Survey for the potential fibre yielding plants in the flora of Lakhimpur and Dhemaji districts of Assam in North-east India

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Abstract

Fibres are the second most economically important plant based products after food. They serve innumerable roles in our day to day life, thereby making their presence indispensable. A survey was conducted from June 2017 – July 2018 in Lakhimpur and Dhemaji districts of Assam, India for potential fibre yielding plants of the region. Out of the recorded 130 species of plants, only two are pteridophytes and of the 128 species of angiosperms, 103 (20 families & 69 genera) of Dicotyledonous (Magnoliopsida) and 25 species (9 families & 24 genera) of Monocotyledonous (Liliopsida). The fibres are used in numerous ways, including making ropes, mats, clothes, thatching the roofs, etc. The study is a first such attempt to document the potential fibre-yielding plants of this region.

Key words: Fibre plants, Potential use, Assam, Lakhimpur, Dhemaji

INTRODUCTION

Nature, mainly the plants, provide almost everything for the survival of every species including man. Among the plant materials commonly used by man, fibres hold the second position after the food in their economic importance. These vegetable-fibres have multiple roles especially in rural areas (Manandhar 1986, 1992; Singh & Shrestha 1988; Parisara & Kiran 2016). The major constituents of vegetable fibres are cellulose, hemicellulose and lignin, and can be extracted from bast, leaf, seed, fruit, wood, stalk and grass/reed (Pecas *et al.* 2018). The use of fibres by man can be dated back early in civilization. The ancient nomadic men covered their bodies with plant materials like bark mainly to protect themselves from cold and started using to thatch or cover their shelters and huts; mats for sleeping and for host of other day to day activities (Royle 1855). With the advancement of life, man became civilized but their dependence on plants remained as a part and parcel in their sophisticated life-style. Even in their civilized urban life, fibres play an important role in the form of innumerable types of textiles, woven clothes, papers, basketries, mats, hats, ropes and cordage materials for their endless type of uses.

There are three major groups of natural fibres based on their origin: animals, minerals (asbestos) and plants (Figure 1) (Pecas *et al.* 2018). Of these, plant fibres have garnered the most attention from industries as well as the research community owing to short growth period, quick renewability and wider availability (Cicala *et al.* 2010; Pecas *et al.* 2018). The unique qualities of plant fibres include thermal insulation, resistance to water and other desirable traits. The plant fibres are classified mainly on the basis of morphological nature, structure, origin and from the utilitarian aspects. Based on their origin, vegetable fibres are grouped into soft fibre/bast fibre, hard fibres or structural fibre and surface fibre (Royle 1855; Gaur & Nautiyal 1993). Animal fibres are not commonly used except for woolen-

Figure 1. Types of natural fibres

clothes and asbestos was banned due to risks of exposure and associated human health (Kazan Allan 2016; Pecas *et al.* 2018).

Owing to their varied roles and eco-friendly nature, plant-fibres have seamlessly integrated into our lifestyle to seal an unavoidable place and became a part and parcel in civilization. India is a IUCN recognized Megadiversity country (Mittermeier *et al.* 2005; Das 2011) with extremely rich flora. However, even today, the information on fibre yielding plants is rare and scattered (Manandhar, 1986, 1992; Singh & Shrestha, 1988; Chandrasekar *et al.* 2010; Das & Lungphi 2019).

According to Encyclopedia Britannica (on line), fibre is defined as, “Natural fibre, any hairlike raw material directly obtainable from an animal, vegetable, or mineral source and convertible into non-woven fabrics such as felt or paper or, after spinning into yarns, into woven cloth. A natural fibre may be further defined as an agglomeration of cells in which the diameter is negligible in comparison with the length” (<https://www.britannica.com/topic/natural-fibre>). However, in practical application, even slender branches of climbers, long stretches of sliced bark taken out from the stem surface, stilt and diffuse roots, etc. are also used as fibres.

It is now needless to reiterate the global phenomenon of fast depletion of natural vegetation leading to the loss of innumerable useful but yet unassessed non-recoverable biodiversity (Das 2011).

Major part of Assam falls within the IUCN declared Indo-Burma Biodiversity Hotspot (Mittermeier *et al.* 2005). It is a part of North-east India and is known to host extremely rich biodiversity with innumerable endemics and Rare, Endangered and Threatened (RET) plants. Even today, in remote areas, majority of the poor tribal people depend on local natural vegetation for most of their daily requirements. For survival, they need to construct their houses, weave their traditional clothes, tie their domesticated animals, etc. and for other endless uses. The plant-fibres are variable in characteristics with respect to

strength, durability, length, texture, plant part in which present, chemical composition, pigmentation, resistance to water, etc. (Royle 1855).

