Criteria for identification and assessment of agro-biodiversity heritage sites: Evolving sustainable agriculture

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Need for identification and value assessment of agro-biodiversity heritage sites in the context of recent Acts has been highlighted to facilitate conservation and evolution of sustainable agriculture. Six indices reflecting agriculture providing livelihood support; custodianship of irreplaceable natural resources; continued co-evolution and development of new agro-biodiversity responding to changing scenario; intangible religious, artistic and cultural association; locals' ingenuity responding to changing scenario and ability to adapt external inputs are proposed for identification of National Agro-biodiversity Heritage/Hotspot Sites (NAHS). Value assessment for conservation and use is being suggested, based on biophysical and landscape, social and cultural, and economic values. An action plan need to be developed for use of products, practices and knowledge from NAHS, ensuring empowerment and benefit sharing to locals within the frame work of national legislations, such as the Biological Diversity Act and the Protection of Plant Varieties and Farmers' Rights Act.

Keywords: Agro-biodiversity, economics aspect, heritage sites, social aspect, value assessment.

AGRO-BIODIVERSITY is an evolutionary divergent line of biodiversity concerned with agro-ecosystems, and variation in agriculture-related plants, animals, fish, insects, microbes, avian species and their wild relatives. It includes both flora and fauna that are part of an agro-ecosystem, as well as elements of 'natural' habitats that are part of the food-production chain. It has multiple, economic, ecological and social benefits, and is a crucial and integral component of sustainable development. Section 37 of the Biological Diversity Act[1] (BDA) 2002, deals with identification of Biodiversity Heritage Sites. The State Governments in consultation with local bodies are supposed to notify the important areas of biodiversity as Biodiversity Heritage Sites. Further, notification, and framing of rules for managing and conserving biodiversity heritage sites have to be harmonized with the Protection of Plant Varieties and Farmers' Rights Act 2001, that has a provision for utilization of a Gene Fund, particularly in areas identified as agro-biodiversity hot spots according to Rule 70(2)[2]. However, approaches for identification and conservation are lacking and therefore, there is a need to develop indices for identification of this valuable component of biodiversity, important for food, fodder and nutritional security. In addition to identification, there is a need for their characterization and value assessment to facilitate their promotion and use in evolving sustainable agriculture.

Heritage refers to history, traditions and qualities that a country/place and society has had over generations and that is considered an important feature. The World Heritage Convention (WHC), 1972 is a unique international effort for conserving the cultural and natural heritage of outstanding value. It provides an opportunity for protecting such natural sites from historical, ethnological or aesthetic perspective. Convention has recognized three categories of cultural landscapes as heritage sites, namely (a) clearly defined landscapes designed and created by humans; (b) organically evolved landscapes and (c) landscapes associated with the virtues of religious, artistic or cultural practices that are intangible.

In relation to agriculture, the term 'heritage' has been used to highlight the biophysical, technical, social and cultural manifestations of long-lasting, continually evolving relations of people and their communities with the land and bio-resources. The heritage aspects should be an integral part of a living, evolving system, and should include knowledge and culture that has been passed down from one generation to another. Therefore, Agro-biodiversity Heritage Sites encompass all the components of the WHC. Recognizing their tangible and intangible values, these sites are to be protected from global changes that are adversely affecting their sustainable management and use.

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The concept of domestication of landscape with crop species planted at random in the forest areas is referred as 'domiculture'[3]. It is an attempt at concentrating biodiversity of economic value as part of management of the overall landscape. This is the first step towards organized agriculture of domesticated plants and animals. It is different from present-day intensified agriculture, where the emphasis is on modification of individual crop species and organization of crop species in agriculture.

The transition from 'domiculture' to shifting agriculture is natural. Economically selected crop species and cultivars are being concentrated in agriculture plots, as a part of the multi-species complex agro-ecosystem, overall landscape organization[4]. The shifting agriculture is essentially 'farming the forests', which is the next important step in socio-ecological evolution of 'domiculture'. Further, cultural diversification and settlement have led to a more intensely managed multi-species complex agro-ecosystem, maintaining the overall integrity of the landscape[5]. All the traditional farming/production systems are less energy intensive, dependent on local resources and their recycling, and are invariably based on background information that the surrounding landscape has to offer for sustainability. Therefore, they account for all significant changes in the biotic composition of agricultural practices in response to local needs and goals. In contrast, modern agriculture is practiced for economic gains with uniform genotypes, almost irrespective of background ecological conditions. Hence they ultimately result in homogeneity leading to reduction in biodiversity, making them vulnerable to environmental vagaries. Further, mechanized tillage is degrading other components of the agro-ecosystem. Therefore, recognizing the importance of agro-biodiversity, this scenario demands revitalization of heterogeneity-based traditional systems, that ensured sustainability to the production systems till recently, and is still prevalent in some remote areas.

