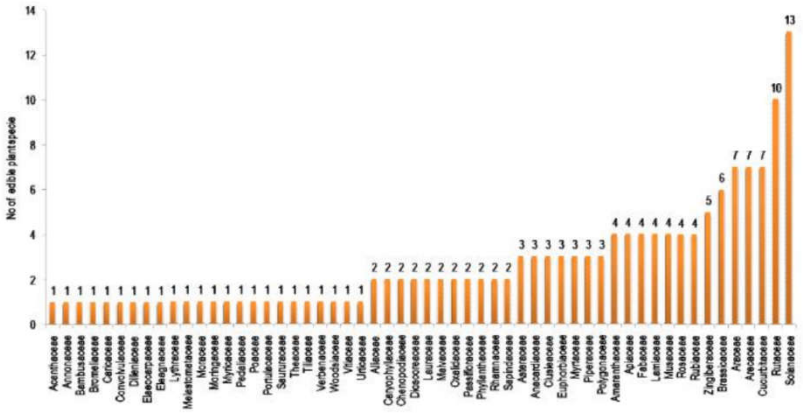

Fig.2 Number of edible plant species and their plant families

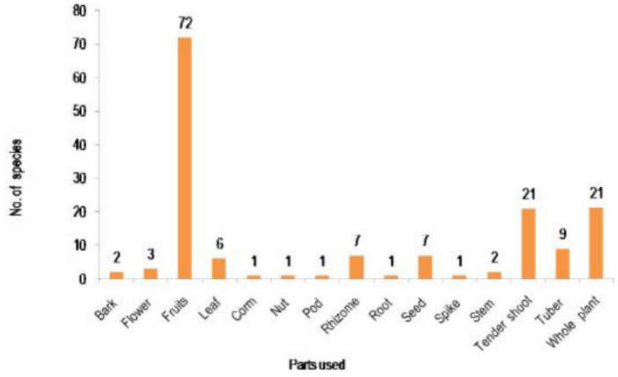

Fig.3 Number of different parts of edible plant species consumed by Khampti tribe

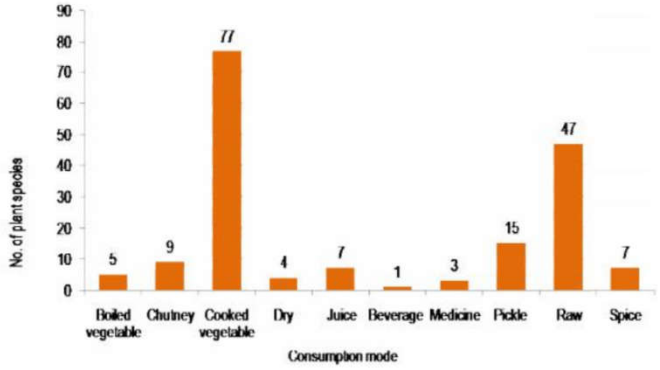

Fig.4 Different mode of consumption edible plant by Khampti tribe

Fig 5 A few edible plant species of homesteads of Khampti tribes, Namsai district Arunachal Pradesh (**A**) *Piper betel*; (**B**) *Melastoma malabathricum* ; (**C**) *Clerodendron colebrookianum*; (**D**) *Eryngium foetidum* ;(**E**) *Phlogachanthus thyrsiflorus*; (**F**) *Murraya koenigii* ; (**G**) *Amona squamosa*; (**H**) *Sarcochlamys pulcherrima* ; (**I**) *Eleagnus latifolia* ; (**J**) *Dillenia indica* ; (**K**) *Alocasia macrorrhizos* ; (**L**) *Sesbania grandiflora*; (**M**) *Manihot esculenta* ; (**N**) *Alternanthera aquatica* ; (**O**) *Homalonema aromatic*; (**P**) *Garcinia lanceifolia* ; (**Q**) *Pinanga gracilis*; (**R**) *Glycosmis pentaphylla*; (**S**) *Blumea lanceolaria*; (**T**) Bamboo shoots (Right), Cane shoots (Middle) *Dillenia indica* fruits (Left) sold in local market (**U**) Tender shoot of *Zanthoxyllum oxyphyllum* sold in local market.

Discussion

The Khampti homesteads were also multi-story plant composition herb, shrub and trees of agriculture, forestry and food production systems to mitigate social, cultural and economic requirements. They have been played as a key food source to manage malnutrition, hunger and livelihoods. Similar observations were also reported from Sri Lanka (Dilrukshi *et al*., 2013) and a few case studies from Ethiopia, Kenya, Tanzania and Uganda (Johnson-Welch, 2000). Although, more than a dozen of research literatures described the status of wild edible plants (WEP) used by the tribal communities in Arunachal Pradesh (Angami, *et al*., 2006; Gajurel and Doni, 2020; Haridasan *et al*., 1990; Namsa, *et al*., 2011) but none of them were found to emphasize the importance of homesteads/ home gardens as a safe shelter of many wild plant species as well as cultivated crops. The study could document 45 planted species which are domesticated by the Khampti tribes in their homesteads from the wild habitat by planting them with time as a source of food yielding plants. It was also found that most of them are planted for edible fruits and vegetables. In addition to these planted species the Khampti tribe has shown to conserve 60 cultivated plant species of which, majority were local varieties except a few commercial crops. Hazarika *et al* (2014) studied on homesteads of four communities of Assam and described as people choice biodiversity conservation sites of useful plants domestication from the wild with time and need. Indeed, homesteads of Khampti villages are playing a vital role conserving over a 44 numbers of wild edible plant species. As a whole homestead gardens of this tribe may be a potential landmass for household and community level food security and habitat for considerable number of edible plant species. The study also observed that the soil fertility management systems of Khampti homesteads were unique and managed through animal manure and organic residues, no chemical fertilizers and pesticides were reported to use so far. The study has given new interpretation about the importance of home gardens as community choice conservation of plant species and also no prior work on documentation has been carried out for edible plant species at community level in homesteads. Documentation of edible plant species of Khampti tribe could help for planning future research on biodiversity conservation in general and food security at community level. Authors are hopeful the work could contribute in future research planning for promotion of livelihood, adopt technology for production/ value addition skills depending upon demand and resource availability.

Conflict of interest: There is no room for conflict of interest among the authors.

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Phytosociological vis-a-vis Cultural implications of homestead plant species of Khampti tribe, Arunachal Pradesh

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Abstract

This study was conducted in 15 Khampti villages of Namsai district, Arunachal Pradesh during 2018-19. Objective of the study was to identify tree, shrub and herb species utilized by the Khampti people available in their homesteads for their livelihood. The quadrate method was followed to record tree and shrub species found in 225 homesteads of 15 Khampti villages. Shanon-Weiner Diversity Index, Margalef's index and Sorenson's Similarity Index were analysed for determining the biodiversity of the villages. A total of 105 tree species and 65 shrub and climber species were recorded from Khampti homesteads. The common species found all the Khampti villages were *Cocos nucifera* L., *Areca catechu* L., *Livistona jenkinsiana* Griff., *Sapindus mukorossi* Gaertn., *Albizia chinensis* (Osbeck) Merr., *Albizia lucidior* (Steud.) Nielson., *Bambusa tulda* Roxb., *Citrus limon* (L.) Osbeck. The study exposed that the tree species diversity was highest in Mankao village and lowest in Manmow village. The Species Diversity of shrubs was recorded as highest in Sulungtoo and lowest in Manmow village. On the other hand, the Species Richness for tree species was marked highest in Kherem village and lowest in Wengko village. While Species richness for shrub species was found highest in New Lathao village and lowest in Old Mohong village. The Khampties were rich in traditional knowledge for utilization of homestead plants and reflected in their strong cultural practices. This study produced preliminary data on the phytodiversity of the Khampti homesteads for future scientific activities and also attempted to find out cultural linkages with phytodiversity of the Khampti tribe.

Keywords: Phytodiversity, Khampti tribe, homesteads, livelihood

Introduction

The homesteads play an important role in socio-economic and cultural heritage of tribal community and could be a prototype of traditional agroforestry (Hazarika et al., 2021). It has immense influence on the daily life of tribal communities in remote places of the country. These homesteads are source of provide food, fodder, medicines, construction materials etc. for the family. A well-designed homestead rich in biodiversity also acts as a good source of income for the family. The layered canopy configurations and a mixture of compatible species are the most conspicuous characteristics of all home-gardens (Nair, 1993). Thus, homesteads are important land form of optimum utilisation of growing trees, shrubs and herb. Canopy structure of a homestead consist of a herbaceous layer at the lower level, a tree layer at the upper level and an intermediate layer of shrubs (Hazarika et al., 2021). Along with these plants homestead owner grows cash crops as intercrop for making the maximum profit. Homestead also provides almost all the possible household goods and services of daily consumption with sources vitamin A, vitamin C, iron, and calcium (Talukdar et al., 2000).

The Khampti people of Namsai district, Arunachal Pradesh are also known for their homestead farming. They were migrated from Myanmar since the 13th century and settled themselves in Namsai, presently in Arunachal Pradesh with homesteads surroundings their house called Chang Ghar (Geyi, 2021).Their homesteads are sizable and have a rich and diverse flora (Hazarika et al., 2021). The diversity of plant species in homestead was reported more in comparison to the other conventional agricultural practices. Homestead agroforestry is considered as an inexpensive exercise for maintaining the soil's fertility, as well as combating erosion and nutrient leaching (Ojo, 1966). Above all agroforestry helps to conserve biological diversity by providing other ecosystem services such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat (Jose 2009).

The people of Khampti tribe have an intense attachment with the nature. They have been dependent on nature for their basic needs of food, water and shelter. They have huge of knowledge on traditional medicines acquired with time and passed on generation after generation (Khatib et al., 2021.). Their food habit, lifestyle and cultural heritage are built with time based on the available plant species in their surroundings (Nimachow et al., 2008).

This study was primarily done to select the productive components in their homesteads which are directly link with the livelihood, culture and are suitable to include in the proposed agroforestry system trials. Apart from that it was also intended to know about the extent of biodiversity that has been traditionally conserved in Khampti homesteads of Namsai district, Arunachal Pradesh.

Materials and Methods

Study area

The study was conducted at 15 villages of Namsai district of Arunachal Pradesh and GPS locations of Khampti villages are presented in fig 1. The villages were Old Mohong, Pathar Gaon, Piyong, Lathao-1. New Lathao, Sulungtoo, Kherem, Marua camp, Mankao, New Mohong, Manphaiseng, Manmow, Wagon Pathar, Jenglai, Wengko. The district is newly formed in 2014 and lies between 95.45 to 96.20 E longitudes/ 27.30 to 27.55 N latitudes with a total geographical area about 1587 sq km. The political boundary of the district shares the boundary with Tinsukia district of Assam, towards the West & South West; in the South & South East it shares the boundary with Changlang district. Likewise towards the East it shares the boundary with Anjaw & Lohit and in the North with Lohit district of Arunachal Pradesh. The area has a tropical climate with an annual rainfall of about 3500-4000 mm and elevation of around 156 m from Mean Sea Level (MSL). The average temperature ranges between 28ºC – 40ºC in summer and 10 ºC- 25 ºC during winter.

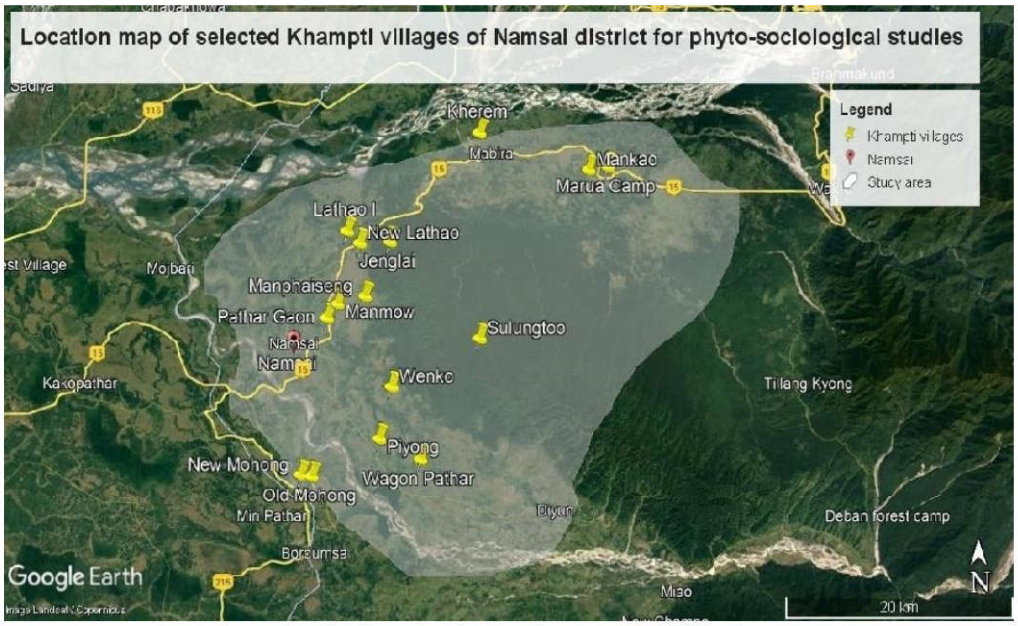

Fig 1. Location map of selected Khampti villages of Namsai district for phyto-sociological studies

Data collection

Multistage purposive randomized sampling technique was exercised to select the samples for the study to determine the biodiversity, socio-cultural relationship with the plant species present in homesteads of 15 Khampti villages distributed in 5 administrative Circles of the Namsai district of Arunachal Pradesh. The species recorded in the survey were classified as trees and shrubs. Prior permission was taken from the owners of the homesteads while conducting the survey. A total of 225 homesteads were surveyed to document plant species from 15 randomly selected homesteads of each of the 15 Khampti village. The data obtained by placing quadrates in each of the 15 villages. For tree species the size of the quadrate was 10 m × 10 m and for shrub species the size of the quadrate was 5 m × 5 m. Interviews were also done with the locals with the help of a questionnaire for documenting the use of different plant species in their cultural and traditional practices. Following equations were used for determining the biodiversity of the different homesteads.

The Shanon-Wiener Index: The species diversity within a community is determined by using the Shanon-Weiner Index. It represents the number of species occur in a habitat (richness) and their relative abundance (evenness).

$$H = - \Sigma pi \, (lnpi)$$

Where, pi = Proportion of individuals of each species,ln = Natural logarithm. H= The Shanon-Wiener Index (Rajasekaran, et al., 2017).

Species Evenness: Species evenness represents the relative abundance of the different species that constitute the richness of an area. The formula for calculating evenness (E) is given by Magurran (1988).

$$E = H/lnS$$

Where, E = Evenness of the species in an ecosystem, H = Shannon index, S = number of species (Agroforestry, Livelihood and Biodiversity Nexus: The Case of Madhupur Tract, Bangladesh (Islam et.al., 2022)

Species Richness: Species richness denotes the number of species present in a community. It is measured using Margalef Index equation.

Margalef Index **(Da) = S-1/lnN**

Where, S= Total no. of taxa N= No. of individual in all species (Rajasekaran, et al., 2017).

Importance Value Index (IVI): It is calculated with the help of Relative Frequency,

Relative Density and Relative Dominance of the different species found in the 15 quadrates of each Khampti village.

IVI = Relative frequency+ Relative dominance+ Relative density

Similarity Index: The similarity index of the homesteads plan species were calculated using Sorenson's Similarity Coefficient (Ss).

Ss=2a/ 2a+b+c

Where, a- No. of species common to all the habitats; b- No. of species occurring in Habitat b, c- No. of species occurring in Habitat c

Use Value (UV): The Use value was calculated first by finding out the Use Report (UR) of the desired species. The UR of a species or its importance in the culture of a community is determined by its rate of mentioning or its mention frequency by informants. The UR of the species of plants being utilized was calculated by using the formula (Dossou et al., 2012; Khatib et al., 2021)

UR=Ni/n

Where, Ni is the number of times a particular species was mentioned by the informents; n is the total number of times that all species were mentioned

The Use Value was calculated using the formula (Tabuti et al., 2003)

UV=ΣUri/N

Where URi is the total number of UR per plants and N is the total number of informants.

Measuring collar diameter of tree species in Old Mohong

Measuring collar diameter of a tree in Lathao Measuring collar diameter of a tree in Lathao

Fig 2. A few moments of measuring plant girth in different villages of Khampti homesteads, Namsai, Arunachal Pradesh while applying quadrate method.

Results

A total of 105 tree species belongs to 42 plant families along with local name, family and status of plant species recorded in 225 homesteads of 15 Khampti villages of Namsai district, Arunachal Pradesh were presented in table1. Of the tree species recorded from homesteads 2 species i.e. *Aquilaria malaccensis* and *Hydnocarpus kurzii* are critically endangered); *Livistona jenkinsiana* is endangered; 4 species i.e. *Aegle marmelos*, *Phyllantus acidus*, *Terminalia myriocarpa)* and *Saraca asoca* are *vulnerable. Another 7 tree species i.e. Averrhoa carambola*, *Azadirachta indica*, *Garcinia pendunculata*, *Litchi sinensis*, *Litsea glutinous*, *Litsea monopelata* and *Melia azedarach* are near threatened. The shrub and climber species also occupy a major share in species composition in Khampti homesteads with 68 species and were presented in table 2. *Garcinia lanciefolia* is an endangered shrub species found in Khampti homesteads. *Flemingia strobilifera* is a threatened species. Likewise, *Justicia gendarussa* is a vulnerable plant of Khampti homesteads and extinct in wild. The status of *Clerodendron colebrookianum* a traditional medicinal plant is vulnerable.

Lower canopy plant species were mostly cultivated herb species in different seasons of the year and presented in table 7.

Importance Value Index (IVI)

IVI of Tree species

Importance value index (IVI) of homesteads tree species in 15 Khampti villages of Namsai district, Arunachal Pradesh is presented in Table 3. Among the tree species the highest IVI was recorded in Old Mohong for *Mangifera indica*. (19.04) and *Litchi sinensis* (2.09) had the lowest IVI. In Pathar Gaon, *Dillenia indica* (15.35) had the highest IVI and *Zizyphus oenopila* (1.84) had the lowest IVI. In Piyong *Areca catechu* (13.60) had the highest IVI and *Nyctanthes arbor-tristis* (1.92) had the lowest IVI. In Lathao, *Aquilaria malaccensis* (16.77) had been calculated for the highest IVI and *Cascabella thevetia* (3.46) had the lowest IVI. In New Lathao, *Bambusa tulda* (17.97) had the highest IVI and *Cascabella thevetia* (2.65) had the lowest IVI. In Sulungtoo, *Bambusa tulda* (17.68) had the highest IVI and *Cascabella thevetia* (2.08) had the lowest IVI. In Kherem *Areca catechu* (18.63) had the highest IVI and *Cascabella thevetia* (1.93) had the lowest IVI. In Marua Camp, *Bambusa tulda* (21.34) had the highest IVI and *Cascabella thevetia* (1.78) had the lowest IVI. In Mankao *Oroxylum indicum* (26.42) had the highest IVI and *Plumeria obusta* (1.6) had the lowest IVI. In New Mohong, *Bambusa balcooa* (19.83) had the highest IVI and *Cascabella thevetia* (2.15) had the lowest IVI. In Manphaiseng, *Bambusa tulda* (16.56) occupied the highest IVI and *Musa acuminata* (2.34) had the lowest IVI. In Manmow, *Bambusa tulda* (23.98) had the highest IVI and *Garcinia pendunculata* (2.79) had shown the lowest IVI. In Wagon Pathar, *Bambusa tulda* showed the highest IVI (23.49) and *Mangifera sylvetica* L (2.49) had the lowest IVI. In Jenglai, the highest IVI was calculated for *Livistona jenkinsiana* (20.89) and *Cascabella thevetia* (2.43) had the lowest IVI. In Wengko village, IVI of *Dillenia indica* (22.16) calculated for the highest value and *Morus nigra* (2.55) had score of the lowest IVI.

Table 1. Tree species recorded in the 15 Khampti villages of Namsai district, Arunachal Pradesh [Local name: Khampti(K); Assamese (A)]

Sl No.	Tree Species	Local name	Family	Status
1.	*Aegle marmelos* (L.) Corrêa	Bel(A), Maklak (K)	Rutaceae	Vulnerable
2.	*Aesculus assamica* Griff.	Maham ling(K)	Sapindaceae	Endemic
3.	*Ailanthus integrifolia* Lam.	Borpat(A)	Simaroubaceae	Least concern
4.	*Albizia arunachalensis* Sahni et Naithani	Shaw(A)	Mimosaceae	Endemic
5.	*Albizia chinensis* (Osbeck) Merr.	Sagurenka(K)	Mimosaceae	Least concern
6.	*Albizia lebbeck* (L.) Benth.	Siris(A)	Mimosaceae	Least concern
7.	*Albizia lucidior* (Steud.) Nielson.	Moj(A)	Mimosaceae	Least concern
8.	*Alstonia scholaris* (L.) R.Br	Maitang(K)	Apocynaceae	Lower risk/conservation dependent
9.	*Aporosa octandra* (Roxb) Muell	Tasang(K)	Phyllanthaceae	
10.	*Aquilaria malaccensis* Lam.	Sasi/Tun namsasa(K)	Thymelaeaceae	Critically endangered/ endemic
11.	*Areca catechu* L.	Mak mow/Kha.Ton(K)	Arecaceae	Lower risk/conservation dependent
12.	*Artocarpus heterophyllus* Lam.	Tun-Malang (k)	Moraceae	Lower risk/conservation dependent
13.	*Artocarpus lacucha* Buch-Ham.	Haabang(K)	Phyllanthaceae	
14.	*Averrhoa carambola* L.	Me phung/ Kurangi(K)	Oxalidaceae	Near threatened
15.	*Azadirachta indica* A.Juss.	Mahaneem(K)	Meliaceae	Near threatened
16.	*Baccaurea motleyana* Müll.Arg.	Ma phai (K)	Phyllanthaceae	Lower risk/conservation dependent
17.	*Baccaurea ramiflora* Lour.	Ma phai(K)	Phyllanthaceae	Lower risk/conservation dependent
18.	*Balakata baccata* (Roxb.) Esser	Seleng (A)	Euphorbiaceae	Lower risk/conservation dependent
19.	*Bambusa balcooa* Roxb.	Mai sang nam (K)	Poaceae	Not Determined
20.	*Bambusa nutans* Munro.	Mai sang koi(K)	Poaceae	Not Determined
21.	*Bambusatulda* Roxb.	Mabang (K)	Poaceae	Not Determined
22.	*Bauhinia variegata* (L.) Benth.	Sekang(K)	Fabaceae	Least Concern
23.	*Bischofia javanica* Blume	Urium(A)	Phyllanthaceae	Lower risk/conservation dependent
24.	*Bombax ceiba* L.	Mai liu (K)	Bombacaceae	Least concern
25.	*Carallia brachiata* (Lour.) Merr.	Mahow on (K)	Rhizophoraceae	Least concern
26.	*Caryota urens* L.	Kunhang (K)	Arecaceae	Least concern
27.	*Cascabella thevetia* (L.) Lippold	Korobi (A)	Apocynaceae	Lower risk/conservation dependent
28.	*Cephalostachyum pallidum* Munro.	Khawlam banh (K)	Bambusaceae	Least concern

29.	*Chukrasia tabularis* A. Juss.	Poma (A)	Meliaceae	Lower risk/conservation dependent
30.	*Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm.	Tejpat (A)	Lauraceeae	Lower risk/conservation dependent
31.	*Cinnamomum zeylenicum* Br.	Dalcheni (A)	Lauraceae	Lower risk/conservation dependent
32.	*Citrus grandis* (L.) Osbeck	RobabTenga (A)	Rutaceae	Lower risk/conservation dependent
33.	*Cocos nucifera* L.	Maksaanphow(K)	Arecaceae	Lower risk/conservation dependent
34.	*Cordia dichotoma* G.Forst.	Mawphaman(K)	Boraginaceae	Lower risk/conservation dependent
35.	*Croton roxburghii* Bolar.	Hongkii (K)	Euphorbiaceae	Lower risk/conservation dependent
36.	*Delonix regia* (Boj. ex Hook.) Raf	Krishnachura(A)	Fabaceae	Lower risk/conservation dependent
37.	*Dendrocalamus giganteus* Munro	Boriyal Banh IA)	Poaceae	Lower risk/conservation dependent
38.	*Dillenia indica* L.	Tun-Makchang (K)	Dilleniaceae	Lower risk/conservation dependent
39.	*Diospyros kaki L.F*	Halwa tendu (H)	Ebenaceae	Lower risk/conservation dependent
40.	*Duabanga grandiflora* (Roxb. ex DC) Walpers	Khakon (A)	Lythraceae	Lower risk/conservation dependent
41.	*Elaeis guineensis* Jacq.	Plam oil (E)	Arecaceae	Lower risk/conservation dependent
42.	*Elaeocarpus floribundus* Blume.	Jalphai (A)	Elaecarpaceae	Lower risk/conservation dependent
43.	*Elaeocarpus serratus* L.	Rudraksha (A)	Elaecarpaceae	Lower risk/conservation dependent
44.	*Erythrina variegate* L.	Maga making(K)	Fabaceae	Lower risk/conservation dependent
45.	*Ficus auriculata* Lour.	Manau(K)	Moraceae	Lower risk/conservation dependent
46.	*Ficus hispida* L.f.	Mukanpong/ Mawa (K)	Moraceae	Lower risk/conservation dependent
47.	*Ficus religiosa* L.	Anhot (A)	Moraceae	Lower risk/conservation dependent
48.	*Garcinia cowa* Roxb.	Kujithekera (K)	Clusiaceae	Lower risk/conservation dependent
49.	*Garcinia pendunculata* Roxb. ex Buch. Ham	Mannang/ Mhahau(K)	Clusieaceae	Near threatened
50.	*Gmelina arborea* Roxb.	Gamari(A)	Verbenaceae	Lower risk/conservation dependent
51.	*Grewia disperma* L.	-	Malvaceae	Lower risk/conservation dependent
52.	*Gynocardia odorata* R.Br.	Makampo(K)	Flacourtiaceae	Vulnerable
53.	*Heteropanax fragrans* Roxb.	Keseru (A)	Meliaceae	Lower risk/conservation dependent
54.	*Hydnocarpus kurzii* (King) Warb	Makhapong (K)	Achariaceae	Critically endangered
55.	*Lagerstroemia speciosa* (L) Pers.	Safed ajar (K)	Lythraceae	Lower risk/conservation dependent
56.	*Lannea coromandelica* (Houtt.) Merr.	Jia (A)	Anacardiaceae	Lower risk/conservation dependent
57.	*Litchi sinensis* J. Gmelin	Lichu(K)	Sapindaceae	Near threatened

