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**Nilamani Dikshit**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

**Vikas C Tyagi**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

**Gitanjali Sahay**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

**Seva Nayak D**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

**Shahid Ahmed**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

**Ajay Kumar Singh**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

**Dibyendu Deb**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

**Correspondence**
**Nilamani Dikshit**
ICAR-Indian Grassland and Fodder, Research Institute, Jhansi, Uttar Pradesh, India

# Diversity in forage genetic resources of Assam and Ri-Bhoi district of Meghalaya

**Nilamani Dikshit, Vikas C Tyagi, Gitanjali Sahay, Seva Nayak D, Shahid Ahmed, Ajay Kumar Singh and Dibyendu Deb**

**Abstract**
The present paper deals with forage genetic resources of Assam and adjoining Ri-Bhoi district of Meghalaya belonging to North Eastern region of India. Attempt has been made to collect the important forage genetic resources and to document the minor grasses and legumes of the region. In total, ten districts of Assam and Ri-Bhoi district of Meghalaya were explored during November-December 2018 and a total of 33 accessions comprising *Pennisetum pedicellatum* (7), *Panicum maximum* (5), *Zea mays* var. *maxicana* (2), *Eleusine indica* (2), *Tripsacum andersonii* (2), *Vigna unguiculata* (2) and one accession each of *Setaria palmifolia, Pennisetum purpureum, Avena sativa, Brachiaria mutica, Sorghum halepense, Chrysopogon zizanioides, Miscanthus fuscus, Coix lacryma-jobi, Saccharum ravennae, Themeda villosa, Panicum antidotale, Setaria sphacelata* and *Vigna umbellata* were collected. Passport characteristics were recorded at the collection sites. Morpho-agronomical characteristics revealed variation for leaf hairiness, pigmentation in plant parts, culm colour, branching pattern, plant height and inflorescence length in *Panicum maximum* (Guinea grass) and *Pennisetum pedicellatum* (*Deenanath* grass). Diversity observed and key traits of these species are also presented.

**Keywords:** Forage genetic resources, diversity, distribution, NE region

## 1. Introduction
The Northeastern Region of India (NER) is geographically nestled in one of the richest biodiversity-rich regions of the world covering nearly 262,379 square kilometers and has been divided into two bio-geographic zones – the eastern Himalaya and Indo-Burma based on floristic composition, the naturalness of the flora and the local climate [1]. WWF has identified the entire eastern Himalaya as a priority Global 2000 Eco region; and Conservation International has subsumed its eastern Himalaya 'hotspot into a wider Indo-Burma hotspot, which now includes all the states of northeast India along with the neighboring territories of Bhutan, southern China, and Myanmar [2]. The region's lowland and montane moist to wet tropical evergreen forests are considered to be the northern-most limit of true tropical rain forests in the world [3].

Assam and Meghalaya are among the seven states of North Eastern region of India. The States of Assam and Meghalaya are bordered by Bhutan and the state of Arunachal Pradesh to the north; Nagaland and Manipur to the east; Tripura, Mizoram and Bangladesh to the south; and West Bengal to the west via the Siliguri Corridor. State-wise species richness indicate that the state of Assam accounts for 3010 species and Meghalaya 3500 species which are 26.51% of the total North Eastern Region. The states experiences heavy rainfall and high humidity. Forest cover in the states of Assam and Meghalaya are 24.04% and 75.08%, respectively. The cereals, sugarcane, bamboos, forage and weedy grasses are of pre-eminent importance in human economy. Livestock is an integral part of the mixed farming system of the farmers of Assam and Meghalaya. It is also a source of earning and is an insurance against adversity. Non availability of green fodder and depletion of open-grazing land in rural areas is a great concern and making the situation worse. As per the State Animal Husbandry Department of Assam there is a requirement of green fodder in the tune of 2.3 mMT but the availability is only 85,633 MT.

The grass family Poaceae is the fourth largest family after Asteraceae, Orchidaceae and Fabaceae. Grasses occur in virtually every terrestrial habitat, cover as much as one-fifth of the Earth's land surface [4]. Consolidated work on the grasses in the *Flora of Assam* has been attempted [5-8].

Three hundred three species of grasses reported from the political boundary of Assam [9]. Studies on forage genetic resources covering grasses and legumes have received very little attention. In order to undertake an effective plant genetic resources programme, it is essential to understand geographic distribution of the available species and the data sets generated are essential for studies on biogeography besides providing a baseline for crop improvement programmes. Hence, an attempt has been made to explore and collect forage genetic resources from different geographic location of the state of Assam and Ri-Bhoi district of Meghalaya.

