

Probable Agricultural Biodiversity Heritage Sites in India: X. The Bundelkhand Region

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Abstract

The Bundelkhand region of central India, lying south of the Yamuna river, between the fertile Gangetic plains and the highlands of central Madhya Pradesh and Chhattisgarh, has a unique terrain that has undergone an ecological succession from predominant forestland to grassland, because of acute ecological degradation (deforestation and erosion of top soil). Most people of the region are involved in agriculture or related activities from ancient times. The flora of the region is rich in grasses as well as valuable herbs. To overcome the problems of short rainfall period, and the difficult terrain that limits rainwater harvest, the local people and the successive dynasties of rulers had the foresight of developing suitable structures for rainwater harvesting, including in-situ and ex-situ strategies. In the alleviation of poverty, tackling the problems of low productivity, and in responding to the changing climate and the edaphic scenario, the region can be credited for the successful integration of pastoral economy with traditional agriculture. The region has judiciously exploited the changing climatic patterns to evolve genetic diversity in crop species, suited to the changing scenario. Culturally, the region has a rich heritage and is known for its numerous forts, palaces, and temples. Khajuraho, with a large group of medieval temples exhibiting exquisite and intricate stone sculptures, has been listed as a UNESCO World Heritage Site. For these reasons, the region is being proposed as another National Agricultural Biodiversity Heritage Site, and the present article discusses the supporting features in brief.

Geographically, Bundelkhand lies between the Indo-Gangetic Plain to the north and the Vindhya Range to the south. This complex, diverse, and vulnerable agrarian region is socioeconomically heterogeneous and ethnically unique. Over 90% of the

population is dependent on agriculture, livestock, usufructs from forest and outsourcing income by seasonal migration after *rabi* sowing. The flora of the region is rich in grasses with declared pasture lands, a reason for the dominant pastoral economy.

The region can be credited with traditional agriculture, where field agriculture has an effective integration with pastoral agriculture, which plays a major role in agricultural activities, starting from the use of draft in sowing, irrigation, transport of goods and passengers and even the use of dung as fuel and manure, and for generating additional income from selling of milk, to improve the rural economy. Consequently, until recently, Bundelkhand had more livestock than humans. Recognizing that the monsoon is the only source of water [the majority of which falls in about 40 days spread over four months (June–September), with 50% in just 20 hours, limiting the time for penetration into the soil and recharging the groundwater (Prakash *et al.*, 1998)], and the prevalence of severe runoff problems, because of depression of water channels and height of their banks, the local people had developed a unique science-based pond system for water harvesting centuries ago. Some of the ponds are still functional. The region can also be credited for the development of the third crop season ‘*zaid*’, taken in the river beds on residual moisture, in addition to *kharif* and *rabi*. The diverse ecology has supported the evolution of a unique genetic diversity in crop species responding to changing climate (drought and heat). Culturally, the region has been part of the Indian ethos from ancient times and has played a significant historical role, therefore quite rich, as reflected by the world heritage site of Khajuraho, identified in the region. For these reasons, it is being proposed as another national Agricultural Biodiversity Heritage Site based on the indices illustrated by Singh and Varaprasad (2008).

Location and extent

The Bundelkhand region is located between 23°20' and 26°20' N latitude, and 78°20' and 81°40' E longitude. Geographically, it falls in central India and is a semi-arid plateau that includes the Bhamder plateau and the Kaimur hills. It is physically located in the central Hindi belt south of the Yamuna River, between the fertile Gangetic plain stretching across northern Uttar Pradesh (UP) and the southern highlands of central Madhya Pradesh (MP). Geographically, it also works as a gateway between North and South India. Administratively, the region comprises thirteen districts – seven districts of UP (Jhansi, Jalaun, Lalitpur, Hamirpur, Mahoba, Banda, and Chitrakoot) and six districts of MP (Datia, Tikamgarh, Chhatarpur, Damoh, Sagar, and Panna). However, traditionally, some other districts of MP (Satna, Morena, Sheopur, Bhind, Shivpuri, Guna, and Ashoknagar) are also considered as part of larger Bundelkhand. Gwalior, Jabalpur, and even Bhopal have the cultural influence of Bundelkhand (Fig. 1).

Landscape

Bundelkhand is an old landmass composed of horizontal rock beds resting on a stable foundation. The landscape is rugged,

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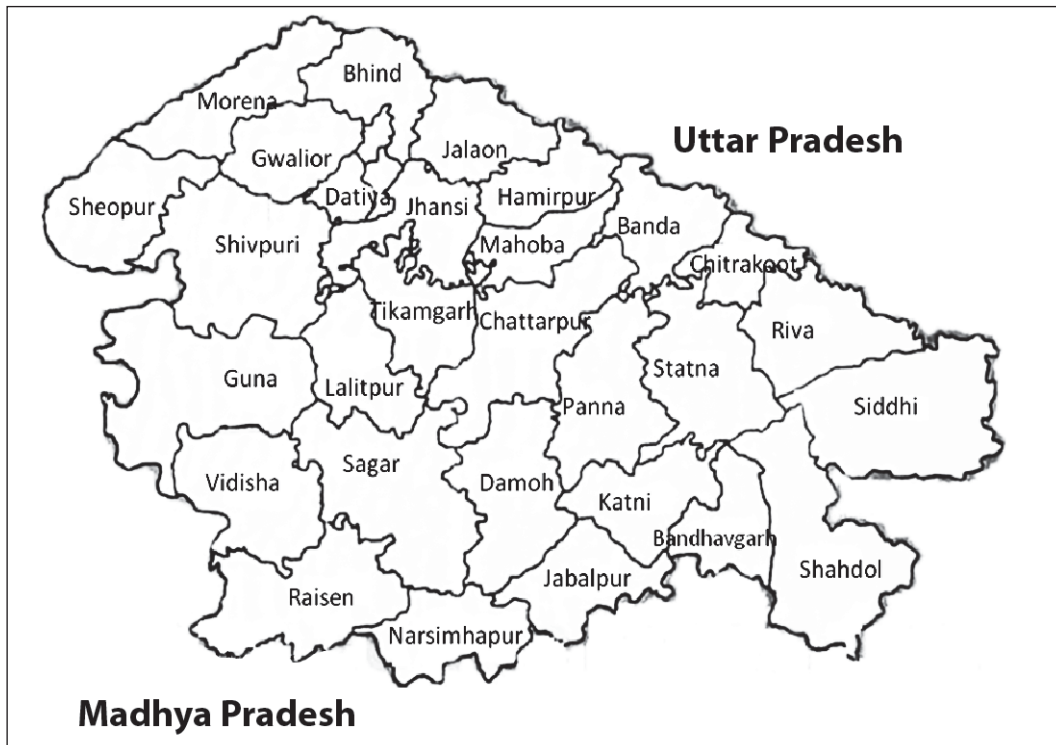