58.	*Litsea cubeba* (Lour). Pers.	Rukmeer (K)	Lauraceae	Lower risk/conservation dependent
59.	*Litsea cubeba* (Lour).C.B. Rob.	Baghnala(A)	Lauraceae	Near threatened
60.	*Litsea monopelata* Roxb.	Hoi phet(K)	Lauraceae	Near threatened
61.	*Livistona jenkinsiana* Griff.	Tong-ko(K)	Arecaceae	Endangered
62.	*Magnifera indica* L.	Momung (K)	Anacardiaceae	Lower risk/conservation dependent
63.	*Magnolia hodgsonii* (Hook.f. & Thomson) H. Keng	Borhmthuri (A)	Magnoliaceae	Lower risk/conservation dependent
64.	*Mallotus paniculatus* (Lam.) Mull.Arg.	Morolia (A)	Euphorbiaceae	Lower risk/conservation dependent
65.	*Mallotus tetracoccus* (Roxb.) Kurz.	Bormorolia (A)	Euphorbiaceae	Lower risk/conservation dependent
66.	*Melia azedarach* L.	Ghora neem (A)	Meliaceae	Near threatened
67.	*Melia composita* Willd.	Pahari neem(A)	Meliaceae	Lower risk/conservation dependent
68.	*Mesua ferrea* L.	Kamko (K)	Callophyllaceae	Lower risk/conservation dependent
69.	*Moringa oleifera* Lam.	Sajina (A)	Moringaceae	Lower risk/conservation dependent
70.	*Morus laevigata* (L.)	Bola(A)	Moraceae	Lower risk/conservation dependent
71.	*Morus nigra* L.	Nuni(A)	Moraceae	Lower risk/conservation dependent
72.	*Musa acuminata* Colla.	Koi(K)	Musaceae	Lower risk/conservation dependent
73.	*Musa cavendish* Lamb.	Jahanji(A)	Musaceae	Lower risk/conservation dependent
74.	*Musa paradisiaca* L.	Jahaji-kol (A)	Musaceae	Lower risk/conservation dependent
75.	*Myrica esculenta* Ham.	Nogatenga (A)	Myricaceae	Lower risk/conservation dependent
76.	*Neolemarkiacadamba*(Roxb.) Miq	Kadam (A)	Rubiaceae	Lower risk/conservation dependent
77.	*Nyctanthes arbor-tristis* L.	Kansuki (K)	Oleaceae	Lower risk/conservation dependent
78.	*Oroxylum indicum* (L.) Benth. Ex Kurz	Bhatgila (A)	Bignoniaceae	Lower risk/conservation dependent
79.	*Phoebe attenuate* Nees.	Bonsum(A)	Lauraceae	Lower risk/conservation dependent
80.	*Phoenix dactylifera* L.	Kejur(A)	Arecaceae	Rare
81.	*Phyllanthus embilica* L.	Amlokhi (A)	Phyllanthaceae	Lower risk/conservation dependent
82.	*Phyllantus acidus* (L.) Skeels.	Por Amlokhi (A)	Phyllanthaceae	Endangered/vulnerable
83.	*Plumeria obusta* L.	Gulonchi(A)	Apocynaceae	Lower risk/conservation dependent
84.	*Premna benghalensis* C.B.Clarke	Gohora(A)	Lamiaceae	Lower risk/conservation dependent
85.	*Prunica granatum* L.	Dalim (A)	Lythraceae	Lower risk/conservation dependent
86.	*Prunus persica* (L.) Batsch	Aam-toh (K)	Rosaceae	Lower risk/conservation dependent
87.	*Psidium guajava* L.	Mantaka (K)	Myrtaceae	Lower risk/conservation dependent

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88.	*Pyrus communis* L.	Naspoti(A)	Rosaceae	Lower risk/conservation dependent
89.	*Pyrus pyrifolia* (Burm.) Nak.	Naspoti (A)	Rosaceae	Lower risk/conservation dependent
90.	*Sapindus mukorossi* Gaertn.	Maksak (K)	Sapindaceae	Lower risk/conservation dependent
91.	*Saraca asoca* (Roxb.)Willd	Asoka(A)	Fabaceae	Endangered/vulnerable
92.	*Spondias pinnata* (L.f.) Kurz	Mokog (K)	Anacardiaceae	Critically endangered / vulnerable
93.	*Sterculia villosa* Roxb.	Iswarai (K)	Sterculiaceae	Lower risk/conservation dependent
94.	*Stereospermum chelenoides* DC.	Paroli (A)	Bignoniaceae	Lower risk/conservation dependent
95.	*Syzygium cumini* (L.) Skeels.	Jamun(A)	Myrtaceae	Lower risk/conservation dependent
96.	*Syzygium jambos* (L.) Alston	Golapi Jamun (A)	Myrtaceae	Lower risk/conservation dependent
97.	*Talauma hodgsonii* Hk. f. & Thomson	Borhumthuri (A)	Magnoliaceae	Lower risk/conservation dependent
98.	*Tamarindus indica* L.	Mekeng(K)	Fabaceae	Lower risk/conservation dependent
99.	*Tectona grandis* Linn.	Segun (A)	Verbenaceae	Introduced
100.	*Terminalia arjuna* Roxb.	Arjun gose (A)	Combretaceae	Lower risk/conservation dependent
101.	*Terminalia chebula* Retz.	Manaa (K)	Combretaceae	Lower risk/conservation dependent
102.	*Terminalia myriocarpa* Heurck and Mull. Arg.	Holokh (A)	Combretaceae	Vulnerable
103.	*Vitex peduncularis f.* Roxb.(C.B. Clarke) Molden	Osai (A)	Verbenaceae	Lower risk/conservation dependent
104.	*Zizyphus mauritiana* Lam.	Mokho (K)	Rhamnaceae	Lower risk/conservation dependent
105.	*Zizyphus oenopila* (L) Mill	Bogori (A)	Rhamnaceae	Lower risk/conservation dependent

Table 2. Shrub and climber species recorded in the 15 Khampti villages of Namsai district, Arunachal Pradesh

Sl No	Species Name	Khampti name	Local name	Family	Status
1.	*Acacia fernasiana* L.	Korom neng	Tarua kadam	Fabaceae	Lower risk/conservation dependent
2.	*Alangium chinense* (Lour.) Harms.	Thuru-rah	Sikamorolia	Alangiaceae	Least concern
3.	*Allamanda cathartica* L.	Yakunglota	Korobiphul	Apocynaceae	Least concern
4.	*Adhatoda zeylanica* Medic.	Bogabahak	Bogabahak	Acanthaceae	Lower risk
5.	*Bougainvillea glabra* Choisy	Bougainvillia	Bougainvillia	Nyctanginaceae	Conservation dependent
6.	*Bougainvillea spectabilis* L.	Bougainvillia	Bougainvillia	Nyctanginaceae	Least concern
7.	*Buddleja asiatica* Lour.	Bana	Pisola	Scrophulariaceae	Least concern
8.	*Caesalpinia bonduc* (L) Roxb.	Leta guti	Leta guti	Fabaceae	Least concern
9.	*Citrus maxima* (Burm) Meer	Mak lung	Bortenga	Rutaceae	Lower risk
10.	*Calamus tenuis* Roxb.	Munn Khum	Jati bet	Arecaceae	Least concern
11.	*Calotropis procera* Br.	Akon-Asing	Akon	Apocynaceae	Least concern
12.	*Camellia sinensis* (L.) Kuntze	Toon neng	Sah	Theaceae	Least concern
13.	*Citrus limon* (L.) Osbeck	Tun ma lue	Pati nemu	Rutaceae	Lower risk
14.	*Citrus medica* L	Maksaneng	RobabTenga	Rutaceae	Lest concern
15.	*Citrus reticulata* Blanco	Makmighi	Komolatenga	Rutaceae	Lower risk
16.	*Citrus x sinensis* (L.) Osbeck	Mingi	Komolatenga	Rutaceae	Lower risk/
17.	*Citrus limetta* Risso	Mousami	Mousami	Rutaceae	Lower risk
18.	*Clerodendron colebrookianum* Walp	Patakkhai	Nefafu	Verbenaceae	Vulnerable
19.	*Clerodendrum grandulosum* (L.)				Lower risk
20.	*Clerodendrum indicum* (L.)Kuntze	Patuiya	Akal bih	Verbenaceae	Lower risk
21.	*Clerodendrum infortunatum* L.	-	Dhapattita	Verbenaceae	Lower risk
22.	*Clerodendrum thomsoniae* Balf.f.	-		Lamiaceae	Lower risk
23.	*Codiaeum variegatum* (L.) Rumph. ex A.Juss.	-	Pat bahar	Euphorbiaceae	Conservation dependent
24.	*Croton tiglium* L.	Saklang	Konibih	Euphorbiaceae	Lower risk
25.	*Datura innoxia* Mill.	Pukumii	Datura	Solanaceae	conservation dependent

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26.	*Derris elliptica* (Wall.) Benth.	-	Etamchali	Fabaceae	conservation dependent
27.	*Dracena fragrans* (L.) Ker Gawl.	-		Asparagaceae	conservation dependent
28.	*Duranta repens* Linn.		Duranta	Verbenaceae	Introduced
29.	*Euphorbia cotinifolia* L		Red Spurge	Euphorbiaceae	conservation dependent
30.	*Euphorbia pulcherrima* Willd. ex Klotzsch.	Sepak	Poinsettia,	Euphorbiaceae	conservation dependent
31.	*Flemingia strobilifera* (L.) W.T.Aiton		Makhioti	Fabaceae	Near threatened
32.	*Garcinia lanciefolia* Roxb.		RupohiThekera	Clusieaceae	Endangered
33.	*Gardenia jasminoides* J.Ellis		Tagarphul	Apocynaceae	Near Threatened
34.	*Gaultheria fragrantissima*Wall.	Shegshing mrep	Gandapura	Ericaceae	conservation dependent
35.	*Glyscosmispentaphylla*(Retz.) DC	Chauldhuwa	Hengenapoka	Rutaceae	Lower risk
36.	*Grewia asiatica* L.		Kukurhuta	Tiliaceae	conservation dependent
37.	*Hibiscus rosa-chinensis* L.	Nognangtibi	Joba	Malvaceae	Lower risk/conservation dependent
38.	*Hibiscus syriacus* L.	Nongnangtibe		Malvaceae	conservation dependent
39.	*Holmskioldia sanguina* Retz.		GhantiPhul	Verbenaceae	Lower risk/conservation dependent
40.	*Ixora chinensis* Lam.		Ixora	Rubiaceae	conservation dependent
41.	*Justicia gendarussa* Burm.f.		Jatrasidhi	Acanthaceae	Extinct in wild/ Vulnerable
42.	*Lawsonia inermis* L.		Jetuka	Lythraceae	conservation dependent
43.	*Manihot esculenta* Crantz	Shingjoktang	Simolu Alu	Euphorbiaceae	conservation dependent
44.	*Melastoma malabathricum* L.	Mohapatta	Phutuka	Melastomataceae	Lower risk/conservation dependent
45.	*Murraya koenigii* (L.) Sprenge	Hom	Narasingha	Rutaceae	Lower risk
46.	*Murraya paniculata* (L.) Jack	Mutangkaril	Kamini	Rutaceae	Lower risk
47.	*Nerium indicum* Mill.	Neram	Korabi	Apocynaceae	
48.	*Nerium oleander* L.	Roktokorobi	Rongakorobi	Apocyanaceae	Lower risk
49.	*Passiflora quadrangularis* L.				conservation dependent
50.	*Phlogachanthus thyrsiflorus* Nees.	Mochomkhum	Titaphul	Rubiaceae	Endemic
51.	*Phlogachanthus tubiflorus* Nees.	Mochomkhum	Titaphul	Rubiaceae	Endemic

52.	*Phlogachanthus thyrsiformis* (Roxb.) Nees.	Mochomkhum	Titaphul	Rubiaceae	Endemic
53.	*Picrasma javanica* Bl	Tita sasi	Bonposola	Simaroubaceae	Not determined
54.	*Piper betle* L.	Pan	Pan	Piperaceae	Conservation dependent
55.	*Prunica granatum* L.	Dalim	Dalim	Lythraceae	Conservation dependent
56.	*Pyrus communis* L.	Glung	Nas poti	Rosaceae	Conservation dependent
57.	*Quisqualis indica* L.	Suangjaik	Malati	Combretaceae	Conservation dependent
58.	*Ricinus communis* L.	Ton kong	era	Euphorbiaceae	Near Threatened
59.	*Rosa chinensis* L.	kathgulap	RongaGolap	Rosaceae	Not determined
60.	*Rosa indica* L.		Boga Golap	Rosaceae	Not determined
61.	*Sarcochlamys pulcherrima* Gaudich.	Mesaki	Mesaki	Urticaceae	Not determined
62.	*Sesbania grandiflora* (L.) Poir.	Bog	Bog phul	Fabaceae	Not determined
63.	*Tabernaemontana divaricata* L.	Mok-ya-khow	Kathanaphul	Apocynaceae	Lower risk
64.	*Trevesia palmate* (Roxb. ex Lindl.) Vis.	Katta pul	Karabi	Araliaceae	Conservation dependent
65.	*Zanthoxylum acanthopodium* DC.	Mekat	Masala pat	Rutaceae	Near Threatened

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Table 3. Importance value index of homesteads tree species in 15 Khampti villages of Namsai district, Arunachal Pradesh, India

Tree species in homesteads	Old Mohong	Pathargaon	Piyong	Lathao-1	New Lathao	Sulungtoo	Kherem	Marua camp	Mankao	New Mohong	Manphaiseng	Manmow	Wagon pathar	Jenglai	Wengko
Aegle marmelos (L.) Corrêa	0	4.48	0	0	0	0	0	0	0	0	0	0	0	0	6.79
Aesculus assamica Griff.	2.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ailanthus integrifolia Lam.	0	0	7.83	0	0	0	0	0	0	0	0	0	0	0	0
Alangium chinense (Lour.) Harms.	0	0	0	0	0	0	0	0	0	4.64	0	0	0	0	0
Albizia arunchalensis Sahni & H.B.Naithani	0	0	0	0	0	0	0	0	0	0	15.32	0	0	0	7.32
Albizia chinensis (Osbeck) Merr.	10.09	0	0	0	0	0	0	0	0	0	7.38	0	6.45	0	0
Albizia lebbeck (L.) Benth.	4.88	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albizia lucidior (Steud.) Nielson.	16.69	8.23	3.34	5.46	5.06	8.29	10.78	7.88	3.32	12.89	12.2	5.77	18.9	9.52	0
Alstonia scholaris (L.) R.Br	12.08	0	7.32	0	5.32	8.58	8.11	0	3.68	0	0	0	0	10.8 3	0
Annona squamosa L.	0	6.2	0	0	0	0	0	0	0	0	0	0	0	0	0
Aporosa octandra (Roxb) Muell	4.42	0	0	0	0	0	0	0	0	2.46	0	0	0	0	0
Aquilaria malaccensis	0	0	5.79	16.77	8.31	6.89	11.2	2.43	3.1	3.72	0	10.6 5	0	4.11	0
Areca catechu L.	15.43	13.85	13.6	14.51	10.7	13.42	18.63	11.38	11.19	16.03	12.38	18.3 1	14.3 9	19.7 5	20.7 1
Artocarpus heterophyllus Lam.	9.67	12.33	9.8	9.32	8.22	9.94	6.03	5.73	7.92	10.78	9.9	13.4 9	10.0 6	12.2 2	15.7 6
Artocarpus lacucha Buch-Ham.	0	0	0	0	0	0	0	0	0	6.81	0	14.3 6	0	0	0
Averrhoa carambola L.	2.77	0	0	0	0	0	2.64	2.48	1.91	2.86	0	0	8.24	0	0
Azadirachta indica A..Juss.	14.47	8.46	5.82	8.29	4.49	7.26	7.03	9.63	11.44	12.49	7.32	0	0	8.45	0
Baccaurea motleyana Müll.Arg.	1.77	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccaurea ramiflora Lour.	0	5.46	0	0	0	0	5.19	5.19	6.27	0	0	0	0	0	0
Balakata baccata (Roxb.) Esser	0	0	6.87	0	0	0	0	0	0	0	0	0	0	0	0
Bambusa balcooa Roxb.	0	12.14	0	0	0	0	0	0	0	19.83	0	0	0	0	0
Bambusa nutans Munro.	0	0	0	0	5.43	9.26	6.74	15	5.48	0	0	0	0	8.93	0

Bambusa tulda Roxb.	11.4	9.3	8.82	15.99	17.97	17.68	16.29	21.34	23.3	10.19	16.56	23.98	23.49	9.4	18.1
Bambusa vulgaris	0	0	7.72	0	0	0	0	0	0	0	0	0	0	0	0
Bauhinia variegata (L.) Benth.	0	0	0	7.21	8.23	2.64	5.4	3.86	8.27	0	0	3.45	0	2.95	0
Bischofia javanica Blume	2.63	6.13	8.62	0	0	3.38	8.37	8.9	8.32	3.21	3.52	7.95	0	0	0
Bombax ceiba L.	3.32	6.81	3.71	12.09	5.31	8.06	3.84	3.86	10.32	2.54		11.46	16.15	5.69	10.17
Carallia brachiata (Lour.) Merr.	0	0	0	10.83	0	0	0	0	0	0	0	0	0	0	0
*Carica papaya*L.	11.05	6.17	4.53	7.52	3.38	11.75	4.96	11.06	7.55	0	10.16	6.06	11.51	8.77	0
Caryota urens L.	0	0	2.32	3.84	3.3	2.64	2.39	9.11	6.09	0	5.2		9.07	9.33	0
Cascabella thevetia (L.) Lippold	1.7	4.53	3.71	3.46	2.65	2.08	1.93	1.78	2.97	2.15	0	0	0	2.43	0
Cedrus deodara	0	0	2.39	0	0	0	5.28	0	3.66	0	0	0	0	0	0
Chukrasia tabularis A. Juss.	0	0	0	0	10.27	0	0	0	0	0	0	0	0	0	0
Cinnamomum tamala (Buch.-Ham.) T.Nees & C.H.Eberm.	3.38	0	5.32	0	10.28	3.05	0	0	0	0	9.28	0	0	0	0
Cinnamomum zeylenicum Br.	0	0	0	0	2.91	0	0	0	0	0	0	0	0	0	0
Citrus grandis (L.) Osbeck	9.84	5.14	4.97	8.27	3.66	4.55	2.65	4.99	6.84	0	0	0	0	6.86	0
Cocos nucifera L.	13.15	12.63	12.21	11.53	11.9	9.37	10.59	8.65	5.11	9.83	8.99	19.91	14.11	10.43	11.38
Cordia dichotoma G.Forst.	0	0	0	0	0	0	6.36		0	0	0	0	0	0	0
Croton roxburghii Bolar.	0	0	0	0	0	0	4.3	3.61	0	0	0	0	0	0	0
Dalbergia sissoo Roxb.	0	0	0	0	0	0	0	3.61	3.22	0	5.99	16.55	8.72	0	0
Delonix regia (Boj. ex Hook.) Raf	2.38	2.01	4.28	0	0	0	3.85	5.6		0	0	0	0	0	0
Dendrocalamus giganteus Munro	0	0	0	0	0	0	0	16.79		0	0	0	0	0	0
Dillenia indica L.	0	15.35	3.75	10.76	11.15	4.63	4.17	6.38	3.75		8.38	11	6.44	11.27	22.16
Diospyros kaki L. F	0	0	0	0	0	0	0	5.03	0	0	0	0	0	0	0
Duabanga grandiflora (Roxb. ex DC) Walpers	4.58	0	0	11.64	10.57	4.54	4.3	5.18	7.83	0	0	4.12	0	5.13	0
Elaeis guineensis Jacq.	0	0	0	3.48	2.81	7.15	4.05	1.86	3.2	2.88	0	0	7.27	5.18	0
Elaeocarpus floribundus Blume.	2.56	0	5.53	0	0	0	0	0	2.93	7.02	0	0	0	0	0
Elaeocarpus serratus L.	0	4.79	0	4.87	9.23	7.6	5.14	4.53	0	0	0	0	0	6.62	6.7
Erythrina variegata L.	2.55	5.24	2.72	12.22	4.23	3.24	6.12	5.6	5.26	7.12	6.66	14.5	0	8.22	7.99

Eucalyptus globulus Labill.	0	0	0	0	0	0	0	0	0	0	6.24	4	0	0	0
Ficus auriculata Lour.	0	0	0	0	0	2.44	0	0	0	0	0	0	0	0	0
Ficus hispidaL.f.	0	5.99	0	0	0	3.36	3.27	0	10.94	10.79	6.65	0	0	0	0
Ficus religiosa L.	9.31	0	0	0	0	0	0	0	0	6.81	0	0	0	0	0
Garcinia cowa Roxb.	0	0	6.52	0	0	0	0	0	0	0	0	0	0	0	0
Garcinia pendunculata Roxb. ex Buch. Ham	0	3.18	0	0	0	0	0	0	0	0	0	2.8	0	0	0
Gmelina arborea Roxb.	0	0	9.14	0	0	0	0	0	0	0	4.66	5.64	0	0	0
Grewia disperma L.	4.42	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gynocardia odorata R.Br.	0	0	0	0	0	0	0	0	5.6	0	0	0	0	0	0
Heteropanax fragrans Roxb.	0	0	0	0	0	0	0	0	0	0	0	5.86	0	0	0
Hydnocarpas kurzii (King) Warb	0	0	0	0	0	0	0	0	0	5.79	0	0	0	0	0
Lagestroemia speciosa (L.) Pers.	11.39	7.7	6.1	9.63	8.54	5.78	5.54	8.67	8.29	12.43	12.75	0	13.21	0	0
Lannea coromandelica (Houtt.) Merr.	7.59	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Litchi sinensis J. Gmelin	2.09	4.59	2.33	3.89	3.54	6.4	5	9.68	4.26	0	5.28	0	0	3.1	0
Litsea cubeba (Lour). Pers.	0	0	0	0	0	0	0	0	0	0	6.52	0	0	0	0
Litsea gluctinosa (Lour). C.B. Rob	0	5.69	2.66	0	0	0	0	5.78	5.37	0	2.98	0	9.09	0	0
Litsea monopelata Roxb.	0	0	0	0	0	0	0	0	0	0	0	0	8.97	0	0
Livistona jenkinsiana Griff.	13.16	9.56	11.31	14.89	13.18	11.81	13.95	8.32	8.22	11.62	11.75	20.49	9.2	20.89	13.74
Magnolia hodgsonii (Hook.f. & Thomson) H.Keng	0	0	8.28	0	0	0	0	0	0	0	0	0	0	0	0
Mallotus paniculatus (Lam.) Mull.Arg.	0	0	3.56	0	0	0	2.31	3.51	3.42	0	0	0	7.05	0	0
Mallotus tetracoccus (Roxb.), Kurz.	8.28	7.83	0	0	0	0	0		0	0	0	8.91	0	0	0
Mangifera indica L.	19.04	11.37	12.26	14.52	15.02	11.25	7.88	10.17	9.53	7.15	12.11	15.91		18.59	20.29
Mangifera sylvetica L	0	0	0	0	0	0	0	0	0	0	4.54	0	0	0	0
Melia azedirach L.	9.14	3.62	0	0	0	0	0	0	2.01	2.84	4.36	8.88	2.49	0	0
Melia composita Willd.	0	0	8.87	0	0	0	0	0	0	0	6.15	0	5.22	0	0
Mesua ferrea L.	0	6.1	4.1	8.24	5.99	7.6	7.23	4.65	0	6.34	0	0	0	10.68	7.28

Mimusops elengi L.	0	0	5.77	0	0	0	0	0	0	0	0	6.47	0	0	0
Moringa oleifera Lam.	2.23	0	0	0	0	4.79	4.3	0	0	0	0	0	0	0	0
Morus laevigata (L.)	3.64	0	9.14	0	0	0	0	0	0	0	0	0	0	0	0
Morus nigra L.	0	0	0	0	0	0	0	0	0	3.27	0	0	0	0	2.55
Musa acuminata Colla.	0	0	0	0	0	0	0	0	0	0	2.34	0	0	0	0
Musa balbisiana Colla.	8.24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0										13.7	0
Musa cavendish Lamb.	6.06				6.42	6.5	7.33	6.57	5.07	6.17		13.1	6.54	7	
Musa paradisiaca L.	0	0	0	0	0	0	0	0	0	0	5.87	0	0	0	0
Myrica esculenta Ham.	0	0	0	0	0	0	0	0	0	2.62	0	0	0	0	0
Neolamarckia cadamba (Roxb.)	0		0	0	0	0	0	0	0			0		0	
Bosser		3.19								4.59	5.52		0		5.87
Nyctanthes arbor-tristis L.	0	1.87	1.92	0	0	2.47	3.94	0	3.07	4.65	0	0	0	0	0
Oroxylum indicum (L.) Benth. Ex		0	0							0	0	0	0		0
Kurz	2.12			11.63	8.91	5.58	2.64	6.21	26.42					3.35	
Phoebe attenuata Nees.	0	0	0	0	0	0	0	0	0	10.54	0	0	0	0	0
Phoenix dactylifera L.	0	3.19	5.61	0	0	0	0	0	0	0	0	0	0	0	0
								0	0			0	10.3		
Phyllanthus embilica L.	0	6.97	4.73	7.93	3.62	10.2	2.7			3.89	8.21		1	7.4	9.94
Phyllantus acidus (L.) Skeels.	2.76	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plumeria obusta L.	0	0	0	0	0	0	2.06	0	1.6	0	0	0	0	0	0
Polyalthia longifolia (Sonn.)	0	0	0	0	0	0	0	0	0	0		0		0	0
Thwaites											6.15		8.32		
		0		0	0	0	0	0	0	0	0	0	9.21	0	11.9
*Premna benghalensis*C.B.Clarke	4.45		3.34												2
Premna latifolia Roxb.	0	0	0	0	0	0	0	0	0	0	4.56	0	0	0	0
Prunus domestica L.	0	2.99	0	0	0	5.51	4.13	4.08	2.46	0	0	0	0	3.25	7.11
Prunus persica(L.) Batsch	2.43	0	2.81	6.38	10.29	3.26	6.18	2.66	4.92	0	0	0	0	7.11	0
												10.1	0		
Psidium guajava L.	5.2	6.57	4.72	4.83	9.07	6.28	4.64	4.94	5.56	8.72	10.76	7		9.49	9.96
			0	0	0	0			0				0	0	14.2
Pyrus pyrifolia (Burm.) Nak.	7.33	4.61					6.59	1.82		4.57	0	7.8			2
Sapindus mukorossi Gaertn.	2.31	3.38	5.93	9.24	7.41	10.17	4.24		4.5	0	8.52	0	0	3.52	0
Saraca asoca (Roxb.) Willd	0	0	0	0	0	0	2.24	2.88	0	0	0	0	6.28	0	0

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Spondias pinnata (L.f.) Kurz	0	6.63	0	0	0	0	0	0	0	0	0	2.99	0	0	4.71
Sterculia villosa Roxb	0	9.54	8.12		3.82	3.18	2.86	5.26	4.43	4.51	9.75	0	0	3.24	0
	0										0	0	19.8		0
Stereospermum chelenoides DC.		5.47	8.64	7.88	6.59	5.1	8.31	5.29		11.94			9	6.44	
Syzygium cumini (L.) Skeels.	0	6.6	6.81	0	0	0	0	0	0	3.88	0	0	11.8	0	0
	0	0	0								0	0	0	10.0	0
Syzygium jambos (L.) Alston				7.64	6.84	2.79		2.39	5.63					8	
Talauma hodgsonii Hk. f. &	0	0	0	0	0	0	0	0	0		0	0	0	0	12.2
Thomson										2.65					1
Tamarindus indica L.	0	0	0	0	0	0	0	0	0		3.21	0	9.31	0	0
Tectona grandis Linn.	0	3.38	0		0	0	0	0	0	2.84	0	2.36	0	0	0
	0		0	0			0	0	0		0	0		0	17.6
Terminalia arjuna Roxb.		10.73			5.38	4.33				9.81			5.39		9
Terminalia chebula Retz.	0	2.86	8.94	5.78	14.43	6.42	3.4	4.37	5.8	6.28	4.85	0	0	9	4.56
Terminalia myriocarpa Heurck and	0			0	0					0	0			0	0
Mull. Arg.		5.3	7.42			10.29	4.15	5.37	3.97			3.96	0		
	0	0	0	0	0	0	0	0	0	0		0	0	0	17.9
Trema orientalis (L.) Blume											4.48				8
Vitex peduncularis f. Roxb.(C.B.	0	0	0		0	0	0	0	0		0	0	0	0	
Clarke) Molden				4.88						3.43					12.8
Zizyphus mauritiana Lam.	0	0	0	0	0	5.23	0	0	0	0	0	0	0	0	0
Zizyphus oenopila (L) Mill	5.6	1.84	0	4.58	5.57	3.26	5.12	5.92	6	4.42	4.48		4.61	4	0
Pyrus pyriflora (Burm.) Nak.	0	0	0	0	0	0	3.65	0	0	0	0	3.06	0	0	0

Table 4. Importance value index of homesteads Shrub and woody climber species in 15 Khampti villages of Namsai district, Arunachal Pradesh, India

