Probable Agricultural Biodiversity Heritage Sites in India: XV. The Bastar Region

Anurudh K Singh

H.No. 2924, Sector 23, Gurgaon 122017, Haryana, India
(email: anurudhksingh@gmail.com)

Abstract

The Bastar region is known for its rich floristic diversity and tribal culture. Most of its people are involved in agricultural activities, and continue to practice ancient agricultural methods. The archaeological evidence suggests very early human settlement in the region, dating back to the Palaeolithic period. The large-scale practice of primitive agricultural methods has limited farm productivity, but has resulted in the discovery and use of a large number of plant species – as alternative sources of food (88), particularly among root and tuber plant species, and for medicinal properties (166) for use in wellness and health care – making the region an important center of species and genetic diversity for root and tuber crops and medicinal plants. Such ingenious approaches have resulted in the probable domestication of crops such as pigeonpea in the region, besides the neighboring Koraput region. The interaction between tribal farmers' and the terrestrial heterogeneity of the landscape, presenting diverse ecologies, has resulted in the evolution of a very large number of landraces and farmers' varieties with variability for most traits and suitability for diverse agroecologies in staple food crops such as rice, converting the region into a very important center of genetic diversity for rice. The present article discusses these contributions, and proposes the region as another National Agricultural Biodiversity Heritage Site.

The Bastar region was traditionally known from ancient times for its rich floristic diversity and has been mentioned as the Dandakaranya in the epic Ramayana, and as part of the Kosala kingdom in the Mahabharata. Agriculture in the region appears to be very ancient as reflected by the recent archaeological excavations in Dantewada, Bastar caves leading to the discovery of implements potentially dating back to over 50,000 years (Sankhyan *et al*., 2011), extending into the Palaeolithic period, when early humans entered into this region as a result of southward movement from the Narmada Valley. Despite being influenced by various neighboring and national cultures, the region has maintained its unique identity and is known for its tribal culture, where people still lead a very primitive life and practice obsolete agricultural methods leading to poor crop productivity and frequent food scarcity. In India, it has been regarded as one of the regions that is predominantly (70–98 percent) inhabited by tribal communities, confined to rural areas professionally

involved with agriculture. For reasons of food scarcity, the local people/tribals have identified a large number of alternative sources of food (around 88 plant species), many of which are being used in their regular diet (Jain, 1964). In addition, the tribal communities have also generated a rich amount of knowledge about the medicinal properties of different wild taxa, which are being used in the cure of various ailments. Thus, the region can be credited for the identification of a large number of alternative sources of food, and for generation of rich knowledge about medicinal properties in diverse plant species associated with various biological activities either for strengthening the human immune system or acting against various pathogens, thereby making the region an important center of origin/diversity for a large number of alternative common or prospective food crops among root and tuber plant species, which can be brought into regular cultivation, and medicinal plants that can be bio-prospected for use in nutraceutical and/or pharmaceutical industry to promote wellness and treatment of various human ailments under health care. The presence of immediate ancestral species of crops such as pigeonpea suggests that the region might be a possible area of crop domestication. The terrestrial heterogeneity and diverse agroecologies of the region have also facilitated the development of diverse practices of cultivation, and selection of useful genetic diversity amenable to local natural resources, landscape, changing climatic and market needs by the farmers, in most important crops such as rice. For these reasons, the region is being proposed as another National Agricultural Biodiversity Heritage Site, based on the indices illustrated by Singh and Varaprasad (2008).

Location and extent

The Bastar region is situated between 17° 46' and 20° 34' North latitude, and 80° 15' and 82° 15' East longitude and at an altitude of 600 m. It comprises part of the eastern plateau, mainly southern part of Chhattisgarh state, which includes the areas of Dandakaranya. Historically, Bastar was a vast kingdom inclusive of the present Koraput and Malkangiri districts of Orissa, the northwestern Upper Godavari district of Andhra Pradesh, and Sihawa in the Damtari district of Chhattisgarh. Before the formation of Chhattisgarh, it was one of the largest districts of India spread over an area of 39,171 km^2, constituted after Independence, merging the Kingdom of Kanker, which was a separate kingdom with its own history. Presently, the region includes five southern-most districts of the newly formed state of Chhattisgarh: Bastar, Kanker, Dantewada, Bijapur, and Narayanpur, traditionally extending to the neighboring districts of Damtari and Raipur, and Malkangiri of Orissa and parts of Khammam, Warangal, and Upper Godavari districts of Andhra Pradesh (Fig. 1). The region has four borders: Orissa to the east, Maharashtra to the west, and Andhra Pradesh to the south, and the remaining part Chhattisgarh to the north.

Landscape

The dominant landscape in the area is represented by moderate to gentle slopes. The region exhibits a great deal of habitat

Figure 1. Location and extent of the Bastar region (Chhattisgarh), demarcated by bold and dotted lines.

heterogeneity in the form of highlands, valleys, moist slopes, and riverine areas, which run along the North–South direction, connecting the Maikal range with the Chhattisgarh highlands. The Bastar–Bijapur highlands form a part of the larger Chhattisgarh plateau, flanked by the Chhattisgarh plains. The hill ranges extend both in Maharashtra and Chhattisgarh, though Bastar-Jagdalpur is remotely linked with the Eastern Ghats through the Bailadilla hills. Most of these hill ranges, except Abujhmar, are more or less scattered and discontinuous. Several small streams passing through the valleys finally meet the main river, Indravati or its numerous tributaries of the sub-basin. Topographically, Bastar district is predominantly the land of hills, green jungles, waterfalls and a tribal community that has managed to maintain its distinct identity and traditions. Bastar hills have several deep valleys, minor hill ranges and peaks (locally called *metta*) and lateritic plateaus (locally called *madum*). The *madum* occurring between altitudes of 650 m to 850 m shows lateritic formation with vegetation being represented by typical stunted dry type of trees. Within the forests, the special

habitats include undulating and rocky slopes, dry plateau, riverine and bamboo brake.

The landscape of Kanker district is built of three different types of hills: the Vindhyana Hill Group, which are spread in the southeastern part of Kanker, where six phases of quartile and sand are also found; the Archian Hill Group, covering 95 percent area, having granite and Nees rocks; and the Dharwar Hill Group that are very crude and broken in shape and form. Conspicuously, the northeastern part of Kanker comes under the Mahanadi plain.

Agroclimate

The Bastar region is a hot sub-humid ecoregion with red and yellow soils. The climate of the area is characterized by hot summers and cool winters. The area receives an annual rainfall of 1,200 to 1,600 mm, of which 70–80 percent is received between July and September. The rainfall starts in late June and lasts up to November in some hilly parts. The annual rainfall meets about 60 percent of the annual potential evopotranspiration, ensuring the moisture availability from 150 to 180 days in a year for growing crops. The soil remains dry from November to May. Summers are relatively cooler in comparison to adjoining plains. The altitude ranges from 250 m to almost 900 m and temperature fluctuates from about 3°C to 47°C. The soils are generally reddish, calcareous, and neutral to slightly acidic. The soils of the Kanker district can be divided into four sections, *Kanhar*, *Dorsa*, *Matasi*, and *Bhata.*

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Floristic diversity

The Bastar region is known for its rich biodiversity and natural resources globally. Researchers from different parts of the world have been visiting the region to conduct research in this part of the earth with rich biodiversity. The forests of this region are dense like the Amazon forest. Thousands of herbs grow naturally in these forests (Fig. 2). There are hundreds of herbs that are endemic to the region. Of these, many wild fruits

Figure 2. Floristic diversity of the Bastar region, rich in root and tuber crops and medicinal plants.