## 2. Materials and Methods

Survey and collection of forage genetic resources (FGR) were carried out in the state of Assam and Ri-Bhoi district of Meghalaya during the month of November - December 2018. During the exploration, a total of 11 districts comprising Kamrup, Nalbari, Barpeta, Bongaigaon and Chirang districts of lower Assam and Jorhat, Golaghat, Sivasagar, Dibrugarh and Tinsukia districts of Upper Assam and Ri-Bhoi district of Meghalaya were surveyed. The areas explored lies between 25º 71' 532 to 27º 46' 520 latitude and 91º 89' 51 to 95º 08' 315 longitude (Fig-1). Standard practice and procedure of collection of germplasm was followed. Mostly, the local forage genetic resources were the target of the collection. Random and bulk sampling methods were followed as per the population/quantity of germplasm material available. Passport data *viz*. location of the site i.e village, block, district, latitude, longitude, altitude, botanical name of the crops collected and description of the site like habitat, biological status, frequency, breeding system, sample type, soil colour, soil texture and topography were recorded at the collection sites. Morpho-agronomic data for some useful traits were recorded at the collection sites and the variability observed is presented. Seeds and root slips collected at the sites will be characterized and maintained.

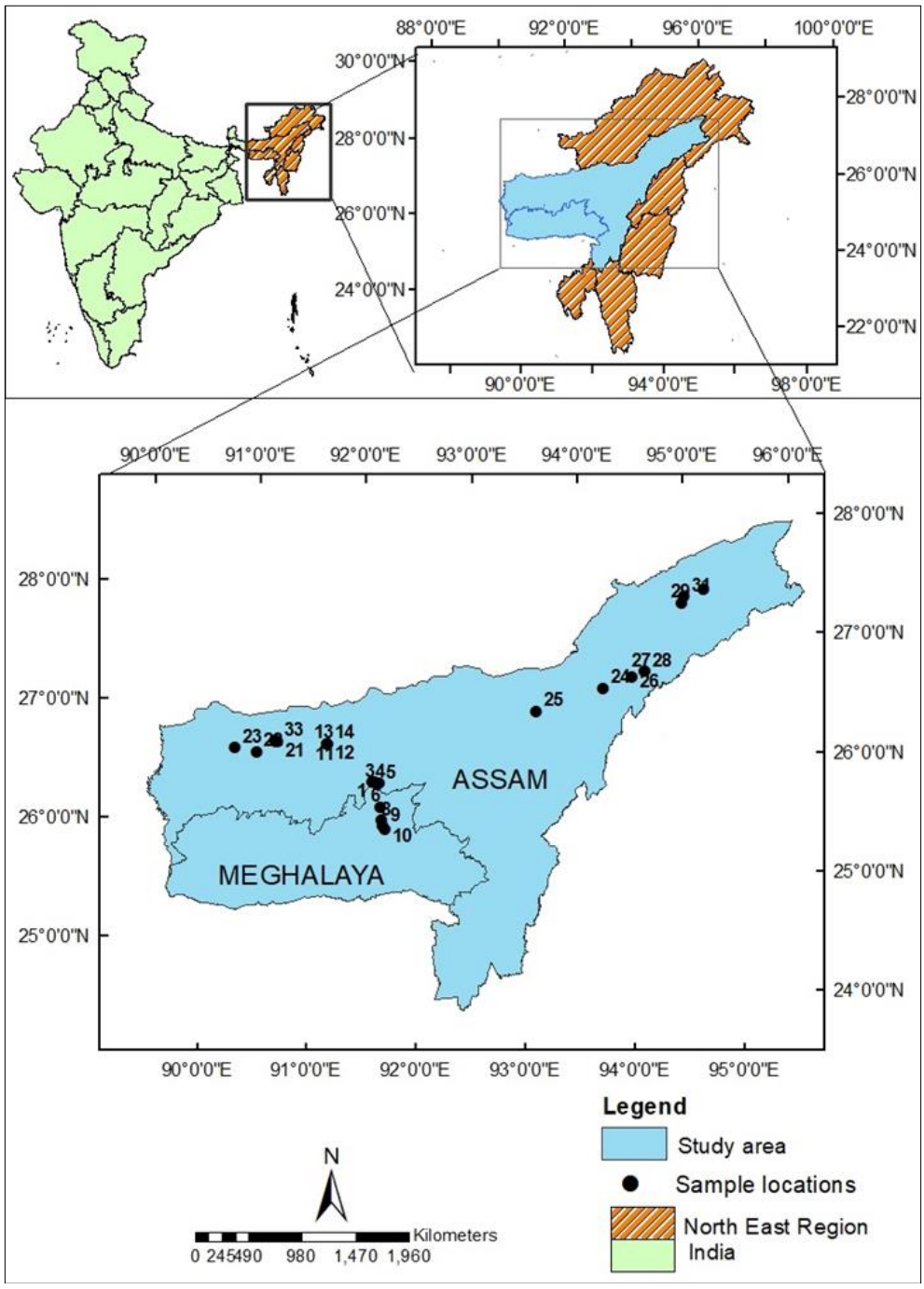


**Fig 1:** Map of Assam and Meghalaya showing study area and collection sites.


**Fig 2:** Forage diversity collected from Assam and Ri-Bhoi district of Meghalaya.

[A] Teosinte [B, C] Deenanath grass
[D] Para grass [E] Nandi grass [F] Guinea grass
[G] Job's tears [H] Johnson grass [I] Rice bean
[J, K, L] Animals grazing different grasses

## 3. Results and Discussion

During the exploration and collection programme, a total of 33 accessions of forage germplasm comprising 15 genera and 19 species were collected from 19 different ecological niche areas (Table-1). Species-wise collection includes *Pennisetum pedicellatum* (7), *Panicum maximum* (5), *Zea maxicana* (2), *Eleusine indica* (2), *Tripsacum andersonii* (2), *Vigna unguiculata* (2) and one accession each of *Setaria palmifolia*, *Pennisetum purpureum*, *Avena sativa*, *Sorghum halepense*, *Chrysopogon zizanoides*, *Miscanthus fuscus*, *Coix lachryma-jobi*, *Saccharum ravennae*, *Themeda villosa*, *Brachiaria mutica*, *Panicum antidotale*, *Setaria sphacelata* and *Vigna umbellata*.

