

Horticultural Biodiversity in Santhal Parganas

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Santhal Pargana region in Bihar is characterized by tribal community and natural forests. The area receives medium-high rainfall (1200-1600) mm/annum) distributed between the month of June of September with mild temperature (30^o-36^oC) which favours growth of a number of horticultural crops of major and minor importance. Most of these crops are cross pollinated and show natural regeneration, leading to considerable variability accumulation in many fruits. The identification and collection of economically important genotypes of jackfruit, custard apple, jamun, tamarind, bael in this season was carried out. Biodiversity areas and collection routes are enumerated. A number of promising collections for various traits in different fruit crops are described.

Key Words: Biodiversity, Fruit crops, Santhal Pargana

The plateau region in Bihar is spread over a large area covering the southern and south-eastern part of the state. The region is dominated by tribal communities like Santhals, Mundas, etc. and has been named on the basis of their predominance. Santhal Pargana consists of six tribal districts viz. Dumka, Godda, Pakud, Sahebganj, Deoghar and Giridih. The region is situated between 23^o50' to 25^o15' N latitude and 25^o53' to 87^o51' E longitude with elevation ranging between 450-1000 m above mean sea level. It is endowed with mild, hot and humid climatic conditions which favours a large number of indigenous and few exotic naturalised plant species to grow. This constitutes the wide genetic base of many important horticultural species. The prominent fruit species exhibiting rich genetic diversity in the region are *Artocarpus*, *Mangifera*, *Buchanania*, *Syzygium*, *Aegle*, *Emblica* (indigenous) and *Annona*, *Tamarindus*, *Carica*, *Phoenix* (exotic, naturalised). Climatically, the region has been classified as semi-humid sub-tropical which receives rains throughout the year with maximum concentration during June to September. The average annual rainfall of the region varies between 1200-1600 mm. The region has red-yellow and light gray category of soils which are acidic in nature and contains low organic matter with poor water holding capacity. Undulating topography and slopes invariable coupled with high rainfall aggravates the problem of soil erosion in the region. High rainfall and warm climate has built up a thick forest cover on about 30% land area in the region. These forests have high degree of genetic variability in fruits, vegetables and medicinal plants which require due attention for their conservation. As a predominately tribal area, the main occupation of people in Santhal Pargana is agriculture. However, they are

also utilising the natural horticultural species for their livelihood and thus, promoting their *in situ* conservation. Considering the immense potential of various horticultural species, a mission mode project has been launched to collect and conserve the horticultural biodiversity of the region under the National Agricultural Technology Project.

Materials and Methods

A joint exploration was undertaken in collaboration with Central Horticultural Experiment Station (IIHR), Ranchi and National Bureau of Plant Genetic Resources, New Delhi during second fortnight of May, 2000. A total of 9 districts viz. Deoghar, Banka, Dumka, Pakud, Shebganj, Bhagalpur, Godda, Dhanbad, Bokaro and Hazaribagh (Santhal Parganas) and adjoining areas were surveyed for various fruit species. Genetic variability of five fruit species (*Artocarpus*, *Syzygium*, *Aegle*, *Tamarindus* and *Annona*) were critically studied and promising genotypes identified for various horticultural traits. High, medium and low degree of diversity in these species were categorised depending upon the population of species at particular diversity site. Individual plants were selected on the basis of useful horticultural traits in each species. Detailed observations were recorded in jack fruit, which is one of the most important multipurpose plant of the region. Quantitative observations on average number of fruits, fruit length, fruit circumference and fruit weight in each genotype were recorded. The qualitative observations on plant growth habit, foliage characters and appearance of the fruits were also recorded. Information pertaining to ethnobotanical knowledge, their utilization pattern, Indigenous Technical Knowledge (ITK), pattern of cultivation and conservation, were documented.

