

Environmental Policy Analysis for Maintaining Diversity*

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Context

Environmental policy in most countries is segmented and sectoralised. That is, a separate department or a ministry looks after environmental considerations. Such an approach to redesign developmental paradigm is obviously inadequate. Unless environmental issues become part of every investment activity in a society, the sustainable path of development can never be pursued. To illustrate the dimensions of such a pursuit, this paper deals with a specific case of environmental policy for maintaining diversity.

Biological diversity cannot be maintained without institutional and cultural diversity. And the articulation of aspirations by diverse cultures inhabiting different ecological niches requires modifying the structures of governance. It can be hypothesised that insistence on uniform designs of delivery system has resulted in the emergence of a large number of eco-protests. While this has been discussed elsewhere (Gupta, 1989a: 64-82; 1990), this work only draws marginally from that to suggest that governance through indigenous ecological institutions be considered a viable alternative to the continuing public interventions in the field of natural resource management.

Part One: Diversity, Complexity, Simultaneity and Learning

In a separate review, I have drawn the implications of ecological diversity and associated processes for public administration (Gupta, 1989b), Intellectual

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Property Rights of indigenous innovators (Gupta, 1991a). The arguments are briefly recapitulated here, expanding on the relationship between these processes and learning and living systems on which the eco-institutional interactions are predicated. The suggestion is to illuminate the discipline of ecological economics by the concepts, categories and heuristics evolved by marginal but more eco-friendly communities and cultures such as Amish, Inuits and American Indians in the North and Buddhists in Bhutan, some of the tribal and other communities in forest and desert regions in various developing countries.

It is strange but true that in a recent document, 'Caring for the Earth: A Strategy for Sustainable Living' published by IUCN, UNEP and WWF in October 1991, the earliest reference was of 1979. About 90 per cent references were post-1985 and the majority of these were western in origin. There was no reference to Vedic, Koranic, Zoroastrian, Chinese, Buddhist, Masai, Inuit and other knowledge traditions and world-views. This kind of discourse would neither take the discipline nor humanity forward in its search for sustainability. Thus to me, it is not enough to bemoan as Herman Daly does that leading textbooks on macro economics do not deal with environmental issues appropriately (Herman, 1990: 24). The argument would have to be taken to its logical conclusion and references to alternative world-views, cultures and heuristics would have to be equally keenly insisted in any discourse on ecological, economic or sustainable development.

Indian policies are no less oblivious of local variations than the global policies. In fact, the way tribal cultures were recalled by the United Nations on the eve of declaring 1993 as the Year of Indigenous People was no different from the way it has always been done on the eve of Republic Day parade in India. On both occasions, the identity of tribal people is symbolised by dance and crafts as if their knowledge system is limited to that.

Elements of Diversity

The physical conditions for generation and maintenance of ecological diversity abound in 20° latitude on both sides of the equator. The mountain ranges, rain forests, niches for speciation and preservation through human mobility and exchange in these regions is well documented (Fowler et al., 1988, Gupta, 1991b). However, what is less well understood is the rationale for regions of high biodiversity also being regions of high poverty. The ecological theories of poverty as suggested by Riggs and others who view poverty as a result of the climate and the context generated indolence, apathy, and lack of initiative do not deserve consideration. On the contrary, an ethics which justifies caring for those who cannot vote—the birds, the beasts and the yet to be born—deserves to be respected. If

diversity created other conditions for the perpetuation of poverty, then we need to understand the assumptions underlying economic theories, organisational designs and political institutions which legitimise such an association. These features are summarised below.

1. Diversity by definition implies the production of different kinds of biological products of varying quality, shape, taste, colour, etc., in different quantities over time and space. The generation of market demand for such a diverse range of products has been considered difficult in the absence of strong consumer preference for the same. The exception being French wine in which diversity in these attributes has been sustained by the market.
2. In whichever products of biodiverse farming systems consumer preference emerges either through markets (as in the case of wine) or through culture, rituals and other mechanisms (in the case of some of the local varieties of rice and other millets), the diversity is maintained so long as the physical limits do not constrain the transition to standardised, high demand, uniform product. Thus even though the market demand for a large number of local varieties of crops, vegetables and fruits does not exist, people grow them because nothing else seems to be possible in the given soil, physical and micro climatic conditions. Once a community gets locked into low return and high variance production system, the immiserisation is inherent.
3. The diversity in nature often is made sense of by generating categories or concepts for comprehension. Thus, the language of Eskimos has the largest number of words for snow and that of many fishing communities for sea waves. A community which is dependent for its survival on a resource thus generates a very deep understanding of the variability (and patterns therein) in the given resource, and coins many different words. Unable to invest in understanding this variability, scientists and technologists often ignore it. The categories of modern institutions and markets are imposed which undermine the coping mechanisms built upon the above understanding of diversity. The progress is measured in terms of the extent and the pace to which the local categories are subsumed under global ones.
4. The cultural institutions implying the need for various kinds of restraint in critical periods of ecological transitions (protection for spawning fish, grazing lands, hillocks grazed by one specie say, yak, being allowed to regenerate for cattle; prevention of inter-specie transfer of diseases and pests; voluntary quarantine during periods of outbreak of communicable diseases among livestock and human beings; generation of the institution of controlled forest fires to clean the deadwood on the ground lest it harbours forest pests like beetles) (for more details see Gupta and Ura, 1990). These institutions take a

long time to evolve but can decline very rapidly by providing economic incentives for destruction rather than diversity preservation.

