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Uncodified system of animal health care in Eastern Himalaya and Indo-Burma hotspots of India: Plant use and their distribution

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Abstract

Northeastern states, Sikkim, Arunachal Pradesh, Assam, Meghalaya, Nagaland, Manipur, Mizoram and Tripura – falling in Eastern Himalaya and Indo-Burma hotspots, house a large number of indigenous communities, mostly forest and forest fringe dwellers, whose economy is also dependent on livestock. To maintain the health of various livestock they practice ethnoveterinary medicine (EVM) which is so important yet scarcely studied. This review is based on eleven core research publication on EVM practices representing these states. Several other peer reviewed publications were also consulted for analysis and synthesis of the contents like, Physiography and Phyto-diversity, Indigenous Communities, Livestock and Common Ailments, Healer Plants, Bio-Active Components and Drugs, Potential Distribution. Analysis revealed that only twenty-three communities out of >200 are researched upon. All most all the livestock are covered in the studied area by using herbal preparation from 195 plants. However, research on pharmacological and distributional details is scanty and needs further exploration since similar plants (*Asparagus racemosus, Allium sativum, Azadirachta indica, Cannabis sativa, Centella asiatica, Curcuma longa, Drymaria cordata*) for ethnomedicine use (for humans) are recorded from various locations and used by different communities. Nevertheless, current compilation of data seems to be useful in the sense of preservation of the indigenous knowledge, otherwise on decline due to oral transfer from one to another generation.

Keywords: ethnoveterinary medicine; distribution mapping; healer plants; indigenous communities; livestock treatment

Introduction

Northeast India being at the confluence of the Indo-Malayan and Indo-Chinese biogeographic regions form a meeting place of the Himalayan Mountains and Peninsular India that is recognized as one of the popular hotspots among the worlds' 34 biodiversity hotspots (Mittermeier *et al.,* 2004; Lalramnghinglova, 2016). Eastern part of this hotspot covers northern states of north eastern Indian region (NER). The other hotspot joining the eastern Himalayan part is the northern part Indo-Burma hotspot covering southern states of NER (Figure 1). Lalramnghinglova (2016) further reviewed that "the region constitutes about 8% of the country,

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but has 25% of the total forest area supporting about 30% of the total growing stock of the forest of the country. Nearly, 64% of the total geographical area of Northeast India is having forest cover, of which 35% of the forest cover is under the control of the Government and rest 65% is under the control of District Councils, Village Communities and Private ownership. The region accounts for approximately 7500 species of angiosperms. Out of 315 families of angiosperms in India, more than 200 families are represented in Northeast India, and the region accounts for nearly 50% of the total number of plant species in India as a whole".

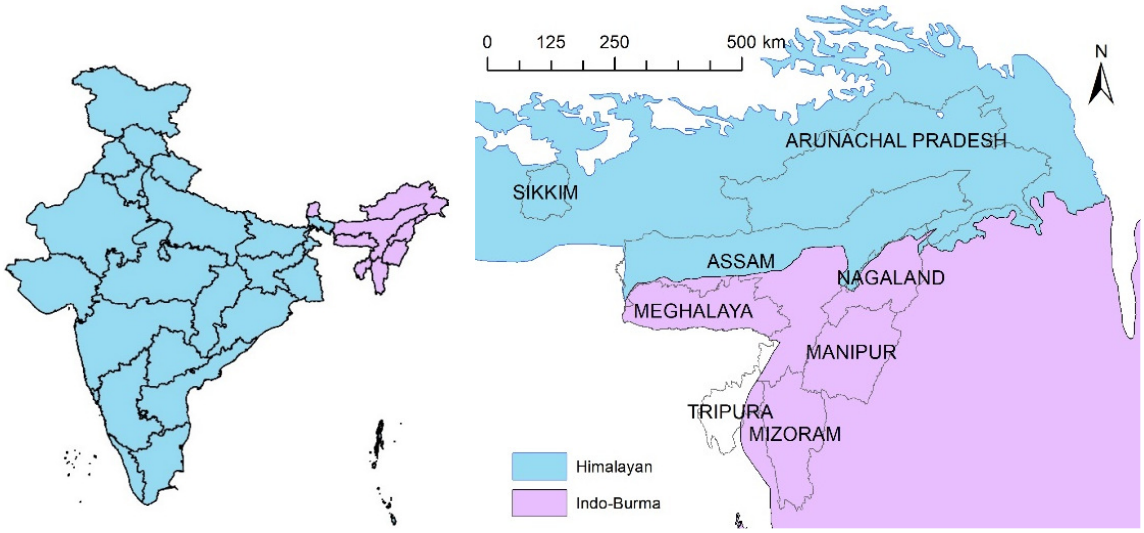

Figure 1. Location of northeast India (purple coloured states on the left) and biodiversity hotspots coverage on the right. Sikkim, Arunachal Pradesh and Assam largely falling in Himalayan hotspot while Meghalaya, Nagaland, Manipur, Mizoram and Tripura largely falling in Indo-Burma hotspot. Modified from Jha and Smith-Hall (2023)

India is an agrarian country with more or less similar nature of occupancy in NER, though forestry practices here are also important. To the farmers, livestock is source of cash income as cropping is seasonal while livestock can provide a regular source of income. They must, therefore, be protected from diseases. Attention must be paid for the maintenance of health and working conditions of the cattle. The common farmers cannot afford costly modern and new methods of disease management. Hence, majority of villagers use herbal formulations for the treatment of various diseases of their cattle (Shrivastava *et al.,* 2017) also known as ethnoveterinary medicine (EVM) system. Ethnoveterinary practices involve use of bioresources in animal healthcare and traditional knowledge and beliefs associated with them (Nongbri and Bokolial, 2019). Ethnoveterinary practices are often cheap, safe, long time tested and based on local resources and strengths. These can provide useful alternatives to modern animal health care systems (McCorkle, 1995).

Rath *et al.* (2020) reviewed that "In India, EVM is largely the practice of veterinary Ayurveda, an uncodified system of medicine. Early written accounts describing the medicinal use of plants are found in the ancient Vedic texts. These writings originated in the period circa 3147 BC (Silver, 2007). Chapters that discuss animal husbandry appear in Skanda Purana, Devi Purana and other lesser known texts. Palkapya, around 1000 BC and Shalihotra, around 2350 BC specialized in the treatment of horses and elephants, respectively. Shalihotra compiled an Indian Materia Medica which provided step-by-step descriptions of methods of administration of herbs, including instructions on preparing injectables. The first book on veterinary medicine was written by Shalihotra in Sanskrit and describes specific techniques in veterinary medicine, including the use of indigenous herbs in the treatment of working animals".

Ancient ethnobotanical literature suggests that tribal and non-tribal communities have been using wild ethno-flora since long ago for curing various diseases and disorders in the domestic animals. The indigenous knowledge of the veterinary healthcare acquired by the traditional healers is orally transmitted from one generation to other till date. Over centuries people have developed their own system of keeping animals healthy and productive using age old home remedies and associated medico-religious practices (Rajkumari *et al.*, 2014). Except in urban and semi-urban areas and in farms set up for commercial purposes, rural and remote areas lack modem veterinary health care systems. Thus, domestic animal husbandry and poultry rearing largely depend on the indigenous veterinary practices for healthcare and maintenance (Nongbri and Bokolial, 2019).

This work synthesizes the available information on EVM in north eastern states of India based on published literature and delves into methodology of literature search, existing and EVM practicing indigenous communities, animals reared and their common ailments and at length the healer plants' distribution and their use for keeping the livestock healthy by the rural communities. Due to scarce reporting of EVM plants, in these biodiversity abundant and underdeveloped states, the manuscript also explores the distribution of a few most popular and similar species (*Asparagus racemosus, Allium sativum, Azadirachta indica, Cannabis sativa, Centella asiatica, Curcuma longa, Drymaria cordata*) used as human medicine by collecting location information from published literature in northeast India.

State of Art

A non-exhaustive but intensive survey of literature was done using systematic method of review, PRISMA (Preferred reporting items for systematic reviews and meta-analyses), reported by Mohar *et al.* (2009). This included identifying, screening, excluding, and including the most relevant literature. We used Google search engine, and combined the keywords ethnoveterinary, domestic animal care, northeastern states of India including Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura separately. This provided records from (i) blogs, (ii) newsprint and multi-media, (iii) official government department pages, and (iv) digital databases (e.g., ResearchGate, JSTOR, ScienceDirect, and CAB Direct). Grey literature, duplicates, papers with a different geographical scope, and single reporting were excluded. Some relevant literature during cross referencing, were also selected to build the background and comparisons (Figure 2).

The whole set of reported plants in the considered papers for this short and quick review, intended at having baseline broadscale information, were categorized artificially for convenience following Jha and Smith-Hall (2023), with modification in popularity index number (PIN), as Highly used or most popular plant species (documented use in > 10 indigenous groups), Moderately used or moderately popular plants (>5 and ≥10 indigenous groups), Uncommonly used or uncommonly popular plants (≥ 2 and 5 indigenous groups) and Rarely used or not popular plants (single indigenous group/community). The PIN was decided as cumulative use by a number of tribes or community, giving 1 score to each tribe using a particular plant.

Post exploration of EVM in northeastern states of India, it was revealed that EVM plants' use and reporting was scarce, which could be speculated as under reporting since similar plants for use of human medicine are reported elsewhere too. Therefore, preparation of actual distribution maps was also attempted for seven most important (most popular EVM plants) to understand the actual distribution status. This was done by collecting longitude and latitude data from shelved publications and plotting them state wise. ArcGIS 10.5 was used for various map preparation.