Results and Discussion

The Santhal Pargana region has rich genetic stock of jack fruit, custard apple, tamarind, bael, jamun and wild dates. Rai and Gupta (1996) have also mentioned the natural biodiversity of these species in plateau region of Bihar. During the exploration, high degree of diversity in various horticultural crops have been observed at different sites. Extent of diversity in some important

crops have been presented in Table 1. Jack fruit has low to high degree of diversity at all the sites in the region. Custard apple is concentrated mainly in Dumka, Pakur and adjoining areas of Sahebganj and Godda. *Jamun*, *bael*, tamarind and *chiroji* have sporadic and localised distribution in the region (Table 3). Variability pattern of the germplasm and its various uses by the local community are described below:

Table 1. Diversity distribution of fruit crops in Santhal Parganas

Name of village	Block/District	Available fruit plant					
		Jackfruit	Bael	Tamarind	Custard	Apple	Jamun
Jogia	Mohanpur, Deoghar	++	+	+	-	-	-
Narayanpur	Jaipur, Banka	++	-	-	+	-	-
Naya Lohmadwa	Sariya Hat, Dumka	+++	+	+	-	-	+
Nawa Deeh	Sariya Hat, Dumka	++	+	-	+	-	++
Nani Hat	Jama, Dumka	++	-	-	+	-	+
Baraplasi	Jama, Dumka	+++	+	+	+	-	-
Kukurtava	Kukka, Dumka	+++	+	++	++	-	+
Negbeel	Dumka, Dumka	++	++	-	+	-	++
Jhurkund	Kumka	++	-	++	++	-	+
Kathikund	Dumka	++	-	+	++	-	-
Gopi Kandar	Dumka	+	-	+	+	-	++
Durgapur	Di,la	++	++	++	++	-	+
Amrapada	Pakud	++	-	++	+++	-	++
Fathepur	Pakud	+	-	+	++	-	++
Salpatra	Pakud	+	-	+	+++	-	+
Paderkola	Pakud	++	-	+	++	-	+
Surajpada	Littipad, Pakud	++	+	++	+++	-	+
Hiranpur	Littipad, Pakud	+++	-	-	++	-	-
Dharmapur	Littipad, Pakud	+++	++	++	+	-	++
Barhet	Littipad, Pakud	++	-	-	++	-	++
Mirzapur	Sahebganj	+	++	+	-	-	++
Mirzachawki	Bhagalpur	+	++	-	-	-	-
Pathargama	Godda	-	-	++	-	-	+
Bhatdeeha	Godda	++	-	+	-	-	+
Marcee Hospital	Pauraiyahat, Godda	+++	-	-	-	-	-
Kudwa	Dumka	++	-	-	+	-	-
Gujsemal	Dumka	++	-	++	++	-	-
Pattabadi	Dumka	++	+	-	++	-	++
Kushpahadi	Dumka	+++	++	++	++	-	++
Barmasia	Shikaripada, Dumka	+++	++	+	+++	-	+
Shikaripada	Dumka	++	-	+++	++	-	++
Nishchintpur	Dumka, Dumka	++	+	-	++	-	-
Mashalia	Mashalia, Dumka	++	-	+	+	-	+
Shikarpur	Dumka	-	-	+	+++	-	-
Heraljori	Dumka	++	-	+	++	-	-
Tehsuriya	Kundhat, Dumka	+	+	++	-	-	++
Sudarpur	Nala, Dumka	+	+	-	-	-	-
Guhajori	Nala, Dumka	+	-	-	-	-	-
Novadech	Jamtara, Dumka	+++	-	-	++	-	+
Ratanpur	Govindpur, Dhanbad	++	+	-	-	-	-
Balideeh	Bokaro	+	-	-	-	-	-
Ramgarh	Hazaribagh	+	-	+	-	-	+

+++ = High variability; ++ = Moderate variability; + = Low variability; - = Variability not observed

Biodiversity of Jack Fruit

Jack fruit is the most common and wide spread species in Santhal Pargana region. Plant population per unit area of the species is inversely proportional to the overall development of the particular site. The sites with well developed agriculture have low plant population as in case of Gopi Kandar (Dumka), Salpatra (Pakud), Mirzapur (Sahebganj), Mirzachawki (Bhagalpur) and Balideeh (Bokaro). In contrast, area having mixed cropping pattern, and closer to the consumption/disposal centers (towns), the plant population of jack fruit is very high. For example, Naya Lohmadwa which is located about 20 km from Deoghar has high concentration of jack fruit. This area has on an average 10-15 jack fruit plants per hectare particularly on the bunds of fields. Usually mixed cropping with maize, turmeric, pigeon pea and some upland paddy is commonly practiced. During the exploration it was observed that the barren and uncared lands also have low population of jack fruit trees e.g. Tehsuriya and Sundarpur (Dumka) and Ramgarh (Hazaribagh).