The region can be credited for the identification of a large number of alternative sources of food, and for generation of rich knowledge about medicinal properties in diverse plant species associated with various biological activities either for strengthening the human immune system or acting against various pathogens.

have been identified for their miraculous medicinal properties. The traditional healers of the region treat many diseases including cancer with the help of these wild fruits. However, the destruction of the natural habitat of native flora in the last few decades has changed the scenario and the landscape, causing damage and potential threat/loss to the general biodiversity and potentially valuable economically important species.

The region has been placed in the Deccan biogeographical area. It houses an important component of rich and unique biological diversity. Most of the Bastar district (851,867 ha) is covered by forest. What is more conspicuous is that the region is significantly rich in endemism with respect to many plants having medicinal importance. The forests of the Chhattisgarh state, including this heritage zone fall under three major forest types: Tropical Semi-evergreen forests, Tropical Moist Deciduous forests, and Tropical Dry Deciduous forests (Jha and Khanna, 2005). Important canopy trees of the tropical semi-evergreen forests are *Terminalia alata* Herb. Madr. ex Wall, *Shorea robusta* C.F. Gaertn., *Stereospermum chelonoides* (L. f.) DC., and *Dalbergia paniculata* Roxb. while the tropical moist deciduous forests are represented by tree species, such as *Tectona grandis* L., *Pterocarpus marsupium* Roxb., *Terminalia bellirica* (Gaertn.) Roxb., *T. chebula* Willd. ex Flem., *Haldina cordifolia* (Roxb.) Ridsdale, and *Lagerstroemia parviflora* Roxb. The important tree species of the tropical dry deciduous forests are *Anogeissus latifolia* (Roxb.) Bedd, *Butea monosperma* (Lam.) Taub., *tendu* (*Diospyros melanoxylon* Roxb.), and *Soymida febrifuga* (Roxb.) A.Juss. Additionally, there are mixed forests containing trees, such as teak (*Tectona grandis*), *arjun* [*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.], *sehara* (*Bauhinia retusa* Roxb. ex DC.), *imli* (*Tamarindus indica* L.), *kulu* (*Sterculia urens* Roxb.), *kumbi* (*Careya arborea* Roxb.), *karanj* [*Pongamia pinnata* (L.) Pierre], *kala siris* [*Albizia lebbeck* (L.) Benth.], *kala tendu* (*Diospyros chloroxylon* Roxb.), and *neem* (*Azadirachta indica* A.Juss.); the shrubs and herbs, such as *chironji* (*Buchanania lanzan* Spreng.), *chirayata* (*Achyranthes aspara* Linn.), *sarpgandha* (*Rauvolfia serpentina* Benth. ex Kurz.), *nirgundi* (*Vitex negundo* L.), *van haldi* (*Cucurma amada* Roxb.) and a large number of other medicinal herbs. The ground flora has predominance of *satawari* (*Asaparagus racemosus* Willd.), *kalmegh* [*Andrographis paniculata* (Burm. f.) Wall], *Vitex negundo*, *vasaka* (*Adhatoda vasica* Nees.), *sankhapushpi* (*Evolvulus alsinoides* L.), *Allium cepa* L., winter leek (*A. porrum* L.), *bach* (*Acorus calamus* L.), etc.

Other notable wood species constituting a significant chunk of the middle canopy of

the forests are *bija* (*Pterocarpus marsupium* Roxb.), *saja* (*Terminalia tomentosa* Wight & Arn.), *dhawra* (*Anogeissus latifolia*), *mahua* (*Madhuca indica* J.F. Gmel.; syn. *M. longifolia* Macbride), *tendu* (*Diospyros melanoxylon*), *aonla* (*Emblica officinalis* Gaertn.), *karra* [*Cleistanthus collinus* (Roxb.) Hook. f.], and bamboo (*Dendrocalamus strictus* Nees.). Sal (*Shorea robusta* L.) and teak (*Tectona grandis*) are the two major tree species found all over the region. From the management point of view, the forests of the state of Chhattisgarh are four types, teak, sal, miscellaneous, and bamboo forests, though as per one classification, the state is endowed with about 22 varied forest subtypes.

Agriculture and agrobiodiversity

Recent archaeological excavations in Dantewada, Bastar, caves have unearthed several implements that potentially date back to over 50,000 years (Paleolithic period), reflecting that agriculture was very ancient to the region (Sankhyan *et al*., 2011), though presently the region is crippled with backwardness and poor development in agriculture. Nevertheless, due to reverence towards nature, primitive life style, significant dependence on forest products and influence of Hindu doctrine, the local people have conserved about 58 percent of the land area, which is still under forest including sacred groves called *Deogudi*. Thus, the majority of the area is still covered by forest and only about 19 percent land is under cultivation, despite agriculture being the main source of livelihood and income.

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The rich forest wealth of Bastar has encouraged farmers to develop agro-silvi horticultural pattern of farming systems. Sixty-six to seventy percent of the population is dominated by tribal farmers. Most tribal communities prefer living in isolation with their own way of life, customs, traditions, and moral values, and thus have well been able to retain their unique practices and traditional ways of life even today. For example, the *Marias* and *Abhuj Marias* are mainly semi-nomadic farmers practicing shifting cultivation. After cultivating an area for two to three years, they abandon the land and move to a much fertile location. They also do not plow the earth, as it would mean inflicting pain on 'Mother Earth'. Pointed wood pieces are used for piercing for cultivation and stone implements are used for harvesting produce. They practice hunting, agriculture, and gathering of fruits from the forests. Also, in other parts of the region, the farmers who live in forests cut the trees before the rainy season and plow the land for agriculture and seed rice or other grains. This type of agriculture in district Kanker is called *Marhan* or *Dippa.*

Rainfed agriculture is the traditional farming system, followed even in the cultivation of horticultural crops, like vegetables (both

leafy and tuberous), fruits, medicinal and aromatic plants, and multipurpose plant species, such as *Dendrocalamus strictus* (paper pulp), *Diospyros melanoxylon* (*beedi* leaves), *Schleichera oleosa* (Lour.) Oken (medicinal *kusum* tree, also used for rearing of the lac insect), etc. Depending on topography some of the farming communities practice terrace cultivation. The major crops cultivated are rice, wheat, millets, and pulses. However, they employ very primitive methods of agriculture; hence the agricultural productivity is very low. The cereals are grown in fields on hill slopes or in valleys, while the pulses and horticultural crops are grown in fields or in *Bari*, the kitchen gardens. Most farmers are used to cultivating paddy in the *kharif* season with an intention to grow summer paddy too, depending on availability of irrigation (Fig. 3). The majority of farmers prefer to grow a second crop after paddy, which is generally gram (chickpea), mustard, linseed, and *khesari* (*Lathyrus sativus* L.). The fertile upper basin of the Mahanadi and its tributaries has extensive rice cultivation and farmers have accumulated vast amount of knowledge about their unique genetic variability for a number of economic features and practices associated with cultivation under different agroclimatic conditions (Richcharia and Govindswami, 1990). Rice is also grown in other small pockets, but the yields are poor due to scanty rains. Wheat is cultivated as a *rabi* crop during winter months. Wherever irrigation is not available, millets, pulses, and groundnut are cultivated instead. Generally, *rabi* wheat-gram (chickpea) crop rotation is followed. The *kharif* sorghum, oilseeds, and small millets are the alternate crops to wheat and gram (chickpea). The common cropping systems are as follows: rice–chickpea, rice–lentil, rice–*khesari*, rice–linseed, and rice–sesame.

Figure 3. Traditional subsistence rice cultivation, with rich diversity.

Today most of the tribals (*Adivasis*) practice some sort of agriculture. Traditional multi-layered horticulture-based cropping system is a common component of their farming system. Because of the richness of floristic diversity in forests, every tribe supplements its cultivated food with vegetables, tubers, fruits, seeds, and leaves collected from forest areas growing in the wild (Fig. 2). Jain (1964), based on an ethno-botanical field study during 1960 to 1963, found 88 plants, which are eaten by the tribals of the region. They are classified under vegetables, fruits, nuts, beverages, grains, oilseeds, pickles, sweets, and condiments. This publication includes notes on processing of these foods and some food taboos practiced.

