

of energy and help in economic empowerment as well as to avoid adding fossil's carbon to the atmosphere.

1. Global Health Observatory Data Repository. Population using solid fuels. World Health Organisation, Geneva, 2013 (cited on 1 June 2018); <https://apps.who.int/gho/data/view/main.1701?lang=en> (accessed on 3 June 2021).
2. Energy uses in India: a case of electricity; https://www.researchgate.net/publication/331929537_Energy_Uses_in_India_A_Case_of_Electricity (accessed on 26 May 2021).
3. Is the world on track to deliver energy access for all? World Bank, Washington, 2018 (cited on 27 April 2018); <https://www.worldbank.org/en/news/feature/2018.05/18/sustainabledevelopment-goal-7-energy-access-all> (accessed on 2 June 2021).
4. Sagumaran, P. and Seshadri, S., *Booklet on Biomass Charcoal Briquetting*, Shri AMM Murugappa Chettiar Research Center, Chennai, India, 2014.
5. ASTM, Annual Book of ASTM Standards; Gaseous Fuels; Coal and Coke; Bioenergy and Industrial Chemicals from Biomass. Standard Test Method for Gross Calorific Value of Coal and Coke, 2013, vol. 5–6.
6. Kumar, S. G., Rao, C. J. and Madhavi, S. K., Evaluation of calorific value of bio-briquette. *Int. J. Res. Eng. Technol.*, 2016, 5(9), 124–128; <http://ijret.esatjournals.org>
7. Sharma, M. K., Priyank, G. and Sharma, N., Biomass briquette production: a propagation of non-convention technology and future of pollution free thermal energy sources. *Am. J. Eng. Res.*, 2015, 4(2), 44–40.

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Non-timber forest products as a means of livelihood in Mon district, Nagaland, India

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The Konyaks in Nagaland, India, since time immemorial have been dependent on the forest and its products for their sustenance and economic growth. The use of non-timber forest products (NTFPs) in Mon district, Nagaland, was studied through surveys and interviews with vegetable vendors in Mon and Aboi town markets, and villagers of Chingkao, Tangnyu, Sheanghah-Lampong, Wakching and Hongphoi. Forest resources and their products have been a source of livelihood providing the local inhabitants with food, medicine, construction materials and other utilitarian items, especially for the economically marginal people residing in and around the forest. This study covers 43 plant species belonging to 26 families that are used by the tribals of Mon district. Family Asteraceae was dominant in yielding forest products followed by Arecaceae and these resources are used with the traditional knowledge passed down from generations. The study shows the diverse NTFPs that fulfill the needs of a thriving Naga tribe.

Keywords: Livelihood, non-timber forest products, traditional knowledge, tribes.

FORESTS provide the richest natural resources that are complex and include both timber and non-timber forest products (NTFPs). NTFPs are the resources or products that can be extracted from the forest ecosystem and are utilized for household purposes or are marketed, or have social, cultural or religious significance^{1,2}. NTFPs include plants and animals that are utilized as medicine, fuel-wood, fodder, house-building material, spices and condiments, fibres, etc.³. The utility of NTFPs is based on the traditional knowledge that has been orally transmitted from one generation to the other. Several studies conducted by various organizations reveal that a significant proportion of the world's rural population living near forests area is highly dependent on forest resources⁴⁻⁶. The efficient extraction of NTFPs can add value to the forests and also provide an incentive for their conservation and sustainable management⁷. Konyaks, one of the major tribes of Nagaland predominantly inhabit Mon district and adjoining regions of Arunachal Pradesh and Assam, India, and Myanmar. Mon is reported as one of the backward districts of Nagaland owing to its remoteness, mountainous terrain and lack of basic amenities. The traditional

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Table 1. Non-timber forest products used by the Konyak tribe in Mon district, Nagaland, India