The jack fruit is a cross pollinated species and predominantly propagated by seed, which has resulted in high range of genetic diversity. Melanha (1998) mentioned that jack fruit is an ancient fruit of India which grows throughout the tropics on variety of soils. Rana (1993) mentioned rich diversity of jack fruit in India. Arora (1998) also reported diversity of *Artocarpus heterophyllus* in Western Ghats and central-east tribal region of the country. On the basis of maturity period, the jack fruit genotypes have been locally classified as *Jethua* types (matures early) and *Sawania* type (late maturing) apart from very late type called *Bhadonha*. Considering the use options, the jack fruit genotypes have been grouped as table type (ripe fruits) and vegetable and pickling type (raw). Diversity was observed with respect to tree characters, fruiting behaviour, fruit characters and yield performance among the genotypes. Upright to spreading trees with dense to sparse foliage have been observed in the region (Table 2 and 2a). The fruit length has been recorded between 20.8 to 80.0 cm, circumference from 19.5 to 78.5 cm and fruit weight from 3.5 to 4.50 kg among the identified genotypes. Characters like fruit colour, shape, uniformity and pattern of tubercles varies among genotypes. Yield/tree is a factor of fruit number and weight of fruits on a particular tree which also varies among the genotypes.

Biodiversity of Custard Apple

Natural population of custard apple is available throughout the Santhal Pargana. However the high concentration has been observed at Shikaripada, Shikarpur and Durgapur in Dumka district and Amrapada, Salpatra, Surajpada in Pakud district. In general, the plants are more prevalent in undisturbed forests and groves. Population density of custard apple varies from site to site in explored areas. In forest area of Shikaripada as many as 70-80 natural plants per hectare of custard apple were seen. The plant develops multistem which flowers during April-May. Ripening of fruit takes place during September-October. Some early types ripens even during mid of August. Rai and Gupta (1996) mentioned diversity distribution of *Annona* in eastern peninsular region of country. Arora (1985) and Pareek and Sharma (1993) mentioned variability of custard apple in India. Pareek and Vishal Nath (1996) enumerated that although custard apple was introduced to India but it has developed considerable variability in warmer and humid part of the country.

Biodiversity of Bael

Santhal Pargana region has sporadic distribution of bael (*Aegle marmelos* Corr.). Bael is an indigenous fruit having medicinal importance and its rich distribution has been recorded in warmer parts of the country particularly in Vindhayan hills (Rai *et al.*, 1991; Pareek *et al.*, 1998). In the present exploration, scattered population of bael was noticed in all the tribal districts of the region. Among the available diversity, plants have shown variability with respect to tree height, foliage pattern and fruit characteristics. A total of 7 genotypes have been collected from different exploration sites (Table 2). Rai *et al.*, (1991) and Rai and Gupta (1996) reported high degree of phenotypic variability in wild bael available in north-central and eastern parts of the country.

Biodiversity of Jamun

Jamun (*Syzygium cumini*) is a native fruit of India (Sham Singh *et al.*, 1967), possesses high medicinal value and grown all over the country (Rai and Gupta, 1996). However, Indo-Gangetic plain of north and eastern India has maximum diversity (Irulappam and Anbu, 1994). Santhal Pargana region which is very close to gangetic plain of Bihar also has considerable plant population and rich diversity in tree and fruit morphological characteristics in jamun. During the present survey, 3 genotypes having larger fruit, sweet pulp and more edible

Table 2. Tree characteristics and fruit appearance of jackfruit selections from Santhal Parganas

