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National Biodiversity Authority
Government of India

ECONOMIC VALUATION OF BIO-RESOURCES FOR ACCESS AND BENEFIT SHARING (ABS)

Training Manual – 1

For SBB UNEP-GEF-ABS Team

ECONOMIC VALUATION OF BIO-RESOURCES FOR ACCESS AND BENEFIT SHARING (ABS)

Content

Economic Valuation Component in the ABS Project

Background

The project on "Strengthening the Implementation of the Biological Diversity Act and Rules with focus on its Access and Benefit Sharing provisions" deals with assessing and quantifying the economic value of biological diversity present at local, state and national levels using appropriate methodologies to determine benefit sharing which will help in better implementation of the Biological Diversity Act and inform national decision makers on prioritizing conservation action. Developing tools, methodologies, guidelines and frameworks inter alia, on PIC, MAT, MTA, Benefit Sharing agreements for realizing ABS provisions will help in developing better ABS agreements.

Project Component

Identification of biodiversity or genetic resources with potential for ABS and their valuation in selected ecosystems such as: forests, wetlands and agriculture.

Major Activities

- *Develop standardized economic valuation methods for valuing biodiversity in forest, agriculture and wetland ecosystems with potential for ABS*
- *Organize three national workshops and five state level workshops on understanding the valuation methodology and using the same in decision making.*
- *Develop methodology and guidance on using the economic valuation in deciding on ABS permits*
- *Develop a data base covering the economic valuation information in finalizing ABS agreements*

Expected Outcomes/results

Enhanced understanding of economic values of biological diversity for improved policy making and implementation of conservation, sustainable use and determining the ABS provisions under the Act enhanced.

Expected Outputs

- *Economic value of biological diversity present at village or districts, state and national levels assessed and quantified using standard valuation methodologies in at least 5 states and 40 Biodiversity Management Committees;*
- *Discussion on provision of access and benefit sharing based on the economic valuation and methods.*

Approaches

- *Standard economic valuation methods developed for forests, agriculture and wetland ecosystems in 5 project states.*
- *Use of standard economic valuation methods to develop ABS agreements that capture appropriate benefit sharing principles.*
- *Surveys/reports of SBBs and BMCs use of the economic valuation methods to realize the ABS potential of the select ecosystems present in their states.*
- *Manuals on Standard Economic Valuation for forests, agriculture and wetland ecosystems.*
- *Interviews/surveys, and others on how provider of biological resources can use economic value for ABS purpose.*

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ECONOMIC VALUATION OF BIO-RESOURCES FOR ACCESS AND BENEFIT SHARING (ABS)

Context

Biodiversity represents the variety of life on earth; which includes species, genetic and ecosystem diversities. Biodiversity is crucial for the functioning of ecosystems and socio-economic development of a nation. Biological diversity is a global asset with tremendous economic values to the present and future generations. However, the species and ecosystem are under threat in recent years than ever before and their losses (45-250 species per day) have become a global concern. The most significant anthropogenic threats to biodiversity are habitat loss due to forest conversion, degradation of habitat due to pollution or pesticides, grazing leading to reduction in plant biomass, fragmentation of habitat, logging, introduction of exotic species from other regions or continents, and climate change (Haripriya, et al, 2006).

According to Pearce and Dominic (1994), “economic forces drive much of the extinction of the world's biological resources and biological diversity; yet biodiversity has economic value. If the world's economies are rationally organized, this suggests that biodiversity must have less economic value than the economic activities giving rise to its loss; yet we know that many biological resources do have significant economic value. We also know that many of the destructive activities themselves have very low economic value; therefore something is wrong with the way actual economic decisions are made or for some reason they fail to ‘capture' the economic values that can be identified. These `economic failures' lie at the heart of any explanation for the loss of biological diversity. If we can address them, there is a chance of reducing biodiversity loss”.

Therefor the primary reason for the failure to conserve biodiversity is that its value is not well understood. According to OECD (2002), for biodiversity and many biological resources the absence of apparent value combined with absent or poorly defined property rights creates a problem of over exploitation and unregulated use, which is experiencing substantially to worlds biodiversity during the last few fears. In the absence of an economic value for biodiversity and biological resources, they fail to compete on a level playing field and may underestimated and destroyed for many developmental activities. For example, the decision to convert one hectare of forest rich in biodiversity for purposes such as agriculture or construction is usually based only on the immediate visible benefits obtain from these activities. Generally policy makers provide limited attention to the many non-measurable or non-marketable ecological services provided by forest biodiversity / ecosystems. Therefore, if biodiversity is not measured, there is no way to arrive at rational decisions relating to competing land uses that may affect the preservation of species.

But biodiversity once lost is lost for ever and likely to cause serious consequences to the ecosystem and human life. Considering this fact, the Convention of Biological Diversity (CBD) was founded at the global level in 1992. The CBD's Conference of the Parties (COP) Decision IV/10 acknowledges that "economic valuation of biodiversity and biological resources is an important tool for well-targeted and calibrated economic incentive measures" for conserving and sustainable use of biodiversity and its benefits. Hence CBD encourages the Parties to "take into account economic, social, cultural, and ethical valuation in the development of relevant incentive measures" to preserve biodiversity. Therefor the central argument is that by attributing economic value to biodiversity, more powerful, more practical arguments can be formulated for its conservation. In this perspective only ABS has emerged as an innovative financial option for preserving biodiversity trough incentivise to the local or indigenous communities, who are the owner and safeguard of biodiversity.

<u>ABS and Economic Valuation</u>

The CBD's mandates or objectives includes: (a) conservation of biodiversity, (b) sustainable use of its components and (c) fair and equitable sharing of benefits arising from the use of genetic resources. 193 countries, including India, are signatories of CBD. Subsequently Government of India enacted the Biological Diversity Act (2002) and Rules (2004) with the following three objectives, which are similar to the CBD mandate.

(i) Conservation of biological diversity
(ii) Sustainable use of its components; and
(iii) Fair and equitable sharing of the benefit arising out of the use of biological resources and knowledge associated thereto.

For operationalization of these objectives, particularly the 'fair and equitable sharing of the benefit arising out of the use of biological resources', a decentralized 'institutional setup' was formed which includes: Biological Management Committees (BMC) at local / regional level, State Biodiversity Boards (SBBs) at State level, and National Biodiversity Authority (NBA) at National level.

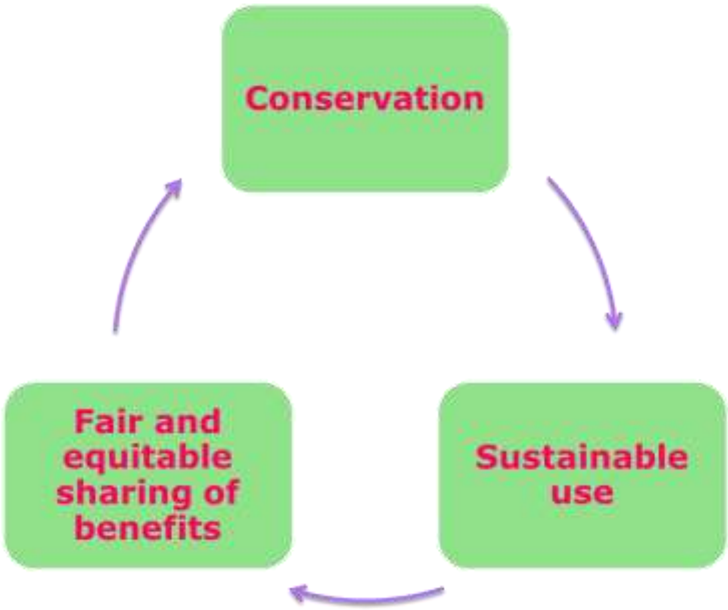
The CBD declared that 'Access and Benefit Sharing (ABS)' is act as an incentive mechanism to local communities in conserving and preserving the biodiversity and it resources potential. A driving force behind the approach is the fact that; a very large part of the world's biodiversity resides in the poorer or developing countries of the world, i.e. in those countries least able to finance its conservation and least able to resist the land use changes that threaten biodiversity. The CBD thus encompasses two compensating mechanisms:

1. The richer world allocating 'new' resources to the financing of conservation in the developing world, in addition to those efforts that they make in their own countries.
2. Ensuring that developing countries gain a more equitable share in the financial and other benefits that the rich world derives from the biodiversity of the poor world.