Botanical name	Common name/local name (Konyak)	Family	Part used	Purpose of use
<i>Gynocardia odorata</i> Roxb.	Pah	Achariaceae	Kernel	After boiling and washing in running water, fermented to be used as a food supplement
<i>Caryota urens</i> L.	Lok	Arecaceae	Stem	The soft portion inside the stem is used as food
<i>Phoebe cooperiana</i> P.C. Kanj. & Das	Kuh lick	Lauraceae	Fruit	Fruit is eaten raw along with rice
<i>Musa aurantiaca</i> G. Mann ex Baker	Ngao re	Musaceae	Flower	Cooked as vegetable
<i>Musa nagensium</i> Prain.	Hemoi	Musaceae	Leaf	The whitish powder on the adaxial surface of the leaf is used to smoothen the wool while weaving
<i>Piper betle</i> L.	Tamulpatta	Piperaceae	Leaf	Consumed along with betel nut
<i>Terminalia chebula</i> Retz.	Linghah	Combretaceae	Fruit	Dried and eaten for digestion
<i>Levistona jenkinsiana</i> Griff.	Lüoh	Arecaceae	Leaf and fruit	Thatching and fruit boiled and eaten along with rice
<i>Canarium strictum</i> Roxb.	Kong	Burseraceae	Fruit	Eaten raw
<i>Phrynium pubinerve</i> Blume.	Laimoi	Marantaceae	Leaf	Used for wrapping culinary items and vegetables during festivals
<i>Macaranga denticulata</i> (Blume) Mull. Arg.	Pock	Euphorbiaceae	Leaf	Used for wrapping food items and fermented products
<i>Houttuynia cordata</i> Thunb.	Kai-ouk	Saurauriaceae	Leaf and root	Juice extract of the plant is consumed in the treatment of ulcer, dysentery and diarrhoea, and for blood purification
<i>Litsea cubeba</i> (Lour.) Persoon.	Luthre	Lauraceae	Bark and fruit	Bark used to poison bees for harvesting honey; fruit is used in pickles.
<i>Calamus tenuis</i> Roxb.	Ishet lick	Arecaceae	Fruit and stem	Ripe fruits eaten raw; stem is used as ropes
<i>Calamus caesius</i> Blume.	Ee-thre	Arecaceae	Stem	Used for ropes and making baskets
<i>Centella asiatica</i> L.	Thruikhah	Apiaceae	Whole plant	Whole plant eaten raw
<i>Clerodendrum glandulosum</i> L.	Mangmik	Verbenaceae	Leaf	Vegetable and also as a medicine for high blood pressure
<i>Hodgsonia heteroclite</i> (Roxb.) Hook. f. & Thomson	Pai	Cucurbitaceae	Fruit	Kernel eaten after burning
<i>Choreospondias axillaris</i> (Roxb.) B.L. Burt & A. W. Hill	Kuimik	Anacardiaceae	Fruit	Ripe fruit eaten, bowel treatment
<i>Begonia palmate</i> D. Don.	Throishi	Begoniaceae	Leaf	Vegetable
<i>Zanthoxylum rhetsum</i> (Roxb.) DC	Tayak	Rutaceae	Fruit and leaf	Leaf used as vegetable; fruit used in chutney
<i>Zanthoxylum piperitum</i> (L.) DC	Rharhoi	Rutaceae	Fruit	Chutney and as preservative
<i>Rhus chinensis</i> Mill.	Mahthra	Anacardiaceae	Fruit	Powdered to treat stomach-related ailments
<i>Phyllanthus emblica</i> L.	Phang	Euphorbiaceae	Fruit	Used in making wine and pickle
<i>Entada phaseoloides</i> (L.) Merr.	Vikock	Fabaceae	Seed	Fermented and used as food supplement
<i>Eupatorium adenophorum</i> Spreng.	Japan patta	Asteraceae	Leaf	Paste made from the leaves is applied to cuts as a hemostatic
<i>Solanum khasianum</i> Clarke.	Waknyu kamhah	Solanaceae	Fruit	Used to cure tooth decay and toothache
<i>Ocimum tenuiflorum</i> L.	Tulsi	Lamiaceae	Whole plant	Food supplement
<i>Momordica charantia</i> L.	Throikhah	Cucurbitaceae	Fruit	Cooked as vegetable
<i>Herpetospermum operculatum</i> K. Pradheep, A. Pandey, K.C. Bhatt & E.R. Nayar	Mao-ouh	Cucurbitaceae	Fruit	Young and tender ones eaten as vegetable
<i>Cinnamomum zeylanicum</i> Blume.	Ngunthre	Lauraceae	Bark and root	Eaten after drying; spicy taste
<i>Auricularia delicata</i> (Mont.) Henn.	Pin tu	Auriculariaceae	Whole plant	Use in culinary, known to treat gastrointestinal and liver ailments
<i>Stixis suaveolens</i> (Roxb.) Baill.	Makhah	Resedaceae	Fruit	Fruit eaten as food after fermentation
<i>Ageratum conyzoides</i> L.	Kipnyurhing	Asteraceae	Leaf	Blood clotting
<i>Elsholtzia ciliata</i> Thunb.	Chete	Lamiaceae	Whole plant	Used as an insect repellent
<i>Elsholtzia blanda</i> Benth.	Threlo	Lamiaceae	Leaf	Paste used in the treatment of diarrhoea
<i>Pilea scripta</i> (Buch. Ham. ex D. Don) Wedd.	Mehithroi	Urticaceae	Leaf	Green leafy vegetable
<i>Gynura bicolor</i> (Roxb. ex Willd.) DC	Throi-nyen	Asteraceae	Leaf	Green vegetable
<i>Diplazium esculentum</i> (Ritz.) Sw	Cheakthroi	Athyriaceae	Leaf	Wild vegetable
<i>Mikania micrantha</i> Kunth.	Yukhah	Asteraceae	Leaf	Paste used for blood clotting during injury, and to maintain blood pressure
<i>Thysanolaena latifolia</i> (Roxb. Ex Hornem.) Honda	Taanmu	Poaceae	Whole plant	Broom
<i>Spilentes acmella</i> L.	Shanglao hing	Asteraceae	Whole plant	Leaf used as vegetable, fodder
<i>Ficus obscura</i> Blume.	Phuk	Moraceae	Leaf	Fodder

