

# **Biodiversity Conservation versus Rural Development: What Kind of Possible Harmonization? The Case Study of Alwar District, Rajasthan, India**

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**ABSTRACT** The recent development in biodiversity conservation policy and the creation of protected areas in many developing countries have often brought about a conflict between local populations, their domestic government and development institutions. These policies have very often ignored the dependence of local communities on natural resources for their day-to-day lives and have contributed to their marginalization. The conservation of natural resources is closely linked to the sustainable development of rural communities. As a result, ecosystem conservation is not only important from an ecological point of view but also includes a dimension of equality and social justice. This article aims to explore the conditions that can enable the integration of conservation objectives with those of rural development. The Sariska Reserve presents an example of a successful community based on conservation initiative. The study of these local communities, their integration with forest ecosystem and their management and conservation system of natural resources, represents a case-in-point for the conception of new conservation approaches.

## **1. INTRODUCTION**

In many developing countries, official policy and laws governing wildlife and the conservation of ecosystems have hardly taken into consideration the dependence of local communities on their environment. The result has been degradation of the forests and overexploitation of the land. Poorer populations have often themselves been at the root of the degradation of biodiversity, particularly due to the lack of alternative sources of revenue, which has forced them to overexploit the resources.

For impoverished human communities in rural areas there are often significant costs associated with living along the border of a national park or other nature reserves. These costs include loss of access to traditional resources, reduced social, political, and environmental autonomy, and increased threats to life and property from wild animals migrating in and out of the nearby protected area (Geisler 2002; Packer et al. 2005).

Conversely, those concerned with protected area management, including government officials, park administrators, donors, and nongovernment organization (NGO) staff, have often confronted substantial problems associated with the presence of nearby villages (Hockings 2003). These problems included direct effects from unauthorized use of park resources and indirect effects from upstream land-use practices that

generated erosion and siltation, habitat fragmentation, and so on. Not surprisingly, the costs that each side imposed on the other has fostered conflicts.

A significant shift has taken place in these last years within the conservation community towards community-based conservation (CBC). The idea of CBC grew in part out of attempts to address these conflicts by generating mutual benefits to reduce or offset costs incurred on both sides. This shift was motivated by discomfort with the social injustice of conservation efforts combined with demands for strategy change from the donor community.

The combination of these factors led to a re-evaluation of the connections between conservation and human development.

Human development and biodiversity protection has become perceived less of a zero-sum game of tradeoffs and more of a set of mutually reinforcing goals. Local communities have shifted from being perceived solely as threats to conservation to being perceived as stewards and a significant part of the solution to the biodiversity crisis. Operationalizing sustainable development and achieving global biodiversity and social justice goals have been seen to require place-based solutions in order to effectively implement global goals at the local level.

Yet despite powerful logic favouring the approach, CBC projects in practice often fail to

meet expectations related either to park protection or to community development (Brown et al 2005; Twyman 2000). Problems of prioritization and emphasis between the dual objectives can contribute to the disappointing results. Although CBC projects are implemented with the primary purpose of promoting conservation in and near protected areas, the problems that undermine success often reflect difficulties experienced in harmonizing both conservation and development objectives.

The Integrated Conservation and Development Projects (ICDPs), promoted by World Bank and Asian Development Bank, have also often floundered (e.g., Brown et al. 2005; Borgerhoff Mulder and Coppolillo 2005). ICDPs projects have been implemented to contribute to long-term conservation goals and to improve local livelihoods in the near term, thereby reduce levels of encroachment and conflict. However, many ICDPs have been either primarily about conservation or primarily about development but rarely both. More common are situations in which one objective or the other dominates (Brown et al. 2005). Involving local communities in conservation has often been used as a mean of making conservation measures less likely to meet local resistance, but the ultimate objective remained the one of conservation. Management approaches that explicitly had more than one objective have been far less common than those that have only one.

Linking conservation to livelihoods, as a broad strategy, requires a search for implementation models and it is not always easy to be attained.

Using a case study conducted in the periphery of the Sariska Tiger Reserve located in Rajasthan, India, we will provide an example of community-based conservation which demonstrates the assumption of "win-win" opportunities in meeting human development and environmental conservation objectives. The study of these local communities, their integration with forest ecosystem and their management and conservation system of natural resources represents a case-in-point for the concept of new conservation approaches. These will be necessary for the achievement of biodiversity conservation and the long term sustainable development of rural societies. The aim of this paper is therefore to explore the conditions that enable the integration

of human societies with local biodiversity in a successful and sustainable manner.