Shrub species in homesteads	Old Mohong	Pathargaon	Piyong	Lathao-1	New Lathao	Sulungtoo	Kherem	Marua camp	Mankao	New Mohong	Manphaiseng	Manmow	Wagon pathar	Jenglai	Wengko
Acacia fernasiana L.	27.61	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adhatoda zeylanica Medic.	0	15.03	0	0	0	0	0	0	0	0	0	0	0	0	0
Alangium chinense (Lour.) Harms.	0	0	0	0	0	0	0	0	0	0	0	0	30.29	0	0
Allamanda cathartica L.	0	16.84	0	0	0	0	0	0	0	0	0	0	0	0	0
Bougainvillea glabra Choisy	0	0	32.99	0	0	0	0	0	0	0	0	0	0	0	0
Bougainvillea spectabilis L.	0	31.31		26.84	8.16	10.36	12.15	0	0	0	0	0	0	9.54	0
Buddleja asiatica Lour.	0	0	9.37	0	0	0	0	0	0	0	0	0	0	0	0
Caesalpinia bonduc (L) Roxb.	0	0	34.78	0	0	0	0	0	0	0	0	0	0	0	0
Calamus tenuis Roxb.	0	16.43	0	0	0	8.07	10.09	0	0	0	0	0	0	0	22.87
Calotropis procera Br.	0	0	0	79.66	0	0	0	0	0	0	0	0	0	0	0
Camellia sinensis (L.) Kuntze	8.3	11.01	21.35	0	11.84	25.46	29.47	0	13.37	0	35.95	0	0	43.4	0
Citrus limetta Risso	0	0	16.49	0	0	0	0	0	0	0	0	0	0	0	0
Citrus limon (L.) Osbeck	42.12	39.16	32	23.23	23.27	25.98	19.69	50.04	31.32	36.8		80.78	13.18	24.3	71.12
Citrus maxima (Burm) Meer	0	0	0	0	0	0	0	0	0	66.85	43.5	0	31.61	0	10.75
Citrus medica L	0	0	0	0	0	0	0	0	0	43.98	0	0	41.9	0	0
Citrus reticulata Blanco	0	0	0	0	11.09	0	0	0	0	0	0	0	0	0	0
Citrus x sinensis (L.) Osbeck	24.91	44.9	23.1	27.83	16.55	19.12	10.98	55.13	50.18	0	0	97.13	0	53.39	0
Clerodendron colebrookianum Walp .	30.75	0	0	0	18	0	0	0	32.33	0	0	0	0	0	0
Clerodendrum grandulosum (L.)	0	37.35	0	0	0	0	0	0	0	0	38.46	0	0	0	0
Clerodendrum indicum (L.) Kuntze	0	0	0	0	31.23	0	0	0	0	0	0	0	0	0	0
Clerodendrum infortunatum L.	0	0	0	0	16.68	0	0	0	0	0	0	0	0	0	0
Clerodendrum thomsoniae Balf.f.	0	0	0	0	0	0	0	0	0	0	0	11.94	0	0	0

Clerodendrum viscosum Vent.	15.31	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Codiaeum variegatum (L.) Rumph. ex A.Juss.	24.55	12.24	14.13	33.96	8.71	15.71	18.13	33.71	20.97	12.3	0	0	22.12	23.26	0
Croton tiglium L.	0	0	0	0	0	0	25.43	0	0	0	0	0	0	0	0
Derris elliptica (Wall.)Benth.	40.92	15.34	0	0	0	0	0	0	0	0	0	0	0	0	0
Dracena fragrans (L.) Ker Gawl.	0	0	0	0	0	0	0	59.28	0	0	0	0	0	0	0
Duranta repens Linn.	0	0	0	0	0	0	0	47.48	0	0	0	0	0	0	0
Euphorbia pulcherrima Willd. ex Klotzsch.	0	0	0	0	0	26.68	0	0	0	0	0	0	0	0	9.97
Euphorbia cotinifolia L	0	0	12.38	0	0	28.94	0	0	0	0	0	0	0	0	0
Flemingia strobilifera (L.) W.T.Aiton	0	0	0	0	0	6.83	0	0	0	0	0	0	0	0	0
Garcinia lanciefolia Roxb.	0	0	0	0	10.05	0	0	0	0	0	0	13.2	0	0	0
Gardenia jasminoides J. Ellis	21.73	0	0	22.82	19.84	9.3	23.89	23.31	40.53	24.32	0	0	0	8.69	0
Gaultheria fragrantissima Wall.	0	0	0	0	0	7.01	0	0	0	0	0	0	0	0	0
Glyscosmis pentaphylla (Retz.) DC	0	0	0	0	0	0	0	0	10.28	0	0	0	0	0	0
Grewia asiatica L.	0	0	0	0	0	0	0	0	0	0	0	0	7.24	0	0
Hibiscus rosa-chinensis L.	12.41	39.07	0	0	24.36	33.86	18.01	12.38	40.21	0	40.21	0	22.39	17.99	66.62
Hibiscus syriacus L.	0	0	0	0	0	0	0	0	8.48	0	0	0	0	0	0
Holmskioldia sanguinea Retz.	0	0	0	0	0	0	0	0	0	23.93	0	0	0	0	0
Ixora chinensis Lam.	0	0	0	0	0	0	0	0	0	24.09	0	0	0	0	0
Justicia gendarussa Burm.f.	0	0	11.4	0	0	0	0	0	0	24.15	0	0	0	0	0
Lawsonia inermis L.	0	0	0	0	9.26	17.65	27.91	0	0	0	0	0	0	17.02	0
Manihot esculenta Crantz.	0	0	0	0	0	0	0	0	0	0	32.19	0	0	0	0
Melastoma malabathricum L.	0	0	0	0	0	0	0	0	0	0	14.11	0	0	0	0
Muehlenbeckia platyclada (F.Muell.) Meisn.	0	0	0	8.93	0	0	0	0	0	0	26.34	0	0	0	0
Murraya koenigii (L.) Sprenge	9.44	10.26	42.65	0	19.74	12.39	69.38	0	0	0	0	0	0	11.14	0
Murraya paniculata (L.) Jack	0	0	0	0	0	0	0	0	0	0	0	37.2	0	0	0
Nerium indicum Mill.	0	0	0	0	0	0	0	0	0	0	13.88	0	0	0	0
Nerium oleander L.	0	0	0	12.67	0	0	0	0	16.89	0	0	0	0	0	0
Passiflora quadrangularis. L.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32.28

Phlogacanthus thyrsiflorus Nees.	9.35	11.34	11.49	21.25	19.68	6.96	19.43	9.98	0	14.26	0	42.36	0	18.1	24.22
Phlogacanthus tubiflorus Nees	0	0	0	0	0	0	0	0	0	13.1	0	0	0	0	0
Phlogacanthus thyrsiformis (Roxb.) Nees	0	0	0	0	0	0	0	0	0	0	33.12	0	25.78	0	0
Picrasma javanica Bl	0	0	0	0	17.98	0	0	0	0	0	0	0	0	0	0
Piper betle L.	6.88	0	16.57	0	0	0	0	0	0	0	0	14.11	0	0	12.35
Polyalthia longifolia (Sonn.) Thwaites	0	0	0	0	0	0	0	0	0	0	22.15	0	20.32	0	0
Prunica granatum L.	0	0	0	25.44	33.65	28.45	15.44	0	0	0	0	0	0	73.17	0
Pyrus communis L.	0	0	0	0	0	0	0	0	35.44	0	0	0	12.76	0	0
Quisqualis indica L.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16.57
Ricinus communis L.	14.3	0	0	17.37	0	0	0	0	0	0	0	0	0	0	0
Rosa chinensis L.	0	0	8.7	0	0	0	0	0	0	16.22	0	0	0	0	0
Rosa indica L.	11.43	0	0	0	0	17.23	0	0	0	0	0	0	0	0	33.25
Sesbania grandiflora (L.) Poir.	0	0	0	0	0	0	0	0	0	0	0	0	12.06	0	0
Sarcochlamys pulcherrima Gaudich.	0	0	0	0	0	0	0	0	0	0	0	0	6.88	0	0
Stephania japonica Miers.	0	0	12.6	0	0	0	0	0	0	0	0	0	13.83	0	0
Tabernaemontana divaricata L.	0	0	0	0	0	0	0	0	0	0	0	0	15.96	0	0
Trevesia palmata (Roxb. ex Lindl.) Vis.	0	0	0	0	0	0	0	0	0	0	0	0	16.28	0	0
Zanthoxylum acanthopodium DC	0	0	0	0	0	0	0	8.69	0	0	0	0	7.4	0	0

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IVI of Shrub species

Importance value index (IVI) of shrub and climber species recorded from 15 Khampti villages of Namsai district, were presented in table 4. In Old Mohong *IVI* of *Citrus limon* (42.12) had the highest and *Camellia sinensis* (8.30) was the lowest IVI. In Pathar Gaon *Citrus x sinensis* was the highest IVI (49.61) and *Murraya koenigii* (10.26) has the lowest IVI. In Piyong village, the highest IVI value obtained for *Murraya koenigii* (42.65) and *Buddleja asiatica* (9.37) had the lowest IVI. In Lathao-I *Calotropis procera* was recorded for highest IVI (79.66) and *Muehlenbeckia platyclada* (8.93) had the lowest IVI value. In New Lathao *Prunica granatum* (49.65) had the highest IVI and *Bougainvillea spectabilis* (8.16) had the lowest IVI. In Sulungtoo *Hibiscus rosa-chinensis* showed the highest IVI (33.86) and *Phlogacanthus thyrsiflorus* (6.96) had the lowest IVI. In Kherem *Murraya koenigii* (69.38) had the highest IVI and *Calamus tenuis* had the lowest IVI (10.09). In Marua Camp, *Dracena fragrans* (59.28) got the highest IVI and *Hibiscus rosa-chinensis* (12.38) had the lowest IVI. In Mankao *Citrus x sinensis* (54.58) has the highest IVI and *Grewia asiatica* (7.24) has the lowest IVI. In New Mohong *Citrus maxima* (66.89) has the highest IVI and *Codiaeum variegatum* (12.3) had the lowest IVI. In Manphaiseng *Citrus maxima* (43.5) hadthe highest IVI and *Nerium indicum* (13.88) had the lowest IVI. In Manmow village the highest IVI was recorded for *Citrus x sinensis* (97.13) and the lowest was calculated for *Murraya paniculata* (L.) Jack (37.2). In Wagon Pathar the highest IVI was calculated for *Citrus medica* (41.9) and the lowest IVI was found for *Sarcochlamys pulcherrima* Gaudich. (6.88). In Jenglai *Prunica granatum* occupied the highest IVI (73.17) and *Gardenia jasminoides* (8.69) had the lowest IVI. In Wengko village, the highest IVI was 71.12 calculated for *Citrus limon* and the lowest IVI for *Citrus maxima* (10.75).

Species diversity, richness and similarity indices

Species Diversity and Species Richness and Similarity Index of tree species of 15 Khampti villages of Namsai are presented in the table 5, and Species Diversity and Species Richness and Similarity Index of shrub species are presented in table 6. The study revealed that the Species Diversity of tree was recorded for highest value in Mankao village (3.75) and lowest in Manmow village (3.02) (Table 5). The Species Diversity of shrub species was observed highest in Sulungtoo village and lowest in Manmow village. On the other hand, the Species Richness for tree species was seen highest in Kherem village and lowest in Wengko village. While Species richness for shrub species was seen highest in New Lathao village and lowest in Old Mohong village.

Table 5: Species Diversity and Species Richness and Similarity Index of tree species of 15 Khampti villages of Namsai

Village	Tree species		
	Species diversity H= - Σpi(lnpi)	**Species richness Da= (S-1/lnN)**	**Sorenson's Similarity Index (Ss)= 2a/2a+b+c**
Old Mohong	3.52	8.64	0.37
Pathar Gaon	3.64	9.2	0.38
Piyong	3.7	9.81	0.39
Lathao-1	3.32	7.36	0.41
New Lathao	3.49	8.73	0.42
Sulungtoo	3.27	9.21	0.44
Kherem	3.64	10.32	0.45
Marua camp	3.42	9.39	0.44
Mankao*	3.75	9.48	1
New Mohong	3.51	8.95	0.35
Manphaiseng	3.53	8.85	0.35
Manmow	3.02	5.71	0.34
Wagon Pathar	3.27	6.28	0.32
Jenglai	3.51	8.57	0.42
Wengko	3.09	5.64	0.22

* Reference area (area with the highest species diversity)

The Khampti people were also found to grow cash crops in their homesteads. These crops helped in increased in the overall economy of the community. They grow these crops in their homesteads and use fewer fertilizers and rely on organic manure. The annual and cash crops grown by the Khampti people in their homesteads are presented in the table 7.

Table 6: Species Diversity and Species Richness and Similarity Index of shrub species of 15 Khampti villages of Namsai

Village	Shrub species		
	Species diversity H= - Σpi(lnpi)	**Species richness Da= (S-1/lnN)**	**Sorenson's Similarity Index (Ss)= 2a/2a+b+c**
Old Mohong	2.15	1.28	0.34
Pathar Gaon	2.35	3.2	0.39
Piyong	2.18	3.004	0.31
Lathao-1	2.22	2.91	0.4
New Lathao	2.7	4.41	0.4
Sulungtoo*	2.65	4.5	1
Kherem	2.45	3.32	0.44
Marua camp	2.002	2.17	0.32
Mankao	2.21	2.79	0.31
New Mohong	2.34	2.81	0.18
Manphaiseng	2.01	2.52	0.14
Manmow	1.21	1.86	0.22
Wagon Pathar	2.43	2.84	0.17
Jenglai	1.52	1.73	0.42
Wengko	2.02	2.07	0.24

*Reference area (area with the highest species diversity

Table 7: List of seasonal crops growing in the traditional homesteads of Khampti villages of Namsai district.

Annual & cash crop	**Kharif season** (April and May)	**Rabi season** (September and October)
Colocasia esculenta L.	*Zea mays* L	*Phaseolus vulgaris* L.
Zingiber officinale Roscoe	*Colocasia esculenta* L.	*Brassicajuncea* (L.) Czern.
Curcuma longa L.	*Lagenaria siceraria* (Molina) Standl.	*Brassica oleracea var. capitata*
Ananas comosus (L.) Merr.	*Benincasa hispida* (Thunb.) Cogn	*Brassica oleracea var. botrytis*
	Capsicum annum L.	*Brassica nigra*, *Brassica napus* L.
	Cucumis sativus L.	*Solanum tuberosum* L
	Solanum melongena L.	*Sesamum indicum* L.
	Solanum myriancanthum	*Raphanus sativus* (L.) Domin
	Cucurbita pepo L.	*Coriandrum sativum* L.
	Luffa cyclindrica M. Roem	*Allium cepa* L.
	Corchorus olitorius L.	*Allium sativum* L
		Lycopersicon esculenta L.

Species evenness of tree species in the 15 Khampti villages of Namsai is presented in fig 3.

Evenness graph presented in fig 3 indicates that except the tree species of Solongto and Marua camp other villages tree abundance of species almost similar at community composition.

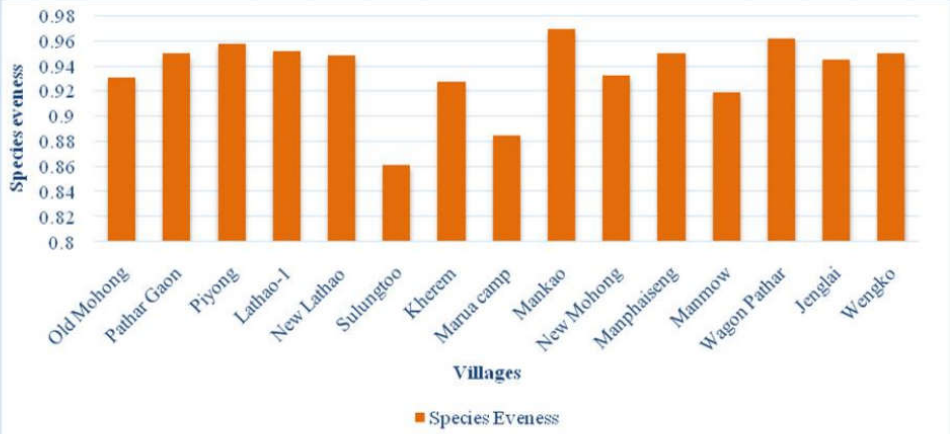

Fig 3: Graph showing species evenness of tree species in the 15 Khampti villages of Namsai

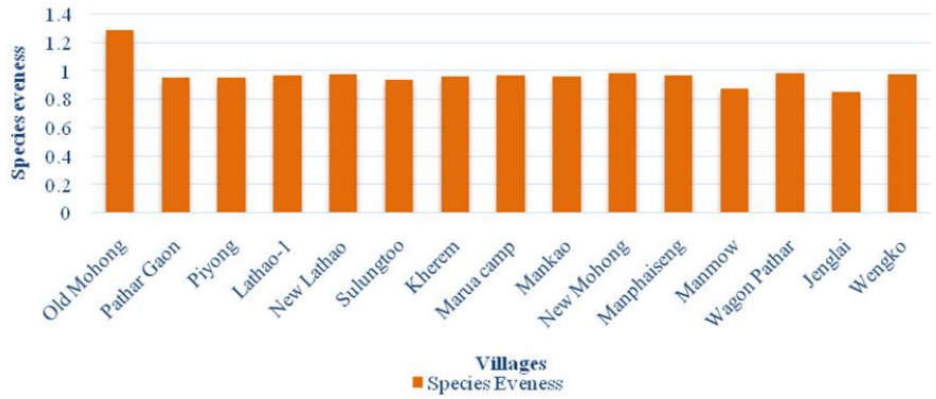

Fig 4: Graph showing species evenness of shrub species in the 15 Khampti villages of Namsai

Similarly, species evenness of shrub species in the 15 Khampti villages of Namsai presented in fig. 4 indicates that there was shrub species relative abundance in all the villages almost similar at community composition level. However, the shrub species found in Old Mohong village had different population abundance at community composition level.

Use value (UV) of the plant species

The use value of 5 tree species and 5 shrub species along with their uses among the Khampti tribe had been calculated and shown in table 8. These species were selected to find out use value because they are dominant species among the 15 homesteads. These species also have high IVI value and are economically very important. The study revealed that use value (UV) of a particular species was different in the 15 different Khampti villages. The range of UV in the table 8 referred the highest use value for *Livistona jenkinsiana* (0.65-0.71) followed by *Areca catechu* (0.58-0.63), *Bambusa tulda* (0.50-0.52), *Cinnamomum zeylenicum* (0.50-0.57), *Camellia sinensis* (0.45-0.49), *Citrus limon* (0.44-0.51), *Musa Cavendish*.(0.42-0.46), *Murraya koenigii* (0.43-0.50), *Derris elliptica* (0.39-0.42) and the lowest was observed in *Prunica granatum* (0.32-0.38).

Table 8. Use Value (UV) of most common plant species in Khampti homesteads of Namsai, Arunachal Pradesh

Species	Use value range	Part used	Ethno-botanical uses
Areca catechu L.	0.58-0.63	Fruit	The fruit is edible and part of Khampti culture and rituals
Livistona jenkinsiana Griff.	0.65-0.71	Leaves	The leaves are used for making roofs. The trees are planted as ornamental plants.
Bambusa tulda Roxb.	0.50-0.52	Culm	The culms are used as building materials, for making culinary dishes and several others.
Musa cavendish Lamb.	0.42-0.46	Fruit	The fruits are edible. The young stem is also eaten as food.
Cinnamomum zeylenicum Br.	0.50-0.57	Bark	It is consumed as both spice and medicine. It is used for respiratory, digestive and gynaecological ailments.
Camellia sinensis (L.) Kuntze	0.45-0.49	Leaves	The tea from leaves is consumed a rich source of antioxidants, vitamins and minerals.
Citrus limon (L.) Osbeck	0.44-0.51	Fruit	The fruit is edible, rich source of vitamin C. the juice is used for treatment of sore throat, fevers, rheumatism, high blood pressure etc.
Derris elliptica (wall.) Benth.	0.39-0.42	Bark	Used traditionally as an antisepsis and used against leprosy.
Murraya koenigii (L.) Sprenge	0.43-0.50	Leaves	It is a commonly used spice. The leaves are also eaten as 'chutney'. It is also used for treating piles, fresh cuts and bruises, dysentery etc.
Prunica granatum L.	0.32-0.38	Fruit	The fruit is delicious, rich in vitamins and minerals and also used for their anti-inflammatory and antibactertial properties.

Homestead plant species and lifestyle of Khampties

During the survey it was observed that Tai-Khampti has strong cultural linkage with their homestead plant species. According to the Khampti people interviewed during the survey informed that they migrated from Myanmar and settled in the Tengapani basin of Arunachal Pradesh and in Sadiya and Lakhimpur of Assam. The Khampti people are followers of Theravada Buddhism. They have their own script called Lik-tai (Tai script). They were found to traditional houses (Sang Ghar) made of bamboo and woods and has thatched roof made from leaves of *Livistona jenkinsiana*. The walls are made from spitted and knitted bamboo. Every household was observed to plant *Kaempferia galanga* in their house campus and belief that it can protect them from demon and devils.

The Khampti tribe celebrates a lot of festivals which include Sangken, POI PEE MAU (New Year festival of the Tai people, celebrated on the last day of the lunar calendar), Mai-Ka-Sung-Phai, Khao-Wa, Poat-Wa, Buddha Purnima etc. The Sangken festival is the Water Festival and the most awaited one among the Khamptis. The Khampti people are also known for their mouth-watering gracefulness. They mentioned to celebrate it on 14th April every year. On this day, after the ceremonial bath the images of Buddha are taken out for procession along with drums and music (Phukan, 2019). People splash water on each other. During this time the people use to make traditional sweets and snacks like ***khautoum*** *(sticky rice made into a roll and wrapped in leaf),* ***khautek*** *(sticky rice made into a ball and wrapped in leaf),****khaupuk*** *(sticky rice and sesame seeds) and distribute these among themselves* .Khampti men wear their distinctive full sleeved cotton shirt (**siupachai**) and the deep multi-coloured lungi (**phanoi**) while women wear half-sleeved blouse (**sui pashao**), a deep coloured skirt (**sui**) made from cotton or silk, and a coloured silk scarf. Married women wear a short green coloured cloth wrapped around the long skirt known as ***Langwat***. As part of their culture they prepare their jewellery from bamboo and birds' feathers. Bamboo even plays an important role in their dance drama *ka-pung* where flutes made from bamboo, drums and cymbals are played. Rice forms an integral part of their food habit. During household survey recorded a variety of unique food items prepared from rice for their consumption namely, ***khaumouning*** *(basic steam rice),* ***khauho*** *(steamed rice made into balls and wrapped in tong leaves),* ***khau-tongtep*** *(rice made into pancakes and wrapped in tong leaves). Another important ingredient in Khampti food in bamboo shoots. A number of food items they made with bamboo shoots, for example, are****noo phan*** *(boiled bamboo shoots with ginger),* ***nou kai noosom*** (chicken with fermented bamboo shoots), ***nou moo shen****(pork with tender bamboo shoots), and* ***nau mu phaun*** (pork with fermented bamboo shoots). Fish items include ***paasa*** **(made from raw fish and traditional spices),** ***Paa pho*** (steamed fish wrapped in tong leaves) and ***paasom****(fermented fish fried in mustard oil).* During household survey it was recorded that Khampti people offers traditionally to their species guest when visited to them a special dish with *paasaa* (a soup made from fresh raw fish and leaves of *Bischofia javanica*, *khauho* or *tupulabhat*) and *steamed* rice wrapped with leaves of *Phrynium pubinerve*) etc. The Khampti people use dried leaves of *Livistona jenkinsiana* to build roof for their houses (Nimachow et al., 2008).

Discussion

The survey was focused mainly assessment of the rich biodiversity present in the homesteads of the Khampti tribe. The on region falls under one of the 36 biodiversity hotspots of the world and the results showed the same. Considering the 15 Khmapti villages the species diversity was somewhat even in all the villages ranging from 3.02 to 3.75 (tree species) and 1.21 to 2.65 (shrub species) which depicts a stable ecosystem. The species richness has been calculated using Margalef Index where it was highest in Kherem and lowest in Wengko (tree species) and highest in New Lathao village and lowest in Old Mohong village (shrub species). The similarity index which was calculated using Sorensen Similarity index ranged between 0 and 1. Thus the villages with similarity index closer to 1 have the highest similarity with respect to the reference area. The reference area for comparing the similarity was taken on the basis of high species diversity among the 15 villages. In case of tree species Mankao had the highest species diversity and the village with the highest similarity with respect to Mankao was Kherem and the least similar village was Wengko. In case of shrub species Sulungtoo had the highest species diversity and the village with the highest similarity with respect to Sulungtoo was Kherem and the least similar village was Manphaiseng. Documentation of edible species in homesteads of Khampti villages by (Hazarika et al., 2021) reported similar findings regarding the number of trees and shrub species. Similar work regarding assessment of biodiversity in homestead gardens of Tigray, Ethiopia was done by Guyassa et al. (2013) where IVI different species found in the homesteads were studied. The comparison between the IVI of the common species found in

homesteads of Namsai revealed higher IVI in the species. This was due to the use of the species among the Khampti people. The species with higher use value was seen to be grown more in the homesteads and as a result their population had increased density, frequency and were found to be dominant.

Use value of the plant species may be important index of utility and may be a criterion of conservation of the species in their homesteads of Khampti tribes. Although the 10-plant species of Khampti homesteads of Namsai district had different UV in different villages but importance of plant species from the point of utility could be ascertained. Many researchers advocated the importance of UV as an index to quantify the relative importance of useful plants (Dossou et al., 2012). Zenderland et al., (2019) observed that UV of cultivated plants were more than that of wild plant species while studied in two ethno-botanical studies of the Republic of Georgia in the Caucasus. Dossou et al (2012) identified 28 woody plant species of Agonvè swampy forest of southern Benin and mentioned that UV may be a tool to select the species for conservation in the management plans by the local community.

The world at present is dealing with a serious problem of food crisis. A number of wild edible plant species were observed to occur in Khampti homesteads during the survey which were reported to consume as vegetable or as herbal medicine. Hazarika et al (2021a) in another study documented 106 edible plant species from Khampti homesteads, of which, 59 were cultivated and 47 were planted. The farmers of the Khampti tribe also observed to take up the daunting task of collecting and preserving the germplasm of local varieties of rice and other crops, thus ensuring food security. Khampti people also use to consume the homestead plant species like *Diplazium esculantum* (Pu kut), *Alternanthera sessilis* (Matikaduri), *Blumea balsamifera* (Yanang hak), *Centella asiatica* (Panang lung), *Calamus latifolius* (Golar), *Houttuynia cordata* (Punkyo), flower of wild banana (*Musa sp*), *Zanthoxylum acanthopodium* (Mekat) and fruits of *Elaeagnus latifolia* (Gamyamrap), *Phyllanthus emblica* (Amolodi), *Prunus persica* (Amuch), *Pyrus communis* (Semo), *Solanum nigrum* (Hor), *Zizyphus mauritiana* (Tehanghat) and *Syzygium cuminii* (Aamun) from their home gardens. Similar observation was also reported for other tribes of Arunachal Pradesh about consumption of wild edible and use to sale in the local market (Angami et al., 2006; Hazarika et al., 2021b). It was observed that Khampti people also conserved traditionally and culturally a number of plants about to extinct, wild, and other living species of a crop plant in their homesteads (Hazarika et al., 2022; Priyanka et al., 2021).

Conclusions and Recommendations

From the survey it was found that the homesteads of the Khampti people are mostly depends on homesteads plant species. Most of their homesteads accumulate all the elements required for maintaining a sustainable economy and cultural well-being. The survey also showed the presence of edible fruit bearing trees and shrubs with high use value (UV) like *Areca catechu, Artocarpus heterophylla* , *Citrus limon, Citrus x sinensis, Magnifera indica* L., *etc.* which help the farmers earn an income and provide ample opportunities for a better livelihood. Moreover, large trees help in wind break, provides shade and also help in preventing soil erosion. Plant species like *Mangifera indica*, *Dillenia indica*, *Phyllanthus emblica* etc. are excellent for making pickles which can offer great business opportunities for the people of the villages as a whole. The homesteads harbour thousands of flowers which is essential for making honey by the honey bees (*Apis cerara*). Production of honey bee on a commercial scale may be a promising source of income from such biodiversity rich homesteads.