Till date, no floristic account on fibre-yielding plants is available for Lakhimpur and Dhemaji districts of Assam. This is the first study of its kind and is aimed at documenting the occurrence of different potential fibre-yielding plants growing in wild as well as under cultivation in these two districts. It will also generate a database of fibre-yielding plants found in Lakhimpur and Dhemaji districts of Assam, India.

MATERIALS AND METHODS

STUDY AREA

The present study covers two adjacent administrative districts, Lakhimpur and Dhemaji, of the North-east Indian state of Assam (Figure 2). Lakhimpur is geographically located approximately at 26.48° and 27.53° N latitudes and 93.42° and 94.20° E longitudes, covering an area of 2,277 sq km and situated at an average altitude of 147 m AMSL. The district is also situated at the feet of the Arunachal Pradesh part of the Eastern Himalaya with the mighty river Brahmaputra and a good number of its tributaries (Mor, Pichala, Dikrong, Ranga, Chila, Koran, Charikara and Dangahara) are flowing through it. Evergreen forests are covering about 29379 hectares of area, which has contiguity with the rich vegetation of Arunachal Himalaya (Anonymous 2011a).

Dhemaji district, sharing border with Lakhimpur, is located approximately between the 94° 12' 18" E and 95° 41' 32" E longitudes and 27° 05' 27" N and 27° 57' 16" N latitudes, covering an area of 3237 sq km and is lying at an average elevation of 104 m AMSL. As much as nine reserved forests has been recognized within the boundary of the district and covers a total area of 53,224.11 hectares. Like Lakhimpur vegetation, these forests are also mostly evergreen. The river Brahmaputra flows through this district too with its large number of tributaries like Jiadhal, Gainadi, Na-Nadi, Moridhal, Dimow, Simen, etc. (Anonymous 2011b).

Collection of specimens

Specimens were collected from different localities, settlement areas of different tribal communities, markets and natural vegetation in Lakhimpur and Dhemaji districts of Assam during 2017 – 2018 spreading all the four recognized seasons of the year and covering wide range of vegetation types, both aquatic and terrestrial. The use of different plants as fibres and/or used for fibre extraction, mat preparation, etc. were recorded using an open questionnaire. A total of 207 people from 36 villages were requested to respond to the questionnaire.

Voucher specimens were processed into mounted herbarium-sheets following (Bridson & Forman 1998; Das 2020) and were identified using available literature like Hooker (1872 – 1897), Kanjilal *et al.* (1934 – 1940), Bor (1940), and *The Materials for the Flora of Arunachal Pradesh* (Hajra *et al.* 1996; Giri *et al.* 2008; Chowdhery *et al.* 2009), publications on the fibre-yielding plants of India (Anonymous 1948 – '76 & 1985 – '92; Royle 1855; Gaur & Nautiyal 1993; Palni *et al.* 1999; Lepcha *et al.* 2009; Chandrasekhar *et al.* 2010) and different virtual herbaria were used for matching and confirmation. For updated nomenclature and family delimitation websites like www.plantsoftheworldonline.org and www.theplantlist.org were consulted. Voucher specimens will be submitted to the HAU Herbarium of the Department of Botany, Rajiv Gandhi University, Arunachal Pradesh.

Figure 2. Map of the study area, Lakhimpur and Dhemaji districts of Assam, India
 [Sources: [https://www.google.com/search?q=location+map+of+assam+in+india&tbm=isch&ved;](https://www.google.com/search?q=location+map+of+assam+in+india&tbm=isch&ved;http://gazeis.in/villages-in-assam-lakhimpur/)
<http://gazeis.in/villages-in-assam-dhemaji/>]

RESULTS

The present survey has recorded 130 species of plants of which one or more parts can be used or treated as fibre. There are two species [1 Family & 1 Genus] of Pteridophyta, 103 species [20 Families & 69 Genera] of Dicotyledonous (Magnoliopsida) and 25 species [9 Families & 24 Genera] of Monocotyledonous (Liliopsida) plants. All these plants are presented alphabetically to their Families and plant names under each family in Table 1.