The Southern Bastar plateau is one of the most backward regions with 70 percent tribal population (Government of Chhattisgarh and CALPI, 2007). The region has dense

forests, which are rich in minor forest produce (MFP). Therefore, where farm productivity is poor, the tribal communities of this area traditionally depend heavily on MFP for their livelihood, in addition to agriculture, to support their food and earning by collecting MFP during the off-season. Some of the forest produce is consumed directly, like most edible fruits (*Borassus flabellifer* L., persimmon fruit, *Diospyros melanoxylon* Roxb., *Dillenia pentagyna* Roxb.), some tubers (*Dioscorea hispida* Dennst.) and tender shoots (bamboo), which make up more than 10 percent of their diet. In addition, they collect gum, resin, honey and fruits, seeds, bark, root and tuber, etc. of other plants that have economic or medicinal value, and bamboo, *kosa* cocoons, etc. for handicraft.

Also, the tribal farmers rear small animals such as goats, pigs, and poultry in their backyards in order to supplement their income. The flock sizes are highly variable and range from as low as two hens to ten hens per household (Shinde and Shrivastava, 2006). During the rainy season, fishing is another main activity. The local tribes have developed traditional fishing techniques involving many types of fishing nets, fishing gear, bamboo frame, etc., commonly used in both running as well as stagnant water. These are locally known as *Jali, Gari, Pelna, Thapa, Bisar, Dandar, Sodiya*, etc. and are widely adopted in small to large flow of water for individual or collective form of fishing (Pradhan *et al*., 2011).

Representative species in various crop groups

Cereals, pseudocereals, and millets. Barnyard millet (*Echinochloa frumentacea* Link.), kodo millet or Italian millet [*Setaria italica* (L.) Beauv; *Paspalum scrobiculatum* L.], *kutki* or common millet (*Panicum miliaeceum* L.), little millet (*Panicum sumatrense* Roth), maize (*Zea mays* L.), *mandia* or finger millet [*Eleusine coracana* (L.) Gaertn.], pearl millet [*Pennisetum glaucum* (L.) R.Br.], rice (*Oryza sativa* L.), sorghum [*Sorghum bicolor* (L.) Moench], and wheat (*Triticum aestivum* L., *T. aestivum* ssp. *sphaerococcum* Percival Mackey).

Grain legumes and oilseeds. Black gram [*Vigna mungo* (L.) Hepper], castor (*Ricinus communis* L.), chickpea (*Cicer arietinum*

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L.), green gram [*Vigna radiata* (L.) Wilczek], groundnut (*Arachis hypogaea* L.), horsegram [*Macrotyloma uniflorum* (Lamk.) Verdc.], *khesari* or grass pea (*Lathyrus sativus*), *kulthi* (*Dolichos biflorus*), lentil (*Lens culinaris* Medic), linseed (*Linum usitatissimum* L.), moth bean [*Vigna aconitifolia* (Jacq.) Marechal], niger [*Guizotia abyssinica* (L.f.) Cass.], pigeonpea (*Cajanus cajan* (L.) Millsp), *popat* bean (*Dolichos* spp.), rapeseed mustard [*Brassica juncea* (L.) Hook.f. & Thomson; *B. rapa* L. var. brown sarson], ricebean [*Vigna umbellata* (Thunb.) Ohwi & H.Ohashi], safflower (*Carthamus tinctorius* L.), sesame (*Sesamum indicum* L.), sunflower (*Helianthus annuus* L.), and vetch (*Vicia sativa* L.).

Fodder and fiber crops. Sunnhemp (*Crotalaria juncea* L.), yellow vetch (*Lathyrus aphaca* L.), and velvet bean [*Mucuna pruriens* (L.) DC.].

Vegetables. *Agasti* [*Sesbania grandiflora* (L.) Poir.], *bhindi* [*Abelmoschus esculentus* (L.) Moench], bitter gourd (*Momordica charantia* L.), bottle gourd [*Lagenaria siceraria* (Molina) Standley], chili (*Capsicum annuum* L.), cucumber (*Cucumis sativus* L.), *kachri* (*Cucumis melo* var. *agrestis* Naud.), *kundri* (*Coccinia indica* Wight & Arn.), muskmelon (*Cucumis melo* L.), plantain (*Musa sapientum* L.), pumpkin (*Cucurbita pepo* L.), ridge gourd [*Luffa acutangula* (L.) Roxb.], *sem* [*Lablab purpureus* var. *typicus* (L.) Sweet], and sponge gourd (*L. cylindrica* Roxb.; syn. *L. aegyptiaca* Mill.).

Leafy vegetables. Amaranths (*Amaranthus paniculatus* L.; *A. polygamus* L.; *A. viridis* L.), *Chenopodium album* L., *Ipomoea aquatica* Forsk., roselle (*Hibiscus sabdariffa* L.), etc. and some less-known vegetables.

Rhizome, tubers, and bulbs. Aerial yam (*Dioscorea alata, D. bulbifera* L.), *arun* [*Colocasia esculenta* (L.) Schott], cassava (*Manihot esculenta*), elephant foot yam [*Amorphophallus campanulatus* (Roxb.) Bl.; *A. paeonifolius* (Dennst.) Nicolson], greater yam (*Dioscorea alata* L.), sweet potato (*Ipomoea batata* (L.) Lam.), yam (*Dioscorea pentaphylla* L., *D. wightii* Hook.f.); other useful tubers – *dhova* or *tenyia* (*Xanthosoma* Schott spp.), East Indian arrowroot (*Curcuma angustifolia* Roxb.), *keaukanda* or *keth* (*Costus speciosus* Sm.), *tikhur* (*Zingiber roseum* Roscoe), *vidarikand* or *didari* (*Pueraria tuberosa* DC.), and edible wild tubers – *bharakanda* or trifoliate yam (*Dioscorea pentakila* Surenda.), *Dioscorea* L. spp., *kulihakanda* (*D. hispida*); mango ginger (*Curcuma amada*), *pitkanda* or bitter yam [*D. dumetorum* (Kunth) Pax.], etc.

Fruits. *Alangi* [*Alangium salviifolium* (L.f.) Wangerin], *aonla* (*Emblica officinalis*), *bael* [*Aegle marmelos* (L.) Correa ex Roxb.], *ber* (*Ziziphus mauritiana* Lam.), *karaunda* (*Carissa carandas* Lour.), *Cordia obliqua* Heyne ex DC., custard apple (*Annona reticulata* L.; *A. squamosa* L.), *Dillenia pentagyna*, *imli* (*Tamarindus indica*), jackfruit (*Artocarpus heterophyllus* Lam.), *jamun* [*Syzygium cuminii* (L.) Skeels], *jangali ber* (*Ziziphus rugosa* Lam.), *katai* [*Flacourtia indica* (Burm.f.) Merr.], persimmon fruit (*Diospyros melanoxylon*) and *Solanum torvum* Sw.

Spices. Ginger (*Zingiber officinale* Rosc.), *Piper longum* L., and turmeric (*Curcuma longa* L.).

Other crop species. *Jasmine* (*Nyctanthes arbor-tristis* L.), *kamala* (*Mallotus philippinensis* Muell.), lemon grass [*Cymbopogon martinii* (Roxb.) Wats.], *palas* [*Butea monosperma* (Lank.) Taub.], sugarcane (*Saccharum officinarum* L.), *Woodfordia fruticosa* Kurz., etc.