Accession (collectors no.)	Plant growth habit	Canopy characters	Foliage density	Fruit colour	Fruit shape	Unifo -rimity	Distribution of tubercles
VN/BS-J0	Upright	Less spreading	Sparse	Yg	Eo	U	Ts
VN/BS-J1	Vigorous	Highly spreading	Sparse	Yg	R	U	Ts
VN/BS-J2	Vigorous	Highly spreading	Dense	G	R	U	Td
VN/BS-J3	Vigorous	Highly spreading	Dense	Yg	O	U	Ts
VN/BS-J4	Less vigorous	Less spreading	Sparse	G	O	U	Ts
VN/BS-J5	Vigorous	Highly branched	Dense	Yg	E	U	Td
VN/BS-J6	Vigorous	Branched	Dense	G	O	U	Td
VN/BS-J7	Vigorous	Branched	Mid-dense	G	L	U	Td
VN/BS-J8	Less vigorous	Med. Spreading	Mid-dense	G	L	U	Td
VN/BS-J9	Less vigorous	Less branched	Sparse	G	MI	U	Ts
VN/BS-J10	Less vigorous	Branched	Dense	G	L	U	Ts
VN/BS-J11	Upright	Less spreading	Dense	G	L	U	Ts
VN/BS-J12	Vigorous	Spreading	Dense	Yg	L	U	Ts
VN/BS-J13	Vigorous	Spreading	Dense	Yg	L	U	Ts
VN/BS-J14	Less vigorous	Med. Spreading	Mid-dense	Yg	R	U	Ts
VN/BS-J15	Vigorous	Highly spreading	Dense	Yg	O	U	Ts
VN/BS-J16	Vigorous	Highly spreading	Dense	Yg	O	U	Ts
VN/BS-J17	Less vigorous	Spreading	Dense	Yg	O	U	Ts
VN/BS-J18	Vigorous	Less branched	Sparse	Yg	R	U	Ts
VN/BS-J19	Vigorous	Spreading	Dense	G	L	U	Td
VN/BS-J20	Upright	Med. Spreading	Dense	G	L	U	Td
VN/BS-J21	Vigorous	Spreading	Mid-dense	Yg	R	U	Ts
VN/BS-J22	Vigorous	Less spreading	Dense	G	L	U	Ts
VN/BS-J23	Vigorous	Less spreading	Dense	G	L	U	Td
VN/BS-J24	Less vigorous	Less spreading	Mid-dense	Yg	R	U	Ts
VN/BS-J25	Vigorous	Highly spreading	Mid-dense	Yg	R	U	Ts
VN/BS-J26	Med. vigorous	Med. Spreading	Dense	Yg	MI	U	Ts
VN/BS-J27	Med. vigorous	Med. Spreading	Dense	Yg	L	U	Ts
VN/BS-J28	Less vigorous	Med. spreading	Sparse	Yg	L	U	Ts
VN/BS-J29	Vigorous	Spreading	Mid-dense	Yg	R	U	Ts
VN/BS-J30	Vigorous	Spreading	Dense	G	R	U	Ts
VN/BS-J31	Less vigorous	Less spreading	Sparse	Yg	O	U	Ts
VN/BS-J32	Tall	Less spreading	Sparse	Yg	O	U	Ts
VN/BS-J33	Tall	Less spreading	Dense	G	O	B	Td
VN/BS-J34	Vigorous	Highly spreading	Dense	Yg	L	U	Ts
VN/BS-J35	Vigorous	Highly spreading	Dense	Yg	O	U	Ts
VN/BS-J36	Med. vigorous	Less spreading	Mid-dense	Yg	O	U	Ts
VN/BS-J37	Med. vigorous	Spreading	Dense	yg	O	U	Ts
VN/BS-J38	Less vigorous	Less spreading	Dense	Yg	O	U	Ts
VN/BS-J39		Spreading	Sparse	Yg	Eo	U	Ts

Fruit Colour : Yg-Yellowish green, G-Greenish

Fruit Shape : Eo-Elongated oblong, R-Roundish, O-Oblong, E-Elongated, L-Long, MI-Medium long

Uniformity : U-Uniform, B-Brown

Distribution of tubercles : Ts-Tubercles spreading, Td-Tubercles dense

* Bunching type; *** Precocious and prolific bearer; ^ High bearing, early type fruiting in bunch; ^B Late maturing type

portion have been identified. In general, the region does not have systematic plantation of jamun but its plants are quite visible at community lands, road sides and in house yards.