Throughout the history of the Indian civilization, attempts at domestication of indigenous/endemic plants and animals or evolving agriculture with the introduction of useful domesticated species from the outside have been an important feature. This has ensured survival of human populations, particularly under adverse environments/ interior regions and in bringing prosperity through trade. Generations of farmers and herders on the one hand, and travellers/traders on the other, for more than 10,000 years, have helped in developing ingenious farming/production systems to achieve the above goals. These efforts of many generations have resulted in the establishment of significant reservoirs of agro-biodiversity associated with supportive landscape, environment and ingenious practices as part of our cultural inheritance. They are mostly confined to river valleys, which ensure availability of physical natural resources (water, fertile enriched soil with nutrition) for the growth of cultigens and domesticated animals, and have great aesthetic beauty for human settlement. Such landscapes/sites can be called National Agro-biodiversity Heritage/Hotspot Sites (NAHS). The traditional societies of most NAHS have maintained/ conserved agro-biodiversity in the form of multi-species (including multi-cultigens) complex agro-ecosystems (presently managed casually or at low intensities) as an integral part of a cultural landscape, based on local value system. They have strong socio-cultural and socio-economic interconnections with the landscape and are the products of eco-cultural interactions occurring in space and time, and may still be evolving.

The changed scenario of property rights on biological diversity from the heritage of mankind to sovereign ownership to nations in the post Convention on Biological Diversity (CBD) era, demands a revisit to the traditional agricultural systems for identification, value-assessment, revitalization and improvement to facilitate designing of sustainable agriculture models. This would need documentation of good products and practices providing resilience and sustainability to agriculture, for the empowerment of local communities associated, with protection and improvization, if needed. Additionally, the traditional agricultural systems have two important perspectives – (a) To conserve and generate genetic diversity responding to the prevailing environments, ensuring its availability for modern agriculture; (b) Conservation of crop biodiversity to ensure livelihood of the local people, realizing that they are dependent upon some specific species/crop level diversity, contained within these traditional systems.

Factors eroding NAHS

Attempts by the agricultural scientific community to transplant agriculture models generated in the experimental garden/farm with integrated value (modern) system, which is alien to the traditional socio-cultural value systems of the local communities and landscapes, have adversely affected sustainable traditional agricultural systems. There are evidences to suggest that national policies, market forces, institutional interplay and inter-institutional conflicts (forestry, agriculture, industry, commerce, etc.) have played a major role in land degradation. Even the socio-cultural changes have contributed to this, as has happened with the spread of exotic cultures/religions, eroding the traditional practices associated with the worship of nature. Increasing population pressure within a region has resulted in large-scale migration causing rapid distortion in the operation of the traditional systems, and their breakdown without any alternative. Unmindful expansion of traditional systems has also caused deforestation and land degradation, making them untenable. Many of these sites, including some prospering agricultural farming/production systems are being threatened by developmental challenges (industries, mining activities, dams, infrastructural development, special economic zones, etc.) and climate changes (caused by deforestation and

land degradation). Additionally, rural impoverishment, exodus to urban areas for greener pastures, and marginalization and isolation of traditional societies and economies are also adversely affecting these systems.

Indices for identification of NAHS

Indices need to be developed for identification, characterization and sustainable use of productive NAHS. Indices need to be in line with the requirements of the WHC, which demands that the heritage site/system should be: (a) unique in the socio-ecological context, (b) a treasure-house of traditional ecological knowledge, (c) highly energy and economically efficient, (d) rich in traditional knowledge based on innovative traditional technology/practices developed for management and sustainability of systems both from structure and functional perspective, and (e) that the technology is linked with unique religious and cultural heritage (www.environment.gov.au/heritage/worldheritage/convention.html). Therefore, in addition to richness in agro-biodiversity, the indices must include the following parameters to facilitate identification of NAHS.