Medicinal plants. The forests of the region are known for medicinal plant diversity at the global level (Fig. 2). Dr HF Muni carried out a survey of the medicinal plants of Dantewada between 1938 and 1943 and was awarded a PhD for the survey and documentation of the medicinal plants as the eighth richest area in the world. As the region is full of diverse terrains and much of the forest remains unexplored, it is highly probable that this area contains some undocumented species. Mr Bharat, a highly decorated retired Forest Officer, listed a total of 166 plants with medicinal properties in the database created by him (Source: www.dantewada.gov.in/medi.htm). Some common knowledge medicinal plants of the region are *antmul* [*Tylophora indica* (Burm.f.) Merr.], *aonla* (*Emblica officinalis*), *arjun* (*Terminalia arjuna*), *babchi* (*Psoralea corylifolia* L.), *bach* (*Acorus calamus*), *bael* (*Aegle marmelos*), *baheda* [*Terminalia bellirica* (Gaertn.) Roxb.], *Baliospermum montanum* (Willd.) Muell., *bharang* [*Clerodendron serratum* (L.) Moon], *bijasal* (*Pterocarpus marsupium*), *brahmi* [*Bacopa monnieri* (L.) Pennell], *chitraka* (*Plumbago zeylanica* L.), *Cissus quadrangularis* L., *dronpushpi* (*Leptadenia reticulata* Wight & Arn.), *geloi* [*Tinospora cordifolia* (Willd.) Hook.f. & Thomson], *Gloriosa superba* L., *Gymnema sylvestre* R.Br., *harda* (*Terminalia chebula* Willd. ex Flem.), *Helicteres isora* L., *Hemidesmus indicus* (L.) R.Br., *hingol* [*Balanites aegyptiaca* (L.) Del.], *ishwarmul* (*Aristolochia indica* L.), *jyotismati* (*Celastrus paniculatus* Willd.), *kali musali* (*Curculigo orchioides* Gaetrn.), *kalmegh* (*Andrographis paniculata*), *keukand* [*Costus speciosus* (Koen ex. Retz.) Sm.], nux vomica (*Strychnos nux-vomica* L.), *palas* (*Butea monosperma*), *Piper longum*, roselle (*Hibiscus sabdariffa*), *ramdataun* (*Smilax macrophylla* L.), *safed musali* [*Chlorophytum borivillianum* Santapau & Fernandes and *Chlorophytum* spp.], *sarpgandha* (*Rauvolfia serpentina*), *sankhapushpi* (*Evolvulus alsinoides*), *saptparna* [*Alstonia scholaris* (L.) Br.], *satawari* (*Asparagus racemosus*), *shivlingi* (*Bryonia laciniosa* Linn.), *Spilanthes acmella* L., *van haldi* (*Cucurma amada*), *vasaka* (*Adhatoda vasica*), *kevatch* or velvet bean (*Mucuna pruriens*), *Vitex negundo,* winter leek (*Allium porrum*), *Woodfordia fruticosa, Wrightia tinctoria* R.Br., etc.

Timber. *Bija* (*Pterocarpus marsupium*), *dhawra* (*Anogeissus latifolia*), *saja* (*Terminalia tomentosa*), sal (*Shorea robusta*), and *teak* (*Tectona grandis*).

Multipurpose species. *Agasti* [*Sesbania grandiflora* (L.) Poir.] (leafy vegetable, fodder, fuel wood, medicine), *Artocarpus heterophyllus* (wood and fruit), *Dendrocalamus strictus* (wood and paper pulp), *Diospyros melanoxylon* (wood and *beedi* leaves), *kultha* (*Dolichos biflorus* L.) (food, fodder, medicinal), *Madhuca*

longifolia (edible fruits and flowers, and brewing), *Phoenix humilis* Royle ex Becc., and *Schleichera oleosa* (host for rearing the lac insect).

Minor forest products. In addition to gum, resins, and honey, some common MFP collected by tribes are fruits like *chironji* (*Buchanania lanzan*), *karaunda* (*Carissa carandas*), *shikakai* [*Acacia concinna* (Willd.) DC.], tamarind, *aonla*; seeds of mango (*amchur*), *peng*, *karkatiya*, *nirmali*, *charota*, *karanj*, *bhilwan*; medicinal plants such as *chirayta*, *harra*, *baheda*, *vaybidang*, *ghot pal*; multipurpose plants, *mahua*, bamboo, *ambadi*, *tora*, *dhavai phool*, and *kosa* cocoons.

Wild relatives of crop species. *Abelmoschus crinitus* Wall., *Allium porrum, Cajanus cajanifolius* (Haines) Maesen, *C. scarabaeoides* (L.) Thours, *C. sericeus* (Baker) Maesen, *Cucurma amada, C. pseudomontana* J.Graham, *C. angustifolia*, *C. zedoaria* Rosc., *Dioscorea* L. spp. (7), *Grewia* L. spp. (3), *Indigofera pulchella* Roxb., *Momordica balsamina* L., *M. tuberosa* (Roxb.) Cogn., *Oryza granulata* Nees & Arn. ex Watt, *O. nivara* Sharma & Shastry, *O. rufipogon* Griff., *Phoenix humilis* Royle var. *pedunculata* Beog., *Solanum surattense* Burm. f., *S. torvum* Sw., *Vigna pilosa* (Klein ex Willd.) Baker, *Ziziphus oenoplia* Mill., and *Z. rugosa* Lam.

Endemic species. The region is considered rich in endemism, particularly for those species, known for medicinal properties. Some species considered endemic are *Acacia donaldii* Haines, *Albizia orissensis* K.C.Sahni & Bennet, *Cajanus cajanifolius* (syn. *Atylosia cajanifolia* Haines), *Desmodium tortuosum* (Sw.) DC., *Erythrina resupinata* Roxb., *Hoya wightii* Hook.f., *Oryza nivara, Tephrosia roxburghiana* J.R.Drumm, and *Uraria prunellaefolia* Baker. The third Conservation Assessment and Management Plant (CAMP) workshop for southern Indian medicinal plants held at Bangalore in January 1997 recorded *Sophora bakeri* Prain, *khip* (*Crotalaria trifoliustrum*), *pitharan* (*Uraria prunellaefolia* Baker), *kevatch* (*Mucuna imbricata* DC.), *Vigna pilosa, Nogra* Merr. spp., *Lespedeza* Michx spp., *Hoya wightii, sarivan* [*Desmodium tortuosum* (Sw.) DC.], *pangra* (*Erythrina resupinata* Roxb.) as endemic, and as either rare or critically endangered (Source: www.cgvanoushadhi.gov.in/Endangered%20spices.htm). A representative set of economic plant species endemic to the region are listed in Table 1.

Threatened species. Roy and Chaturvedi (1987) and Kumar and Sikarwar (2002) studied the rare and endangered plants of Bastar and reported that over-exploitation, invasive species and encroachment have been causing severe threats to native plants and their habitat. They reported that *Caryota urens* L., *Costus speciosus, Dendrobium peguanum* Lindl., *Drosera burmannii* Vahl, *Eulophia* R.Br. sp., *Gloriosa superba*, *Gymnema sylvestre*, *Rauvolfia serpentina*, *Riccia fluitans* L., *Strychnos nux-vomica*, and *Vitex leucoxylon* L. have declined in the area. A floristic study of seven districts of Chhattisgarh, including Bastar, was made by the National Botanical Research Institute, Lucknow, identifying 45 species as endangered, of which the following economically important species are critically endangered and vulnerable: *aini* (*Artocarpus*

Table 1. Representative economic species endemic to the Bastar region.

