Collection of Multi-crop Germplasm from Lower and Upper Subansiri Districts of Arunachal Pradesh, India and their Range of Diversity

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Abstract

A 13-day exploration trip was undertaken in the Lower Subansiri and Upper Subansiri districts of Arunachal Pradesh. During this exploration trip, 38 sites explored and a total of 251 accessions of different crops was collected. The crop group wise break-up of collections is cereals (99), millets (30), oilseeds (01), grain legumes (22), vegetables (47), tuber/root crops (12), spices (36), fruits (02), sugarcane (01) and miscellaneous (01). Individual and selective sampling methods were adopted for horticultural crops and random sampling method adopted for other agricultural crops, with an aim to represent the whole population. Among the collected crop materials, rice, maize, cowpea, French bean, chillies and pumpkin germplasm showed a wide range of variability. Further evaluation of these crops in multi-location or otherwise maybe useful for identification of economic traits of breeders' interest.

Key words: Germplasm collection, diversity, local landraces, Arunachal Pradesh

Introduction

Northeastern region of India is situated between 22-30^0 north latitude and 80-97^0 east longitude and surrounded between Bhutan and Tibet in north, Burma in east and Bangladesh in south, has a total geographical area of little of 25.50 m ha. Arunachal Pradesh is one of the largest states with an area of 83,743 sq Km and it is located between 26°28' to 29°30'N latitudes and 91°30' to 97°30' E longitudes. It shares international border with China in the North, Myanmar in the East, Bhutan in the West and the Indian states of Assam and Nagaland in the South. The state has 82.21% area under forest, which covers the sub-tropical to the alpine vegetation in the upper region of the Northwest, where it is bordered by the Himalayan ranges (NEC, 2002). The state is consisted of 15 major districts, i.e. Tawang, West Kameng, East Kameng, Kurung Kumey, Papumpare, Lower Subansiri, Upper Subansisri, West Siang, Upper Siang, East Siang, Dibang Valley, Lower Dibang Valley, Lohit, Changlang and Khonsa districts. Anthropologically, there is near uniformity across the larger tribal communities in Arunachal Pradesh; Adi, Nyishi, Monpa, Tagin, Idu, Khampti, Tangsa, Nocte, Singpho, Mishmi, Miji, Galo, Wancho, Apatani, Aka, Sherdukpen, Khawa and Hill Miri. Area wise it is the largest state of North-East region of India. Agriculture is their main occupation of the people of state. They practice terrace cultivation unlike most of the northeastern that practice *Jhum* cultivation. Apart from being agriculturist, they even tried livestock's rearing like yak, sheep, etc.

Owing to different ecological rich and availability of vast plant resources and crop diversities that are existed in the northeast region, it was felt necessary to collect this valuable resource before they disappear from the nature or its natural habitat. Major emphasis was laid on the collection from remote, unexplored, unexploited areas and to collect the underutilized plants, endemic plant species, rare and endangered economic plants, primitive cultivars, landraces and absolute varieties. An attempt has been made to explore some of the area in Arunachal Pradesh and to collect variable crop germplasm in this area. The Lower Subansiri and Upper Subansiri districts of Arunachal Pradesh were selected, since cultivation of local landraces of crops is in practice with little or no modern agricultural inputs and there is every possibility of finding such trait specific materials. Therefore, an exploration was planned in these districts with an objective to collect the landraces of crop plants. The basic purpose was to collect the propagative materials in the form of either vegetative or seed materials and to identify useful traits/genes that may contribute in crop improvement purposes and simultaneously to make an assessment on genetic erosion.

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Materials and methods

Collection site

Lower Subansiri District (LSD) of Arunachal Pradesh is lying approximately between 92^0 40' and 94^0 21' east longitudes and 26^0 55' and 28^0 21' north latitudes. The districts is bordered by China and some parts of Upper Subansiri District (USD) to the north, West Siang district and some part of Lower Subansiri District to the east, Papumpare district and state of Assam to the south and East Kameng district to west, respectively. As per the 2001 census, the total population of LSD and USD is 97614 and 54995, with the density of district is 10 and 9, respectively. The dominant tribal communities in these areas were Apatani, Nishi (Nishang/ Dafla), Hill Miri, Tagin, Hill Miri, Galo and Nyishi.