Over a period, the ABS is emerging as an innovative approach and an incentive mechanism in biodiversity conservation and its sustainable utilization. The ABS framework provides a formal guidance for the way in which biological or genetic resources are accessed, and the way benefits are shared between people or countries using the resources (users) and the people or countries that provide them (providers). The ABS philosophy proposes that providers of bio-resources are entitled to receive fair benefits from the users. In this context ABS balances the rights of the users of bio-resources with the rights of the providers of such resources. Further, the ABS can manage biodiversity as a community asset and support biodiversity-based businesses in an effective and sustainable manner as indicated as a circular flow chart in figure 1. Or in other words ABS can resist the process of commercialization of biodiversity and large portion of biodiversity based economic activities. Commercialization may lead to loss the opportunities of the local communities, who are historically play a predominant role in biodiversity based trade and business.

Fig: 1

CBD and Biological Diversity Act Objectives and its Function



It is vital that both users and providers understand and respect the legal, administrative and policy frameworks at the national and local levels, as well as those outlined in the Convention of Biological Diversity (CBD) and the Nagoya Protocol on ABS. The ABS is based on prior informed consent (PIC) being granted by a provider to a user, and negotiations between both parties that result in mutually agreed terms (MAT). The negotiation between a provider and a user of resources should be based on the true/actual value of the resources. Hence, understanding the real value of bio-resources is a pre-requisite for equitable benefit sharing and signing of ABS agreements.

The above factors point to the significance of valuation of biodiversity and the bio-resources, because in the absence of proper price or value of bio-resources actual exchange or benefit sharing between the developed and developing countries never materialized in an equitable manner. Further the debate may also emerge on at what flows of resources from rich to poor countries would be justified in the interests of helping developing countries conserve their biodiversity? According to OECD (2002), unless there is some idea of the value that the world as a whole gets back, and, indeed, what the donor countries get back, from such investments, the question of what resources to transfer is likely to be settled on an *ad hoc* and probably unsatisfactory basis.

How the valuation of Bio-resources for ABS differs from the normal 'ecosystem' valuation?

The valuation of bio-resources for ABS differs from the normal 'ecosystem valuation' which environmental economists are generally involves. The ecosystem valuation is emphasized on site specific (such as areas covered with forests, mangroves, corals, wetlands etc.) with Total Economic Value (TEV) Approach. In TEV, both the goods and services provided by an eco-system are taken in to account. But the valuation required for ABS is primarily for the visible and tangible goods or products, which are coming out from the ecosystem. Biological resources are simply those components of biodiversity which maintain current or potential human uses. A common taxonomy for environmental asset valuation is presented in Figure 2.

Figure 2

Categories of Economic Values Attributed to Environmental Assets

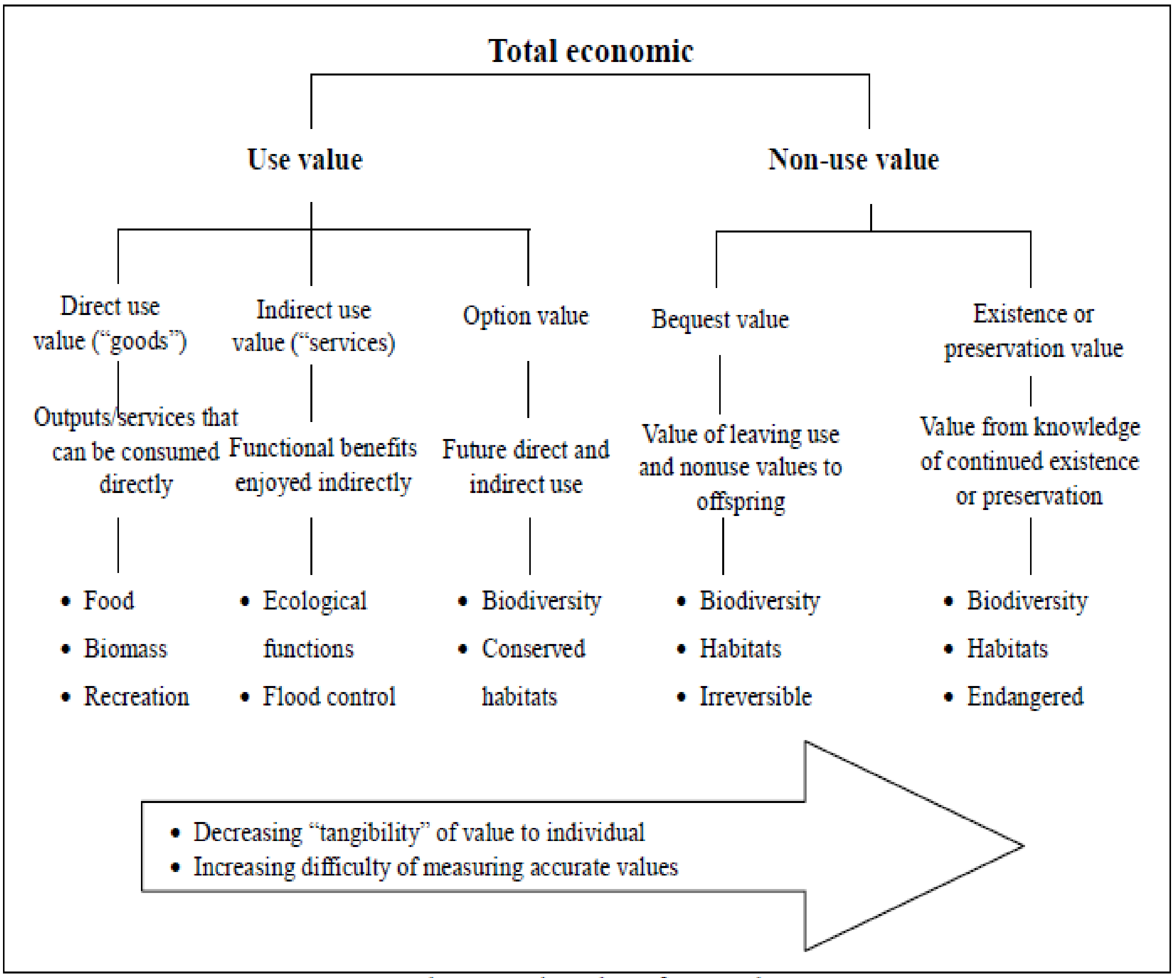


Fig. 1 Total Economic Value of Coastal Resources

Conceptually, total economic value (TEV) of an environmental resource consists of its use value (UV) and non-use value (NUV). A use value is a value (in the form of commodities and services) arising from an actual use made of a given resource. This might be the use of a forest for timber, or of a wetland for recreation or fishing, and so on. Use values are further divided into direct use values (DUV), which refer to actual uses such as fishing, timber extraction etc; indirect use values (IUV), which refer to the benefits deriving from ecosystem functions such as a forest's function in protecting the watershed; and option values (OV), which is a value approximating an individual's willingness to pay to safeguard an asset for the option of using it at a future date. This is like an insurance value.