In the next section will provide a background for the area of study, and evidence for the core argument that a possible harmonization between biodiversity conservation and local development can be effectively achieved. On the basis of this study case, the reasons how this has been possible will also be examined and conclusions and lessons will be drawn.

## 2. METHODOLOGY

The field work took place from October to November 2002 and from February to April 2007 in four villages in the Thanagazi region. Data come from individual and group interviews as well as from participative observation and informal interviewing. The participant observation method was used to complement the data collected through the interview process.

The analysis is mainly based on qualitative information collected through interviews with villagers who were members of local village organizations, the Gram Sabbhas. In addition to participant observation of forest resource use practice through living in the villages for several months, 32 semi-structured interviews were carried out amongst a cross section of the communities living at the periphery of the reserve. The total population approximates 3000 inside the 11 villages of Core Area I. 87.4% of these people belong to the Gujjar caste and are occupationally buffalo-herders. Meenas, Bairwas, Brahmins, Meos and Rajputs make up the remaining population. The interviewees have been selected on the base of parameters such as age, ethnic group, caste, and economic conditions. The interviews have consisted of semi-structured components. Most of the interviews were tape-recorded with the permission of the interviewees, and the author also benefited from informal conversation on various occasions with the actors involved.

The data obtained from the interviews have been complemented and validity has been checked by informal group discussions.

Two methods of data collection have been used, each of which views the interaction from differing perspectives and requires different sampling strategies. The *first stage* has involved interviews with key informants (local leaders, TBS members, social workers etc.) and participant observation.

The *second stage* has involved in-depth interviews with a number of villagers selected using the snow-ball technique. To reduce the pitfalls associated with this kind of sampling method, a sample of randomly selected households in the villages has been used.

### 3. RESULTS AND DISCUSSION

#### 3.1 Presentation of the Case Study

The Sariska Tiger Reserve, declared protected area in 1978, lies in the Alwar district of the northern Indian state of Rajasthan, in the Thanagazi block zone and presents an extension of 866 sq km.

Pre-independence, the forests within the Reserve were part of the erstwhile Alwar State and considered a hunting reserve for the local *Maharaja*. After independence, in 1955, these wooden areas were registered as a State reserve. Later in 1975, in order to achieve the most effective conservation of wildlife, some forest areas contiguous to the reserve were also incorporated to the Sariska Reserve and have officially become protected areas (IIPA 1999).

The protected surface includes three zones which are submitted to high protection : *core zone* I, II and III.

Rural population, that roughly reach the number of 600 inhabitants, dwell inside and at the periphery of the reserve and exercise their traditional rights of use over the forest, which is submitted to the reserve authorities management (IDPS 2000).

In the past, the dense forests localised in what is now the periphery of the reserve, represented an integral part of the local rural economy. In the 1930s, they started to become gradually depleted when the colonial government completely abolished the communal rights to forest land and allowed timber companies to exploit the forest (Forest Survey of India 2007). The hills of Aravalli mountains in the proximity of the Sariska reserve were stripped of vegetation. The lack of tree cover to trap the moisture resulted in rain water swiftly flowing away during monsoons leading to rapid soil erosion. Consequently, local bodies of water progressively dried out and the groundwater level fell.

A remarkable ecological transformation has been wrought in this area over the last 20 years, when local communities have initiated consi-

derable forest conservation measures at the periphery and around the Sariska reserve. Helping them in this transformation is the non-governmental organization (NGO) *Tarun Bharat Sangh* (TBS), set up in the mid-1980s for rural development and environmental conservation work. TBS activities include water and forest conservation, rural education and health.

The members of TBS identified the lack of natural resources as the main cause of poverty. In their discussions with the villagers and elders, they explored ways of tackling drought and erosion and learned about the *johads*, a traditional water harvesting structure used in the past.<sup>1</sup>

Local communities, with the support of TBS, have built numerous structures close to the reserve as well as inside the reserve itself. The community based resources management initiative has had considerable success. Currently, the work of TBS covers 700 villages in the Alwar district, parts of Jaipur and Sawai Madhopur districts. In these areas, nearly 7,000 water bodies of varying sizes have been either newly created or restored.