A 13 days exploration trip was undertaken in the month of September, 2004. The soil of this area is generally yellow in color and it is sandy clay loam and silty loam with high percentage of micronutrients, depending upon the location. During this survey and exploration trip 38 sites were visited and 251 of crop germplasm collected. The main exploration sites were Paka, Lili Dong, Don Basti, Dawn Basti Lower, Mig Basti, Daporijo Market, Jiri Riba, Riba Upper, New Riba, Tajiparam, Paka Rizo, Digbak, Bello, Gasar, Radeng, Book Ney, Noamarg, Kodak, Arma, Don and Chikampat (under USD); Surya, Tamentri, Boasimla, Pickikteri Pite, Muri, Bellamuri, Raga, Rere Kalung, Hiza, Nenchanlya, Hapoli Market, Kudung Barang and Dutta (under LSD) and the adjoining areas (Fig. 1). It was observed that both the districts are rich in diversities of banana and bamboos. Extensive survey was conducted in villages, *Jhum* fields and hilly terrain in order to identify and collect local landraces and traditional varieties of all major crops of agri- horticultural importance.

Individual and selective sampling methods were adopted for horticultural crops and random sampling method adopted for other agricultural crops, with an aim to represent the whole population. The collection was made from farm store, farmer's field and threshing yards. This was made in the form of seed, bulbs, corms, rhizomes, tubers, etc., according to the crop and their mode of propagation. Sampling was made in fruit form in case of *Citrus* spp., which is recalcitrant in nature. In case of vegetatively propagated crops, sufficient quality of bulbs, corms, rhizomes, tubers etc., were collected. For each collected germplasm, the necessary standard passport datasheet was filled and collected accession allotted with a collection/ collector number. The NBPGR descriptor for agri-horticultural crops (Mahajan *et al*., 2000) was used as a guideline for discriminating the variability in the collected germplasm.

Results and discussions

During the exploration trip a total of 251 accessions were collected (Table 1), which belongs to different crop groups. The range of variability on cereal crops, millets, grain legumes, vegetables and chillies have also been recorded as remarkable variation was observed within the genotypes.

A wide range of diversity was observed in collected germplasm which is discussed as follows.

Paddy (*Oryza sativa* L.)

Paddy is the locally known as *Aiimo* (in LSD) and *Amme* (in USD). The notable landrace were collected during the trip are *Buyi, Kecha, Ginre, Pumin Mumpu, Gapo, Pumin, Lai, Mite, Nepali Dhan, Iyar Bui, Kesa, Basa Ram, Kera, Uiyere Bui, Liruk, Gapeu, Yaparading, Pengin, Kumuk, Aam, Bodikilb, Bachik, Gamipe, Pyph, Areamo, Kogya Mipia, Jemipia, Emo, Miciemo, Rade, Imomipia, Impu Imo, Tipe Pyapin, Papu Papin, Kogyam Piya* and *Payapin*. Diversity in paddy was recorded on the basis of present/absent of awing, husk colour, kernel colour, type of species, grain length (mm), grain diameter (mm) and 100-seed weight (g). The most of paddy accessions belong to *Indica* type but few accessions like; IC447350, IC447387, IC447430 and IC447467 are belongs to *Japonica* type. According to Singh (2002), *Intermediate* types, *Indica* and *Japonica* type races were reported in these districts. The maximum grain length was recorded in IC447277 (9.49 mm) and minimum in IC447467 (5.42 mm), whereas, the grain diameter is maximum in IC447254 (4.15 mm) and minimum in IC447276 (2.37 mm). The 100-seed weight ranged between 1.44 g (IC447387) to 3.56 g (IC447299) among the collected genotypes. The accessions IC447267, IC447429, IC447438, IC447452, IC447461, IC447462, IC447468, IC447469, IC447470, IC447473 and IC447474 are *awan* type paddy. The husk colour was recorded golden (19 accs.), brown (4 accs.), yellow (18 accs.), golden brown (1 accs.), brown stripped (3 accs.), brown tipped (3 accs.) and black (1 accs.). Aroma was present in 11 accessions while absent in 38 accessions. The kernel colour was observed white in 42 accession and brown in 7 accessions. Each accession showed

wide variations in respect of the characters studied as presented in Table 2.