5. Once the relationship between biodiversity and cultural diversity is understood, the variability in expectations about basic needs and norms for meeting them has to be appreciated: In a competitive society and an accumulationist culture, voluntary deprivation to safeguard natural resources is considered foolishness. And yet communities and individuals in different parts of the world have been pleading for the same for a long time (recall Gandhi's famous dictum, 'there is enough in the world for everybody's need but not enough for everyone's greed'). Assuming that generation of surplus is a necessary condition for participation in market exchange, the processes of generating surplus would have to be analysed. The choice of technology and cultural approval of the pace and size of extraction would become important determinants of the surplus. Public institutions as well as markets influence the extent to which legitimacy for different styles and scope of resource extraction exists. Uniform design and norms of public bureaucracies directly hit at the variability and diversity of cultures and, accordingly, of the technologies of resource use (Gupta, 1984; 1985; 1989). Uniform designs cannot breed, preserve or reproduce diverse systems or institutions.
6. In any democratic system, the hegemony of the ruling elites is expressed through domination and control. The communities which, on the one hand, are poor because they inhabit biodiverse regions and on the other, are denied even the freedom to maintain their own institutional relationships with nature often become restive. The organisation of popular protests among various native communities the world over in recent times is an indicator of the emerging tensions. It is also true that the literacy level and economic development among these communities is extremely low. It is not surprising that most of the slum dwellers and petty labourers in urban areas are from high risk environments such as drought, flood-prone, forest and hill regions. Any society in which a particular ethnic or regional social group has to remain subservient to another group for a long time without enough opportunities for mutual mobility cannot remain peaceful. The decline of diversity, therefore, is a direct threat to democracy, peace and survival of eco-friendly ethics and cultures.
7. The choice of technology plays an important role in influencing the rate, size, site, specie (and composition thereof), etc., of extractable resource in a given region. The choice can be endogenously derived or exogenously influenced (recall the recent film, 'The Medicine Man'). The range of choices that are available to a group can also be culture constrained (e.g., taboo on cow slaughter). The range can be influenced by several other factors such as compatibility of a technology

with prior tools, techniques, farming systems; local renewability; ease in use or development of skills; gender preference or bias; and capital requirement or risks involved. Many of these choices impinge directly on our understanding and appreciation of the available diversity. For instance, weed control is considered a necessary feature of modern agriculture. On the other hand, the allelopathic interactions, ability of certain weeds to attract predators of the crop pests, nutritional implications, etc., are now being noted and appreciated by the formal scientists (though many communities have known these for a long time). The design of technology in isolation of the local ecological knowledge systems could not be expected to serve the ends of diverse and sustainable resource use systems.

8. Ecological systems are characterised by complex and simultaneous interactions. The reductionist scientific tools require the assumption of *ceteris paribus*. There is no doubt that for any causal chain of logic to be established, a boundary has to be drawn around a phenomenon. Such a boundary by definition renders the analysis partial. However, such a use of reductionist logic can indeed complement holistic perspectives the same way that incomplete meanings inherent in any language/communications are complimented by non-verbal cues. The framework of holistic thinking (Pereira and Sandbrook, 1990) implies recognition of the boundaries of human wants and needs. This is not the question of economics alone. It emanates in economics but gets resolved in ethics. The complexity in ecological systems does not necessarily mean complexity in social systems. Bureaucracies are very complex but information generation and processing is totally out of step with the similar process in nature. The result is that a crisis is seen too late, understood even later and responded when it is hardly of any consequence. The simpler and accountable social institutions (usually based on a combination of utilitarian and non-utilitarian logic) often clothed in metaphorical imageries do the trick.
9. It is understandable that risk and uncertainty should characterise any natural system. To generate certainty in our life we may evolve institutions (formal or informal) that provide assurance. These assurances can be generated through long-term guarantees, legal mechanisms or other instruments to ensure that future returns from present investments (vertical assurances) are commensurate with our expectation of reasonable risk. But our ability to realise those returns depends in no small measure on the collective rationality, i.e., others' behaviour vis-à-vis our own (horizontal assurances). We can use redundancy to safeguard our interest. Redundancy in the short run is considered 'uneconomic' (Clark, 1989: 484). The components of modern systems, Clark believes, are too complex, interact over long distances, and lack (adequate) redundancy. However, it must be