The *Gram Sabha*, a community institution, has been constituted by the villagers to manage their natural resources. This institution at village level, even though it has been established by the Panchayat Raj Act, is nevertheless different from the Gram Sabha present in the Thanagazi region. According to Indian legislation the Gram Sabha represents the smallest democratic structure within the village which is formed by a limited members of the community. The Gram Sabha must coordinate its decision-making process and its intervention with the Panchayat.

The villagers in the Thanagazi region became aware of the importance of an institution which should be the expression of the community as a whole. Every household of the community is supposed to take part in the meetings and the decisions are taken according to the democratic principle of consensus.

Although the construction of the new *johads* and the restoration of those fallen in obsolescence represents the main activity of TBS. This activity constitutes just a part of the strategy of local ecosystem's restoration in Sariska. Aiming to attain the objectives of the ecosystem's regeneration, the local communities have carried out initiatives of conservation of the forests. A surface of about 5000 hectares around the reserve has been reforested in a decade. This figure approximately corresponds to 6% of the surface of the reserve.

These initiatives have had important ecological results. The water harvesting structures have allowed not only to store surface water but to replenish the groundwater beneath.

Due to the raised water table and the replenished groundwater, 5 rivers in the district, like the Arvari, that had in recent decades held water only after monsoon storms, currently flow continuously.

As a consequence of the rise in the water table that provides moisture for vegetation, a wide area of Sariska reserve has been regenerated. The increase in plant covering has contributed to the reduction of soil erosion, thus improving the groundwater recharge.

### 3.2 Enhancement of Local Livelihoods and Conservation in Sariska

The restoration of the traditional water storage system and the reforestation initiatives carried out in large scale by the local communities in the last 15 years have considerably increased the infiltration of the rains. This has increased the availability of water for irrigation purposed and has improved the soil quality. As a consequence, there has been an improvement of agricultural production as well as a diversification of the crops.

In Sariska, the augmentation of agricultural production is explained by two factors: the cultivation of the marginal plots that were previously unutilised and the boost in the productivity of the existing agricultural lands.

In the village of Gopalpura before the realization of the johads, 73 hectares represented the cultivable land. Of this land the surface irrigated amounted to 31 hectares. The unproductive land was 219 hectares. After the construction of the johads, the unproductive land was reduced to 100 ha. Always in the same village, before the conservation activities, 80 hectares of grazing land were depleted and presented scanty vegetation. Following the construction of the johads, as a result of increased water availability and the increased moisture of the soil, 16 ha of this land are currently covered with vegetation.

Before the community conservation initiatives in the village of Bhaonta-Kolyala, 140 out of 221 hectares around the village were classified under the category of *banjar bhumi* (earth incultivable). Currently more than half of this uncultivated extension has been regenerated and is used for the collection of fodder by the villagers.

The improvement of the quality of the soil and hence of its productivity has been confirmed by an assessment study led by the People's Academy for Farming Development of Jaipur in 2006.

This study shows that in the villages at the periphery of the reserve where the johads were built, the agricultural productivity increased by 50% in ten years (from 1995 to 2005).

This trend has been confirmed by the villagers. According to the estimates of the villagers at the periphery of Sariska, the average production of wheat increased from 720 kg by acre to 1500 kg by acre (1 acre: 0,4 ha). A villager of Gopalpura affirms: *"Before we could produce only one harvest during the year. We were often forced to buy seeds elsewhere. Now many farmers have observed an increase of productivity until 4 times more"*.

The increase of water availability allowed the farmers a crop differentiation. A villager explains: *"In the past we could only cultivate mustard, a culture that needs very little amount of water. At the present I can cultivate corn, potatoes and onions"*.

The increase in agricultural production owing to the improved irrigation, allowed more abundant harvests and an accumulation of an agricultural surplus. In many villages, the farmers have been able to sell the surplus in the local markets. According to an assessment led by D. Agrawal,<sup>2</sup> the positive repercussions of johad construction from an economic point of view have been important in the district of Alwar.

The increase of the cultivable lands necessary for the rural development of these communities has not proved to be incompatible with the maintenance of the forest resources and the local biodiversity. In several villages close to the reserve, the selection of more profitable and productive plant species and the improvement of the local irrigation system has allowed the villagers to reduce the extension of the agricultural surface without decreasing the agricultural production and the final agricultural income.

In Sariska the livestock breeding, in particular of buffalos boosted due to the increase of the water and the availability of grazing lands.