Figure 1. Map of Bundelkhand during the rule of the Chandels (16th century CE).

featuring undulating terrain with low rocky outcrops, narrow valleys, and plains. Surface rocks are predominantly granite of the lower Pre Cambrian/Archaean period. Some Dharwarian and Vindhyan rocks present in the region contain minerals of economic value. Sandstone, shale, and limestone of high quality, along with dykes, sills, and the famous pink Archaean gneiss rocks, are also found in places. The Bundelkhand gneiss rocks are one of the oldest rocks in India.

The landscape is a gently sloping upland, distinguished by barren hilly terrain with sparse vegetation, although historically it was thickly forested. The plains of Bundelkhand are intersected by three mountain ranges,

the Vindhya, the Fauna, and the Bander chains, the highest elevation not exceeding 600 m above sea level. Beyond these ranges the region is further diversified by isolated hills rising abruptly from a common level, and presenting from their steep and nearly inaccessible scarps, eligible sites for forts and strongholds of local kings. The general slope of the country is towards the northeast, as indicated by the course of the rivers which traverse or border the territory, and finally discharge themselves into the Yamuna River.

Bundelkhand has a number of northbound perennial rivers (such as Sindh, Pahuj, Betwa, Dhasan, Ken, Baghein, Paisuni, and

Tons) with numerous tributaries (such as Chandrawal, Bardaha, Banganga, Jamuni, Urmil, Sonar), which drain water from the constituent districts into the flowing Yamuna river. The Kali Sindh, rising in Malwa, marks the western frontier of Bundelkhand. Parallel to this river, but further east, is the course of the Betwa. Still farther to the east, flows the Ken, followed in succession by the Bagahin and Tons. The Yamuna and the Ken are the only two navigable rivers. Notwithstanding the large number of streams, the depression of their channels and height of their banks render them for the most part unsuitable for the purposes of irrigation, which is conducted by means of ponds and tanks. These artificial lakes are usually formed by throwing embankments across the lower extremities of valleys, and thus arresting and impounding the waters flowing through them.

The dominant soils of the region are represented by gentle to very gentle slopes with moderately deep Ustochrepts and nearly level deep Chromusters black soils. Chromusters are typified by the soils of the *kheri* series, which are clayey, calcareous and slightly alkaline in reaction. They show distinct shrink-swell properties. The presence of ferruginous red soil, mixed red and black soil, and medium black soil

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indicates that the soil profiles of the region have the footprints of its geological history due to continental drift and the seduction of the peninsular Indian plate. Prevailing soil types are a mix of black and red; the latter being relatively recently formed is gravely and shallow in depth, and thus unable to retain moisture well. For this reason, much of the region suffers from acute ecological degradation due to top soil erosion and deforestation, leading to low productivity of the land. Soil erosion is a persistent problem, and it is aggravated by the hilly landscape, high winds and the poor holding capacity of the soils, leading to the widespread growth of gullies.

Agroclimate

It is a semi-arid to hot subhumid ecoregion. The climate of the region is characterized by hot summers and mild winters (Sehgal *et al.*, 1992). The Bundelkhand region is marked by extremes of temperature, reaching the mid to upper 40°C during the summer months (up to 48°C), and dropping to as low as 1°C in winter. During the summer season, high temperatures in the plains cause low-pressure areas that induce movement of the monsoon. The temperature begins to rise in February and peaks in May–June. Hot breezes known locally as *loo* are common during this period. The rainfall distribution pattern is irregular. Approximately 90% of the rainfall is caused by the monsoon, falling between June and September in the region. The annual rainfall ranges between 838 and 1,251 mm over the region, though there has been a gradual decline in the rainfall. The rainfall increases from north to south, which also reflects on

the vegetation. Datia in the north receives the lowest (dry) and Sagar in south highest (wet) rainfall. Lalitpur district exhibits the highest degree of variability in the rainfall. However, most rainfall is lost to runoff, due to the typical terrain and the fact that it is limited to about 40 effective rainy days, and that 50% of this may fall in just 20 hours providing little time to percolate into the soil, recharging the groundwater. The annual rainfall covers about 80% of the annual potential evapotranspirative demand, leaving long periods under dry spell, with the growing period extending from 90 to 150 days. July and August are the months of maximum rainfall, while November to April are the driest months of the year. The scanty winter rainfall is useful for the cultivation of *rabi* crops, but it is usually inadequate without access to supplementary irrigation sources.

Historically, the Bundelkhand region used to have one drought in 16 years in the 18th and 19th centuries. This has trebled during the period 1968 to 1992 due to climatic changes caused by degradation of forests, soil, groundwater, etc., and the past four years have witnessed continuous drought.

Floristic diversity

The Bundelkhand region at one time was very rich in floristic diversity as mentioned in the ancient Indian literatures and epics such as the Ramayana. Even during the medieval period, the region might have been heavily forested, as there are stories that it was the safest hideout for the fugitive and defeated armies of warring kings and feudatories. But the forests of Bundelkhand have been dwindling

continuously, and have been the cause of concern, because they represent a major source of livelihood for poor people. People living in and around the forests have been using them for shelter, fuel, food, medicinal plants, crafts, and cottage industries. In recent times, the control of forests by the government through its forest department, and the nexus between feudals and officials has further caused miseries, depriving the local poor of the benefits of the forests.

Bundelkhand districts have much lower forest cover than the notified forest areas. Now, only the district of Panna has over 50% forest cover. Satna and Chhatarpur have about 20–30% forest cover, while Datia and Tikamgarh have less than 20%. The forests of Datia and Tikamgarh are northern sub-type thorn-forests, while those of Chhatarpur, Panna, and Satna are of eastern sal type, a sub-type of tropical moist deciduous forests. Therefore, Panna is the only district in Bundelkhand that is self-sufficient in forest resources. Chhatarpur and Satna are having deficit in fuel-wood but surplus in timber. Datia and Tikamgarh are among those districts showing deficit in both timber and fuel-wood. This might be due to the excessive cutting of forests in these districts.