Plant species	Family	Habit	Distribution	Remarks
Acacia donaldii	Mimosaceae	Tree	Northeastern Ghats	Therapeutic use
Albizia orissensis	Mimosaceae	Tree	Bastar and Koraput	Wood, food for larvae
Cajanus cajanifolius	Fabaceae	Shrub	Bastar and Koraput	Genetic resource
Crotalaria trifoliustrum	Fabaceae	Shrub	Raigarh	Medicinal
Desmodium tortuosum	Fabaceae	Herb to shrub	Chhattisgarh	Medicinal
Erythrina resupinata	Fabaceae	Herb	Chhattisgarh (marshy)	Medicinal
Hoya wightii	Asclepiadaceae	Perennial creeper	Bailadilla	Medicinal
Mucuna imbricata	Leguminosae	Undershrub	Raigarh	Medicinal
Sophora bakeri	Leguminosae	Tree	Jaspur	Medicinal
Tephrosia roxburghiana	Leguminosae	Herb	Jaspur	Medicinal
Uraria prunellaefolia	Fabaceae	Shrub	Bastar	Medicinal root extract
Vigna pilosa	Leguminosae	Vine	Raigarh	Genetic resource

hirsutus Lamk.), *chandan* (*Santalum album* L.), *Curcuma pseudomontana, dantt* (*Baliospermum montanum* Muell.), *hulhul* (*Cleome burmanni* Wight & Arn.), *koha* (*Terminalia arjuna*), *mahua* (*Madhuca longifolia*), *nirgundi* (*Vitex trifolia* L.), *Oryza nivara, pen* (*Celastrus paniculatus* Willd.), *ramdataun* (*Smilax zeylanica* L.), *ritha* (*Sapindus laurifolius* Vahl.), *tendu* (*Diospyros paniculata* Dalz.), and *vai-virang* (*Embelia tsjeriam-cottam*). The species diversity is also threatened by alien invasive species such as *Lantana camara* L. and *Eupatorium adenophorum* Hort.Berol. ex Kunth. In addition, Govekar (2008) has reported some of the relatively rare species from Bastar and East Gadchiroli, which include *Naravelia zeylanica* DC., *Canseja rheedii*, *Osbeckia muralis* Naudin, *Canscora heteroclita* (L.) Gilg, *Hygrophila balsamica* (L.f.) E.Hossain, *Rhenacanthus nasutus* L., and *Amorphophallus sylvaticus* (Roxb.) Kunth. (Source: www.cgvanoushadhi.gov.in/Endangered%20spices.htm). Table 2 lists a set of representative economic plant species under threat from the region.

Chhattisgarh is possibly the last home of genetically un-swamped and critically endangered wild buffalo (*Bubalus bubalis* L.) and Bastar myna (*Gracula religiosa* L.), which have been declared as the State animal and State bird respectively.

Associated culture and tribes

Traditionally the area is known from ancient times, and has been referred in the Indian epics. It was considered to be a part of

Table 2. Representative economic species under threat in the Bastar region.

Plant species	Family	Habit	Threat level[1]	Use
Artocarpus hirsutus	Moraceae	Tree	VU	Medicinal
Baliospermum montanum	Euphorbiaceae	Shrub	VU	Medicinal
Celastrus paniculatus	Celastraceae	Climber	VU	Medicinal
Cleome burmanni	Capparaceae	Herb	DD	Medicinal
Curcuma pseudomontana	Zingiberaceae	Corm	VU	Genetic resource; 'mother' of turmeric
Diospyros paniculata[2]	Ebenaceae	Tree	VU	Food
Embelia tsjeriam-cottam	Myrsinaceae	Herb to shrub	VU	Medicinal
Madhuca longifolia	Sapotaceae	Tree	EN	Multipurpose species
Santalum album	Santalaceae	Tree	EN	Wood, medicinal
Sapindus laurifolius	Sapindaceae	Tree	DD	Pharmaceutical, cosmetic
Smilax zeylanica	Liliaceae	Woody shrub	VU	Pharmaceutical
Terminalia arjuna	Combretaceae	Tree	DD	Bark medicinal
Vitex trifolia	Verbenaceae	Shrub to tree	DD	Medicinal

1. EN = Endangered; VU = Vulnerable; DD = Data deficient.
2. Notified by the Ministry of Environment and Forests (MoEF), Government of India.

the Dandakaranya region of the kingdom *Dandak–Janpad* mentioned in the *Puranas*. The region is inhabited by Indo-Aryan, Austric, and Dravidian races. The region is famous for its unique and varied tribal populations: 66 percent of the population is dominated by tribal groups, including the world-famous *Gond* tribe, having a rich cultural heritage dating back to thousands of years. The tribal population is mainly confined to rural areas as 98 percent of them live in villages. The tribal population is not a single homogenous society. There are seven major scheduled tribes: *Gond*, *Muria*, *Maria*, *Dhorla*, *Bhatra*, *Halba*, and *Dhurva*. The tribal communities possess a considerable degree of heterogeneity, though they tend to live in homogeneous groups covering distinct and defined territories. *Gonds* are the largest tribal group in terms of population. The *Gonds* of Bastar area are one of the most famous tribes in India, known for their unique *Ghotul* system of marriages. The *Halbas* are mainly farmers and derive their name from the word *hal*, which means plow. The *Murias* are neat, industrious, and good cultivators who constitute the major bulk of the tribal population and derive their name from *Moolnivasi*, the original inhabitants. There are three categories of *Murias – Raj Muria*, *Ghotul Muria*, and *Jhoria Muria*. The *Maria* or *Madia,* derive their name from *madia*, a word *mad* of the Gondi dialect, which means the hills. Therefore, *Madias* are mostly from the hills. They have two categories, *Abujj Madias* and *Dandami Madias*. *Abujj Madias* are confined to the

Narayanpur district and hills. People of the group that left the hills and inhabit the plains of Bastar, i.e., Bijapur and Dentewada, are called *Dandami Madias* or *Bison Horn Madias*. The *Bhatras* are considered a well advanced tribe of Bastar. The king used to address them as *Bhadr* (civilized). The *Dorlas* are mainly confined to Konta and Bhopalpattanam areas. Their dialect *Dorli* is highly influenced by the Telugu language, suggesting that they probably migrated from the Warangal region of Andhra Pradesh. People of the *Dhurva* tribe are found mainly in Darbha and Chintgarh areas, and are known for their courage and bravery.

The region is known for its sacred groves, as most tribes have great respect for plants and trees, because of the belief that plants are homes of gods and goddesses, and the highest sanctity is attached to the venerated trees, particularly those used in religious rituals and medicine. The tribal communities believe that if these plants are not maintained properly in the *Deogudi* (sacred groves) or destroyed, the gods and goddesses residing in them will become angry and invoke natural calamities to ruin their communities. Thus, the traditional *Deogudi* have played a vital role in the conservation of plant biodiversity of the region and protection of forests, and therefore, the local tribes can be credited with the development of the tribal concept of conservation of biodiversity and/or forest management (Rai and Tripathi, 2008).

All these tribes living in interior villages lead a very primitive lifestyle with traditional agriculture as the main source of income. The traditional agriculture suffers from poor productivity and therefore the tribes are dependent on forest products as well, for their livelihood. The weekly *haats* are an indispensable integral part of *Adivasi* life, and each village has its own *haat*, where villagers come to buy salt and tobacco, barter their MFP (Fig. 4), meet friends and relatives, catch up with news, gossip, and entertain themselves on cockfights, the star attraction. These *haats* also serve as a vehicle for the exchange of seeds, by lending the seeds of new varieties developed/selected or preserved by different tribal groups/farmers. These are some valuable traditions of the tribes/farmers

Chhattisgarh is possibly the last home of genetically un-swamped and critically endangered wild buffalo* (Bubalus bubalis) *and Bastar myna* (Gracula religiosa), *which have been declared as the State animal and State bird respectively.