Table 1. Recorded potential fibre-plants from the Lakhimpur and Dhemaji districts of Assam in North-east India

[Abbreviations used: *Habit*: **CA** – Annual climber; **CE** – Epiphytic climber; **CG** – Geophytic climber; **CS** – Shrubby climber; **HA** – Annual herb; **HG** – Geophytic herb; **HP** – Perennial herb; **HPR** – Rosette Perennial Herb; **L** – Liana; **S** – Shrub; **T** – Tree; **TS** – Small tree; **US** – Undershrub. *Plant parts*: **Bk** – Bark; **Cl** – Culm; **Cm** – Coma; **Lf** – Leaf; **Lm** – Lamina; **Ln** – Lint; **LS** – Leaf-sheath; **Mc** – Mesocarp; **Mv** – Mid-vein; **St** – Stem; **WP** – Whole plant. *Usable product*: **Ff** – Fine fibre; **Fl** – Floss; **Flf** – Flat fibre; **Rps** – Rope substitute; **Shf** – Short fibre; **Sf** – Stiff fibre; **Sw** – Soft wood; **Td** – Thread; **Tf** – Thick fibre. *Use in Study area*: **N** – Not in use; **Y** – In use. *Demand*: * - *****: Number of stars indicates the degree of use; — : Not in use; **NK** – Not known. *Nativity*: **E** - Exotic species; **L** – Local species; **N** – Naturalized plant]

Plants	Habit	Part use	Usable product	Use in study area	Demand	Nativity
AGAVACEAE						
<i>Agave americana</i> L.	HPR	Lf	Ff	N	****	E
<i>Agave cantula</i> Roxb.	HPR	Lf	Ff	N	****	E
<i>Agave sisalana</i> Perrine	HPR	Lf	Ff	N	****	E
<i>Furcraea foetida</i> (L.) Haw.	HPR	Lf	Ff	N	**	E
ANNONACEAE						
<i>Annona squamosa</i> L.	TS	Bk	Rps	N	NK	NC
<i>Monoon simiarum</i> (Buch.-Ham. ex Hook.f. & Thomson) B.Xue & R.M.K.Saunders	T	Bk	Rps	N	NK	L
APOCYNACEAE :: APOCYNOIDAE						
<i>Chonemorpha fragrans</i> (Moon) Alston	L	St	Rps	Y	--	L
<i>Ichnocarpus frutescens</i> (L.) W.T.Aiton	L	St	Rps	Y	--	L
APOCYNACEAE :: ASCLEPIADIOIDEAE						
<i>Calotropis gigantea</i> (L.) W.T.Aiton	S	Cm	Fl	Y	**	L
<i>Calotropis procera</i> (Aiton) W.T.Aiton	S	Cm	Fl	Y	**	L
<i>Cryptolepis dubia</i> (Burm.f.) M.R.Almeida	CS	St, Cm	Rps, Fl	Y	NK	L
<i>Marsdenia griffithii</i> Hook.f.	L	St, Cm	Rps, Fl	Y	NK	L
<i>Marsdenia roylei</i> Wight	L	St, Cm	Rps, Fl	Y	NK	L
ARACEAE						
<i>Scindapsus officinalis</i> (Roxb.) Schott	CE	St	Rps	N	NK	E
BORAGINACEAE						
<i>Cordia dichotoma</i> G.Forst.	T	Bk	Rps	N	NK	L
BROMELIACEAE						
<i>Ananas comosus</i> (L.) Merr.	HPR	Lf	Ff	N	**	E
CANNABACEAE						
<i>Cannabis sativa</i> L.	HA	Bk	Ff	Y	***	N
<i>Trema orientalis</i> (L.) Blume	T	Bk	Ff, Rps	Y	NK	L
<i>Trema politoria</i> (Planch.) Blume	T	Bk	Ff, Rps	Y	NK	L
COMPOSITAE / ASTERACEAE nom.cons.						
<i>Mikania micrantha</i> Kunth	CS	St	Rps	Y	--	N