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The forest vegetation has elements of both the tropical northern and southern dry deciduous type (Champion and Seth, 1968). Therefore, original vegetation of the region consisted of tropical dry deciduous forest, dominated by teak (*Tectona grandis* L.f.) associated with *tendu* or ebony (*Diospyros melanoxylon* Blume), *dhaora* [*Anogeissus latifolia* (Roxb.) Bedd.], *lendia* (*Lagerstroemia parviflora* Roxb.), *saja* (*Terminalia tomentosa* Wight & Arn.), *dhanoda* or *monyen* [*Lannea coromandelica* (Houtt.) Merr.; syn. *L. grandis* Engl.], *Hardwickia binata* Roxb., and *salai* (*Boswellia serrata* Roxb.) (Source: www.en.wikipedia.org/wiki/Bundelkhand). The tropical dry deciduous forest basically has the following tree representations: *Aegle marmelos* (L.) Corr., *Anogeissus latifolia*, *Boswellia serrata*, *Butea monosperma* (Lam.) Taub., *Cordia obliqua* Willd., *Cochlospermum religiosum* (L.) Alston, *Diospyros melanoxylon*, *Hardwickia binata*, *bija* or Indian kino (*Pterocarpus marsupium* Roxb.), *Lagerstroemia parviflora*, *aonla* (*Embllica officinalis* Gaertn.), *Soymida febrifuga* Roxb., and teak (*Tectona grandis*). Some of the common shrubs are *ankol* [*Alangium salvifolium* (L.f.) Wang.], *Casearia elliptica* Willd., *Capparis zeylanica* L., *Flacourtia indica* (Burm.f.) Merr., *Holarrhena antidysenterica* (Roxb. ex Fleming) Wall., *Kirganelia reticulata* (Poir.) Baill., and *dhawari* (*Woodfordia floribunda* Salisb.). Some of the herbaceous species, which are important genetic resources, are *kundru* (*Coccinia indica* Wight & Arn.), *kakrol* or *kankro* or teasle gourd (*Momordica dioica* Roxb. ex Willd.),

vidharikand [*Pueraria tuberosa* (Willd.) DC.], and *karkandhauh* [*Ziziphus oenoplia* (L.) Mill.].

In the early 1900s, the rising demand for wood and agricultural expansion further led to increasing levels of deforestation. Post-independence population growth and the emergence of the Green Revolution brought even larger tracts of land under the plow and further increased the demand for wood-based energy. These factors, combined with poor land management and reckless government approval for commercial logging drastically reduced forested area in the region (Fig. 2). Today, only small patches remain, of dry miscellaneous and thorny forests comprising *dhak* (*Butea monosperma*; syn. *B. frondosa*), teak (*Tectona grandis*), mahua [*Madhuca indica* J. F. Gmel.; syn. *M. longifolia* Macbride], *chirongi* (*Buchanania lanzan* Spreng.; syn. *B. latifolia* Roxb.), *kardhai* (*Anogeissus pendula* Edgew.), *dhau* (*Anogeissus latifolia*), *khair* [*Acacia catechu* (L.f.) Willd.], and *thuhar* trees (*Euphorbia nivulia* Buch.-Ham., *E. tirucalli* L.).



Figure 2. Much of ‘notified’ forestland has ceased to be a forest due to deforestation, soil degradation, and overexploitation (courtesy B Prakash).

Presently, sub-region wise flora in the plain of Banda, Hamirpur, and Datia, along the banks of rivers Pahuj, Betwa, and Yamuna, is represented by acacias such as *babul* [*Acacia nilotica* (L.) Delile] and *khair* (*Acacia catechu*), *palas* (*Butea monosperma*), *ber* (*Zizyphus* spp.), *tendu* (*Diospyros melanoxylon*), *mahua* (*Mahuca indica*), *semal* (*Salmalia malabarica* Schott. & Endl.), and *kardhai* (*Anogeissus pendula*), in the intermediate sub-region, by *salai* (*Boswellia serrata*), *seesham* (*Dalbergia sissoo* Roxb.), *dhau* (*Anogeissus latifolia*), *jamun* [*Syzygium jambos* (L.) Alston, *S. heyneanum* Wall.], *seja* or *karaundha* (*Carissa spinarum* L.) shrub, and occasional teak trees. In the southern uplands (Panna, Chhatarpur, Tikamgarh) there is teak, besides the above-mentioned species. In the Damoh and Sagar plateaus, trees known locally as *dhau* or *dhawda* (*Anogeissus latifolia*), *tinsa* (*Augenia delbergioides* Benth.), and *bija* (*Pterocarpus marsupium*) can also be seen. Bamboo [*Dendrocalamus strictus* (Roxb.) Nees] is found in small patches across the region.

People living in and around the forests have been using them for shelter, fuel, food, medicinal plants, crafts, and cottage industries. In recent times, the control of forests by the government through its forest department, and the nexus between feudals and officials has further caused miseries, depriving the local poor of the benefits of the forests.

In the plateau and hilly areas of central and southern Bundelkhand are found large stretches of grasslands, officially classified as 'permanent pastures and other grazing land'. However, the area under permanent pastures has been reducing rapidly, due to lack of moisture consequent to reduction and unpredictable rain pattern, high livestock population and pressure to bring more area under cultivation. The greatest reduction appears to have taken place in Tikamgarh, where area under permanent pastures was reported to have been over 66,000 ha in 1984–85, and only 14,900 ha in 2004–05 (Source: www.bundelkhandinfo.org). The most common grasses of Bundelkhand are *doob* [*Cynodon dactylon* (L.) Pers.], *mushial* (*Iseilema laxum* Hack.), *sain* [*Sehima nervosum* (Rottler) Stapf], *kail* [*Dichanthium annulatum* (Forssk.) Stapf], *lumpa* (*Heteropogon contortus* Beauv. ex Roem. & Schult.), *guneria* [*Themeda quadrivalvis* (L.) Kuntze.], and the *kans* (*Saccharum spontaneum* L.), an aggressive weed.

