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Probable Agricultural Biodiversity Heritage Sites in India: XIV. The Chotanagpur Plateau Region

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Abstract

The Chotanagpur Plateau in eastern India is a geohistorically unique region, being the oldest landmass on the earth. Agriculture has been practiced in this region from the ancient times, and appears to be an extension of the Ganga basin agriculture. Being the link between the Eastern Himalayas and the Satpura Hills with transitional ecology, the region has functioned as the passage for migration of flora and fauna from the Indo-Malayan region to peninsular India. For these reasons, it is very rich in floristic diversity and endemism of species. The region is dominated by tribal populations, including ancient tribes such as the Oraons, who are involved in diverse agricultural activities, starting from hunting-gathering of forest products, fishing, and livestock rearing to settled agriculture. The region can be credited for evolving farming/production systems suited to different toposequences in slopy terrain, such as rice-based efficient production systems, pulse-based mixed cropping systems, facilitating conservation of soil fertility and efficient use of water and genetic diversity, such as early maturing and drought-resistant gora *varieties in rice, the Chotanagpuri sheep breed in animals, and production of cottage products such as* tasar *silk (along with Chhattisgarh), etc. The present article discusses these contributions of the region, proposing it to be another national agricultural biodiversity heritage site based on the established indices.*

The Chotanagpur region is a plateau in eastern India, covering much of the recently created Jharkhand state, as well as the bordering areas of Orissa, West Bengal, Bihar, and Chhattisgarh. The Gondwana substrates attest ancient origin to the plateau. Geohistorically, it was part of the Deccan Plate, which broke free from the southern continent during the Cretaceous period to embark upon a 50-million-year journey that was violently interrupted by the northern Eurasian continent. Climatically, the Chotanagpur region receives less rainfall than the adjacent ecoregions, which explains its drier vegetation. However, it does include patches of moist deciduous forests and swampy areas, thereby offering diverse ecologies for agriculture. The region derives its name probably from the *Nagavanshis*, who ruled in this part of the country, and Chutia, a village on the outskirts of Ranchi, which has the remains of an old fort belonging to the Nagavanshis. The name of the newly created state of Jharkhand, which covers the major part of the plateau, is derived from

the domination of scrub vegetation, locally called '*jharies*'.

Agriculture in the region is very old, as the earliest settlements of the Chalcolithic period extended from the Ganga basin to the Chotanagpur Plateau. Limited numbers of bronze and copper tools have been recovered, reflecting that agriculture was practiced from the times of early human settlement. The economy of the region from this period onwards was exclusively based on agricultural components, such as stock raising, hunting, fishing, etc., in addition to conventional field agriculture involving most of the population. On the basis of latitude, the plateau can be divided into three steps, each providing diverse ecology for adoption of different agroecosystems, thereby evolving both diverse production systems and important genetic diversity in the important commodity crop species cultivated in sloping terrain; for example, early maturing and drought-resistant *gora* rice varieties, breeds such as the Chotanagpuri sheep, and the use of local biodiversity in cottage products such as *tasar* silk and *lakh* (lac). Thus, the region being the oldest landmass on the earth with geohistorical uniqueness, rich floristic diversity containing components of both the northern and the southern hemispheres, practice of agriculture from the ancient times involving majority of the people, significant contributions in the development of farming systems, practices and products such as various mixed and intercropping systems and evolving valuable genetic diversity in component crops facilitating subsistence agriculture, and natural resources management under the fragmented sloping landscape, the Chotanagpur plateau is being proposed as another agricultural biodiversity heritage site, based on the indices illustrated by Singh and Varaprasad (2008).

Location and extent

Ecologically, the Chotanagpur region lies between the moist deciduous forests of the Eastern Ghats and the Satpura Range and the lower reaches of the Gangetic Plains in eastern India, extending across the states of Bihar, Chhattisgarh, and West Bengal. The Chotanagpur plateau is one of the oldest landmasses on the earth. It is composed of Precambrian rocks that are more than 540 million years old. The plateau in its entirety lies between the basins of the Ganges and the Son Rivers to the north, and the Mahanadi River to the south. To the north of Chotanagpur lie the Rajmahal Hills, which are very important on account of their fossiliferous deposits (containing knowledge about the richness of floristic diversity, phylogeny and plant evolution). To its west lie the highlands of Chhattisgarh and the districts of Uttar Pradesh. Biogeographically, the Chotanagpur plateau has a special significance, as it forms the northern limit of Peninsular India that lies within the Paleotropic region. Rodgers and Panwar (1988), in their biogeographic classification

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of India, recognized this plateau as part of province 6B (Deccan peninsula).

Thus, the Chotanagpur region constitutes the southern and eastern plateau of Jharkhand and contiguous districts in Orissa and West Bengal. Administratively, it comprises all the southern districts of Jharkhand, districts of Purulia and part of Bankura and western Medinapur district of West Bengal, and the Mayurbhanj and Sundargarh districts of Orissa. The other districts of the region include Singhbhum, Gumla, Ranchi, Lohardaga, Palamu, and Hazaribagh, and Santhal Pargana of Jharkhand (Fig. 1).

Landscape

The region has undulating topography presenting a highly dissected landscape of small hillocks and mounds. The dominant landscape in the area is represented by moderate to gentle slopes with numerous streams dissecting the uplands into a peneplain (an area reduced almost to a plain by erosion) with isolated hills (Fig. 2). On the basis of altitude, the plateau is divided into three steps – the highest step is in the western part of the plateau, called pats (900–1,100 m); the next part contains larger portions of the old Ranchi

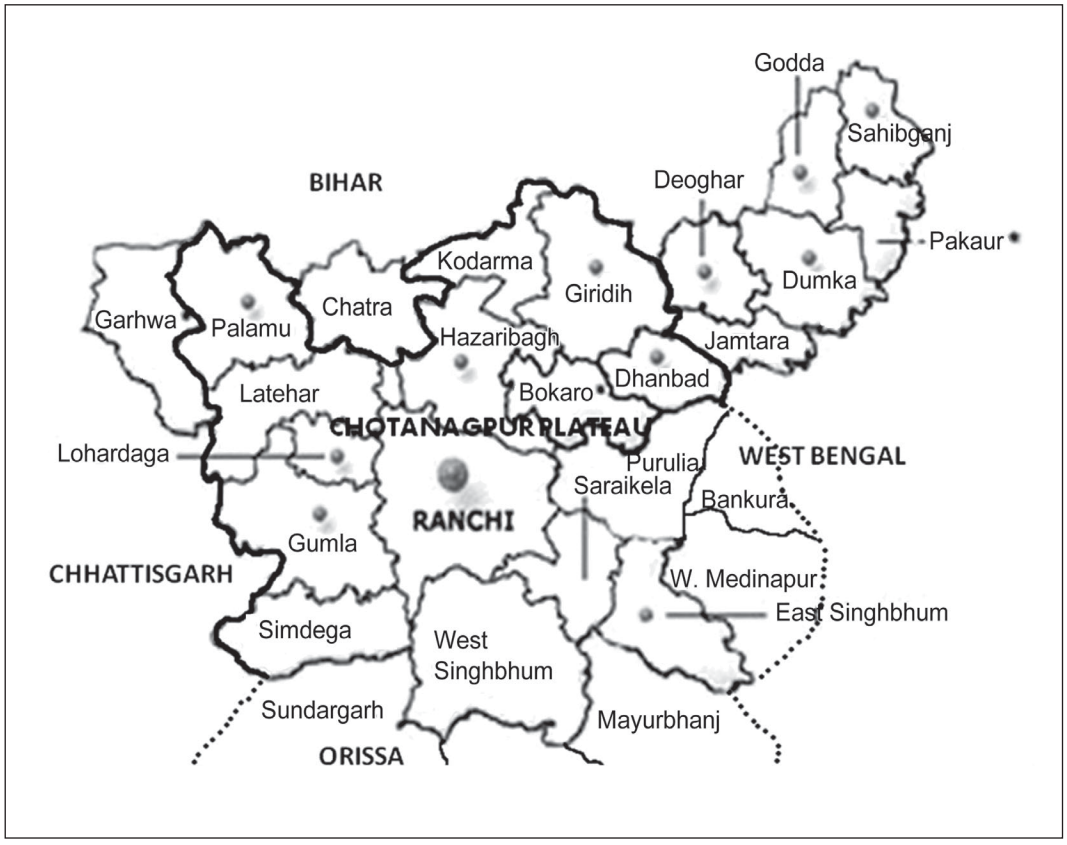

Figure 1. Location and extent of the Chotanagpur Plateau (dark solid line in Jharkhand, and dotted line in Orissa and West Bengal).