Plants	Habit	Part use	Usable product	Use in study area	Demand	Nativity
DILLENIACEAE						
<i>Dillenia pentagyna</i> Roxb.	T	Bk	Rps	Y	--	L
GRAMINEAE / POACEAE nom.alt.						
<i>Chimonobambusa callosa</i> (Munro) Nakai	HP	Cl	Flf	Y	*****	L
<i>Arundo donax</i> L.	HP	St	Rps	Y	NK	L
<i>Bambusa bambos</i> (L.) Voss		Cl	Flf	Y	*****	L
<i>Dendrocalamus hamiltonii</i> Nees & Arn. ex Munro	HP	Cl	Flf	Y	*****	L
<i>Eulaliopsis binata</i> (Retz.) C.E.Hubb.	HP	Lf	Tf	N	*****	L
<i>Imperata cylindrica</i> (L.) P.Beauv.	HP	Lf	Tf	Y	*****	L
<i>Phragmites karka</i> (Retz.) Trin. ex Steud.	HP	Rt	Tf	N	*****	L
<i>Tripidium bengalense</i> (Retz.) H.Scholz	HP	St	Rps	Y	NK	L
<i>Saccharum spontaneum</i> L.	HP	Lf	Flf	Y	****	L
<i>Themeda arundinacea</i> (Roxb.) A.Camus	HA	St	Flf, Rps	Y	NK	L
LECYTHIDACEAE						
<i>Careya arborea</i> Roxb.	T	Bk	Rps	N	--	L
LEGUMINOSAE / FABACEAE nom.alt.: CAESALPINIOIDEAE						
<i>Bauhinia variegata</i> L.	L	Bk	Rps	Y	--	L
<i>Phanera vahlii</i> (Wight & Arn.) Benth.	T	St	Rps	Y	--	L
LEGUMINOSAE / FABACEAE nom.alt.: MIMOSOIDEAE						
<i>Entada phaseoloides</i> (L.) Merr.	L	St	Rps	Y	--	L
LEGUMINOSAE / FABACEAE nom.alt.: PAPILIONOIDEAE						
<i>Abrus melanospermus</i> Hassk.	CS	St, Bk	Rps	Y	NK	L
<i>Abrus precatorius</i> L.	CS	St, Bk	Rps	Y	NK	L
<i>Aeschynomene aspera</i> L.	HA	St	SW	Y	*****	L
<i>Butea monosperma</i> (Lam.) Kuntze	T	Bk		N	--	L
<i>Cajanus cajan</i> (L.) Huth	S	Bk	Ff	N	NK	L
<i>Callerya cinerea</i> (Benth.) Schot	L	St, Bk	Rps, Ff	N	NK	L
<i>Crotalaria assamica</i> Benth.	HA	Bk	Ff	N	NK	L
<i>Crotalaria juncea</i> L.	HA	Bk	Ff	Y	*****	L
<i>Crotalaria albida</i> B.Heyne ex Roth	HA	Bk	Ff	Y	**	L
<i>Mastersia assamica</i> Benth.	L	St, Bk	Rps, Ff	Y	--	L
<i>Millettia extensa</i> (Benth.) Benth. ex Baker	L	St, Bk	Rps, Ff	Y	*	L
<i>Mucuna pruriens</i> (L.) DC.	CA	St	Rps	Y	--	L
<i>Pongamia pinnata</i> (L.) Pierre	T	Bk	Rps	Y	--	L
<i>Pueraria tuberosa</i> (Roxb. ex Willd.) DC.	CS	St, Bk	Ff, Rps	Y	**	L
<i>Sesbania bispinosa</i> (Jacq.) W.Wight	HA	Bk	Ff	Y	****	L
<i>Sesbania sesban</i> (L.) Merr.	HA	Bk	Ff	Y	***	L
<i>Spatholobus parviflorus</i> (Roxb. ex G.Don) Kuntze	CS	St, Bk	Rps, Ff	Y	NK	L
LINEACEAE						
<i>Linum usitatissimum</i> L.	HA	Bk	Ff	Y	*****	E
MALPIGHIACEAE						
<i>Hiptage benghalensis</i> (L.) Kurz	CS	St	Rps	N	--	L
MALVACEAE [s.s.]						
<i>Abutilon indicum</i> (L.) Sweet	S	Bk	Ff	Y	NK	L
<i>Abutilon persicum</i> (Burm.f.) Merr.	S	Bk	Ff	N	NK	L
<i>Abutilon theophrasti</i> Medik.	S	Bk	Ff	N	NK	L
<i>Abelmoschus esculentus</i> (L.) Moench	HA	Bk	Ff	N	NK	L