remembered that too much redundancy can create inertia and too little can cripple (Gupta, 1984). Several types of redundancy are seen in the natural system. For instance, aerial roots may be redundant till the main trunk of the tree is strong, but once it becomes weak, the roots may become the main support. Likewise, when main channels of communication get choked, parallel channels like the stilt roots may perform the same function. However, if an organism or organisation relies too much on the parallel redundant channels, it may, by its very reliance weaken the main line of communication. Redundancy is a double edged sword. Sometimes redundancy may not be in the components but in the processes. Thus, a system does not provide for every contingency (the inventory costs of such an assurance will be prohibitive) but provides rules and norms which help in generation of appropriate responses. Redundancy thus becomes a spur for learning. The mechanism of creative learning, according to Riedl (1984: 32), in natural systems depends upon two basic peculiarities, 'one is its considerable redundancy content; the other is its indefinite constancy. That is to say: in most cases we must expect that the same events will recur, but it remains quite open in what circumstances and in what sequence'. In social systems we are not allowed the luxury of leaving the unfolding of possibilities totally to nature. The paradox is that the more we try to ensure that the future resembles the present or our image of the future, the more surprises nature springs on us.

10. The learning systems in nature as well as societies reflect the cost we are willing to pay to reduce unexpected losses or deviations in our trajectory of progress. The regrettable feature is that we tend to discount those knowledge systems the most which have been tested for the longest period (Dharampal, 1983: 229-56). For instance, the sustainability of planted forests is nowhere compared to that of natural forests. At the same time the decline in the productivity of planted mono-cultures has set in faster than most expected, within 3 or 4 cycles (Yale University Conference on Wood Based Biomass Energies and Sustainable Rural Development, February 1992). Likewise, the productivity of agricultural inputs has declined considerably in India as well as in America. The agricultural research system has not still geared itself to properly understand and build upon organic and other alternative systems of sustainable resource management. The consumer preference shaped by media, the legislature and scientists continues to be lukewarm to the ecological products. Given the price margin, it is not surprising that not all believers in sustainable development buy organic products. The result is a lag between what we think we should do and what we actually do. There is a need to understand the ways in which

consumer preference and pressure of that preference can be created to influence the powerful supply side. It is obvious that the access to information and the ability to use that information to shift investment and consumption patterns would depend upon the kind of assurances and cultural attitudes that emerge in times to come.

**Part Two: The Eco-institutional Perspective: Building upon
Local Ecological Knowledge Systems**

In a separate review, examples of various indigenous institutions that are sustainable and yet are not amenable to conventional economic or institutional analysis are provided (Gupta, 1990c: 79-96). It is shown that the rule making process in common property resource institutions is built upon a very different logic than following from the game theoretic or marginal benefit costs approaches. It is necessary first to reiterate the relationship between ecology, institutions, technology and culture that emerges from the above review and then illustrate with some of the examples, how this framework can be operationalised.

| | Eco-Institutional Perspective | | | |
|------------|-------------------------------|--------------|------------|---------|
| | Ecology | Institutions | Technology | Culture |
| Access | **** | | | |
| Assurances | | **** | | |
| Ability | | | **** | |
| Attitudes | | | | **** |

The access to ecological resources and the ability or skill to convert these resources into investments would serve limited purpose if the households do not have assurances from the institutions. These assurances could be either vertical or horizontal. The former refers to future returns from present investments and the latter refers to others' behaviour vis-à-vis one's own. The institutional mechanisms for both the kinds of assurances would be difficult to sustain if the attitudes reinforced by the cultural beliefs and value systems are supportive of these assurances. Cultural variables are both the cause and effect of the interaction between access, assurances and ability.

While each vector on both the axis can interact with all the vectors on the other axis, only the interactions on diagonal have been deliberately highlighted. The purpose is to draw attention to the third dimension of the matrix which is time or sequence. For instance, if we determine the access mode first and assume that these would remain unchanged, then the sequence in which institutional, technological and cultural variables may change can be speculated. It is possible that the exact sequence varies

although the direction resembles the predicted one. To that extent, the theory is still an evolving one. Another reason for highlighting the values on diagonal is that if time was kept constant, the nature of outcomes would differ depending upon the vector through which the intervention is begun. For instance, if one intends to modify the institutional arrangements (sharing of forest produce with the communities living on the periphery of forests), the limits imposed by access, abilities and attitudes would not operate the same way as it would have if one began with changing the access although to some extent each vector is influenced by others. For example, the access to resources is a function of the historical assurances an individual or a group has had about the ability to use a resource.