Biodiversity of Tamarind

Tamarind (*Tamarindus indica* L.) is a hardy fruit tree which flourishes well under extremes of odd conditions

like degraded, eroded, gravely land with uneven rainfall. Although it is a naturalised crop in India but wide variability has been reported in different parts of the country (Pareek and Vishal Nath, 1996). In the surveyed area sporadic population of tamarind have been observed. Old seedling plantations along the road side are quite common. Being cross pollinated (Thimmaraju *et al.*,

Table 2(a). Fruit characters of jack fruit genotypes from Santhal Parganas

Genotype Collector (nos.)	Average fruit number	Fruit length(cm)	Fruit circumference (cm)	Average fruit weight (kg)
VN/BS-J1	23.00	47.50	55.00	30.67
VN/BS-J2	125.00	40.00	65.70	35.00
VN/BS-J3	113.00	32.50	48.00	13.50
VN/BS-J4	48.00	45.00	53.50	32.50
VN/BS-J5	48.00	38.50	54.00	16.50
VN/BS-J6	84.00	43.00	57.30	36.00
VN/BS-J7	83.33	45.43	52.40	27.50
VN/BS-J8	62.67	50.50	50.70	30.00
VN/BS-J9	73.67	48.00	43.60	15.50
VN/BS-J10	44.67	40.50	38.00	20.00
VN/BS-J11	53.67	45.50	38.50	30.50
VN/BS-J12	22.33	40.50	30.00	20.50
VN/BS-J13	125.00	52.30	57.80	32.80
VN/BS-J14	73.67	60.00	59.50	35.00
VN/BS-J15	17.33	37.20	38.00	27.30
VN/BS-J16	158.33	60.80	59.70	28.00
VN/BS-J17	43.67	61.20	58.00	32.00
VN/BS-J18	113.67	30.50	28.70	15.00
VN/BS-J19	74.33	25.80	24.90	6.70
VN/BS-J20	54.33	30.33	28.00	14.80
VN/BS-J21	43.67	49.80	45.33	22.00
VN/BS-J22	60.00	52.00	48.20	25.50
VN/BS-J23	125.00	55.00	50.60	32.00
VN/BS-J24	72.67	70.90	65.40	36.40
VN/BS-J25	39.33	58.50	54.60	25.00
VN/BS-J26	155.00	65.00	67.50	42.00
VN/BS-J27	13.00	35.60	34.70	15.50
VN/BS-J28	94.33	70.20	68.50	27.70
VN/BS-J29	57.00	69.50	65.20	21.83
VN/BS-J30	33.00	25.00	27.50	11.20
VN/BS-J31	336.67	20.80	19.50	3.50
VN/BS-J32	112.67	32.50	30.80	8.50
VN/BS-J33	5.00	80.00	78.50	45.00
VN/BS-J34	113.33	50.50	48.30	17.20
VN/BS-J35	32.67	48.30	47.50	20.00
VN/BS-J36	105.00	62.80	60.50	30.20
VN/BS-J37	38.00	70.30	65.20	25.30
VN/BS-J38	45.00	40.80	38.70	15.30
VN/BS-J39	65.00	52.90	50.70	20.90
VN/BS-J40	125.00	69.70	63.70	57.80
VN/BS-J41	4.64	0.85	0.50	0.98
VN/BS-J42	13.07	2.40	1.42	2.78
VN/BS-J43	10.30	3.02	1.77	6.84
Sem±	4.64	0.85	0.50	0.98
CD at 5%	13.07	2.40	1.42	2.78
CV%	10.30	3.02	1.77	6.84

* Bunching type; ** Early type; *** Precocious and prolific bearer; A High bearing, early type fruiting in bunch; B Late maturing type

1977) and wider adaptability, its dense plant population has been observed in undisturbed lands, pasture lands and on the bunds of open depressions. High population of tamarind has been observed at Guji Semal village near ponds on bund. It is general believe of the people of the region, that only fallen fruits of tamarind should be used. Three promising genotypes of tamarind have

been identified on the basis of fruit character and bearing performance.