The Khampti people also grow a wide variety of spices namely *Amomum subulatum*, *Cinnamomum zeylenicum*, *Coriandrum sativum*, *Curcuma longa*, *Eryngium foetidum*, *Murraya koenigii*, *Zanthoxylum armatum*, *Polygonum pangianum*, *Piper nigrum* etc which help them become self-sustained and earn an income due to their high

demand in the market. Although most of the homestead plant species were have gain conservation importance of livelihood, cultural linkage and ritual faith and traditional beliefs but needs to educate the people regarding the benefits which are not much conscious of biodiversity point. The study may be helpful to generate scientific database for improving homestead into a viable agroforestry system with ample flora and fauna to boost the economy of the homestead owner and the Khampti community as well.

Conflict of Interest

Authors do not have conflict of interest

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RARE, ENDANGERED, THREATENED AND ENDEMIC (RET & E) PLANT SPECIES IN TRADITIONAL KHAMPTI HOMESTEADS OF NAMSAI DISTRICT, ARUNACHAL PRADESH

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ABSTRACT:

A survey of rare, endangered, threatened and endemic plant species present in the homesteads of 15 Khampti community villages of Namsai district was done during 2019-2020.The objective of the study was to know the extent of conservation of RET & E species in the traditional Khampti homesteads and to evaluate the traditional uses of those species for why those species were being sheltered in their homesteads. The study documented 48 threatened plant species from their homestead gardens belongs to 35 plant families. Most importantly, among them 4 species were critically endangered, 6 were endangered, 1 data deficient, 1 rare and another 1 plant species was extinct in wild. Apart from that 18 plant species were near to threatened and 12 plant species were vulnerable. Of these plant species 39 were utilized for traditional medicine and other 9 were edible, timber or fuel wood species. As such home gardens of Khampti community have been playing a vital role by sheltering and by virtue conservation RET & E species.

KEYWORDS: *Traditional homesteads, Rare, Endangered, Threatened and Endemic plant species.*

INTRODUCTION:

The Homestead or home gardens were the 1st step towards habitat development by human being with gradual culmination of nomadic life. Homesteads are nothing but an area surrounding to a house and was assumed to create by the human being at the event of adoption of cropping system near about 12000 years ago or more. Since then homesteads are being played important role by fulfilling the basic needs of human society and develop with many inclusions of various components with time and has direct linkage with the cultural and biological evolution of ethnicity. The present day homesteads are also outcome of old aged residential landforms at household level composed of agricultural crops with forestry species such as food, fruit, vegetables, medicinal, aromatic, spices and condiment, beverages and drinks, timber, fuel wood, fodder etc and plant species of commercial important such as tea, coffee, rubber, bamboo and rattan, ornamental and aesthetic plants etc (Bhat et al., 2014; Hazarika et al., 2003). Thus, a considerable extent of biodiversity has been conserved by the people in their homesteads that are socio-cultural and economically important to human civilization (Hazarika et al., 2014; Hazarika et al., 2021; Smith et al., 2006). Consequently, home garden represents as traditional agroforestry system and is a significant area of integration of important components utilizing accumulated traditional knowledge and experiences for the livelihoods for self-sustaining to family and community & local needs with ecological and even economical traditions (Leiva et al., 2002; Roy et al., 2013; Kabir et al., 2020).

In India total numbers of plant species recorded so far were 47,513(Singh & Dash, 2014). However, International Union for Conservation of Nature (IUCN) has evaluated only a total of 2093 plant species, of which 1524 were least concern(LC) and 98 were data deficient(DD). As per evaluation of IUCN, 475 plant species of Indian continental and enlisted as threatened in the Red List (2020/2) of 85 were Critically Endangered (CR), 182 are Endangered (EN) and 147 are Vulnerable (VU), 50 are near threatened species. Apart from that 48 RET plant species were reported to occur in Arunachal Pradesh (Paul et al., 2015).

Arunachal Pradesh is also rich in endemic flora as it is under the "cradle of flowering plants" (Takhtajan, 1969) and "Hindustan Centre of origin of crop plants" (Vavilov, 1951). In the checklist of Endemic Plants of Arunachal Pradesh, 2013 it is found to have 220 endemic plant species. Although such data are available but there is no study on the RET &E plant species which are being conserved in the homesteads by the people indeed for their needs. Therefore this study attempts to document such plant species and would try to find out the reason for which these plant species have been being sheltered and conserved by evaluating their traditional uses.

STUDY AREA:

The survey was done to document RET species in homesteads of Khampti tribe in Namsai district, Arunachal Pradesh during 2019 to 2020. Namsai district is located in between latitude 27°30' to 27°55'N and longitude 95° 52' to 96° 20' E and sharing border with Lohit and Changlang towards the east; Assam to the West; Lohit and Assam towards the North, and the south border adjoins Changlang district (Fig-1). The climate is warm and temperate. The rainfall in summers has much more than the winter. The average annual temperature is 22.8°C. Average annual precipitation is 2728 mm. High quantity of rainfall (750-800 mm) is recorded during July-August with a relative humidity of 80%. An average maximum summer temperature 25° C and minimum winter temperature is 10° C.

MATERIAL AND METHODS:

Data collection

A survey was conducted in 15 Khampti villages of Namsai district i.e. Old Mohong, New Mohong, Lathao, New Lathao, Sulungtoo, Pathar Gaon, Piyong II, Kherem, Mankao, Marua Camp, Manphaiseng, Manmow, Wagon Pathar, Jenglai, and Wenko. Randomly selected 15 homesteads of each of the 15 Khampti villages were surveyed to record the plant species available in their homesteads. The objective of the study was clearly explained to the homesteads owner. Information of edible plant species, parts used for different purposes were recorded, the associated indigenous knowledge etc were collected with the interview by a semi structured questionnaire with prior informed consent (PIC) from the homestead owner. The rare, endangered and endemic plant species found in their homestead were photographed along with the useful parts.

The rare, endangered, threatened and endemic plant species available in their homesteads were taxonomically authenticated with the help of standard Flora of Assam (Kanjilal et al. 1934 – 1940) and Flora of Arunachal Pradesh (Hajra et al., 1996; Chowdhery et al., 2009), and Flora of Lower Subansiri (Pal, 1993). Consulted the threatened status referred by CAMP, IUCN plants list, Threatened Species of India Listed in IUCN Red list, Checklist of Threatened Plants of Arunachal Pradesh and discussed specific research situation. The accepted scientific names were verified in the website www.theplantlist.org and www.plantsoftheworldonline.org.

RESULTS AND DISCUSSIONS:

A 48 numbers of rare, engendered, threatened and endemic plant species were sheltered by the Khampti homesteads (Fig 2). During the documentation survey of 48 RET& E plant species occur in homesteads belongs to 35 families, their scientific and local names, habit, traditional use are presented in the table 1. Among them *Albizia arunachalensis*, *Garcinia lanceifolia*, *Kaempferia*

galanga, *Livistona jenkinsiana*, *Picrorhiza kurroa*, *Saraca ashoca* are endangered plant species in IUNC plant list. It is a known fact that these endangered plant species are at high risk of extinction if happens to be an unexpected and fast decline in their population. Such decline may also happen due to loss of their required and prevailing habitat. Critically endangered plant species were in homesteads are *Aquilaria malaccensis*, *Tinospora cordifolia* and *Hydnocarpas kurzii* and *Kaemferia galanga*. These critically endangered plant species fond in the homesteads must have to look into immediate conservation strategies so as protect further declination of their population. Likewise, *Justicia gendarussa* is reported as extinct in wild found in Khampti homesteads. The Khampti homesteads were also detected as a conservation spot of a numbers of endemic plant species such as *Aquilaria malaccensis*, *Phlogachanthus thyrsiflorus*, *Pilea trinerea* and *Rubus ghanakantae*. Apart from the above *Phoenix dactylifera* L. is a rare non native plant species cultivated by the Khampties in their homesteads. Vulnerable plant species were *Acorus calamus*, *Aegle marmelos*, *Blumea balsamifera*, *Bombax ceiba*, *Cinnamomum tamala*, *Clerodendron colebrookianum* , *Dioscorea deltoidea* , *Eleagnus latifolia*, *Flemingia strobilifera*, *Homalomena aromatica* and *Phyllantus acidus*. The homesteads of Khampti villages also found to occur 18 plant species which are near to threatened. They were *Alstonia scholaris* , *Andrographis paniculata*, *Asparagus racemosa*, *Averrhoa carambola*, *Azadirachta indica*, *Benincasa hispida*, *Cucurbita pepo*, *Garcinia pendunculata*, *Gardenia angusta*, *Gardenia jasminoides*, *Hydrocotyl sibthorpioides*, *Kalanchoe pinnata*, *Litchi chinensis*, *Litsea gluctinosa*, *Melia azedirach*, *Ricinus communis*, *Zanthoxylum armatum* and *Zingiber officinalis*. Data also depicted that of 48 RET & E plant species 39 plant species were recorded to use for traditional medicine and other 9 were either edible or use for timber and fuel wood purposes (Table-1). As such the plant species which were mainly use only for traditional medicine may lose the interest of the community people due to increased popularity with time of modern medical systems.

The study of threatened plant species in Arunachal Pradesh was reported many workers and government agencies (Paul et al., 2015; ENVIS, 2020, Nayar and Sastry, 1990). Paul et al (2015) described about 48 Rare Endangered, Threatened and Endemic plant species from Arunachal Pradesh in general. However, the study on plant species that have been sheltered or cultured in the homesteads by the community is rare and not even reported. This study may also help to further determine the cause of concern to become critically endangered, endangered, vulnerable and near to threatened species. Further they study also focus on endemic plant species are on service of the Khampti community too.

CONCLUSION:

The traditional Khampti community of Namsai district, Arunachal Pradesh in their homesteads has been conserving RET & E plant species which are not only purely purposive but also have direct link with their culture, food habit and other socio-economic and ecological condition. However, awareness needs to be created about the status of their plant species so that they may take necessary care for these threatened plant species. This work would certainly help to the community and the researchers for future planning to protect these plant species and their sustainable utilization.

CONFLICT OF INTEREST:

Authors do not have any conflict of interest

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Table 1 Threatened plant species of India recorded in the homesteads of Khampti villages of Namsai district, Arunachal Pradesh (after Nayar & Sastry, 1990)

(DD- data deficient; En- Endemic; R- Rare;CR- Critically endangered; EN- Endangered; T- Threatened; NT- Near threatened)

Sl No.	Species Name & Family	Khampti/ Local name	Habit/ habitat	Ecological ststus	Traditional use
1	*Acorus calamus* L. Fam: Acoraceae	Sam pu/ Sabbhu /Bos	Herb/ planted	VU	Medicinal: Leaf juice is used to treat epilepsy and stomach problem. Roo t juice taken snake bites.
2	*Aegle marmelos* (L.) Corrêa ex Roxb. Fam: Rutaceae	Bel	Tree/ planted	VU	Ripe fruit edible, root extract use to treat dysentery
3	*Albizia arunachalensis* Sahni et Naithani Fam: Mimosaceae	sau koroi	Tree/ planted	En, R and T	Wood use as timber & fuel wood
4	*Alstonia scholaris* R.Brown. Fam: Apocyanaceae	Motongke / Sotiyana	Tree/wild	NT	Medicinal: water extracted from bark used for cough, anti malarial, gastrointestinal and latex use for treatment of boil in skin. Wood use as timber
5	*Andrographis paniculata* Wall.ex. Nees Fam: Acanthaceae	Hirota /Kalmegh	Herb/ cultivated	NT	Plant extract use as vermifuse, liver tonic and anti diabetes
6	*Aquilaria malaccensis* Lam. Fam: Thymelacaceae	Tun nam sasa/ Sachi Gosh	Tree/ planted	CR/ En/ CITES sp.	Used in asthma, digestive, and for fragrance.
7	*Asparagus racemosa* Willd Fam: Liliaceae	Sottish sora/ Satmul	Climber/ planted	NT	Water extract of tuber use as appetizer, also for treatment of recurrent cough.
8	*Averrhoa carambola* L. Fam: Oxalidaceae	Me phung/ Kurangi/ Kordoi	Tree/ planted	NT	Fruit edible, use to make pickle, juice use as drink, water extract of leaves use as liver tonic.
9	*Azadirachta indica* A..Juss.	Mahaneem	Tree/ planted	NT	Leaves are used as vegetable; Dry leaves liquor use as appetizer,

Sl No.	Species Name & Family	Khampti/ Local name	Habit/ habitat	Ecological ststus	Traditional use
	Fam: Meliaceae				antimalaria, vermifuse.
10	*Benincasa hispida* (Thunb.) Cog. Fam: Cucurbitaceae	Maipawl/ Kumura	climber/ cultivated	NT	Use as vegetable,
11	*Blumea balsamifera* (L.) D.C Fam: Asteraceae	Yanang	Herb/ wild	VU	Tender plant & leaves use as vegetable; use for treatment of diarrhea in children and stomach trouble
12	*Bombax ceiba* L. Fam: Bombacaceae	Mai liu/ Simolu	Tree/ wild	VU	Wood use as timer & fuel wood, fruit silk use for making pillow, extract gum from bark to treat dysentery, fresh flower eaten as vegetable
13	*Cinnamomum tamala* Nees & Eberm. Fam: Lauraceae		Tree / cultivated	VU	Leaves use as spice; control diarrhea, Fresh leaf paste apply to relief fever
14	*Clerodendron colebrookianum* Walp . Fam: Verbenaceae	Patak khai /Helle Yasak /Nefafu	Shurb/ wild	VU	Boiled tender shoot use as vegetable, water extract of leaves use to control high blood pressure.
15	*Cucurbita pepo* L. Fam: Cucurbitaceae	Ma pak kham /Rongalau	climber/ cultivated	NT	Fruit use as vegetable, seeds use as vermifuse
16	*Dioscorea deltoidea* Wall. ex Griseb. Fam: Dioscoreaceae	Kukur tarul	climber/ cultivated	VU	Tubers are used to cure relief from snake bite.
17	*Eleagnus latifolia* L. Fam: Eleagnaceae	Mu lot /Mirika Tenga	Climbing Shrub/planted	VU	Fruit edible, use to make pickle,
18	*Flemingia strobilifera* (L.) W.T.Aiton Fam: Fabaceae	Makhioti	Shrub/ planted	VU / NT	Decoction of leaves use to treat malaria
19	*Garcinia lanciefolia* Roxb. Fam: Clusieaceae	Rupohi Thekera	Shrub/ planted	EN	Fruit edible, eaten as chutney, prickle.
20	*Garcinia pendunculata* Roxb. ex Buch. Ham Fam: Clusieaceae	Mannang/ Mhahau /Bor thekera	Tree/ planted	NT	Medicinal: Dry fruit juice use for dysentery and urinary troubles. Fruit eaten; use for making pickle;
21	*Gardenia angusta* (L) Merr. Fam: Apocynaceae	Tagar	Shrub/ planted	NT	Tender twig use as tooth brush for prevention of dental caries
22	*Gardenia jasminoides* J.Ellis Fam: Apocynaceae	Tagar phul	shrub /planted	NT	Flower for fragrance
23	*Homalomena aromatica* (Roxb.)	Suanpa /Gandh-	Herb	VU	Rhizome and petiole edible; cure impotency , paste of raw leaf

Sl No.	Species Name & Family	Khampti/ Local name	Habit/ habitat	Ecological ststus	Traditional use
	Schott. Fam: Araceae	Kochu			is applied to relief joint pain
24	*Hydnocarpas kurzii*(King) Warb. Fam: Achariaceae	Makhapong /Salmugra	Tree/wild	CR	Seed extract use in treatment of leprosy, bark decoction as general tonic and skin and internal disorder.
25	*Hydrocotyl sibthorpioides* Lam. Fam: Apiaceae	Panang on/ Saru manimuni	Herb/wild	NT	Whole plant edible; water extract fresh plant use to treat chest pain, debility, stomach disorder.
26	*Justicia gendarussa* Burm.f. Fam: Acanthaceae	Jatrasidhi	Shrub/ planted	Extinct in wild	Decoction of leaves use to treat bronchitis, inflammation , vaginal discharges
27	*Kaempferia galanga* Linn. Fam: Zingiberaceae	Ban hom/ Wan hom / Gathion	Herb/planted	CR	Rhizome extract use to treat skin infection, use for marriage festival
28	*Kalanchoe pinnata* (Lam.) Pers Fam: Crassulaceae	Yapong/ Dupor tenga	Herb/ planted	NT	Leaf extract use to treat jaundice and liver disorder, kidney stone and urinary trouble.
29	*Oroxylum indicum* (L.) Vent. Fam: Bignoniaceae	Bhatghila	Tree/ wild	VU	Extract of stem bark and roots use to treat jaundice, cough, diarrhea, and heart pain. Bark use to extract black dye.
30	*Litchi chinensis* Sonn. Fam: Sapindaceae	Lichu	Tree/ planted	NT	Fruit edible,
31	*Litsea glutinosa* (Lour) Robinson Fam: Lauraceae	Baghnala	Tree/ wild	NT	Bark burnt to make ash and ash applied to treat skin boil, fuel wood
32	*Livistona jenkinsiana* Griff. Fam: Arecaceae	Tongko /Tokow	Tree/ planted/En	EN	Leaves use for roofing; Seeds eaten; paste of young leaves with *Murraya keonigi* treat for diarrhea.
33	*Melia azedirach* L. Fam: Meliaceae	Ghora neem	Tree/ planted	NT	Use as fuel wood, leaves use as pesticides
34	*Phlogachanthus thyrsiflorus* Nees. Fam; Rubiaceae	Mochomkhum /Titaphul	Shrub/ planted	En	Dried/ fresh inflorescences as vegetable
36	*Phoenix dactylifera* L. Fam: Arecaceae	Khejur	Tree/ planted	R	Fruit edible
35	*Phyllantus acidus* (L.) Skeels. Fam: Phyllanthaceae	Por Amlokhi	Tree/ planted	EN/VU	Fruit edible, eaten raw and chutney, pickle, treat for gonorrhoea, Jaundice
37	*Picrorhiza kurroa* Royle Fam: Scrophulariaceae	Kutki	Shrub/ wild	EN	Decoction of root used in jaundice, fever and liver disorder.
38	*Pilea trinerea* Wall. Fam: Urticaceae	Rambodusak	Herb/ wild	En	Decoction of leaves use to treat stomach disorder. Pain and cancer

Sl No.	Species Name & Family	Khampti/ Local name	Habit/ habitat	Ecological ststus	Traditional use
39	*Pogostemon benghalensis* (Burm. f.) O. Kuntze Fam: Lamiaceae	Ya kin phit/ Suklati	Herb/ planted/ escapices	DD	Boiled leaf soup consumed during chest and stomach pain.
40	*Rhyncostylis retusa* (L.) Fam: Orchidaceae	Kopu phul	Epiphyte	EN	Flower aesthetic, leaves extract use to take bath for treatment of rickets
41	*Ricinus communis* L. Fam: Euphorbiaceae	Ton kong/ era	Shrub/ cultivated	NT	Leaves use to relieve muscle pain; Rear endi silk, Seed oil use as purgative.
42	*Rubus ghanakantae* Sm. Fam: Rosaceae	Jetulipoka	Climber/ wild	En	Fruit eaten when ripped,
43	*Saraca ashoca* (Roxb.) de Wilde Fam: Fabaceae	Asoka	Tree/ planted	EN	Water extract of stem bark is use for treatment of fever and cold and gynecological problem
44	*Terminalia chebula* Retz. Fam: Combretaceae	Manaa/ Silikha	Tree/ planted	VU	Fruit edible; bark use to extract blue dye, bark and leaf extract used to treat diarrhea of childern
45	*Tetrastigma obovatum* Gagnep. Fam: Vitaceae	*Ya enka*	Climber/ wild	En	Rarely eaten as vegetable,
46	*Tinospora cordifolia* (Willd.)Miers Fam: Menispermaceae	Hak yungha /Amor lota	Climber/ wild	CR	Water extract of dry stem powder use for treatment of gastric, urine trouble , typhoid.
47	*Zanthoxylum armatum* DC. Fam: Rutaceae	Mekat /Masala pat	Shrub / planted	NT	Leaves in raw, dried use as chutney. Fruits chewed for treatment of stomach pain and indigestion
48.	*Zingiber officinalis* Roscoe. Fam: Zingiberaceae	Hing/Khing /Ada	Herb/ cultivated	NT	Rhizome use as spice/ condiment.

Appendix 3 – List of Trainings/ Workshops/ Seminars with details of trained resources and dissemination material and Proceedings

Appendix 3 [A]. The list of 10 the exposure trainings conducted among the Khampti Tribe of Namsai district, Arunachal Pradesh

Sl. No.	Date	Title of training	Venue	Total trainees	Men	Women
1	10th and 11th March, 2023	Floriculture and Plantation Management of Fruits plant in Agroforestry Homegarden	Community Hall, Manmow Village, Namsai	38	10	28
2	26/02/2023 and 27/02/2023	Skill development training on Japi Making for Value Addition and Livelihood at Village, Namsai, Arunachal Pradesh	Pathar Gaon Community Hall	18	18	0
3	16th & 17th November, 2022	Skill Development Training on Bee-keeping, Value Addition and Entrepreneurship	Community Hall, Lathao Village, Namsai	23	14	9
4	16/06/2022	Skill Development Training on Jigat Production and Agarbatti Making	Community Hall, Piyong Village, Namsai	20	09	11
5	17/06/2022	Skill Development Training on Jigat Production and Agarbatti Making	Community Hall Pathar Gaon, Namsai	26	03	23
6	07/04/2021	Composting and Vermicomposting	APVS School, Namsai	24	17	7
7	02/03/2022 to 12/03/2022	Skill Development training on Bamboo Handicrafts for Artisans of Namsai District, Arunachal Pradesh	RFRI, Jorhat	12	12	0
8	19/01/2021	Mushroom Cultivation and Vermicomposting	Krishi Vigyan Kendra, Tinsukia, Assam	17	8	9
9	08th to 20th November 2021	Establishment of Food Processing Unit	IIE , Guwahati	10	5	5
10	03/03/2020 to 05/03/2020	Establishment and Management of Nursery	Arunachal Pali Vidyapith Society, Chongkham, Namsai	24	20	4
			Grand Total	**212**	**117**	**95**

Appendix 3 [B] List of 15 Technology Awareness camps conducted among the Khampti Tribe of Namsai district

Sl. No.	Date	Title of camp/ meeting	Venue	Total participants	Men	Women
1.	05/12/2019	Awareness camp cum PRA for bioresources mapping	Old Mohong Village	50	22	28
2.	28.12.2019	Awareness camp cum PRA for bioresources mapping	Mankao Village	46	18	18
3.	30. 12.2019	Awareness camp cum PRA for bioresources mapping	Pathar Gaon	33	16	17
4.	10.01.2020	Awareness camp cum PRA for bioresources mapping	Lathao Village	31	16	15
5	12.01.2020	Awareness camp cum PRA for bioresources mapping	Piyong Village	35	19	06
6.	10.04.2021	Entrepreneurship development based on local bioresources for self sustain	Pathar Gaon	10	06	04
7.	15.02.2021	Mushroom Cultivation and Value Addition	Old Mohong	24	06	18
8.	16.02.2021	Vermicomposting and application	Old Mohong	23	06	17
9.	06.04.2021	Vermicomposting and application	Lathao	10	02	08
10.	08.03.2021	Mushroom Cultivation and Value Addition	Lathao	12	03	09
11.	17.02.2021	Mushroom Cultivation and Value Addition	Piyong	12	03	09
12.	18.02.2021	Vermicomposting and application	Piyong	10	03	07
13	09.04.2021	Entrepreneurship development based on local bioresources for self sustain	Old Mohong	24	09	15
14.	19.02.2021	Vermicomposting and application	Pathar gaon	10	03	07
15.	20.02.2021	Mushroom Cultivation and Value Addition	Pathar gaon	11	04	07
			Grand Total	341	118	185

Appendix -3.[C]. The training conducted for technology transfer, capacity building and skill development, value addition etc.

Appendix -3. [C].1. Training on 'Establishment and Management of Nursery'

Venue: Arunachal Pali Vidyapith Society, Chongkham, Namsai district, Arunachal Pradesh

Duration : 03/03/2020 to 05/03/2020

A 24 number of trainees from five Khampti villages i.e. Mankao, Lathao, Piyong Khampti, Pathar Gaon and Old Mohong of Namsai district took part in 3 days training programme. Name, village name and contact number of progressive farmers took part in the training are presented in the table 16. On 03/03/2020 the first day of the training programme Dr. Dandeswar Dutta, Scientist C and Coordinator Facility, RFRI, Jorhat presented the inaugural speech on the topic "*Importance of Nursery for Livelihood and Biodiversity Conservation*". In his inaugural species Dr. Dutta urged the farmers took benefits of the project acquiring advance technologies and skill development activities for enchantment of livelihood and conservation of biodiversity as well. In the inaugural session village headmen of Pathar Gaon, Old Mohong and Lathao were participated along with Shri Indrajit Tingwa, Secretary, Arunachal Pali Vidyapith Society. All of them offered their valuable views and addressed to the trainees to take benefit of the training programme. After that Dr. Prosanta Hazarika, ACTO, RFRI, Jorhat and Principal investigator of the project gave a ppt presentation on '*Establishment of an Agroforestry Nursery: basic infrastructure and propagules*'. Delivering the training Dr. Hazarika described about technology know-how for establish a nursery of the native plants, vegetables and cash crops with seasonal collection, processing and storage of seeds. Also described about raising of seedlings from seeds and vegetative propagules and their after care. In the 1st session of the training program, Dr. Dandeswar Dutta, Scientist-C, RFRI, Jorhat delivered ppt presentation on '*Nursery Disease management*' Dr. Dutta explained different causal organisms that can caused diseases in Nursery and also described application of pesticides and botanicals to manage the diseases of nursery and plantation.

In the second session of the training program of the day Shri Protul Hazarika, ACTO, RFRI, Jorhat demonstrated hands on training to the participants on "Nursery bed preparation, potting media preparation, polybag filling, Seed processing, Seed sowing, seedling transplanting etc'

On 04/03/2020 the second day of the training programme, Dr. (Mrs) Indrani. P. Bora, Scientist-C, RFRI, Jorhat presented her training on '*Cultivation of Broom grass as agroforestry component for livelihood*.' Describing the importance of broom grass she told that broom grass can be grown in hill area of Arunachal Pradesh and may be a viable component of homestead agroforestry system. Thereafter, Dr. (Mrs) Kuntala N. Barua, CTO, RFRI, Jorhat offered her training on '*Value addition of agroforestry and homesteads plant resources for livelihood enhancement*'. Dr (Mrs) Barua opined that native NTFP crops grown in homesteads and agroforestry system have the potential to utilize as components of many small and subsidiary

industrial products. She has cited a dozen of such unit which can made food, spice and other products.

On 05/03/2020, the 3rd day of the training programme shri. Protul Hazarika, ACTO, RFRI, Jorhat offered hands on training on "*Vegetative propagation, cutting, bud grafting*' at farmers level with cheap and eco-friendly manner. Dr. Prosanta Hazarika, ACTO, RFRI, Jorhat assisted to demonstrate the entire process.

In the second half of the day there was an interaction and feedback session in which trainee farmers took part and offered their views. After that, the valedictory session was chaired by Mrs. Rani Gogoi, Principal; the school ran by Pali Vidyapit Society, Chownkham. As a part of closing the training programme Dr. Hazarika offered vote of thanks to the trainees, resource persons, Gaon burha's and School Authority and Arunachal Pali Vidyapith Society, Chowkham, Namsai for their active cooperation for successful completion of the training programme.

Distinguish guests and resource persons on dice.