My reason for distinguishing access from assurances (also see Range, 1986: 623–35; Sen 1967: 112–24) is to capture history in the former and future in the latter. Thus how assurances operated in the past would determine how access has evolved in the present. But how access would be influenced in future will be governed by how we price the skills/abilities (as given or augmented) of different groups/individuals to use the resource in a manner that the cultural norms of sustainability are strengthened. It may be defensible for a local community to cut forests recklessly if the Forest Department and private contractors (on which it fails to have any control) also destroy the resources. However, such a behaviour may not have cultural approval either by the local norms or the global norms. Under such a circumstance, if the global as well as the national polity remains unconcerned about the entire resource allocating mechanisms and this community remains deprived of a fair share of the resources, then should one expect an ethics responsible for sustaining resources to survive when the survival of the community itself is in danger.

Many of the protest movements against dams and other such projects have taken a totally indefensible position that tribal people should be left as such in the forests or other catchment regions to safeguard the resource (and provide cheap labour for the urban and rural elite by remaining poor, illiterate and loosely integrated with the markets). Unless society is willing to compensate the resource preserving communities appropriately, there is no reason why the poor disadvantaged people should remain content with their role as a 'nature watchdog'.

There are others who believe that any attempt to compensate these communities would unleash similar accumulationist culture that we want to protect against. My view is that if a particular ethical and ecological knowledge system is worth preserving then society should invest in its augmentation and value addition. There is a need, therefore, to generate institutions that maintain the cultural core of a community and yet provide educational, health and other basic needs in a eco-friendly manner. This would mean professional experts with competence in analytical scientific tools to become apprentice with the informal experts to observe, analyse

and abstract the underlying theories in collaboration with the local communities. This would obviously require sharing of the knowledge so produced with the people themselves.

Skills or abilities evolve over time partly through practice and partly through innovation. These skills may become redundant if the market cannot price their outputs. The consequence is that with passage of time, skill or knowledge erosion takes place. Once the skill is lost, the resource ceases to be an utility. A medicinal plant may become a weed.

Part Three: Building Upon What is Known: Local Creativity and Organisational Development

One of the persistent reasons why many externally induced interventions fail is because the local knowledge system is often discounted and if considered, is seen only in an utilitarian perspective (Gupta, 1980; 1981: 157–61; 1987b: 111–27; 1989: 64–82; 1991a; 1991b; Richards, 1989: 39–43; Gupta with Kamra, 1992: 540–68; Gupta with Patel, 1992; Dharampal, 1971; Periera and Sandbrook, 1991). This realisation has dawned on development planners now for some time but the mechanisms chosen to build upon local knowledge are often worse than the problem itself. Various short cut methods popularly known as rapid rural appraisal (RRA) are invoked to get a grip on the local situation. We have critiqued these methods on ethical as well as efficiency grounds separately (Gupta and Patel, 1992). It is necessary to note here that organisations of creative people whether in the form of networks or informal cooperatives or just loose associations would generate a very different pressure on society for sustainable development. The spirit of excellence, critical peer group appraisal, competitiveness and entrepreneurship, so vital for self-reliant development, may emerge only in the networks of local 'experts', innovators and experimenters. It is true that every farmer or artisan does make experiments. But not everyone is equally creative. The transition of developmental paradigm is from the *victim's* perspective to that of the *victor's*. The organisational principles for a creative group are also likely to be different from that for the rest. The organisational principles which guide collective action in different regions would obviously have some common but many uncommon dimensions.

The process of institution building involves simultaneous intervention in eight dimensions of organisational change, viz., leadership,¹ stake

¹ The iterative, rotational and interactive leadership models are the only ones which sustain local community organisations. A study of Chenchu food gathering and hunting tribe in Andhra Pradesh (Gupta, 1987) revealed three principles of sustainable organisational sustenance; first, the leader and follower can iterate. The leader in honey collection subgroup has no particular skill in hunting group and becomes just a follower in that group. Second, the skills and not status determine the leadership (the person who knows the most

building,² value reinforcement,³ clarifying norms and rule making process,⁴ capacity building,⁵ innovation and creativity, self-renewal,⁶ and networking. The theory of institution building (IB) has to be significantly remodelled because of historical reasons. The IB processes were evolved to increase the capacity of Third World organisations to receive funds/aid and use it efficiently and effectively. The problem was defined from an external perspective and resolved or sought to be resolved accordingly. Such a perspective provided only limited insights for strengthening the capacities of organisations which have emerged autonomously at the local level. In a recent study Kleymeyer succinctly observed:

... (T)he cultural expression, in all its richness and variety, is not just a by-product of how a society organizes its social and productive relationships; it is a vital instrument for generating the insights and energy needed to transform those relationships.

Nearly two decades of grassroots development experience confirms Wali's contention that this aid is wasted unless it builds upon and strengthens the patterns of community organization which form the core of ethnic identity. This means the community must be given options that allow local people to set the agenda for their own development and to select technologies that reinforce rather than undermine community cohesion.

critical functions in a task becomes the follower rather than the one who is chief of the tribe or his kin). Third, the pooling is independent of the redistribution. Honey, game, food, fish or fuel is shared in this tribe among all the members and not just the one who went on the expedition.

