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FORAGE GENETIC DIVERSITY IN MURSHIDABAD, NADIA AND NORTH 24 PARGANAS DISTRICTS OF WEST BENGAL

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SUMMARY

Systematic exploration and forage germplasm collection was carried out in three districts namely Murshidabad, Nadia and North 24 Parganas of West Bengal region of India during October-November 2019. During the exploration, efforts were made to collect the important grasses and legumes of the region. A total of 37 samples of forage importance belonging to 21 species of 17 genera *viz*. *Avena sativa* (1 acc.), Bajra napier hybrid (2 acc.), *Brachiaria brizantha* (1 acc.), *Brachiaria mutica* (1 acc.), *Cenchrus ciliaris* (1 acc.), *Chloris barbata* (4 acc.), *Chrysopogon zizanioides* (1 acc.), *Clitoria ternatea* (1 acc.), *Coix lacryma-jobi* (4 acc.), *Digitaria ciliaris* (1 acc.), *Echinochloa colona* (1 acc.), *Echinochloa* spp. (1 acc.), *Eleusine indica* (4 acc.), *Lablab purpureus* (1 acc.), *Oplismenus burmannii* (1 acc.), *Panicum maximum* (2 acc.), *Pennisetum pedicellatum* (2 acc.), *Setaria sphacelata* (1 acc.), *Setaria verticillata* (3 acc.), *Sorghum bicolor* (2 acc.), *Sorghum halepense* (1 acc.) and *Themeda quadrivalvis* (1 acc.) were collected. Passport characteristics of forage diversity collected including discussions on fodder availability, deficit and future scope of increasing fodder areas in the state of West Bengal were highlighted in the paper.

Key words : Distribution, diversity, forage genetic resources

Crops and livestock are the two main components of mixed farming system, which influence agricultural economy and eco-sustainability of the country. The value of livestock in India's economy can be deciphered from the reality that 90 million farming families, cultivating 140 M ha area, are keeping 90 million milch animals (FAO 2018). In order to feed this large livestock population, there is a severe fodder and feed deficiency. It is estimated that, there is a deficit of green fodder and dry fodder to the tune of (11.24%) and (23.4%) respectively (Roy *et al* 2019). Similarly, the estimated annual availability of total concentrate feed is only 61 million tonnes against a demand of 96 million tonnes, indicating a deficit of 36% at national level (Anonymous, 2018). Almost all the states of the country are under fodder deficit condition including UTs (Union territories) and West Bengal is no exception. West Bengal (WB) is located between 21^{o} 31' & 27^{o} 14' North latitude and 85^{o} 91' & 89^{o} 53' East longitude. The state has six agro-climatic zones conducive for cultivation of paddy, wheat, jute, vegetables and fruits round the year. But the state has a higher fodder deficit and mostly the feed comes from agricultural residues. Roy *et al.*, 2019 reported a deficit of 43.9% and 25-50% dry fodder and green fodder respectively in the state. Indian agro-biodiversity is dispersed in five agro-climatic zones, each with distinct agro ecosystem, having unique gene pools and consists of landraces, primitive forms and wild relatives of different crops including forage species. For the development of Indian dairy and allied sectors, the forages are often considered as orphan crops and do play an important role. More efforts to explore, collect, introduce new exotic crops, their evaluation, conservation and restoring indigenous resources would be useful in enriching forage gene pool of India. A review of the forage genetic resources activities made in the last 25 years showed that there has been no systematic exploration programme on collection, characterisation and conservation of forage genetic diversity of West Bengal (Sahay *et al*., 2019) except documenting the diversity in grasses of West Bengal with reference to their utility (Mitra and Mukherjee, 2009). Hence, the objective of the programme was to collect forage crops and their wild relatives from lower Gangetic plains of West Bengal.

MATERIALS AND METHODS

Planning for exploration including collaborator,

logistics etc. was carried out in advance. GPS and map of the area were used to visit different collection sites and record the passport information at the site. These includes 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 etc. Three districts of Gangetic alluvial zone of West Bengal namely, Murshidabad, Nadia and North 24 Parganas were explored during October-November 2019. Strategies and methodologies of collection of Hawkes (1980) and Arora (1981) were followed. The samples were mainly collected in the form of inflorescence, seeds, live plants and rooted slips. About 50 inflorescences of each grass species were randomly collected from each site. If considerable variation was observed than a separate sample was made. In case of vegetatively propagated plants, 10-15 individual root slips were bulked as a single sample.