Plants	Habit	Part use	Usable product	Use in study area	Demand	Nativity
<i>Abelmoschus moschatus</i> Medik.	HA	Bk	Ff	N	NK	L
<i>Gossypium arboreum</i> L.	S	Ln	Td	Y	*****	L
<i>Gossypium herbaceum</i> L.	HA	Ln	Td	Y	*****	E
<i>Hibiscus cannabinus</i> L.	HA	Bk	Ff	Y	**	E
<i>Hibiscus sabdariffa</i> L.	HA	Bk	Ff	Y	NK	E
<i>Hibiscus tiliaceus</i> L.	TS	Bk	Ff, Rps	Y	--	L
<i>Hibiscus vitifolius</i> L.	HA	Bk	Ff	N	NK	L
<i>Kydia calycina</i> Roxb.	T	Bk	Ff	Y	--	L
<i>Malvastrum coromandelianum</i> (L.) Garcke	US	Bk	Ff	N	--	L
<i>Sida acuta</i> Burm.f.	HA	WP, Bk	Rps, Ff	Y	**	L
<i>Sida cordata</i> (Burm.f.) Borss.Waalk.	US	Bk	Ff	Y	**	L
<i>Sida cordifolia</i> L.	HA	Bk	Ff	N	NK	L
<i>Sida rhombifolia</i> L.	US	Bk	Ff	N	NK	L
<i>Azanza lampas</i> (Cav.) Alef.	HA	Bk	Ff	N	--	L
<i>Urena lobata</i> L.	HA	Bk	Ff	Y	*	L
<i>Urena sinuate</i> L.	HA	Bk	Ff	Y	*	L
<i>Wissadula amplissima</i> (L.) R.E.Fr.	US	Bk	Ff	N	NK	N
MALVACEAE / BOMBACACEAE						
<i>Bombax ceiba</i> L.	T	Cm	Fl	Y	*****	L
<i>Ceiba pentandra</i> (L.) Gaertn.	T	Cm	Fl	Y	*****	N
MALVACEAE / STERCULIACEAE						
<i>Abroma augustum</i> (L.) L.f.	S	Bk	Ff	N	NK	L
<i>Helicteres isora</i> L.	TS	Bk	Ff	Y	**	L
<i>Melochia corchorifolia</i> L.	HA	Bk	Ff	N	**	L
<i>Sterculia villosa</i> Roxb. ex Sm.	T	Bk	Rps	Y	--	L
MALVACEAE / TILIACEAE						
<i>Corchorus capsularis</i> L.	HA	Bk	Ff	Y	*****	N
<i>Corchorus aestuans</i> L.	HA	Bk	Ff	N	NK	L
<i>Corchorus olitorius</i> L.	HA	Bk	Ff	Y	*****	L
<i>Grewia asiatica</i> L.	TS	Bk	Ff, Rps	Y	--	L
<i>Grewia optiva</i> J.R.Drumm. ex Burret	TS	Bk	Ff, Rps	Y	--	L
<i>Triumfetta pilosa</i> Roth	HA	Bk	Ff	N	*	L
<i>Triumfetta rhomboidea</i> Jacq.	HA	Bk	Ff	N	*	L
MARANTACEAE						
<i>Schumannianthus benthamianus</i> (Kuntze) Veldkamp & I.M.Turner	S	Bk	Flf	N	*****	L
MENISPERMACEAE						
<i>Cissampelos pareira</i> L.	CS	St	Rps	Y	--	L
<i>Stephania japonica</i> (Thunb.) Miers	CS	St	Rps	Y	--	L
<i>Stephania elegans</i> Hook.f. & Thomson	CG	St	Rps	Y	--	L
<i>Stephania rotunda</i> Lour.	CG	St	Rps	Y	--	L
MORACEAE						
<i>Artocarpus lacucha</i> Buch.-Ham.	T	Bk	Rps	Y	--	L
<i>Broussonetia papyrifera</i> (L.) L'Hér. ex Vent.	TS	Bk	Rps	Y	***	L
<i>Ficus auriculata</i> Lour.	T	Bk	Rps	Y	--	L
<i>Ficus benghalensis</i> L.	T	Bk	Rps	N	--	L
<i>Ficus racemosa</i> L.	T	Bk	Rps	N	--	L
<i>Ficus semicordata</i> Buch.-Ham. ex Sm.	T	Bk	Rps	Y	--	L
<i>Ficus virens</i> Aiton	T	Bk	Rps	--	--	L
<i>Streblus asper</i> Lour.	T	Bk	Rps	N	--	L