Figure 2. The exotic landscape of the Chotanagpur plateau (Source: soumya9. blogspot.com).

and Hazaribagh districts and some parts of old Palamu district (600 m); and the lowest step covering districts of old Manbhum (Purulia) and Singhbhum with an average height of 300 m.

The pat region is also referred to as the Western Ranchi Plateau, and is believed to be composed of Deccan lava. The next part of the Ranchi plateau gradually slopes down towards the southeast into the hilly and undulating region of Singhbhum and is highly dissected. The Damodar River originates from here and flows through a rift valley. There are many waterfalls on the edges of the Ranchi plateau, where rivers coming over the plateau surface, form waterfalls when they descend through the precipitous escarpments of the plateau, and enter the area of significantly lower height. The Hazaribagh plateau is often subdivided into two parts – the higher plateau and the lower plateau. The higher is referred as the Hazaribagh plateau, and the lower as the Koderma plateau. It is generally separated from the Ranchi plateau by the Damodar River trough (narrow channel). The western portion of the Hazaribagh plateau constitutes a broad watershed between the Damodar drainage on the south and the Lilajan and Mohana rivers on the north. The Damodar basin forms a trough between the Ranchi and Hazaribagh plateaus resulting from enormous fractures at their present edges, which caused the land between to sink to a great depth, and incidentally preserved from denudation, the Karanpura, Ramgarh and Bokaro coalfields. Further, to the east, the Damodar River passes tamely into the Manbhum sector, the lowest step of the Chotanagpur plateau (Purulia). In the west, the Palamu division generally lies at a lower height than surrounding areas. On the east, the Ranchi plateau intrudes and the southern part of the division merges with the pat region. Also, on the west are the Surguja highlands of Chhattisgarh and Sonbhadra district of Uttar Pradesh. The Lodh Falls drop from a height of 140 m of these hills, making it the highest waterfall on the Chotanagpur Plateau. The Netarhat and Pakripat plateaus are physiographically part of the pat region. Therefore, in the lowest step of the Chotanagpur Plateau, the

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Manbhum area covers the present Purulia district in West Bengal, and Dhanbad district and parts of Bokaro district of Jharkhand. The Singhbhum area contains much more hilly and broken country, with hills alternating with valleys, steep mountains, deep forests on the mountain slopes and some stretches of comparatively leveled or undulating landscape in the river basins.

Agroclimate

The climate of the plateau is humid and sub-humid, characterized by hot summers and cool winters. Basically, the climate is tropical monsoon type with three distinct seasons: summer (March to mid June), monsoon (mid June to October), and winter (November to February). May is the hottest month with the temperature going up to 45°C. During May and June, the state also experiences hot winds known as the *loo*. January is the coldest month with temperatures ranging from 6°C to 22°C. Likewise, the humidity varies from 38% (April–May) to 94% (August–September). On the basis of the ratio of total monthly precipitation and total monthly evaporation, Thornthwaite (1933) placed the region under dry sub-humid category. The average rainfall varies between 1,000 mm and 1,600 mm, while the potential evapotranspiration (PET) is 1,400 to 1,600 mm leading to a short dry moisture regime. The annual rainfall is sufficient for 80% of the annual PET ensuring moisture availability for a growing period ranging between 150 and 180 days (up to 210 days in some places) in a year. The soil is dry for more than 90 days. The mean annual soil temperature is more than 22°C.

The plateau has predominantly red soil that is derived from peculiar rock formations. The common soils are red and yellow, fine loamy to clayey, non-calcareous with slight to moderate acidic in reactions. This soil exhibits a high percentage of acid-soluble ferric oxide and lower pH ranging from 5 to 6.8. The soils of the region mainly consist of components formed from disintegration of rocks and stones, and on this basis can be divided into: red soil, found mostly in the Damodar valley, and the Rajmahal area; micacious soil (containing particles of mica), found in Koderma, Jhumeritilaiya, Barkagaon, and areas around the Mandar hill; sandy soil, generally found in Hazaribagh and Dhanbad; black soil, found in the Rajmahal area; and laterite soil, found in the western part of Ranchi, Palamu and parts of Santhal Parganas and Singhbhum, and some higher parts of the plateau. The climate of Koderma is a transition type between the dry and moderately extreme climate of northern India and the warm, humid climate of the Bengal Basin. The laterite soil being acidic in nature is not suitable for traditional agriculture and is referred as *usar* land.

There are two sets of rivers flowing in the region, rivers flowing from the southern part of the Chotanagpur plateau and the rivers flowing from the Chotanagpur plateau towards the north. Damodar, Barakar, Koel, and Suvarnarekha are the principal rivers of the region that largely contribute towards the agriculture in the region.

Floristic diversity

The region is very rich in floristic diversity because of its past geological history. It is

believed that in the geological past, this plateau formed a link between the Satpura Hill Ranges and the Eastern Himalaya that allowed species exchanges between these ranges (Hora, 1949). Plants from the Eastern Himalayas, Assam, Myanmar, Malay Peninsula and other countries of Southeast Asia migrated from here to the Eastern and Western Ghats and Sri Lanka. Jharkhand is even recognized as a distinct geographic region (IND-JK) in the Indian subcontinent by the Royal Botanic Gardens, Kew (Brummitt, 2001).

The forest vegetation of the Chotanagpur Plateau is represented by three major groups as per the classification by Champion and Seth (1968): (i) Tropical Moist Deciduous Forests (3C/C3a and 3C/E1); (ii) Northern Tropical Dry Deciduous Forests (5B/C1c, 5B/C2, and 5/DS2); and (iii) Central Indian Subtropical Hill Forests (8A/C3). The total vegetation cover on the plateau is about 29.61%. Of this, 3.19% area is under very dense forest cover whereas 11.39% has moderately dense forests, 13.76% has open forests, and 0.92% area has scrubland.

The general vegetation comprises of tropical dry deciduous and moist deciduous forests and is characterized by *sal* (*Shorea robusta* C.F. Gaertn.), usually in association with *bael* [*Aegle marmelos* (L.) Correa ex Roxb.], *dhautha* [*Anogeissus latifolia* (Roxb.) Bedd], *palas* [*Butea monosperma* (Lam.) Taub.], *mohua* [*Madhuca indica* J.F. Gmel.; syn. *M. longifolia* Macbride var. *latifolia* Roxb. A.Chev. (=*Bassia latifolia* Roxb.)], *Diospyros melanoxylon* Roxb., *Dillenia pentagyna* Roxb., *Schleichera oleosa* (Lour.) Oken, *Syzygium cuminii* (L.) Skeels, *Lagerstroemia parviflora* Roxb., *Pterocarpus marsupium* Roxb., and *Symplocos racemosa* Roxb.

At higher altitudes, there are shola-type forests characterized by *Phoenix robusta* Hook.f., *Pterospermum acerifolium* Benth., and *Clematis nutans* Royle; new name *C. roylei* Rehder. (Davis *et al.,* 1995). The ecoregion also includes patches of moist deciduous forests and swampy areas, with several interesting plant species such as *Syzygium cuminii, Manilkara hexandra* Dubard, *Ficus* L. spp., and *kamala* or *kamopillaka* [*Mallotus philippensis* (Lam.) Muell.] that are typical of moist deciduous forests.

The dry deciduous forests are typically composed of three stories, with an upper canopy reaching 15–25 m, a high understory at 10–15 m, and an undergrowth at about 3–5 m. The vegetation is characterized by *Shorea robusta,* usually in association with *Anogeissus latifolia, Terminalia alata* Herb. Madr. ex Wall, *Lagerstroemia parviflora, Pterocarpus marsupium, Aegle marmelos, Syzygium operculatum* (Roxb.) Nied. (syn. *S. nervosum* DC.), *Symplocus racemosa,* and *Croton oblongifolius* Roxb. (Puri *et al.,* 1989; Davis *et al.,* 1995). Lianas (woody vines) are common in dense forests. A dry deciduous scrub that grows to about 3–6 m in height is another common habitat. This scrub includes bamboo and shrubs, such as *Holarrhena* R.Br. spp. and *Dodonaea* Mill. spp. (Puri *et al.*, 1989).