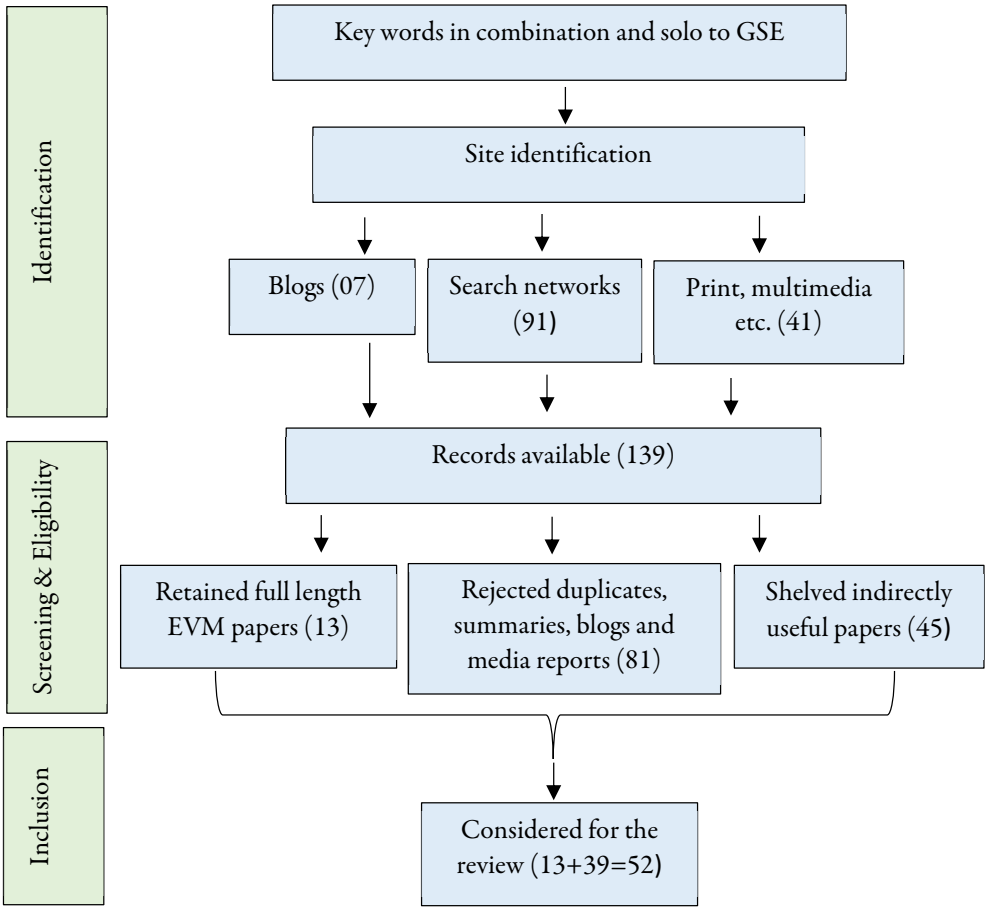

Figure 2. PRISMA diagram for the present systematic review. Modified from Page *et al.* (2021) and Jha and Smith-Hall (2023). GSE = Google search engine, EVM = Ethnoveterinary medicine. Numbers in parentheses indicate the number of documents considered at various stages and steps. Note: References presented in supplementary material are not included here

Physiography and Phyto-diversity

Chakravarty *et al.* (2012) recorded that "North East India" is the geographical 'gateway' for much of India's flora and fauna and as a consequence, the region is one of the richest in the world in biological values. Within India, the north eastern part is the richest in floristic diversity and thus has immense valuable genetic resources which are now threatened to extinction unless urgent and proper actions are taken to conserve these valuable forest genetic resources at local, national and international level." The North Eastern Region of India lies between 22°N and 29°5'N latitude and 88°E and 97°30'E longitude. This region comprises of the Plateaus (Meghalaya plateau, Karbi Plateau), the Hill and Mountains (Himalayan Mountains Region, Inner Himalayan, Lesser Himalayan Region, Eastern Hills, Dibong-Lohit Knot, Patkai-Hrap-Nagaland-NorthCadmr and Manipur Hills, Mizoram-Tripura Range and Valley country) and the Plains (Brahmaputra Plain, Bhabar-Tarai/Belt, Northern Built-Up strip, Brahmaputra Flood Plain, Southern Built-up Strip, Southern Foot-hill zone, Intermontane and Piedmont plains, Manipur Basin, Barak Plain, Tripura Plain). Temperature, precipitation and elevation have two extremes, ranging, -28.02 °C – 25.42 °C, 235 mm – 9312 mm and -34 m – 7358 m, respectively (Figures 3-6). Such diverse conditions support fifty-one forest types and are found in

the region broadly classified into six major categories viz., tropical moist deciduous, tropical semi evergreen, tropical wet evergreen, subtropical temperate and alpine forests (Hegde, 2000).

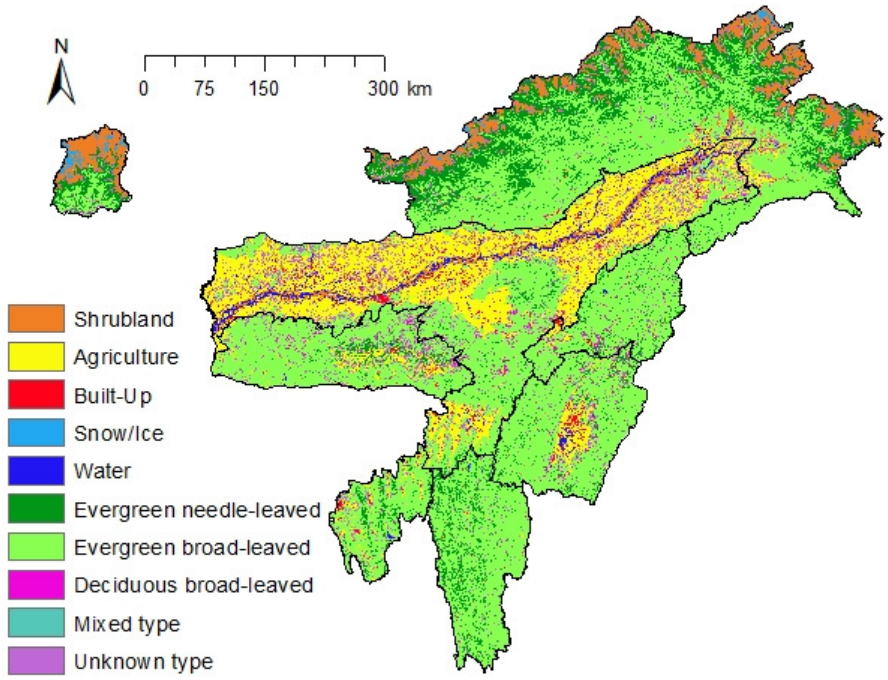

Figure 3. Modified Land use landcover classification of northeast region of India provided by Buchhorn *et al.* (2020). Vegetation classes (bottom five in the legend are forests type) presented above (exception: Built-Up, snow/ice and water) provide various types of ethnoveterinary plants discussed in this review

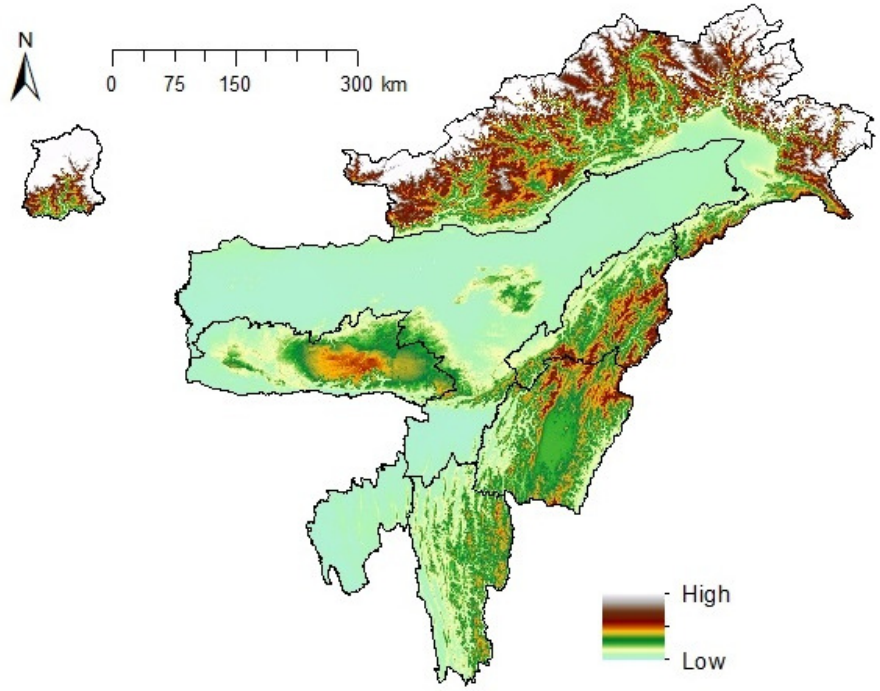

Figure 4. Elevation gradients (-34 m – 7358 m) in northeast region of India (Buchhorn *et al.*, 2020)