Maize (*Zea mays* L.)

Maize is locally known as *Topo* (in USD) and *Tanee* (in LSD). Mostly *Badam* and *Potte local* landraces are found in these districts. During the trip a total of 50 accessions were collected. Out of these six accessions were collected in seed form and rest in cob form. Morphological data recorded on cob length (cm), cob diameter (cm), number of kernel row, number of seeds/row, kernel row arrangement, grain shape, grain size, seed colour and 100-seed weight (g). Each collected accessions showed variations among the genotypes. The cob length ranged between 8.50 cm (IC447245) to 24.0 cm (IC447445) and the cob diameter ranged between 2.46 cm (IC447275) to 4.80 cm (IC447408). The number of kernel rows/cob ranged between 10.0 (IC447270, IC447310, IC447368, IC447464, IC447475 and IC447486) to 18.0 (IC447275 and IC447463). The number of seeds/ row ranged from 12.0 (IC447275) to 37.00 (IC447463). The 100-seed weight was maximum for IC447445 (43.88 g) and minimum for IC4474331 (7.00 g). The accession IC447445 is bold seeded in comparison to other accessions. A wide range of variability obseved for kernel colour, which were orange (15 accs.), yellow (3 accs.), white (16 accs.), variegated (6 accs.), brown (1 accs.) and red (9 accs.). Variation in kernel row arrangement was also observed as, regular (2 accs.), spiral (13 acces.), irregular (6 acces.), and straight (23 acces.). The grain size was recorded bold in 20 accessions, medium in 15 accessions, and small in 15 accessions. The grain shape was recorded rounded, shrunken, indented and pointed in 24, 12, 10 and 4 accessions, respectively. Each collected accession showed distinct variations based on the above morphological features.

Cowpea (*Vigna unguiculata* L. Walp.)

Cowpea is locally known as Pereu and *Ubiyo* in Upper and *Perung* in Lower Subansiri district. The morphological variations were observed in seed colour, seed length, seed diameter, seed mottling and 100-seed weight. The minimum and maximum seed length was found in accession IC447344 (9.14 mm) and IC447286 (12.85 mm), respectively. The diameter of seed was minimum (3.47 mm) for IC447344 and maximum (4.39 mm) for IC447311. The 100-seed weight ranged from 10.00 g (IC447244) to 17.08 g (IC447274). Seed coat colour among the collected accession were - black (2 accs.), brown (3 accs.), dark brown (2 accs.) and light brown (1 accs.). Seed mottling was absent in all the accessions.

French bean (*Phaseolus vulgaris* L.)

It is locally known as *Peren* (in USD) and *Perung* (in LSD). In this exploration trip a total of 10 accessions were collected. Morphological variability was recorded (Table-3) on the basis of seed length, seed diameter, seed size, seed colour, seed mottling and 100-seed weight. The maximum seed length was recorded in IC447419 (15.20 mm) and minimum in IC447427 (10.26 mm), while the seed diameter was maximum (6.94 mm) and minimum (5.18 mm) in IC447444 and IC447426, respectively. The 100-seed weight ranged between 39.85 g (IC447426) to 53.39 g (IC447443). Seed coat colour among the collected accession were - black (1 accs.), brown (2 accs.), maroon (1 accs.), cream (4 accs.) and red/white spotted (1 accs.). Seed mottling was absent in all the accessions.

Chillies (*Capsicum annuum* L.)