1. Agriculture should be geographically and/or socially important in the site, providing livelihood to many people with few, if any, local alternatives.
2. Agriculture should be functioning as the custodian of irreplaceable natural resources and valuable agricultural biodiversity with indigenous knowledge systems linked to agro-ecosystem process and functioning, like *Jhum* cultivation.
3. The site must be providing opportunities for continued evolution, development and adaptation to changing conditions with interbreeding and naturally occurring inter- and intra-specific diversity resulting in domestication and development of new diversity (cultigens).
4. Agricultural practices in the site shall have intangible religious, artistic or cultural associations. Intangible elements should be part of a unique socio-ecological system connected to the place; for example, 'Demajong' landscape of Tibet, associated with Buddhist culture.
5. Community ingenuity should be visible through innovative practices in responding to the changing scenario and severe biophysical context. For example, crop cultivation with unique mixed cropping, crop rotation practices or crop protection practices, etc.
6. There may be external inputs from other civilizations, cultures and agricultural systems for improvement and diversification of agriculture, but at low levels.

The consequent agricultural farming/production systems thus developed as part of the heritage site may include forestry, aquaculture (fish, crustaceans and other aquatic fauna), animal husbandry (herding and grazing systems) and their combination.

(i) The term system covers all social, cultural and institutional aspects as well as biophysical, agronomic and management practices. It accounts for the manner in which Traditional Ecological Knowledge (TEK) of local communities in terms of cultural values was integrated in institution building ensuring community participation for sustainability, for example, the traditional slash and burn ecosystem in Nagaland.

(ii) The system needs to be considered at a variety of spatial and temporal scales to reflect the complex management of resources by different members of the farming community. It may vary from an individual parcel or field to communal resources, to landscape, to region, and from one growing season to a several year rotation. Therefore, the cultural landscape may have a variety of traditional agro-ecosystems operated by distinct cultural groups. For example, nomadic tribes involved in animal husbandry practices as part of the large landscape in the arid zone of the country, in addition to arid agriculture and horticulture.

(iii) The heritage systems may be complex, and ingenuity can be found at any level of complexity or diversity, even to the extent, that some may stand out in simplicity.

Based on the above indices high-altitude tribal areas of north coastal Andhra Pradesh can qualify for a possible agro-biodiversity heritage site (see Box 1).

Value assessment for sustainable use and conservation

All sites/systems may not stand out in comparative advantage with reference to the prevailing agricultural scenario needing attention. Therefore, an assessment has to be made predominantly on the basis of value and profitability, which need integration for increasing productivity and sustainability to agriculture. This would facilitate selecting NAHS for detailed research programme for conservation and use. A scoring system of 1–10 scale may be developed using Participatory Rural Appraisal System, attaching value to the perceptions of the local communities, using the yardstick of criteria listed below. Such a scoring system will be useful in focusing on priorities, with primary focus on biophysical and landscape aspects, social and cultural aspects, and economic aspects.

Biophysical and landscape value

Biophysical and landscape criteria and their benefits would account for richness in agro-biodiversity and the agricultural

Box 1. High altitude tribal areas of north coastal Andhra Pradesh: Case of a possible agricultural heritage site

The area has predominantly an agrarian population, dependent on the land and forests: large areas are at high altitude up to 1000 m, with rainfall over 1400 mm; number of crop species cultivated is around 19 + vegetables, varieties cultivated are around 150 belonging to paddy, sorghum, small millets and pigeonpea. More than 95 wild relatives of crop plants are recorded. Over 75 species are endemic to this region out of 359 endemic species recorded for the Eastern Ghats. Wild relatives of pigeonpea, viz. *Cajanus scarabaoides* and *Cajanus cajanifolia*, brinjal, i.e. *Solanum indicum*, *S. incanum*, *S. insanum*, *S. surattense*, *S. viarum* and *S. pubescens* and rice, *Oryza rufipogon* (locally called as *Dussodlu*) has co-evolved. Farmers have developed unique practices of *Podu* cultivation (slash and burn cultivation), joint cultivation (pottu vyavasayam) and terrace cultivation. Basically, the tribals are Dravidian, influenced by Aryan and Negroid cultures, incorporating animal husbandry and fisheries from the Aryan culture. The tribals are commonly known as Adivasi, Girijan and Vanya Jati, with a religion of their own. Most religious festivals are connected with either agriculture or the collection of minor forest produce, facilitating management and use of natural resources.