Figure 4. A family of the *Gond* tribe of Bastar at the local *haat* market, with their minor forest produce.

that are evolved, considering it as the social response of the local people against market forces. The *Gonds* and *Murias* are famous for their *Ghotul,* a village dormitory where teenagers of both sexes live and undergo a transition to adulthood under the supervision of elders. Though the broader cultures have made impact on Bastar, nevertheless, the region has retained the uniqueness of its culture in many respects.

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Technology and products

The region is traditionally known as the Rice Bowl of India. The terrestrial heterogeneity, creating diversity in agroecology has helped the local communities of the region in shaping suitable agricultural practices from ancient times. The notable variation in the agroeco-climatic conditions, topography with toposequences, soil, and hydrology coupled with variation in cultural heritage of the inhabitants has resulted in the evolution of significant levels of genetic variability in the local germplasm (Richharia, 1979). Over 20,000 rice varieties have been recorded from Chhattisgarh (Fig. 3). These have evolved because of efforts of rice farming indigenous communities, making selection and adaptation of a variety to soil, water, and micro-ecosystem conditions, including predators, for centuries. For example, the Rajnandgaon district alone has recorded the cultivation of about forty local varieties by traditional farmers: *Ajania gaja*, *Asam chudi*, *Baikoni*, *Bako ajaan*, *Bako manjri*, *Bansb bhira*, *Bhata safri, Budhia bako*, *Chhid ghofa*, *Chirai guda*, *Chirai nakkhi*, *Dhania*, *Dhunraj masuri*, *Dub raj*, *Gaja guda*, *Gandho*, *Dabar*, *Gurmatia desi*, *Gurmatia gol*, *Gurmatia Nagpuri*, *Kali*, *Kalsa jhool*, *Kanthi*, *Katasela*, *Khurabal*, *Kolihapuri*, *Kolyari Chitrakoot*, *Lalu dhan*, *Lochai*, *Mejri*, *Mudria*, *Nan keshar*, *Nau mohar*, *Ramni*, *Rampuri*, *Safri*, *Satia*, *Terhgi*, and *Uraibuta*. Pandravada *et al.* (2004) have further listed *Atia, Badshah bhog, Baghthado, Barangi chudi, Basua bhog, Bata mokdo, Batta dhan, Bhus katia, Bobbili gantlu, Budama vadlu, Chalka vadlu, Chipti, Chitti mutyalu, Chudi dhan, Duppi tokalu, Ekhlo, Erra vadlu, Goranka mukkulu, Goyandhi dhan, Jadanga, Kakdo, Kanai, Kare budama, Kurso bhog, Lal mhokudo, Lalu, Mach kanta, Metta sannalu, Mokhdo, Nalla vadlu, Neem chudi, Parbhat jeera, Pedda vadlu, Roti singaralu, Samudro chila, Sindhu ayalu, Sunasheri*, and *Umer chudi* as common knowledge traditional varieties from the region.

The late Dr RH Richharia, one of the foremost rice scientists of India, initiated systematic rice germplasm collection in the erstwhile undivided Madhya Pradesh between 1972 and 1981, and collected a total of 18,541 accessions of rice, generally referred as the Raipur Collections, maintained at the Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur and at the National Bureau of Plant Genetic

Resources (NBPGR), New Delhi. During his contacts with local farmers in remote tribal areas, which were untouched by the official agriculture development programs, he observed a high level of skills among the farmers taking comparable or higher yields from indigenous rice varieties, compared to the high-yielding varieties (HYVs). Farmers possessed detailed knowledge about genetic diversity/properties of each of these varieties. Some of them were remarkable for high yields, some for supreme cooking qualities, some for aroma, and some were cherished for other qualities. In the late 1970s, Dr Richharia wrote: "A recent varietal cum agronomic survey has shown that only nine percent of the total varieties grown in [Madhya Pradesh] fall under the category of HYV types (3,705 kg and above per hectare)." On the basis of these observations, he concluded that as the existing local practice of cultivation has emerged after centuries of experience, based on trial and error, therefore, the indigenous varieties are sounder, and have wider acceptance and greater resilience against various stresses. In farming practices, the traditional mixed farming systems consisting of man, animals, trees (including grasslands), and agricultural fields were inseparable, as the harmoniously placed components of a single agroecosystem working in synergy (Dogra, 1983). Based on similar experience, more than a century ago, the well-known English scientist JA Voelcker wrote the same: "I believe that it will be possible here and there to graft onto native practice, the results of the western experience, but the main advance will come from an enquiry into native agriculture, and from the extension of the better indigenous methods to parts where they are not known or employed" (Dogra, 1983). There are examples, to support this, where a farmer planting a rice variety called *Mokdo*, using his own cultivation practices obtained about 3,700 to 4,700 kg of paddy per hectare, while another farmer belonging to the *Dhamtari* block (Raipur), with just one hectare of rice, obtained about 4,400 kg of paddy per hectare from the *Chinnar* variety, a renowned scented type, year after year.

The value of the traditional farming systems, based on indigenous agricultural knowledge and resilience of farmers' varieties was again experimentally validated by Singh (2007), under rainfed rice-based farming systems. He reported that indigenous practices of rice crop management vary in degree between the *Halba* and *Gond* tribes considering the variability in biophysical and socio-cultural conditions, but most of the indigenous varieties are tolerant to disease and insect pests. The varieties like *Lal hazari, Lodiyari, Mancha, Vasta bhog, Saprichuri, Kanta gurmatiya, Gurmatiya, Barai, Dubraj early, Kharela, Kalchar, Sindur singar, Khujje (early), Para*, and *Luchai* were tolerant to drought and insect pests, while landraces *Hardi gati, Banse*

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bad, Sapri, Gada khutta, Dubraj late, Log machhi, Suriya, Khujje (Lal), Sakari, Asam churi, and *Madhuri* were tolerant to waterlogging and insect pests, thereby they help to reduce expenditure on farming and increase the cost/benefit ratio. Singh (2007) further noted that farming practices are also providing opportunities to manage the gene flows between different varieties and to conserve the important genes for future crop improvement. Indigenous methods of selecting and conserving local paddy varieties included the selection of desirable plants/trees/shrubs and cultural practices of seed selection and preservation, and location-specific management, which contributed significantly towards sustainable agriculture, corroborating the observations on traditional agriculture from other parts of the world (Sibanda, 1998). For these reasons, several researchers (Brush, 1990; Sillitoe, 2001; Prakash, 2003; and Singh, 2010) have emphasized that the protection of such indigenous knowledge could help in the development of innovative systems with a focus on effectively combining the sustainability and conservation elements of traditional systems with the technological advancement of scientific farming systems, for greater efficiency and affectivity.

Paddy cultivation in the Bastar region still relies upon valuable indigenous knowledge of the peasants. The crop cycles of different varieties have been closely understood, and only the suitable varieties having compatible crop cycles are grown in the areas with particular geoclimatic conditions. For instance, in the irrigated plains, varieties having a crop cycle of 120 days are generally grown. On rainfed lands, only the varieties having a crop cycle of 90–100 days are grown. In the traditional waterlogged lands, the varieties having a shorter crop cycle, i.e., 60–65 days are cultivated. Varieties requiring transplantation are usually not grown in waterlogged and rainfed lands. In the terrace systems, the upper levels are cultivated with meticulously selected drought-tolerant paddy landraces, and the lowermost levels are cultivated with flood-tolerant types. Despite this, and the experimental validation by Singh (2007) contradicting the general perceptions about the low-yielding capacities of traditional varieties, these varieties are being lost to market forces promoting so-called HYVs with focus only on yield without giving due weightage to other economic gains and environmental services. This insidious development, in addition to the genetic erosion with the loss of traditional varieties, has also been causing tremendous loss of traditional knowledge associated with traditional agroecosystems and production practices. Nevertheless, many traditional farmers still grow countless such local varieties of rice for their quality features, which have premium price, negating the pressures of globalization (Fig. 3). Also, efforts have been made by farmers' organizations such as *Dharohar Samiti*, which have conserved over 260 traditional rice varieties along with varieties of other crops, such as minor millets (*ragi*, *kodo*, and *kutki*).