Inaugural speech Dr. D. Dutta, Co(F), RFRI Jorhat

Speech by Chow Indrajit Tingwa, Secy, APVS

Dr. D. Dutta, Scientist-C imparted training

Dr. P. Hazarika, PI described the objectives of training

A partial view of the trainees

A snap on trainees of the programme

Dr. P. Hazarika performinng training

Dr. K. N. Barua imparted training on value addition

Dr. P. Hazarika spoke on Nursery establishment

Sh. Protul Hazarika briefing of cutting and grafting

Demonstration on cutting and grafting

Fig. 14 A few moments of the training on “Establishment and Management of Nursery’

Table 16. List of trainees' participant of the training on "Establishment and Management of Nursery"

Sl. No.	Name	Village name	Contact number
1	Chow Makang Mantaw	Piyong Khampti	8974643448
2	Chow Mutuwom Manchey	Piyong Khampti	8732805076
3	Chow Allin Thaumoung	Piyong Khampti	8974643692
4	Chow Pandicha Thaman	Piyong Khampti	845895474
5	Chow Moho Chowmong	Piyong Khampti	6009150769
6	Chow Newta Mantaw	Lathao	8730093547
7	Chow Mokha Mantaw	Lathao	8837443871
8	Chow Walicham Manlong	Lathao	7630823267
9	Ng. Ludis Singkai	Lathao	9612865707
10	Ng. Kaitong Manlang	Lathao	8730093276
11	Chow Siladham Mannaw	Old Mohong	8974427483
12	Chow Aticha Mannow	Old Mohong	9862201091
13	Chow Makang Manlong	Old Mohong	986417561
14	Chow Pantita Hopak	Old Mohong	7630861607
15	Chow Subham Mannaw	Old Mohong	9365540893
16	Chow Seng Manlong	Mankao	9612987366
17	Chow Jorani Namchoom	Mankao	8974517485
18	Chow Kosale Chauhai	Pathar Gaon	8131849128
19	Chow Peng Mounlen	Pathar Gaon	708559811
20	Nang Soikheya Manchey	Pathar Gaon	7630092457
21	Nang Wichakha Thaman	Pathar Gaon	708559560
22	Chaw Appumon Manchey	Pathar Gaon	8118918366
23	Chaw Kungney Manchey	Pathar Gaon	9436213459
24	Chow Ayoka Manlong	Mankao	8974511076

Appendix-3.[C].2. Training on 'Establishment of Food Processing Unit'

Venue: Indian Institute of Entrepreneurship, Guwahati

Date: 08th to 20th November 2021

A technology based entrepreneurship development training programme was conducted at Indian Institute of Entrepreneurship, Guwahati from 08th to 20th November 2021 for twelve days on '*Establishment of Food Processing Unit*'. The training programme was funded by National Mission on Himalayan Studies(NMHS). Ten (10) participants from Namsai district were

attended the training (Table 17). Mr. Prasanta Goswami, Course Director, IIE inaugurated the training on 08th November, 2021. Dr. Bhaskarjyoti Saud, Project Head sensitized the participants on various '*Food Processing Techniques*' and requirements for establishing a processing unit. During the training a number of food processing equipments and machinery were demonstrated and hands-on training performed under the guidance of Mrs. Malamoni Hazarika, an entrepreneur cum master trainer and Rupam Das, Project executive, of IIE. A few recipes were prepared such as Juice, Pickle, Jam, Jelly and Chutney under their guidance. Classes on personal hygiene, Hazard analysis and critical control points (HACCP), various food processing techniques, packaging methods and online marketing, etc. were held from time to time. Mr. Deepankar Bhattacharya, a professional motivational speaker was invited for an encouraging speech on 'scoping the entrepreneurship' to boost confidence among the trainees for their upcoming future in this sector. Mr. Pankaj Sharma, employee of IIE specialised in licensing matters described about licensing matters required for establishment of food processing unit. The way of establishing online commerce platform to facilitate the sales of various marketable products globally was taught by Syed. Mohsin Raza, a software developer by profession working as consultant in DIGITAL MEDIA EDUCATOR. An exposure visit to the trainees was also conducted to a cottage industry owned by Mrs Malamoni Hazarika of Basisthachal, Ganesh Nagar, Guwahati by IIE to understand the working atmosphere, avenue and overall functioning of a MSME food processing unit.

Mr. Biraj Das and Mr. Neeraj Das of IIE illustrated to prepare a 'Detailed Project Report' (DPR) for availing loan from bank. Hands-on training was conducted to acquire necessary skills by trainees and enabled to establish their own food processing unit. Trainees were apriciated by providing certificates at the end of training course. Dr. Prosanta Hazarika, Principal Investigator of the project offered thanks to the Director, IIE, Dr. Saud, Mrs. Ruchira Chaudhary, master trainers and the trainees on behalf of Director RFRI, Jorhat.

Introductory session by Malamoni Hazarika

Demonstration on raw materials selection

Demonstration of selection of proper spices

Hands on training of peeling and cutting

Training on preparation of raw materials

Preparation of Tomato sauce

Demonstration of proper bottle filling technique

Group photo with Master Trainer

Display of prepared value products by trainees during the training period

Fig.15 Glimpses of the training programme on 'Establishment of Food Processing Unit'

Table-17 List of trainee participants attended training at IIE Guwahati on 'Establishment of Food Processing Unit'

Sl No.	Name	Contact number
1	Chow Seng Manlong	
2	Yudhistir Deori	
3	Nang Chetjawa Mannow	
4	Nang Tongsa Singkai(Mein)	
5	Nang Akhon Maio	
6	Nang Swathi Mannow	
7	Chow Shaching Thaumoung	
8	Nang Monusha Munglang	
9	Nishant Jyoti Saikia	
10	Sunit Deori	

Appendix-3 [C].3. Training on 'Mushroom Cultivation and Vermicomposting'

Venue: Krishi Vigyan Kendra (Assam Agricultural University), Tinsukia district, Assam

Date : 19/01/2021

A total of 17 trainees from Lathao, Piyong Khampti, Pathar Gaon and Old Mohong village of Namsai district took part in 1day training program (Table 18). Dr Prosanta Hazarika, Principal Investigator of the project briefed the objectives. The dignitaries and resource persons were felicitated with gamosa as token of respect. Dr. Sanjoy Borthakur, Senior Scientist and Head, Krishi Vigyan Kendra (KVK), Tinsukia, Assam presented the welcome speech on the occasion of the training programme. In his welcome address Dr. Borthakur urged the farmers took benefits of the project acquiring advance technologies of Rain Forest Research Institute and KVK for skill development and enchantment of livelihood. He highlighted the benefits of cultivation of mushroom and organic cultivation through vermicomposting technology and also expected that this training could benefit the trainees for skill up and enhance livelihood. In the 1st training session Dr Sarodee Baruah, Subject Matter specialist, KVK, Tinsukia presented an hour long ppt presentation describing detail on mushroom cultivation with special reference to Oyster mushroom including value addition. She trained on mushroom cultivation, harvesting, drying, packaging and marketing too. In her training economic aspects of mushroom cultivation also addressed. Following the classroom presentation Dr. (Smt) Baruah had demonstrated various steps of mushroom cultivation in a hand on training session to the trainees.

Dr. P. Hazarika briefing on the programme

A partial view of the trainees

Welcome speech Dr. S. Borthakur, Head, KVK

Dr. P. Amonge described on vermicomposting

Dr. Sarodee Baruah on Mushroom Cultivation

Dr. Amonge demonstrated on vermicomposting

Hands on traning by Dr. Sarodee Baruah

A snap shown the trainees, resource persons

Fig.16. Projected a few activities of the training on 'Mushroom Cultivation and Vermicomposting'

In the 2nd training session Dr. Priyanka Amonge, Subject Matter Specialist, KVK, Tinsukia, had offered a ppt presentation on '*Vermicompost Technology*'. Delivering the training speech Dr.(Mrs) P. Amonge described about detail know-how of a vermicomposting staring from collection of organic wastes, sorting of materials, processing, pit filling, vermi production, compost production, sieving etc. She also addressed on the process of packaging, storage and marketing. After the class room training Dr. Amonge demonstrated in hands on training to the trainees on different steps of vermicompost technology. Shri Protul Hazarika, ACTO, RFRI, Jorhat offered vote of thanks.

Table-18 List of trainees' participant of the training on "Mushroom Cultivation and Vermicomposting"

Sl. No.	Name	Village name	Contact number
1	Ng Uktrani Chouhai	Piyong Khampti	
2	Chow Mutuwom Manchey	Piyong Khampti	
3	Chow Kharika Mantaw	Piyong Khampti	
4	Ng. Jutika Manataw	Piyong Khampti	
5	Ng. Sumitra Mantaw	Piyong Khampti	
6	Ng Swathi Mannow	Lathao	
7	Ng. Junmoni Mannow	Lathao	
8	Chow Walicham Maunglang	Lathao	
9	Ng. Jemi Guju	Lathao	
10	Ng. Chantawati Khamhoo	Old Mohong	
11	Ng Mukhi Khamhoo	Old Mohong	
12	Chow Makang Manlong	Old Mohong	
13	Chow Silatha Mannow	Old Mohong	
14	Chow Pumang Khamhoo	Old Mohong	
15	Chow Appumon Manchey	Pathar Gaon	
16	Nang Monusha Munglang	Pathar Gaon	
17	Chow Kungney Manchey	Pathar Gaon	

Appendix-3.[C].4. Training on ‘‘Production and Application of Compost and Vermicompost’

Venue: APVS School, Chongkham, Namsai district.

Duration : 07/04/2021

A part of the trainees and master trainers on dais

Dr. P. Hazarika tainined on vermicomposting

A moment of lecture delivered by Dr. P. Hazarika

A moment of lecture delivered by Protul Hazarika

A moment of demontration by Dr. P. Hazarika

A moment the trainees observation on vermi bed

Fig.17 Glimpses of training activities on Production and application of compost and vermicompost’

A total of 23 numbers of trainees from five Khampti villages i.e. Mankao, Lathao, Piyong Khampti, Pathar Gaon and Old Mohong of Namsai district were taken part in the training programme held at Arunachal Pali Vidyapith, Chongkham (Table 19). Of which 16 were male

and 7 were female. Mrs. Rani Gogoi, Principal, Arunachal Pali Vidyapith, Chowkham delivered the welcome address to the trainees. Shri Indrajit Tingwa, Secretary, Arunachal Pali Vidyapith Society, Chongkham briefing about the objectives of the training programme organized by Rain Forest Research Institute, Jorhat under the project funded by NMHS. Dr. Prosanta Hazarika, ACTO, RFRI, Jorhat delivered a training presentation on 'Production and application of compost and vermi-compost' at farmers level with cheap and eco-friendly manner. After that all trainees were brought to the field to demonstrate how compost and Vermicompost' can be prepared with organic and agricultural wastes. Shri Protul Hazarika, ACTO, RFRI, Jorhat assist Dr. Prosanta Hazarika in demonstration of vermicomposting technology. Certificates were given to the trainees after completion of day long programme.

Table-19 List of participants of the training on 'Production and application of compost and vermicompost'

Sl. No.	Name	Village name	Contact number
1	Chow Mutuwom Manchey	Piyong Khampti	
2	Chow Makang Mantaw	Piyong Khampti	
3	Ng. Jutika Manataw	Piyong Khampti	
4	Chow Pandicha Thaman	Piyong Khampti	
5	Chow Moho Chowmong	Piyong Khampti	
6	Chow Mokha Mantaw	Lathao	
7	Chow Walicham Manlong	Lathao	
8	Ng. Ludis Singkai	Lathao	
9	Ng. Junmoni Mannow	Lathao	
10	Ng. Chantawati Khamhoo	Old Mohong	
11	Chow Siladham Mannaw	Old Mohong	
12	Chow Pumang Khamhoo	Old Mohong	
13	Chow Makang Manlong	Old Mohong	
14	Chow Pantita Hopak	Old Mohong	
15	Chow Ayoka Manlong	Mankao	
16	Chow Seng Manlong	Mankao	
17	Chow Jorani Namchoom	Mankao	
18	Chow Kosale Chauhai	Pathar Gaon	
19	Chow Peng Mounlang	Pathar Gaon	
20	Nang Soikheya Manchey	Pathar Gaon	
21	Nang Wichakha Thaman	Pathar Gaon	
22	Chaw Appumon Manchey	Pathar Gaon	
23	Chaw Kungney Manchey	Pathar Gaon	

Appendix-3.[C].5. Skill Development training on Bamboo Handicrafts for Artisans of Namsai District, Arunachal Pradesh

Venue : ICFRE-Rainforest Research Institute, Jorhat

Date : 02/03/2022 to 12/03/2022

A 10 day training programme was held at Rainforest Research Institute, Jorhat. A total of 12 trainees from Piyong, Mahadevpur, Manmow and Pathar Gaon of Namsai district, Arunachal Pradesh participated in this training programme (Table 20). The "*Skill Development training on Bamboo Handicrafts for Artisans of Namsai District, Arunachal Pradesh*" was conducted under a project titled 'Improving the traditional homestead to a viable agroforestry system for biodiversity conservation and inclusive growth of Khampti tribes of Namsai District, Arunachal Pradesh' funded by National Mission on Himalayan Studies(NMHS). The training was inaugurated on 2nd March, 2022, by Dr. Rajib Kumar Borah, Scientist-G & GCR, RFRI. Dr. Prosanta Hazarika, Principal Investigator of the project briefed the objectives of this training programme. The master trainers- Shri Mohan Saikia, Md. Sagir Ahmed, Dulal Chandra Bora, Debokanta Borah, Nripen Gogoi were facilitated. After the inaugural session Shri R.K Kalita, Scientist-F delivered a talk on '*Importance of bamboo and its potential as a substitute of timber'*. After that Dr. Prosanta Hazarika accompanied the team to Bambusetum, Nursery, Vermicompost unit, Tissue culture lab and Mycology lab and introduced the trainees with various labs to land activities of RFRI. Dr. Runumee Borthakur demonstrated the process of bamboo treatment and different machines used for processing of bamboos. Shri Mohan Saikia, master trainer demonstrated handling of various appliances, tools and machineries use for preparation of bamboo handicrafts articles. On 3rd March 2022, Shri Mohan Saikia trained the trainees on bamboo furniture making. On 4th March 2022, Chua Chowna Mein, Hon'ble Deputy Chief Minister, Arunachal Pradesh visited RFRI Jorhat to have interaction with the trainees. In the interaction session, Deputy Chief Minister assured the trainees for proper market linkage for the handicrafts of Namsai. The hands on training sessions during 3rd march to 7th March were conducted by master trainer Shri Mohan Saikia on different techniques and skills in making different bamboo furniture. He was assisted by Dulal Chandra Bora, Debo Kanta Bora and Nripen Gogoi. During the session the trainees could prepare beds, sofa and a table were made of bamboo. After that from 8th March to 11th March the training was conducted by Md Sagir Ahmed, master trainer on various techniques on making handicraft items from coconut shells and bamboo. During his session the trainees prepared different handicrafts which included Mushroom Night Lamp, Toothpick and Napkin stand with fennel seed server, Night lamp with

mobile stand, Incense stick stand, Coconut tree with mobile stand, Butterfly wall clock, Leaf table clock and Pen stand.

Inaugural meeting of the training programme

Hon'ble DCM, Arunachal Pradesh Chou Chowna Mein with the trainees

Hands on training at Bamboo Composite Centre (BCC), RFRI, Jorhat

Trainees making different bamboo products

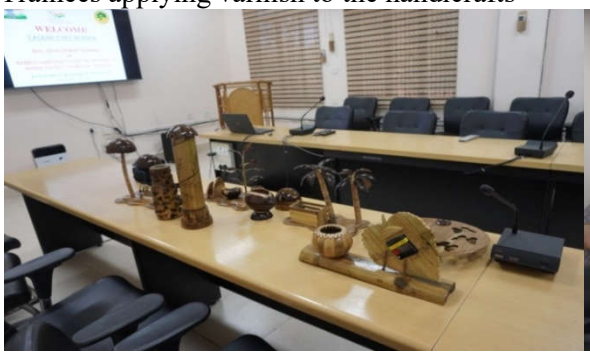
During finishing touch to their products

Bamboo sofa made by the trainees

Bed from bamboo made by the trainees

Trainees applying varnish to the handicrafts

Trainees working with coconut shells



Bamboo handicraft items made by trainees

Trainees displaying their handicraft items

Director RFRI distributing certificates

Group photo of trainees & the organizers

Fig 18 . A few moments of the training activities on 'Bamboo Handicrafts for Artisans'

The Valedictory session was held on 11th March and Chaired by Dr. R.S.C Jayaraj, Director, ICFRE-RFRI, Jorhat, reviewed the training programme, feedback was taken from trainees. Dr. Prosanta Hazarika, PI of the project and Dr. Kuntala N. Barua, Co-PI also took part in the interactive session. At the end of the session Dr. R.S.C. Jayaraj, Director RFRI distributed the certificates to the trainees.

Table-20 List of trainees "Skill Development training on Bamboo Handicrafts for Artisans of Namsai District, Arunachal Pradesh"

Sl. No.	Name	Contact number	Village
1	Chow Srichey Mantaw		Piyong
2	Narmi Tamuk		Mahadevpur
3	Amardeep Handique		Mahadevpur
4	Joyraj Lokhonary		Mahadevpur
5	Dulu Deori		Mahadevpur
6	Diganta Moran		Mahadevpur
7	Ajoy Chouhai		Pathargaon
8	Jintu Mech		Namsai
9	Chow Suto Chowhai		Pathargaon
10	Chow Suktasana Chowhai		Pathargaon
11	Chow Inseng Chowhai		Manmow
12	Manash Bora		Hatigarh

Appendix-3.[C].6. Skill Development Training on Jigat Production and Agarbatti Making

Venue : Community Hall Piyong, Namsai district

Date : 16/06/2022

A total of 20 numbers of trainees (Table 21) from Piyong Circle, Namsai district took part in the day long training programme on "Jigat Production and Agarbatti Making". Dr. Kuntala Neog Barua, Co-PI of the project briefed the objective of the Jigat production from leaves, bark, twigs and flowers of locally available plant species of Namsai district and can be a viable livelihood option as Jigat has high demand for agarbatti industry in the country and have to import from county like china, Thailand, Vietnam etc. She also highlighted that particularly women of Khampti tribes using locally made jigat and engaged them for making of machine made and hand rolled agarbatti as a business to meet even the local demand. After that Dr. Prosanta Hazarika delivered a Power Point presentation of on "Jigat Production and Agarbatti making' for livelihood, self employment and entrepreneurship development. In his presentation Dr Hazarika described in detail about the methodologies of Jigat production from different plant

parts of 25 locally available plant species of Namsai district, Arunachal Pradesh. Apart from Jigat production he also described the process of making bamboo sticks, Charcoal powder from wood and bamboo for agarbatti including indigenous herbal source of fragrance materials. In the ppt he also showed the tools and machineries required for setting up a small Agarbatti unit. After that the technology of making hand rolled agarbatti and machine made agarbatti was described.

Table 21 List of trainees' participant of the training on "Skill Development Training on Jigat Production and Agarbatti Making" of Piyon Circle, Namsai district at Community Hall of Piyong village held on 16th June, 2022

Sl. No.	Name	Circle/ Village name	Contact number
1	Chow Muthuam Manchey	Piyong	
2	Chow Moho Chowmong	Piyong	
3	Chow Hunseng Yoya	Piyong	
4	Chow Shaching Thaumoung	Piyong	
5	Chow Kheman Moumay	Piyong	
6	Nonghow Maio	Piyong	
7	Nang Suphata Hopak	Piyong	
8	Nang Chotini Mannow	Piyong	
9	Nang Rasna Chowpoo	Piyong	
10	Gulab	Piyong	
11	Nang Obanti Chowmoung	Piyong	
12	Nang Sukshanti Mantaw	Piyong	
13	Chalom Maio	Piyong	
14	Nang Anulisha Mantaw	Piyong	
15	Nang Rashmi Mantaw	Piyong	
16	Nang Summa Mein	Piyong	
17	Nang Jyotika Mantaw	Piyong	
18	Nang Sumitra Mantaw	Piyong	
19	Chow Thonsa Singkai	Piyong	
20	Chow Allin Thoumoung	Piyong	

Dr. K. N. Barua briefing project activities

A part of trainees in Piyong Circle, Namsai

Dr P. Hazarika presented on 'Jigat Production and Agarbatti making' in Piyong

Dr. P. Hazarika showed to make masala

Dr. P. Hazarika gave practical demonstration

Distribution of certificate to an entreupruner

Group photo of trainees of Piyong Circle, Namsai

Fig. 19 Activities of training programme on Jigat production and Agarbatti making at Piyong

There was a hands-on training for 'Jigat production and agarbatti making' in the afternoon session. Dr. Prosanta Hazarika demonstrated practically making of Jigat, Charcoal powder,

round bamboo sticks from locally available *Bambusa tulda*. During the training special emphasis was given on making of masala with powder mixture of Jigat, charcoal and saw dust with their different ratio and hand rolled agarbattis to the trainees. The trainees were given to do practically to roll the filler material (Masala/jigat-charcoal paste) on to bamboo sticks to obtain agarbatti. During the training drying of agarbattis, application of fragrance and packaging were also taught. The trainees showed keen interest in the agarbatti making process and were eager to start the agarbatti business with the help of RFRI and the local government. The certificates were distributed to the trainees

Appendix-3.[C].7. Training on Jigat Production and Agarbatti Making

Venue: Community Hall Pathar Gaon, Namsai, Arunachal Pradesh

Date : 17/06/2022

A total of 26 number of trainees from Pathar Gaon village of Namsai district took part in the training program (Table 22) on 17th of June 2022 that was held in Community Hall of Pathar Gaon on " Jigat Production and Agarbatti Making". Of which, only 3 were male and 23 were female trainees. Dr Prosanta Hazarika, Principal Investigator of the project briefed the objectives. Then Dr. Kuntala Neog Barua, Co-PI of the project presented her talk about the project activities that have been carried out for the benefits the Khampti people would derive upon completion of the project. Her speech was followed by the Power Point presentation of Dr. Prosanta Hazarika on " Jigat Production and Agarbatti making' for livelihood, self employment and entrepreneurship development. In his presentation Dr Hazarika described in detail about the tools and techniques of Jigat production from different plant parts of 25 locally available plant species of Namsai district, Arunachal Pradesh. He also described the process of making bamboo sticks, Charcoal powder from wood and bamboo for agarbatti including indigenous herbal source of fragrance materials which are the materials used for agarbatti makin.. In the ppt he also showed the tools and machineries required for setting up a small Agarbatti unit. After that the technology of making hand rolled agarbatti and machine made agarbatti was described.

In the 2nd session of the day a hands-on training was undergone for 'Hand rolled agarbatti making'. Dr. Prosanta Hazarika demonstrated how to make Jigat from home garden plants like *Hibiscu*s sp, *Corchorus* spp, *Ipomoea batatas* and *Manihot esculenta*; Charcoal powder, round bamboo sticks from locally available *Bambusa tulda*. During the training special emphasis was given on making of masala with powder mixture of Jigat, charcoal and saw dust with their different ratio and hand rolled agarbattis to the trainees. The trainees were given to do

practically to roll the filler material (Masala/jigat-charcoal paste) on to bamboo sticks to obtain agarbatti.

Dr K.N. Baruah addressed to the trainees

Dr P. Hazarika presented PPT at Pathar Gaon

Dr. Hazarika demonstrated on Jigat production

Dr. Hazarika demonstrated on agarbatti making

Trainees making agarmatti masala

Trainees with hand rolled agarbatti they made

Distribution of certificate to an entreupruner

Group photo of trainees of Pathar Gaon

Fig.20 Glimpses of training activities on Jigat Production and Aagarbatti making at Pathar Gaon

During the training drying of agarbattis, application of fragrance and packaging were also taught. Trainees were thought to produce 'Substitute of Jigat' from cultivated plant species in their home gardens like *Hibiscus rosa-sinensis* (Joba phul), *Corchorus* spp (Pat mora), *Ipomoea batatas* (Ronga alu) and *Manihot esculenta* (Simolu Alu) for the agarbatii industry of India. Dr. Hazarika also emphasized that India has to imoport Jigat powder from Vietnum, China etc per annum. So it has a huge market potential and young entrepreneurs of this state can choose for startup business setting up 'Substitute Jigat Production Unit' in Namsai district. He also shown other 20 plant species which could be collected from the wild source for making of substitute Jigat too. He described entire process of making 'substitute Jigat' as a value added product to met at least local demand. The trainees showed keen interest in the agarbatti making process and were eager to start the agarbatti business with the help of RFRI and the local government. The certificates were distributed to the trainees after completion of the training. **Table 22** List of trainees' participant of the training on "Skill Development Training on Jigat Production and Agarbatti Making" of Namsai Circle, Namsai district at Community Hall of Pathargaon held on 17th June, 2022

Table 22 List of trainees attended in the training programme on 'Jigat Production and Agarbatti Making"

Sl. No.	Name	Circle/Village name	Contact number
1	Ng Ontika Chowhai	Pathar Gaon	
2	Ng Samawati Manchey	Pathar Gaon	
3	Ng Chanti Chowhai	Pathar Gaon	
4	Ng. Nampa Mounglang	Pathar Gaon	
5	Ng Sumikthi Mannow	Pathar Gaon	
6	Ng Chandrama Chowmong	Pathar Gaon	
7	Ng. Kaliya Chowmong	Pathar Gaon	
8	Ng Sumpi Chowhai	Pathar Gaon	
9	Ng Janan Insha	Pathar Gaon	
10	Ng Kaipa Waulong	Pathar Gaon	
11	Ng Thanika Euling	Pathar Gaon	
12	Ng Champa Chauhai	Pathar Gaon	
13	Ng Ingya Cloulu	Pathar Gaon	
14	Ng Kenmitey Thaman	Pathar Gaon	
15	Ng Nima Thamoung	Pathar Gaon	
16	Ng Nelon Chowlik	Pathar Gaon	
17	Ng Milika Longchat	Pathar Gaon	
18	Ng Nang Wichakha Thaman	Pathar Gaon	

19	Ng Nima Mannow	Pathar Gaon
20	Ng Jemi Guju	Pathar Gaon
21	Ng Onpha Mantaw	Pathar Gaon
22	Ng Sarnalata	Pathar Gaon
23	Ng Dolly Chowmik	Pathar Gaon
24	Ch Peng Mounglang	Pathar Gaon
25	Ch Suto Chowhai	Pathar Gaon
26	Ch Ajoy Chouhai	Pathar Gaon

Appendix-3.[C].8. Skill Development Training on Bee-keeping, Value Addition and Entrepreneurship

A total of twenty-three trainees from different Khampti villages of Namsai district, viz. Lathao village, Pathar Gaon, Piyong, Mankao and Old Mohong took part in the two-days training programme on 16th and 17th of November, 2022 that was held at Community Hall, Lathao Village, Namsai (Table 23). The training programme on "Skill Development Training on Bee-keeping, Value Addition and Entrepreneurship" was organized by Dr. Prosanta Hazarika P.I and Protul Hazarika CoPI, and Shri Mayur Suman, PA, RFRI, Jorhat. The training was performed under the project titled "Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh" funded by NMHS. The names and contact number of the trainees who took part in the training are presented in the Table 1. On the 1st day of the training programme Dr Prosanta Hazarika, Principal Investigator of the project welcomed the trainees and invited guest in the opening session and also delivered a brief introduction about the training programme. Thereafter, Shri Protul Hazarika, Co-PI of the project presented his talk about the project activities that have been carried out for the benefit of the Khampti people. His speech was followed by the felicitation of the resource persons, Dr. Madhumita Sonowal, Scientist, KVK Namsai and Shri Mohon Saikia, Master Trainer, Sivasagar. After this the Technical Session of the workshop was started in which Dr. Madhumita Sonowal presented ppt to the trainees on "Bee-keeping, Colony care, Queen Care and Worker bee management".