**Table 1:** Description of Forage genetic resources collected from Assam and Ri-Bhoi district of Meghalaya.

| S. No. | Botanical name | Origin | Chromosome number | Habit |
|---|---|---|---|---|
| **Poaceae** | | | | |
| 1 | *Avena sativa* L. | Mediterranean region | 2n = 6x = 42 | A |
| 2 | *Brachiaria mutica* (Forssk.) Stapf | Brazil | 2n=36 | A |
| 3 | *Chrysopogon zizanioides* (L.) Roberty | Tropical Asia | 2n=20 | A |

| | | | | |
|---|---|---|---|---|
| 4 | *Coix lacryma-jobi* L. | Southern and Eastern Asia | 2n= 4x= 20 | P |
| 5 | *Eleusine indica* (L.) Gaertn. | Africa and temperate and tropical Asia | 2n=20 | A |
| 6 | *Miscanthus fuscus (Roxb.) Benth.* | Southeast Asia | 2n = 3x = 57 | P |
| 7 | *Panicum antidotale* Retz. | Indian subcontinent, the Arabian peninsula and Western Asia | 2n=28 | P |
| 8 | *Panicum maximum* Jacq. | Tropical Africa | 2n= 18, 32, 36, 48 | A |
| 9 | *Pennisetum pedicellatum* Trin. | Ethiopia, tropical Africa | 2n=72 | A |
| 10 | *Pennisetum purpureum* Schumach | Sub-Saharan tropical Africa | 2n = 27, 28, 56 | A |
| 11 | *Saccharum ravennae* (L.) L. | Southern Europe, western and South Asia | 2n=20 | P |
| 12 | *Setaria palmifolia* (J. Koenig) Stapf | Indian Sub-continent | 2n=36 or 54 | A |
| 13 | *Setaria sphacelata* (Schumach.) Stapf & C.E.Hubb. ex Moss | Tropical Africa | 2n= 18, 36, 45, 54, 72, 90 | A |
| 14 | *Sorghum halepense* (L.) Pers. | Mediterranean basin and Western Asia | 2n=20 or 40 | P |
| 15 | *Themeda villosa* (Lam.) A. Camus | Tropical & Subtropical Asia | 2n=40 | P |
| 16 | *Tripsacum andersonii* J.R. Gray | Tropical America | 2n=64 | A |
| 17 | *Zea mays* var.*mexicana* (Schrad.) Kuntze | South America | 2n=20 | A |
| **Fabaceae** | | | | |
| 18 | *Vigna umbellata* (Thunb.) Ohwi & H. Ohashi | Asia | 2n=22 | A |
| 19 | *Vigna unguiculata* (L.) Verdc. | Africa | 2n = 22 | A |