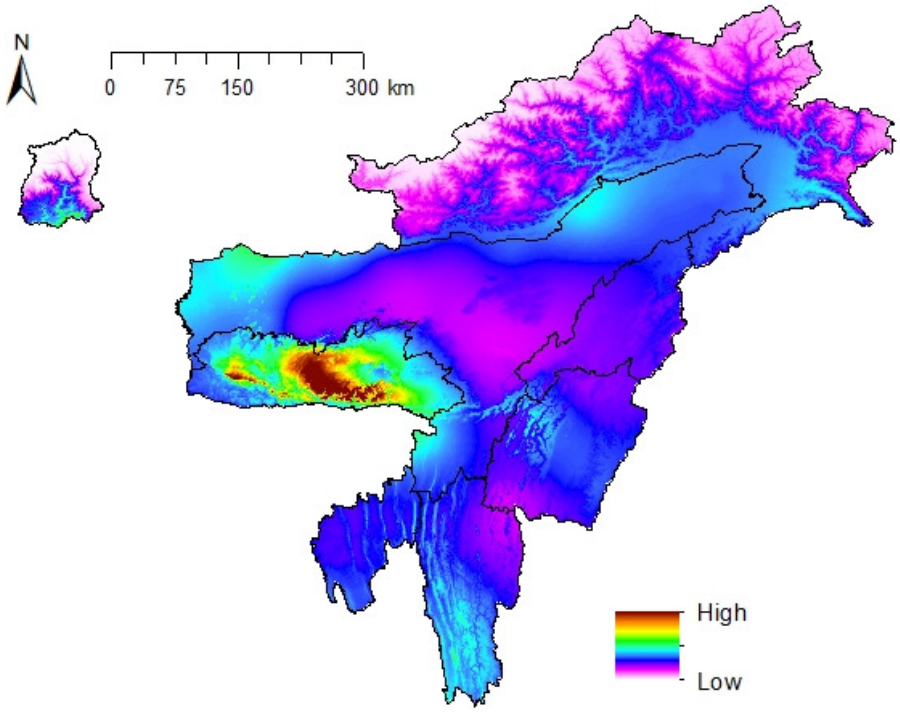

Figure 5. Precipitation ranges (235 mm – 9312 mm) in northeast region of India (Buchhorn *et al.*, 2020)

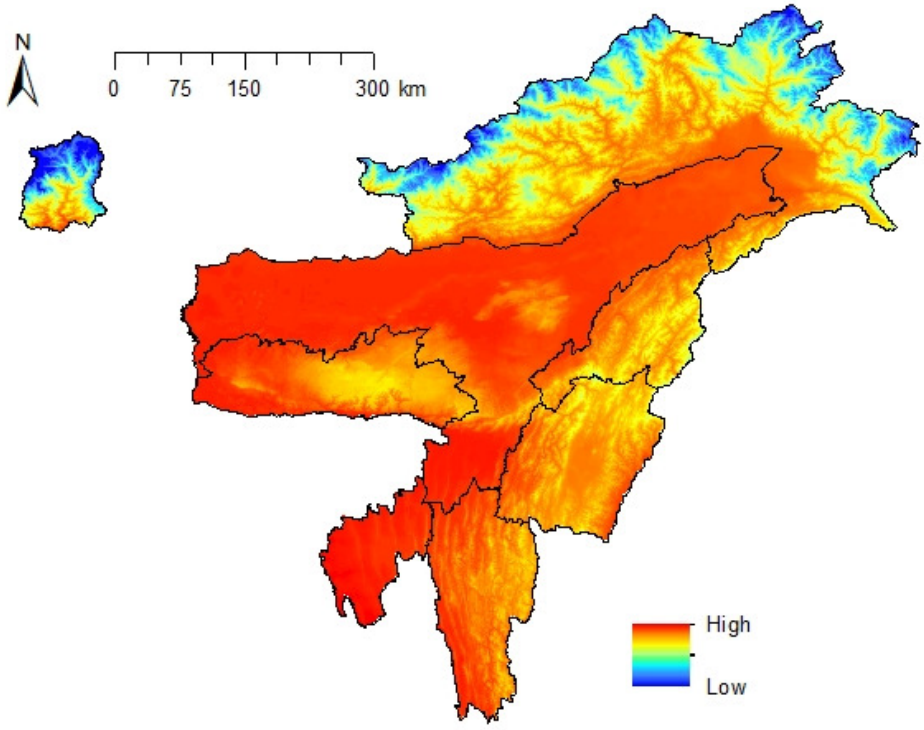

Figure 6. Temperature ranges (-28.02 °C – 25.42 °C) in northeast region of India (Buchhorn *et al.*, 2020)

Indigenous Communities

Kar (2003) and Mao and Roy (2016) have recorded a number of tribes residing in the northeast Indian states. For example, Adi, Aka, Apatani, Bangani, Khamba, Khampti, Khowa, Memba, Miji, Hill Miri, Mishing/Miri, Mishmi, Monpa, Na, Nishi (Dafla), Nocte, Sherdukpen, Sulung, Singpho, Tagin, Tangsa, Wancho, Yobin (Lishu), Zakhring (Meyor) in Arunachal Pradesh; Chakma, Dimasa; Kachari, Garo, Hajong, Hmar, Khasi, Jaintia, Synteng, Pnar, War, Bhoi, Lyngngam, Any Kuki tribe, Lakher, Man (Tai speaking), Any Mizo (Lushai) tribes, Mikir, Any Naga tribes, Pawi, Syntheng, Barmans Cachar, Boro, Borokachari, Deori, Hojai, Kachari; Sonwal, Lalung (Tiwa), Mech, Miri (Mishing), Rabha in Assam; Aimol, Anal, Angami, Chiru Chothe, Gangte, Hmar, Kabui, Kacha Naga, Koirao, Koireng, Kom, Lamgang, Mao, Maram, Maring, Mizo (Lushai), Monsang, Moyon, Paite, Ralte, Sema, Simte, Suhte, Tangkhul, Thadou, Vaiphei, Zou in Manipur: Bhoi, Boro, Chakma, Dimasa; Kachari, Garo, Hajong, Hmar, Jaintia, Khasi, Koch, Kuki, Lakher, Lyngngam, Man (Tai speaking), Mizo (Lushai), Naga, Pawi, Pnar, Raba; Rava, Synteng, War in Meghalaya; Chakma, Dimasa (Kachari), Garo, Hajong, Hmar, Khasi and Jaintia, Any Kuki tribes, Lakher, Man (Tai-speaking), Any Mizo (Lushai) tribes, Mikir, Any Naga tribes, Pawi in Mizoram; Adi, Aka, Dimasa (Kachari), Galong, Caro, Khasi and Jaintia, Khowa, Kuki, Karbi (Mikir), Mizo, Any Naga tribe, Synteng, Momba in Nagaland; Bhutia, Lepcha, Limboo, Tamang in Sikkim; Bhil, Bhutia, Chaimal, Chakma, Garo, Halam, Jamatia, Khasia, Kuki, Lepcha, Lushai, Mag, Munda, Noatia, Orang, Riang, Santal, Tripura Tripuri, Tippera, Uchai/Ochoi in Tripura.

Against above mentioned indigenous communities of northeastern states of India, though ethnobotany of different tribes has been studied for several tribespeople (Adi, Aka, Apatani, Bugun, Galo, Hill Miri, I-Idu, Khampati, Lisu, Memba, Monpa, Nyshi Padam, Sartang, Singpho, Tagin, Tangsa, Wancho, Ahom, Barman, Bodo, Chorei, Chothe, Deori, Dimasa, Garo, Hmar, Hill Tiwas, Kacharis, Kalita, Koch, Kosari, Rajbonshi, Nath, Mishing, Jaintia, Karbi, Kuki, Riang, Reangmei, Rongmai Naga, Rabha, Sonowal-kachari, Tiwa, Pnar, Vaiphei, Tangkhul-Naga, Thadou, Meitei, Mao Naga, Paite, Thadou, Maring, Lio, Zeme, Zeliangrong, Taithibi, Gangte, Kabui, Kom, Khasi, Mizo, Phom-Naga, Ao-Naga, Sangtam-Naga, Angami, Lotha, Sema, Sumi, Ao, Zeliang, Konyak, Chakhesang, Khiamniungam, Rengma, Phom, Yimchunger-Naga, Subbas, Bhutias, Lepchas, Nepalis, Sherpas, Mangers, Tamang, Limboos, Tripuri, Halam, Chakma, Mog, Reang, Uchai, Debbarma, Mandawi) in this region (Jha and Smith-Hall 2023) but works focusing on ethnoveterinary plants are scanty in literature (Nongbri and Bokolial 2019). This is further corroborated in this review as only few tribes (Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau, Mog, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Mising, Tai-Aiton, Santhal, Chiru, Meghalaya tribes, local tribes and rural people of Assam) have been covered for ethnoveterinary practices in limited number of publications (Bharti and Sharma, 2012; Maiti *et al*., 2013; Rajkumari *et al*., 2014; Laskar *et al*., 2015; Lalramnghinglova, 2016; Reang *et al*., 2016; Nongbri and Bokolial, 2019; Soren *et al*.; 2021; Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al.,* 2022).

Livestock and Common Ailments

As stated earlier also agriculture is the prime source of livelihood for the majority (85%) of rural population in northeastern region of India. It is confined to mild slopes and valleys, and is characterized by subsistence, low input-low output, technologically lagged mixed farming system, and is dominated by smallholders. Although cereals dominate the cropping pattern in this region, livestock are an important component of mixed farming system and dependence on livestock as an alternative source of income, is significant (Kumar *et al*., 2007). The most common livestock species in the mixed crop farming systems in this region are cattle (cows and bullocks), buffaloes, goats, sheep, pig, horse, ponies, yaks and mithun. Milk at a large scale produced from cow and sold at the service centers of the nearby villages forming the partial source of income. Bullocks are mainly used for plowing the fields. Goats are reared at a large scale, particularly above 1000

m and used for meat and wool. Horses and ponies are also reared moderately and mostly used for transportation. Manure is another source of indirect income which is obtained from cattle, buffaloes, and goats (Koireng *et al.,* 2017). Though commercial poultry farming is practically absent, rural tribal people of this region practice traditional backyard poultry farming, rearing of indigenous birds, as an option for their livelihood and nutritional security (Singh *et al.,* 2021).