² The original model of IB which emphasised the intra-organisational changes is less useful now. The evolution of stakeholders' interest in the organisation plays a vital role in the self-reliance process.

³ Some values are brought by the members of any organisation along with them but some are acquired in the organisational life experience. It is these values which have to be so shaped that reliance on external instruments of control and supervision becomes less important.

⁴ The rule making process is the one of the most crucial aspects of the IB in any organisation. The fine tuning of rules, norms and belief systems in accordance with the strategic future directions is not a function of just the leader. The group has to collectively evolve the norms and changes therein so as to ensure that collective spirit is maintained.

⁵ One of the most inappropriate terms in developmental jargon is 'unskilled' labour. There is practically no person who has no skill whatsoever. The challenge is to provide space within and outside the organisations for each member to grow. The learning systems at the individual and collective levels are to be strengthened in such a manner that the errors are not masked and corrections are not delayed inordinately.

⁶ The process of self-renewal requires recalibrating the scales of measurement periodically. It is the ability to discriminate finer shades of the colour of life which in the normal course may be missed. The historical perspective helps just as does the urge to relate to larger social causes. One cannot discover the immense source of energy to pursue any specific goal till one finds the broader dimension of growth.

The only snag in the above inference is that the choices perhaps refer to the selection of technologies developed elsewhere. Value can be added in local technologies which carry the cultural genetic code, through a conscious collective or individual decision. Such an approach would transform the relationships more organically.

Thus, if there exist local plant protection practices which worked at the individual level in local varieties, the developmental options may often include another chemical based pesticide which fits into individually managed solution of the pest problem in a new variety.

An alternative way could be to demonstrate through local initiative the processes of increase in the pest infestation subsequent to the introduction of a mono-culture of a new variety. Later, a combination of collective preventive care could be coupled with individual herbal pesticide so that collective processing of new information takes place. It is possible that either the mono-culture would be replaced or other ways would be found so as to reduce the incidence of the problem. Organisation building in such a framework is a slower, patient and a much more rigorous scientific process. It is possible that the available scientific tools cannot properly understand some of the local culturally embedded technologies or other practices. In such a case the scientific paradigm itself would need to be modified.

To illustrate, many indigenous communities in North America as well as in Asia and perhaps elsewhere believe that there is a relationship between the health of the soil and human beings.⁷ K.M. Munshi, a Cabinet Minister in the 1950s in India, linked the soil with the soul in a lecture entitled, 'The Gospel of Dirty Hand' addressed to the governing body of the Indian Council of Agricultural Research. He strongly repudiated the urge among bureaucrats in the Ministry of Agriculture to borrow concepts from outside for technology development and diffusion. He strongly believed that unless a concept struck chords in the hearts of millions of people (as it did when Gandhi gave various calls during the freedom struggle), it would alienate the masses and perhaps force the officials to bypass the Gospel of Dirty Hand implying learning the hard way by working with the people. He felt that the concept of extension—an American term—was ill-suited to Indian conditions and would weaken the self-reliance potential. After 40 years not only he has been proved right but even the consequences he predicted have come true. In every country there must have been similar leaders and thinkers who must have given a serious thought to building their societies through indigenous genius and cultural ethos. However, in the wake of modernisation these voices were stifled.

⁷ Personal communication by Raymond Obaswamin. 1992.

Ecological Ethics

The restoration of the ecological ethics in the communities where it has become weak, as evident from the decline of common property resources and associated knowledge systems, will depend upon identifying historical strands of critical thinking as mentioned above. By linking the new interventions with the old ideas, such institutional processes are triggered which generate respect for continuity and at the same time facilitate the introduction of change.

The local knowledge systems include practices where farmers, fishermen, pastoralists, etc., do the right things for wrong reasons as well as for the right reasons. They engage in practices which may have been right at one time but are no longer so. Thus, one does not have to romanticise the capabilities of indigenous knowledge systems. There are, however, strengths of the local knowledge system which can help extend the frontiers of natural as well as social sciences.

Kurien has provided a rich account of how the interaction among traditional and modern systems of knowledge takes place in the context of fisheries. He has rightly observed that any fishing operation is a combination of skill evolved through past experience and responses to the proximate reality and diversity inherent in it. The responses are shaped by the way sense is made of the environment, the feel of the sea bottom assessed by touching the depth gauging plumb line, the smell of the sea, the sight of the birds, landmarks, stars, the colour of the sea and ripples in it, the sound of the shoal movement, etc. He adds that 'it is this merging of experience with proximate reality which initiates the toll using response—dropping of hooks, casting of nets or laying of traps. The result: fish is soon caught'. Only one aspect needs to be corrected here. Even the most simple technical operation has a theory behind it. Otherwise, there will not be efficiency. The articulation may not be easy. Further, not all actions are purposive.