*Habit-Annual (A), Perennial (P)

### 3.1 Diversity collected

### 3.2 Poaceae

The grass family Poaceae is one of the largest families of vasc ular plants with an estimated 700 genera and 11,000 species [10]. Grasses are probably of greater importance than any other family of plants as it includes the important cereals (rice, wheat, maize), other food crops (sorghum, pearl millet, barley, oats, Small millets), commercial sugar, forage grasses and bamboos. Forage grasses are used as grazed pastures or/ and as cut fodder for livestock. Seventeen forage species of Poaceae collected during the exploration are described.

Guinea grass (*Panicum maximum*): Grows near road sides or hill slopes and collected from Assam (Khanapara, Sariatoli, Barpeta, Kaliapani) and Ri-Bhoi district of Meghalaya. Plants are perennial, tufted, height 1.5-2.0 metre, stem and leaves green and pubescent, nodes slightly pubescent, leaves 40-50 cm length, sometimes pigmented, inflorescence 30-45 cm length, lax panicle, branched, spikelets shattering in nature. Variability was observed in leaf hairiness, culm colour, branching pattern, plant height and inflorescence length. Deenanath grass (*Pennisetum pedicellatum*): Collected from Khanapara, Kamrup metro, Sariatoli, Dighelli, Jamirah tenali, Dibrugarh of Assam and Umsing villages of Ri-Bhoi district, Meghalaya. Plants are annual in nature, stem light purple, leaves pigmented, hairy, internode light purple, inflorescence light purple, spikelets in clusters of 1-5 within the involucre, at least one of the spikelets upon a pedicel of 1-3 mm long; bristles densely woolly plumose, forming a fluffy ovate involucres 0.5-1 cm long. 2-flowered, lower floret of fertile spikelet male, upper bisexual or female, bisexual mixed in the same inflorescence, lower glume shorter than florets, completely surrounded by a ring of bristles. Variability was observed in plant height (60-150 cm), habit (erect, decumbent), leaf hairiness (mild- strong), anthocyanin pigmentation (leaf, stem, Culm), branching pattern, and inflorescence length. Napier grass (*Pennisetum purpureum*): Perennial in nature, bamboo like clumps, tall up to 2.0 metre, long leaves (upto 100 cm) of 1.5-2.0 cm width, inflorescence a bristly false spike 10-30 cm length, yellowish brown in colour; propagate through short rhizomes or rooting at stem nodes. *Aruna* grass (*Setaria palmifolia*): Collected from Jorhat, Assam; plants tall, stem pubescent, leaves broad, elongated 60 cm length and 3-10 cm width, palm like and inflorescence droopy in nature. *Nandi ghas* (*Setaria sphacelata*): Collected from Barpeta. Perennial, leaves green, glabrous, palatable, grown as a pasture grass and cut fodder. Suitable for silage making, also helps in soil conservation, tolerant to flooding and water logging. Oat (*Avena sativa*): Plants are annual in nature. It is one of the important sources of animal feed but recently introduced to the region. It is mainly grown by the commercial farmers in the areas surveyed. The plants can be used as green forage, silage or hay. Para grass (*Brachiaria mutica*): Collected from Barpeta. It is perennial in habit. Grows in low-lying, water logging situation where stems float in the water. Plant is stoloniferous, basal leaf sheath hairy. Propagated through stem cuttings or seeds. This grass is highly palatable, nutritious and used as green fodder. Teosinte (*Zea mays var. maxicana*): Collected from Sariatoli and Nalbari. Plants are tall. Green leaves preferred by the local farmers for fodder purpose. Vetiver (*Chrysopogon zizanoides*): Occurs naturally throughout the areas surveyed. It is a coarse, evergreen, perennial grass forming large, dense clumps, height (1.0 - 1.5 metre, occasionally to 3 metres). The plant has a stout, compact, aromatic, branched, spongy rhizome and fibrous root system. It is a source of a valuable essential oil used in religious ceremonies. Local farmers use it for mat purpose and artifacts. Young leaves are eaten by cattle. Guatemala (*Tripsacum andersonii*): Collected from Dibrugarh and Tinsukia districts of Assam. Plants are perennial, robust, shallow rooted, leaves 1.0-1.2 metre length and 8-10 cm width, height upto 2.0 metre, grown in fallow lands before tea plantations for improving soil health, also used as fodder. It holds promise as a future fodder crop of the region. Goose grass (*Eleusine indica*): The plants are annual in nature, erect, branching at the base and forming clumps. The plants are difficult to pull out as it has a tough root system. Like *Cynodon dactylon*, goose grass is having high forage value. Johnson grass (*Sorghum halepense*): Occurs throughout the subtropics and warm temperate regions, semi-arid to sub-humid. The plants are rhizomatous and perennial in nature. The dry matter could be ensiled or used as hay. Blue panic (*Panicum antidotale*) is an important perennial grass that has an immense potential for growing in stress condition.