Animals are susceptible to a number of diseases and conditions that may affect their health. Some of the important livestock diseases in NER are foot-and-mouth disease, bluetongue, brucellosis in bovine, porcine, sheep and goat, babesiosis, theileriosis, porcine reproductive and respiratory syndrome, porcine cysticercosis, classical swine fever, porcine circovirus, and 'Peste des petits ruminants' (Barman *et al.,* 2020). However, this review suggests that the indigenous communities have developed traditional knowledge to treat wounds, ulcers & sores, eye problem, infection of throat, bird flu, mastitis, bone fracture, diarrhoea, cattle loose motion, dysentery, thin animals, expel intestinal worms in chicken, inflammation, anorexia, worms, cuts & wounds for domestic animals, blood dysentery, diarrhoea of dogs, fever, little and frequent urine pass, bloat, stomach problem, skin disease, galactogogue, indigestion and constipation, goitre, sore-worms, ruminal tympany, hen lice infestation, cough, bone fracture & setting, mange, general sickness, itching, nose bleeding, fungal infection, insects from hair, skin irritation, snake and insect bite, hoof infection, sore-worms of cows, pigs & goats, mouth ulcer, anthrax, burns on skin, sore-worms of dogs and goats, conjunctivitis, pinpoint swelling in the eyelid, pain in teeth, purulent wound, smallpox, leech-bites, centipede-bites etc. (Bharti and Sharma, 2012; Maiti *et al.*, 2013; Rajkumari *et al.,* 2014; Laskar *et al.,* 2015; Lalramnghinglova, 2016; Reang *et al.*; 2016; Nongbri and Bokolial, 2019; Soren *et al.*, 2021; Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al.,* 2022).

Healer Plants

Indigenous communities from northeastern states of India use plant products to treat and cure various ailments of their domestic animals, termed here as healer plants. Some of them are most and a few are least used plants. Most popular plants are described by their utility, tribes and area where EVM is practiced. Figures 7-15 provide distribution of selected most popular species in different states along with the indigenous communities using them. Arunachal Pradesh and Nagaland are not fully represented like others since most popular EVM plants are not reported in these states. These are the representative plants among nineteen reported most popular EVM species. For the sake of brevity other categories like, moderately popular plants are given in Table 1 with at least one example. Uncommonly popular and rarely used or not-popular plants are recorded in the boxes 1 and 2. Some of the ethnoveterinary medicinal plants are presented in Figures 16 and 17.

Most popular plants

1. *Curcuma longa* L.
   This plant is used by Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau, Mog, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Mising, Tai-Aiton, Santhal, Chiru, and Meghalaya tribes for wounds, ulcers & sores, eye problem (conjunctivitis), infection of throat, bird-flu, mastitis, bone fracture, and diarrhoea treatment of livestock in Mizoram, Assam, Manipur, and Meghalaya states (Rajkumari *et al.,* 2014; Lalramnghinglova, 2016; Nongbri and Bokolial, 2019; Gogoi and Bohra, 2021; Soren *et al.,* 2021; Gogoi, 2022).
2. *Cannabis sativa* L.
   Mising, Tai-Aiton, Santhal, Chiru, Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau, Mog, Bhutias, Lepchas, Nepalese, tribal farmers, local healers, and Meghalaya tribes use *C. sativa* plant products for treating their domestic animals' ailments like, cattle loose motion, diarrhoea and dysentery, strengthen thin animals and expel intestinal worms in chicken, inflammation, and anorexia in Assam, Manipur, Mizoram, Sikkim, Tripura, and Meghalaya (Bharti and Sharma, 2012; Rajkumari

et al., 2014; Lalramnghinglova, 2016; Nongbri and Bokolial, 2019; Soren *et al.,* 2021; Jamatia *et al.,* 2022).

3. *Mikania micrantha* H.B.K.

   Some notable researchers (Lalramnghinglova, 2016; Laskar *et al.,* 2017; Gogoi and Bohra, 2021; Gogoi, 2022) recorded use of this plant in Assam and Mizoram for treatment of livestock to cure worm problems, dysentery, healing cuts and wounds for domestic animals by the indigenous groups (Halam, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog).

4. *Dillenia indica* L.

   Blood dysentery, and diarrhoea of dogs are treated by Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog tribes of Assam and Mizoram using this plant's product (Lalramnghinglova, 2016; Gogoi and Bohra, 2021; Gogoi, 2022).

5. *Centella asiatica* (L.) Urban.

   Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Chiru, Bhutias, Lepchas, Nepalese, Reang, Uchoi, Jamatia Debbarma and Meghalaya tribes (Gogoi and Bohra, 2021; Gogoi, 2022; Rajkumari *et al.,* 2014; Bharti and Sharma, 2012; Jamatia *et al.*, 2022; Reang *et al.,* 2016; Nongbri and Bokolial, 2019) from Assam, Manipur, Sikkim, Tripura, and Meghalaya treat the infirmities of their domestic animals using this plant for fever, diarrhoea, little and frequent urine pass, bloat, stomach problem, loose motion, dysentery and skin disease.

6. *Achyranthes aspera* L.

   Rajkumari *et al.* (2014), Lalramnghinglova (2016), and Reang *et al.* (2016) reported use of *A. aspera* plant products in curing galactogogue, indigestion, constipation, goiter, sore and worm infestation of domestic animals in Manipur, Tripura, and Mizoram by the indigenous communities like, Chiru, Reang, Uchoi, Jamatia, Debbarma, Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog.

7. *Asparagus recemosus* Willd.

   Indigenous communities of Assam, Sikkim, and Tripura (Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Bhutias, Lepchas, Nepalese, Reang, Uchoi, Jamatia and Debbarma) use plant products of *A. racemosus* for curing galactogogue and increasing milk-yield of their cattle (Bharti and Sharma, 2012; Reang *et al.,* 2016; Gogoi and Bohra, 2021; Gogoi 2022).

8. *Calotropis procera* (Ait). R. Br

   Reang, Uchoi, Jamatia, Debbarma, Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog communities of Tripura, and Mizoram treat bone fracture and skin infection of their livestock using this plant (Lalramnghinglova, 2016; Reang *et al.,* 2016).

9. *Dillenia pentagyna* Roxb.

   In Tripura, and Mizoram local communities like, Reang, Uchoi, Jamatia, Debbarma. Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog treat their animals for bone fracture, mange, cough and general sickness using herbal preparation of *D. pentagyna* (Lalramnghinglova, 2016; Reang *et al.,* 2016).

10. *Allium sativum* L.

    Ruminal tympany, worms on wound area, indigestion, constipation, goiter, cough of cattle and hen lice removal is taken care by Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Reang, Uchoi, Jamatia, Debbarma and Meghalaya tribe of Assam, Tripura, and Meghalaya using herbal preparation of this plant (Gogoi and Bohra, 2021; Gogoi, 2022; Reang *et al.,* 2016; Nongbri and Bokolial, 2019).

11. *Artemisia vulgaris* L.

Bharti and Sharma (2012) and Lalramnghinglova (2016) have reported use of *A. vulgaris* in treatment of domestic animals for cuts and wounds, itching, and nose bleeding by Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog. Bhutias, Lepchas and Nepalese in Mizoram and Sikkim.

12. *Azadirachta indica* A. Juss.

    Fungal attack, general weakness, removal of insects from hair, skin irritation, skin disease, snake and insect bite, and hoof infection in the livestock are treated using this plant by Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Chiru, tribal farmers local healers, and Meghalaya tribe from Assam, Manipur, Tripura and Meghlaya (Rajkumari *et al.,* 2014; Nongbri and Bokolial, 2019; Gogoi and Bohra 2021; Gogoi, 2022; Jamatia *et al.,* 2022).

13. *Erythrina stricta* Roxb.

    To get rid of sore-worms of cows, pigs and goats, and cattle skin infection, Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau, Mog, Mising, Tai-Aiton and Santhal tribe people from Mizoram and Assam use *E. stricta* products (Lalramnghinglova, 2016; Soren *et al.,* 2021).

14. *Drymaria cordata* (L.) Willd. Ex Roem. & Schult.

    Chiru, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Bhutias, Lepchas and Nepalese from Manipur, Assam and Sikkim use *D. cordata* preparation to take care of their livestock ailments like, constipation, bloat, fractured bone, and mouth ulcer (Bharti and Sharma, 2012; Rajkumari *et al.*, 2014; Gogoi and Bohra, 2021; Gogoi, 2022)

15. *Ocimum sanctum* Linn.

    Some important reporting (Reang *et al.*, 2016; Gogoi and Bohra, 2021; Gogoi, 2022) has been done from Tripura and Assam about use of *O. sanctum* products for cure of eye infection, and general weakness. Reang, Uchoi, Jamatia, Debbarma, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris are known to adopt this practice of animal husbandry.

16. *Alstonia scholaris* (L.) R. Br

    Halam, Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog indigenous community from Assam and Mizoram have adopted herbal use for animal care. They are known to treat their livestock for skin infection, pig's mange, wounds and sores using *A. scholaris* (Laskar *et al.,* 2015; Lalramnghinglova, 2016).