Non-use values (NUV) are more problematic in definition and estimation since these are non-marketed services of ecosystem. NUV are usually divided between a bequest value (BV) and an existence or `passive' use value (XV). The former measures the benefit accruing to any individual from the knowledge that others might benefit from a resource in future. The latter are unrelated to current use or option values, deriving simply from the existence of any particular asset. An individual's concern to protect, say, the blue whale although he or she has never seen one and is never likely to, could be an example of existence value (Pearce and Dominic, 1994).

Thus in total economic value we have:

$$TEV = UV + NUV = (DUV + IUV + OV) + (XV + BV)$$

In the ABS perspective we are not involving in to the TEV estimation of a particular ecosystem such as forests or wetlands. Here the direct use value of the ecosystem or biodiversity, particularly the goods, which are having huge market potential and business scope or utility, is significant. However these goods are part of ecosystems. For example a good or rich forest ecosystem only can provide substantial amount of timber or other non-timber forest products.

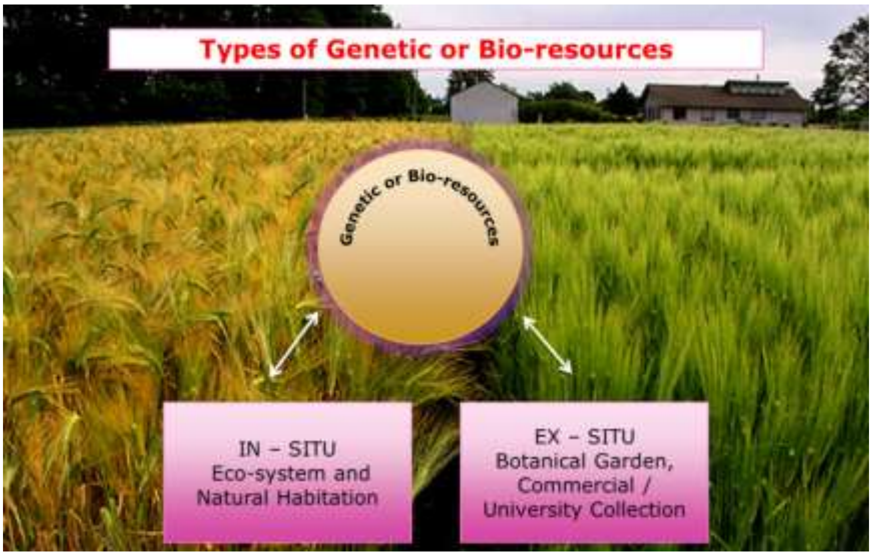
Historically these bio-resources, which include different genetic materials, are extracted by local communities with the help of their unique and traditional knowledge and sells to the companies at low or negligible prices. Since there are no proper markets for bio-resources at its collection point, the existing price for the product is not revealing its actual value. Actual value may be more than the existing market price. In this context only valuation of bio-resources and signing of ABS agreements are significant. This will facilitates in obtaining reasonably better share of the overall benefits of bio-resources related economic activities to the local communities, who are involved in its collection and management.

Bio-resources: Nature and Characteristics and Economic Potential

Bio-resources / biological resources means: plants, animals and micro-organisms or parts thereof, their genetic material and by-products (excluding value added products) with actual or potential use or value, but not human genetic material (The Biological Diversity Act, 2002). This biotic component of ecosystems has direct and indirect use and value for humanity for fulfilling various requirements. In this context biological resources should be considered as part of biological diversity or biodiversity. Biological resources have been commercialised ever since humankind created markets and even before the invention of money. During the *"barter system"* most of the transactions were on tangible goods, which are from ecosystems, either wild or cultivated. After the invention of money bio-resources were started to transacted heavily. In the modern global economy, bio-resources based industries are emerging in a substantial level.

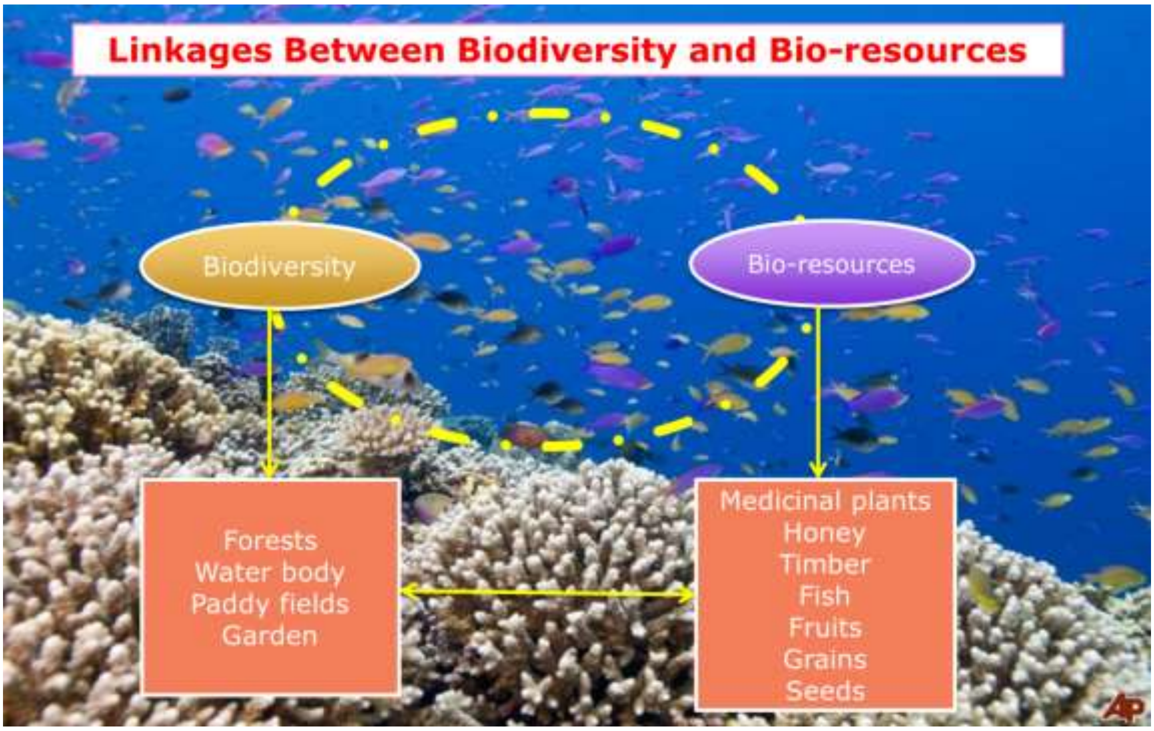
Biodiversity exists in in-site and ex-situ situations. In in-situ conditions, genetic resources exist within ecosystems and natural habitats. In-situ conservation is significant, where conservation of ecosystem and natural habitats and the maintenance and recovery of viable population of species in the natural surroundings and in the case of domesticated and cultivated species, in the surroundings where they have developed their distinctive properties. In the case of ex-situ case, conservation of the components of biological diversity take place outside their natural habitants such as zoos, botanical gardens, and seed banks (see Figure 3).