The **Parasnath hills** of the region with montane subtropical forests have *Pittosporum wightii* A.K.Mukh., *Grewia* L.

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spp., *Meyna spinosa* Roxb. ex Link, *Berberis asiatica* Roxb. ex. DC., *Reinwardtia indica* Dum, *Thalictrum foliolosum* DC., *Polygala* L. spp., *Lobelia alsinoides* Lam., *L. heyneana* Roem. & Schult., *Clematis gouriana* Roxb. ex DC., etc., above 1,220 m. The areas between 650 m and 1,220 m are dominated by *Litsea monopetala* (Roxb.) Pers. (syn. *Tetranthera monopetala* Roxb.), Chinese banyan tree (*Ficus microcarpa* L.f.), *Ficus mollis* Vahl, *Symplocos racemosa*, *Alangium salvifolium* (L.F.) Wang., *Indigofera pulchella* Roxb. (syn. *I. cassioides* Rottler ex DC.), *Vitis* L. spp., *Bauhinia vahlii* Wight & Arnott, *B. sericea* Lace var. *anguina*, *Persea bombycina* (King ex Hook.f.) Kosterm. (food plant of *muga* silkworm), *Chionanthus ramiflorus* Roxb., and *Caesalpinia bonduc* (Linn.) Roxb., to name a few. The **Saranda forests** in the hilly region of West Singhbhum district are very suitable for orchid habitat and have all the 11 species of *Dendrobium* Sm., and the last remnant population of *Bulbophyllum* Thouars, an epiphytic orchid represented by the single species, *Bulbophyllum crassipes* Hook.f., and an interesting orchid *Pecteilis triflora* (D.Don) Tang & F.T.Wang. Saranda also hides amongst its dense forests the Ligirdah swamp, which harbors a unique swamp vegetation dominated by the members of the family Zingiberaceae, such as *Hedychium coronarium* Koenig., and other families of sedges and grasses. The **Netarhat hills** have moist and dry deciduous *sal* forests. The Lodh Falls of this area represent an ideal riverine ecosystem, harboring a very important economic orchid of the region called *Pholidota imbricata* Lindl., locally called '*Pathal Kela*', and 10 out of 11 species of *Dendrobium*. Economically, this area is highly suited for the cultivation of *Pyrus communis* L. (pear or *naspati*). The Barkapahar hillock, near Ranchi, on steep slopes has *sal* forests and at places mixed forests with *Acacia* Mill. spp. and *Bauhinia variegata* L. (*kachnar*). On the gentle slopes towards the foothills occur *Shorea robusta*, *Bauhinia* L. spp., and *Nyctanthes arbor-tristis* L. (night jasmine). There are some *Terminalia alata* trees too scattered.

Dry scrub forest is the common vegetation of the region, consequent to which, the state Jharkhand apparently draws its name, because of the domination of scrubs, locally called '*jharies*'. The scrubs include bamboos and shrubs, such as *Helicteres isora* L., *Flacourtia indica* (Burm.f.) Merr. (syn. *F. ramontchi* L'Hérit), *Flemingia*

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strobilifera (L.) W.T. Aiton., *Woodfordia fruticosa* (Linn.) Kurz., *Ziziphus mauritiana* Lam. (syn. *Z. jujuba* Mill.), and *Z. vulgaris* Lam. The important grasses in the scrub forests are *Arundinella setosa* Trin. Gram. Pan., *Cymbopogon martini* (Roxb.) Wats., *Capillipedium assimile* (Steud.) A. Camus, *Chrysopogon fulvus* (Spreng.) Chiov. (syn. *C. montanus* Trin.), *Pennisetum pedicellatum* Trin., *Themeda caudata* (Nees) A. Camus, *Themeda quadrivalvis* (L.) Kuntze., etc.

Agriculture and agrobiodiversity

Despite good rainfall, the crop productivity in the region is very poor, because of the slopy, undulating terrain, non-availability of irrigation, and poor water and soil conservation. The transitional climate (dry and warm humid) of the region is reflected in the cropping pattern, which shows cultivation of a mixture of wet and dry crops. Rice is the dominant crop everywhere, whereas maize, wheat, barley, minor millets, gram, oilseeds, and pulses (legumes) are supplementary crops. Sugarcane is grown in fairly well-defined areas. Jute, a crop of the hot, moist lowlands, is found only in the eastern-most districts.

Rainfed agriculture is the traditional farming, practiced in the region. A toposequential land use is prevalent among tribal farmers. High and medium slopes with light textured red soil are cultivated with niger, leguminous trees, upland rice, finger millet, maize, pigeonpea, etc.; medium slopes with light or heavy textured sandy soil are cultivated with rice in *kharif* and vegetables in *rabi*; and lower slopes lowlands and deep lowlands with heavy soils are cultivated with rice. Thus rice, millets, maize, and pigeonpea are major crops during the rainy season (*kharif*) and vegetables, pulses, and oilseeds during the postrainy season (*rabi*). Rice and wheat are also cultivated under irrigated conditions. Direct sowing of *ragi*, red gram, and black gram and ridge planting of maize are some common unique practices followed in the region.

The *kharif* season starts from the third week of May and lasts till the end of October with rice, maize, *arhar* or pigeonpea, etc. Most early varieties of paddy are grown by the broadcast method. The *rabi* season starts by the end of October and lasts up to the last week of February. The main crops grown during this season are *surgujiya* wheat, gram, mustard/oilseeds, barley, potato, etc. In double-cropping, mustard seed is sown after maize and wheat after paddy. During the *zaid* season (the short season during the summer months, between the *rabi* and *kharif*), which begins from March and ends by the second week of May, people grow mostly vegetables such as *kadu*, *kohra*, *bhindi*, French beans, etc. However, there are three major harvests in a year: *bhadai,* dominated by maize that is sown from May to June and harvested in *Bhado* (August to September); *aghani,* consisting primarily of rice sown in mid June and gathered in the month of *Aghan* (December); and *rabi,* made up largely of wheat that ripens (in the plains) in spring.

Most farmers practice cultivation of selected traditional long-duration rice varieties with low inputs of manure in the lowlands, which have plenty of water during the rainy season.

Winter crops, such as rapeseed, linseed, barley, lentil, and gram are cultivated successfully following the monsoon season. Rice is also cultivated on residual soil moisture, particularly in the mid-uplands. However, since there are poor irrigation facilities, the most common cropping pattern is still rice–fallow, which covers 87% of the total medium land plots.

The local farmers have made appropriate selection for rice genotypes suited to different terrains of the region, i.e., uplands, mid-uplands, lowlands. This has resulted in generating genetic and varietal diversities in rice. Consequently, in uplands short-duration (85–90 days) *gora* rice varieties like *Goradhan* are grown; in the mid-uplands (or *baad*) selected medium-duration rice varieties, like *Jarli, Balibhojan* (120 days) are grown; and lower down the hilly terrain, especially in the medium land (where soil moisture is available for longer periods) or lowlands, long-duration rice varieties like *Sugandha* (150 days) are grown (Fig. 3). The medium lands are known as *ajan* in Giridih and *kanali* in Purulia. Other common extant rice varieties of the region are *Cauvery, Palman, Bala*, etc.

Figure 3. Rice-based production system in lowland (Source: topnews.in).

The traditional cropping systems are rice–toria, rice–mustard, rice–niger, rice–groundnut, rice–lentil, and rice–sesame. In Alfisols and related red soil zone in and around the Ranchi region, the common cropping systems are rice–chickpea/linseed, groundnut–barley, and finger millet–chickpea (Rathore and Gupta, 1991). A recent study on indigenous cropping systems in the tribal areas have shown dominance of legume-based mixed and intercropping systems among tribal communities, such as pigeonpea + rice, pigeonpea + black gram, pigeonpea + finger millet, pigeonpea + maize, cowpea + rice, gram + wheat, gram + linseed, and gram + mustard; and crop rotations including rice–gram, rice–lentil, rice–wheat–mungbean, rice–pea, groundnut–wheat, maize–wheat and different vegetables; and *paira* cropping (no-tillage, relay sowing by broadcast in standing crop of lowland rice before its harvest) and recently developed potato-based cropping systems in rice lowlands. *Lathyrus* seed are broadcast in standing rice crop to get yield without irrigation. The basic principle applied in these mixed and rotation systems is to take advantage of the nitrogen-fixation capacities of legume crops for soil fertility conservation (Dey and Sarkar, 2011).