17. *Andrographis paniculata* (Burm. f.) Nees

    Tribespeople of Assam and Tripura (Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Halam, tribal farmers and local healers) have acquired traditional knowledge of treating their livestock. They use *A. paniculata* products to cure fever, worm infestation, stomach and other problem (Laskar *et al.*, 2015; Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al.,* 2022).

18. *Leucas aspera* (Willd.) Link

    Assam and Tripura tribespeople also use *L. aspera* products for worms, diarrhoea, ruminal tympany, cough and fever of their animals. They are Halam, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, tribal farmers and local healers (Laskar *et al.,* 2015; Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al.*, 2022).

19. *Nicotiana tabacum* L.

    N. tobacum is used by Mising, Tai-Aiton, Santhal, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, and Deoris to treat their livestock for hen lice infestation, fungal infection, and ticks attack in Assam state of northeast India (Soren *et al.,* 2021; Gogoi and Bohra, 2021; Gogoi, 2022).

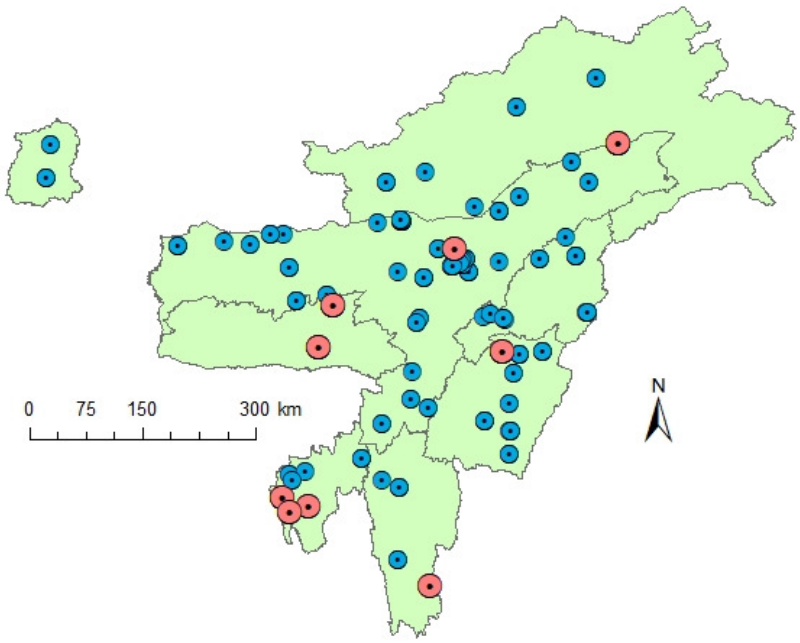

Figure 7. Distribution of ethnoveterinary medicine practicing locations (coral red circles) and human herbal medicine practicing locations (moorea blue circles) for selected seven species

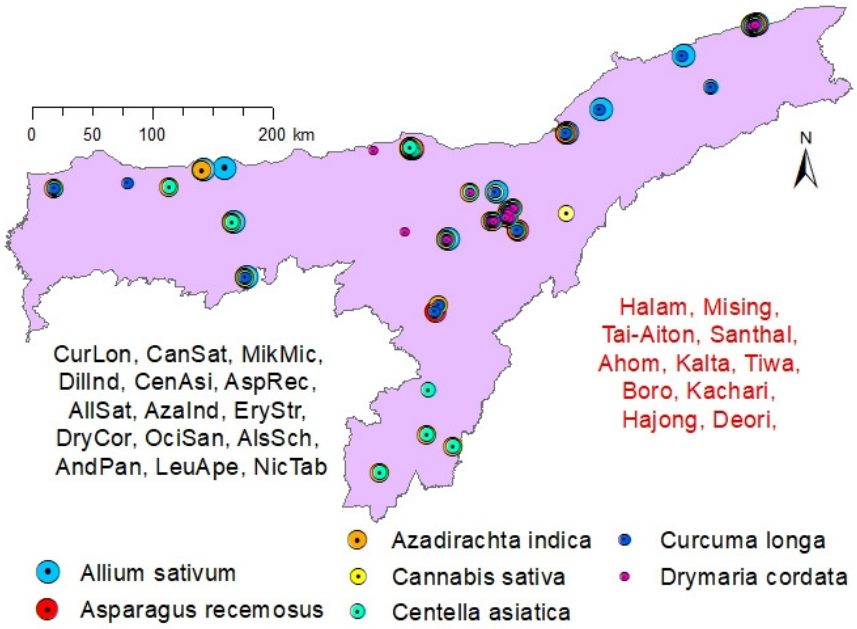

Figure 8. Distribution of EVM plants (black script) and indigenous tribes (red script) reported using most popular plant in the state of Assam. CurLon = *Curcuma longa*, CanSat = *Cannabis sativa*, MikMic = *Mikania micrantha*, DilInd = *Dillenia indica*, CenAsi = *Centella asiatica*, AspRec = *Asparagus recemosus*, AllSat = *Allium sativum*, AzaInd = *Azadirachta indica*, EryStr = *Erythrina stricta*, DryCor = Drymaria cordata, OciSan = Ocimum sanctum, AlsSch = Alstonia scholaris, AndPan = *Andrographis paniculata*, LeuApe = *Leucas aspera*, NicTab = *Nicotiana tabacum*. Ethnomedicine for human use plants and respective locations (coloured circles) may also be noted

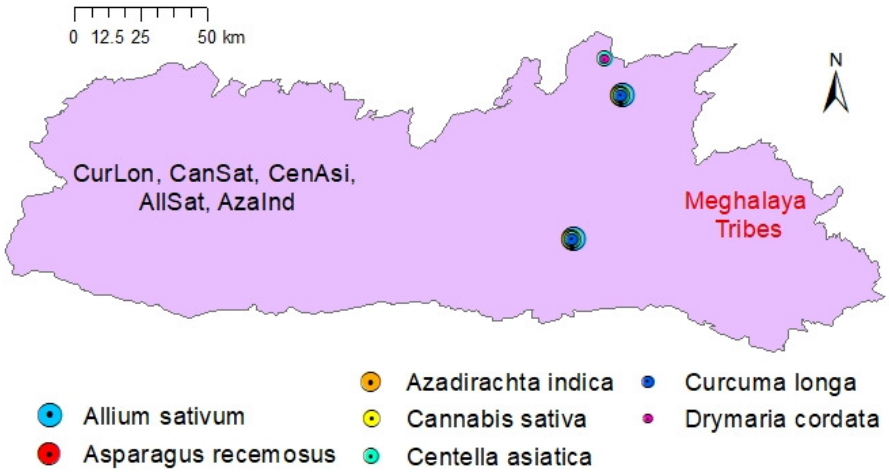

Figure 9. Distribution of EVM plants (black script) and indigenous tribes (red script) reported using most popular plant in the state of Meghalaya. CurLon = *Curcuma longa*, CanSat = *Cannabis sativa*, CenAsi = *Centella asiatica*, AllSat = *Allium sativum*, AzaInd = *Azadirachta indica*. Ethnomedicine for human use plants and respective locations (coloured circles) may also be noted

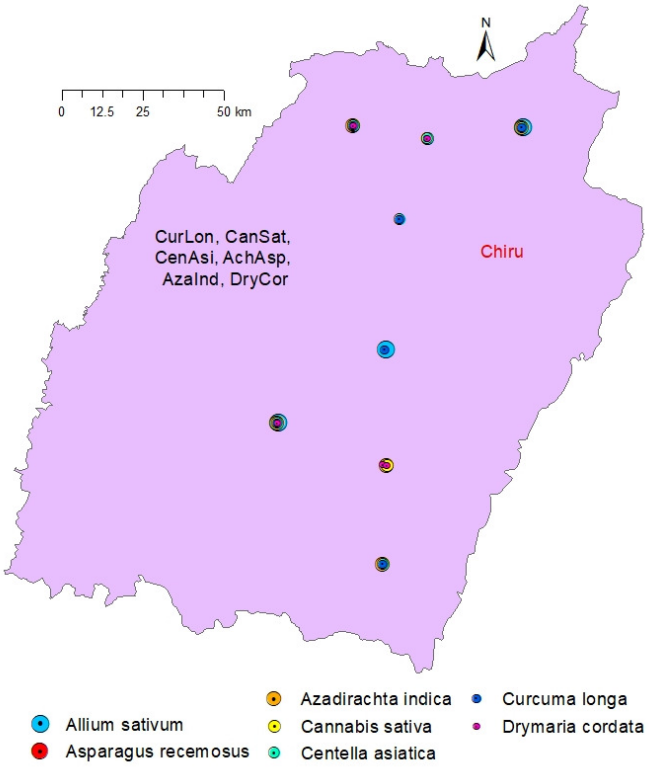

Figure 10. Distribution of EVM plants (black script) and indigenous tribes (red script) reported using most popular plant in the state of Manipur. CurLon = *Curcuma longa*, CanSat = *Cannabis sativa*, CenAsi = *Centella asiatica*, AchAsp = *Achyranthes aspera*, AzaInd = *Azadirachta indica*, DryCor = *Drymaria cordata*. Ethnomedicine for human use plants and respective locations (coloured circles) may also be noted