Biodiversity of Chiroji

Chiroji (*Buchanania langeni*) is native to Central India and Bundel Khand region (Gupta *et al.*, 1996). During the exploration, scattered to medium dense distribution on the marginal land particularly in community places,

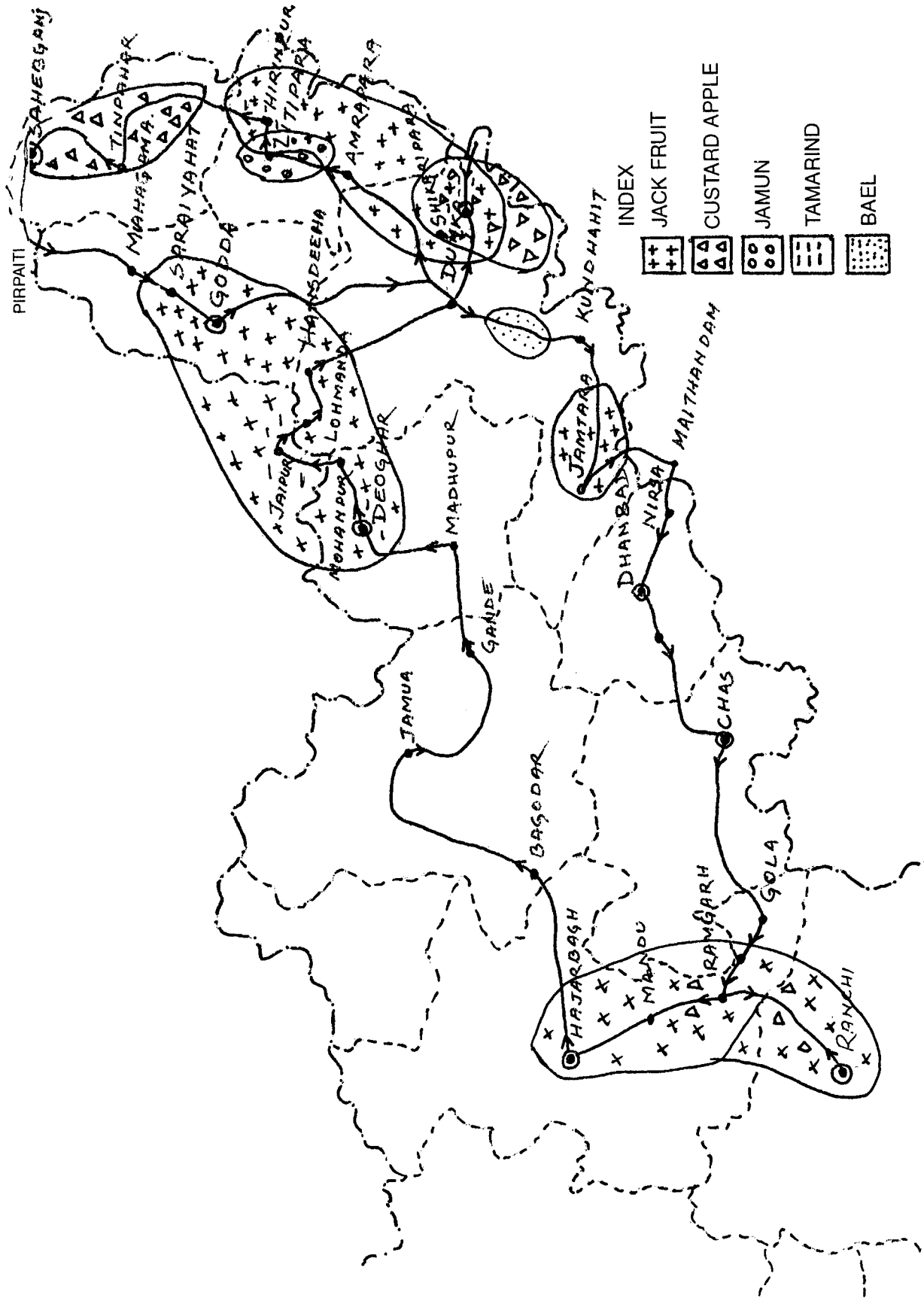


Fig. 1. Diversity of Under Utilized Fruit Crops in Santhal Pargana

undisturbed hill slopes and forest area was observed. It is one of the minor indigenous fruit that grows in natural habitat particularly in tropical region in specific pocket and possesses narrow genetic base for its fruits and tree morphological characteristics. It is one of the dry nut, known for its high nutritive value and used in garnishing sweets and dishes.