The augmentation of the vegetation entailed also a growth of the livestock productivity. Many villagers affirm that the milk production of buffalos and goats nearly doubled. The livestock productivity having increased, the villagers obtained a

surplus of milk and dairy products in general (*ghee*, butter, yogurt, *Khir* etc.). This enhanced the food security of the villagers and also allowed to boost the profits derived from the sale of the dairy products in the local markets. Jadish, a breeder of the village of Gopalpura affirms. “*The last year, I earn 15,000 Rs only with the sale of milk and Khir*”.

The increase of biomass through community-based conservation actions however, did not encourage the villagers to increase number of livestock that would constitute a potential danger for the forest. In Sariska, the maintenance of a large number of livestock is generally justified for the villagers by the limited productivity of their livestock.

Currently, the increased availability of water and fodder created favourable conditions to increase the population of the wild herbivores. This has allowed the wild carnivores to find more easily their preys, helping hence to reduce their attacks to the livestock.

A balance between human productive systems and environment conservation has been achieved.

The regulation of grazing activities in Sariska represented an indispensable component for the conservation of the ecosystems. A balance between the livestock and the quantity of available fodder has been achieved by adapting the grazing activities as far as possible to the alternation of the good and the bad years in terms of fodder availability in the community lands.

An effective management of the grazing lands has lead to an improvement in the vegetation in the common lands around the villages and has increased the number of different plant species.

One of the main objectives of the local grazing areas management in view of the preservation of the local biodiversity has been to balance the use of the plant species so that the fodder comes from numerous plants and not merely from some species that hence undergo the totality of grazing pressure. The ecologic restoration of a vast area of land around the villages has met the need of fodder both of livestock and of the wildlife.

The reforestation initiatives and the creation of water bodies have allowed a more uniform distribution of the livestock on the grazing lands. Infact, the livestock has the tendency to graze in the areas close to the water bodies. As a consequence, large surfaces of land were overgrazed in proximity of the sources of water, whereas many

plots of land were underutilized because of the lack of water. In Sariska, a more uniform distribution of the water bodies have permitted a more effective management of the land.

### 3.3 Key Achievements and Lessons

An important element that has proved to be significant in assuring the success of conciliating the conservation and development objectives in Sariska was the setting up of the environmental education programmes at local level led by TBS.

These programmes reinforced the ecological knowledge of the local communities and increased their awareness on the importance of a sustainable use of resources.

The TBS organised campaigns of information to target different groups such as the women, which proved to be effective in gaining the support of the different social groups.

These campaigns proved to be effective as they were targeted to local cultural settings.

The *padyatra* in particular has been used as a form to increase environmental awareness among the villagers and proved to be very effective. The *padyatra*, which consists in a long march that can last several weeks covers long distances. The *padyatra*, in accordance with the Gandhian vision, is a form of democratic sharing of experience and knowledge in a non-violent way. During these meetings the collective recitation of sacred texts which stress the importance of the harmony between life and nature takes place. This march has permitted the exchange of information, experiences and different points of views concerning the environmental and development issues in Sariska. The organization of several *padyatras* also contributed to reinforce the links between the different villages in the region of Thanagazi.

The degree of the village involvement in these education programmes is reflected in the answers given by the interviewees. According to our data, the majority of the interviewees took actively part in the programmes, marches and meetings organized by the TBS.

As a consequence, the understanding that their well-being is closely linked to the restoration of the ecosystem and to the conservation of the local biodiversity has been enhanced. The interviewees in Sariska region show awareness of the existence a strong link between conservation of local environment and enhancement of



their livelihoods. Several villagers have stressed that water shortage, forest depletion and a decrease in the ecosystem's biodiversity can highly damage the environmental balance, notably with regard to precipitations, weather conditions, availability of natural resources and therefore as a consequence, their livelihoods. As a woman stated: "*Our whole life depends on the forest*".

Another important element that facilitated the harmonization between conservation and development objectives has been the creation of community-based organizations active in the management of natural resources and biodiversity such as the *Gram Sabbha*.

The *modus operandi* of the Gram Sabbha differs from the impersonal and centralised approach followed by the official conservation Authorities, which is often characterized by the imposition of laws, often far removed from the socio-economic and cultural patterns of the local communities.

The villagers are greatly aware of the importance of gaining and maintaining the respect of the other members of the community to which they belong. A preserved forest represents a potential way of gaining the respect of the community, whereas its degradation leads to dishonour and even to dismissal from the community. The fear of social exclusion is a preventative measure that ensures the acceptance of the decisions and the regulations adopted by the majority of the members within the Gram Sabbha. The adherence to the rules is achieved by the social boycott, which is in itself a form of non violent resistance (*satyagraha*).