Figure 3



Bio-resources are renewable natural resources and can consider as a subset of biodiversity. Bio-resources and biodiversity are highly interlinked. One can interpret biodiversity as a stock and bio-resources as the flow from it; they are mutually interrelated in their existence and function as interpreted in the following figure (Figure 4). Hence, the earth's biodiversity stock should be maintained intact through its sustainable utilization (extraction should be less than or equal to its regeneration) for fulfilling various human requirements for ever.

Figure 4



Biodiversity plays significant role in economic development through income and employment generation, particularly in a developing country like India. Biological diversity is a global asset with tremendous economic values to present and future generations. The resources coming out from the biodiversity or ecosystems are having huge economic potential. Unfortunately this element is still poorly understood and accounted for. Globally more than 1.3 billion people depend on biodiversity and on basic ecosystem goods and services for their livelihoods (CBD, 2012). Biodiversity is base for many manufacturing sectors such as pharmaceuticals, agriculture, horticulture, cosmetics and biotechnology.

Market and Property Rights of Bio-resources

According to OECD, only a limited number of biodiversity products and services are traded in the marketplace, mostly at prices that do not reflect their full value. Many biodiversity products and services display some public good characteristic; they are either non-rival in consumption, or non-excludable, or both. Non-rivalry in consumption means that one person's consumption of the good does not reduce its availability to anyone else. Non-excludability entails that once the good is provided, the provider is unable to prevent anyone from consuming it (OECD, 2003). This type of situation arises when the resources are plenty in a common area with limited rate of extraction, where the rate of extraction is far less than its regeneration. For example the marine fisheries around 50 years before may experience this situation. However, in recent decades bio-resources are broadly getting scarce and are becoming more as a community (common property) resources. The public good or common property characteristics of biodiversity induce market failure by precluding its products and services from being easily traded in markets; therefore, prices do not reflect the full value of biodiversity to society.

In other words, the market for bio-resources at this stage (first stage of transaction) is weak or highly imperfect. The non-excludability character of open access resources, like bio-resources, will often make a market price close to zero, when the actual value is quite large. Since some of the bio-resources are non-rivalry in character, there is no (not much) competition of these resources, hence the market price will be inaccurate. Non-excludability is the essence of a public good. If the good is freely available to one person, it is freely available to all. In such a situation, the question will arise why would a consumer pay to acquire this particular good or service? Further, the Non-excludable and non-rivalry characters of bio-resources reflects the "off-site effects" and the resources often flow to wider communities to different provinces and countries skewing the well below market prices than the actual value.

In brief, bio-resources values are implicit rather than explicit, and thus are often not captured by markets. In the case of biological resources, the absence of apparent values combined with their "public good" characteristics in the absence of well-defined property rights, have created problems of over-exploitation and unregulated use. Moreover, increasing development pressures have led to an unprecedented rate of biodiversity loss. In order to create markets, clear property rights are fundamental. If property rights are clearly established and enforced, and if trading is permitted, markets can in principle develop. While perfect markets hardly ever exist in the case of bio-resources, it is useful to understand the conditions in which they may thrive.

A perfect competitive market occurs if all of the following conditions are satisfied simultaneously:

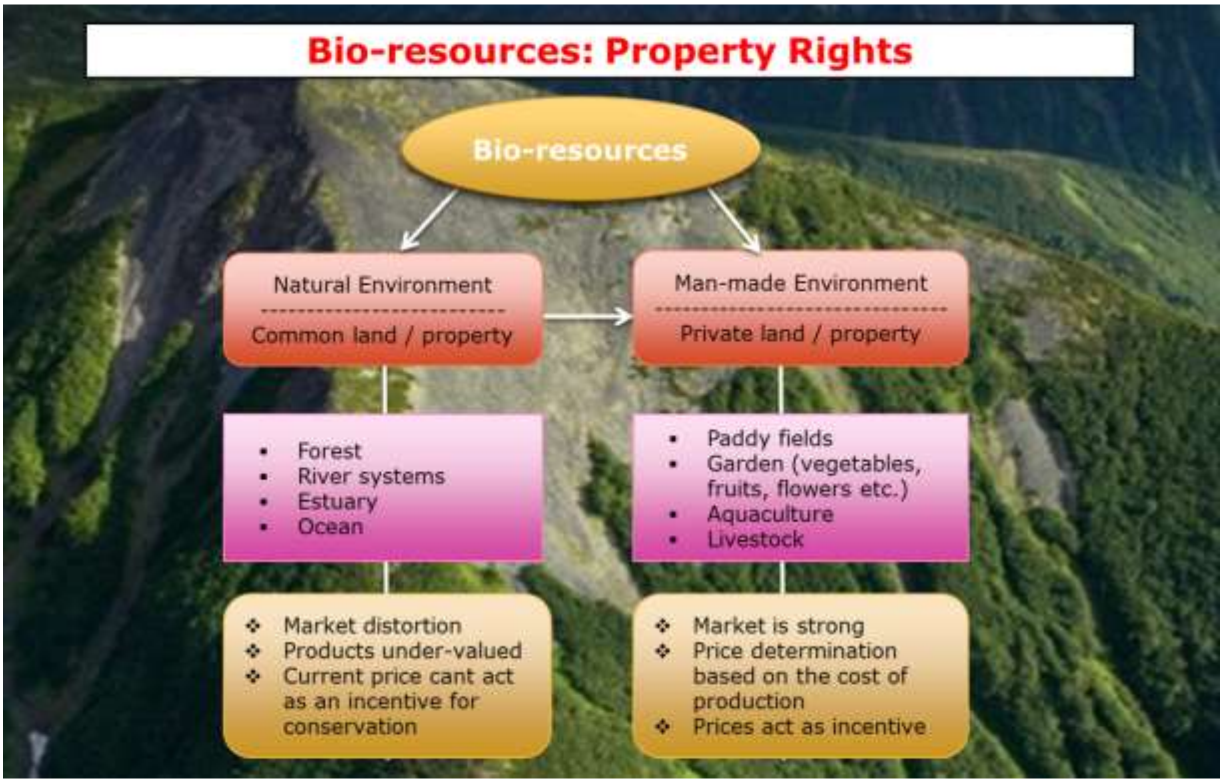
- There are numerous small buyers and sellers;
- A standardised product is traded (also referred to as a homogeneous product);
- Perfect information flows among all buyers and sellers;
- No collusion amongst buyers and sellers;
- All economic agents can freely enter and exit the market;
- Consumers maximise their preferences and sellers maximise total profits; and
- The product is transferable.

However, in the case of bio-resources, most of the above conditions are not fulfilling primarily due to the public good characteristics and the absence of well-defined property rights of bio-resources. It is very clear a huge number of bio-resources are collected by the local communities from different ecosystems (forests, wetlands etc.) and supplying to different users (industries, research organizations etc.) in domestic and international level. However the perfect knowledge regarding the bio-resources and its markets and economic potential is not revealed mutually by the buyers and sellers.