Under agroforestry, mixed cropping involving cereals, pulses, and vegetables is practiced. A number of horticulture crops are grown as per the topography and climatic regimes. Litchi cultivation in the region, particularly in the Ranchi area, and jackfruit cultivation all over the plateau is known nationally.

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Raising of livestock for meat, dairy products, and wool has been part of the traditional agriculture. The region has been using and conserving diverse domestic animal populations, including local and crossbred cattle, like black Bengal goat, Chotanagpuri sheep, murrah and local buffalo, broilers and many varieties of ducks.

Representative crop species in various crop groups

Cereals, pseudocereals, and millets. Amaranth (*Amaranthus hypocondriacus* L.), barley (*Hordeum vulgare* L.), *gundli* (*Panicum antidotale* Retz., a cultivated millet generally used for forage in the rest of the country), maize (*Zea mays* L.), *mandla* or wild finger millet (*Eleusine indica* Steud.), *pedda wundu* or wild barnyard millet [*Echinochloa crus-galli* (L.) P. Beauv.], *ragulu* or finger millet (*Eleusine coracana* Gaertn.), rice (*Oryza sativa* L.), *sanwa* or barnyard millet (*Echinochloa frumentacea* Link.; syn. *Panicum frumentaceum* Roxb.), and sorghum [*Sorghum bicolor* (L.) Moench].

Grain legumes and oilseeds. Black gram [*Vigna mungo* (L.) Hepper], *Brassica* spp., castor (*Ricinus communis* L.), *chana* or chickpea (*Cicer arietinum* L.), cowpea (*Vigna unguiculata* L.), green gram [*Vigna radiata* (L.) Wilczek var. *radiata*], groundnut (*Arachis hypogaea* L.), *kulthi* or horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.], lentil (*Lens culinaris* Medic), linseed (*Linum usitatissimum* L.), mothbean [*Vigna aconitifolia* (Jacq.) Marechal], niger [*Guizotia abyssinica* (L.f.) Cass.], rice bean [*Vigna umbellata* (Thunb.) Ohwi & H. Ohashi], sesame (*Sesamum indicum*), *toria* or rapeseed (*Brassica rapa* L. var. *toria*), *tuar* or pigeonpea [*Cajanus cajan* (L.) Millsp.], and *Vigna vexillata* (L.) A.Rich. (tubers are eaten).

Fodder and fiber crops. *Arundinella setosa, Axonopus compressus* (Sw.) Beauv., *Bridelia squamosa* (Lam.) Gehrm., *Capillipedium assimile* (Steud.) A. Camus, *guria* grass (*Chrysopogon fulvus*), *Crotalaria alata* Buch.-Ham., *dennanath* grass (*Pennisetum pedicellatum* Trin.), *Eulaliopsis binata* (Retz.) C.E. Hubb, *Heteropogon contortus* L., *Iseilema laxum* Hack., jute (*Corchorus capsularis* L.), kenaf (*Hibiscus sabdariffa* L.), *Milletia extensa* (Benth.) Baker (syn. *M. auriculata* Baker), *Themeda caudata* (Nees) A. Camus, *Themeda quadrivalvis,* and *Wendlandia tinctoria* (Roxb.) DC.

Vegetables. Balsam apple (*Momordica balsamina* L.), *bhindi* or okra [*Abelmoschus esculentus* (L.) Moench], bottle gourd [*Lagenaria siceraria* (Molina) Standley], brinjal (*Solanum melongena* L.), cucumber (*Cucumis sativus* L.), *Curcuma angustifolia* Roxb. (source of starch), drumstick (*Moringa concanensis* Nimmo, *M. oleifera* Lam.), *kakrol* or *ban karela* (*Momordica dioica* Roxb. ex Willd.), *karela* or bitter gourd (*Momordica charantia* L.), *kundri* (*Coccinia indica* Wight & Arn.; syn. *C.*

grandis Voigt), *Momordica subangulata renigera* (Wall. ex G.Don) W.J. de Wilde, ridge gourd [*Luffa acutangula* (L.) Roxb.], *Sesbania grandiflora* (L.) Poir., sponge gourd [*Luffa cylindrica* (L.) Roem.], and sugar beet [*Beta vulgaris* L. var. *orientalis* (Roth) Moq.].

Leafy vegetables. The tribals from and around the Ranchi Plateau have been using 33 plant species as leafy vegetables (Kumar and Kumar, 2000). Most of them are also important from the medicinal point of view. They include *Achyranthes aspera* L., *Amaranthus spinosus* L., *Bauhinia purpurea* L., *B. retusa* Roxb. ex DC., *Boerhaavia diffusa* L., *Centella asiatica* (L.) Urban, *Cleome* L. spp., *Euphorbia hirta* L., *Ficus* L. spp., *Ipomoea aquatica* Forsk., *Ophioglossum reticulatum* L., *Oxalis corniculata* L., *Polygonum* L. spp., *Portulaca* L. spp., *Rumex vesicarius* L., etc. In addition, *bathua* (*Chenopodium album* L.), green amaranth (*Amaranthus hypocondriacus* L. and *A. viridis* L.], *methi* (*Trigonella foenum-gracium* L.), *sarson* or mustard green [*Brassica juncea* (L.) Hook.f. & Thomson], swamp cabbage (*Ipomoea aquatica*), and *palak* (*Spinacia oleracea* L.) are cultivated.

Rhizomes, tubers, and bulbs. *Arvi* or taro [*Colocasia esculenta* (L.) Schott], country potato (*Coleus forskholii* Briq.; syn. *C. barbatus* Benth), *Dioscorea kalkapershadii* Prain & Burkill., *D. wightii* Hook.f., *galphuli* edible tubers (*Flemingia vestita* Benth. ex Baker; *F. procumbens* Roxb.), *khamalu* or Asiatic yam (*Dioscorea alata* L.), *nara tegu* (*D. glabra* Roxb.), *pitharu khanda* (*D. belophylla* Voigt ex Haines), potato (*Solanum tuberosum* L.), potato yam (*Dioscorea bulbifera* L.; syn. *D. sativa*), *Pueraria tuberosa* (Roxb. ex Willd.) DC, *suthni* or lesser yam [*Dioscorea esculenta* (Lour.) Burk.], *tava khira* (*Curcuma angustifolia*), and *Vigna vexillata* var. *wightii* (Benth. ex Baker) Babu & Sharma (cultivated for tuberous root).

Fruits. *Alangi* [*Alangium salviifolium* (L.f.) Wangerin], *aonla* (*Emblica officinalis* Gaertn.), *bael* (*Aegle marmelos*), *ber* (*Ziziphus mauritiana*), *chiroli* or *chironji* (*Buchanania lanzan* Spreng.), custard apple (*Annona reticulata* L.; *A. squamosa* L.), guava (*Psidium guajava* L.), *gular* (*Ficus glomerata* Roxb.; syn. *F. racemosa* L.), *imali* (*Tamarindus indica* L.), jackfuit (*Artocarpus heterophyllus* Lam.), *jamun* (*Syzygium cuminii*), *karonda* (*Carissa carandas* Lour.), mango (*Mangifera indica* L.), papaya (*Carica papaya*), *paker* [*Flacourtia indica* (syn. *F. ramontchi*); *F. sepiaria* Roxb.], persimmon (*Diospyros melanoxylon*), pineapple (*Ananas comosus* L.), *shahatoot* or mulberry (*Morus nigra* L.; *M. alba* L.), *Solanum torvum* Sw., toddy palm (*Borassus flabellifer* L.), and *Ziziphus rugosa* Lam. (syn. *Z. glabra* Roxb).

Under agroforestry, mixed cropping involving cereals, pulses, and vegetables is practiced. A number of horticulture crops are grown as per the topography and climatic regimes. Litchi cultivation in the region, particularly in the Ranchi area, and jackfruit cultivation all over the plateau is known nationally.

Spices. Ginger (*Zingiber officinale* Rosc.), mango ginger (*Curcuma amada* Roxb.), turmeric (*Curcuma domestica* Valet.; syn. *C. longa* L.), wild turmeric (*Curcuma aromatica* Salisb.), and *Zingiber purpureum* Roscoe var. *palamaunsis* (Haines) K.K.Khanna.