Post lunch of the day, the second Training session began with another presentation by Dr. Madhumita Sonowal on "Harvesting, processing, purification of honey and value addition, storage, marketing and entrepreneurship". The second part of the afternoon session ended with a presentation cum demonstration on "Tools and Techniques for bee-keeping, plant species and seasonal impact on Honey production' presented by Shri Mohon Saikia, Master Trainer, Sivasagar,

Dr. Prosanta Hazarika delivering the welcome address

Dr. Prosanta Hazarika delivering the inaugural speech

Felicitation of Shri Mohan Saikia

Felicitation of Dr. Madhumita Sonowal

Presenting by Dr. Madhumita Sonowal

Dr. Sonowal interacting with the trainees

Shri Mohan Saikia delivering his speech

Shri Mohon Saikia showing honey comb to the trainees

Shri Mohon Saikia demonstrating on bee keeping technique

hands on training on bee keeping by Shri Mohon Saikia

Shri Mohon Saikia showing bee colony transfer technique

Shri Mohon Saikia showing bee colony transfer technique

Distribution of cerificates among trainees

Distribution of cerificates among trainees

Distribution of cerificates among trainees

Distribution of cerificates among trainees

Fig. 21 Glimpses of training activities Skill Development Training on Bee Keeping, Value Addition and Entrepreneurship'

Table 23 Trainees on 'Skill Development Training on Bee Keeping, Value Addition and Entrepreneurship' held at Community Hall Lathao village on 16th and 17th November, 2022

Sl. No.	Name	Village name	Contact number
1	Nang Samawati Manchey	Pathargaon	
2	Nang Ashwari Moungkang	Lathao	
3	Chow Kolita Lungchat	Lathao	
4	Nang Mounusha Munglang	Pathar Gaon	
5	Chow Roisan Longphong	Lathao	
6	Nang Monika Thaman	Lathao	
7	Chow Meing Mitti	Lathao	
8	Chow Wathaka Thaman	Lathao	
9	Chow Athina Mantaw	Lathao	
10	Nang Alaka Munglang	Lathao	
11	Nang Renumai Singpho	Lathao	
12	Chow Chicktiya Chowhai	Pathar Gaon	
13	Chow Ayoka Manlong	Mankao	
14	Chow Khamseng Chowhai	Pathar Gaon	
15	Chow Muthuwom Manchey	Piyong	
16	Chow Newata Mannow	Lathao	
17	Chow Bhaikon Gogoi	Lathao	
18	Chow Kharika Mantaw	Piyong	
19	Chow Noungun Singkai	Piyong	
20	Nang Tishana Mantaw	Lathao	
21	Nang Prini Engling	Lathao	
22	Chow Makang Manlong	Old Mohong	
23	Nang Chanti Chowhai	Pathar Gaon	

Table -24 List of beneficiaries receiving bee boxes and bee colonies of *Apis cerara*

Sl. No.	Name	Village name	Contact number
1	Chow Newata Mannow	Lathao	
2	Chow Peng Munglang	Pathar Gaon	
3	Chow Makang Manlong	Old Mohong	
4	Chow Muthuwom Manchey	Piyong	
5	Chow AyokaManlong	Mankao	
6	Chow NoungunSingkai	Piyong	
7	Chow KhamsengChowhai	Pathar Gaon	
8	Nang AlakaMunglang	Lathao	
9	Chow KharikaMantaw	Piyong	
10	Chow WathakaThaman	Lathao	

On the 2nd Day of the two days training programme started with a demonstration by Shri Mohon Saikia. The presentation was carried on “Demonstrative training on bee-keeping, Queen care, Colony care and colony separation, harvesting and processing of Honey”. The 2-Day Workshop was successfully concluded with a field exposure-visit to Borkhet Bee Farm (Pomoung Enterprise), Changlang district, Arunachal Pradesh. The visit was intended to give a real life firsth and experience to the participants on bee-keeping and this was demonstrated by Shri Protul Hazarika, Co-Principal Investigator of the project. 10 bee boxes were distributed among the trainees of the workshop (Table 24). Along with the Bee boxes 5 bee colonies of *Apis cerara* were also distributed among the 5 beneficiaries of the Agroforestry homesteads (Table 24). The trainees showed keen interest in bee-keeping and were eager to start the practice of bee-keeping with at least at the household level. A few of them were even interested to take the practice to an industrial/Commercial level. The certificates were distributed to the trainees on completion of the training.

Appendix-3.[C].9. Skill development training on Japi Making for value addition and livelihood at Village, Namsai, Arunachal Pradesh

Venue : Pathar Gaon Village, Namsai, Arunachal Pradesh

Date : 26/02/2023 and 27/02/2023

A total of eighteen (18) trainees from different villages of Namsai district, viz. Lathao village, Pathar Gaon, Piyong, Wingko and Mahadevpur took part in a two-days training programme on 26thand 27th of February, 2023 which was held at Pathar Gaon Village. The workshop was organized by Dr. Prosanta Hazarika, ICFRE-Rain Forest Research Institute, Jorhat, Assam on “Skill Development Training on Japi Making for Value Addition and Livelihood” under the project titled “Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh”. Name and contact numbers of the trainees who took part in the training are presented in the Table 25. Dr Prosanta Hazarika, Principal Investigator of the project gave a brief introduction about the training programme while delivering the welcome address. He also briefed about the ongoing project activities carried out under this project by ICFRE-Rain Forest Research Institute Jorhat with the fund received from National Mission on Himalayan Studies (NMHS) in Namsai district and benefits gained by the local communities in the area.

Dr. Prosanta Hazarika, Principal Investigator of the project delivering the inaugural speech


Shri Pulin Nath, Master Trainer demonstrating Japi making technique

Master Trainer demonstrated for Japi making

Hands on training of making Japi

Trainees practicing their skills

Demonstrating Japi making technique

Demonstration for Japi making technique to the trainnes by Sri Pulin Nath, Master trinner

A moment of demonstration for Japi making

Trainees adding final touch to newly made Japi

Group photos with trainees

Fig. 22 A few activities on the training programme 'Skill development training on Japi Making for value addition and livelihood'

The inaugural speech was followed by the felicitation of the resource person, Mr. Pulin Nath, Master Trainer from Jorhat by Shri Mayur Suman, JPF. After this the master trainer presented a 'hands on training for making Japi'. He showed the trainees to make Japi with the resources available locally such as bamboo and leaves of *Livistona jenkinsiana* (Toko paat).

After lunch, he demonstrated how to make two different types of Japi. One Japi was made for use in agricultural fields use for protection from rain and sun. The other one was Phulam Japi which commercial trade during Rangalee Bihu of Assam by by Bihuwatis and for household decoration mostly. The first day of the training session was limited to demonstration of making Japi for use in agricultural fields. The trainees learned how to make the mould for making Japis in large scale. They also learned about the tools and techniques required for this purpose.

The day two of the workshop was started with demonstration for making decorative Japis of different sizes for different uses. The Master trainer Sri Pulin Nath provided expertise and assistance to the trainees in making beautiful decorative Japis

Table 25 List of trainees of the training on 'Skill Development Training on Japi Making for Value addition and Livelihood' held at Pathar Gaon village on 26th and 27th February, 2023

Sl. No.	Name	Village name	Contact number
1	Chow Kharika Mantaw	Piyong	
2	Chow Supiya Hopak	Nampong	
3	Chow Khamseng Chowhai	Pathar Gaon	
4	Chow Niping Longchot	Piyong	
5	Chow Thonsa Singkai	Piyong	
6	Chow Purnakanta Gogoi	Mahadevpur	
7	Chou Srichey Mantaw	Piyong	
8	Chow Nong Singjat	Manmow	
9	Chow Prodip Langnou	Manhofai	
10	Nogen Deori	Mahadevpur	
11	Pradip Deori	Mahadevpur	
12	Suresh Deori	Mahadevpur	
13	Chow Ani Manchey	Wingko	
14	Sri Bapukon Gogoi	Lathao	
15	Sri Bhaikon Gogoi	Lathao	
16	Chow Mutuwom Manchey	Piyong	
17	Chow Peng Mounglang	Pathar Gaon	
18	Chow Nara Mannow	Nampong	

The trainees showed keen interest in making Japis and were eager to start commercial scale production of Japis for distribution in the local markets. ICFRE-Rain Forest Reasearch Institute, Jorhat assured market linkages for selling their products. The concluding speech was

given by Dr. Prosanta Hazarika which emphasized on importance of making products with locally available resources and how Japing making can prove as a means of livelihood for the local communities living in Namsai district of Arunachal Pradesh. The certificates were distributed to the trainees by Dr. Prosanta Hazarika after completion of the training.

Appendix-3. [C].10. Floriculture and Plantation Management of Fruit Plants in Agroforestry Homegarden

Venue: Mannow, Namsai, Arunachal Pradesh

Date : 10/03/2023 and 11/03/2023

ICFRE- Rain Forest Research Institute, Jorhat, Assam held a training cum skill development programme on "Floriculture and Plantation Management of Fruits plant in Agroforestry Homegarden" during 10th and 11th of March, 2023 at Mannow Village, Namsai, Arunachal Pradesh. A total of thirty-eight (38) trainees from different Khampti villages of Namsai district, viz. Lathao village, Pathar Gaon, Piyong, Wingko, Manhofai and Jona III took part in a two-days training programme (Table 26). The training programme was organized under the project titled "Improving the traditional homestead to a viable agroforestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh" funded by National Mission on Himalayan Studies (NMHS). Dr Prosanta Hazarika, Principal Investigator of the project briefed on the training purposes in his welcome address at the very beginning of the training programme. He spoke about the impact this project carried out by Rain Forest Research Institute Jorhat funded by National Mission on Himalayan Studies (NMHS) in Namsai district and how it benefitted the local communities in the area particularly on the biodiversity and livelihood of the Khampti people. He highlighted about the different training workshops organized in Namsai and other places for empowering the Khampti tibe while focusing the importance of improved agricultural practices for better income of the people and the benefits of this training programme. The inaugural speech was followed by the felicitation of the resource persons, Prof. (Dr.) Sailen Gogoi, Department of Horticulture, Assam Agriculture University, Jorhat and Prof. (Dr.) Preeti Hatibarua, Department of Horticulture, Assam Agriculture University, Jorhat. It was followed by release of RFRI Report 20 was done entitled 'Substitute Jigat for Agarbatti Industry' by Prof (Dr). Sailen Gogoi, Prof. (Dr.) Preeti Hatibarua, Department of Horticulture, Assam Agriculture University, Jorhat. Chow Muthuwom Manchey and Chow Peng Mounglang, the agroforestry demo plot owners were also took part in the event.

The training session Prof. (Dr.) Preeti Hatibarua delivered a lecture on 'Prospect of Floriculture for Self-employment and success stories for entrepreneurs' followed by a demonstration on floriculture. Prof. (Dr.) Hatibarua explained about the different types floriculture methods of the flower species commonly used for the commercial use such as decorations, religious functions and ornamental plants. She presented her lecture on large scale farming of different economically important flower plants and the fertilizers and pest management for fast growth and maximum yield. She also projected successful stories of several man and women from North Eastern region of India to encourage the trainees for choosing floriculture as agribusiness for self employment .

After lunch the technical session commenced titled 'Floriculture and Nursery development, crop management, processing and marketing'. She gave hands on training on propagation of flowering plants and different nursery techniques. She also focused on marketing of these flowers for a good income among the Khampti community.

The day two of the training programme on 11th March 2023 was started with technical session on 'Plantation management of fruits plant in agroforestry home garden' presented by Prof. (Dr.) Sailen Gogoi, Prof Horticulture Department, AAU, Jorhat. He delivered a detailed and elaborated lecture on the importance of fruit plants having in the homestead gardens of every Khampti family. He emphasized on the importance of having a good physical health and how the fruits help in maintaining it. He provided a list of fruit plants which the people are grown in their home gardens with minimum maintenance. He was impressed by the availability of a wide variety of fruit plants in the homesteads of Namsai and acknowledged the awareness among the people regarding this matter. After lunch, in the next technical session was held on 'Value addition of home garden fruits and market linkages'. Dr. Sailen Gogoi described to the trainees about the importance and methods for value addition and making for earning good profit out of the fruits grown in their homesteads. An interactive session was also held where the trainees shared their problems related to plantation management with the resource person. After that the Dr. Prosanta Hazarika, Shri Protul Hazarika, Dr. Sailen Gogoi and Dr. Preeti Hatibarua distributed the certificates to the trainees. The training programme concluded with a vote of thanks offered by Shri Mayur Suman and clicking of a group photo with the trainees.

Dr. P Hazarika delivering the inaugural speech

Snapshots from the training workshop

Snapshots from the training workshop

Report on “Substitute Jigat for agarbatti industry” released

Prof. (Dr.) Preeti Hatibaruah addressing

Prof. (Dr.) Sailen Gogoi addressing

Snapshots of training and technical session from Prof. (Dr.) Preeti Hatibaruah

Snapshots of training and technical session from Prof. (Dr.) Sailen Gogoi

Distribution of certificates to trainees by Prof. (Dr.) Preeti Hatibaruah

Distribution of certificates to trainees by Dr. Prosanta Hazarika

Distribution of certificates to trainees by Prof. (Dr.) Sailen Gogoi

Group photo with trainees

Fig 23. A few moments of training activities on'Floriculture and Plantation Management of Fruits Plant in Agroforestry Home garden' held at Manmow, Namsai

Table 26 List of trainees of the training on 'Floriculture and Plantation Management of Fruits Plant in Agroforestry Home garden' held at Manmow, Namsai on 10th and 11th March, 2023

Sl. No.	Name	Village name	Contact number
1	Chow Wiwaseng Namchoom	Piyong	
2	Nang Hatiwa Mannow	Lathao	
3	Chow Khamseng Chowhai	Pathar Gaon	
4	Nang Rupawati Singkai	Wagun II	
5	Ng. Deepali Chowhai	Pathar gaon	
6	Ng. Manisha Singpho	Lathao	
7	Nang Phatni Chowhai	Pathar gaon	
8	Nang Khamching Mannow	Nampong	
9	Chow Prodip Langnou	Manhofai	
10	Chow Supia Hopak	Nampong	
11	Nang Cinam Khamho	Nampong	
12	Nang Menoka Longkan	2 mile Namsai	
13	Nang Akhon Maio	Enthem	
14	Chow Nehou Langnou	Manhofai	
15	Nang Karishna Singpho	Namsai	
16	Chow Mutuwom Manchey	Piyong	
17	Chow Peng Mounglang	Pathar Gaon	
18	Chow Nara Mannow	Nampong	
19	Alisha Manchey	Chesing Wingko	
20	Nang Anchana Chowmomg	Piyong	
21	Nang Potma Hopak	Nampong	
22	Nang Nihom Chowmong	Piyong	
23	Nang Anita Manchey	Chesing Wingko	
24	Nang Santi Longchot	Jona III	
25	Runjun Gogoi	Jona III	
26	Nang Sotra Longkan	Chesing Wingko	
27	Nang Malati Dhulia	Jona III	
28	Reboti Gogoi	Jona III	
29	Nang Sengsaw Choumong	Piyong	
30	Lozi Gogoi	Jona III	
31	Purnima Guju	Jona III	
32	Nang Ontika Chowhai	Pathar Gaon	
33	Rimjim Guju	Lathao	
34	Nang Khemini Moungkang	Lathao	
35	Nang Keslani Moungkang	Lathao	
36	Nang Monusha Munglang	Pathar Gaon	
37	Chau Wasaka Thaman	Manmow	
38	Chau Ketong Mounglang	Manmow	

Appendix 3 [D] Details of technology demonstration and awareness camps were conducted for the farmers/ beneficiaries on the full benefits of agroforestry systems

Appendix-3 [D] 1. Participatory Apprisal Meetings (PRAs) cum awareness camps

Five (5) participatory rural appraisal (PRA) meetings were conducted in Old Mohong, Piyong, Pathar Gaon, Lathao and Manko villages of Namsai district. Name of selected villages, administrative Circle and date of PRAs conducted are presented in Table 27. During PRAs resources of the villages were also mapped and present status of livelihood options were documented. During PRA meetings, awareness programme on conservation of biodiversity with special reference to homesteads plant species and their importance in present households environment and contribution towards livelihood generation was discussed by Dr. P. Hazarika.

Fig 24 A few moments captured of PRA activities in Old Mohong Village, Lekang (Mahadevpur) Circle, Namsai District, Arunachal Pradesh

Almost 50 % of the gatherings were younger generation. They desired to focus on a few potential resource based technologies for self employment like thread, bags and basket making from *Alpinia* spp, Broom grass cultivation, jaru and basket making from broom grass, handmade paper from biomass, weaving, mushroom cultivation, cultivation of spices and value addition, agarbatii production.

Table 27 Name of the Khampti Villages, administrative Circle of Namsai district, Arunachal Pradesh where conducted PRA meetings.

Sl. No	Name of Village	Administrative circle	Date of PRA Conducting
1	Old Mohong	Lekang (Mahadevpur)	05/12/2019
2.	Lathao	Lathao	10/01/2020
3.	Pathar Gaon	Namsai	30/12/2019
4.	Mankao	Chongkham	28/12/2019
5.	Piyong Khampti	Piyong	12/01/2020

Besides traditionally prepared mat and japi from *Livisona jenkinsiana* and *Shumannianthus dichotomus*, they also urged for advance training to be held on vermi-composting, solar drying of fruits & vegetables for consumption in off seasons; sauce, jam jelly and pickle making, preparation of substitute of plastic cup, plate disc ete. from *Phrynium capitatam* etc were also discussed for utilization of locally available plant resources. It was also informed that need base training may also be given to such progressive youth to set us small production units for self employment base on local resources. In addition to the above, during discussion in the PRA meetings a special focus was given to highlight on the benefits of agroforestry plantation in their homesteads to make the land more productive and to promote production of crops and livelihood thereby value addition of own resources. Five (5) homesteads (plots) of 5 Khampti villages were selected for improving their agroforestry system at the PRA exercises held in those villages. Selection was done with a discussion during the PRA meetings. The size of each selected homestead is more than ha in area and also scattered in each one of the five circles of Namsai district Arunachal Pradesh. During PRAs SWOT analysis was done for each villages and identified following common factors for strength (S), weakness (W), opportunity (O) and threat (T). Accordingly, land and resources was identified astheir strength; poor education and technology skills as weakness; human resource, rich biodiversity, tribal tradition and culture as opportunity; lack of technology exposure and awareness, incompetency in resource generation and utilization as major threats for the tribe.

Fig.25. A few moments of PRA in Piyong Khampti Village, Piyong Circle, Namsai District, Arunachal Pradesh

PRA Resource Mapping inMankao Village, Chongkham Circle, Namsai

PRA Resource Mapping in Lathao Village, Lathao Circle, Namsai district

PRA Resource Mapping in PathargaonVillage, Namsai Circle, Namsai district

Fig. 26 A few moments of PRA in Mankao, Lathao andPathar Gaon Villages, Namsai District, Arunachal Pradesh

Appendix-3.[D]. 2. Field demonstration for skill development and livelihood on mushroom cultivation

On-site training on 'Mushroom Cultivation and Value Addition

On-site training programmes were conducted for skill development and to promote livelihood among the villagers and self help groups (SHGs) with field demonstration on mushroom cultivation. Four such programms were conducted during February and March, 2021 i.e. Piyong Khampti, Pathar Gaon, Lathao village an Old Mahong village of Namsai district (Appendix 3 B). Dr. Prosanta Hazarika, PI of the project was the resource person all the four demonsration and value addition programmes. He trained the beneficiatries on cultivation of Oyster Mushroom by hand on trainings. During the training period in Old Mohong village a total of 24 trainees including 6 male and 18 female Khampti beneficiaries were trained (Fig. 27 A & B). Like wise in Piyong Khampti village the training was conducted for 12 trainees of which 3 male and 9 female on 17.02.2021 (Fig. 27 C& D). Similarly onsite demonstration on "Mushroom cultivation and value addition' for Pathar Gaon was conducted on 20.02.2021. A total of 10 beneficiaries including 3 man and 7 women were trained in Pathar gaon. The programme was conducted for 12 beneficiaries of which 3 men and 9 women for the mushroom cultivation and velue addition in Lathao village on 08.03.2021.

Trainees were shown the entire process of mushroom cultivation i.e. cutting overnight dipping in water & boiling of paddy straw, enriching of cultivation medium with rock phosphate and calcium, filling of paddy straw in porus poly bags, inoculation layer by layer and dark room conditions for mushroom cultivation, sprying of water intermitantly, harvesting of mushrooms, fresh mushroom packeting for sale, drying of mushrooms at 60°C at hot air oven etc. They were tought to make powder of dried mushrooms and to make mushroom soup as value added product.

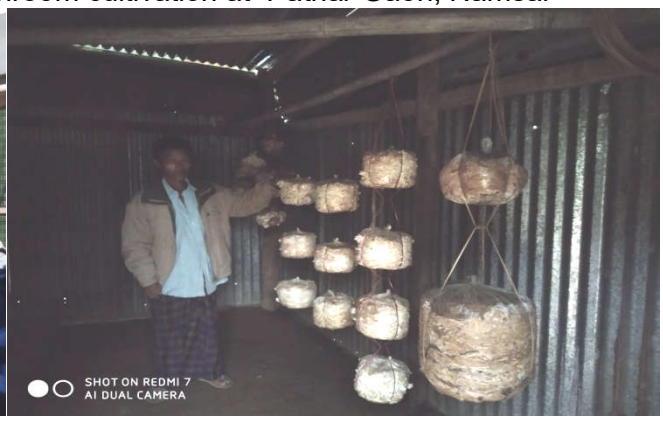
They had been tought to produce mushroom spawn (seed) from mother culture in para boiled rice as medium and their maintainace. At the end of training programmes seeds (Spawn) of 40 packets (200g in each packet) of Oyster Mushroom seeds were also distributed to each of the four SHGs. The beneficiaries of four villages after the field demonstration programme cultivated the mushrooms and a few suchactivities are presented in fig 28.

Fig: 27 A few moments of field demonstration and hands on training programmes conducted in four Khampti villages for Mushroom cultivation and value addition'.[A&B]: at Old Mahong; [C&D]: at Piyong Khampti village; [E&F]: at Pathar Gaon; [G & H]: at Lathao Village

Mushroom seeds disributed in Piyong Khampti

Mushroom seeds disributed in Lathao village

Demonstration to another group on Mushroom cultivation at Pathar Gaon, Namsai



A part of mushroom cultivation at Piyong Khampti by a SHG

A few moments of mushroom cultivation activities after the training by the SHG at Old Mohong Village

Fig 28. Mushroom cultivation activities after the training in different villages

Appendix-3 [D] 3 Field demonstration for skill development on "Vermicomposting and Application"

Four technology demonstration camps on 'Vermicomposting and Application' were conducted in Old Mohong, Piyong, Pathar Gaon and Lathao village of Namsai district under the project during February and March, 2021.

Conduct field demonstration in Piyong **village**

Conduct field demonstration in Old Mohong

Conduct field demonstration programme on vermicomposting in Pathar Gaon village

Conduct field demonstration programme on vermicomposting in Lathao village

Fig 29 A few moments of Field demonstration programmes on 'Vermicomposting and Application' in Old Mohong, Piyong, Lathao and Pathargaon village of Namsai district

Demonstration programmes were conducted in each of the five villages where the vermicompost units those were established as capacity building infrastructure to the agroforestry demo plots for nutrient production to apply in the crops. Date, place of training and number of trainess took part in the field demonstration programmes on 'Vemicomposting and application' are presented in Appendix 3 [B]. During the programmes Dr Prosanta Hazarika and Shri R Bhattacharrya of RFRI, Jorhat offered hands on training to the trainees. Shri Rajarshree Bhatacharya detailed about source and collection of materials for vermicomposting, selection of suitable place for vermicompost pit, processing, cutting, half decomposing of organic wastes, enriching with rock phosphate, ratio of organic waste and cowdung, maintainance of moisture, and temperature in vermicompost pit , filling of materials to the vermicompost pit etc.

Dr. P. Hazarika emphasized on making of lowcost bamboo based overground i pit for vermicomposting. Dr Hazarika described the choice and collection of locally available earth worms from rice fields and banana plants. He also mentioned the earth worn species of commercial production vermicompost. During the demonstration programmes distributed earth worms among the beneficiaies and thought how to muiltipy them for vermicomposting in large scale. Dr. Hazarika also offered hands on training for filling of processed and half decomposted materials to the vermin pit and process of earth worm inoculation to the vermicompost pit. He also described after care and precautionary measures to be taken against ants and rodents and birds and maintainance of excess moisture. He had given special attention on production and use of vermiwash in agroforestry crops for better production and disease management. Dr Hazarika in the 3rd session of each of the demonstration programmes given technology deliberation on harvesting of vermicompost, right time of harvesting, separation of undecomposed materials by sieveing; storage for further application, packaging for sale etc.

Shri Bhattacharya had taken part in field application of vermicompost and described about the time and doses of vermicompost to be applied in different crops. He also showed the application of vermicompost with chemical fertilizers too as a part of integrated nutrient management. During the field demonstration programmes shri Bhattacharya emphasized on application of vermicompost and biofertilizers for organic production of edible crops, upcycle of organic and agricultural residues by producing vermicompost. Dr Hazarika requested the farmers' for extensive use of vermicompost to improve soil quality, enrich soil organic carbon and to mitigate climate change threats. Distribution of pamphlets on vermicomposting of RFRI, Jorhat was done among the beneficiaries of the programmes.

Appendix-3 [D] 4. Orgainzed technology awareness camps

Two 'technology awareness camps' were conducted for encourge the entrepreneurs of Namsai district, Arunachal Pradesh on 9th and 10th April, 2021 in Old Mohong village and Pathar Gaon respectively on "*Utilization aspects of Locally Available Bioresources for Self Employment*' (Appendix 3 [B]). Dr Prosanta Hazarika took part as expert of the awearness camps of both the days. During the programme four technical brochures were distributed among the beneficiaries namely *Thysanolaena latifolia* (Broom grass); Livistona jenkinsiana (Toko Pata); *Phrynium capitatum* (Kou pat) and *Schumannianthus dichotomus* (Patidoi) and described these potential plant resources for cultivation and value addition for livelihood and self employment (details in Appendix 5). It was also seen the except the 4th one all other three plants were cultivated for their traditional uses in the Khampti homesteads. Dr Hazarika emphasized on cultivation in wasteland and home gardens, sustainable harvesting and value addition of broom grass, Tokopata, Kou pat and Paridoi for commercial utilization in mat and japi making, disc and cup making and making of brooms for self employment and setting up of cottage and MSME.

During the aweareness camps Dr. Hazarika also described about the tools and technologies and advance training for commercial production of brooms from broom grass, mat, hat, bags, japies etc from Tokopata and Patidoi; and Disc and cups from Kau pat. Besides these Dr. Hazarika also emphasized to take adequate training for making of value added products such as pickles, jam jelly, souce, squash from locally available agrobased produces. During the aweareness camps 10 beneficiaries were also selected for acquiring training on 'Establishment of Food Processing Unit' which was held at Indian Institute of Entrepreunership (IIE), Guwahati during 08th to 20th November 2021 for 12 days. As discussed the technology aweareness camps also dicided to organize a two days training workshop on Japi making for suatainable use and value addition of Toko Pat which is very common to each of the Khampti homesteads. For that 18 local artisans were selected to offer a skill development training to be conducted in coming days. Out of many Ng. Antina Mantawan entrepruners of organic tea producer had urged to provide training on packageing of value added products to compte the market.

Fig:30 A few moments of the technology awareness camps held at [A-D]:Pathar Gaon and [E & F]: Old Mohong village of Namsai district, Arunachal Pradesh.

Appendix- 4. List of New Products (utilizing the local resources like NTFPs, wild edibles, bamboo, etc.)

Sl No	Name of New product	Local resource used	Producer's detail
1.	Dillenia - Black Pepper Tea	*Dillenia indica* fruit and *Piper nigrum*	Ng. Monusha Munglang, SHG, Pathar Gaon, Namsai, Contact: :9366793600
2.	Dillenia – Zinger Tea	*Dillenia indica* fruit and *Zingiber officinalis*	-Do-
3.	Dillenia– Curry Powder	*Dillenia indica* fruit	-Do-
4.	Garcinia Powder	Fruits of *Garcinia pedunculata*	-Do-
5.	Dillenia Pickle	*Dillenia indica* fruit & other ingradients	-Do-
5.	Mango Pickle	*Mangifera indica* fruit & other ingradients	-Do-
7.	Substitute Jigat	*Manihot esculenta*, *Hibiscus rosa sinensis* and *Corchorus olitorius*	Chow Mutuwom Manchey, Piyong village, Namsai, contact:
8.	Japi	*Livistona jenkinsiana* leaves	Chou Srichey Mantaw Piyong village, Namsai Contact:
9.	Leaf Table Clock,	Bamboo and coconut shell	Ajoy Chouhai Pathargaon, Namsai, Contact :
10.	Coconut tree with mobile stand	Bamboo and coconut shell	Chow Suktasana Chowhai Pathargaon, Namsai Contact:
11	Mushroom Night Lamp	Bamboo and coconut shell	Chou Srichey Mantaw Piyong village, Namsai Contact:
12	Bamboo flower vase	Bamboo	Narmi Tamuk, Mahadevpur, Namsai, Contact :

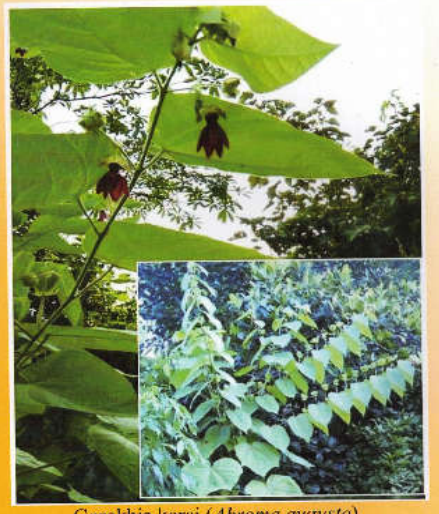
Name of value added products prepared, local resources used for making of value added products name and address of the produces are presented in Appendix 4 above. A total of 12 value added products were produced by the beneficiaries of which 6 were edible product targeting the local markets and other six were non edible. All the above beneficiaries were trained under the project activities for producing the products out of the available resources to their homesteads and agricultural crops. Below are the photographs of them.