systems prevailing in the identified site and how the landscape is promoting their perpetuation, accruing benefits over generations. For example, the shifting cultivation developed in Mizoram and Nagaland for survival of people living on the slopes is the best way to sustain soil fertility and productivity, and to conserve and use the bio-resources in a sustainable manner. This highly organized agro-ecosystem called *Jhum* is based on empirical knowledge accumulated over centuries. It involves slashing of vegetation, burning it before the onset of monsoon, raising a mixture of crops on temporarily enriched soil for a year or two, leaving it fallow for a few years and returning for another cropping cycle after a gap of 5–15 years. Thereby, it functions in harmony with the environment and provides time for recovery of the forest and soil fertility lost during the cropping phase. To meet the changing needs, fresh systems like the Zabo system, a combination of forestry, soil and water conservation; the Alder system for soil health, and the Panikheti system of wet rice cultivation with judicious use of water[6] have been developed. Shifting agriculture with mixed cropping is now being recommended to increase the world food production in hilly areas (Box 2).

These systems have an important component of nutrient and soil-fertility management through nutrient cycling, which may be an attribute of the ecosystem or the species cultivated, and often socially selected with linkage to agro-biodiversity and ecosystem integrity. In certain cases, it even determines the ecological and economic efficiency of the system. For example, multiple rice varieties with fingermillet on bunds and irrigation with gravitational water-management system called Apatani rice cultivation (first noticed in 1887 by He Cabe and in 1890 by HM Crowe in Northeast India) is an eco-friendly system with high ratio of forest and agricultural lands, multi-rice varieties; multi bioresource flow and traditional

Box 2. Other possible Agrobiodiversity Heritage Sites

Nubra Valley, Ladakh: This is situated on the trading route connecting Tibet and Turkistan. Two main rivers that serve this valley are Shyok and Nubra. There are small villages surrounded by forests and wildlife. Camels are common near sand dunes. It is a well cultivated and fertile area; and is also called the 'valley of flowers'. Because of an assured water supply, fruits like apples and apricots have been cultivated in plenty. It is dominated by Buddhist culture, because most local population profess Buddhism.

Ganga Valley: The area along the course of the Ganga river system, originating at Gomukh in the higher reaches of Himalayas and ending into the Bay of Bengal in the east, represents a cultural landscape with important ingenious agricultural heritage systems associated with agricultural biodiversity, folk literature and culture. This can be further classified into upper, middle and lower Gangetic plains.

Demojong: It is the area below mountain Khangechendzonga in west Sikkim, and is the core of sacred line of Sikkim. The uniqueness of this site lies in the holism and inter-connection between soil, water, biota, visible water bodies like river and lakes, all taken together with physical monuments such as monasteries, offering a traditional agriculture system interlinked with some tribes like Bhutias.

Northeastern India: With tradition of shifting agriculture related to land-use practices, ecological, social, economic and cultural tributes of a traditional society. Farmers have adopted tree-based agriculture, strengthened shifting agriculture system based on agro-forestry principle, practised in 870 villages covering a total area of 33,000 ha. Locally identified edible legume cover crop is cultivated as part of the cropping phase for about 3–4 years followed by fallowing the land as a pure tree crop before tree harvest. Nepalese alder (*Alunus nepalensis*) which is part of traditional ecological knowledge and incorporated both during cropping and fallow phases, is widespread. It has several components involving tree species meeting different requirements and strengthening agro-ecosystem. Traditional rainwater harvesting systems, mixed plantations, biodiversity conservation for management of agro-ecosystems are some of the important components.

biological pest control, extending support to sustainable development. Such systems provide valuable input for efficient harvesting of natural resources. In the above example, use of bamboo pipes provides efficient use and distribution of water, might have contributed in developing the modern drip irrigation system. In many systems, efforts are made to restore soil fertility by skillful application of crop rotation; for example, by growing legumes for green manuring or as inter or cover crops according to the requirement and the calendar. Pests and diseases are managed by cultivating locally adopted varieties, cultural and mechanical measures, including use of trap crops.