Other crop species. They include plantation crops such as plantain (*Musa sapientum* L.), *Persea bombycina* for *muga* silk, and ornamental crops such as carnation (*Dianthus caryophyllus* L.), gerbera (*Gerbera* L. spp.), rose (*Rosa* L. spp.), chrysanthemum (*Chrysanthemum* L. spp.), marigold (*Tagetes erecta* L.), tuberose (*Polianthes tuberosa* L.), terrestrial orchids, bulbaceous flowers, and night jasmine (*Nyctanthes arbor-tristis*).

Timber. *Anjan* (*Hardwickia binata* Roxb.), *asan* (*Terminalia tomentosa* Wight & Arn.), *baheda* [*Terminalia bellirica* (Gaertn.) Roxb.], *bakli* or *dhautha* (*Anogeissus latifolia*), *khair* (*Acacia catechu* Brandis), *kulu* (*Sterculia urens* Roxb.), *sal* (*Shorea robusta*), *Terminalia alata*, and tree of haven (*Ailanthus excelsa* Roxb.).

Multipurpose species. *Dendrocalamus asper* Backer ex K.Heyne (timber, edible, ornamental), *Diospyros melanoxylon, palas* or flame tree (*Butea monosperma*), *karanj* [*Pongamia pinnata* (L.) Pierre], *kosum* or Indian lac tree (*Schleichera oleosa*), *mahua* (*Madhuca indica;* syn. *M. longifolia* var. *latifolia*), neem (*Azadirachta indica* A. Juss), and *Phoenix humilis* Royle ex Becc.

Agroforestry, gum, and resin species. Non-wood forest products collected/made by the tribals are the main source of livelihood (Fig. 4). They consist of oilseeds (*mahua, sal*, *neem*, *karanj*, etc.), gums, resins, *guggul* or incense materials, dyes and fermented drinks, soap and cosmetics, raw material for wooden toys, drums, musical instruments, brooms and brushes, perfumes (sandalwood oil, *khus* oil), and *tendu* leaves (*Diospyros melanoxylon*). The leaves of trees such as *Terminalia tomentosa* and *T. arjuna* provide good feed for rearing of silkworms under the sericulture industry. Similarly, the leaves of *Acacia* and *Ficus* spp. are used for rearing of *lakh* or lac insects [*Laccifer lacca* (Kerr)] under the lac industry. Bamboo and *bhabar* (an Indian fiber grass; *Ischaemum angustifolium* Hack. ex Oliv.) from Chotanagpur supply raw materials for paper manufacture. Some other species sought after for extraction of gum and resins are *Anogeissus latifolia, arjun* [T*erminalia arjuna* (Roxb. ex DC.) Wight & Arn.], *Boswellia serrata* Roxb. (syn. *B. glabra* Roxb.), *dikamali* (*Gardenia gummifera* L.f.), *kulu* (*Sterculia urens* Roxb.), and *Lannea coromandelica* (Houtt) Merr.

Figure 4. Collecting forest produce, part of traditional agriculture.

Medicinal plants. *Alangium salvifolium* (L.F.) Wang., *arjun* (*Terminalia arjuna*), *ashwagandha* [*Withania somnifera* (L.) Dunal.], *baheda* (*Terminalia bellirica*),

brahami [*Centella asiatica* (L.) Urb.], *Caesalpinia bonduc* (Linn.) Roxb., *chitraka* (*Plumbago zeylanica* Linn.), *hadjod* [*Cissus quadrangularis* Linn. (CQ)], *Flemingia strobilifera* (L.) W.T. Aiton., *gadhahpurna* (*Boerhaavia diffusa* L.), *ghritakumari* (*Aloe barbadensis* Mill.), *jyotishmati* or *mal-kangani* (*Celastrus paniculatus* Willd.), *kalmegh* (*Andrographis paniculata* Wall. ex Nees), *pani bel* (*Cissus repanda* Vahl.; syn. *C. rosea* Royle, *Vitis repanda* Wight & Arn. and *V. rosea* Royle), *Pueraria tuberosa* (Roxb. ex Willd.) DC, *salai* (*Boswellia serrata*), *sarpagandha* (*Rauvolfia serpentina* Benth. ex Kurz.), *shatawar* (*Asparagus racemosus* L.), *sonapatha* or *shyonaka* [*Oroxylum indicum* (L.) Benth. ex Kurz; syn. *Bignonia indica* L.], *Soymida febrifuga* (Roxb.) A. Juss., *Symplocos racemosa*, *Terminalia alata*, *Vigna sublobata* (Roxb.) Bairig. *et al.* [syn. *V. radiata* (L.) R. Wilczek var. *sublobata* (Roxb.) Verdc.], etc.

Wild relatives of crop species. Arora and Nayar (1984) recorded *Coccinia indica*; (syn. *C. grandis*), *Cucurma longa* Linn. (syn. *C. domestica* Valeton), *Mucuna capitata* Wight & Arn., *Phoenix robusta* Hook.f., *Vigna sublobata* (syn. *V. radiata* var. *sublobata*), and *Zingiber capitatum* Roxb. from the region. Later, many more wild relatives of crops, such as *Abelmoschus crinitus* Wall. [syn. *A. cancellatus* (L.f.) J.O. Voigt], *Acacia donaldii* Haines, *Cajanus cajanifolius* (Haines) Maesen, *C. scarabaeoides* (L.) Thours, *C. sericeus* (Baker) Maesen, *Dioscorea bulbifera* L. (syn. *D. sativa*), *D. glabra* Roxb., *D. wightii* Hook.f., *Eleusine indica* Steud., *Indigofera pulchella, Momordica balsamina*, *M. subangulata renigera, Oryza nivara* Sharma & Shastry (syn. *O. sativa* L. forma *spontanea* Roshev.), *O. rufipogon* Griff. (syn. *O. spontanea* Roschev.), *Echinochloa crus-galli*, *Rhynchosia bracteata* Benth. ex Bak., *R. minima* DC, *R. rufescens* (Willd.) DC., *Vigna aconitifolia* (Jacq.) Marechal, *V. hainiana* Babu, Gopin. & S.K.Sharma, *V. triloba* (L.) Verdec. var. *trilobata*, *Zingiber casumnar* Roxb. (syn. *Z. purpureum* var. *palamauensis*), etc. have been recorded.

Endemic species. Nayar (1996) identified 20 centers of plant endemism in India, of which Chotanagpur is one that has been recognized as an important 'microcenter' and recorded *Acacia donaldii* Haines, *A. thompsonii* var. *galbana* Haines, *Aglaia haselettiana, Carum villosum* Haines, *Chrysopogon hamiltonii* Haines, *Crotalaria ramosissima* Roxb., *Dimeria ornithopoda* Trin. var. *gracillima* Bor, *Eriolaena hookeriana* Wight & Arn. var. *viridis, Iseilema holei* Haines., *Lohopogon kingii*, *Mucuna minima* Haines, *Ophiuros megaphyllus* Stapf ex Haines, *Pycnocycla glauca* Lindl., *Rhyncosia hainesiana* P. Satyanar., *Sophora bakeri* C.B.Clarke ex Prain, and *Tephrosia purpurea* (L.) Pers. var. *maritima.* Later, Nayar *et al*. (2009) reported *Albizia orissensis* K.C.Sahni & Bennet, *Cajanus cajanifolius, Erythrina resupinata* Roxb., and *Phyllanthus narayanaswamii* Gamble from the region. Recently, several more species have been described as endemic to the region, such as *Clematis roylei* var. *patens* (Haines) Kapoor, *Dendrocalamus strictus* (Roxb.) Nees var. *sericeus* (Munro) Gamble, *Leucas lanata* Wallich ex Benth. var. *nagpurensis* C.B.Clarke ex Haines, *Ligusticum alboalatum* Haines, *Swertia angustifolia* Buch.-Ham ex D.Don var. *pyramidalis* Haines, and *Zingiber purpureum*

var. *palamaunsis* (Singh *et al.,* 2001). A representative set of endemic species are listed in Table 1. In addition, the orchids *Dendrobium herbaceum* Lindl., *D. regium* Prain, *Habenaria gibsoni* var. *foetida* Blatt. & McCann, *Nervilia carinata* (Roxb.) Schltr., and *N. falcata* (King & Pantl.) Schltr. are endemic to the region, which are of great ornamental value (Kumar and Rawat, 2008).