RESULTS AND DISCUSSION

During the exploration and collection programme, a total of 37 accessions of forage germplasm comprising 17 genera belonging to 21 species were collected from 18 blocks and 33 villages of the three districts (Murshidabad, Nadia and North 24 Parganas) of West Bengal (Table 1). The area is located between 22° 30' to 24° 90' latitude and 87° 57' to 88° 80' longitude. Site-wise collection includes farmers' field (25), farm store (4), garden (3), threshing yard (2), waste land (2) and natural wild (2).

Diversity in forage crops collected

The collected forage genetic diversity includes 16 different taxa of grasses *(i.e. Avena sativa,* Bajra Napier hybrid (2 acc.), *Brachiaria brizantha, Brachiaria mutica, Cenchrus ciliaris, Chloris barbata* (4 acc.), *Chrysopogon zizanioides, Coix lacryma-jobi* (4 acc.), *Digitaria ciliaris, Echinochloacolona, Echinochloa* spp., *Eleusine indica* (4 acc.), *Oplismenus burmannii, Panicum maximum* (2 acc.), *Pennisetum pedicellatum* (2 acc.), *Setaria sphacelata, Setaria verticillata* (3 acc.), *Sorghum bicolor* (2 acc.), *Sorghum halepense* and *Themeda quadrivalvis*) and two species of legume fodder *viz. Clitoria ternatea* and *Lablab purpureus* (Fig. 1).

A brief passport data of each taxa consisting of common name, botanical name, type of material collected, source of collection, frequency of occurrence, their habit, district/jurisdiction from where the sample was collected, latitude and longitude of the place of collection are mentioned (Table 2).

District-wise accessions collected

Nadia : A total of 13 genera and 18 species comprising *Brachiaria brizantha, Brachiaria mutica, Cenchrus ciliaris, Chloris barbata,Clitoria ternatea, Coix lacryma-jobi, Digitaria ciliaris, Echinochloa colona, Echinochloa spp., Eleusine indica, Lablab purpureus, Panicum maximum, Pennisetum americanum x Pennisetum purpureum, Pennisetum pedicellatum, Setaria sphacelata, Setaria verticillata, Sorghum bicolor* and *Sorghum halepense* were collected.

Murshidabad : Germplasm collection includes a total of eight genera and eight species. It comprised of *Avena sativa, Chloris barbata, Chrysopogon zizanioides, Coix lacryma-jobi, Oplismenus burmannii, Pennisetum americanum x Pennisetum purpureum, Sorghum bicolor* and *Themeda quadrivalvis.*

TABLE 1
Collection sites visited in three districts of West Bengal

S. No.	Districts	Blocks	Villages
1	Nadia	Kaliganj, Dhaulia, Sivliganj, Chapra, Krishnanagar-II, Ranaghat, Chakdaha	Chakdignagar, Bahadurpur, Betai, Charatala, Bhimpur, Radhagovindpur, Gazna, Narayanpur, Fulia, Aisthala, Payradanga, Kalyani, Nagarkhada, Barajaghali
2	Murshidabad	Nabagram, Sagardighi, Jiaganj, Raghunathganj, MJ block, Bhagawangola, Kandi	Sivpur, Gopgram, Narayanpur, Mongram, Prasadpur, Taldi, Basbadi, Bhagwangola, Manoharpur, Kuli, Kashigram, Benakar,
3	North 24 Parganas	Gaighata, Rajarhat, Barrackpore, Barasat	Chandpara, GholBathan, Kesdelpur, Noapara, Malonchoi
	Total	18	33