Most of the time the transaction is taking place through brokers / traders. The peculiar functioning of transaction and market may led to the exploitation of local communities (through pay a negligible or a low price for the resources), who normally put their hard work and unique knowledge in mobilising the resources. Since it is a public good (state property) and collected legally or sometimes illegally, the local community has certain in bargaining. Generally these resources are base for manufacturing different consumer products, possess high utility. Further the entire process is a multi-billion business and a profit option for the large number of business community. However, in some bio-resources case, certain area specific cooperative societies are functioning in most transparent and effective manner.

Origin of the bio-resources is from nature and is considered as the free gifts of nature or in other words it has manufactured by nature with its unique and intrinsic ability. In most of the core biodiversity spots (such as: forests, wetlands, marine and coastal zones) the property rights are not well defined. The community, who have the traditional rights on these resources are, historically collecting these resources and provide to the immediate users (traders, industries, research organizations, etc.) at free of cost or at meagre amount. However the bio-resources coming from the private lands may differ. Bio-resources such as grains, cereals, vegetables, fruits, fishes from aquaculture ponds and life stocks, that exist in private lands (fields and gardens) are controlled by private entrepreneurs and priced in better manner. These cultured or cultivated products' market prices reveal their cost of production and act as an incentive to flourishing agri-business (see figure 5).

Figure: 5



Economic Valuation of Bio-resources from Selected Ecosystems

Valuation of biodiversity goods is a fundamental step towards operationalizing the "Access and Benefit Sharing (ABS)" philosophy. Through the on-going GEF – ABS project in NBA an attempt towards valuation of ABS potential bio-resources from selected ecosystems such as: forests, wetlands and agriculture in the 5 project implementing states in India (Andhra Pradesh, West Bengal, Sikkim, Himachal Pradesh and Gujarat) is progressing. Hence developing the standard methodology for economic valuation of bio-resources is an integral part of the project.

Forests

Forests are important renewable ecosystems capable of providing a wide range of benefits (environmental, economic, social and cultural) to the society. Forests provide raw-materials for food, fuel and shelter. In forests, ecosystem components such as microorganisms, soil and vegetative cover interact to purify air and water, regulate climate and recycle nutrients and wastes. Hence forest attributes significantly in global life support system, economic growth and the environmental conditions of the country. Large numbers of bio-resources (goods) are coming out from the forests as timber and non-timber forest products and are exchanged at low price at forest gate. The following table (table 1) provides a broader picture about the various goods and services provided by the forest ecosystem.

Table 1
Primary Goods and Services Provided by Forest Ecosystems

Goods	Services
• Timber • Fuel wood • Drinking and irrigation water • Fodder • Non timber forest products • Food (honey, mushrooms, fruit, and other edible plants; game) • Genetic resources • Cultural resources	• Remove air pollutants, emit oxygen • Cycle nutrients • Maintain array of watershed functions (infiltration, purification, flow control, soil stabilization) • Maintain biodiversity • Sequester atmospheric carbon • Moderate weather extremes and impacts • Generate soil • Provide employment • Provide human, wildlife, and beneficial insect habitat • Contribute to aesthetic beauty and provide recreation

Source: OECD, 2003

However, these resources are used as unavoidable input factor for manufacturing various value added products having huge market potential. For examples see Figure 6.

Figure 6

Timber and Non-timber Forest Products

Wetlands

Wetlands are one of the most productive ecosystems in the earth. Wetland includes: (a) estuaries – where rivers meet the sea and salinity is intermediate between salt and freshwater (e.g., deltas, mudflats, salt marshes), (b) marine – not influenced by river flows (e.g., shorelines and coral reefs), (c) riverine – land periodically inundated by river overtopping (e.g., water meadows, flooded forests, oxbow lakes), (d) palustrine – where there is more or less permanent water (e.g., papyrus swamp, marshes, fen) and (e) lacustrine – areas of permanent water with little flow (e.g., ponds, kettle lakes, volcanic crater lakes). The major components of a wetland includes biotic (plants and animals) and non-biotic (soil and water). The interactions between the components make wetland as functions, including nutrient cycling and exchange of water between the surface and the groundwater and the surface and the atmosphere (hydrological cycle). The system also has attributes, such as the diversity of species (Table 2).

Table 2

Primary Goods and Services Provided by Different Wetland Ecosystems

Type of Wetland Ecosystem	Goods	Services
Coastal ecosystems	• Fish and shellfish • Fish meal (animal feed) • Seaweeds (for food and industrial use) • Salt • Genetic resources • Cultural resources	• Moderate Storm Impacts (mangroves; barrier islands) • Provide wildlife (marine and terrestrial habitat) • Maintain biodiversity • Dilute and treat wastes • Provide harbour and transportation roots • Provide human and wildlife habitat • Provide employment • Contribute to aesthetic beauty and provide recreation
Freshwater ecosystems	• Drinking and irrigation water • Fish • Hydroelectricity • Genetic Resources • Cultural Resources	• Buffer Water flow (control of timing and volume) • Dilute and carry away wastes • Cycle nutrients • Maintain biodiversity • Provide aquatic habitat • Provide Transportation corridor • Provide employment • Contribute to aesthetic beauty and provide recreation

Source: OECD, 2003

Wetland species (animals and plants) are having huge economic value and ABS potential (Figure 7).

Figure 7
Wetland / Marine Species and Products

Fish

Seaweeds

Agriculture

Agricultural biodiversity is an essential component for global food production, livelihood security and sustainable agricultural development. The plant, animal and microbial organisms influenced on food and agriculture must be conserved and used sustainably for universal food security. Agricultural biodiversity of all food species is highly threatened during globalisation induced unsustainable industrial food production. It is the first link in the food chain, developed and safeguarded by farmers, herders and fishers throughout the world. Agricultural biodiversity includes: harvested crop varieties, livestock breeds, fish species and non-domesticated ('wild') resources within field, forest, rangeland and in aquatic ecosystems; (b) non-harvested species within production ecosystems that support food provision, including soil micro-biota, pollinators and so on; and (c) non-harvested species in the wider environment that support food production ecosystems (agricultural, pastoral, forest and aquatic ecosystems).

Agricultural biodiversity emerged from the interaction between the environment, genetic resources and the management systems and practices used by culturally diverse peoples resulting in the different ways land and water resources are used for production. It thus encompasses the variety and variability of animals, plants and microorganisms which are necessary to sustain key functions of the agro-ecosystem. In brief, agricultural biodiversity is essentially the interaction of knowledge and genetic resources used for food, biological support or ecological services.

The following table (Table 3) provide comprehensive information about the primary goods and services provided by agriculture and grassland ecosystems.

Table 3

Primary Goods and Services Provided by Agriculture and Grassland Ecosystems

Ecosystem	Goods	Services
Agro ecosystems	• Food crops • Fibre crops • Crop genetic resources • Other crops (energy, fodder, etc) • Cultural resources	• Maintain limited watershed functions • Provide habitat for humans, birds, pollinators, soil organisms important to agriculture, maintain biodiversity and cycle nutrients. • Sequester atmospheric carbon • Provide employment • Contribute to aesthetic beauty and provide recreation
Grassland ecosystems	• Livestock (food, game, hides, fiber) • Drinking and irrigation water • Genetic resources • Cultural resources	• Maintain array of watershed functions (infiltration, purification, flow control, soil stabilization) • Cycle nutrients • Remove air pollutants, emit oxygen • Maintain biodiversity • Generate soil • Sequester atmospheric carbon • Provide employment • Provide human and wildlife habitat • Contribute to aesthetic beauty and provide recreation

Source: OECD, 2003

Agriculture products or outputs are having huge market and business potential and is playing a significant role in manufacturing different food items and achieving food security (see Figure – 7).