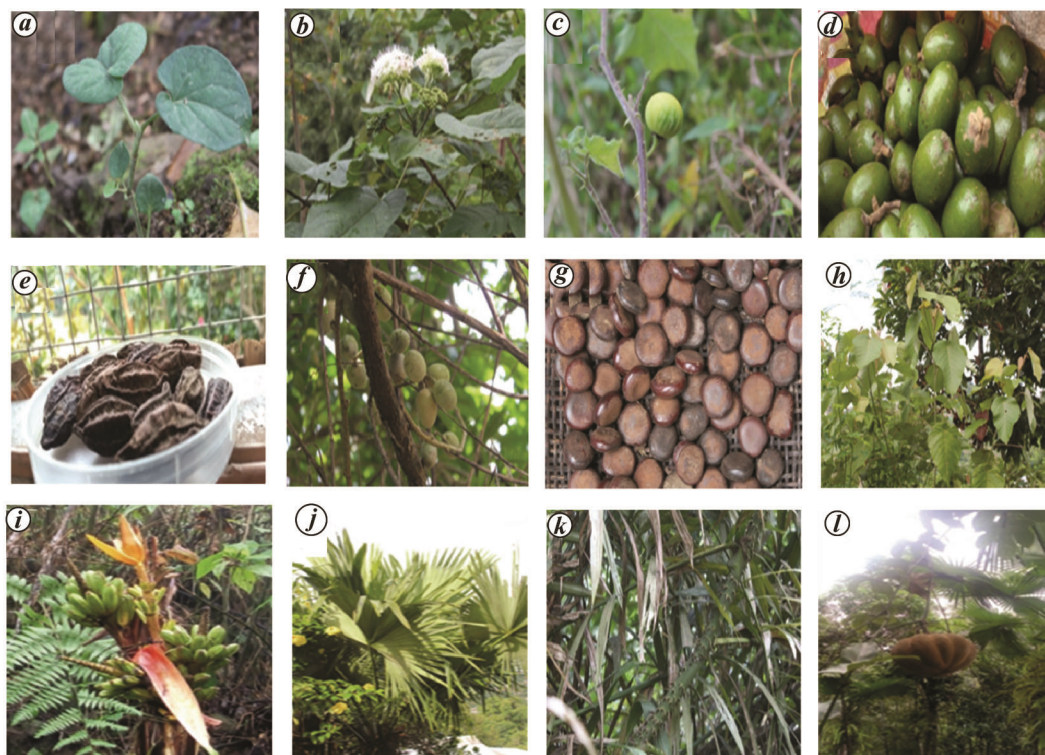


Figure 1. Non-timber forest products used by Konyaks Nagas. *a*, *Houttuynia cordata*; *b*, *Clerodendrum glandulosum*; *c*, *Solanum khasianum*; *d*, *Phoebe cooperiana*; *e*, *Terminalia chebula*; *f*, *Stixis suaveolens*; *g*, *Entada phaseoloides*; *h*, *Marcaranga denticulate*; *i*, *Musa aurantiaca*; *j*, *Levistona jenkinsiana*; *k*, *Calamus tenuis*; *l*, *Hodgsonia heteroclite*.

knowledge on the use of natural resources still exists among the Konyaks. They depend mostly on forest products for food, medicines, vegetables and basic needs despite their main occupation being jhum cultivation⁸. Due to the significant role of NTFPs in their livelihood, some plant species like *Clerodendrum glandulosum*, *Rhus chinensis* and *Zanthoxylum rhetsum* are being domesticated or protected in jhum fields by the Konyaks⁹. With the growing awareness and need for conservation, documentation of NTFPs and their uses is vital. However, in North East India and in particular Nagaland, the tribal plant resources are understudied. Therefore, the present study aims to impart traditional knowledge of NTFPs that are utilized by the Konyaks of Nagaland.

The study area is located in Mon district of Nagaland, bordered by the Tuensang district in the south, Longleng in the west, Sibsagar district of Assam in the northwest, Longding district of Arunachal Pradesh in the northeast and Myanmar in the east¹⁰. For this study the villages of Chingkao, Tangnyu, Sheanghah-Lampong, Wakching and Hongphoi were chosen. Vegetable vendors from Aboi and Mon towns were also interviewed as part of the study. Information was gathered on NTFPs that are used by the villagers for different purposes. The resources are either harvested from the wild or cultivated in protected jhum lands and home gardens. Local names and other required descriptions on the uses of each species were rec-

orded by direct observation and through group interviews with street vendors, farmers, village elders and council members. Plant specimens were identified using the related literature and with the help of experts in the field of taxonomy^{11,12}.