Today, the dominant vegetation in the region primarily consists of scrub forest *siris* [*Albizia lebbek* (L.) Benth., *A. procera* (Roxb.) Benth.], *katai* (*Flacourtia indica*), *gunj* (*Abrus precatorius* L.), *bel* (*Aegle marmelos*), *ghout* trees [*Zizyphus xylopyrus* (Retz.) Willd.], etc., and scrub brush. Much of the forests have an open canopy with large tracts of land classified as "wastelands". Soil erosion is the most common phenomenon of the area along with water stagnation in some places during the rainy season. Therefore, the major portion of the region further faces ecological degradation, loss of biodiversity due to soil erosion and deforestation (Fig. 2).

Agriculture and agrobiodiversity

Crop cultivation and animal rearing alone constitutes more than 90% of the overall Bundelkhand economy. However in recent times, the reducing levels of land fertility and the low productivity, lack of irrigation facilities, improper land distribution, poor management of crops (because the majority is of resource-poor farmers), and cultivation without the integration of modern methods in agriculture, have kept the agriculture-based economy at the subsistence level (Fig. 3).

Local inhabitants primarily rely on subsistence rainfed single-crop agriculture and small-scale livestock production for their livelihood, with sorghum (*jawar*), wheat, grams, and oilseeds as the predominant crops. Apart from wheat, the other major crops grown in the area are rice (in some areas), maize, pearl millet, *kodo*, *kutki*, chickpea, pigeonpea, green gram (*moong*), black gram (*urd*), soybean, linseed, sesame, groundnut, jute, and vegetables. Cultivators grow pigeonpea, groundnut, sugarcane, and soybean (recent introduction) during *kharif*,



Figure 3. A traditional farmer toiling in his field (courtesy B Prakash).

and wheat, mustard, lentil, green gram, and black gram during *rabi*. Traditionally, the crops grown among cereals are coarse cereals and dual-purpose varieties for grain and fodder. As per some observations, soybean has adversely affected the genetic diversity of traditional rainy season crops, such as millets, pulses, and oilseeds and also the traditional practices of water conservation in the fields.

As traditionally the farming is rainfed, usually *kharif* crops are grown on red soils and *rabi* crops are taken on black soils. Usually, monocropping is practiced, while double-cropping is feasible in black soil with irrigation facility. The crops grown are sorghum, pigeonpea, groundnut during *kharif* season; green gram during the normal monsoon period and early-maturing varieties of sorghum, pearl millet, and soybean during the delayed monsoon season. Barley, chickpea, rapeseed mustard, and safflower are the suitable crops for the *rabi* season. In black soil, the crops cultivated are

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sorghum, cowpea, black gram, and green gram or fodder sorghum. The dominant cropping systems are pulses (black gram, green gram), sesame, or fodder sorghum during *kharif*, followed by mustard or linseed during *rabi*, in combination, such as green gram–linseed/safflower, sesame–mustard/lentil/peas. Watermelon, musk melon, and vegetables are raised along the dried river beds, a practice known as ‘*zaid*’ developed as a third cropping season. Due to lack of resources in some areas single crop in a year is taken with *kharif* and *rabi* alternating. Other common practices are intercropping (wheat–chickpea; wheat–barley; barley–chickpea; chickpea–linseed; pigeonpea–black gram; sorghum–pigeonpea), staggered sowing over time, use of short-duration varieties, mixed farming, share cropping, agroforestry and enterprises, etc. Sorghum is generally intercropped with pulses.

A recent survey of districts falling in UP showed that the normal *kharif* cultivation is around 25% of the total sown area, while *rabi* is around 74%. During *kharif*, rice is traditionally grown in Banda, where assured irrigation from the Bariyarpur project on Ken River is available since about a century, and Chitrakoot, where irrigation is made available through ponds, wells, etc. Sorghum and pearl millet are more popular in Hamirpur, Banda, and Chitrakoot. In Lalitpur, maize is the preferred cereal among farmers. Among *kharif* pulses, black gram is preferred to green gram and pigeonpea in all districts, except in the case of Hamirpur, Banda, and Chitrakoot, where pigeonpea is preferred. Among *kharif* oilseeds, groundnut is preferred in Jhansi. Among

rabi cereals, wheat is mainly grown in all seven districts and the area varies from 20% of the annual area sown in Mahoba to 33% in Banda. Among *rabi* pulses, lentil, chickpea, and pea are preferred in all districts, except Chitrakoot, where only chickpea is sown. *Rabi* oilseeds are also grown in all districts but the quantum is small. Sugarcane is grown in a very small area.

Although the economy of the region is predominantly based on agriculture, the progress of agriculture in the region has been severely restricted because of the climatic changes caused by deforestation after the 18th century (predominantly during the latter half of the 20th century), soil erosion and rise in human population causing severe infertility of land, low productivity, and improper land distribution (a few medium and large farmers have the major share in landholdings). However, in the subsistence traditional agriculture economy, to provide greater security, bovine and small ruminant rearing has been integrated as part of the agrarian economy, and it contributes significantly to the livelihood of farmers, especially the women-headed, landless, and small farmers. The diverse livestock provide draft animals for sowing, drawing water from wells, and to transport people and goods. Also, they provide dung, used as fuel and manure, and milk, for supplementary income. This has led to the development of a pastoral economy in the region, which further evolved into an agropastoral and agro-silvo-pastoral economy, and use of crop residues, which contributed 67% of the animal fodder. For these reasons, and also possibly due to dominant Hindu traditions, the local people have great reverence for

the cow. Bundelkhand has had a high livestock population for ages. It is often said that there are more livestock than humans in Bundelkhand. However, this was only true till the 1980s – the total livestock population of the region in 1982 was 8.96 million (Tyagi, 1997), close to the human population figure, but since the 1980s the livestock population growth rate has declined in comparison to the human population growth (Source: www.bundelkhandinfo.org/economy/.../livestock_bundelkhand.html).

Fishing is another agriculture related activity, done mainly by scheduled caste groups such as the *dhimar*, in the numerous tanks and ponds of the region, especially in MP Bundelkhand. For instance, the district statistical handbook data of Chhatarpur indicates that in 2004, the district had 761 ponds, covering in all an area of around 1,600 ha, where fishing was done. The annual fish production was 2,500 tons (Source: www.bundelkhandinfo.org/economy/.../fisheries_bundelkhand.html).

As the region at one time was very rich in forest resources, the poor farmers and rural masses traditionally harvest or collect various non-timber forest products, which are economically beneficial. Some of the common products are *tendu* leaves, *palash* leaves, *aonla*, *harra*, *gond* (gum), *imli*, *trifala*, *khair*, *chironji*, *babul*, *anjan*, sal seed and many medicinal plants. Mahua has been one of the major sources of food for poor communities. If one passes across Bundelkhand district during March–April, one can observe the importance of mahua in the life of the people. One can smell the mahua all around during these two months.