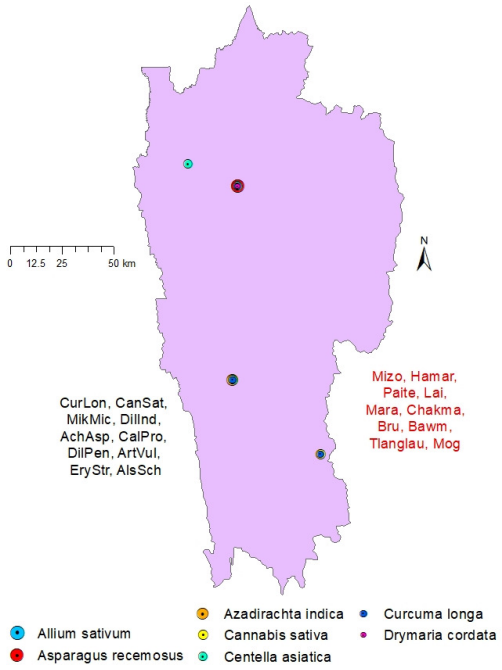

Figure 11. Distribution of EVM plants (black script) and indigenous tribes (red script) reported using most popular plant in the state of Mizoram. CurLon = *Curcuma longa*, CanSat = *Cannabis sativa*, MikMic = *Mikania micrantha*, DilInd = *Dillenia indica*, AchAsp = *Achyranthes aspera*, CalPro = *Calotropis procera*, DilPen = *Dillenia pentagyna*, ArtVul = *Artemisia vulgaris*, CenAsi = *Centella asiatica*, EryStr = *Erythrina stricta*, AlsSch = *Alstonia scholaris*. Ethnomedicine for human use plants and respective locations (coloured circles) may also be noted

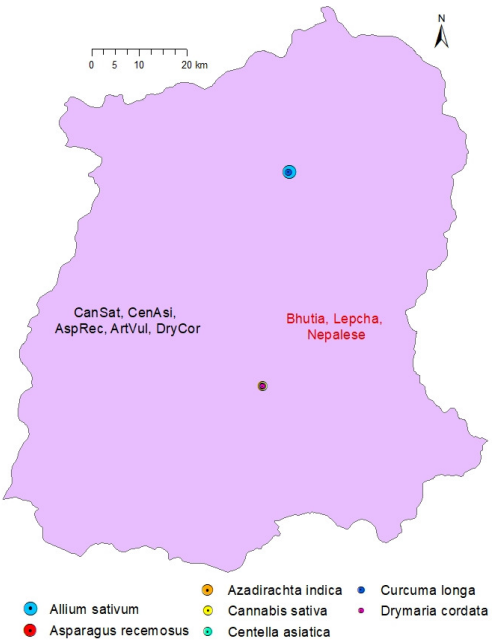

Figure 12. Distribution of plants (black script) and indigenous tribes (red script) reported using most popular plant in the state of Sikkim. CanSat = *Cannabis sativa*, CenAsi = *Centella asiatica*, AspRec = *Asparagus recemosus*, ArtVul = *Artemisia vulgaris*, DryCor = *Drymaria cordata*. Ethnomedicine for human use plants and respective locations (coloured circles) may also be noted

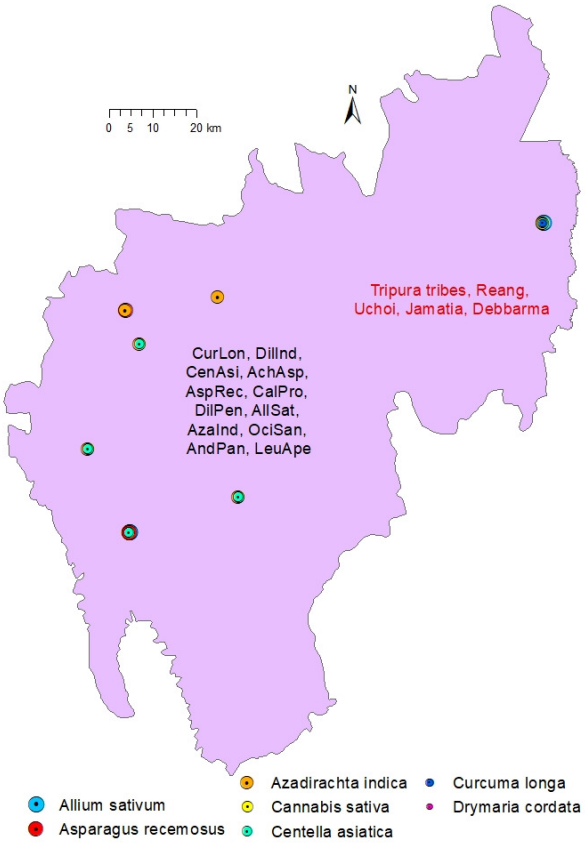

Figure 13. Distribution of plants (black script) and indigenous tribes (red script) reported using most popular plant in the state of Tripura. CurLon = *Curcuma longa*, DilInd = *Dillenia indica*, CenAsi = *Centella asiatica*, AchAsp = *Achyranthes aspera*, AspRec = *Asparagus recemosus*, CalPro = *Calotropis procera*, DilPen = *Dillenia pentagyna*, AllSat = *Allium sativum*, AzaInd = *Azadirachta indica*, OciSan = *Ocimum sanctum*, AndPan = *Andrographis paniculata*, LeuApe = *Leucas aspera*. Ethnomedicine for human use plants and respective locations (coloured circles) may also be noted

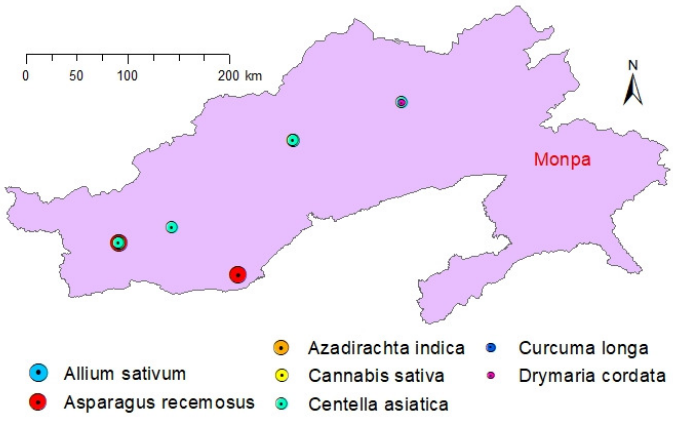

Figure 14. Distribution of indigenous tribe (red script) reported using ethnoveterinary medicine plant in the state of Arunachal Pradesh. However, ethnoveterinary medicine use of most popular plants reporting is lacking. Ethnomedicine for human use plants and respective locations (coloured circles) may be noted

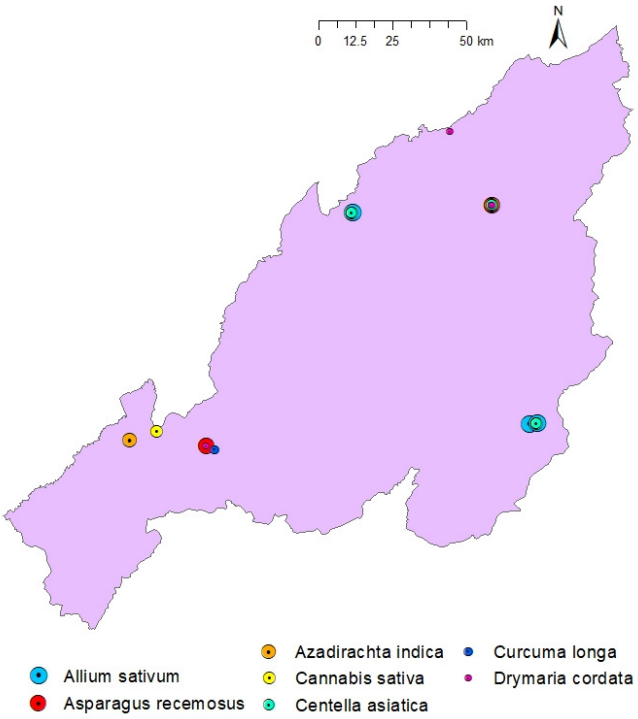

Figure 15. Ethnoveterinary medicine use of most popular plants and indigenous community reporting is lacking in the state of Nagaland. However, ethnomedicine for human use plants and respective locations (coloured circles) may be noted

Moderately popular plants

Herbal care plants for animal husbandry which are moderately popular in northeastern states of India are listed in the Table 1 below.