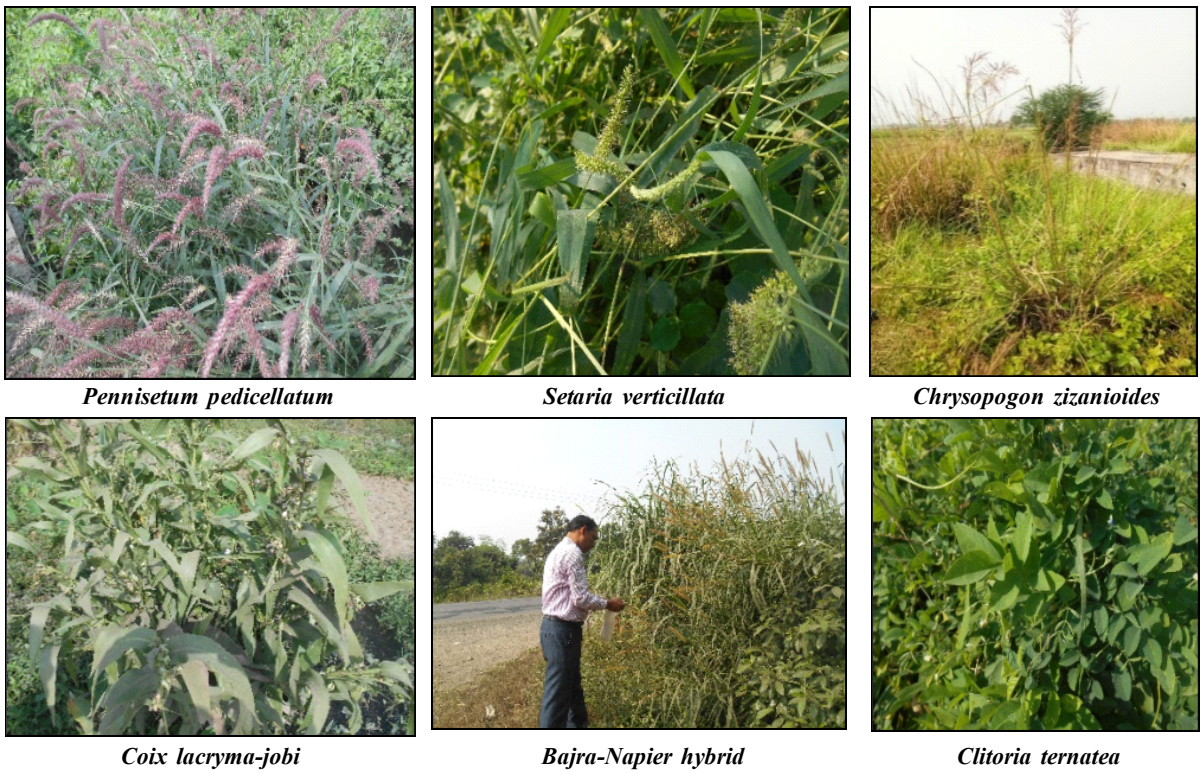

Fig 1. Forage diversity of some grasses and legumes collected.

North 24-Parganas : Germplasm collection includes *Chloris barbata, Coixlacryma-jobi, Eleusine indica and Setaria verticillata.*

Classification of germplasm collected

Collected accessions can be categorised conveniently into cultivated fodder, range grasses, cultivated legumes and minor grasses for better understanding of the crop diversity and their importance in fodder crop production. Category-wise plants are as under:

Cultivated fodder : In this group, a total of eight accessions comprising *Sorghum bicolor*, BN hybrid (*Pennisetum americanum* × *Pennisetum purpureum*), guinea grass and *Avena sativa* were collected. These grasses contribute maximum to the fodder production. Fodder sorghum is palatable and provide nutritionally superior fodder during lean season and has a share of about 60 per cent of the total dry weight of fodder of dairy animals (Elangovan *et al.,* 2013; Jain and Patel, 2013). Oat grows in northern India mostly but the area of adoption extends up to West Bengal. Bajra-Napier hybrid is the most preferable grass by the livestock growers of the country.

Range grasses : Range grasses are important for livestock population of these districts. These grasses are naturalised and meet seasonal forage requirements. Under this category, a total of 11 accessions comprising *Chloris barbata* (4), *Pennisetum pedicellatum* (2) and one accession each of *Brachiaria brizantha* (1), *Brachiaria mutica* (1), *Cenchrus ciliaris*, *and Chrysopogon zizanioides* and *Digitaria ciliaris* were collected.