For these reasons, and also possibly due to dominant Hindu traditions, the local people have great reverence for the cow. Bundelkhand has had a high livestock population for ages. It is often said that there are more livestock than humans in Bundelkhand. However, this was only true till the 1980s.

The flower, fruit, and seed of mahua are used by poor people for their livelihood. The mahua flower provides almost ready food. It has been recorded that it fulfils at least three months' food requirements of the poor community. It is considered to be the poor man's food, and fodder for the animals of the rich. Such is the importance of mahua in this region that there is a saying, which translates as "if one does not like the smell of Mahuwa, he should not send his daughters in marriage to Bundelkhand" (Source: www.planningcommission.nic.in/reports/sereport/ser/bndel/stdy_bndel.pdf).

Representative crop species in various crop groups

Cereals, pseudocereals, and millets. Barley (*Hordeum vulgare* L.), barnyardgrass [*Echinochloa crus-galli* (L.) P.B.], finger millet (*Eleusine coracana* Gaertn., *E. indica* Steud.), foxtail millet (*Setaria italica* L.), kodo millet (*Paspalum scrobiculatum* L.), maize (*Zea mays* L.), pearl millet [*Pennisetum glaucum* (L.) R.Br.], proso millet or little millet (*Panicum miliare* Lam.), rice (*Oryza sativa* L.), *sanwa* [*Echinochloa*

frumentacea (Roxb.) Link], sorghum [*Sorghum bicolor* (L.) Moench], and wheat (*Triticum aestivum* L.).

Grain legumes and oilseeds. Black gram [*Vigna mungo* (L.) Hepper], castor (*Ricinus communis* L.), chickpea (*Cicer arietinum* L.), cowpea [*Vigna unguiculata* (L.) Walp.], green gram [*Vigna radiata* (L.) Wilczek, *V. radiata* var. *sublobata* (Roxb.) Verdc.], groundnut (*Arachis hypogaea* L.), Indian mustard [*Brassica juncea* (L.) Czern.], masur or lentil (*Lens culinaris* Medik.), alsi or linseed (*Linum usitatissimum* L.), moth bean [*Vigna aconitifolia* (Jacq.) Maréchal.], mustard (*Brassica campestris*), ramtil or niger [*Guizotia abyssinica* (L.f.) Cass.], pea (*Pisum sativum* L.; *batla*), pigeonpea [*Cajanus cajan* (L.) Millsp.], bold-seeded cultivars; safflower (*Carthamus tinctorius* L.), til or sesame (*Sesamum indicum* L.), soybean [*Glycine max* (L.) Merr.], and sweet pea (*Lathyrus odoratus* L.).

As the region at one time was very rich in forest resources, the poor farmers and rural masses traditionally harvest or collect various non-timber forest products, which are economically beneficial. Some of the common products are tendu leaves, palash leaves, aonla, harra, gond (gum), imli, trifala, khair, chironji, babul, anjan, sal seed and many medicinal plants. Mahua has been one of the major sources of food for poor communities.

Fodder and fiber crops. The figures on land use in Bundelkhand show the largest area of land under grasslands (a reason for dominant pastoral agriculture) is found in the Sagar district, followed by Chhatarpur. Considerable stretches of grassland are also found in Damoh and Tikamgarh. Significant area of permanent pastures is not found in the UP districts of the region, except in the southern portion of Lalitpur district. The region is very rich in grasses, as the family Poaceae is represented by 172 species under 84 genera, with *Brachiaria brizantha* (A. Rich.) Stapf, reported new to the flora (Shukla and Sinha, 2004). The other grasses cultivated and used for fodder are *doob* (*Cynodon dactylon*), *guneria* (*Themeda quadrivalvis*), *kail* (*Dichanthium annulatum*), *lumpa* (*Heteropogon contortus*), *mushial* (*Iseilema laxum*), and *sain* (*Sehima nervosum*). In addition, multicrop *Avena sativa* L. and *Sorghum* spp., fodder type *bajari* or *bajra* (*Pennisetum glaucum*) and *Cenchrus ciliaris* L. [syn. *Pennisetum ciliare* (L.) Link] are cultivated for animal fodder. In fiber, jute (*Corchorus olitorius* L.), alsi or flax/linseed (*Linum usitatissimum*), and *sanai* or hemp (*Cannabis sativa* L. subsp. *indica* Lam.) are grown to obtain fiber from the bark.

Vegetables. Bitter melon (*Momordica charantia* L.), bottle gourd [*Lagenaria siceraria* (Molina) Standl.], brinjal or eggplant (*Solanum melongena* L.), cucumber (*Cucumis sativus* L.), *sahijan* or drumstick (*Moringa oleifera* Lam.), *phut* (*Cucumis melo* L. var. *culta* Royle), *kakri* (*Cucumis melo* var. *utilissimus* Duthie & Fuller), *kakrol* or *kankro*

(*Momordica dioica*), kundru (*Coccinia indica*), balsam apple (*Momordica balsamina* L.), muskmelon (*Cucumis melo* L.), okra [*Abelmoschus esculentus* (L.) Moench], pea (*Pisum sativum*), petha or ash gourd [*Benincasa hispida* (Thunb) Cong.], sponge gourd (*Luffa cylindrica* M. Roem.; syn. *L. aegyptiaca* Mill.), and tomato (*Lycopersicon esculentum* L.).

Leafy vegetables. *Bathua* (*Chenopodium album* L.), *chauli* (*Amaranthus viridis* L.), false amaranth [*Digera muricata* (L.) Mart.] (pot herb), green amaranths (*Amaranthus hybridus* L., *A. viridis* L.), *methi* or fenugreek (*Trigonella foenum-graecum* L.), and salad (*Amaranthus tricolor* L.).

Rhizomes, tubers, and bulbs. *Arbi* (*Colocasia antiquorum* Schott.), sweet potato [*Ipomoea batatas* (L.) Lamb.], and *vidharikand* (*Pueraria tuberosa*).