During this exploration trip a total 34 accessions of chilles were collected. It is locally known as *Tero* (in LSD) and *Yeluk* (in USD). In these districts many local landrace i.e. *Kada*, *Maan*, *Lukpo* and *Lugni* are found. All the accessions were collected as the fruit form. Maximum morphological and genetical variability was found in chillies. This variability was recorded on the basis of fruit length (cm), fruit diameter (mm), ripe fruit colour, fruit shape, fruit pedicle length (cm), fruit surface, fruit weight (g), number of seeds/ fruit, seed weight/fruit (g) and 100-seed weight (g). Variability was observed in characters like fruit length, fruit diameter, ripe fruit colour, fruit shape, fruit weight, number of seeds /fruit and 100-seed weight. The range of fruit length was 1.30 cm (IC447413) to 8.30 cm (IC447455) while fruit diameter 5.96 mm (IC447413) to 19.34 mm (IC447458). Maximum fruit pedicle length was 4.6 cm for IC447414 and minimum 1.9 cm for IC447327. The maximum fruit weight was recorded in accession IC447352 (2.51 g) and minimum in IC447413 (0.08 g). Maximum number of seeds/fruit was 116.00 (IC447450) while the minimum was 10.00 (IC447341). The 100-seed weight varies from 0.28g (IC447413) to 0.88g (IC447247). The fruit colour was observed among the collected accession as dark red (18 accs.), light red (4 accs.), orange (9 accs.) red (2 accs.) and yellow (1 accs.). Fruit surface was observed smooth (17 accs.), wrinkled (9 accs.), and semi wrinkled (8 accs.),. The fruit

shape was conical (14 accs.), oval (10 accs.), long (9 accs.), and round (1 acc.).

Pumpkin (*Cucurbita mosschata* Dutch ex poir)

Pumpkin is locally known as Tape (in LSD) and Tap (in USD). During this exploration trip total 14 accessions were collected, out of these nine accessions collected as fruit form and rest as seeds form. The morphological variability on the basis of per fruit weight , fruit length , fruit diameter, number of seeds/fruit, seed length , seed diameter, peduncle separation from fruit, nature of base of peduncle, 100-seed weight, number of seed placenta/fruit, fruit shape, flesh thickness and flesh texture. The maximum and minimum fruit weight was recorded in IC447291 (2.68kg) and IC447316 , IC447330 (0.68 kg), respectively. The fruit length ranged between 13.20 cm (IC447330) to 23.80 cm (IC447291), whereas, fruit diameter ranged between 8.82 (IC447261) to 14.78 cm (IC447291). Number of seeds/fruit was maximum in IC447290 (545) and minimum in IC447261 (51). The range of seed length was 18.97 mm (IC447288) to 11.50 mm (IC447291), whereas, seed diameter ranged between 1.59 mm (IC447330) to 3.01 mm (IC447261). Mostly accessions belong to difficult peduncle separation from fruit; however, only 3 accessions were easy in separation. 100-seed weight varies from 4.42 (IC447330) to 27.71g (IC447288) and flesh thickness was maximum in IC447291 (3.30 cm) and minimum in IC447316 (1.50 cm). Mature fruit colour was observed dark red (18 accs.), light red (4 accs.), orange (9 accs.), red (2 accs.) and yellow for (1 accs.). The fruit surface was observed among the collected accession were as smooth (17 accs.), wrinkled (9 accs.) and semi-wrinkled (8 accs.). The fruit shape was recorded long, oval, conical, and round in 9, 10, 14, and 1 accession, respectively.

Conservation status

The collected seed samples were properly dried and cleaned and dispatched as voucher sample. Subsequently, the seed material was sent to the National Gene Bank, NBPGR, New Delhi for storing in medium term module. This was accompanied with relevant passport data sheets. The vegetatively propagated materials were retained at the NBPGR Regional Station- Shillong, Umiam (Meghalaya) for maintenance and subsequent characterization.