Knowledge in many of the traditional societies is not always sought. It happens. Rengifo⁵ provided an interesting insight when he mentioned that knowledge could happen while standing at a bus stand, or attending a social function or playing other roles. Paul Richards (1989) has argued similarly when he talked about agriculture as a performance and critiqued attempts to seek or impose systems on the local knowledge conditions. He believed that there was no point in seeking a consistency in what people do so as to call it an indigenous knowledge system. I agree with this view to the extent that there is an element of fun or playfulness in the activities of people (including all of us). However, the activities are not entirely random nor without an underlying theory. It is possible that this theory may not be apparent or all the connections in the theory may not be made only in a

⁵ Personal communication, PRATEC, Peru, 1990.

given framework of rationality. But there is rationality if the activities are sustainable.

The relationship between culture, technology and environment has to be seen together if strongly rooted organisations have to be developed. The examples of a parrot flying away or the poacher being punished by being made to stand under the sun and feed the birds, illustrate how indigenous institutions combine culture and environment, particularly in regions where environmental risks and resource scarcity are high. It is in this context that the *Honey Bee* network was started.

Honey Bee (HB): An Experiment in People to People Learning

Honey Bee (HB)—an informal newsletter started three years ago—is an effort to make the Golden Bird sing again. We realised that much against the conventional understanding poor people were poor indeed but not so poor that they could not even think. For them, experimentation and innovation was a matter of life and death given the uncertainties of nature expressed through droughts, floods and hailstorms.

The honeybee does two things which we often are not sure of doing ourselves. She picks pollen without making the flowers poorer. She connects one flower to another through pollination. Researchers extract knowledge of people which sometimes results in exacerbation of their poverty. They very seldom connect farmers to farmers. They write in the English language which connects them globally and also domestically with the elite but which prevents them from reaching to the people from whom they have learnt. Thus, while they grow in their careers and achieve wider recognition and professional rewards, the people suffer in silence. The ethics of knowledge extraction, its documentation, dissemination and abstraction into theories or technologies becomes their central concern (Gupta, 1989).

We reviewed in the *HB* the discussion on 'The Gospel of Dirty Hand' enunciated by Dr. Munshi in 1951–52 providing a framework for linking the soil, the toil of the field worker and the farmer with the soul of the learners and users of knowledge. Unfortunately, his thesis did not gain much ground in the bureaucracy or technocracy. We also referred to a Griffith Memorial lecture by Mazumdar in 1925 on the ancient Indian science of botany in Calcutta. Two masters theses guided by Dr. Y.P. Singh, way back in 1965–67 on indigenous animal husbandry, provided perhaps the first acknowledgement of indigenous knowledge by formal scientists. Ashis Nandy planned a large research project on ethno agriculture in order to systematically catalogue the science and culture behind farmers' wisdom. However, he could not get through the labyrinth of bureaucracy because the Green Revolution was serving us well in the late 1970s. Dharampal in a book, entitled *Indian Science and Technology in Eighteenth Century* (1971), brought together several travelogues by British

visitors to India 150 to 200 years ago testifying to the brilliance of Indian scientific genius.

The *Honey Bee* also appeals to fellow researchers, activists and planners in other developing countries to identify native wisdom both to inspire and also to provoke the young minds to explore. In every country a very strong oral tradition of knowledge generation, validation, scrutiny and diffusion exists. The *Honey Bee* strongly advocates the view that the boundaries between formal and informal knowledge systems may often be false. The informal system may have formal rules waiting to be discovered. The formal system may have informal beliefs, accidents, or conjectures providing impetus for further enquiry.

There has been of late an upsurge of the so-called rapid rural appraisal methods and approaches. There is nothing more disdainful than to use shortcuts in learning. It is true that sometimes researchers get lost in long-term surveys which throw useful light but long after the event is over. Therefore, efficiency in learning, analysing and disseminating results is necessary. But that should not imply that one can abandon rigorous methods of research or analysis. At the same time, one should not be too enamoured by methods when it comes to exploring a phenomenon.

It was felt that genuine faith, curiosity and a willingness to court uncertainties would be necessary for documenting people's own knowledge systems. The second year and third year students of rural colleges during their vacation were contacted and a beginning was made with documentation of their own experience of dealing with hardships in life or at their homes. A long list of various approaches that the students on their own or their parents or relatives had tried to cope with the stresses in the agricultural environment was drawn up. By underlining the one which impressed us most, we gave an indication of our biases.

More than 600 innovative practices were collected predominantly from dry regions to prove that disadvantaged people may lack financial and economic resources but are very rich in knowledge resource. That is the reason the term 'resource poor farmer' is considered the most inappropriate and demeaning western contribution. If knowledge is a resource and if some people are rich in this knowledge, why should they be called resource poor? At the same time, it is realised that the market may not price people's knowledge adequately. It should be remembered that out of 114 plant derived drugs, more than 70 per cent are used for the same purpose for which the native people discovered their use (Farnsworth, 1988).