Minor grasses : Sixteen accessions of minor grass species were collected. These species are less preferred by the animals. Species in this category includes *Coix lacryma-jobi* (4), *Eleusine indica* (4), *Setaria verticillata* (3) and one accession each of *Oplismenus burmannii*, *Themeda quadrivalvis, Echinochloa colona*, *Sorghum halepense and Setaria sphacelata.*

Cultivated legumes : Under this category, one accession of each of *Clitoria ternatea,* and *Lablab purpureus* were collected. Butter fly pea and lablab bean plants meet short-term forage needs of the animals and are considered as good feed for cattle and sheep. These plants are drought tolerant and can be grown in the periphery of bunds and waste lands.

Dikshit *et al*. (2019) conducted similar

TABLE 2
Passport characteristics of forage genetic resources collected

S. No.	Common name	Botanical name	Material type	Source of collection	Frequency	Habitat	District	Lat.	Long.
1.	Jai/Oat	*Avena sativa* L.	Seeds	Farmer's field	Occasional	Cultivated	Murshidabad	24° 9′	88° 8′
2.	Palisade grass/ Congo Signal Grass	*Brachiaria brizantha* (Hochst. ex A. Rich.) Stapf.	Live plants	Farm store	Abundant	Cultivated	Nadia	22° 57′	88° 26′
3.	Para grass/ buffalo grass	*Brachiaria mutica* (Forssk.) Stapf	Live plants	Garden	Abundant	Cultivated	Nadia	22° 57′	88° 26′
4.	Buffel grass/Anjan Grass	*Cenchrus ciliaris* L.	Live plants	Farmer's field	Abundant	Cultivated	Nadia	22° 57′	88° 26′
5.	Swollen finger grass	*Chloris barbata* Sw.	Seeds	Waste land	Occasional	Wild	Murshidabad	24° 8′	88° 11′
6.	Swollen finger grass	*Chloris barbata* Sw.	Seeds	Farmer's field	Occasional	Wild	Murshidabad	23° 3′	88° 15′
7.	Swollen finger grass	*Chloris barbata* Sw.	Seeds	Farmer's field	Occasional	Wild	Nadia	23° 12′	88° 31′
8.	Swollen finger grass	*Chloris barbata* Sw.	Seeds	Farmer's field	Occasional	Wild	North 24-Parganas	22° 45′	88° 24′
9.	Bena grass	*Chrysopogon zizanioides* (L.) Roberty	Seeds	Farmer's field	Occasional	Wild	Murshidabad	24° 12′	88° 6′
10.	Aparajita/ Butterfly pea	*Clitoria ternatea* L.	Seeds	Threshing Yard	Occasional	Cultivated	Nadia	23° 47′	28° 33′
11.	Job's tear	*Coix lacryma-job i*L.	Seeds	Farmer's field	Occasional	Cultivated	Murshidabad	23° 56′	87° 57′
12.	Job's tear	*Coix lacryma-jobi* L.	Seeds	Farm store	Frequent	Cultivated	Murshidabad	23° 48′	87° 59′
13.	Job's tear	*Coix lacryma-jobi* L.	Seeds	Farmer's field	Occasional	Cultivated	Nadia	23° 15′	88° 37′
14.	Job's tear	*Coix lacryma-jobi* L.	Seeds	Farmer's field	Frequent	Cultivated	North 24-Parganas	22° 48′	88° 37′
15.	Crabgrass	*Digitaria ciliaris* (Retz.) Koeler	Seeds	Farmer's field	Frequent	Cultivated	Nadia	22° 56′	88° 37′
16.	Jungle rice	*Echinochloa colona* (L.) Link	Live plants	Garden	Occasional	Cultivated	Nadia	23° 7′	88° 33′
17.	Barnyard grass	*Echinochloa spp.*	Seeds	Farmer's field	Occasional	Cultivated	Nadia	23° 24′	88° 42′
18.	Goose grass	*Eleusine indica* (L.) Gaertn.	Seeds	Farmer's field	Frequent	Cultivated	Nadia	23° 25′	88° 38′
19.	Goose grass	*Eleusine indica* (L.) Gaertn.	Seeds	Farmer's field	Frequent	Cultivated	Nadia	23° 13′	88° 3′
20.	Goose grass	*Eleusine indica* (L.) Gaertn.	Seeds	Farmer's field	Frequent	Cultivated	Nadia	22° 57′	88° 26′
21.	Goose grass	*Eleusine indica* (L.) Gaertn.	Seeds	Farmer's field	Frequent	Cultivated	North 24-Parganas	22° 45′	88° 24′
22.	Dolichus bean	*Lablab purpureus* (L.) Sweet	Seeds	Farmer's field	Occasional	Cultivated	Nadia	23° 33′	88° 32′
23.	Basket grass	*Oplismenus burmannii* (Retz.) P. Beauv.	Seeds	Farmer's field	Frequent	Cultivated	Murshidabad	24° 26′	88° 17′
24.	Guinea grass	*Panicum maximum* Jacq.	Seeds	Farmer's field	Abundant	Cultivated	Nadia	22° 57′	88° 26′
25.	Guinea grass	*Panicum maximum* Jacq.	Seeds	Farmer's field	Frequent	Cultivated	Nadia	22° 57′	88° 26′
26.	Napier	*Pennisetum americanum x Pennisetum purpureum*	Rooted slips	Waste land	Occasional	Partly disturbed	Nadia	23° 2′	88° 28′
27.	Napier	*Pennisetum americanum x Pennisetum purpureum*	Rooted slips	Farm store	Occasional	Cultivated	Murshidabad	24° 9′	88° 17′
28.	Deenanath grass	*Pennisetum pedicellatum* Trin.	Seeds	Farmer's field	Occasional	Cultivated	Nadia	23° 7′	88° 33′
29.	Deenanath grass	*Pennisetum pedicellatum* Trin.	Seeds	Natural wild	Abundant	Partly disturbed	Nadia	22° 57′	88° 26′
30.	Setariagrass/ Nandi	*Setaria sphacelata* (Schumach.) Stapf & C.E. Hubb. ex Moss	Live plants	Garden	Occasional	Cultivated	Nadia	22° 57′	88° 26′
31.	Hooked bristlegrass	*Setaria verticillata* (L.) P. Beauv.	Seeds	Farmer's field	Occasional	Cultivated	Nadia	23° 25′	88° 41′
32.	Hooked bristlegrass	*Setaria verticillata* (L.) P. Beauv.	Seeds	Farmer's field	Occasional	Cultivated	Nadia	23° 21′	88° 42′
33.	Hooked bristlegrass	*Setaria verticillata* (L.) P. Beauv.	Seeds	Farmer's field	Frequent	Cultivated	North 24-Parganas	22° 57′	88° 45′
34.	Sorghum	*Sorghum bicolor* (L.) Moench	Seeds	Farmer's field	Occasional	Cultivated	Nadia	23° 25′	88° 28′
35.	Sorghum	*Sorghum bicolor* (L.) Moench	Seeds	Threshing Yard	Frequent	Cultivated	Murshidabad	24° 9′	88° 25′
36.	Sorghum	*Sorghum halepense* (L.) Pers.	Seeds	Farmer's field	Occasional	Cultivated	Nadia	22° 57′	88° 26′
37.	Kangaroo grass	*Themeda quadrivalvis* (L.) Kuntze	Seeds	Farm store	Occasional	Cultivated	Murshidabad	24° 17′	88° 2′

