

- Conservation practices of the tribe, the taboos associated with certain plants, and their impact on the ecosystem.
- Tribal peoples have some rules and regulations regarding the medicine practice such as age, gender, and background relating to plants and the reasoning behind the practice.
- The tattooing, painting, dancing, customs, foods need thorough local study for the development of ecocenters.
- Tribes have specific plants for various uses, and their use differs with the tribe; this needs greater attention where the cross-cultural study may lead to many revelations.

Conclusion

There is need for documentation of all tribal health practices and the plants used by them. Deforestation seriously affects the life of tribals who are the 'forest children.' Their health, wealth, and culture depend on the forest and no one can alienate them from nature and it is a crime to deprive their resource base. The elite society that thinks that these people are illiterate and ignorant and need modern medication and education should understand first the dynamic element of the systems before introducing any reform.

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Forest Biodiversity Prospecting

S A Laird, University College London, UK

K ten Kate, Insight Investment, London, UK

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Introduction

Forests have long been an invaluable source of medicines, foods, crops, and other products based on genetic resources. A wide range of commercial sectors is involved today in 'biodiversity prospecting' as part of research and development programs aimed at developing new products, processes, and ingredients. Although scientific and technological advances have changed the role of natural products in many industry research programs, they continue to contribute significantly to existing sales and new product development. Biodiversity prospecting takes place within a legal and ethical framework that has transformed in the last decade, in part as a result of the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture. Biodiversity prospecting partnerships must now incorporate requirements for prior informed consent, mutually agreed terms, and benefit-sharing with source countries and communities.

Sectors Involved in Biodiversity Prospecting

The collection and trade in genetic resources is as old as human civilization, but the term biodiversity prospecting (bioprospecting) was first defined in 1993 as 'the exploration of biodiversity for commercially valuable genetic resources and biochemicals.' Biodiversity prospecting involves a wide range of commercial industries including the pharmaceutical, biotechnology, seed, crop protection, horticulture, botanical medicine, cosmetic and personal care, and food and beverage industries. These sectors vary significantly in terms of size, and the role of genetic resources in research and development, and markets (Table 1).

In some sectors, such as the botanical medicine, horticulture, and agricultural seed sectors, commercial products are 100% natural products. In others, the contribution of genetic resources might be more indirect. For example, in the pharmaceutical, crop protection, and sometimes the cosmetic industry, genetic resources are screened for active compounds. The final commercial products might be chemically identical to the pure natural product, might start with a natural product that is then chemically modified, or

Table 1 Industries involved in biodiversity prospecting: comparison of size in 1998, and the role of genetic resources and traditional knowledge

Industry	Size of sector (US\$)	Average size of top companies (annual sales in US\$)	Percentage of sales dependent on genetic resources	Use of traditional knowledge (importance: scale of 1–5) ^a
Pharmaceutical	\$300 billion	>\$10 billion	25–50%	3–4
Crop protection	\$0.6–3 billion	\$2–3 billion	< 10%	3–4
Agricultural seed	\$30 billion	\$500 million–\$1 billion	100%	3–4
Horticulture	\$16–19 billion	\$200–500 million	100%	4
Botanical medicine	\$20 billion	<\$200 million	100%	2
Personal care and cosmetic	\$75 billion	\$5 billion	< 10%	3–4
Biotechnology (other than agriculture and healthcare)	\$60–120 billion	Great variation	100%	4

^a 1, Very important, central to research strategy; 2, regularly used to identify, develop and market new products; 3, occasionally used to identify, develop, and market new products; 4, currently rarely used, but many products and the roots of the industry are based in traditional knowledge; 5, never used.