In parts of Maharashtra and Madhya Pradesh, farmers use rhizosphere soil collected from beneath banyan trees, to spread over the field to improve soil fertility and the *amritpani,* a special bioinoculant prepared from cow dung, ghee and honey for seed and seedling treatment. This is further supported through irrigation working as fertigation, coupled with mulching and organic wastes available locally.

The basic principle involved in these practices is to harness energies based on the ecosystem networking approach with understanding of greening and recycling of biomass available in the neighbourhood, to enrich the fertility of the soil in an intelligent way by:

(i) Recycling the biomass and establishing proper energy chain.

(ii) Development and maintenance of white root zone for efficient absorption of nutrients.

(iii) Harnessing solar energy through proper canopy management for efficient photosynthesis.

Social and cultural value

Assessment of social and cultural aspects provides information on the potential value of a system from the point of view of its contribution to social uplifting, prosperity, cultural enrichment and peace. These would be good parameters for assessment of opportunities offered and would also be useful in monitoring the impact. With regard to their contribution to cultural and knowledge diversity, demand for species diversity would be the prime criterion, promoting conservation and use. This would also provide information on the appropriateness and efficiency of their customary arrangements in the management and use of natural resources. There are several plants that are considered important in some societies for performing birth or death ceremonies. A grass called 'Dharbha', sesame, niger, etc. are essential while performing death ceremonies. Natural dyes extracted from plants and vegetables form an integral part of painting houses. Specific recipes are eaten on specific festivals prepared from specific varieties selected over generations for specific taste, aroma, etc. These linkages of agricul-

tural biodiversity with religious, artistic and cultural practices are important in increasing the income of the locals and needs assessment; for example, Barmer teak for carved furniture and white sandal wood (*Tella punigi*) for Kondapalli toys. There may be socio-cultural institutions promoting equity and gender consideration (employment to women/different sections of society). Traditional *Jhum* system promises additional possibilities for adoption of various components of agriculture, such as agro-forestry, tea, oyster and mushroom cultivation and home gardens for cash income.

Most Indian systems are based on systematic and synergistic harnessing of energies from the cosmos, earth, plants and domesticated animals, particularly the cow. Emphasis is made on the adoption of an agriculture calendar. The agriculture calendar is related to the lunar movement that promotes lifting up of the water table, providing good germination and seedling establishment and thereby plant stand. Whereas formulations prepared with cow milk, curd, ghee, dung and urine duly fermented with sugarcane juice, coconut water and mashed banana for over a month are used in minute quantities to provide nutritive support for better growth. These preparations are rich in nutrients, auxins, gibberellins, microbial fauna and act as tonics enriching the soil. They induce plant vigour and show remarkable effects on plant growth, metabolism, crop yield and quality of production.

Homa organic farming system comes from Vedas. Here Agnihotra pyramid fire is used as a therapy. This process leads to purification of the atmosphere through the agency of fire in a copper pyramid, tuned to the biorhythm of sunrise and sunset. Recently, it has been demonstrated that the smoke created by burning medicinal plants can completely eliminate diverse plant and human pathogenic bacteria in the air within a confined space[7]. As an impact of Agnihotra, tremendous amount of energy is generated that creates a magnetic field, which neutralizes the negative energy and reinforce positive energy. The pyramid is a generator and the fire a turbine. Cow dung, ghee and rice then interact to form a composition, which thrusts and provides nutrients for survival, yield and quality production.

Economic value

In relation to the economic aspects, the identified criteria may overlap with biophysical and landscape criteria, but with a different emphasis and viewpoint. In this regard, support to production systems providing sustainability or increase in productivity is a dominant criterion. Among the important local economic gains are resilience of crop/commodity against biophysical and economic shocks, changes seen in terms of ability to mobilize assets, and in terms of the range of economic benefits (including both quantitative and qualitative, such as nutritional, health and diversity of productive activities). For example, in the Apatani system, cultivation of late maturing varieties of rice in combination with pisciculture, synchronizes well with late ripening of rice, making harvest both easy and manageable, and provides greater economic yield; and the *Jhum* system provides additional opportunities for generation of more income.