Table 1. List of ethnoveterinary plants (moderately popular) from northeast India

Plants	Ailments	Indigenous community	State	References
1. *Ageratum conyzoides* L.	Sore leg/toes	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
2. *Aloe vera* (L.) Burm. F	Anthrax, burns on skin, wounds and cuts	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Chiru, Meghalaya tribe	Assam, Manipur, Meghalaya	Rajkumari *et al.*, 2014; Nongbri and Bokolial, 2019; Gogoi and Bohra, 2021; Gogoi, 2022
3. *Blumea lanceolaria* (Roxb.) Druce	Sore-worms of dogs/goats are instantly killed or expelled	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
4. *Brassica juncea* (L.) Czern.	Fever, purulent wound	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, tribal farmers and local healers	Assam, Tripura	Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al.*, 2022

5. *Bryophyllum pinnatum* (Lam.) Oken	Wound, conjunctivitis, pinpoint swelling in the eyelid, pain in teeth	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, tribal farmers and local healers	Assam, Tripura	Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al*., 2022
6. *Butea superba* Roxb.	Snake-bites on animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
7. *Cassia hirsuta* L.	Snake-bites on animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
8. *Clerodendrum infortunatum* L.	Healing pig's wounds	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
9. *Congea tomentosa* Roxb.	Sore-worms, wounds, ulcers, sores of domesticated animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
10. *Curculigo crassifolia* (B) Hook f.	Animal's wounds, cuts including snake-bites	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
11. *Curcuma minor* King	Snake-bites on animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
12. *Elsholtzia communis* L.	Snakes-bites on animals, Foot and mouth	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog, Chiru	Mizoram, Manipur	Rajkumari *et al*., 2014; Lalramnghinglova, 2016
13. *Ficus auriculata* Lour.	Domestic animal's sore/ulcers	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
14. *Ficus semicordata* Buch. Ham. ex Sm.	Snake-bites on animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
15. *Gardinia coronaria* Buch-Ham.	Chakma medicine man use it as snake-repellant against the attack of snakes	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
16. *Garcinia sopsopia* (Buch. Ham) Mabb.	Bawm practioner use it for healing wounds of snake-bite/tiger-bite	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
17. *Gelsemium elegans* Benth.	Effective for pig's mange, diarrhoea, sickness and cough	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
18. *Ilex umbrellulata* (Wall.) Loes.	Used to cure pig's sickness and mange	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
19. *Ipomoea aquatica* Forssk.	Anthrax, galactogogue, smallpox	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong,	Assam, Tripura	Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al*., 2022

		Deoris, tribal farmers and local healers		
20. *Lepidagathis incurva* F. Ham. ex D. Don.	Leech-bites on animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
21. *Lindernia ruelloides* (Colms.) Penn.	Chicken bone-setting and contraction of nerves	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
22. *Litchi chinensis* Sonner	Animal-bites like dog bite	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
23. *Milletia piscidia* Wt.	To get rid of animal sore-worms	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
24. *Musa* spp.	Snake-bites and insect-bites on animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
25. *Musaenda roxburghii* Hk.f.	Snake-bites on squirrels and domesticated animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
26. *Picrasma javanica* Blume	Indigestion and sores	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
27. *Podocarpus neriifolius* D. Don.	Centipede-bites on animals	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
28. *Sapindus mukorossi* Geartn.	Leech-bite on animals and as vermifuge/ biocide	Mizo, Hmar, Paite, Lai, Mara, Chakma, Bru, Bawm, Tlanglau and Mog	Mizoram	Lalramnghinglova, 2016
29. *Acorus calamus* Linn.	Wounds, fever, dizziness, vomiting, loose motion, bone fracture, indigestion and constipation	Bhutias, Lepchas and Nepalese, Tribal farmers and local healers, Reang, Uchoi, Jamatia and Debbarma	Sikkim, Tripura	Bharti and Sharma, 2012; Reang *et al.*, 2016; Jamatia *et al.*, 2022
30. *Carica papaya* Linn.	Galactogogue, diarrhoea	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Meghalaya tribes	Assam, Meghalaya	Nongbri and Bokolial, 2019; Gogoi and Bohra, 2021; Gogoi, 2022
31. *Cissus quadrangularis* L.	Bone fracture	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Halam	Assam	Laskar *et al.*, 2015; Gogoi and Bohra, 2021; Gogoi, 2022
32. *Citrus limon* (L.) Burm. f.	Dysentery, bloat	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Chiru	Assam, Manipur	Rajkumari *et al.*, 2014; Gogoi and Bohra, 2021; Gogoi, 2022
33. *Prunus persica* L.	Maggot, worms on wound area	Chiru, Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Manipur, Assam	Rajkumari *et al.*, 2014; Gogoi and Bohra, 2021; Gogoi, 2022

34. *Terminalia arjuna* (Roxb.) Wight and Arn.	Bone fracture, cold and fever	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris, Halam	Assam	Laskar *et al*., 2015; Gogoi and Bohra, 2021; Gogoi, 2022
35. *Capsicum annuum* Linn.	Fever	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
36. *Citrus aurantifolia* (Chirstm) Swing	Dysentery, cataract	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
37. *Cyclosorus parasiticus* (L.) Farw.	Sluggishness	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
38. *Eleusine indica* (L.) Gaertn.	Bone fracture	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
39. *Ensete glaucum* (Roxb.) Cheesman	Cough, weakness	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
40. *Ficus religiosa* L.	Bloating	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
41. *Garcinia morella* (Gaertn.) Desr.	Diarrhoea	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
42. *Garcinia xanthochymus* Hook. f.	Diarrhoea	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
43. *Hisbiscus sabdariffa* L.	Diarrhoea	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
44. *Lasia spinosa* (L.) Thwaites	Worm problem, fever	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
45. *Mimosa pudica* L.	Fever	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
46. *Oryza sativa* L.	Diarrhoea	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
47. *Oxalis corniculata* L.	Blood dysentery	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
48. *Piper betel* L.	Dysentry	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
49. *Solanum melongena* L.	Urine problem	Ahoms, Kalitas, Tiwa, Boro, Misings, Kacharis, Hajong, Deoris	Assam	Gogoi and Bohra, 2021; Gogoi, 2022
50. *Streblus asper* Lour.	Dysentary, swine flu	Reang, Uchoi, Jamatia and Debbarma. Mising, Tai-Aiton & Santhal	Tripura, Assam	Reang *et al*., 2016; Soren *et al*., 2021
51. *Zingiber officinale* Roscoe	Constipation, cold, cough, bloat, chronic cough	Chiru, Bhutias, Lepchas and Nepalese, Tribal farmers and local healers, meghalaya tribes	Manipur, Sikkim, Tripura, Meghalaya	Bharti and Sharma, 2012; Rajkumari *et al*., 2014; Nongbri and Bokolial, 2019; Jamatia *et al*., 2022

Uncommonly popular plants

Box 1. Uncommonly popular plants

Bombax ceiba L., *Diplazium esculentum* (Retz) SW., *Justicia gendarussa* Burm. f., *Albizia procera* (Roxb.) Benth., *Aristolochia tagala* Cham., *Bambusa balcooa* Roxb., *Cajanus cajan* (L.) Hutch., *Catharanthus roseus* (L.) G. Don., *Chromolaena odorata* (L.) R.M. King. & H. Rob., *Cinnamomum glanduliferum* (Wall.) Meisn, *Clerodendrum chinense* (Osbeck) Mabb., *Crotalaria pallida* Aiton, *Curculigo orchioides* Gaertn., *Curcuma zedoaria* (Christm.) Roscoe, *Dracaena reflexa* var. *angustifolia* Baker, *Ficus racemosa* L., *Hoya* spp., *Ichnocarpus frutescens* (L.) W.T. Aiton, *Luffa acutangula* (L.) Roxb., *Lygodium scandens* (L.) Sw., *Macaranga* spp., *Microcos paniculata* L., *Moringa oleifera* Lam., *Oroxylum indicum* (L) Vent., *Pandanus foetidus* Roxb., *Piper longum* L., *Rubus ellipticus* Smith, *Smilax* spp., *Spermacoce ocymoides* Burm. f., *Sterculia villosa* Roxb., *Terminalia chebula* (Roxb.) Retz., *Thysanolaena maxima* (Roxb.) Kunze, *Vanda roxburghii* R. Br., *Vitex negundo* L., (PIN 4); *Abies densa* Griff., *Amomum subulatum* Roxb., *Arundinaria maling* Gamble, *Bauhinia variegata* L., *Bergenia ciliata* (Haw.) Sternb., *Brassica campestris* L., *Calotropis gigantea* (L.) R. Br., *Capsicum frutescens* L., *Celastrus paniculatus* Willd., *Christella parasitica* (L.) Lev., *Cissampelos pareira* L., *Costus speciosus* (J. Koenig) Sm., *Elatostema ficoides* Wedd., *Eleusine coracana* Gaertn., *Embelia ribes* N. Burman., *Equisetum debile* Roxb. ex Vaucher, *Fragaria nubicola* (Hook. f.) Lindl., *Holarrhena antidysentrica* (L.) Wall., *Lecanthus peduncularis* (Wall. Ex Royle) Wedd., *Lycopodium clavatum* L., *Mallotus philippensis* (Lam.) Müll. Arg., *Mentha viridis* L., *Picrorhiza kurroa* Royle ex Benth., *Plantago major* L., *Polygonum hydropiper* L., *Prunus domestica* L., *Rauvolfia serpentina* (L.) Benth. ex Kurz, *Rhododendron arboreum* Sm., *Rhododendron campanulatum* D. Don, *Rubia cordifolia* L., *Rubus moluccanus* L., *Sinopodophyllum hexandrum* (Royle) T.S. Ying, *Swertia chirata* (Wall.) C.B. Clarke, *Tagetes patula* L., *Terminalia bellirica* (Gaertn) Roxb., and *Urtica dioica* L. (PIN 3).