Figure 7
Agriculture Resources and Products

Methods for Bio-resources Valuation: Evidences from Literature

Understanding the non-marketed benefits of biodiversity and the true value of bio-resources are critical for initiating effective policies towards the conservation and sustainable use of biodiversity. Methodology development, particularly for valuing the non-marketed services of the ecosystem/biodiversity has progressed substantially in the last two decades. Methodologies such as: market prices, replacement costs, avoidance of damage cost, production function, hedonic price, travel cost, contingent valuation, participatory environmental valuation and benefits transfer are well established, and widely used in valuing ecosystem services in different parts of the world. However, developing the standard methods/tools for finding out the true value of bio-resources (a pre-requisite for operationalizing ABS) is still in a preliminary stage.

A thorough review of the literature on ecosystem or biodiversity valuation revealed that some of the environmental economists indicated certain possible approaches or methods to valuing the bio-resources such as medicinal plants; genetic resources and microbial resources (see Appendix 1). Even if these studies are not directly related to ABS relevant valuations, it will helpful in our overall attempt in finding the real value of bio-resources.

The following section examines the economic significance of medicinal plants in India and the possible approaches towards its valuation from the study done by (Haripriya, et al, 2006) on the value of biodiversity in India's forests.

India has rich flora and fauna and known as one of the mega-diverse countries in the world. Further India is one of the world's richest medicinal plant heritages. About one-fifth (20%) of all the plants found in India are used for medicinal purpose, while the world average stands at 12.5%. Studies by Schippmann Leaman, and Cunningham (2002) and Shiva, (1996), indicated that India ranks first in per cent flora that contains active medicinal ingredients. According to an all India ethno-botanical survey carried out by MoEF (Ministry of Environment and Forests), over 8000 species of plants are being used by the people of India, with 90 to 95% of these coming from forests. However, of the 8000 species which are used, only 1800 species are systematically documented in the codified ISM (Indian System of Medicine) while the rest of the species are undocumented and their details are transmitted orally through traditional knowledge (EXIM 2003).

Of the documented species, only 880 medicinal plant species are involved in the all India trade, with 48 medicinal plant species exported to foreign countries and about 42 medicinal plants being imported. These 880 species are spread across 151 families, with nearly 80% belonging to high-class quality. Ayurveda accounts for more than 80% of the traded medicinal plants with 710 plants. Only 49 species are used in the modern systems of medicine.

The analysis of the distribution of the origin of species across major biogeographic zones reveals that about 18% of the species are exclusively confined to the Himalayan and the trans-Himalayan zones, 4% belong exclusively to the Western Ghats, and about 77% of the species belong to other biogeographic zones. About 61% of the traded species are from the wild, with no known plantations or cultivation. Only 10% of these species are cultivated. The consequence of this skewed pattern of sourcing medicinal plants is that about 100 medicinal plants are under the IUCN Red List category. Fourteen species are identified as threatened globally as they are endemic to India.

However, medicinal plants in India are highly over-extracted and are under depletion. The causes of over-extraction include open access to medicinal plants in the wild, the low price paid to gatherers of medicinal plants, and the lack of sufficient data on wild plant populations, marketing, and trading. The biodiversity loss is not only a threat to the ecology of the planet but also a more immediate threat to the livelihood security of rural communities, who historically depends on its collection and processing. Further medicinal plants loss has huge implications to the economy.

One of the most important services that biodiversity provides to the economy is in the form of the genetic material. Modern pharmaceutical research has relied heavily upon plant-based genetic material to develop lifesaving commercial drugs that are marketed nationally and internationally. About 119 pure chemical substances taken from 90 species of higher plants are used internationally in medicines. In the developed world, some 25% of all medicinal drugs are based on plants or their derivatives, however, this number is three times higher in developing countries (Principe 1991). As per the WCMC (1992), 80% of the developing country inhabitants relay one way or other on traditional medicines. The plant-based drugs already exist in the market, but losing any one species may be a risky proposition because that species may potentially contain a new and useful chemical.

For plant-based drugs already in the market, three approaches have been developed to obtain the value of genetic material contained within them. The first approach looks at the values arising from traded plant material on the assumption that the market value represents the true WTP. The second approach uses the market value of plant-based drugs. The third approach estimates the value of plant-based drugs in terms of their lifesaving properties. However, these studies are for genetic material, which has already been discovered and mostly undervalued due to market imperfections.

If we want to know whether the conservation of a species is worthwhile, we need to know the value of undiscovered genetic material. Several approaches have been used for this. One approach has been to simply look at the investment already committed by companies for the exclusive right to bio-prospect. The best known example for such a transaction occurred in 1991 when Merck and Co., the world's largest pharmaceutical company, paid Costa Rica about 1 million dollars for the private rights to examine 2,000 samples of the gene pool. This is in addition to promising to pay royalties associated with new commercial products. More recently, Glaxo-Welcome, the world's second-largest pharmaceutical company, signed an agreement with a Brazilian company for the right to screen 30,000 samples of compounds from plants, fungus, and bacteria. The value of the transaction was 3.2 million dollars in 1999 (Nunes and van den Bergh 2001).

A second approach has been to estimate the future expected returns to pharmaceutical companies if a new drug is discovered. The potential contribution of the unknown species to the new drug can be interpreted as the value of preserving a plant species. Such an approach has been used by Aylward (1993). He assumed that a genetic prospector is able to examine a wild area that contains over 10,000 different plant species to find one potential pharmaceutical product. Assuming a success rate of 1 in 10,000, on an average, one new drug source will be found by the end of one year. The net return on the new drug is calculated as the gross revenue net of costs associated with prospecting and development. The value of the plant species is estimated as the species success rate multiplied by the net return to biotic samples adjusted for the number of samples per species that are screened. If two samples from each species are screened, then the success rate for biotic samples (as opposed to species) is 1 in 20,000. Finally, the average net return per biotic sample is estimated.

Empirical results revealed that all these procedures are likely to yield very low values for pharmaceuticals due to market imperfections. This is a major problem in developing countries like India where medicinal plants are collected at a very minimal charge. The first method will undervalue genetic material and even the second approach will not represent the value properly because in India, almost 8000 plants are used in traditional medicines whereas only 88 species are traded in the market. There are many Ayurvedic practitioners who prefer processing medicine on their own and the value generated is not recorded anywhere. Even households use traditional plant based medicines. For example, most of the rural households in India use neem for cleaning their teeth and also as a pesticide. Similarly, turmeric, *tulsi*, pepper, and honey are used to cure minor health problems. All these values are unrecorded.

The third approach (valuation in terms of the lifesaving properties of the plant) may lead to overestimates and also suffers from other controversies regarding estimating the statistical value of life. The remaining two approaches are also likely to give very low values and will not reflect the social value of pharmaceuticals. Due to the limitations in the existing studies, some recent studies focused on estimating the value of marginal species. In the pharmaceutical context, the relevant economic value is the contribution that one more species makes to the development of new pharmaceutical products (termed as marginal value). The marginal value is the incremental contribution of a species to the probability of making a commercial discovery.