A very important factor that explains the success of these village institutions in promoting community-based conservation in the Sariska region has been the consistent effort made by the villagers in partnership with TBS, in establishing as far as possible a transparent and democratic local governance structure, which is reflected in the process of decision making.

Community-based conservation may not always reflect the complexity of the network of relationships linking the members of the communities in the village. Social structures such as caste and class can influence the dynamics of power within local communities. Social hierarchies in the form of religion and caste are among the strong factors, which most of the recent studies have found to be critical in household partici-

pation in local participatory institutions (Shackleton et al. 2002; Deshingkar et al. 2005). Indian society is characterized by highly unequal distribution of wealth and largely divided in the line of age-old caste systems (Borooah Vani 2002). The presence of these factors can undermine the conservation community actions, intimidate and reduce the cohesion and the motivation of the villagers. This issue requires particular attention if an effective community-based conservation is to be achieved. An element that stands out is the necessity to reinforce the capacity of local communities to effect the equitable distribution of profits between gender and caste in the region and promote true participation (Puppim de Oliveira 2002). Thus, the contribution of weakest and marginalised members of the communities should not be restricted to the implementation level, but should be included in the determination phase of community objectives and initiatives.

In India, the landless villagers and the *scheduled tribes* are often excluded from the decision-making process. However, in the case of the Thanagazi region, this exclusion is not prevalent due to the relative homogeneity present in the villages from the point of view of social background and caste belonging. This has facilitated the social cohesion between the community members and reduced the conflicts between the members of the communities.

Homogeneity of community groups is widely acclaimed to facilitate collective action (Dahal and Capistrano 2006; Saxena 2000) and this is explained to be so because of closer social ties and norms (Pacheco 2005). Conversely, caste heterogeneity is known to contribute to disputes and may increase factionalism (Chhatre 2007).

The setting up of the community-based conservation is facilitated by the fact that these villages are populated mainly by a dominant ethnic group in numeric terms (*Gujjar* or *Meena*). From the field analysis it emerges that the efforts to mobilize the communities have been successful especially where the villages are small (about 35-50 households) and present a dominant ethnic group. As the villages increase in size and become less homogeneous, the logistics of organisation and negotiation within the community become more complex.

Increased attention must be paid to local institutions involved in the management of natural resources. The example of the Sariska reserve shows that local organizations have been one of

the determining factors in attaining the conservation objectives. These results are in line with a significant literature that suggests that natural resource governance outcomes are not merely dependent on population and demographic pressures but are a function of local institutions that enable communities to successfully manage the common resources (Gibson et al. 2000; McKean 2000; Ostrom et al. 2002).

The maintenance of ecosystem balance in the region of Sariska and the conservation of its ecosystems is very important for the survival and the development of rural communities, whose future is bound to the availability of natural resources.

Nevertheless, the conciliation of the conservation requirements with those of communities development is often confronted, and especially in countries such India, to a structural problem regarding the lack of land for the biomass withdraws. This contributes to increase the livestock and human pressures in the forests, protected areas included.

Statistics in India indicate that only 4% of the lands is controlled at the community level by a local institution of the Panchayat and used essentially as pasture land.

The 12 millions of hectares, under the category of community pasture lands, present a very limited surface of land for the community needs. As a consequence, despite all legislations and restrictions, the livestock continues to graze in the forests and in the state-controlled lands due to the fodder shortage. In India, about 70% of the protected zones are subject to grazing activities on behalf of the domestic livestock (Chhatre 2007).

The marginal farmers and the landless villagers are forced, in order to meet their biomass needs, to overuse these lands.

Sariska study case shows that the coexistence between the rural communities and the forest, as well as the coexistence of the objectives of development of these societies and biodiversity conservation is possible and sustainable in the long term. The balance between these two objectives can be attained if actions for the regeneration of the ecosystem and for the increase of natural resources are carried out.

As it is well-known, a disruption of the biologic balance of the ecosystem undermines its biomass productivity. In an already depleted ecosystem, even a limited pressure on behalf of

the communities can accentuate the current ecological damages while putting the conservation of the ecosystem in danger (Wilshusen et al. 2003).