This goes to prove that basic research could link cause and effect and it has been done successfully by the people in majority of the cases. Modern science and technology could supplement the efforts of the people, improve the efficiency of the extraction of the active ingredient or synthesise analog of the same, thereby improving effectiveness.

The scope for linking scientific search by scientists and farmers is

enormous. People's knowledge system need not always be considered informal just because the rules of the formal system fail to explain innovations in another system. The soil classification system developed by the people is far more complex and comprehensive than the USDA classification systems. Similarly, the hazards of pesticides, residues and associated adverse effects on the human as well as the entire ecological system are well known. In the second issue of the *Honey Bee*, out of 94 practices, 34 dealt with indigenous low external input approaches to plant protection. Some of these practices could extend the frontiers of science. For instance, some farmers cut 30 to 40 days old Sorghum or Calotropis plants in the irrigation channel so as to control or minimise the termite attack in light dry soils. Perhaps hydro-cynids present in Sorghum and similarly other toxic elements in Calotropis contributed towards this effect. There are a large number of other plants of pesticidal importance found in arid and semi-arid regions, hill areas and flood-prone regions which can provide sustainable alternatives to highly toxic chemical pesticides. It is possible that private corporations may not evince much interest in the development and diffusion of such alternatives which pass control of knowledge in the hands of the people. However, an informed, educated and experimenting client always spurs better market innovations as evident from the experience of the computer industry. Therefore, there is no basic contradiction between the knowledge systems of people and the evolution of market rules to strengthen and build upon it. However, such a model of market would be highly decentralised, competitive, open and participatory. The *Honey Bee*, in that sense, is an effort to mould markets of ideas and innovations but in favour of sustainable development of high risk environments.

Valuing Local Skills

To understand this process better a biodiversity contest among children and adults in drought-prone regions was organised with the help of a NGO.⁹ In this contest the participants were supposed to bring samples of all the plants which they were familiar with in the neighbourhood before a judging committee. They were expected to explain the uses of these plants and be prepared for being quizzed. Among adults, many agricultural labourers preferred to forego their daily wage in order to participate in the contest. The prizes were announced as part of a large research project at the IIMA on Sustainable Development of High Risk Environments.

The child who stood first was 12 years old and a student of class five. Being a shepherd's son he had ample opportunity to spend long periods of time in the fields. He could identify 116 different plants along with their uses. The farmer who came first could identify 240 plants. The most

⁹ Personal communication by P. Vivekanandan, 1992.

remarkable fact was that the 12 year old had completed almost half the intellectual journey covered by the most knowledgeable adult. However, the regrettable part was that this knowledge was unlikely to be of any use to the child in later life. On the contrary, he would have to unlearn this and learn 'a' for apple and 'b' for ball. When a skill precious and rare as it is cannot be priced, recognised and rewarded properly, it is a signal provided to society.

As a part of this contest, the local community identified 12 plants which had become almost rare. The action plan to conserve these plants did not have to be initiated by outsiders. It spontaneously emerged. The community also realised that a lot of plant collectors were paying low prices for local medicinal plants. The concern to safeguard diversity directly became related with the issue of IPR and compensation to the local people for their skill and institutional arrangements preserving diversity. The economics of these plants cannot be worked out by calculating the opportunity cost of labour. Instead, the skill, associated institutional arrangements and inherent rules of access have to be simultaneously viewed while calculating the rate of compensation.

Part Four: Sustainability—The Concept and Implications for Technology Development

'Sustainable development' as a term is much abused and little understood. If the idea is to use resources at a rate and by a technology such that future generations can use them at their preferred rates then sustainability is a non-starter. How do we determine 'preferred' rates across cultures and generations? Our previous generation did not restrain itself in the use of groundwater, land or aquatic resources, etc., so that we could use them at our 'preferred' rates. They did it partly out of some larger social and ethical concern. But it happened partly because more destructive alternatives maximising short-term returns did not exist then. It is true that today productivity of practically every natural resource is higher than ever before. Some believe that we can continue to increase productivity through science and technology without in any way damaging the renewability of the resource base. But it is also true that non-sustainability of present technological pursuits (comprising chemical intensive agriculture) was never so apparent as now.

I do not want to argue with those who have more confidence in scientific and technological tools but lack courage to confide in human nature. I believe that scientists cannot perform scientific functions honestly and in a professionally rigorous manner without bringing in ethical and environmental issues on the central agenda. Thus as a scientist, I will be failing in my profession if I promised politicians or other policy makers that I can deliver more productive alternatives indefinitely as long as I have a liberal supply of capital, equipment and scientific manpower. Some exaggeration is inevitable when one prepares grant proposals for funding institutions.