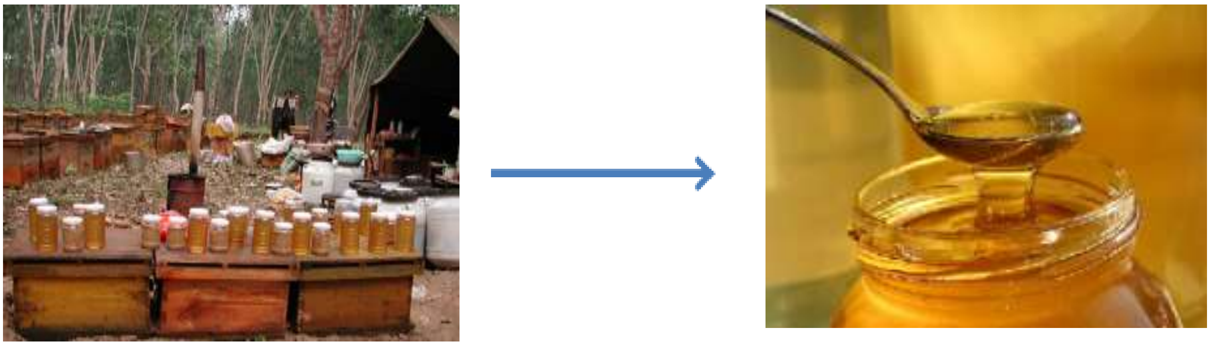
Based on the above evidence, more investigations are progressing in development of standardised methodology for estimating the real value of the bio-resources. In this regard, additional literature collection and review, discussions with experts, and field level information and feedback mobilization are under progress.

Value Addition for Bio-resources

The value addition of bio-resources is highly related to the second and third approaches (market value of plant-based drugs and value of plant-based drugs in terms of their lifesaving properties) as mentioned in the medicinal plant case in earlier section. Many value added products are derived from bio-resources. Generally, value addition for bio-resources (raw) and bio-resources based products occurs either through transaction costs or / and processing / manufacturing costs. Besides, the markets for bio-resources at its collection point are highly uncertain. Number of unexpected factors depends on the intensity of imperfection also to be considered. Transaction costs are the costs on particular bio-resources from their collection point to the company gate, and occur through transportation and brokers or dealers' profits. For example: in the case of honey, the collection price at the forest gate may be Rs. 50.00 per kg, and its final consumer price at a distant city may be Rs. 200.00, transacted through different agencies such as federations, wholesalers, and retailers at different locations (see figure 8). Hence, the price spread is Rs. 150.00 (Rs. 200 - 50). The ABS concern is whether the price spread is reasonable or not, and if not, what are the abnormalities in and how will it bounce back to the communities or providers of the honey?

Figure 8

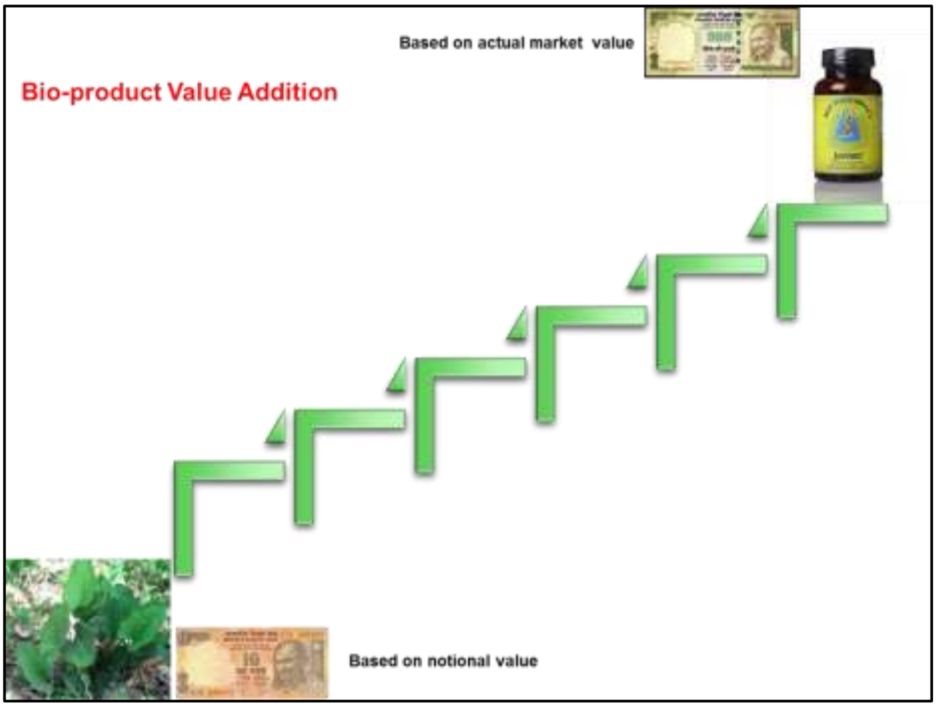
Value Addition of Bio-resources through Transaction Costs



Further, certain bio-resources are basic raw-materials for manufacturing final consumer products. For example: *Jeevani* an immuno-modulatory product (ayurvedic medicine) is manufactured from the plant known as *Arogyapacha*. Here the *Arogyapacha* (required for manufacturing one bottle of medicine) may be provided by an indigenous community for Rs. 10.00 and a bottle of *Jeevani* may cost Rs. 500.00 (figure 9). In this production process, *Arogyapacha* is an unavoidable input factor, but not an exclusive one. Many other products (inputs) and knowledge/skill (research and development) also contribute to *Jeevani* development. Hence, the processing / manufacturing costs at different stages are significant. Through an amortised (remunerated) pricing technique, one can estimate the real price of *Arogyapacha*.

Figure 10

Value Addition of Bio-resources through Transaction Costs



Bio-resources Real Price Estimation: Major Steps

From the ABS perspective, the estimation of the real price of bio-resources is important. The value chain or amortized pricing technique has been identified as a tool for estimation, and the following steps (general as well as specific) are proposed with reliable information sources (see the Tables 4 and 5). However, substantial support from various stakeholders, who are part of this exercise, is required for the successful estimation of the value of bio-resources.

Table: 4

Bio-resources real price estimation: basic/general steps

Steps	Tasks	Sources of Information
First	Identification of the **key bio-resources** (having economic and ABS potential) extracted from a geographical area / ecosystem	BMC, PBR, local community, indigenous group, forest department
Second	Understand its **potential /** purpose / usage	BMC, traders, research organizations, government departments, industries
Third	Identify its leverage / **movements**: local → regional → state → national → international	BMC, traders, industrial association, companies, exporters, customs department
Fourth	Prioritize the **promising uses** based on value addition (ranking)	Industries, traders, research organizations.