As "extinction is forever" (Prance and Elias, 1977) so, too is germplasm forever. The present form of agriculture that is being practiced in this region is not sustainable and requires innovative intervention. Poor road connection, lack of marketing avenues, lacks of awareness of modern technology of cultivation and political factors are major hindrance for commercial agriculture in hilly areas. The magnitude of work related to crop genetic resources conservation is so wide that there is a need to have germplasm inventory, information system, research and development network, legal provisions (IPR) for identification, assessment and monitoring of the resources. One cannot simply ignore the role of farmers in agro-biodiversity conservation as they are one who are constantly toiling to grow crops since ages and knowingly or unknowingly practicing the selection for better crop yield, averting diseases and pest problems.

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Table 1 : List of crop group wise collections

SN	Crop Group	Crops	Total
1	Cereals	Paddy (49) and maize (50)	99
2	Millets	Finger millets (27), Foxtail millets (02) and Sorghum (01)	30
3	Oil seeds	Sesame (01)	01
4	Grain legumes	French bean (10), Cowpea (08), Soybean (03) and Rice bean (01)	22
5	Vegetables	Pumpkin (14), Bottle gourd (05), Bitter gourd (01), Water melon (03), Cucumber (05), Tomato (02), Cabbage (01), Brinjal (06), Okra (06), *Amaranthus* (01) and Leafy Brassica (03)	47
6	Tuber/root crops	*Colocasia* (04), *Dioscorea* (07) and *Amorphophallus* (01)	12
7	Spices	Ginger (01), Chillies (34) and Garlic (01)	36
8	Fruits	Pumello (01) and Banana (01)	02
9	Sugarcane	Sugarcane (01)	01
10	Miscellaneous	*Solanum spirale* (01)	01
Total			251

Number within parenthesis indicates the germplasm collected

Table 2 : Morphological variation among the collected germplasm

SN	Crop	No. of accessions	Characters	Range	Mean	CV (%)
1.	Paddy	49	Grain length (mm)	5.42- 9.49	7.46	13.38
			Grain diam (mm)	2.37 - 4.15	3.31	12.09
			100 seeds wt. (g)	1.44 - 3.56	2.55	18.91
2.	Maize	50	Cob length (cm)	24.00 - 8.50	14.48	19.46
			Cob diameter (cm)	4.80 - 2.46	3.75	15.18
			No. of kernel rows	18.00 - 10.00	2.91	15.45
			No. of seeds/row	12.00 - 37.00	22.00	41.80
			100 seeds wt. (g)	7.00 - 43.88	27.73	20.75
4.	Cow pea	08	Seed length (mm)	9.14 - 12.85	10.70	12.99
			Seed diam (mm)	3.47 - 4.39	3.93	8.02
			100 seeds wt. (g)	10.00 - 17.08	14.29	16.68
5.	French bean	10	Seed length (mm)	10.26 - 15.02	12.64	11.28
			Seed diam (mm)	5.18 - 6.94	5.93	10.39
			Seed size (mm)	9.53 - 55.10	75.15	16.40
			100 seeds wt. (g)	39.85 – 53.39	45.32	11.15
6.	Pumpkin	14	Fruit wt. (kg)	0.68 - 2.68	1.32	53.31
			Fruit length (mm)	13.20 - 23.80	19.61	20.82
			Fruit diam. (mm)	8.82 - 14.78	11.77	18.46
			No of Seeds/fruit	51.00 - 545.00	14.51	12.02
			Seed length (mm)	11.50 -18.97	2.48	17.55
			Seed diam (mm)	1.59 - 3.01	335.67	42.28
			No of seed placenta/fruit	3.00 - 6.00	4.11	35.34
			Flesh thickness	1.50 - 3.30	2.17	25.07
			100 seeds wt. (g)	4.42 - 27.71	11.35	46.27
8.	Chilli	34	Fruit length (cm)	1.30 - 8.30	3.59	42.88
			Fruit diam. (mm)	5.96 - 19.34	12.51	33.45
			Fruit pedicle length	1.9 – 4.6	2.86	22.13
			Fruit wt. (g)	2.51 – 0.08	0.80	81.50
			No. of seeds/fruit	10.00 - 116.00	59.97	54.39
			100 seeds wt. (g)	0.28 - 0.88	0.52	27.45