The use of NTFPs among the Konyaks has been an age-old practice. In total, 43 plant species representing 26 families were recorded in the present study (Table 1). Family Asteraceae was the most dominant in yielding forest products, followed by Arecaceae. Wild medicinal plants such as *C. glandulosum* and *Solanum khasianum* were found to be used by the people of Mon district, especially those in rural areas. The food supplements account for 23 species which are used based on the traditional knowledge with certain improvisations. *Caryota urens*, a palm species was one of the many plants that provided food security when proper farming was not introduced to the tribe. Among the food supplements, *Phoebe cooperiana*, popularly known as 'kuh', is in high demand in the market, the reason being that it is rarely available and also because of its medicinal value. A common plant used for thatching of houses is *Levistona jenkinsiana*, which was reported as an endangered species^{13,14}. Villagers have few patches of land where *L. jenkinsiana* is cultivated in the secondary forest. The green leafy vegetable such as *Pilea scripta* and *Gynura bicolor* are abundantly found, especially in remote villages where

primary forests are available. The leaves of *Musa nagen-sium*, a species of banana that was first reported in Nagaland, are used for smoothening wool while weaving. Apart from those used as food and medicine, a good number of plant species are collected as fodder for animals, such as *Spilenthos acmella* and *Ficus obscura*. The women folk play a major part in collecting forest resources; some sell their products in local markets for seasonal income, while some others use them for their daily living. For vegetable vendors NTFPs are the only source of income for their basic necessities such as food, clothing, shelter and education. Some wild fruits that are sold in local markets are *P. cooperiana*, *Canarium strictum* and *Phyllanthus emblica*. Wild vegetables like *Ocimum tenuiflorum* and *Zanthoxylum rhetsum* are also economically important. Young children and women are often seen collecting and selling broom (*Thysanolaena latifolia*), which is also a good source of income. Figure 1 represents some NTFPs used by the Konyak Nagas.