In Sariska, due to the numerous pressures and the process of ecological deterioration, a sustainable use on behalf of the villagers was not sustainable and therefore the balance of the ecosystem was endangered. A more substantial approach, such as the one achieved through community based conservation initiatives, has allowed the increase of the natural resources in Sariska through a process of ecosystem regeneration.

The actions of community-based conservation improved the condition of the local ecosystem, a condition of primary importance to minimize the future impact of the human pressures on the natural resources.

An increase of natural resources and of the forest biomass through community-based conservation actions could constitute in the long term a viable solution for the improvement of livelihood of rural communities and for their socioeconomic development (Wolmer et al. 2004; Salafsky and Wollenberg 2000).

It seems therefore obvious that in Sariska the balance of the ecosystem and the abundance of biomass constitute a necessary condition to harmonise the coexistence between conservation and development objectives. This also constitutes the prerequisite for an effective and sustainable management of natural resources from an ecological and social point of view (Singh and Sankaran 2000; Emerton 2001).

It is important to note however that, while the value of community based on conservation initiatives at the local level, the institutional change that supports it generally comes from policies or laws enacted at a state or national level. Addressing poverty reduction and conservation needs to work both at the local level (facilitating equitable decision-making and distribution of benefits within a community) and at wider policy levels (using policy processes to provide supportive institutional mechanisms).

Nevertheless, it should be kept in mind that even when there are more enabling conditions for integrating conservation and development, the challenge of effective implementation remains and is aggravated by the fact that different stakeholders see integrated conservation and development initiatives as means to achieve quite different ends, which may not be compatible (Murphree 2001).

Integrating conservation and development requires deep structural changes and new ways of working. Tools to negotiate trade-offs in conservation and development situations are already available and have demonstrated encouraging results (Brown et al. 2005). It is also essential to develop and organise capacity both for the application of participatory, inclusionary decision-making and priority setting tools and for the implementation of agreed goals and actions. Monitoring and learning is equally crucial. This includes tracking and reviewing implementation to ensure learning and adaptation, which in turn should enable goals and roles to be refined, renegotiated if necessary, and further developed (Pretty and Smith 2004).

#### 4. CONCLUSION

Sariska shows the importance of adopting an integrated perspective on social and ecological systems or society and nature. As field examples such as Sariska shows, the local communities should not only be considered as an element capable of creating pressures on the ecosystem but as a source of initiatives and new solutions. Identifying, understanding and sustaining the initiatives of community-based conservation could be a way forward to harmonise conservation and development objectives.

Yet the creation of the biomass and the restoration of the balance in the ecosystem through community-based interventions represent a necessary but non sufficient condition for the maintenance of such a balance between local communities and their environment. The positive outcome obtained through the community-based on conservation initiatives to be sustainable should imply, among other, the commitment of the whole community. This former should commit itself in using the resources in a sustainable one once they have been restored. This form of commitment, as Sariska study case shows it, implies a deep understanding of the economic and ecologic value of resources and could possibly be achieved through awareness programmers promoted by NGOs and local leaders. Local organisations are crucial for the conservation and sustainable use of biodiversity as they can facilitate collective action and help coordinate natural resource management at grass-roots level. Local institutions such as the Gram Sabbha can enforce rules, incentives and penalties for eliciting

behaviour conducive to rational and effective resource conservation and use.

It is important to emphasize though that there is no blueprint that can be applied to all situations requiring the integration of conservation and development. Sets of principles such as those provided by adaptive management are a useful starting point but need to be tailored to fit the specificities and context of the problems they are aimed at.

Research efforts, rather than trying to provide a quick and universal solution to problems of poverty and biodiversity loss, need to focus on the contextual details that make particular outcomes more or less likely. Further, for research to be policy-relevant, new studies need to focus on the dynamics of the relationship between various measures of poverty and biodiversity, and on how these dynamics are affected by macro-social and political variables.

#### NOTES

1. The *johads* are mainly crescent-shaped earthen embankments approximately 5 m deep, with an area of 100-200 sqm, which is built across a sloping cathment to capture the surface run-off water then percolates into the soil increasing the ground water. This traditional water harvesting system had been built in Rajasthan for hundreds of years but many fell into disrepair during the 20th century due to the increasing role of the state in water management and the consequent weakening of village-level water management institutions and practices.
2. Source : Enginner's Evaluation of Water Conservation Efforts of TBS in 36 Villages of Alwar district, D.Agrawal, 1996).

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