Fruits. *Anjir* (*Ficus caricoides* Roxb.), *aonla* (*Emblica officinalis*), *bel* (*Aegle marmelos*), *ber* [*Ziziphus nummularia* (Burm.f.) Wight & Arn.; *Z. mauritiana* Lam.; syn. *Z. jujuba* Mill.; *Z. vulgaris* Lam.], *chironji* (*Buchanania lanzan* Spreng.), *ghout* (*Ziziphus xylopyrus*), *gular* (*Ficus glomerata* Roxb.), *jamun* (*Syzygium jambos*), *karaundha* (*Carissa spinarum* L.; *C. carandas* Lour.), *karkandhu* (*Ziziphus oenoplia*), *katai* (*Flacourtia indica*), *khirni* (*Mimusops kauki* L.), *labhera* (*Cordia myxa* Roxb.; syn. *C. dichotoma* Forst.), *phalsa* (*Grewia asiatica* L.), and watermelon [*Citrullus lanatus* (Thunb.) Matsum & Nakai].

Spices. *Dhaniya* (*Coriandrum sativum* L.), *pudina* (*Mentha arvensis* L.) in Jalon,

Jhansi district is known for the quality of its turmeric (*Curcuma longa* L.) and ginger (*Zingiber officinale* Rosc.); turmeric is also cultivated in Orchha, Niwari, and Tikamgarh; parts of Mahoba district are known for *paan* or betel leaf (*Piper betle* L.).

Other crop species. Indigo (*Indigofera tinctoria* L. Deutsch) and sugarcane (*Saccharum officinarum* L.).

Agroforestry, gum, and resin species. *Acacia senegal* (L.) Willd. (syn. *A. verec* Guill. et Perr.), *alai* (*Boswellia serrata*), *babul* (*Acacia nilotica*), *khejri* (*Prosopis cineraria* Druce), and *vilayti kiker* [*Prosopis juliflora* (Sw.) DC.].

Timber. *Bija* or Indian kino (*Pterocarpus marsupium*), *dhaora* (*Anogeissus latifolia*), *kardhai* or *dhok* (*Anogeissus pendula*), *sal* (*Shorea robusta* C.F. Gaertn.), *shisham* (*Dalbergia sissoo*), *teak* (*Tectona grandis*), and *tendu* (*Diospyros melanoxylon*).

Multipurpose species. *Arjun* (*Terminalia arjuna*), *chironji* (*Buchanania lanzan*), *dhak* (*Butea monosperma*), *kush* [*Imperata cylindrica* (L.) Beauv.], *mahua* (*Madhuca indica*), *neem* (*Azadirachta indica* A.Juss.), *siris* (*Albizia lebeck*, *A. procera*), *tendu* (*Diospyros melanoxylon*), and *ritha* (*Sapindus trifoliatus* L.; syn. *S. laurifolius* Vahl.).

Forest species providing non-timber products. *Aonla* (*Emblica officinalis*) – fruit, *chironji* (*Buchanania lanzan*) – seed, *khair* (*Acacia catechu*) – bark, *mahua* (*Madhuca indica*) – flower and seed, and *tendu* (*Diospyros melanoxylon*) – leaf, and

seasonal fruits and vegetables, like *kundari* (*Coccinia indica*), *Momordica* spp., medicinal herbs, gum, and honey.

Medicinal plants. The region is very rich in knowledge regarding the medicinal properties of plants. Lalitpur forest division is the richest. A recent survey listed 66 medicinal plants from Lalitpur, which are commonly used in Ayurveda/drug industries and used by the local inhabitants (Dixit and Mishra, 1999). Some of the plants harvested from the wild or cultivated for medicinal properties are *Alstonia scholaris* (L.) R.Br., *arjun* [*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.], *bahera* [*Terminalia bellirica* (Gaertn.) Roxb.], *bhanga* or *ganja* (*Cannabis sativa*), *Balanites aegyptiaca* (L.) Delile, *Baliospermum montanum* (Willd.) Müll. Arg., *Celastrus paniculatus* Willd., *Embelia tsjeriam-cottam* (Roem. & Schult.) A.DC., *harda* (*Terminalia chebula* Willd. ex Flem.), *Helicteres isora* L., *Holarrhena antidysenterica* (Roxb. ex Fleming) Wall. ex DC., *kalama* (*Acorus calamus* L.), *Plumbago zeylanica* L., *babchi* (*Psoralea corylifolia* L.), *nux-vomica* (*Strychnos nux-vomica* L.), *Vitex negundo* L., and *Woodfordia fruticosa* (L.) Kurz.. In addition, *gugul* [*Commiphora wightii* (Am.) Bhandari] and *ashwagandha* [*Withania somnifera* (L.) Dunal] have been found growing in Jhansi, and *safed musali* (*Chlorophytum borivilianum* Santapu & Fernandes) and *kalmegh* [*Andrographis peniculata* (Burm.f.) Wall. ex Nees] in Lalitpur forests. *Martynia annua* L., an exotic medicinal plant now naturalized is well known to the villagers of the region by the names of *kaua*, *baghnakha*, and *hathajoru*. Seeds and

fruits of this plant are being used for the treatment of asthma, and itch and eczema, respectively (Saxena and Vyas, 1981), and *panjhuli* (*Kirganelia reticulata* Baill.) as toothbrush.

Wild relatives of crop species.

Abelmoschus pungens (Roxb.) J. Voigt [syn. *A. manihot* (L.) Medik. var. *pungens* (Roxb.) Hochr., *A. tetraphyllus* Wall., *Hibiscus pungens* Roxb.], *A. tuberculatus* Pal & Singh, *Alysicarpus monilifer* (L.) DC. (syn. *Hedysarum moniliferum* L.), *Amaranthus spinosus* L., *A. viridis*, *Cajanus scarabaeoides* (L.) Thouars, *C. sericeus* (Benth. ex Baker) Maesen, *Cucumis callosus* (Rottb.) Cogn., *C. setosus* Cogn., *Indigofera deccanensis* Sanjappa, *Momordica balsamina*, *M. dioica*, *Saccharum spontaneum* L. (an invasive species, which has become a concern in the region), *Sesamum laciniatum* Willd., *Sorghum cernuum* (Ard.) Host var. *yemense* (Körn.) Snowden, *S. controversum* (Steud.) Snowden., *S. halepense* (L.) Pers., *S. miliaceum* (Roxb.) Snowden, *S. nitidum* (Vahl) Pers., *Trigonella occulta* Delile, and *Vigna trilobata* (L.) Verdc..

Endemic species. As the region lies between the fertile Gangetic plains and highlands of central MP in a continuum from the Gangetic plains to the highlands of central MP and Chhattisgarh, it lags species endemism; nevertheless there are ecotypes of various species endemic to these regions.