Source: ten Kate K and Laird SA (1999) *The Commercial Use of Biodiversity*. London: Earthscan Publications; Laird SA and ten Kate K (2002) Linking biodiversity prospecting and forest conservation. In: Pagiola S, Bishop J, and Landell-Mills N (eds) *Selling Forest Environmental Services*. London: Earthscan Publications.

might result when the parent structure comes from nature, but the final product is synthesized to a design based on a natural template. Interest in natural products has been cyclical over the last four decades in these industries, but naturally inspired compounds continue to contribute significantly to companies' profits. For example, 11 of the 25 best-selling blockbuster drugs in 1997, representing 42% of industry-wide sales and with a total value of US\$17.5 billion, are biologicals, natural products or entities derived from natural products. Of the 87 cancer drugs approved by the US Food and Drug Administration between 1985 and 1995, 62% are of natural origin or are modeled on natural product parents.

Contribution of Traditional Knowledge

Traditional knowledge forms a component of some biodiversity prospecting discovery programs. In most cases, this is acquired through literature and databases, but traditional knowledge is also collected through ethnobotanical research with communities. Scientific and technological advances in recent decades have made the role of traditional knowledge more marginal than it once was, but all of the industries involved in biodiversity prospecting have their roots in this knowledge and many products continue to be marketed based on earlier research on traditional use (Table 1). For example, of the approximately 120 pharmaceutical products derived from plants in 1985, 75% were discovered through the study of their traditional medical use. In 1997 a study demonstrated that for the base compound in most of the top 150 plant-derived prescription drugs, commercial use correlates with traditional medical use.

Forest species that have been commercialized include the pharmaceuticals *Cinchona* spp. (which yield quinine) from South America; *Chondodendron tomentosum* (D-tubocurarine) from South America; *Rauvolfia serpentina* (reserpine) from Asia; *Pilocarpus jaborandi* from Brazil (pilocarpine), and *Campothecan acuminata* (topotecan) from China. Botanical and herbal medicines from forests with large international markets include *Uncaria* spp. (cat's claw) from Central and South America; *Prunus africana* (pygeum) from Africa; *Panax ginseng* and *P. quinquefolius* (ginseng) from Asia and North America respectively; and *Hydrastis canadensis* (goldenseal) from North America. By far the most commercially successful product to result from biodiversity prospecting in forests in recent decades is the case of the Pacific yew trees *Taxus brevifolia* and *T. baccata*, which yield anticancer compounds. Original collections of *T. brevifolia* were made in 1962 in the Pacific Northwest of the USA. Previously considered a waste tree following logging in the region, numerous groups struggled to develop large-scale sustainable supplies of raw materials once the commercial potential of this species became apparent in the late 1980s. By 2000, the commercial products derived from the Pacific yew tree had annual sales in excess of US\$2 billion, making this one of the top selling drugs worldwide.

The Policy Context for Biodiversity Prospecting

In the last 15 years the ways in which biodiversity prospecting is viewed, and the ethical and legal framework in which it takes place, have transformed.

The Convention on Biological Diversity (CBD) sets out provisions according to which states should regulate access to genetic resources and associated traditional knowledge. It balances sovereignty and the authority of national governments to regulate access to their genetic resources with the obligation for them to facilitate access for environmentally sound purposes. Access to genetic resources is to be subject to governments' prior informed consent, on terms mutually agreed by the provider and recipient that promote the fair and equitable sharing of benefits. Similarly, subject to national law, access to the knowledge, innovations and practices of indigenous and local communities requires the prior approval of the holders of that knowledge and the resulting benefits should be shared fairly and equitably with the communities concerned.

The 186 Parties to the CBD are developing guidelines to spell out these provisions and translate them into action. When the Parties to the CBD met in The Hague in April 2002, they adopted the voluntary *Bonn Guidelines on Access and Benefit-Sharing* (<http://www.biodiv.org>). These provide operational guidance for 'users and providers' of genetic resources and serve as information for governments drafting national laws and for governments, communities, companies, researchers, and others involved in access and benefit-sharing agreements.

Figure 1 The Convention on Biological Diversity and 'Access and Benefit-Sharing.'