Plants	Habit	Part use	Usable product	Use in study area	Demand	Nativity
MUSACEAE						
<i>Musa x paradisiaca</i> L.	HP	LS	Tf	Y	*	L
MYRTACEAE						
<i>Eucalyptus globulus</i> Labill.	T	Bk	Rps	N	NK	E
PALMAE / ARECACEAE nom.alt.						
<i>Areca catechu</i> L.	T	Mc	Shf	N	NK	E
<i>Borassus flabellifer</i> L.	T	Lm	Flf	Y	***	L
<i>Calamus erectus</i> Roxb.	L	St, Bk	Rps, Flf	Y	*****	L
<i>Calamus jenkinsianus</i> Griff.	L	St, Bk	Rps, Flf	Y	*****	L
<i>Cocos nucifera</i> L.	T	Mc, Lf, Lm, Mv	Coir, Flf, Sf	Y	*****	L
<i>Phoenix sylvestris</i> (L.) Roxb.	T	Lf, Lm	Flf	N	**	L
PANDANACEAE						
<i>Pandanus furcatus</i> Roxb.	TS	Rt	Tf	N		L
RHAMNACEAE						
<i>Gouania leptostachya</i> DC.	L	St, Bk	Rps, Ff	Y	--	L
<i>Ventilago denticulata</i> Willd.	L	St, Bk	Rps, Ff	Y	--	L
RUTACEAE						
<i>Murraya paniculata</i> (L.) Jack	TS	Bk	Rps	N	--	L
SMILACACEAE						
<i>Smilax zeylanica</i> L.	CG	St	Rps	Y	--	L
SCHIZAEACEAE						
<i>Lygodium flexuosum</i> (L.) Sw.	CG	St	Rps	Y	--	L
<i>Lygodium japonicum</i> (Thunb.) Sw.	CG	St	Rps	Y	--	L
THYMELAEACEAE						
<i>Aquilaria malaccensis</i> Lam.	T	Bk	Rps	Y	--	L
TYPHACEAE						
<i>Typha elephantina</i> Roxb.	HG	Lf	Flf	Y	***	L
ULMACEAE						
<i>Ulmus wallichiana</i> Planch.	T	Bk	Rps, Ff	N	--	L
URTICACEAE						
<i>Boehmeria nivea</i> (L.) Gaudich.	S	Bk	Ff	Y	***	N
<i>Boehmeria virgata</i> subsp. <i>macrophylla</i> (Hornem.) Friis & Wilmot-Dear	S	Bk	Ff	Y	**	L
<i>Boehmeria virgata</i> var. <i>macrostachya</i> (Wight) Friis & Wilmot-Dear	S	Bk	Ff	N	*	L
<i>Debregeasia longifolia</i> (Burm.f.) Wedd.	S	Bk	Ff, Rps	Y	*	L
<i>Girardinia diversifolia</i> (Link) Friis	S	Bk	Ff	N	*	L
<i>Oreocnide frutescens</i> (Thunb.) Miq.	S	Bk	Rps, Ff	N	--	L
<i>Oreocnide integrifolia</i> (Gaudich.) Miq.	S	Bk	Rps, Ff	N	--	L
<i>Urtica dioica</i> L.	S	Bk	Ff	N	**	L
VITACEAE						
<i>Cissus quadrangularis</i> L.	CS	St	Rps	N	--	L
<i>Cissus repanda</i> (Wight & Arn.) Vahl	CS	St	Rps	Y	--	L
<i>Tetrastigma leucostaphylum</i> (Dennst.) Alston	CS	St	Rps	Y	--	L
ZINGIBERACEAE						
<i>Alpinia nigra</i> (Gaertn.) Burt	HG	WP	Rps	Y	--	L

Considering the habits of these plants, there are 26 species each for trees and annual herbs, 17 species of shrubs, 13 species of liana, 12 species of shrubby climber, 8 species of trees, 9 species of perennial herbs, 5 species each for perennial rosette plants and geophytic

Figure 3. Percentage distribution of plant parts used as fibre

climbers, 4 species of undershrubs, 2 species of geophytic herbs and one species each for epiphytic climber and annual climber. A good number of these plants are already in cultivation but many potential ones are not used to their potential.

DISCUSSION

Present survey for the potential fibre plants in Lakhimpur and Dhemaji districts of Assam in NE India, lead to the recognition of 130 species of vascular plants that represent only two species of Pteridophytes and remaining all 128 species of angiosperms. Of the angiosperms, 103 species are dicotyledonous and 25 are monocotyledonous.

Quite a good number of plant parts are used directly as fibre or are processed to produce fibre. Bark of the stem is the main source, represented by 80 species. Stems are directly used as rope for 35 species, leaves of 11 species, coma (on seeds) of 7 plants, etc. are the main contributors. Coir, produced from the fibrous mesocarp of *Cocos nucifera* is one very important industrial raw material. Figure 3 shows the percentage distribution of different plant parts used as fibre in the Lakhimpur-Dhemaji area of Assam.

There are numerous exotic species of plants growing in India which were introduced in different times for different purposes. The list of recorded plants also contains 19 species of exotics. Of these, eight species have been naturalized and some are in wide-scale cultivation. Plant like *Agave americana* is rarely cultivated here but are commonly grown along the fences. Two other species of *Agave* and *Furcraea foetida* are popular ornamentals. The Australian tree *Eucalyptus globulus* is cultivated for oil as well as for paper pulp thereby contributing a lot to the economy. *Areca catechu* is cultivated extensively for its edible stony endosperm but not for fibre of its mesocarp. Some other exotic species like *Corchorus capsularis*, *Gossypium herbaceum*, *Linum usitatissimum* and *Boehmeria nivea* are in cultivation for different types of fibre since long.