Threatened species. Recently, the Ministry of Environment and Forests has notified *Alectra chitrakutensis* from the

region as Critically Endangered. A large number of species with medicinal properties, native to the region, and many commonly known naturalized medicinal plant species, have been reported to be under threat or on the verge of extinction, because of overexploitation and degrading environmental conditions (Source: www.aseanbiodiversity.info/scripts/count_article.asp; Datt *et al.*, 2001).

Associated culture and tribes

The region has been part of Indian ethos from ancient times. During the ancient period, Lord Rama stayed for a long time in the forests of Chitrakoot (Ramayana). Similarly, in the Mahabharata, there is the mention of the Chedi state, whose boundaries touched the river Betwa in the west and the river Yamuna in the north. The description of this state resembles present-day Bundelkhand. Shishupala was the ruler of this kingdom with its capital at Chanderi.

During the first half of the 14th century CE, when the Chandelas were on the decline, the Bundelas took over Bundelkhand. The Bundelas claimed to be the descendants of King Pantham of Kashi. Sahanpal Bundela captured Garhkundar from Khangar king and his successors ruled the areas around it till 1531 CE. Chhatrashal Bundela, the fourth son of Champat Ray, was one of the greatest Bundelas who fought for the freedom and development of the region after whom the region was named Bundelkhand.

Bundelkhand has a rich cultural background. The Chandela and Bundela rulers of

Bundelkhand were great builders and constructed numerous forts, palaces, and temples. The region is full of temples, particularly those of Lord Shiva. Khajuraho, the famous attraction in India, is situated in the district of Chhatarpur. Khajuraho has a range of temples with exquisitely carved stone sculptures and depictions on the outer walls. They were created by the Chandela kings who ruled Bundelkhand, before the rise of the Bundelas in the region.

The major tribes in Bundelkhand are Biar, Biyar (Tikamgarh), Saur, Sawur, Sonta (Tikamgarh/Chhatarpur), Soner (Tikamgarh), Kol, Manjhasi (Panna/Satna), Mawasi, Agaria (Panna), Bhaini (Satna), Dhanuk (Datia/Satna), Saharia (Datia), and Bedia (Panna/Chhatarpur).

Technology and products

For the conservation of biodiversity, the region has established traditional gardens, called *baughs*, in the districts of Panna, Chhatarpur, Sagar, Damoh, Satna, Rewa, Sidhi, and Shahdol of MP, and Jhansi in UP. They are the equivalent of sacred groves established for the conservation of economically important plant species.

Because of the absence of perennial sources of water, the entire Bundelkhand region is dependent on rainwater for irrigation. However, the unique structure of natural water channels, permitting very high runoff of the monsoon water, and short spells of heavy rainfall causing high levels of soil erosion, have made water harvesting a major concern for development of irrigated agriculture and livestock farming. Water is conserved in wells, the traditional source of

irrigation in the region. To facilitate pastoral economy, the farmers also conserve rainwater in tanks and in-situ in the field, which increases the fodder availability for animals while recharging the aquifers. Several centuries ago, with the support of rulers like the Chandela and the Bundela, the local people tapped many streams and exploited the sloping topography, by building embankment and water harvesting structures such as lakes and surface-reservoirs in the region (Fig. 4). This extremely scientific tradition continues to this day. Consequently, each village in the region has ponds/tanks to meet the water needs of the inhabitants. Some of the old structures created during the time of the Chandelas and Bundelas are still in use. The Chandelas created a large number of ponds now known as Chandeli-ponds for irrigation and drinking water supply (Fig. 4). For example, in Tikamgarh, the Chandeli-ponds are well scattered in the district. Thus, the area has evolved three traditional irrigation systems: (i) reservoirs, primary surface tanks, and ponds; (ii) inundation irrigation systems; and (iii) in-situ storage facilities. The people of Bundelkhand continue to innovate. For



Figure 4. A traditional multipurpose tank (courtesy B Prakash).

example, Mangal Singh, a farmer of Bhailoni, Lalitpur, succeeded in inventing an efficient, simple, and low-cost turbine (water wheel) that requires a very low water head. He coupled it with a pumping and sugarcane-crushing system, and used this energy for other operations (Prakash *et al.*, 1998).

The Bundelkhand region experiences regular drought today, which has hindered the development and growth of the region, and has increased its vulnerability and marginalization, thereby unbalancing the village economy. For this reason, there is a gradual decrease in the cultivated area during the *kharif* season. However, historically, the region had good rainfall (800 to 1,250 mm) and was known for lakes, ponds, tanks, *bavdis*, wells, etc., and therefore, in the olden times the region has evolved significant genetic diversity in all major crops and even later responded to the changing scenario. For example, in wheat, varieties such as *Kathia* grown in some parts, command a premium. Other wheat varieties grown are *Halna*, *Kudrat*, and *Sharbati*. Similarly, in the case of rice, scented varieties, such as *Tulsi bhog*, *Kala sudanas*, and *Ram bhog* have a premium. The farmer's variety *Kalimuchh* of Gwalior, an export-quality material, is losing its quality and identity and needs research and attention. Also, from wild weedy types, hardy varieties such as the *Pasahi* paddy or wild paddy, *Savan*, and *Kakun* have been selected for early maturity to be ready for harvest within 60 days, to provide food security to poor families in difficult times. Some of the traditional rice varieties cultivated in Banda and Chitrakoot are *Chinnawar*, *Maha-chinnawar*, *Muskan*,

Badshah pasand, Luchai, Kalasudas, Lakda, Ram karoni, Saathi, Dubraj, and Bhainslot (B Prakash, personal communication). In sorghum, the region is known for scented landraces (Singh and Borkar, 2005), which are still being collected (Source: <http://www.sorghum.res.in/ann-report.pdf>).

The region is rich in genetic diversity of grain legumes. Variability for foliage, seed size, shape, and color, and maturity time in lentil has been recorded in areas along Yamuna river, leading to the development of varieties such as K 75 (Malika), which in turn has been derived from local landraces (Singh *et al.*, 2006b). Variability in seed size with bold-seeded type in green gram, and good morphotype in black gram are known from the region. In pigeonpea, the Banda district has small-seeded delicious *deshi arahar*, which tastes best among all, though bold-

Several centuries ago, with the support of rulers like the Chandela and the Bundela, the local people tapped many streams and exploited the sloping topography, by building embankment and water harvesting structures such as lakes and surface-reservoirs in the region. This extremely scientific tradition continues to this day. Consequently, each village in the region has ponds/tanks to meet the water needs of the inhabitants. Some of the old structures created during the time of the Chandelas and Bundelas are still in use.