In particular, the Convention on Biological Diversity (CBD) (Figure 1), which opened for signature at the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, and the International Treaty on Plant Genetic Resources for Food and Agriculture (IT), finalized in Rome in November 2001, promote new principles of prior informed consent, mutually agreed terms, and benefit-sharing. At the same time, researchers and indigenous peoples' groups are exploring the parameters of what constitutes equitable research relationships, and have articulated appropriate terms for collaboration. A range of indigenous peoples' statements and declarations, researchers' codes of ethics, and institutional policies have been developed in response. All of this combines to create a new context in which biodiversity research and prospecting take place, in order to ensure source countries and local communities control and benefit from commercial use of their resources and knowledge.

Biodiversity Prospecting, Benefit-Sharing, and Conservation

The bulk of benefits for conservation and development resulting from biodiversity prospecting in recent years grew from the research process, and an increasing number of partnerships between companies and source countries. Benefits resulting from these partnerships include: information and research results, participation in the research process, technology transfer, training and capacity-building, and in some cases financial benefits in the form of fees, milestone payments, and royalties.

Benefit-sharing arrangements have improved significantly over the last decade, following entry into force of the CBD, and wider awareness of the issues

raised by biodiversity prospecting. Benefits resulting from these partnerships can positively impact a country's capacity to undertake research and develop its own biodiversity, and lead to numerous spin-off benefits for research institutions, universities, local businesses and others. The direct impact of biodiversity prospecting on conservation remains modest in most cases, but can include capacity-building and support for biodiversity science; sustainable economic activities based on the supply of raw materials to industry; and in a few cases direct financial contributions to conservation programs and objectives. For example, in the case of INBio in Costa Rica, biodiversity prospecting is directly linked to building basic biodiversity science and management needs, like national inventories, and a financial contribution – 'conservation overhead' – for conservation areas is built into all commercial agreements.

Biodiversity prospecting can also pose dangers to the environment and can poorly serve local groups' interests. For example, poor collection of samples for research purposes can result in localized threats to populations of sought-after species. Unsustainable bulk collection of raw materials for manufacture can endanger species; this is a common concern for medicinal plants, many of which have landed on CITES Appendices as a result of overharvest in the wild (e.g., *Panax* spp., *Prunus africana*, and *Rauwolfia serpentina*). Inequitable relationships with local communities and source countries can mean that they benefit little from commercialization of resources and knowledge, and have limited or no control over the research and commercialization process.

In order for biodiversity prospecting to maximize its potential to positively benefit local groups and promote conservation, a number of basic steps and

strategies are required. These include: effective national 'access and benefit-sharing' measures, growing from a solid national consultation process and a strategy addressing these issues; policies or guidelines for research institutions, protected areas, and in some cases local communities, to guide research collaborations; and a trust fund or guidelines for distribution of financial benefits to ensure equity and the service of national and local priorities.

See also: **Biodiversity:** Endangered Species of Trees; Plant Diversity in Forests. **Medicinal, Food and Aromatic Plants:** Medicinal and Aromatic Plants: Ethnobotany and Conservation Status; Medicinal Plants and Human Health; Tribal Medicine and Medicinal Plants. **Silviculture:** Managing for Tropical Non-timber Forest Products. **Sustainable Forest Management:** Definitions, Good Practices and Certification.

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Edible Products from the Forest

B K Tiwari and S Rani, North-Eastern Hill University, Shillong, India

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Introduction

Forests are one of the major forms of natural landscape and are the most important natural resources of the world. The term 'non-wood forest products' (NWFP) has emerged as an umbrella expression for the vast array of both plant and animal resources other than wood derived from forests or forest tree species. The forests are important not only for their economic utility but they also influence the social and economic life of humankind. Forests are an important source of food; in fact people were dependent mainly on forest collected food when they were wanderers and the concept of cultivating food came in only after people started living in settlements. The cultivation of food items made life much easier for humans, who not only started cultivating food but also cultivated the selected ones they liked more. Thereby the number of plants that were included in the cultivated list was much less than the actual number of edible plants found in the wild. In the modern world people seem to have forgotten that all the edible things being used by them now are actually derivatives of those that used to grow in the wild once upon a time, and they also seem to be unaware