Considering their importance in the society and market demand 22 species have been recognized as most important (5 stars), majority of these are in cultivation. *Imperata cylindrica* is one troublesome grass with very rigid underground sobol that is never cultivated but its long,

sometimes over a meter, narrowly linear leaves are collected from nature and is used in numerous ways. While the exotic *Ceiba pentandra* is always planted over wide areas, the *Bombax ceiba* has a very good natural population and is also in plantations.

Demand for different types of bamboo need not to be discussed here. But, two species of *Calamus* are commonly found in natural forests, rarely cultivated and have wide market demand. *Schumannianthus benthamianus*, though a local plant, is always used from the cultivated population. *Sheetal-paati*, weave with its bark, has high demand even in the international markets. The soft-wood stem of *Aeschynomene aspera* has wide use in the manufacture of artistic materials.

Many of these plants are used in more than one ways, e.g. *Linum usitatissimum* is for flax fibre and also for its seed-oil; in addition to fibre, young plants *Corchorus olitorius* is widely taken as green-vegetable and it has also medicinal applications. In fact, a good proportion of the recorded plants has at least one non-fibre additional use. But, the case of coconut trees (*Cocos nucifera*) is quite different. In addition to the entire leaf, it's leaflets (though morphologically leaves are 'simple'), strong mid-vein of leaflets (broom-sticks), and fibrous mesocarp, etc. all are used as different forms of fibre. Nearly equally important are two other palms, *Borassus flabellifer* and *Phoenix sylvestre*.

Traditional people use a wide range of fibres extracted from innumerable species. Type of fibre required varies greatly according to the purpose. Slender long stems of numerous species of climbing plants are directly used as rope. Such 'ropes' are also used for making hanging bridges. Also, fine fibres are collected from numerous small herbaceous or shrubby plants like *Urena lobata*, *Sida acuta*, *Hibiscus vitifolius*, *Abutilon indicum*, *Triumfetta rhomboidea*, *Urtica dioica*, etc. Nepali people living in Darjeeling and Sikkim areas produce a special type of cloth using fibre from *Urtica dioica* stem after retting.

The short fibre present in the mesocarp of *Areca catechu* is quite strong. Every year millions of fruits are processed in Assam itself for marketing, but its fibre is never in use. If appropriate processing technique is developed, it is expected to produce short but strong and fine usable fibre.

Industry as well as traditional society needs a wide range of fibres. Indian Museum at Kolkata exhibits a good collection of natural fibres but the knowledge of modern science needs to apply again in this field to select more usable natural fibres along with their characterization and methods of processing for promising ones.

CONCLUSION

The study documents the presence of 130 fibre yielding plants in Dhemaji and Lakhimpur districts of Assam. Mass cultivation of many of these plants can enhance the economy of the dwellers of the region. Scientific community can contribute by devising efficient and sustainable fibre extraction techniques and popularizing those to the industry for a good number of potential but so far un- or under-exploited species of plants from different habit groups.

LITERATURE CITED

- Anonymous, 1948 – '76 & 1985 – '92. *The wealth of India – raw materials*, Vols. I-XI (1948 – '76) & Vols. 1-3 revised series (1985 – '92). Publications and Information Directorate, Council of Scientific and Industrial Research, New Delhi.
- Anonymous 2011a. *Census of India – 2011. Assam: District Census Handbook, Lakhimpur*. Parts XII A & B. Directorate of Census Operations, Assam.