Table 1. List of representative endemic species from the Chotanagpur Plateau region.[1]

Species	Family	Habit	Distribution	Remark
Acacia donaldii	Fabaceae	Scrambling tree	Northern Eastern Ghats	Agroforestry
Albizia orissensis	Fabaceae	Tree	Northern Eastern Ghats	Less known species
Bupleurum andhricum	Apiaceae	Herb	Northern Eastern Ghats	Used for sudorific complaints
Cajanus cajanifolius	Fabaceae	Shrub	Northern Eastern Ghats	Green manuring
Clematis roylei var. *patens*	Ranunculaceae	Herb	Chotanagpur plateau	Medicinal
Dendrocalamus strictus var. *sericeus*	Poaceae	Shrub	Chotanagpur plateau	Strong bamboo
Dimeria ornithopoda var. *gracillima*	Poaceae	Herb	Chotanagpur plateau	Grass
Iseilema holei	Poaceae	Herb	Chotanagpur plateau	Grass
Leucas lanata var. *nagpurensis*	Lamiaceae	Perennial herb	Chotanagpur plateau	Medicinal
Phyllanthus narayanaswamii	Euphorbiaceae	Undershrub	Northern Eastern Ghats	Wild relative
Pycnocycla glauca	Apiaceae	Herb	Northern Eastern Ghats	Roots used to treat dysentery
Sophora bakeri	Leguminosae	Shrub	Jharkhand	Medicinal
Swertia angustifolia var. *pyramidalis*	Gentianaceae	Annual herb	Jharkhand	Medicinal
Zingiber purpureum var. *palamaunsis*	Zingiberaceae	Herb	Chotanagpur plateau	Genetic resource

1. Source: Nayar, 1996; Singh *et al*., 2001; and Kumar and Rawat, 2008.

Threatened species. *Aglaia haselettiana, Carum villosum,* and *Pycnocycla glauca* have been reported to be under threat by Rawat and Wikramanayake (2001); *Oryza nivara, Jasminum strictum* Haines, and *Ligusticum albo-alatum* Haines presumed extinct by Nayar and Sastri (1987, 1988, 1990); and *Clematis roylei* var. *patens, Leucas lanata* var. *nagpurensis, and Zingiber purpureum* var. *palamaunsis* found in the region have been listed to be under threat by the Ministry of Environment and Forests (MoEF), Government of India. Table 2 lists the species reported to be under threat from the region.

Associated culture and tribes

The Chotanagpur region is known for non-Aryan, Austric tribes. Around 22.5% of the human population in the region is of tribal origin, belonging to more than 30 different tribes. Vidyarthy (1968) originally classified them on the basis of their association with specific cultural activities. It included hunter-gatherers (such as *Birhor, Korwa, Hill Kharia*); shifting agriculturists (such as *Sauria, Paharia*); simple artisans (such as *Mahli, Lohra*, *Karmali, Chik Baraik*); and settled agriculturists (such as *Santhal, Munda, Oraons, Ho, Bhumij*).

Most of these tribes are partly dependent on the forest resources for their living (Fig. 4). Some of the other tribes recorded are *Baiga, Asur, Chero, Gond, Larmali, Kond, Kurmi, Tharu, Kols, Tamar, Khewar, Birjia, Savar, Korwa, Malpaharia, Parhaiyas*, etc. These tribals collect non-wood forest products from the forests and are also engaged in

Table 2. List of representative species under threat from the Chotanagpur Plateau region.

Species	Family	Habit	Threat level[1]	Remark
Aglaia haselettiana	Meliaceae	Tree	I	Vegetation
Carum villosum	Apiaceae	Herb	EX/EN	Genetic resource
Clematis roylei var. *patens*[2]	Ranunculaceae	Liana	EN	Medicinal
Jasminum strictum	Oleaceae	Shrub	I	Ornamental, genetic resource
Leucas lanata var. *nagpurensis*[2]	Lamiaceae	Perennial herb	EN	Medicinal
Ligusticum albo-alatum	Apiaceae	Herb	P.EX/EN	Vegetation
Pycnocycla glauca	Apiaceae		I	Medicinal; roots used in dysentery
Oryza nivara	Poaceae	Tall herb	I	Wild relative of rice
Zingiber purpureum var. *palamaunsis*[2]	Zingiberaceae	Shrub	EN	Fruit, genetic resource

1. EN = Endangered; I = Indeterminate; EX = Extinct; P.EX = Possibly Extinct.
2. Listed by the Ministry of Environment and Forests (MoEF).

subsistence farming. The tribal communities sell bamboos and canes, seed-oils and fats, cordage, mats, baskets, etc., in their '*hats*' (weekly local village markets).

The *Birhors* are a traditional nomadic primitive tribe of the Chotanagpur region, belonging to the forest-hunting type. Ethnically they belong to Austro Asiatic Mundari group of the Proto-Australoid stock. They are still mostly landless and earn their living by rope making, hunting, gathering forest products, and fishing. They are threatened to extinction.

The *Mundas* are tribal people having their origins in the Kols of the Vindhya Mountains. The *Mundas* also have resemblances in cultural traits with the *Santhals*. They are settled agriculturists, besides earning their livelihood by means of collecting minor forest products. They are also engaged in fishing and animal husbandry and work as unskilled laborers. They developed the *parha* system of government, which is basically a confederacy of village governments.

The *Oraons* are considered to be related to the Proto-Australoid stock, which has been described as 'pre-Dravidian' and 'Veddoid' (Kirk *et al.,* 1962). They generally speak the Kurukh language. The *Oraons* mainly depend on agriculture and are believed to have first introduced plow cultivation into the Chotanagpur Plateau, with the present system of pastureland management working together in unison. Recent findings have suggested that the pre-Dravidian aborigines, whose descendants are speakers of the Munda Austric languages, living today in parts of Chotanagpur (Jharkhand), Chhattisgarh, Orissa, and Bengal, are the original inhabitants of India.

The *Gaderiyas* are another scattered and small populated lesser-known scheduled caste community whose origin is not known. They are living with tribals and scheduled caste communities since a long time, according to their knowledge. They are famous for their traditional occupation of livestock rearing and are known as a caste of shepherds, engaged in grazing of sheep, collection of sheep fur, preparation of woolen thread, and blanket weaving.

Technology and products

Despite good rainfall, the region suffers from poor crop yields. This is because of non-availability of irrigation systems and loss of most of rainwater in the runoff due to slopy and undulating terrain, soil lacking in water-holding capacity, because of rocky origin, and poor quality of water. The topsoil gets eroded every year, because of runoff and lack of soil conservation efforts, further limiting the agricultural productivity. Nevertheless, the local farmers have developed practices to protect and facilitate water resource management along with efficient utilization, with methods like water harvesting in artificial structures, water recycling, earthen bunding, stone bunding, stone-cum-earthen bunding across the slopes and strengthening such bunds with weeds, bushes, etc., and management of water from rivulets. Similarly, they have developed practices to improve soil fertility and restrict soil and water erosion by building low-cost structures like the *doba* (Dey *et al.,* 2003).

For increasing productivity, the farmers have developed practices, such as supplying water to the uplands close to the homesteads, called *barhi,* from dug wells. The *barhi* land is intensively used for cultivation of cash crops such as vegetables and potato to meet the food requirement of the family and to get immediate income. In distant fringe areas, the traditional farmers largely cultivate drought-resistant and flood-resistant long-duration traditional varieties of rice. These areas have remained isolated from the Green Revolution, and therefore offer appreciable genetic diversity for collection and conservation.

To mitigate the unpredictable monsoon, farmers grow selected crops and varieties such as *gora* rice, which are short-duration (85–90 days), tolerant to drought, low in yield, but ensure sustainable productivity, because of their capacity to escape drought. Some of these varieties grown in the region can survive even in a drought-like situation. They are grown on highlands where the water runoff is higher; some of them mature barely in 60 days, compared to the 90 days of usual varieties. In these cultivable uplands, during the monsoon, the other crops that are cultivated are traditional minor millets, such as finger millet, *kodo* millet or *gundli*, solely or in association with other crops as mixed crops.

The Chotanagpur region is known for non-Aryan, Austric tribes. Around 22.5% of the human population in the region is of tribal origin, belonging to more than 30 different tribes.