The region is rich in genetic diversity of grain legumes.

seeded pigeonpea landraces are also known from the region (Singh *et al.*, 2006a).

Among oilseeds, variation has been recorded in sesame for plant type (erect bunch), seed size, color (white), and percentage oil, tolerance to drought, and resistance to gall fly and capsule borer. This has resulted in the development of varieties such as Type 3 (50% oil, drought tolerance, white seed) from Hamirpur local; N 32 (53% oil, resistance to gall fly and capsule borer, white bold seed) from Chattarpur local; and G-35 (erect bunch type with white bold seed) from a Gwalior landrace, through selection (Duhoon *et al.*, 2004). Variability has also been collected from the region in the case of rapeseed mustard (Kumar *et al.*, 2004). The region is also known for significant variability in castor with dark red, white rose mahogany and sulfur-white colored capsule, and also for wide variation in seed color and shape. The plants grow tall up to 3 m with large leaves having more than 50 cm diameter. Such types have been successfully used in rearing silkworms (Anjani and Jain, 2004).

In vegetables, the region is known for variability in solanaceous crops such as *Solanum melongena*, and landraces such as *Bundelkhand Desi* with tolerance to drought are known nationally (Rai *et al.*, 1993). Rich genetic diversity has been recorded among the minor arid fruits. For example, in *bel* (*Aegle marmelos*) traditional varieties such as *Kagzi Etawah* are known, whereas in the

case of *chironji* (*Buchanania lanzan*), diversity has been recorded for panicle, fruit size, and quality kernels. Diversity has also been recorded in *aonla* (*Emblica officinalis*), *ber* (*Ziziphus mauritiana*), and *karonda* (*Carissa carandas*) (Vashishtha *et al.*, 2005).

Due to its pastoral, agropastoral, and agro-silvo-pastoral economy, the region has introduced several fodder species. During the British period, *Cenchrus ciliaris* (grass) and *Leucaena glauca* Benth. [*L. leucocephala* (Lam.) de Wit] were introduced around the forts to provide rich fodder for horses. In recent times, the Indian Grassland and Fodder Research Institute, Jhansi has further enriched the fodder germplasm with the introduction of *Brachiaria ruziziensis* R.Germ. & C.M.Evrard, *B. brizantha*, species of *Paspalum* L., *Stylosanthes* Sw. and many other legumes (PS Pathak, personal communication).

As the livestock are an integral component of agriculture, the local people have developed a notable feeding practice called *gwari*. Cattle from black soil areas of the plains are sent to particular pasturelands in plateau and hilly areas (known as *gwaris*) during the monsoon, under the supervision of *charwahas* who build temporary shelters for themselves and the animals. Animals from several neighboring villages are reared in this manner for a period of three to four months (Source: www.bundelkhandinfo.org). In addition, open grazing is the norm, including stray grazing, a practice known as *annapratha* – animals are left to roam around and find food for themselves.

However, *annapratha* has been blamed for poor agriculture and livestock economy.

Recognizing the importance of livestock in traditional agriculture, the local people have developed indigenous traditional knowledge about the use of various plants that facilitate the healthcare of livestock: *lampa* (*Heteropogon contortis*), *phalkara* (*Bothriochola* sp.), *gunaria* (*Iceilema laxum*), *kail* (*Dichanthium annulatum*), *sain* (*Sehima nervosum*) among grasses, and *jharber* (*Ziziphus nummularia*), neem (*Azadirachta indica*), *peepal* (*Ficus religiosa*), *dhak* (*Butea monosperma*), and *desi babool* (*Acacia nilotica*) (Mishra *et al.*, 2010). Use of fodder trees for feeding the livestock has been a popular and unique practice of the region.

The region had also developed the technology for harvesting, baling, and exporting grasses from the region for horses in the armies of different countries. Grass trade had been a feature of this region organized at Jhansi (by Mr Abbot), and grass was collected from Panna, Chhatarpur, Sagar, etc. (PS Pathak, personal communication).

A wide range of genetic diversity in freshwater fish has also been conserved in Bundelkhand's rivers, including species known locally as *rahu*, *bhadur*, *mrigal*, *tingar*, *singahi*, *mangur*, *awda*, *baam*, *sooja*, *sinni*, and *mahasir* (Source: www.bundelkhandinfo.org).

Future perspectives

Today, the Bundelkhand region is characterized by some of the lowest levels

of per capita income and human development. The mismanagement of environmental issues and land use in the past has led to the rapid decline of forest cover, reducing the traditional sources of fuel, fodder, and food. These factors, combined with limited rainfall and lack of water resources, have resulted in low agricultural productivity. Therefore, appropriate afforestation with native trees along the bunds and ravines, management of rainwater harvesting with the development of channels as per contours and topography, storage facilities, prevention of logging for fuel, weather forecasting, and development of new combinations of early-maturing and drought-resistant crops as per the changing weather scenario can help transform the vast land and help it regain its fertility. This needs to be initiated on priority.

Poor crop yields have been one of the major problems, because of erosion of the topsoil leading to poor soil fertility and water runoff. Therefore, with improved water management, revival of traditional crop rotations, which can help maintain the fertility of the land and the introduction of new crops/crop rotation systems suited to the local environment should be promoted after proper evaluation. In this endeavor, the potential of horticultural crops, such as vegetables and minor fruit, needs to be tapped. It may need promotion of special crops for specific areas as per climatic conditions.

The region has rich knowledge about the medicinal properties of herbs. These can provide an important source of livelihood apart from playing a role in improving medicare at low cost. The temporary and

long-term out-migration of males from rural villages in search of alternative sources of livelihood has become increasingly common, therefore rural employment based on indigenous resources revolving around field-agriculture, horticulture (vegetables and minor fruits), and livestock rearing has to be created and encouraged.

In the past, the forests provided various non-timber forest products, which are economically beneficial for the poor. They have become depleted today, and access is denied to the remaining products in the name of conservation. There is an urgent need for integrated planning of natural resources to support livelihoods, by bringing more land under forest cover and integrating the objectives of conservation and increasing forest cover with the livelihoods of the tribal and rural poor.

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