- Anonymous 2011b. *Census of India – 2011. Assam: District Census Handbook, Dhemaji*. Parts XII A & B. Directorate of Census Operations, Assam.
- Bor, N.L. 1940. *Flora of Assam* Vol. 5 (Gramineae). Assam Govt of Press, Shillong.
- Bridson, D. & Forman, L. (eds.). 1998. *The Herbarium Handbook*, 3rd edn. Royal Botanic Gardens, Kew, UK.
- Chandrasekar, K.; Bhatt, I.D.; Rawal, R.S.; Nandi, S.K. & Dhyani, P.P. 2010. *Promising fibre-yielding plants of the Indian Himalayan region*. G.B. Pant Institute of Himalayan Environment & Development, Almora, Uttarakhand, India.
- Chowdhery, H.J.; Giri, G.S. & Pramanik, A. 2009. *Materials for the Flora of Arunachal Pradesh*. Vol. III. Botanical Survey of India, Calcutta.
- Cicala, G.; Cristaldi, G.; Recca, G. & Latteri, A. 2010. Composites Based on Natural Fibre Fabrics. In: Dubrovski, P. (ed.), *Woven Fabric Engineering*. InTech, London.
- Das, A.P. 2011. Conservation efforts for East Himalayan Biodiversity and need for the establishment of corridors. In: C. Ghosh & A.P. Das, *Recent Studies in Biodiversity and Traditional Knowledge in India*. Sarat Book House, Kolkata. Pp. 329 – 346.
- Das, A.P. 2020. Herbarium Techniques. In: J.B. Bhandari & Cyria Gurung, *Instrumentation Manual*. Narosa, New Delhi. [in press]
- Das, A. P. & Lungphi, P. 2019. Floristic Studies vis-à-vis Medicinal Plants in the Eastern Himalaya – past and the present status. In: S.K. Tripathi, K. Upadhyaya & N. Hegde (eds.), *Medicinal Plants of India: Conservation and sustainable use*. Today & Tomorrow's Printers and Publishers, New Delhi. Pp. 39 – 56. ISBN: 978817096525.
- Gaur, R.D. & Nautiyal, S. 1993. A survey of fibre-yielding plants of Garhwal Himalayas. *Higher Plants of Indian Subcontinent* 2: 193 – 208.
- Giri, G.S.; Pramanik, A. & Chowdhery, H.J. 2008. *Materials for the Flora of Arunachal Pradesh*. Vol. II. Botanical Survey of India, Kolkata.
- Hajra, P.K.; Verma, D.M. & Giri, G.S. 1996. *Materials for the Flora of Arunachal Pradesh*. Vol. I. Botanical Survey of India, Calcutta.
- Hooker, J.D. 1872 – 1897. *Flora of British India*, Vols. 1-7. L. Reeve & Co Ltd, Ashford, Kent. London.
- <https://www.britannica.com/topic/natural-fibre>
- Kazan-Allen, L. 2006. *Asbestos – The Human Cost of Corporate Greed*. European Parliamentary Group, Brussels.
- Kanjilal, U.N.; Kanjilal, P.C.; Das, A. & Purkaystha, C. 1934. *Flora of Assam*, Vol. 1, Assam Govt. Press, Shillong.
- Kanjilal, U.N.; Kanjilal, P.C. & Das, A. 1938. *Flora of Assam*, Vol. 2, Assam Govt. Press, Shillong.
- Kanjilal, U.N.; Kanjilal, P.C.; Das, A. & Dey, R.N. 1939. *Flora of Assam*, Vol. 3, Assam Govt. Press, Shillong.
- Kanjilal, U.N.; Kanjilal, P.C.; Das, A. & Dey, R.N. 1940. *Flora of Assam*, Vol. 4, Assam Govt. Press, Shillong.
- Lepcha, S.T.S.; Bahti, S. & Kumar, A. 2009. *Common fibre yielding plants of North-West Himalayas – with special reference to Uttarakhand*. Uttarakhand Bamboo and Fibre Development Board (UBFDB), Dehradun.

- Manandhar, N.P. 1986. Ethnobotany of Jumla district, Nepal. *Intn. J. Crude Drug Res.* 24(2): 81 – 89.
- Manandhar, N.P. 1992. The ethnobotanical observations on fibre bearing wild plants of Nepal. *Journal of Economic and Taxonomic Botany. Additional Series* In: J.K. Maheshwari et al. (eds.), *Ethnobotany in India*. Scientific Publishers, Jodhpur, 1993; 10:117-122.
- Mittermeier, R.A.; Gil, P. R.; Hoffmann, M.; Pilgrim, J.; Brooks T.; Mittermeier, C.G.; Lamoreux, J.; Da Fonseca, G.A.B. 2005. Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. *Conservation International*.
- Palni, L.M.S.; Rikhari, H.C. & Sharma, S. 1999. *Enterprise development in natural fibre-based products – a study of the status and potential in the Central Himalayan region of India*. International Centre for Integrated Mountain Development, Kathmandu, Nepal.
- Parisara, N. & Kiran, B.R. 2016. A preliminary survey of Fibre yielding plants in and around Bhadra Reservoir Project area, Karnataka. *J. Med. Pl. Stud.* 4(1): 47 – 49.
- Peças, P.; Carvalho, H.; Salman, H. & Leite, M. 2018. Natural fibre composites and their applications: a review. *J. Composites Sci.* 2(4): 66.
- Royle, R.F. 1855. *The Fibrous Plants of India*. Smmith Elder & Co., London [Reprint 1984, Periodical Experts Book Agency, Delhi.]
- Singh, S.C. & Shrestha, R. 1988. *Girardinia diversifolia*, a nonconventional fibre resources in Nepal. *Econ. Bot.* 42(3): 445 – 447.
- www.plantsoftheworldonline.org
- www.theplantlist.org