Agriculture in the area is largely oriented towards rice cultivation for subsistence. Local farmers typically distinguish four different land types according to the land's position in the microtopography: upland, mid-upland, medium land, and lowland. The farmers' perception about increasing soil fertility as one goes down in the toposequence (land position) has been corroborated by soil analysis of the Indian Statistical Institute (ISI). Accordingly, farmers have adapted to the local topography by adjusting cropping patterns (particularly with adaption of rice varieties) and crop management practices according to the plot's position and land type. Upland plots are typically planted with short-duration (85–90 days), drought-tolerant traditional varieties (TVs) of rice or minor millets that generally provide low yields. Mid-upland plots are typically planted with medium-duration TVs, whereas medium land plots – where soil moisture is available for a longer period than on the higher terraces – are most widely planted with long-duration TVs. At the bottom of the toposequence, i.e., on lowland plots, farmers typically plant long-duration rice TVs, with low inputs of manure (as the soils are comparatively rich in fertility) or modern varieties (MVs) of rice (Fig. 3). Thus, planting of TVs is predominant, though MVs of rice are also cultivated (the share of land area planted with MVs was 21% on lowland and 24% on medium land) mainly on medium land and lowland plots where the ambient moisture is higher, and the soils are better suited to MVs, which tend to be more sensitive to water availability. Average paddy yields differed significantly across land types, and the yields generally increase as one moves

down in the toposequence. Rice yields averaged 2.1 t ha^{-1} on upland plots compared with an average yield of 3.3 t ha^{-1} on lowland plots. Analysis of traditional farming technical efficiency at the disaggregated plot-level suggests that poor rice farming households in the region are considerably more efficient technically than they appear, based on the aggregate farm-level analysis (Fuwa *et al*., 2007).

Chandel *et al*. (1989) recorded considerable genetic variability in rice, which is predominantly adapted to the varying degree of soil conditions. They collected more than 150 distinct landraces of *Oryza sativa* var. *indica* with amazing genetic variability in plant height, foliage color, internode length, stem thickness, stiffness of straw, maturity, grain size, color, and aroma, glume color, etc.

The primitive upland cultivars cultivated in the region as the rainfed upland crop are of short duration and photoperiod insensitive, e.g., the varieties of rice called *Goradhan.* Consequent to natural selection pressures, these varieties have developed significant genetic diversity for duration (short) and resistance to drought, as they can withstand moisture stress to a certain degree. Some of the commonly known short-duration *gora* varieties are *Black gora*, *Brown gora*, *White gora* (BP23), and many others, like *Jhuli, Baid, Budhadhan, Soreya, Sathi, Bala bora, Bhadai, Jarki, Asmi, Saro salar, Rohni, Dhani gora,* etc. Similarly, traditional cultivars have evolved for midland with medium-duration varieties, like *Jarli*, *Balibhojan*, *Arababa*, *Rash*, *Bakra*, *Bali*, *Hiradhan*, *Lunchi*, *Birsadhan*, *Hazaridhan*, etc. (last two with resistance to rice blast and bacterial leaf blight), and long-duration varieties, such as *Bhojna*, *Kalam dani*, *Malti*, *Sugandha*, *Rajashri*, etc., for rainfed lowland (Lakra *et al.,* 2009) (last two with resistance to gall midge and rice blast). The level of genetic diversity among TVs of the region is significant and consequently Gene Campaign (an NGO working in the region) has collected seeds of more than 1,000 distinct rice varieties, most of which were about to be lost. Recently, these have been screened in collaboration with the Indian Agricultural Research Institute (IARI), against bacterial leaf blight, identifying eight of these TVs – *Hardimuri, Kala Jeera, Bhatind, Sitwa Dhan, Sarna Gora, Chaina Gora, Lamba Asari*, and *Jhulur* – with resistance to this second most devastating disease of rice (Tyagi *et al.,* 2009).

The agroecological diversities and terrestrial heterogeneities have generated ecotypes and morphotypes in important small millets as well, several of which have been used in breeding improved cultivars. For example, in finger millet, RAU 8 has Ranchi local in its parentage. In kodo millet, the variety JK 41 is a selection from a local germplasm of Chotanagpur; and in little millet, Birsa is a selection from local *Gundli* 1.

Among fiber crops, landraces have been collected in jute. Among pulses, in mungbean, resistance to Cercospora leaf spot has been recorded, while in pigeonpea, wild relatives of *Cajanus cajan* are naturally distributed in the region, such as *C. scarabaeoides, C. sericeus*, and *Rhynchosia bracteata,* which have been found to be sources of resistance to pod fly damage and general resistance to other diseases (Sharma *et al.,* 2003).

In sesame, Kanke white has been derived through selection from a local collection from Palamu (Duhoon *et al.,* 2004).

The Plateau has recorded significant amount of variability for fruit characteristics such as shape, size, color in solanaceous vegetables (brinjal) and in cucurbits such as cucumber, ridge gourd, pointed gourd, etc., which has been used in developing many of the present cultivars. Among spices, significant variability has been recorded in the case of ginger and turmeric. Some indigenous ginger (*Zingiber officinalis*) cultivars are *Maran*, *Kuruppampadi, Ernad*, *Wynad*, *Himachal*, and *Nadia*. The region is very rich in the diversity of ornamentals, particularly the commercially significant tropical orchids, which are represented by a large number of species; for example, *Dendrobium*, a group of epiphytic orchids comprising 11 species, is distributed throughout the altitudinal gradient of the plateau (Kumar *et al.,* 2011).

The region is known for important traditional varieties of mango – *Bathua*, *Bombai*, *Himsagar*, *Kishen bhog*, *Gopal bhog*, *Sukul, Rani pasand, Safed maldah, Chausa, Fazali, Zardalu,* etc. – extending from the middle and lower Gangetic plains. In litchi, which is cultivated extensively in the region, appreciable genetic diversity has been recorded resulting in the collection of 51 accessions (Karihaloo *et al.,* 2005). Some commonly known extant varieties are *Shahi, Rose scented, China, Purbi, Early bedana,* and *Late bedana*. Rich genetic diversity has been recorded in jackfruit (*Artocarpus heterophyllus*) in the Santhal Parganas for tree characters, fruit behaviors, fruit characters, and yield (Nath *et al.,* 2001). Similarly, *Carissa carandas* exhibits variability for fruit and plant type.

The tribal-dominated people of Jharkhand have generated a significant amount of knowledge about the medicinal properties of a large number of plant species used in the local tribal medicinal system. Additionally, they have been exploiting various natural resources for different other purposes, such as alternative food under which there is a high consumption rate, for example, of young bamboo shoots and a number of root and tuber crops, which are mostly harvested unsustainably from nearby forests. Bamboo and *sabaigrass* are important resources used in the manufacture of rope and paper. The sticky, resinous secretion of the tiny lac insect, *Laccifer lacca,* which deposits lac on the twigs and young branches of several varieties of soapberry and *Acacia* trees and the sacred fig (*Ficus religiosa*) in forests, is commercially exploited for the production of *lakh*. The Chotanagpur region contributes 41% of the total *lakh* production of the country. Tropical *tasar* silk production originated in the Chotanagpur plateau of India; however, its origin and history are lost in antiquity. *Tasar* culture is a way of life for the tribals and forest dwellers. *Arjuna* (*Terminalia arjuna*) and *asan* (*Terminalia tomentosa*) are breeding hosts for the moth, which produces the cocoon from which *tasar* yarn is reeled. For these reasons, feasibility studies are being conducted to evolve new production systems, involving economically important trees or shrubs with vegetables, spices and other basal crops. For example, the cultivation of vegetables under the edible

bamboo is being discussed with plantation of *Dendrocalamus asper* plantlets raised through tissue culture and intercropped with potato (*Solanum tuberosum*), tomato (*Lycopersicon esculentum*), pea (*Pisum sativum*), and ginger (*Zingiber officinalis*).

The region is also known for knowledge about the medicinal properties of even food crops. For example, *Kurthi*, which is used like a pulse, is considered a cure for kidney stones. *Karhaini*, a drought-resistant variety of rice from the region, has been identified to cure jaundice and also used in the preparation of a rice beer called *handiya* (named after the earthen pot used for its fermentation or brewing). Indeed *handiya* or rice beer is culturally associated with native tribals. Another common liquor is called *mahu*, made from the *mahua* fruit.

Sheep and goat farming is a specialized occupation associated with certain tribes and communities, and the region has made significant contributions with evolution and conservation of breeds, such as the short Chotanagpuri sheep.