The rice cultivated in the region is globally known for variability in grain size, aroma, and medicinal value and genotypes suited for making *kheer* (Indian pudding), evolved and perfected by the locals over time. These genotypes have been selected for small grain

size and aroma, and are suffixed with '*bhog*' in their name. Many of these traditional varieties such as *Basabhog* and *Asamchudi,* have the potential to yield up to 7 to 8 tons per hectare under the System of Rice Intensification (SRI), which is as good as any HYV in the market. With the application of similar strategies – observation for desired traits, repeated selections, advancement to uniformity and multiplication – the farming communities over the years have evolved significant genetic diversity for several traits, resulting in the development of a large number of traditional varieties. For example, short-duration and photoperiod-insensitive primitive upland landraces, such as *Tikradhan* (for rainfed upland conditions), *Jag phool* (smallest grain), *Dokra dokri* (longest grain), *Hathi panjara* (two grains in one floret), *Naargoidi* (submergence-tolerant, which can grow in up to 10 feet of water), and *Gurmutiya* (purple stem); varieties with medicinal value, such as *Aalcha* (effective against pimples), *Karhani* (against paralysis), *Meharaji* and *Liacha* (against weakness in pregnant women), *Bassior* (against headache and epilepsy), *Sonth, Gaduwan* (against rheumatism), *Regbhadder* (against gastric ailment), *Serei* (effective as tonic), etc.; cultivars such as *Bhejri*, which when fed to cows, is believed to help quick release of the placenta during calving (Das and Oudhia, 2001); and the *Nagkeshar* group of rice varieties, utilized for eradicating wild rice (*Karga*), an age-old practice in Chhattisgarh. Of these, there are about 42 varieties that are so much adapted to the local practice of rice cultivation and extremely indispensible, despite being comparatively low yielders, because of their specialized functions of facilitating an indirect increase in the yields. For example, types such as *Assam chudi* and other *chudi* types are mostly confined to the Bastar region, because of climatic preference and being tolerant to water-lodging and insect pests. Types such as *Nariyal chudi* yield as high as 42 bags per acre (7,780 kg ha^{-1}), and *Naina Kajal,* an early-maturing rice variety, gives similar yields. Consequently, around 5,000 landraces are reported from the region. This genetic diversity is further enriched by the presence of wild relatives such as *Oryza rufipogon* and *O. nivara*, which contribute useful genes to rice breeding. The Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur has issued a series of publications documenting the genetic variability for various characteristics available in the farmers' varieties and landraces of the region.

The local communities have also exploited the diversity of terrestrial heterogeneity and agroecology over generations in developing varieties and landraces in other crops as well, suited to different geoclimatic and socioeconomic conditions. *Maghi* sorghum cultivation, which is basically a practice of early *rabi* sowing, is unique to the Khammam district of Andhra Pradesh. Generally, the sowings are taken up during August when the southwest monsoon is active in this part and the produce is harvested in December (Pandravada *et al.,* 2004). In minor millets, the local landraces represent significant variability

Paddy cultivation in the Bastar region still relies upon valuable indigenous knowledge of the peasants.

for stem pigmentation, tillering, ear length, grain size, etc. The region, along with Koraput is also the center of origin (domestication) of pigeonpea, whose closest wild relative and most probable ancestor *Cajanus cajanifolius*, which differs from cultivated species by a single feature, the presence of seed strophiole, is found here (Remanandan and Singh, 1997). Terrace cultivation has allowed the cultivation of diverse types of the same crops in different terraces. This process allows natural cross-pollination of different strains in cross-pollinated crops producing hybrid populations and allowing the farmer to select the best strain with the desired traits from segregating populations. Farming communities have made selections in naturally occurring interbreeding populations between cultigens and wild relatives in the case of pigeonpea, involving wild *Cajanus cajanifolius, C. scarabaeoides,* and *C. albicans*, in sesame involving *Sesamum indicum* with *S. mulayanum*, and in vegetable crops, such as brinjal (eggplant), involving wild *Solanum* species and *S. melongena*, releasing variability for fruit size, color, and shape.

For *chironji* (almondette tree; *Buchanania lanzan*), which is native to central India, the region has wide diversity for panicle, fruit size, and quality of kernel, and also in *Carissa carandas,* variability has been exhibited in fruit characteristics, particularly the flesh, which is present both in white and red color (Vashishtha *et al*., 2005).

In addition, the forests of the region offer a rich floristic and genetic diversity in plant species that are used as alternative foods by the local tribes (Fig. 2). Of the 88 plants used by the local people for food, around 50 are vegetables, 29 fruits, 8 nuts, 4 grains, 3 oilseeds, etc., including diverse species in *Bauhinia* (3), *Dioscorea* (7), *Diospyros* (2), *Ficus* (3), *Grewia* (3), *Ziziphus* (3), etc., with significant genetic diversity offering a reservoir of genetic resources in these species (Jain, 1964). Similarly, with regard to medicinal plants, a recent survey conducted by Nanda and Shaw (2008) observed the maximum diversity for *Chlorophytum* spp. in the eastern and southern regions of Abujhmar, some pockets of the Machkot range, in the river valley of Bhopalpatnam, Barsur, and the Kotumsar cave forests of Bastar. *Gloriosa superba* has been observed with maximum diversity in forests surrounding Sukma, eastern Abujhmar, Cheetapadar, and Tiriya forests. The occurrence of some other important species, *Dioscorea* spp., *Amorphophallus* spp., *Colocasia* spp., *jangli angoor* or *datte lata* (*Ampelocissus arnottina* Pleach), and *dokar bela* or *duthila kanda* (wild *Vitex* sp.) was recorded in all the forests with the maximum level of diversity in the forests of Abujhmar hills, Machkot, Gupteswar river forest, Binta forests, Sukma, Kanger Ghatti, Bhopalpatnam, Barsur, and Dantewara. *Ramdatoun* (*Smilax macrophylla*) was found with moderate occurrence, but with maximum occurrence in the forests of Abujhmar, Machkot, Tiriya, Kotumsar, and Barsur. However, considering the density and diversity, medicinal species such as *Gloriosa superba*, *Chlorophytum borivillianum*, *C. laxum*, *Aristolochia indica* L., *Dioscorea hispida*, *D. rotundata* L., *Smilax macrophylla*, *Andrographis paniculata*, and *Rauvolfia serpentina* appeared to be endangered and with location-specific diversity. *Piper*

longum is noted to be endangered except in the river valleys of Abujhmar, Tiriya and Gupteswar surroundings, where it was observed to a considerable extent.

To overcome the postharvest constraints, local people have developed some ingenious methods. For example, in kodo millet, the major constraint is the milling of the grains. Milling drudgery is associated with upper husk sticking to the endosperm tightly, which reduces the efficiency of grain recovery from each spikelet. The indigenous mill *jatta* is made out of well-mixed soil and straw that helps to check deflocculation while working (Verma and Mishra, 2010).

The *Haat Bazaar* facilitates exchange of MFP and seeds, besides the trade of local cuisines, like *salphi* (sap of fish-leaf, sago-palm), *mahua* (a local brew), which happens to be very heady, and *landa* (rice beer) evolved and perfected by the local tribals.