Less known fodder species collected during the exploration includes, *Miscanthus fuscus*, *Themeda villosa*, *Coix lachryma-jobi* and *Saccharum ravennae*. *Coix lachryma-jobi is* commonly known as Job's tears. Green materials of the plants are used for fodder purposes. Seeds are hard-shelled, pearl white, oval structure and locally the seeds are used as beads for necklace purposes. *Themeda villosa* is a perennial grass, occurs in hill slopes, road sides and open places. Young

leaves are eaten by animals. *Miscanthus fuscus* is a perennial rhizomatous grass commonly known as elephant grass. *Saccharum ravennae* plants are tall, leaf broad, grown near moist water bodies and river beds.

### 3.3 Fabaceae

Grain legumes are second in importance to human and animal diets after cereals and occupy an important place in the world's food and nutrition economy [11]. They are usually cultivated in marginal lands under rainfed conditions with low and unstable productivity [12] and provide high quality nutritious fodder for animal consumption. In addition to food and fodder, the nitrogen fixing capacity of grain legumes decreases the need for direct application of N-fertilizers and makes them an important component in cropping systems and improving and sustaining soil fertility and texture [13]. Grasses in combination with legumes become more palatable and energy rich. Two accessions of cow pea (*Vigna unguiculata*) were collected from Barpeta and Bongaigaon and one accession of rice bean (*Vigna umbellata*) was collected from Barpeta of Assam. Variability in cow pea was observed in growth habit, leaflet length, leaf texture, internode length, leaf colour, flower colour, pod length and number of seeds per pod.

## 4. Conclusion

Livestock in the state of Assam and Meghalaya is largely fed on crop residues like rice straw, rice husk and other crop waste. There is also nomadic system of rearing mostly in the fringes of forests. Very few livestock growers grow Guinea grass, Bajra x Napier hybrid and Para grass. Majority of the bovine population depends upon minor grasses of the region. Efforts were made to identify the occurrence of predominant grass species of the region. These include *Cynodon dactylon*, *Axonopus compressus*, *Panicum auritum*, *P. brevifolium*, *P. notatum*, *Echinochloa colona*, *Brachiaria subquadripara*, *Paspalum conjugatum*, *P. scrobiculatum*, *Leersia hexandra*, *Arundo donax*, *Erianthus logisetus*, *Imperata arunduinacea* (*Ullu* grass), *Hymenachne amplexicaulis*, *Oryza rufipogon*, *Oryza sativa var. spontanea*, *Digitaria ciliaris*, *D. setigera*, and *Chrysopogon aciculatus*, etc. In legumes, *Vigna trilobata*, *V. sublobata*, *Dolichos* species, *Clitoria ternatea*, *Indigofera zollingeriana*, I. *galegoides*, I. *nigrescens*, *Millettia pulchra*, M. *prainii*, *Desmodium gangetticum*, D. *heterophyllum*, D. *pulchellum*, D. *triflorum*, *Cliotria ternatea*, *Flemingia macrophylla*, *Rhynchosia viscosa*, *Uraria picta* and *U. rufescens*. Anthropogenic pressures on the grasslands in the form of removal of grasslands for agricultural activities, overgrazing, construction of building and dams for developmental activities etc. are putting enormous pressure on the grassland habitat. As a result, the area under grassland habitat is decreasing at an alarming rate with its negative effect on the flora and fauna of the region. Thus there is an urgent need for a detail study of the grassland habitats, the pattern of distribution and diversity of grassland and the factors responsible for shrinking habitat and avian diversity in the area [14]. The present collection efforts and its further characterization, multiplication and conservation work will be a step forward towards conserving Forage Genetic Resources of the region.

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