exploration programme to Assam and Ri-Bhoi district of Meghalaya and collected a total of 33 accessions comprising 17 species of Poaceae and two species of Fabaceae. Morpho-agronomical variability 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) were highlighted in the paper. Sahay *et al*. (2019) reported a collection of total of 4741 accessions of forage germplasm across the country during the period of 1993-2018 and highlighted the accomplishments and future strategies of forage genetic resources at ICAR-IGFRI, Jhansi. There is a huge shortage of fodder and feed in the state. In order to meet the demand of fodder supply,increasing forage areas, production and productivity of forage crops following strategies may be adopted.

(i) Emphasis may be given on adoption of high biomass forage varieties
(ii) Rejuvenation of grazing lands/common property resources
(iii) Forage production from degraded and non-arable lands, existing orchards
(iv) Management of crop residues and conservation of forages during rainy season etc.

CONCLUSION

Collecting genetic diversity of forage crops is important for present and future crop improvement programmes. In the current scenario, grasslands are encroached for human habitation and different developmental projects. This results in loss of important forage species. During the present exploration, emphasis was given to collect maximum variability in germplasm of different forage crops and their wild relatives. As the area was not explored earlier, the collection efforts would enrich forage genetic resources activities and also create awareness among the local people to help maintain and conserve the grassland and pastures of the region.

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