In addition, there may be components contributing to overall economic gain, which may facilitate wider adaptations for harnessing benefits. For example, efficiency in the use of critical resources, such as land, water, energy, plant nutrients, biological resources and human resources, should be recognized as a major criterion. Most tribal communities live on their own produce and forest collections. For example, in the high-altitude ecosystems spread over the tribal belt extending from north coastal Andhra Pradesh through Koraput region in Orissa up to Bastar in Chhattisgarh, the main occupation is agriculture, dependent on rice, minor millets, pigeonpea, field beans, niger, brinjal, amaranth and other uncultivated greens. The tribals completely depend for their livelihood on these crops and forest collections, such as tamarind, honey, etc. for food, bamboo and palm trees for housemaking and palms for drinks (toddy and 'Jheeluga kallu'). Occasionally, they exchange or buy/barter other products from the tribal shandies (markets) organized within the vicinity of their homes. They have evolved products and practices to meet their requirements; for example, paddy varieties suitable for rain-fed conditions ('Budama' in Andhra Pradesh and various other landraces in Koraput and Bastar).

Applicability and relevance of sites/systems (sites in semi-arid regions of the country) in the national perspective, i.e. what practices can help in overcoming major national constraints can be important criteria needing characterization, promotion and intensification. Therefore, identification of the best production systems and practices, particularly under low input areas requires promotion and conservation. Other benefits accrued could be manifested in several ways, including stewardship over irreplaceable resources, proven effectiveness in counteracting climate change or stress environment and selection of genotypes for specific ecologies. The selection process in crop diversity is a unique traditional knowledge. For example, in parts of Chhattisgarh, in terrace systems, upper levels are cultivated with meticulously selected drought-tolerant paddy landraces and lower levels with submergence tolerance-type (in critical periods). In case of cross-pollinated species, communities have taken advantage of naturally occurring interbreeding populations between wild relatives and cultivated species, and made selection of improved types; for example, in case of brinjal involving wild *Solanum* species, in pigeonpea involving wild *Cajanus cajanifolia*, *C. scaraboides* and *C. albicans*, and in sesame involving *Sesamum mulayanum* that has resulted in the evolution, development

and adoption of diversity within crops and even of diverse species, enriching the agro-biodiversity in the tribal belts of Andhra Pradesh, Chhattisgarh and Orissa. Adaptation of uncultivated greens and their perpetuation under fluctuating climate to serve as famine foods is another traditional knowledge with regard to alternative sources of food prevalent in several traditional systems.

The number of people supported by the system(s) and the integration of use of different resources should be considered as important descriptive characteristics from livelihood point of view. In Kerala, the present monoculture of coconut palm requires 157 man-days in comparison to traditional coconut palm mixed cropping system, which required employment of 960 man-days per year, providing matching increase in benefits. Thus in a densely populated country like India, the traditional systems provide greater sustainability and resilience to both natural resources and livelihood.

Most traditional agricultural systems developed over time are generally self-contained and have multiple functional links within, but not much with the outside world. The latter needs to be integrated for long-term sustainability of the system, and therefore, the site contacts with other cultures, societies, markets, etc. become important. Also, the facility with which ideas would flow into and out of a site/system would be an important aspect in assessment of flexibility, evolution (dynamism) and adaptability of a system.

There may be marginal NAHS that are isolated or under threat of disappearance. Their potential value does not extend beyond the niche they are adapted to; they are unique and are currently surviving because of their isolation or remoteness. They might disappear if changed drastically or are easily accessible to the outside world, which would have an adverse impact on agriculture and overall climate. Therefore, such ecologies and economies need protection for the survival of such hidden treasures of knowledge, culture and systems of eco-friendly development. For example, the area below Mount Khangchendzonga in west Sikkim, known as 'Demojong', is the core of the sacred land of Sikkim. The protective deities are made offerings to, but no meaningful performance of Buddhist rituals are possible, if this land is desecrated. Any large-scale human-induced perturbation in the land of the holy Yoksum region would destroy the hidden treasures in such a manner that the chances of recovering them in the future will diminish. Any major perturbation in the river system would disturb the ruling deities of the 109 hidden lakes of the river, thus leading to serious calamities. Therefore, the very cultural fabric of the Sikkimese society is dependent upon the conservation of the whole sacred landscape. The uniqueness of this heritage site lies in the holism and interconnections between the soil, water, biota, visible water bodies, river and the lake systems on the river bed, all taken together with physical monuments, such as the monasteries. A variety of traditional agricultural systems inter-linked with nomadism of some of the tribes, like the 'Bhutias' make this further interesting. In the Himalayan region, villages or a cluster of villages are associated with small or large forest reserves. Agro-ecosystem and village systems are interspersed throughout the region having a close connection with the sacred mountain landscape in which they are placed (Box 2).