	
Dillenia – Zinger Tea	Dillenia - Black Pepper Tea
	
Dillenia– Curry Powder	Garcinia Powder
	
Mango Pickle	Dillenia Pickle

	
Japi	Substitute Jigat
	
Coconut tree with mobile stand	Leaf Table Clock
	
Bamboo flower vase	Mushroom Night Lamp

Fig.31 Few value added product prepared by project beneficiaries

Appendix - 5. Copies of the Supporting Materials like Manual of Standard Operating Procedures (SOPs) developed under the project



Gorokhia korai (*Abroma augusta*)

For more details please contact:
The Director
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Sotai, Jorhat-785001, Assam
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RFRI Report -20

SUBSTITUTE JIGAT FOR AGARBATTI INDUSTRY

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Jigat is one of the important materials used as binder of filler materials that are rolled on the bamboo sticks to obtain agarbatti. Originally, Jigat (adhesive material) was extracted from the glutinous bark of *Persea macrantha* (Syn. *Machilus macrantha*) in Central India. Later on the bark of *Litsea glutinosa* (Syn. *Litsea chinensis*) and *Canarium strictum* emerged as the substitutes of the Jigat. Apart from these, resin from *Ailanthus triphysa, Acacia farnesiana, Myroxylon toluifera, Boswellia serrata,* glues and gum from *Acacia nilotica* etc. are also utilized as adhesive materials by Agarbatti industry.

However, increasing demand for Jigat due to the expansion of agarbatti industry in India has led to unsystematic felling of Jigat producing trees of the evergreen and semi- evergreen forests of Western Ghats and Northeast India. The agarbatti industry of India has been in search of substitute to Jigat powder or binding agent with unique burning properties. Presently, the industries import more than 50 percent of Jigat (Joss powder) or its raw materials from Malaysia, Vietnam and Thailand.

Substitutes for Jigat

ICFRE-Rain Forest Research institute, Jorhat developed natural plant based adhesives suitable for use as substitute of Jigat from a few plant species of Northeast India for incense sticks industry.

Twenty five (25) plant species from Northeast India were identified, which are suitable to be used as substitute Jigat (SJ). These plant species are identified from their different habitat from in 7 states of the Northeast India. They are- *Abroma augsta* (Gorakhia korai), *Actinodaphne angustifolia* (Sati sali), *Actinodaphne obovata* (Bor Petarichewa), *Actinodaphne lawsoni* (Soru Petarichewa), *Altingia excelsa* (Jutili), *Cinnamomum tamala* (Patcheni), *Cinnamomum zeylenicum* (Dalcheni), *Ipomoea batatas* (Mitha alu), *Corchorus olitorius* (Mithamora), *Corchrus capsularis* (Titamora), *Colocasia macrorrhizos* (Mankachu), *Grewia multiflora* (Kukutsuta), *Glychenea sp* (Dhekia loti), *Hibiscus rosa-sinensis* (Joba Phul), *Homalomena aromatica* (Gandha kachu), *Impatiens glandulifera* (Koriya bijal), *Litsea cubaba* (Mejankari), *Litsea sebifera* (Neluka), *Manihot esculenta* (Simolu Alu), *Morus alba* (Nuni), *Pouzolgia indica* (Borali bokuwa), *Sida cordifolia* (Soru Sonboriyal), *Sida rhombifolia* (Sonboriyal), *Pilea rotundinucula* and *Urena lobota* (Bor Honborolua) .

Production of Substitute Jigat

For the purpose of conservation of the species that are harvested destruction for jigat production and also for import substitution, the project on identification of substitute plants was conceived and executed.

Harvesting

Harvesting of plant parts such as bark, leaves, seeds, flowers, whole plant and tender shoots is required for production of substitute jigat from these plant species. Unscientific collection from wild has led to the threat of species extinction and severe genetic erosion among the wild populations of the species yielding jigat. Therefore, cultivation or farming of wild plant species is recommended. Harvesting is to be done only from cultivated or domesticated sources for making of substitute Jigat.

The plant bark may be collected from the standing crops by non-destructive method. In this method, vertical narrow strips are cut in the stem bole or from big branches to extract bark maintaining at least 60 % gap in between two strips. There may be several discontinuous vertical cuts in a stem depending upon the diameter of the plant. However, cut strips should not exceed more than 8 cm in breadth and 60 cm in length and may be less depending the stem dia.

Similarly, cut strips of the stem bole are also to be distributed evenly at a 120 cm vertical distance between two cuts. Immediately after extraction cut, the area may be treated with fungicides to avoid further damage. The bark of the cut area will heal after a few months and extraction can be done in next season without damaging the plant following this method. However, enough skill is required to maintain plant health and also large quantity extraction is not possible from individual plant. In case of leaves to be harvested from standing tree such as *Abroma augsta* (Gorakhia korai), *Actinodaphne angustifolia* (Sati sali), *Actinodaphne obovata* (Petarichawa), *Actinodaphne lawsoni*, *Altingia excelsa* (Jutili), *Cinnamomum tamala* (Pat cheni) and *Cinnamomum zeylenicum* (Dalcheni) 30% of small branches may be harvested at a time. In some cases all the branches of a tree may be pruned, allowing growth of new branches. Pruning or plucking may be done for harvesting of tender plant tips from *Hibiscus rosa sinensis* and *Morus alba* L.

Processing

Harvested or collected raw materials should be unloaded and unpacked quickly upon arrival at the processing unit. Prior to processing, the plant materials should be well protected from

rain, moisture and any other conditions such as fungal and bacterial growth/contamination that might cause deterioration.

Drying

Jigat is prepared from plant materials in dry form. So the moisture content of the materials should be kept as low as possible to make them suitable for grinding into powder. The other necessity of drying is to reduce damage from mould and other microbes. Harvested plant parts are to be chopped into small sizes and sun dried or oven dried at 60^0 C until almost 80% moisture is lost. Processing may vary depending upon the type of materials. Following are the methods of processing for different plant material for preparation of substitute Jigat (SJ).

(a) **Leaves**: The list of plant species from which leaves are to be collected is presented in Table 1. The leaves are to be collected and separated from the branches and kept for oven drying at 60°C or allowed to sun dry. It takes 2-3 days for complete drying.

(b) **Whole plant & tender shoots**: The list of plant species from which tender shoots/entire plants are to be collected is presented in Table 2. Collected herbs and tender shoot are either to be sun dried or oven dried. In sunny days the plant materials may be dried

in sun. For rapid drying of plant materials one can use to dry in roof top or roofing sheet made of tin.

(c) **Bark**: The list of plant species from which bark is to be collected is presented in Table 3. The collected barks are made into small pieces for faster and proper drying. They are then put for oven drying at 60°C or may be dried in sun. It takes about 3-6 days for complete drying.

(d) **Corm/rhizome**: The list of plant species from which corms to be collected is presented in Table 4. Collected corms are to be sliced into small pieces. The sliced corms are then put for oven drying at 60°C and complete drying requires 3-7 days. Alternatively corm slices may be dried in roofing sheet made of tin until drying is sufficient.

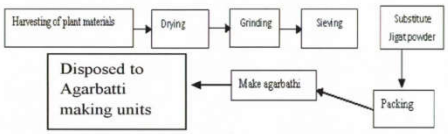


Fig- 1 Diagrammatic sketch of entire process involves in preparation of substitute Jigat.

Machinery and tools

Following machines and tools are required for production of substitute Jigat –

1. Hot air oven
2. Cutter/ chopper machine
3. Grinder machine
4. Powder sieving machine
5. Harvester/plucker
6. Weighting machine/ balance
7. Packing machine

Production of Substitute Jigat (SJ)

After drying of plant materials i.e. leaves, tender plant or bark etc, it is necessary to prepare the Jigat to avoid absorption of moisture or growth of mould or attack by insects. Following procedures are required:-

Grinding: After the plant materials are completely dried, these are to be ground to the finest particles using grinder.

Sieving: The ground plant materials are to be sieved with 100 µm sieve. As an alternative one may also go for traditionally used sieve in household purposes (for sieving *pithaguri* in Assam).

Storage: The powdered and sieved plant materials are to be stored in air tight containers/ poly coated bags to avoid

damage by absorbing moisture or any fungal and insect attack.

This powdered form of plant materials is now termed as substitute Jigat (SJ). The SJ obtained from a plant species can be use alone as substitute Jigat or in combinations mixing with filler materials to prepare 'Masala'. The masala is used to roll over the bamboo sticks for making incense sticks (agarbatti). Charcoal powder and saw dusts are known as filer materials. As of now the market price of per kg Jigat/ Joss powder cost in India is Rs. 40-50 + 5 % GST. It is also evaluated that on an average 10 kg fresh leaves or tender plant parts gives 2.5 -3.0 kg dry powder (SJ) and 10 kg fresh bark in turn gives 3.0-4.0 kg of substitute Jigat. This is an encouraging result for the entrepreneurs for setting up of Jigat production unit by cultivating the SJ yielding plants at commercial scale.

Precautions

Precautions also need to be taken while harvesting the plant materials not to be mounded for long time. Suitable arrangement need to be taken for drying them immediately after harvesting. The temperature should be maintained 60°C at the time of drying in Hot Air Oven to avoid any change in the physico-chemical property of the plant materials. This is done to retain the exact properties of the plant materials as they possess in raw forms. Therefore, one should never be

set the temperature of Hot air oven beyond 60°C while drying materials.

Table 1 List of plant species suitable for making Jigat / Joss powder from leaves

Sl No	Name of the plant species	Local name	Family	Habit	Fl/Fr
1.	*Abroma augusta* (L.) Lf	Gorokhia korai	Malvaceae	Shrub	Nov- Jan
2.	*Actinodaphne lawsoni* Gamble.	--	Lauraceae.	Small tree	July- oct/ Dec-Jan
3.	*Actinodaphne angustifolia* (Blume) Nees	Satisoli	Lauraceae	Medium tree	June-Sept Nov- Dec
4.	*Actinodaphne obovata* (Blume) Nees	Peterisewa	Lauraceae.	Small tree	June- Sept Nov-Dec
5.	*Altingia excelsa* Noronha	Jutuli	Altingiaceae	Tree	April- May/ Dec to Feb
6.	*Cinnamomum tamala* var. *ellip tifolium* Baruah & S.C.Nath	Pat cheni	Lauraceae	Small tree	July-August
7.	*Cinnamomum zeylenicum* Br.	Dalcheni	Lauraceae	Tree	July-August
8.	*Grewia multiflora* Juss.	Kukur suta	Tiliaceae	Shrub	Aug- Nov.
9	*Litsea sebifera* Pers.	Neluka	Malvaceae	Tree	Sept-Oct

We can use oven to dry prepared agarbatti at 60°C for 2-3 hrs. After drying, plant materials can be stored in a suitable dry chamber or shed for a short period of time. However, regular monitoring is required to ensure that no infestation of insect or fungal growth is occurred. Therefore, to avoid this problem it is required to be grinded in to Jigat powder and immediate packaging. After packaging there is very little chance of detoriation of Jigat quality for a year or two.

Standard ratio of preparation Masala with substitute Jigat

Substitute Jigat (SJ) can be prepared from individual species or combinations by mixing two of more plant materials. The suitable ratio of SJ: filler ratio i.e. 1:3 for hand rolled agarbatti and 1:4 for machine make agarbatti.

Table 2 List of plant species suitable for making Jigat /Joss powder from whole plant/ tender plant / branch tip

Sl No	Name of the plant species	Local name	Family	Remark
1.	*Corchorus capsularis* L.	Mora pat	Malvaceae	Tender plant/ seedlings
2.	*Corchorus olitorius* L.	Mitha mora	Malvaceae	Tender plant/ seedlings
3.	*Glychenea sp*	Bon Dhekia	Gleicheniaceae	Tender plant
4	*Hibiscus rosa sinensis* L.	Joba	Malvaceae	Tender plant
5.	*Ipomoea batatas* (L) Lam	Ronga alu	Convolvulaceae	Tender plant
6.	*Impatiens glandulifera* Royle	Koria Bijal	Balsaminaceae	Tender plant
7.	*Manihot esculenta* Crantz	Simolu alu	Euphobiaceae	Leaves/ tender plant
8.	*Morus alba* L.	Nuni	Moraceae	Leaves/ tender plant
9.	*Pilea rotundinucula* Hayata	Piela	Urticaceae	Whole plant
10.	*Pouzolzia indica* (L) G. Benn.	Borali bukuwa	Urticaceae	Tender plant
11	*Sida cordifolia* L.	Saru sonborial	Malvaceae	Tender plant / seedlings
12	*Sida rhombifolia* L.	Sonborial	Malvaceae	Tender plant / seedlings
13	*Urena lobota* L.	Honbaroluwa	Malvaceae	Herb

Production in commercial scale

The plant species such as *Alocasia macrorrhizos* (Man Kasu), *Corchorus capsularis* (Tita Mora), *Corchorus*

olitorious (Mitha mora) *Hibiscus rosa sinensis* (Joba Phul), *Homalomena aromatica* (Gandh Kasu), *Ipomoea batatas* (Ronga alu), *Manihot esculenta* Crantz. and *Morus alba* can be cultivated annually for production of 'Substitute Jigat'.

Table 3 List of plant species suitable for making Jigat /Joss powder from bark

Sl No	Name of the plant species	Local name	Family	Propagation	Collection
1.	*Altingia excelsa* Noronha	Jutuli	Altingiaceae	Seed	Dec – Feb.
2.	*Cinnamomum zeylenicum* Br.	Dalcheni	Lauraceae	Seed	July-Aug.
3.	*Litsea cubaba* (Lour.)	Mejangkori	Lauraceae	Seed	Aug- Sept.
4.	*Litsea sebifera* Pers.	Neluka	Lauraceae	Seed	Sept- Oct.

Table 4 List of plant species suitable for making Jigat /Joss powder from Corm/rhizome

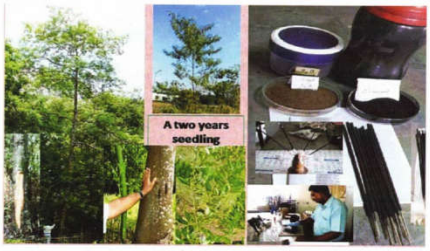
Sl No	Name of the plant species	Local name	Family	habit	propagation
1	*Alocasia macrorrhizos* (L.) G.Don	Man kachu	Araceae	herb	Corm
2	*Homalomena aromatica* (Spreng.) Schott	Gandh kachu	Araceae	herb	Corm

Tender branch tips of *Hibiscus rosa sinansis*, *Manihot esculenta*, *Morus alba* and entire aerial part of *Ipomoea batatas*, rhizome of *Alocasia macrorrhizos*, *Homalomena*

aromatica and one month field grown *Corchorus capsularis* and *Corchorus olitorious* are suitable for making SJ. Commercial cultivation of *Corchorus capsularis*, *Corchorus olitorious* is also practiced by a large numbers of farmer for jute production. The plant tips above two species being wasted while harvested by farmers as of no use. These plant tips can also be used for making SJ. It is also observed that at the time of harvest of tubers of *Ipomoea batatas*, the aerial part of the plant is being wasted. As such, value addition by making Jigat can be done by collecting, drying and pulverizing in to SJ from these above ground plant materials (biomass) of *Ipomoea batatas* very effectively. Moreover, three more plants i.e. *Hibiscus rosa sinensis*, *Manihot esculenta* and *Morus alba* are very common in homesteads of this region. *Manihot esculenta* can be cultivated by stem cutting even in poor soil. Farming of *Hibiscus rosa sinensis* and *Morus alba* can very effectively be done for Jigat production following the same practice as tea growers done for cultivation of tea. Seedlings of both the plant species can be prepared in the nursery by stem cutting or planting tender branch tip as vegetative propagules. Similar to the tea crop cultivation and pruning/ plucking of tender tips may be viable alternative of self employment and to make a new enterprise similar to tea industry.

Potentiality of commercial production of rhizomes of *Alocasia macrorrhizos* and *Homalomena aromatica* is very prominent as both the plant species including roots of *Manihot esculenta* are being cultivated and very popular foods among the tribal's of this region.

Fig. Agarbatti made from SJ of *Actinodaphne obovata* leaves



Agarbatti using SJ of *Litsea cubeba* bark

We do not have the agro techniques for other potential Jigat species of wild annual and perennial herbs such as *Glychenea sp*, *Impatiens glandulifera*, *Pilea rotundinucula*, *Pouzolzia indica*, *Sida cordifolia*, *Sida rhombifolia* and *Urena lobata*. At present, knowledge also scanty regarding the regeneration dynamics, resilience to harvest, data on the density and size-class distribution for allowing them sustainable harvesting from wild sources. However, this information regarding suitability of these plant species may be useful to the entrepreneurs to collect plant species from that area which are being cleared for cultivation and other purposes.

The plant species such as *Abroma augusta*, *Actinodaphne angustifolia*, *Actinodaphne obovata*, *Actinodaphne lowsonii*, *Altingia excelsa*, *Listsea cubaba*, *Litsea sebifera*, *Cinnamomum tamala*, *Cinnamomum zylenica* and *Grewia multiflora* are also wild and do not know much more to harvest from wild sources.

The Jigat prepared from these plant species are having good binding ability (stickiness) and produce textured agarbatti with better burning ability, burning time & odor in comparison to commercial Jigat. Most importantly, agarbattis produced by using SJ are low fragrant absorbent and during storage no moisture absorb, no loss of stickiness and no

fungal growth observed. They can be stored in open in a dry room condition up to 1 year and suitable transportation.

Three more combinations of Substitute Jigat (SJ)

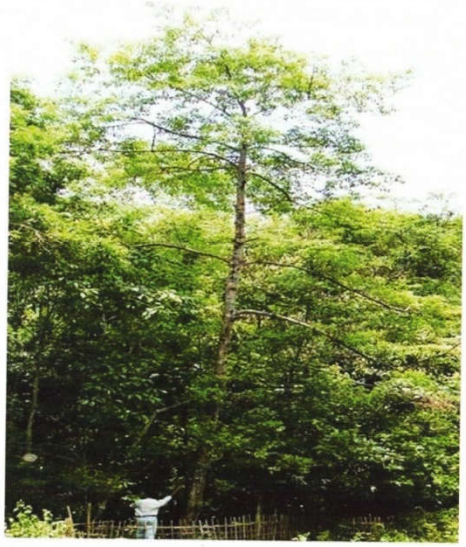
It is to be mentioned that all the plant species presented in (Table 1-4) are suitable to produce Jigat alone or in combinations. However, three more formulations are also produced comprise of plant materials from a number of plant species. These three combinations are named as RFRI-SJ_1, RFRI-SJ_2 and RFRI-SJ_3.

Jutuli (*Altingia excelsa*)

Satisoli (*Actinodaphne angustifolia*)

This was done keeping in view of reduce risk in loss of biodiversity of the plant species used for production of Jigat. The formulation RFRI-SJ_1 is comprised of leaves of 10 plant species and most of them are wild species except *Cinnamomum zylenica* and *Cinnamomum tamala*.

Even these two plant species may not be used for making this formulation and that will not change Jigat property. The above formulation comprising of adequate amount of 100-200 microns mesh sized powder of dried leaves



Mejangkori (*Litsea cubeba*)

Neluka (*Litsea sebifera*)

of *Actinodaphne angustifolia*, *Actinodaphne obovata*, *Actinodaphne lawsoni*, *Cinnamomum zylenica*, *Cinnamomum tamala*, *Grewia multiflora*, *Litsea sebifera*, *Sida cordifolia*, *S. rhombifolia*, and *Urena lobota*.

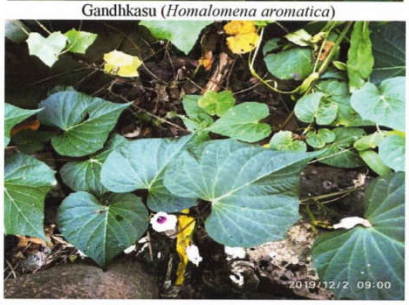
RFRI-SJ_2 is comprised of powdered formulations made from leaves and tender plant or seedlings of *Abroma augsta*, *Corchorus capsuaris*, *Croton roxburghii*, *Hibiscus rosa sinensis*, *Impatiens glandulifera*, *Litsea cubaba*, *Morus alba*, *Pouzolgia indica*, *Glychenea sp* and *Pilea rotundinucula*. Shelf life of this SJ product is 12 months and agarbatti made from this Jigat formulation is as good as RFRI-SJ_1.

RFRI-SJ_3 is composed of rhizomes of *Alocasia macrorrhizos* and *Homalomena aromatica*; Leaves and bark of *Altingia excelsa*. *Cinnamomum zeylenicum* and seedlings or plant tips of mature plant of *Corchorus olitorius*. All three formulations are safe, eco-friendly, cheap, easy to use and can be prepared at home as it does not require any heavy infrastructure and investment.

Apart from that plant species like corm of *Homalomena aromatic*, bark of *Cinnamomum zeylenicum*, *Litsea cubaba* and *Croton ruxburghii* can be used as natural fragrance materials. Powdered form of these plant parts could be mixed with masala for making of agarbatti in adequate quantity.

Keeping in view the significance of Jigat in making of incense sticks in Agarbatti industry these 'Substitute Jigat' from 25 plant species may contribute to fulfill substantial local demand. It has potential to produce in rural sector.

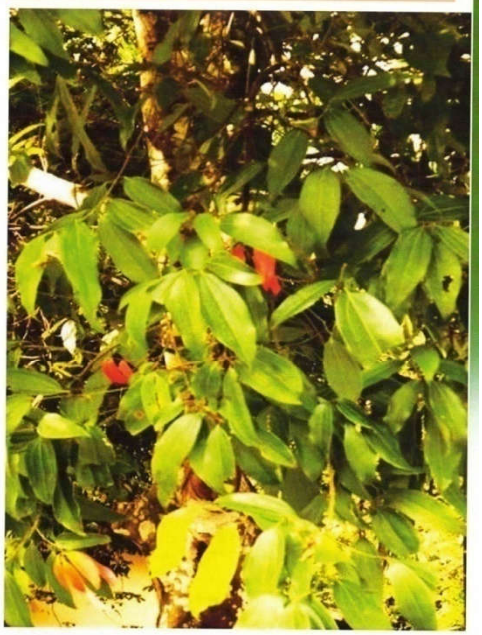
Gandhkasu (*Homalomena aromatica*)



Mitha Alu (*Ipomoea batatas*)

Pulverizer for Jigat powder Production

Sieving of Jigat using 100 Micrion mesh sieve



Dalcheni (*Cinnamomum zeylenicum*)

Fig. Making hand rolled agarbatti in training organized by RFRI in Namsai district, Arunachal Pradesh

Jute *Corchorus capsularis & C. olitorius*)

Kukur Suta (*Grewia multiflora*)

Fig. Evaluation of Shelf life of agarbatti keeping normal temperature in well ventilated room

Simolu Alu (*Manihot esculenta*)

Nuni plant (*Morus alba*)

Fig. 3 A few plant species suitable for making Substitute Jigat (SJ)

Prepared by Ms. Geetashri Borah, Ms. Clerissa Handique and Dr. Prosanta Hazarika, under the project- "Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh" funded by the National Mission on Himalayan Studies

Published by Director, Rain Forest Research Institute, Jorhat-785010, Assam .

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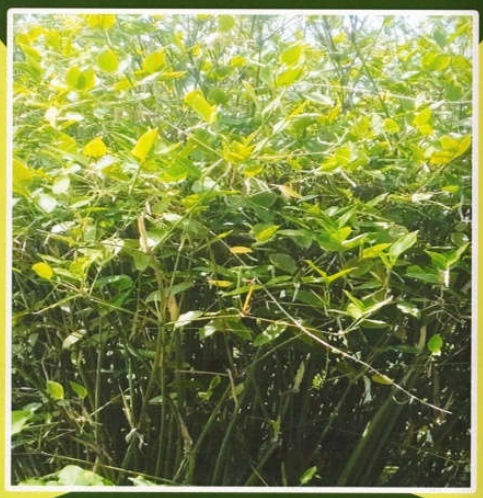
Schumannianthus dichotomus (Roxb.)Gagnep
(Pati-doi or Shital pati)



National Mission on Himalayan Studies

Rain Forest Research Institute
(Indian Council of Forestry Research and Education)
Ministry of Environment, Forest and Climate Change

Schumannianthus dichotomus (Roxb.) Gagnep.

Local name : Patidoi (Assamese), Pong (Khampti)
Family : Marantaceae.
Life cycle : Perennial plant.

INTRODUCTION

Patidoi is a rhizomatous shrub with an erect and glossy green stem attaining a height of 3–5m and a diameter of up to 20mm. The stems are leafy and dichotomously branched. The leaves have leathery leaf blades that are oval. Its flowers are faint pinkish-white with a yellowish staminode, borne on a simple or sometimes branched inflorescence. The fruits are indehiscent and sub-globose.

It is a perennial shrub which grows in swamps and along rivers, often forming thickets. Geographically, it is distributed in India, Bangladesh, Myanmar, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Borneo and the Philippines. In India it is found in Northeast India, West Bengal, and Coromandel Coast. In Assam, it is common in riverine areas like Majuli island and in groves of foot-hills.

CULTIVATION

Swampy and marshy wastelands are suitable for cultivation. It grows under partial shade and cannot tolerate direct sunlight. Therefore, it is an ideal plant to grow as under storey plant in agroforestry system tolerant in waterlogged condition too. It prefers clayey or clayey-loam soil having stagnant water of 3-10 cm depth. Propagation is either by seeds or using suckers from a previously sown crop or branch cuttings. Fruits ripen in June-July and the fruits are collected when the colour changes from green to light yellow and sown immediately in nursery beds. It is more commonly propagated through rhizome and is preferred, as seed germination is poor and needs intensive management.

The propagules are planted during the months of May–June at 1 x 1 m spacing. The plants take one year to mature when propagated through rhizome and it usually takes 2 to 3 years when they are cultivated by seeds. In the first year after transplanting, each seedling produces many suckers which may be planted in a nursery for producing further propagating material.

PLANTATION & DISEASE MANAGEMENT

Weed is not a major threat to the plant. However, weeding twice a yea is recommended. Soil can also be added or cow dung used as fertilize Use of chemical fertilizers is not required. There are no serious pest or diseases in the species.

HARVESTING

The mature culms have two to three branches and are slightly reddish Harvesting is done manually using dao (a sharp curved knife) and th stems are harvested under water at a height of 5-7 cm from the base. I is harvested from mid-September to the end of March, almost ever year.

Carrying harvested patidoi bundle on his head.

AGROFORESTRY

Since it grows in marshy areas, it may not fit into the traditional agroforestry systems. In the low-lying areas adjoining habitations, it can be cultivated and harvested for use. Patidoi can be cultivated in poor soil, which are not suitable for any other cultivation/ wasteland profitably. It is an inexpensive. In such cases upper story plant species may be water tolerant species i.e. *Salix tetrasperma*, *Bombax cieba*, *Lagerstroemia speciosa*, *Barringtonia acutangula*, *Lagerstroemia parviflora*, *Ficus indica*, *Bischofia javanica*, *Dillenia indica*, *Dillenia pentagyna*, *Diospyros embryopteris*, *Streblus asper*, *Caryota urens* etc.