Table: 5

Bio-resources real price estimation: specific steps

Steps	Tasks	Sources of Information
First	Select any manufacturing or **bio-resources processing company**	Appropriate industry
Second	Estimate the **transaction cost** of bio-resources: from forest gate to company gate. **(Price at company gate – price at forest gate)**	Forest dwellers, traders, industries
Third	Identify the **major production steps**	Company management and production manager
Fourth	Identify the **different factors of production** involved in each stage and its cost / remuneration **(Factor cost method)**	Company management, production manager and labourers
Fifth	Identify the **abnormal benefit claimers** and rates **(differences between company rate with general market rate)**	Company management, production manager, labourers, industrial/govt. departments.
Sixth	Fix the **optimum benefit and share the surplus** to local communities who preserve the bio-resources **(Royalty;** institutional mechanism for distribution)	Company management, production manager, labourers, industrial/govt. departments and BMC

Conclusion

Valuation of bio-resources is an integral part in operationalization of ABS principle. Unfortunately the current or existing market price at bio-resources, at its collection point is not reveals the true value due to various imperfect nature of the market. In this context development of standard valuation methods for biodiversity valuation and value the ABS potential bio-resources is significant, which is progressing through the UNEP – GEF – ABS project in National Biodiversity Authority. Most of the environmental economics literatures emphasized on the valuation of non-marketed services of ecosystems. However, the available inferences from the literature are considering as the base for developing the valuation methods for identifying the true value of bio-resources or goods coming out from the ecosystems.

One of the prominent approaches one can consider for bio-resources valuation is through examine the bio-resources based products value chain analysis with consider the amortised or value addition method. The bio-products value chain to be analysed from the first stage of transaction (local community / providers / sellers to the immediate buyers) to the final products market price with consider the production function and factor costs approachs.

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Appendix – I

Different Methods Applied for Valuing the Bio-resources

Source	Research Attempt	Methods Used	Emphasis	Remarks
Masahiro Miyazaki, (2006), "Economic value of Microbial Resources". *Microbial cult. Coll.* pp15-19.	Valuation of Microbial Resources	$$Ve = c + \sum_{i=n}^{m} \frac{p.r.Si}{(1+d)^i}$$ Ve : Eco.val.of microbial resources (*ex situ* conservation) (per strain) c : initial charge (per strain) p : expected probability of success in developing a new pharmaceutical product Si : expected pharmaceutical sales in the ith year (per drug) r : royalty (rate of pharmaceutical sales)	Examined the economic value of microbial resources used as screening materials for developing new pharmaceuticals.	This can be useful to analyse value of microbial organisms to strain.
Michael Balick and Robert Mendelsohn (1992) "Assessing the economic value of traditional medicines from tropical rain forest". *Conservation Biology*: 6(1).	Valuation of Medicinal plants	$V = R/(I – e^{–rt})$ R = net revenue from a single harvest r = is the real interest rate (5%) (analysis based on current market data)	Estimates the value of medicinal plants in two different elevations of tropical forests.	Useful to assess the total value of different medicinal plants in different geographical areas.

Peter P. Principe.(…) "Valuing the Biodiversity of Medicinal Plants" in 'In the Conservation of Medicinal Plants'(Book) pp.79-124 .	Valuing the medicinal plants	NB_P = E(CS) + OV + EV + E(R) – E (Cpd) – Cp Where E (CS) = Expected value of consumer surplus OV = Option value EV = existence value E(R) = expected value of product revenues E (Cpd) = expected cost of product development Cp = costs of implementing preservation programme.	Medicinal plants Biodiversity Conservation	Useful to understand the Total Economic Value of a forest in medicinal plants values perspective
Nguyen Chinh (-----) "Economics values of Conservation & Use of floral and Medicinal Plant Genetic Resources in Vietnam Toward Sustainable Use" Centre for Environmental Economics & Regional Development (CEERD) National Economics University (NEU), Hanoi.	Valuation of Medicinal plants.	TEV = F (DUV, IUV, QOV, BV, EV) TV = G (PV, TEV) TV = Total Environmental Value TEV = Total Economic Value DUV = Direct Use Value IUV = Indirect Use Value QOV = Quite Option Value BV = Bequest Value PV = Primary Value EV = Existence Value	Valuation of medicinal plants or genetic resources	Useful to obtain the TEV estimation of genetic resources.

Michael Salassi et al., (2000) "Valuation of Perennial Crops Associated with Agricultural Land Sales: The case of sugarcane in Louisiana" *Journal of the ASFMRA* PP 11-21.	Valuation of perennial crops (Agricultural Biodiversity)	$VCt=(1+ROR)*[\sum_{j=1}^{t} PLTCj(1+i)^{t-j}$ $+\sum_{j=1}^{t} PRDC_j(1+i)^{t-j}]$ (1) where VCt = estimated value of sugarcane per acre in month t using the cost approach ROR = estimated rate of return on money invested in growing sugarcane PLTCj = unrecovered planting costs as of month j PRDCj = unrecovered production costs Incurred through month j i = monthly interest rate Equation 1 tabulates initial Income Capitalisation Approach $^{t}{}_{j=1}$ $VIt = [\sum_{j=1}^{t} PLTC_j(1+i)^{t-j}$ $+\sum_{k=t}^{n} PRDC_j(1+i)^{t-j}+$ $\sum FNR_k/(1+r)^{n-t}]$ (2) Where, VIt = estimated value of sugarcane per acre in month t using the income approach PLTCj = planting costs as of month j PRDCj = unrecovered production costs Incurred through month j FNRk = estimated net returns from future harvests in the crop cycle i = monthly interest rate r = monthly discount rate	Valued the sugarcanes (perennial nature).	Helpful to understand the real value estimation of perennial crops based on the Cost of Production Approach.

David Pearce and Dominic Moran (1997) "The Economic Value of Biodiversity"	a) Medicinal Plant Valuation. b) The value of land for medicinal plant	$V_{mp}(L) = p.r.a.Vi\ (D)$ *P* = Probability *D* = Drug *Vi (D)* = Value of drug *i* =1 indicates one of two ways of estimating the value. The market price of drug on the world market. i =2 value of statistical life r = royalty __________________________________ $V_{mp}\ (L) = \{N_R.\ P\ .r.\ a\ \ Vi/n\}/H$ *per Annam* $N_R =$ number of plant species at risk *n* = number of drugs based on plant species *H* = number of hectares of land likely to support medicinal plants and $N_R = 60,000$ $P = 1/10,000$ *to* $1/1000$ $r = 0.05$ *a = 0.1 to1* *V/n = 0.39 to 7.00 billions US$* *H* = 1 billion hectares, the approximate area of tropical forest left in the world.	Medicinal plant value	Helps to understand medicinal plant and medicinal plant cultivating land values

Diwakar Poudel and Fred Johnson (2009) "Valuation of crop genetic resources in Kaski, Nepal: Farmers willingness to pay for rice landraces conservation". *Journal of Environmental management* 90. Pp. 483-491.	Valuation of crop genetic resources.	TEV = DUV + EFV + OV + E V + BV TEV = Total Economic Value DUV = Direct Use Value EFV = Ecological function value OV = Option Value EV = Existence Value BV = Bequest Value $WTP = \sum (A_i\ Y_i\ P_i) - \sum_{i=1}^{N} (a_i\ y_i\ p_i)$ WTP = Total willingness to pay for in-situ conservation of land races A_i = total area of conservation = $a_1 + a_2 + a_3 \ldots an$, Y_i = yield of preferred variety P_i = price of the preferred variety yi = expected yield of land race i pi = price of land race i N = total number of land races that the respondent to willingness to pay for (maximum six) $WTP = [\sum_{i=1}^{N} (X_i)/N]12$ WTP = average willingness to pay per landrace per year (exsitu conservation) X i = amount paid per month to conserve land race i. (i = 1- N), N = total number of land races that the respondent showed willingness to pay for (maximum six)	Economic value of crop genetic resources based on the farmers' willingness to pay for conservation.	Helps to understand the differences in- situ and ex-situ conservation value of medicinal plants.