Distribution of Genetic Diversity and Collection Priority

The genetic diversity as a result of long history of cultivation, continuous sexual propagation and development of superior genotypes through conscious and unconscious selection by the farmers is eroding fast due to shrinkage of resources, deforestation,

urbanisation and introduction of new crops and improved varieties. The genetic diversity of some of the fruits of the Santhal Parganas of Jharkhand, their distribution and collection priority has been listed in Table 3.

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Table 3. Fruit characters of jack fruit genotypes from Santhal Parganas

Crop/species	Diversity status	Diversity distribution	Erosion status	Collection
Mango	Rich	Wide spread	Medium	High
Jack fruit	Rich	Wide spread	High	High
Custard apple	Medium	Wide spread	Medium	Medium
Bael	Rich	Sporadic	Medium	High
Aonla	Medium	Wide spread	Medium	High
Guava	Medium	Medium	Fast	High
Jamun	Medium	Sporadic	Medium	High
Tamarind	Rich	Sporadic	High	High
Banana	Localised	Medium	Low	Medium
Chiroji	Localised	Less	Fast	High
Barhal	Localised	Wide spread	High	High
Wild dates	Rich	Medium	Medium	Medium
Wild ber	Rich	Wide spread	Medium	Medium

References

- Arora RK (1985) *Genetic Resources of Less Known Cultivated Food Plants*. NBPGR Sci. Mongr. 9: National Bureau of Plant Genetic Resources, New Delhi.
- Arora RK (1998) Genetic resources of native tropical fruits in Asia: Diversity, distribution and IPGRI's emphasis on their conservation and use. In: RK Arora and VR Rao (eds.), *Tropical Fruits of Asia-Diversity, Maintenance, Conservation and Use*. IPGRI Office for South Asia, New Delhi, pp 42-53.
- Gupta PN, Rai M and Chandel KPS (1996) *Genetic Resources of Tropical Fruit Collection, Evaluation and Conservation*. NBPGR, New Delhi.
- Irulappan I and S Anbu (1994) Under exploited tropical fruit trees with promising economic value. In: PK Thampan (eds.), *Trees Farming*. Peckay Tree Crops Development Foundation, Cochin, pp 205-235.
- Melanha KR (1998) Genetic variability, characterisation and utilization of germplasm in jack fruit. In: RK Arora and VR Rao (eds.), *Tropical Fruits of Asia-Diversity, Maintenance, Conservation and Use*. IPGRI Office for South Asia, New Delhi, pp 207-208.
- Pareek OP and S Sharma (1993) Underutilised fruits. *Indian Hortic.* 38: 48-49.
- Pareek OP and Vishal Nath (1996) *Coordinated Fruit Research in India Arid Zone: Two decades profile*. National Research Centre for Arid Horticulture, Bikaner.
- Pareek OP, S Sharma and RK Arora (1998) Underutilized edible fruits and nuts-An Inventory of genetic resources in their regions of diversity. IPGRI office (S.Asia), New Delhi, 79-106.
- Rai M, R Dwivedi and PN Gupta (1991) Variability and potentials of identified germplasm of bael (*Aegle marmelos* Corr.) *Indian J. Plant Genet. Resour.* 4: pp 86-92.
- Rai M and PN Gupta (1996) Distribution and diversity of indigenous tropical fruits. In: PN Gupta, Mathura Rai and KPS Chandel (eds.), *Genetic Resources of Tropical Fruits - Collection, evaluation and conservation*, NBPGR, New Delhi, pp 21-43.
- Rana RS (1993) *Indian National Plant Genetic Resources System*. In: RS Rana, RK Saxena, Sanjeev Saxena and Vivek Mitter (eds.), *Conservation and Management of Plant Genetic Resources*. NBPGR, New Delhi, pp 1-18.
- Sham Singh, S Krishnamurthy and SL Katyal (1967) *Fruit culture in India* (Revised edition). Indian Council of Agricultural Research, New Delhi.
- Thimmaraju KR, MAN Reddy, N Swamy and UV Sulladmath (1977) Studies on the floral biology of tamarind (*Tamarindus indica* L.). *Mysore J. Agric. Sci.* 11: 293-298.