Future perspective

The ignorance and lack of appreciation for traditional knowledge in the region is leading to great damage to both the biodiversity and crop diversity. As the local saying goes, "*When human is ignoring human, then who will understand the problem of the worried Bastar Myna searching for his nest in the dense population of exotic trees of cashew and eucalyptus?*" Ignorant of these facts, today's planners are promoting the plantation of exotic cashew and many other forestry tree species at the cost of well-adapted local species, non-evaluated, but with greater economic significance. Similarly, under the guise of modernization, agricultural researchers and extension workers are forcing the cultivation of high-yielding rice varieties, replacing the cultivation of traditional millets such as *kodo*, *kutki*, *ragi*, etc., despite the established resilience and sustainable yields of these crops. If plantation is a must, it should be preferably done with native plants of greater adaptability and traditional economic value. For example, instead of concentrating on *Jatropha* for biodiesel, the focus should be on native species such as *karanj* (*Pongamia pinnata*), which has immense potential and grows naturally in Bastar, or on endangered indigenous species such as *sulfi* (*Caryota urens*), which yields the traditional drink *Bastar Beer*.

To facilitate the cultivation of traditional crops and varieties, there should be an effort to improve and rebuild the traditional systems, particularly those of mixed farming with integration of traditional practices with technological advancements, promoting synergies between agriculture, forestry, animal husbandry, etc., at the village and block level.

The tribals of the region have identified a large number of alternative sources of food and herbal medicine, but almost no systematic attempt has been made to develop information on their comparative utility and anti-nutritional elements to recommend them with confidence as source of food, wellness or in health care, to enable industry to take up large-scale production. These aspects need attention from food and nutrition, and pharmacognosy scientists.

Lastly, in addition to the erosion of biodiversity and crop diversity, the local

land is highly susceptible to soil erosion. There are problems of partial waterlogging because of torrential rains during the rainy season in the early stages of crop growth on the one hand, and seasonal drought at crop maturity on the other, affecting crop productivity. These trends demand research on better management of not only bioresources, but also other natural resources, primarily water.

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References

Brush SB. 1990. Diversity and change in Andean agriculture. In: Lands at Risk in the Third World (Little PD, Horowitz MM, and Nyerges AE, eds.). Westview Press, Boulder, USA. pp. 271–289.

Das GK and **Oudhia P.** 2001. Rice as a medicinal plant in Chhattisgarh (India): a survey. Agricultural Science Digest 21:204–205.

Dogra Bharat. 1983. Traditional agriculture in India: high yields and no waste. The Ecologist 13 (No. 2/3):84–87.

Govekar R. 2008. Vegetation characteristic and special habitats in the transition zone of Vidarbha-Dandakaranya, Deccan Plateau. In: Special Habitat and Threatened Plants of India (Rawat GS, ed.). ENVIS Bulletin Wildlife and Protected Areas Wildlife Institute of India, Dehradun, India, Vol. 11(1):155–162.

Government of Chhattisgarh and **CALPI.** 2007. Livestock and Poultry Sector in Chhattisgarh: Present Status and Approach for Future Development. South Asia Pro Poor Policy Programme: A joint initiative of NDDB and FAO, New Delhi, India. 4 pp.

Jain SK. 1964. Wild plant-foods of the tribals of Bastar (Madhya Pradesh). Proceedings of the National Institute of Science, India, Vol. 30B(2):56–80.

Jha AK and **Khanna KK.** 2005. Plant wealth (Angiosperms) of Kanger Valley National Park, Bastar (Chhattisgarh). Phytotaxonomy 5:12–31.

Kumar V and **Sikarwar RLS.** 2002. Observations on some rare and endangered plants of Chhattisgarh State, India. Phytotaxonomy 2:135–142.

Nanda HC and **Shaw SS.** 2008. Diversity of medicinal and tuber bearing plants in Bastar Plateau of Chhattisgarh. Indian Journal of Plant Genetic Resources 21(2):98–112.

Pandravada SR, Sivaraj N, and **Varaprasad KS.** 2004. The changing pattern of plant biodiversity in the Eastern Ghats. In: Plant Genetic Resource Management (Dhillon BS, Tyagi RK, Lal A, and Saxena S, eds.). Narosa Publishing House, New Delhi, India. pp. 136–152.

Pradhan A, Nag SK, and **Patil SK.** 2011. Traditional fishing techniques of tribes in Bastar region of Chhattisgarh. Indian Journal of Traditional Knowledge 10(2):386–387.

Prakash S. 2003. Nurturing Traditional Knowledge Systems for Development. IK Notes No. 61, October 2003. The World Bank Programme on Indigenous Knowledge for Africa Region's Knowledge and Learning Center, Washington, DC, USA. 4 pp.

Rai R and **Tripathi SP.** 2008. Deogudi sacred grove – a tribal concept of conservation of plants

in Bastar District, Chhattisgarh. Indian Forester 134(12):1686–1695.

Remanandan P and **Singh L.** 1997. Pigeonpea. In: Biodiversity in trust – conservation and use of plant genetic resources in CGIAR center (Fuccillo D, Sears L, and Stapleton P, eds.). Cambridge University Press, Cambridge, UK. pp. 156–167.

Richharia RH. 1979. An aspect of genetic diversity in rice. Oryza 34(3):209–212.

Richcharia RH and **Govindswami S.** 1990. Rices of India. Academy of Development Sciences, Karjat, Maharashtra, India.

Roy GP and **Chaturvedi KK.** 1987. Less known medicinal uses of rare and endangered plants of Abujh-marh reserve area, Bastar (M.P.). Journal of Economic and Taxonomic Botany 9:325–328.

Sankhyan AR, Dewangan LN, Sahoo RH, Chakravarty R, and **Chatterjee R.** 2011. Early prehistoric signatures of man in Bastar region, Central India. Current Science 101(9):1146–1149.

Shinde PK and **Shrivastava N.** 2006. Adaptive research interventions on household poultry: lessons learned and feedback for further research. In: Poultry Research Priorities to 2020. Central Avian Research Institute, Bareilly, Uttar Pradesh, India. pp. 239–243.

Sibanda H. 1998. Sustainable Indigenous Knowledge Systems in Agriculture in Zimbabwe's Rural Areas of Matabelel and North South Provinces. IK Notes No. 2, November 1998. The World Bank Programme on Indigenous Knowledge for Africa Region's Knowledge and Learning Center, Washington, DC, USA. 2 pp.

Sillitoe P. 2001. What know natives?: Local knowledge in development. Grassroots Voice: A Journal of Indigenous Knowledge and Development 4(1):1–28.

Singh Anurudh K. 2010. Agricultural biodiversity heritage sites from hilly regions of India: Reservoir of conservation farming systems. In: Proceedings of the International Conference on Traditional Practices in Conservation Agriculture, September 18–20, 2010, JRN Rajasthan Vidyapeeth University, Udaipur, Rajasthan (Choudhary SL, Khandelwal SK, and Nene YL, eds.). Asian Agri-History Foundation (AAHF), Secunderabad, Andhra Pradesh; and Rajasthan Chapter of AAHF, Udaipur, Rajasthan, India. pp. 18–24.

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 RK. 2007. Indigenous agricultural knowledge in rain-fed rice based farming systems for sustainable agriculture: Learning from Indian farmers. In: Sustainable Development: Relevance for Africa (Boon Emmanuel K and Hens Luc, eds.). Indigenous Knowledge Systems and Tribes and Tribals Special Volume No. 1:101–110.

Vashishtha BB, Saroj PL, Kumar Gunjeet, and **Awasthi OP.** 2005. Arid fruits. In: Plant Genetic Resources: Horticultural Crops (Dhillon BS, Tyagi RK, Saxena S, and Randhawa GJ, eds.). Narosa Publishing House, New Delhi, India. pp. 168–189.

Verma PK and **Mishra N.** 2010. Traditional techniques of processing on minor millets in Bastar district of Chhattisgarh, India. Research Journal of Agricultural Sciences 1(4):465–467.