UTILISATION

The harvested stem is manually split into strands and the bark of one plant gives 7-8 thin strands. The strands are dried in sun for 2-3 days and processed. Processing of pati is an important part in manufacturing quality mat. A bundle of pati/strips are bound into round roll which is therafter dipped in water for overnight. The bundle is then boiled for one hour, followed by sun drying for another one hour. This process makes strips soft, supple and glossy. Pati devoid of boiling process remains hard with reddish colour. The mat prepared with such pati is not attractive to consumers, though it is more durable and lasting more than seven years. All the graded pati are segregated once more and then chopped at the end following the standard length to be used for preparation of mat in accordance with respective mat quality. (Mandal et al. 2014)

VALUE ADDITION

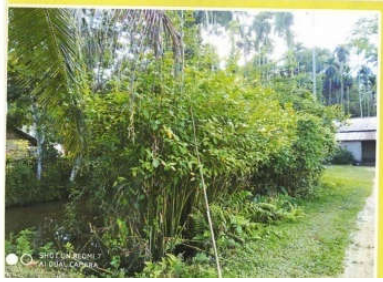
The split strips from the outer portion of the stem are used for making mast, bags, basket and other novel items. The strips from the pith portion are used as binding material. Colourful pati is made through dyeing by mixing of locally available materials used as ingredients based on indigenous knowledge. Ivory colour is obtained by boiling the pati with rice starch, boiled leaves extract of tengamora (*Hibiscus sabdariffa* L.) and leaves extracts of Tetali (*Tamarindus indica* L.). Pati are wrapped with Aam (*Mangifera indica* L.) bark and kept under mud for seven days for obtaining black colour. (Mandal et al, 2014)

MARKET POTENTIAL

Patidoi has high demand in market in the form of mats, bed mats, handfans and hand bags. Patidoi are commonly used as fascinating decorative items like wall decor as well as lamp shades in middle and upper class families. Single bed mats are sold at Rs 450 while double bedmats are sold at price of Rs 900-2000/- in local market in Namsai or neighbouring districts. A farmer can earn a good amount of money by selling value added product.

ECONOMIC IMPORTANCE

It provides additional income for the farmers for their livelihoods. It is an easy growing plant and requires moderate maintenance. Since it is grown on lands not suitable for cultivation of other agricultural crops, it dose not do any competition for the food crops or cash crops. It can be a source of additional income, without much effort. When grown along roads, canals, ponds, homesteads and fallow lands, it checks soil erosion, which is one of the major ecological issues in the Brahmaputra valley. The processing and value addition can provide employment to a considerable number of people. In perspective of economy and livelihood, one decorated mat with size of 150 cm × 210 cm requires 10 man days for weaving, costing around Rs 3000. The amount of money earned in relation to man days may be considered moderate income for one household for standard livelihood. (Mandal et al. 2014)



FOR FURTHER READING:

Ahmed, R., Islam, A.N.M.F., Rahman, M. and Halim, M.A. (2010) Management and economic value of *Schumannianthus dichotoma* in rural homesteads in the Sylhet region of Bangladesh. The International Journal of Biodiversity Science and Management, 3(4):252-258.

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Mandal, B.K., Chaudry, P.P. and Chatterjee, P. (1990) Cultivating mat making shrubs for high profits. Indian Farming, 40(4):16-18.

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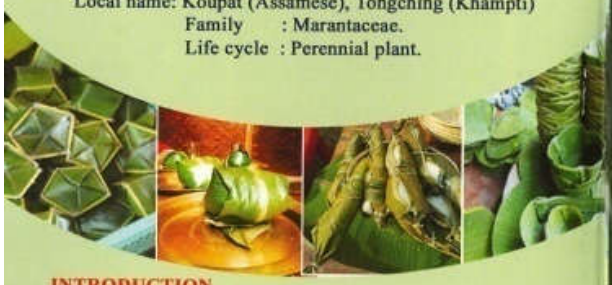
Phrynium capitatum Willd. (Koupat)

National Mission on Himalayan Studies

Rain Forest Research Institute
(Indian Council of Forestry Research and Education)
Ministry of Environment, Forest and Climate Change
Government of India

Phrynium capitatum Willd.

Local name: Koupat (Assamese), Tongching (Khampti)
Family : Marantaceae.
Life cycle : Perennial plant.



INTRODUCTION

This perennial plant is having broad shiny leaves bearing white flower. It attains a height up to 2m. It is found in Eastern Himalayas, Malay Peninsula, Malabar and Sri Lanka. The leaves are used in weddings and various religious ceremonies by the local people.

CULTIVATION

In agroforesty system of the cultivation, the plant is semi-domesticated and its growth is promoted by pruning of leaves/ lateral tillers for enhancing light conditions and weeding of the forest floor. The plant grows naturally through seeds in the natural forests as well as in agroforesty.

HARVESTING

Phrynium leaves can be harvested both from natural forest as well as from agro-forests. A mature plant generally consists of 6-7 leaves. Entire older leaves are cut from the base of the plant excluding at least 2 younger leaves. This helps the plant for further regeneration. The harvesting can be done three times in a year.

UTILISATION

The leaves are preferred as packing and wrapping material by local people over polythene because of its capacity in retaining moisture and keeping the packed edibles fresh and lasting longer. Fifteen to eighteen leaves are vertically placed and tied together to form a roll and these rolls are sold in bundles in local market. The Tagin tribe o Arunachal Pradesh reported to utilize leaves of *P. capitatum* as antidiabetic, analgesic, anti-hyperglycemic traditional medicine (Jaiswal, 2019)

Bundles of *Phrynium* leaves.

AGROFORESTRY

Phrynium capitatum can be cultivated with other crops such as *Piper betel* (Pan), *Thysanolaena latifolia* (Broom grass), *Areca catechu* (Tamul) and other vegetables and seasonal crops (Tynsong, et al. 2011).

VALUE ADDITION AND USES

The leaves of the *Phrynium* are traditionally used as plates and dish by the tribal communities and same also introduced presently in hotels. Leaves are used to fashion small plates for use in homes. Also used to wrap, fruits and vegetables. traditionally pepole use to wrap fish fillets for baking in hot ashes in remote village homes or while out fishing in the hill streams. It also adds flavours and colour to the wrapped food items .

When sold in local market, a farmer can sale one bundle @ Rs. 25. Every bundle consists of 100 leaves. Wholesale rate of 5 bundles of leaves are sold for Rs.100. Value addition can be done by making two dishes or 4 bowls from one *Phrynium* leaf, and these dishes or bowls can be sold at Rs. 1.00 respectively. By value addition the farmer can makes 4 times profit.

MARKET POTENTIAL

The *Phrynium* leaf has got a very good market in the state of Meghalaya and Arunachal Pradesh. There is very small inter-state marketing with Assam and a small quantity is traded to Bangladesh via Dawki market. The growers bring the product to the local market where they sell it to the traders, who in turn directly sell it to the consumer at different local and regional markets.

ECONOMIC IMPORTANCE

Leaves of *Phrynium* are the most common wrapping and packaging material used by the people of Meghalaya and Arunachal Pradesh. It is also used in different religious ceremonies by tribal people. It has high demand and market potential.

Various uses of *Phrynium* leaves.

Various uses of *Phrynium* leaves.

FOR FURTHER READING

Tynsong, H., and Tiwari, B.K. (2011) Contribution of *Phrynium capitatum* Willd. leaf a non-timber forest product to the livelihoods of rural poor of South Meghalaya, North-East India. Indian Journal of Natural Products and Resources, 2(2) :229-235

Prepared by Ms. Geetashri Borah, Ms. Clerissa Handique and Dr. Prosanta Hazarika, under the project- "Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh" funded by the National Mission on Himalayan Studies

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Livistona Jenkinsiana Griff.
(Tokow)

National Mission on Himalayan Studies

Rain Forest Research Institute
(Indian Council of Forestry Research and Education)
Ministry of Environment, Forest and Climate Change
Government of India

Livistona jenkinsiana Griff.

Common name: Himalayan Fan Palm
Local name: Tokow (Assamese), Tankau (Khampti)
Family: Arecaceae
Life cycle: Annual

INTRODUCTION

It is a palm tree with large fan-shaped leaves on spiny petioles. This beautiful endemic palm is only found in northeast region of India. It is also native to Myanmar, China, Thailand and Bangladesh. It mainly grows in open forest, and it is also commonly planted in villages or other disturbed areas; at elevations from 100 - 2,500 m.

CULTIVATION

Planting is done when seedlings are about 18 months old at a spacing of 4m x 4m during May-June with the beginning of rainy season. Seed propagation is easy and germination rate is almost cent percent. The seeds are sown in the month of February, March and April. Good germination rate of seed has been seen when seed is sown at 2 to 3 inches under the soil. Usually clearance of forest is not necessary to sow the seed. This tree is suitable for multiple cropping and also planted on boundary to demarcate the boundary.

PLANTATION & DISEASE MANAGEMENT

The plantation of the plant can be done by natural regeneration and artificial regeneration.

- **Natural Regeneration:** The natural seeds fallen from the tree are carried over by birds, or squirrel or dropped on soil during winter season start germinating in good habitat with pre monsoon showers in April-May and establish to grow the plants. Profuse regeneration can also be seen in the vicinity of mature fruiting trees along partially open moist slopes

- **Artificial Regeneration:** Propagation by seeds is the most easy, cheap and conventional method. Seeds can be gathered during November-December when they are fully ripe. Freshly harvested seeds are used for sowing. The seeds are extracted from fleshy fruits by de-pulping, or removing the peel. This can be done manually or fruits can be kept in water or in soak-pits for a couple of days by which time slight rotting of fruit peel takes place and then it becomes easy to remove the peels by gentle mashing and washing.(Singh, et al. 2010)

HARVESTING

The fan shaped leaves are harvested from mature tree while harvesting, only 2-3 leaves are left in the palm excluding the tender leaves. The leaves are harvested every alternate year (Singh et al, 2010).

AGROFORESTRY

Tokow can also be planted as an agroforestry or shade/nursery tree species with other crops. It does not produce much shade as the stem is branchless and leaves occur at the top only. Therefore, seasonal crops and vegetables can easily be grown below Toko plantation in agroforesty system (Singh et al, 2010).

VALUE ADDITION AND USES

Japis (traditional hats) can be prepared from the leaves; ropes can also be made from rachis by peeling. The seeds are eaten as a substitute for betel nut. The leaves are commonly used for thatching. The leaves are woven into mats, hats etc. Different size of Japis and hats are available in the market made from the leaves. From rachis, mats, baskets and hats can be prepared. The remaining white portion of the rachis can be used in for compost making.

MARKET POTENTIAL

The leaves can be sold in bundles. Japis (hats) can be made of juvenile leaves and can be sold to the Japi makers. The mature leaves can be also used as roofing material in tribal households. The harvested leaves are bundled and traded in raw. Generally, each bundle has 40 leaves and sold or bartered for other materials with neighboring tribes. There is a variation in price of Toko leaves. In the remote villages, 40 Toko leaves are sold for Rs 200-300 @ Rs. 5 or 6 per leaf, however, the same can be sold in Pasighat market for Rs 250-400. According to the market survey, the leaves are recorded to be sold @ Rs 5 per leaf. Similar observation was also reported in Itanagar (state capital) by Singh et al, 2010.

ECONOMIC IMPORTANCE

A good harvest can be obtained up to 35-40 yrs. On an average, 10 leaves appeare from January to December. It is found that after 5 yrs, on an average 10 leaves can be harvested per plant/year. In ideal situation, from 625 plant/ha, a total of 6,250 leaves can be harvested @ 10 leaves from each plant. (Singh et al, 2010). Thus a farmer can earn Rs. 31,250 per year from 625 tokow plants. Household involvement for preparation of japi, hat, mat etc may be a viable option for livelihood.

Second year onwards of planting, one could harvest almost 3960 number of leaves which can used to make 1320 number japis. The rate of sale of one japi is Rs. 250 in local market, and in turn, one can earn Rs.3,30,000 per annum. Apart from making japis, the rachis of harvested 3960 numbers of leaves may also be utilized for preparation of mats and hats of different sizes.

FOR FURTHER READING:

1. Singh, R.K., Srivastava, R.C., Adi Community & Mukherjee, T.K. 2010. Toko-Patta (*Livistona jenkinsiana* Griff.): Adi community and conservation of culturally important endangered tree species in eastern Himalaya. Indian Journal of Traditional Knowledge, 9(2): 231-241.

Prepared by Ms. Geetashri Borah, Ms. Clerissa Handique and Dr. Prosanta Hazarika, under the project- "Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh" funded by the National Mission on Himalayan Studies.

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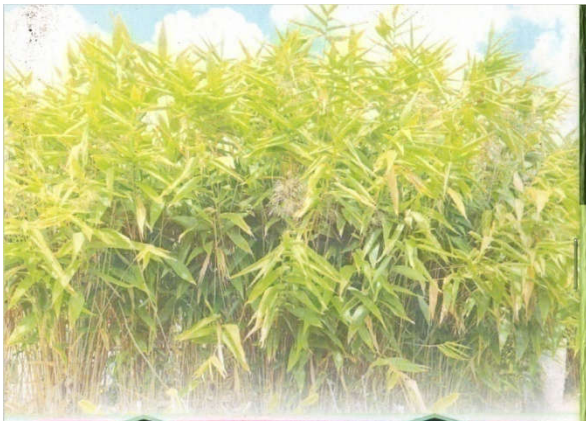

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Broom grass

***Thysanolaena latifolia* (Roxb. ex Hornem.) Honda.**

National Mission on Himalayan Studies

Rain Forest Research Institute
(Indian Council of Forestry Research and Education)
Ministry of Environment, Forest and Climate Change
Government of India

***Thysanolaena latifolia* (Roxb. ex Hornem.) Honda.**

Common name : (Tiger or broom grass)
Local name : Phool jharu (Assamese), Jharu bon (Khampti)
Family : Poaceae
Life cycle : Perennial plant

INTRODUCTION

It is a perennial shrub, found growing along steep hills, sandy banks of rivers and damp steep banks along ravines. It grows naturally in temperate and subtropical parts of India, Bhutan, Myanmar, China, East Asia, Nepal, New Guinea and Malaysia up to 2000m elevation. This grass is tolerant to drought situation, while it performs well in high rainfall conditions also, where there is no water logging. It grows well in soil with pH 5.3- 9.3, moisture 11.6- 37.6%, carbon 0.4-2.7%.The grass can be grown on severely degraded and marginal lands. Broom grass tends to grow in tussocks, with 4-5 tussocks in a 100-metre radius and is harvested during the winter seasons between January and March.

CULTIVATION

Broom grass is cultivated by the farmer for local and commercial production of broom. The plant can be cultivated through propagation through seeds, rhizome and seed sowing in nursery bed.

- **Propagation through seeds :**

Seeds are collected from the matured inflorescence during the month of February and March. Approxmiately 10g of seeds are broadcasted in nursery beds of 2m x 1m size. Seeds are covered with a thin layer of soil and then with thatch grass to keep moist. Grass cover is removed after germination of seeds. After 4 to 6 weeks seedlings are either transplanted into other beds at spacing of 10cmx10cm or raised in poly bags which were filled with mixture of soil, sand and farmyard manure in a ratio of 1:2:1. Then they are ready to plant in the main field.

- **Propagation through rhizomes :**

After harvesting of brooms, the rhizomes from natural stock are uprooted from the healthy culms and the green stems trimmed to about 12cm to 15cm in length and rhizome cutting is made along with 2 to 3 culms of 15-20cm height and planted either in poly bags or pits. Polybags are filled with a mixture of soil, sand and farmyard manure in a ratio of 1:2:1. Watering is done to keep the soil moist for better establishment. After three months the sprouted rhizomes are ready for transplantation in the main field.

- **Seed sowing :**

In nursery seeds are to be sown immediately in beds in horizontal position and watered. Beds are to be provided with thatch cover to protect the emerging seeds from direct sunlight. Seeds start germination after 2- 4 days of sowing. Germinated seeds are to be transferred to media filled the polythene bags.

• Maintenance of plantation:

Farm yard manure and 10grams 10% BHC per pit are mixed into the pits before planting the seeds. The plant requires to be weeded 3-4 times in the first year and annually in the following years. Manure can also be applied to the soil during the second weeding to provide the best yield in the first year. Watering is done to keep the soil moist at the early stage of plantation for better establishment if rainfall does not occur for a longer period of time. As this grass is a good fodder for animals appropriate fencing should be raised for protection particularly in the early stage of growth of plant.

HARVESTING

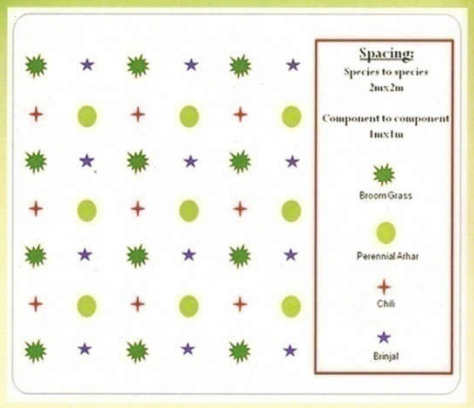
The mature panicle which turns light green or red becomes ready for harvest by December and January and the harvest continues until March. Culms with mature inflorescences are harvested by cutting above the ground, dried in sun. For making brooms, the inflorescences of 1-1.5 ft long are kept. The inflorescences are made into bundle of 30-35 to make a broom. Such brooms are marketed at the rate of Rs. 10 to Rs.20 per bundle. Sometimes dried inflorescences in bulk are sold by the farmer without any value addition. Leaves of the plant are harvested for fodder. The highest yield is obtained in the third year of repeat plantation. After the last harvest, all the vegetative part is cut down to 30cm for regeneration. The culms are also used to make baskets of different types. The residual part of the broom grass can be used for making vermicompost.

AGROFORESTRY

Thysanolaena latifolia was reported to grow under *Alnus nepalensis* at wider spacing (4m x 5m) at Mid hills in Eastern and central Nepal. *Thysanolaena latifolia* is also cultivated as cash crop in the region in agrisilviculture system and according to one estimate farmers can get a net return of Rs. 41,140/ ha in third year by the harvesting of this crop (Ahlawat and Deori, 1997; Bisht and Ahlawat, 1998).

Broom grass based agri-olericultural agroforestry model was practised in Tripura as *Thysanolaena latifolia* and *Cajanus cajan* as upper canopy plant and Brinjal & Chilli as lower canopy crops and fetches a subsistence income to the growers annually even up to 12 to 15 years. It was observed that 2x2 m spacing produced the maximum number of brooms/ panicle in high acid content soil in Chittagong Hill Tracts, Bangladesh.

VALUE ADDITION AND USES



Thysanolaena latifolia brooms are cost effective, more durable than those made from Phragmites. It is also a very good fodder plant for the animals. It is sold as brooms. The leaves provide green forage for livestock, the roots promote soil conservation, and the dried up stems can be used as stakes to support growing vegetables.

MARKET POTENTIAL

The cultivation of broom grass is found to be very high in Arunachal Pradesh. In local market of Namsai district one broom is sold at Rs 20 and when get exported same broom cost upto Rs100. Brooms are also made attractive by knitting with coloured plastic thread or other suitable material which makes it more durable and also by increasing the price to its twice the normal price. The cultivation of broom grass is seen less in the plains region of India. So there is a profuse market demand of broom grass in plain areas.

ECONOMIC IMPORTANCE

There is a heavy demand for broom grass in local, national and international market. The cultivation of broom grass can be a cost-effective enterprise which can bring immediate benefit to the local inhabitants at the shortest possible time and thus uplift the economy of rural people. It is harvested twice in a year and two-year-old broom crop may provide a net return of as much as Rs. 44,113 /- ha, if grown as sole crop as reported from Sikkim. In Meghalaya, the yield varies between 300 and 500 kg of inflorescence (broom material) per hectare, depending upon the quantity of planting materials, the fertility of the land, and the cultural practices adopted for maintenance.

FOR FURTHER READING:

1. Tiwari, B. K., Shukla , R. P., Lynser, M. B. & Tynsong, H. (2012) Growth pattern, production, and marketing of *Thysanolaena maxima* (Roxb.) Kuntze : An important non-timber forest product of Meghalaya, India, Forests, Trees and Livelihoods, 21:3, 176-187.

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Appendix 6 – Details of Technology Developed/ Patents filled, if any

Nil

Appendix 7 – Any other

Nil

Annexure-I

Consolidated and Audited Utilization Certificate (UC) and Statement of Expenditure (SE)

For the Period: 22/08/2019 to 31/03/2023

1.	Title of the project/Scheme/Programme:	Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh
2.	Name of the Principle Investigator & Organization:	Dr. Prosanta Hazarika ICFRE- Rain Forest Research Institute, P.O. Chenijan, Pin 785010, Jorhat, Assam
3.	NMHS-PMU, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand Letter No. and Sanction Date of the Project:	No.: GBPNI/NMHS-2019-20/SG Date: 22-08-2019
4.	Amount received from NMHS-PMU, G.B. Pant National Institute of Himalayan Environment, Kosi-Katarmal, Almora, Uttarakhand during the project period (Please give number and dates of Sanction Letter showing the amount paid):	1. No.: GBPNI/NMHS-2019-20/SG Dated: 22-08-2019 2. No. : GBPN/N M HS-20 1 9-20/SG/ 261/ 84 / 304 / 146 / 290; Dated: 20.01.2021 3. No. : G BPNI/ N M H S /2019 -20 / SG / 26 1/84 / 304 / 146 / 290 /7 7/99 , Dated 28.07.2022
5.	Total amount that was available for expenditure (Including commitments) incurred during the project period:	Rs (1337400+ 1501400+1281400) Rs. 41.202 Lakhs-
6.	Actual expenditure (excluding commitments) incurred during the project period:	
7.	Unspent Balance amount refunded, if any (Please give details of Cheque no. etc.):	
8.	Balance amount available at the end of the project:	
9.	Balance Amount:	
10.	Accrued bank Interest:	

Certified that the expenditure of **Rs._____ (Rupees _____)** mentioned against Sr. No. 6 was actually incurred on the project/scheme for the purpose it was sanctioned.

Date:

(Signature of Principal Investigator)

(Signature of Registrar/ Finance Officer)

(Signature of Head of the Institution)

OUR REF. No.

ACCEPTED AND COUNTERSIGNED

Date:

COMPETENT AUTHORITY
NATIONAL MISSION ON HIMALAYAN STUDIES (GBP NIHE)

Statement of Consolidated Expenditure

[ICFRE- Rain Forest Research Institute]

Statement showing the expenditure of the period from : Date 05.09.2019 to 31.03.2023

Sanction No. and Date : No.: GBPNI/NMHS-2019-20/SG, Date: 22-08-2019

1. Total outlay of the project : Rs.41.202 Lakhs

2. Date of Start of the Project : 05.09.2019

3. Duration : 3 Years + 06 Months and 27 Days

4. Date of Completion : 31.03.2023

a) Amount received during the project period : Rs. 39.572Lakhs

b) Total amount available for Expenditure :

S. No.	Budget head	Amount received	Expenditure	Amount Balance/ excess expenditure
1	Salaries	**869857.00**		
2	Permanent Equipment Purchased (Item-wise	00		
3	**Travel(Domestic):**	**973274.00**		
4	**Contingency:**	**171773.00**		
5	**Activities & other project cost**: Resources identification, socio--economy and Livelihood Through PRA, Assessment of phyto-sociological, Capacity building for alternative livelihood options and develop master trainer & exposure Visit to Entrepreneurs, Development of demonstration plot, Awareness programs/ Conduct of hands on training	**1579947.00**		
6				
7				
8				
9				
10	Institutional charges	**362400.00**		
11	Accrued bank Interest	60,003.00		
12	**Total**	**3957252.00**		

Certified that the expenditure of **Rs._____ (**
Rupees:_____) mentioned against Sr. No.12 was actually incurred on the project/ scheme for the purpose it was sanctioned.

Date:

(Signature of Principal Investigator)	(Signature of Registrar/ Finance Officer)	(Signature of Head of the Institution)

OUR REF. No.

ACCEPTED AND COUNTERSIGNED

Date:

COMPETENT AUTHORITY
NATIONAL MISSION ON HIMALYAN STUDIES (GBP NIHE)

Annexure-II

Consolidated Interest Earned Certificate

Please provide the detailed interest earned certificate on the letterhead of the grantee/ Institution and duly signed.

Annexure-III

Consolidated Assets Certificate

Assets Acquired wholly/ substantially out of Government Grants
(Register to be maintained by Grantee Institution)

Name of the Sanctioning Authority: Nodal Officer, G. B. Pant National Institute of Himalayan Environment (GBPNIHE), (NMHS.PMU)

1. Sl. No. Ref. No.: GBPNI/NMHS-2019-20/SG
2. Name of Grantee Institution: ICFRE-Rain Forest Research Institute, Jorhat
3. No. & Date of sanction order : 22/08/2019
4. Amount of the Sanctioned Grant : 00.00
5. Brief Purpose of the Grant : N/A
6. Whether any condition regarding the right of ownership of Govt. in the property or other assets acquired out of the grant was incorporated in the grant-in-aid Sanction Order: N/A
7. Particulars of assets actually credited or acquired :N/A
8. Value of the assets as on : N/A
9. Purpose for which utilised at present :N/A
10. Encumbered or not :N/A
11. Reasons, if encumbered :N/A
12. Disposed of or not :N/A
13. Reasons and authority, if any, for disposal :N/A
14. Amount realised on disposal :N/A

Any Other Remarks : NiL

(PROJECT INVESTIGATOR)
(Signed and Stamped)

(FINANCE OFFICER)
(Signed and Stamped)

(HEAD OF THE INSTITUTION)
(Signed and Stamped)

Annexure-IV

List or Inventory of Assets/ Equipment/ Peripherals

S. No.	Name of Equipment	Quantity	Sanctioned Cost	Actual Purchased Cost	Purchase Details
	Nil	Nil	Nil	Nil	Nil

(PROJECT INVESTIGATOR)

(Signed and Stamped)

(FINANCE OFFICER)

(Signed and Stamped)

(HEAD OF THE INSTITUTION)

(Signed and Stamped)

Annexure-V

Letter of Head of Institution/Department confirming Transfer of Equipment Purchased under the Project to the Institution/Department

To,

The Convener, Mountain Division
Ministry of Environment, Forest & Climate Change (MoEF&CC)
Indira Paryavaran Bhawan
Jor Bagh, New Delhi-110003

Sub.: Transfer of Permanent Equipment purchased under Research Project titled "Improving the traditional homestead to a viable agro-forestry system for biodiversity conservation and inclusive growth of Khampti tribe of Namsai District, Arunachal Pradesh " funded under the NMHS Scheme of MoEF&CC – reg.

Sir/ Madam,

This is hereby certified that the **no** permanent equipment purchased under the aforesaid project have been transferred to the Implementing Organization/ Nodal Institute after completion of the project:

Procured: NIL

Head of Implementing Organization:
Name of the Implementing Organization:
Stamp/ Seal:
Date:

Copy to:

1. The Nodal Officer, NMHS-PMU, National Mission on Himalayan Studies (NMHS), G.B. Pant National Institute of Himalayan Environment (NIHE), Kosi-Katarmal, Almora, Uttarakhand-263643

Annexure-VI

Details, Declaration and Refund of Any Unspent Balance

Please provide the details of refund of any unspent balance and transfer the balance amount through RTGS (Real-Time Gross System) in favor of **NMHS GIA General** and declaration on the official letterhead duly signed by the Head of the Institution.

Kindly note the further Bank A/c Details as follows:

Name of NMHS A/c:	NMHS GIA General
Bank Name & Branch:	Central Bank of India (CBI), Kosi Bazar, Almora, Uttarakhand 263643
IFSC Code:	CBIN0281528
Account No.:	3530505520 (Saving A/c)

In case of any queries/ clarifications, please contact the NMHS-PMU at e-mail: nmhspmu2016@gmail.com