Future perspective

Despite the biogeographical significance and uniqueness, the Chotanagpur Plateau is, agriculturally speaking, under severe threat due to human-induced activities such as mining, industries, settlement, infrastructure development projects, and direct harvest of forest products, overgrazing of pastures, and forest fires, which have been causing severe erosion of biodiversity in general and of agrobiodiversity in particular. The majority of forest lands are lost due to these reasons, even after their due recognition in supporting livelihoods. Its unique biodiversity needs protection for improved understanding of evolution. Being one of the oldest landmasses on earth, the region might hide some unforeseen knowledge concerning the evolution of the earth and phytodiversity. Thus, there is an urgent need to conserve the rich biodiversity (including fossil) of the region before it is lost forever, particularly with an immediate in situ conservation of special habitats.

The agroecological diversities and terrestrial heterogeneities have generated ecotypes and morphotypes in important small millets as well, several of which have been used in breeding improved cultivars.

The tribal-dominated people of Jharkhand have generated a significant amount of knowledge about the medicinal properties of a large number of plant species used in the local tribal medicinal system.

In addition to deforestation, soil erosion due to rainwater runoff is another major problem causing concern for the sustainability of the agrobiodiversity in the region. Appropriate rainwater harvesting methods need to be evolved. Improving the existing knowledge on contour bunding along slopes would help develop and promote sustainable agriculture.

Being one of the oldest landmasses on earth, the region might hide some unforeseen knowledge concerning the evolution of the earth and phytodiversity.

Natural resources, such as the variability among root and tuber crops and tropical orchids need exploitation through advanced horticulture. Root crops, though not very systematically grown, are part of the 'food lore' of the tribal communities of the region and offer great opportunities. Similarly, the availability of a number of medicinal plants, herbs, and ornamentals, such as tropical orchids, offers a good scope for investment in the respective areas.

References

Arora RK and **Nayar ER.** 1984. Wild relatives of crop plants of India. National Bureau of Plant Genetic Resources (NBPGR), Kapoor Art Press, A 38/3, Mayapuri, New Delhi, India. 88 pp.

Brummitt RK. 2001. World Geographical Scheme for Recording Plant Distributions. Plant Taxonomic Database. The Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, USA.

Champion HG and **Seth SK.** 1968. A Revised Survey of Forest Types of India. Manager of Publications, Government of India, Delhi, India.

Chandel KPS, Chauhan JS, Chauhan VS, and **Sinha PK.** 1989. Exploration and genepool sampling of landrace diversity in *Oryza* from Chhotanagpur region. Indian Journal of Plant Genetic Resources 2:1–8.

Davis SD, **Heywood VH,** and **Hamilton AC.** (Eds.) 1995. Centres of Plant Diversity: A Guide and Strategy for Their Conservation. Volume 2: Asia, Australasia and the Pacific. IUCN, Cambridge, UK.

Dey P and **Sarkar AK.** 2011. Revisiting indigenous farming knowledge of Jharkhand (India) for conservation of natural resources and combating climate change. Indian Journal of Traditional Knowledge 10:71–79.

Dey P, Sarkar AK, and **Sikka AK.** 2003. Management of upland for horticulture development in Jharkhand, Chotanagpur. Horticulture 20:4–5.

Duhoon SS, Sharma SM, Lakhanpaul S, and **Bhat KV.** 2004. Sesame. In: Plant Genetic Resources: Oilseeds and Cash Crops (Dhillon BS, Tyagi RK, Saxena S, and Agrawal A, eds.). Narosa Publishing House, New Delhi, India. pp. 118–135.

Fuwa N, Edmonds C, and **Banik P.** 2007. Are small-scale rice farmers in eastern India really inefficient? Examining the effects of microtopography on technical efficiency estimates JEL Classification: O13, O33, Q12, Q16. Agricultural Economics 36(3):335–346.

Hora SL. 1949. Satpura hypothesis of the distribution of the Malayan fauna and flora to Peninsular India. Proceedings of National Institute of Science, India 15:309–314.

Karihaloo JL, Malik SK, Rajan S, Pathak RK, and **Gangopadhyay KK.** 2005. Tropical fruits. In: Plant Genetic Resources: Horticultural Crops (Dhillon BS, Tyagi RK, Saxena S, and Randhawa GJ, eds.). Narosa Publishing House, New Delhi, India. pp. 121–145.

Kirk RL, Lai LYC, Vos GH, and **Vidyarthi LP.** 1962. A genetical study of the Oraons of the Chota Nagpur plateau (Bihar, India). American Journal of Physical Anthropology 20:375–385. Doi: 10.1002/ajpa.1330200321.

Kumar B and **Kumar S.** 2000. A checklist of some leafy vegetables used by tribals in and around Ranchi, Jharkhand. Zoos' Print Journal 16(3):442–444.

Kumar Pankaj and **Rawat GS.** 2008. Chotanagpur Plateau: Relict habitats and endemic plants. In: Special Habitats and Threatened Plants of India (Rawat, GS, ed.). ENVIS Bulletin. Wildlife and Protected Areas, Vol. 11(1). Wildlife Institute of India, Dehradun, India. pp. 167–174.

Kumar Pankaj, Rawat GS, and **Wood PH.** 2011. Diversity and ecology of *Dendrobium* (Orchidaceae) in Chotanagpur Plateau, India. Taiwania 56(1):23–36.

Lakra V, Rahman ANM, Jaim WMH, Paris T, Hossain M, and **Singh RP.** 2009. Diversity, spatial distribution and the process of adoption of improved rice varieties in Jharkhand, India. In: Adoption and Diffusion of Modern Rice Varieties in Bangladesh and Eastern India (Hossain M, Jaim WMH, Paris TR, and Hardy B, eds.). IRRI Research Monograph. IRRI, Manila, Philippines. pp. 59–73.

Nath V, Singh B, and **Rai M.** 2001. Horticulture biodiversity in Santhal Parganas. Indian Journal of Plant Genetic Resources 14:92–98.

Nayar MP. 1996. Hot Spots of Endemic Plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, Kerala, India. 252 pp.

Nayar MP and **Sastri ARK.** 1987, 1988, 1990. Red Data Book of Indian Plants. Vol. 1. Botanical Survey of India, Calcutta, West Bengal, India. [Environmental Information System (ENVIS) on Floral Diversity]

Nayar MP, Singh AK, and **Nair KN.** 2009. Agrobiodiversity Hotspots in India: Conservation and Benefit Sharing. Vol. I. Protection of Plant Varieties & Farmers' Right Authority, New Delhi, India. pp. 134–138.

Puri GS, Gupta RK, and **Meher-Homji VMPS.** 1989. Forest Ecology. Volume 2. Oxford & IBH Publishing Company, New Delhi, India.

Rathore SS and Gupta IN. 1991. Crops and cropping system in India. In: Dryland Resources and Technology (Somani LL *et al*., eds.). Scientific Publishers, Jodhpur, Rajasthan, India. pp. 41–75.

Rawat GS and **Wikramanayake ED.** 2001. Chhota-Nagpur dry deciduous forests. In: Terrestrial Eco-regions of the Indo-Pacific: A Conservation Assessment. Island Press, Washington, DC, USA.

Rodgers WA and **Panwar HS.** 1988. Planning Wildlife Protected Area Network in India. Vols. I & II. Wildlife Institute of India, Dehradun, Uttarakhand, India.

Sharma HC, Pampathy G, and **Reddy LJ.** 2003. Wild relatives of pigeonpea as a source of resistance to the pod fly (*Melanagromyza obtusa* Malloch) and pod wasp (*Tanaostignodes cajaninae* La Salle). Genetic Resources and Crop Evolution 50:817–824.

Singh Anurudh K and **Varaprasad KS.** 2008. Criteria for identification and assessment of agro-biodiversity heritage sites: evolving sustainable agriculture. Current Science 94(9):1131–1138.

Singh NP, Mudgal V, Khanna KK, Srivastava SC, Sahoo AK, Bandopadhayay S, Aziz N, Das M, Bhattacharya RP, and **Hajra PK.** 2001. Flora of Bihar: Analysis. Botanical Survey of India, Calcutta, West Bengal, India.

Thornthwaite CW. 1933. The climates of the Earth. The Georgraphical Review 23:433–440.

Tyagi JP, Singh T, and **Singh S.** 2009. Identification of landraces of rice from Jharkhand and Bihar resistant to bacterial blight. Indian Journal of Plant Genetic Resources 22(2):89–92.

Vidyarthy LP. 1968. Cultural changes in tribes of modern India. Journal of Social Research 11(1):1–36.