Citations: Bharti and Sharma, 2012; Maiti *et al.,* 2013; Rajkumari *et al.*, 2014; Laskar *et al.,* 2016; Reang *et al.,* 2016; Soren *et al.,* 2021; Jamatia *et al.*, 2022

Not-popular or rarely used plants

Box 2. Not popular plants

Anthocephalus cadamba Roxb., *Cestrum diurnum* Linn., *Colocasia* spp., *Curcuma domestica* Valet., *Euphorbia supremacoce*, *Ficus exasperata* Vahl., *Holarrhena pubescence* (Buch. Ham.) Wall., *Hygrophila auriculata* S., *Manihot esculenta* Crantz, Musa spp., *Phlogacanthus thyrsiflorus* Nees., *Ricinus communis* L., *Saccharum officinarum* L., *Sansevieria trifasciata* Prain, *Sesamum indicum* L., *Syzygium cumini* (L.) Skeels, *Tamarindus indica* L., *Zea mays* L (PIN 2); *Adiantum lanulatum*, *Adiantum philippense* L., *Agave amaricana* Linn., *Aleuritopteris subdimorpha, Allium tuberosum* Rottl., *Aralia* sp., *Areca catechu* L., *Arisaema auriculatum*, *Artemisia nilagirica* (Clarke) Pamp. *Bambusa tulda* Roxb., *Basella alba* L., *Bauhinia purpurea* L., *Cassia alata* L., *Cassia fistula* L., *Cassia occidentalis* L., *Cinnamomum tamala* L., *Cissus adnata* Roxb., *Citrullus colocynthis*, *Crinum glaucum*, *Cucurbita maxima* Duchesne, *Datura inoxia*, *Datura metel* Linn., *Dichrocephala integrifolia*, *Elsholtzia blanda*, *Erythrina arborescens* Roxb., *Galium aparine* L., *Jaropha curcas* L., *Juniperus procera* Hochst., *Imperata cylindrica* (L.), *Maranta arundinacea*, *Mentha spicata* L., *Millettia pachycarpa* Benth., *Mirabilis jalapa* L., *Myrica esculenta* Buch.-Ham, *Nardostachys jatamansi* (D.Don) DC., *Ocimum gratissimum* L., *Ornithogalum umbellatum* L., *Paederia foetida* L., *Persicaria chinensis* (L.) H. Gross, *Phyllanthus acidus* L., *Phytolacca acinosa* Roxb., *Portulaca grandifolia* Hook., *Psidium guajava* L., *Pteridium aquilinum* (L.), *Pterocephalus hookeri* (C.B. Clarke) E. Pritz., *Rubus idaeus* L., *Rumex maritimus* L., *Rumex nepalensis* Spreng., *Scoparia dulcis* L., *Spilanthes paniculata* Wallich ex. DC., *Spondias pinnata* (L. f.) Kurz, *Tagetes minuta* L., *Terminalia citrina* (Gaertn.) Roxb. ex Fleming, *Thalictrum foliolosum* L., *Trigonella foenumgraecum* L., *Triticum aestivum* L., *Urena lobata* L., *Urginea indica* Roxb., *Vigna mungo* (L) Hepper, and *Ziziphus mauritiana* Lam. (PIN 1).

Citations: Maiti *et al.,* 2013; Rajkumari *et al.*, 2014; Laskar *et al.,* 2015; Nongbri and Bokolial, 2019; Gogoi and Bohra, 2021; Gogoi, 2022; Jamatia *et al.,* 2022

Figure 16. Ethnoveterinary medicinal plants: Left to right – *Asparagus racemosus* and *Piper longam* (top row), *Clerodendron infortunatum* and *Cassia alata* (bottom row)

Figure 17. Ethnoveterinary medicinal plants: Left to right – *Leucas aspera* and *Calotropis procera* (top row), *Ocimum sanctum* and *Ricinus communis* (bottom row)

Bio-Active Components and Drugs

Faheem *et al.* (2022) reviewed that "Medicinal plants have long been recognized as a valuable resource of therapies or healing remedies and are now widely used in global health care systems. The need for herbal extracts, mixtures plus various forms of the plant formulations for treatment of the various diseases and disorders has been described in several past cultures (Ifeoma and Oluwakanyinsola, 2013; Majeed *et al.,* 2021)". This is due to their greater compatibility, cultural appropriateness and adaptation with human/animal body, as well as the fact that they have less adverse effects (Hassan, 2012). The curative properties of medicinal plants are due to presence of major group of active components which are mainly phytochemicals like flavonoids, tocopherols, santonins, choline, tannins, carotenoids, folic acid, ascorbic acid, benzoic acid and cinnamic acid

(Mahapatra *et al*., 2019; Bhat, 2021; Faheem *et al.,* 2022). Iwu (2002) reported several drugs derived from ethnobotanical leads, for example, Curcumin from *Curcuma longa*, *Asiticoside canescens* from *Centella asiatica* etc. In the case of human pharmacognosy which lead to development of modern drugs based on laboratory tests, lots of studies are available but in veterinary science such information is scarce (Bhat, 2021). Bharti and Sharma (2012) reported the same plant used for human and veterinary treatment, for example *Cannabis sativa*, *Drymaria cordata* etc. However, some examples, though based on human use research, may be useful in drug development for animals in future are tabulated below (Table 2).

Table 2. Plants included in research for human use that may be useful in future drug development for animals

Ethnoveterinary plants	Important bio-active compounds	Reference
Curcuma longa	Curcumin, demethoxycurcumin, bisdemetoxicurcumin	Filho *et al*., 2020
Cannabis sativa	Cannabinoids, flavonoids, phenolics, terpenes, alkaloids	Liu *et al*., 2022
Mikania micrantha	Mikanolide, dihydromikanolide, mmethoxy benzoic acid, dioxymikanolide, scandenolide, dihydroscandenolide	Li *et al*., 2013
Dillenia indica	Flavonoids, triterpenoids, steroids, tannins; cycloartenone, n-hentriacontanol, sitosterol, betulin; betulinic acid	Gogoi *et al*., 2020
Centella asiatica	Rutin, kaempferol, quercetin, gallic acid, luteolin, catechin	Azmin and Nor, 2020
Achyranthes aspera	Saponin, oleanic acid, achyranthine, ecdysterone, alkaloids, flavonoids, steroids, terpenoids.	Singh *et al*., 2018
Asparagus recemosus	Saponins- shatvarins, oligospirostanoside – Immunoside, polycyclic alkaloid-Aspargamine A, cyclic hydrocarbon-racemosol, etc.	Alok *et al*., 2013
Calotropis procera	Cardiac glycosides, phenolic compounds, flavonoids, saponins, terpenes	Farooq *et al*., 2017
Dillenia pentagyna	Botulin, botulinic acid, botulinic acid, morolic acid, lupeol, diploic acid	Saxena *et al*., 2022
Allium sativum	Allicin (diallyl thiosulfonate), diallyl sulfide, diallyl disulfide, diallyl trisulfide, E/Z-ajoene, S-allyl-cysteine, alliin (S-allyl-cysteine sulfoxide)	Shang *et al*., 2019
Artemisia vulgaris	Flavones, flavone glycosides, flavanols, flavonol glycosides	Anibogwu *et al*., 2021
Azadirachta indica	Nimbolide, azarirachtin, gedunin	Sarkar *et al*., 2021
Erythrina stricta	Pterocarpans, isoflavones, flavonones, Chalcones and erythline, erysodine, erythrinine	Hussain *et al*., 2011
Drymaria cordata	Cyclohexan-1,4,5-triol-3-one-1-carboxylic acid, Beta-D-glucopyranose-1,6-anhydro, L-gala-L-ido-octose, 3, 7, 11, 15-Tetra-methyl-2-hexadecen-1-ol, n-Hexadecanoic acid, 9, 12 Octadecadienoic acids (Z, Z)-, 9,12-Octadecadienoic acid, methyl ester, Oleyl alcohol and 17-Octadecynoic acid	Bhattacharyya *et al*., 2019
Ocimum sanctum	Eugenol, Benzene, α – Farnesene, Cyclohexane, 1, 2, 4-triethenyl	Borah and Biswas, 2018
Alstonia scholaris	Alkaloids, flavonoids, phenolic acids, luteolin	Fatima *et al*., 2023
Andrographis paniculata	Diterpenoids, flavonoids and polyphenols; andrographolide	Chao, 2010
Leucas apera	Flavonoids, alkaloids, phenolic acids, stilbenes, lignans, lignin and tannins	Priya *et al*., 2018
Nicotiana tabacum	Flavonoids, terpenoids, alkaloids, polysaccharides: Nicotine	Zou *et al*., 2021

Potential Distribution

Reported distribution of the most popular EVM plants (e.g., *Asparagus racemosus, Allium sativum, Azadirachta indica, Cannabis sativa, Centella asiatica, Curcuma longa, Drymaria cordata*), including others, is apparently not adequate since it is from selected few districts or study locations in some states. Contrastingly, extrapolated or proxy distribution spread is sufficiently large. Figure 7 provides overall distribution (seven species in all eight states) for EVM (coral red circles) human use (moorea blue circles) and Figures 8-15 provide state and species wise details. These maps provide the proxy of EVM use assuming that the remaining area is unexplored but animal care exist there. It is anticipated that further exploration (research) is bound to reveal use of EVM in new areas by the indigenous community. Supplementary Table 1 records the proxy area (locations) of EVM use of above-mentioned selected plants based on human use.

Conclusions

EVM is a practical, effective, affordable and sustainable approach for management of common animal health problems. There are a large number of indigenous tribes in northeast India relying on EVM and animal husbandry. But very few tribes have been touched upon by the researchers for the system of animal health care they are currently using. Understanding ethnoveterinary practices can lead to their validation and eventually to better animal healthcare provision and enhanced living standards for the rural poor, yet there seem to be a notable scarcity of studies. This warrants further exploration of EVM used by various other tribes in different states, particularly Arunachal Pradesh and Nagaland. Projected distribution also suggests works on similar line. Pharmacological studies of at least most popular and moderately popular EVM plants may help in development of commercial drugs ultimately to help the farmers itself.

Authors' Contributions

The authors made following contribution to this paper: Conceptualization (KKJ); Data curation and Formal analysis (KKJ, RJ); Methodology (KKJ, RJ); GIS work (RJ); Writing - original draft (KKJ); Writing - review and editing (KKJ, RJ). All authors have read and approved the final manuscript.

Ethical approval

Not required

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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