Estimating comparative value and structuring of the suggested criteria and indicators, particularly those cutting across social, biophysical and economic aspects are of primary importance. The sites should also be viewed from the linkages point of view among the socio-cultural, economic, biophysical and institutional mechanisms, rather than viewing them in isolation. In addition, criteria should involve the national policy on environment in their considerations for integration and relevance of a system with respect to the CBD, desertification and climate change, which may be the underlying principles for adoption. Other criteria include: whether a system would play a key role in an eco-region; inclusion of the human element in the ecosystem, which should be seen as a functional rather than a spatial entity, and the provision of amenities.

Planning for promotion and conservation

According to the value or threat perception to the selected agricultural heritage site/system, there may be a need to develop programmes for promotion and conservation. It should contain sustainable livelihoods approach in the assessment to account for five kinds of capitals: (i) Natural (resources); (ii) Physical (infrastructure); (iii) Human (skills and knowledge); (iv) Social, cultural, institutional, and (v) Economic and financial components.

It may help complementation with other approaches. The process and planning should include:

- Identification of potential sites,
- Labelling, characterization and valuation with hard data, and
- Development and implementation of a community-driven action plan with leverage for human and financial resources.

The first few sites need to be selected considering their wide visibility/popularity, and potential to fire the imagination of the general public. They should include significant urban components as well as policy-makers, cover diverse agro-ecosystems and land-use patterns, satisfying the criteria specified above. If NAHS are to capture widespread interest and support, their characterization should highlight their specific value elements, such as their contributions to local and perhaps national food and nutritional security; economic benefits both local and in a

wider perspective; soil, water and other natural resources conservation; regulation and quality assurance of downstream water supply; interface between local and global biodiversity; carbon sequestration, social and cultural stability, risk factors and poverty alleviation, and possibility of their adaptation in other areas either in totality or by components.

It is of key importance that the services found beneficial are recognized/established as being part of the essential value to the functioning of agricultural ecosystems and economics at all levels and should therefore be considered in all decision-making affecting the systems. If their values can be quantified in a sound and convincing manner, institutional arrangements could be found to facilitate payment and other types of returns by external beneficiaries to the local communities or land users. In this context, the provisions of the Biological Diversity Act and Protection of Plant Varieties and Farmers' Rights Act can come in handy through their various financial mechanisms, such as 'National Gene Fund'. In instances, where NAHS communities and the wider socio-economic environment is not served by such financial rewards for the rendered ecosystem and other services. They should be enabled through legal and policy environment. Also sustainable development efforts be made to ensure the continued existence, functioning and sustainability with opportunities for their further development/evolution. Therefore, action plan may be drawn within the fame work of these Acts and various other international agreements for empowerment of communities. This will enable them to legally claim benefit-sharing on profits harnessed through commercialization of their practices and products.

The above action plans would identify and produce inventory of NAHS, and assess the strengths, weaknesses and needs. It may work as a checklist in the characterization, value assessment and further development according to the prevailing scenario. The methodology developed to record Community Biodiversity Registers (Plant Biodiversity Registers mentioned in BDA) by organizations like Indian Institute of Science, Bangalore; Deccan Development Society, Hyderabad and M.S. Swaminathan Research Foundation, Chennai may be useful in this regard.

Epilogue

India is one of the mega-centres of agro-biodiversity, rich in cultural, social and economic heritage associated with agriculture, which simultaneously originated and evolved at a number of sites, developing innovative practices based on indigenous resources, circumventing the prevailing negative environment and promoting conservation of natural resources. There is a need for identification and characterization of potentially valuable biophysical, social, cultural, and economic ground to draw benefits from their products and practices that can provide greater resilience and sustainability to national agriculture and the farming/production systems in an eco-friendly manner. The criteria/indices suggested with examples may prove to be of value to the authorities in the Ministries of Environment and Forests (National Biodiversity Authority), Agriculture (Plant Variety Protection Authority), and Commerce and Industry (Geographical Indications) to harmonize and develop suitable action plans.

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