The herbs, shrubs and creepers of medicinal value are diverse and found in abundance, for example, *Houttuynia cordata*, *Centella asiatica*, *Eupatorium adenophorum* and *S. khasianum*. However, with the increase in anthropogenic disturbances, the loss of such species is possible as they are hardly being cultivated. The traditional knowledge on the use of species like *C. urens*, *Gynocardia odorata*, *Entada phaseoloides* and *Hodgsonia heteroclite* needs special attention to be documented, as these are the bioresources that people relied on during famine and food shortage. Less importance has been given to wild edible fruits like *C. strictum* and *Terminalia chebula* because of the lack of knowledge on their nutritive value. A study on nutrient content and health benefits of all these plant species must be incorporated in future research. In a cash-constrained rural economy, with no alternate ways to generate income, there are tendencies of unsustainable harvesting of some species which may be destructive for the forest ecosystem. Therefore, the domestication of commercially important NTFPs is not only important from an economic point of view, but to reduce the threats caused by the increasing demand for forest resources.

Conflict of interest: The authors declare that they have no conflict of interest.

- World Commission on Forests and Sustainable Development, *Our Forests our Future*, Cambridge University Press, Cambridge, UK, 1999.
- World Bank Group, A revised forest strategy for the World Bank Group, World Bank, Washington DC, USA, 2001.
- FAO, Harvesting of the non-wood forest products. Food and Agriculture Organization of the United Nations, Rome, Italy, 2003.
- Mipun, P., Bhat, N. A., Borah, D. and Kumar, Y., Non-timber forest products and their contribution to healthcare and livelihood security among Karbi tribe in Northeast India. *Ecol. Process.*, 2019, **8**(41), 1–2.
- Jamir, N. S., Asemba, L. and Jamir, N., Ethnomedicinal plants used by Konyak Naga tribes of Mon district in Nagaland. *Ethnobotany*, 2008, **20**, 48–53.
- Pradheep, K., Chiten, S., Pandey, A. and Bhatt, K. C., Wild edible plants used by Konyak tribe in Mon district of Nagaland: survey and inventorisation. *Indian J. Nat. Prod. Res.*, 2016, **7**(1), 74–81.
- District Human Development Report – Mon, Department of Planning and Coordination, Government of Nagaland, 2011, p. 30.
- Changkija, S., Folk medicinal plants of the Nagas in India. *Asian Folklore Stud.*, 1999, **58**, 205–230.
- Dey, S., Studies of the diversity of flowering plants of Tuensang district, Nagaland. Ph.D. thesis, Nagaland University, 2018.
- Singh, O. P. and Tiwari, B. K., State level biodiversity strategy and action plan of Nagaland, National Biodiversity Strategy and Action Plan, Project Report, 2002, p. 94.
- BSI, *Red Data Book of Indian Plants, Vols I–III*, Botanical Survey of India, Kolkata, 1987.

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An empirical method for estimation of groundwater unit draft of energized agricultural tube wells

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Field methods for the estimation of groundwater unit draft are not fully reliable due to non-uniformity of draft in the time domain. In India, use of norm values recommended by the Groundwater Estimation Committee is in common practice. However, large-scale electrification in agricultural sector has drastically changed the agricultural pumping scenario. Conversion of diesel-powered pump sets to unmetered electrified pump sets

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- Shackleton, C. and Shackleton, S., The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa in South. *Afr. J. Sci.*, 2004, **100**, 658–664.
- Marshall, E., Newton, A. C. and Schreckenberg, K., Commercialisation of non timber forest products: first steps in analysing the factors influencing success. *Int. For. Rev.*, 2003, **5**(2), 128–137.
- Sarmah, R., Commonly used non-timber forest products (NTFPs) by the Lisu tribe in Changlang district of Arunachal Pradesh, India. *Sibcoltejo*, 2010, **5**, 68–77.