Nobody wants to fund someone who does not promise the moon. However, science requires taking into account all the evidence available so that the consequences of various choices can be faced squarely. This is not to imply that there is no scope for innocence or ignorance. Both are noble virtues and worthy of respect. However, what is being suggested is that drawing a very narrow conceptual boundary around a problem so that the negative externality can be ignored is no longer acceptable. The boundaries of disciplines and professions are increasing their overlap. This overlap helps us understand a phenomenon better. The logic of reductionism as a tool may still be valid. Because maintaining *ceteris paribus* conditions at the level of large systems would be impossible. No inference, howsoever tentative, can be derived without drawing a boundary. If everything is related to everything else, causality cannot be attributed.

Therefore, sustainability of resource management depends upon the way one defines a causal model of interactions, draws a boundary, attributes responsibility for consequences, organises institutions to correct or contain the negative consequences and maintain the positive ones, generates information and feedback sharing system so that enlightened self-interest can become compatible with and lead to collective rationality.

No one research programme would be able to address all the concerns of sustainability. But each research programme can certainly be modified in such a manner that (a) the causal model is modified to take into account some more interactions in the natural eco-system than was the case before, and (b) the negative externality of each technology is minimised.

The paper is organised in three parts. First, the concept of sustainability is discussed as it applies to the conduct of science followed by a discussion of specific issues regarding agricultural research. Finally, the conundrum of developing and diffusing sustainable technologies through non-sustainable institutions is described. An attempt is made to link personality of a scientist with the research pursuits for sustainability.

Having One's Cake and Eating It Too

Actually the idea of 'having your cake and eating it too' is not so absurd as long as one does not eat all of it and right away. Nature makes it possible for us to have our cake if not of the same size or flavour as we wish, nearly so. But when it comes to eating, it is not necessary that the process of eating should be pursued through the same norms, rituals and recipes across different cultures. Thus, some people share the cake with not only those who cooked it but also with those who could not either because they did not know how to, or they had gone out collecting firewood or were sick and sometimes just a little lazy. There are others who argue that the cake needs to be shared with only those who are directly responsible for its acquisition. Others can see it but not partake.

In some societies, not only human beings but also ants, birds and other

living beings are supposed to have a claim on the cake. When the number of claimants increase (that is, population size grows), some rules or norms for prioritisation are necessary. The scientists responsible for developing efficient recipes might argue that their job was restricted to the delivery of the cake. How could they influence its distribution! That is a decision which social scientists, policy makers and other stake holders must take. But assume that the cake was such that it would have a particular flavour liked by the consumers only if it was cooked in a particular way and in a limited size.

The French wine is indeed one such product which meets the requirement of a small scale site specific (4-S) production with flavour being a function of 4-S. The market forces have not yet found a way of overcoming consumer preference for taste, and the resultant biodiversity of grape gardens. The diversity of recipes and methods has also been maintained. Would such norms apply to only products of leisure-oriented consumption? 'What about thousands of local rice, potato and bean varieties which would have disappeared but for the 'resistance to change' among the cultivating communities?'

Even if the making of the cake cannot be restricted in size or to a site, can it be produced in stages or through semi-processed components so that different consumers can recombine the components or semi-processed recipe according to their taste, resources and preferences.¹⁰ It is quite likely that certain combinations of the cake components will be more tasteful/profitable than others. However, the variance between the combinations may be lesser than the conventional model of having uniform recipe with the 'take it or leave it' option.

It is difficult to anticipate the preferences although market researches do make an attempt. If they cannot anticipate, they try to mould the preferences through advertising and media planning. The cake can be sold even if it is less nutritious. However, the trade-off between long-term demand versus short-term viability is unlikely to be resolved only by manipulating the quality of the cake.

Leaving aside this metaphor, let us see some of the issues which emerge in the discussion on sustainability.

1. Sustainable resource use requires inter-institutional linkages such that interventions in each resource market generate positive externality to the extent possible. Scientists cannot always take institutions as given. The technological choices in such a case may legitimise the

¹⁰ Dr. Krishnamurthy, Former Director of All India Coordinated Research Project on Dryland Agriculture, had coined a concept of 'tiers of technology' in 1971. It implied that in dry regions the package approach was unlikely to succeed and thus farmers should be offered recombinable components. Different combinations may offer various advantages depending upon the initial endowments of the households.

given institutions. The linkages have to be forged between crop, livestock, tree, and craft related institutions. In addition, linkages between formal and informal knowledge systems, political and technological lobbies, formal and informal sectors, etc., would have to be conceptualised. To illustrate, groundwater may be used through private institutions, power supply may be distributed through public institutions, and surface irrigation may also be through public institutions. The sustainability of conjunctive water use would not depend only on the agronomic water use efficiency models. It will also depend upon the reliability of each system, the extent of costs for generating negative externality and the ability to free ride. The linkages between institutions, therefore, are a concomitant aspect of linkages between enterprises, sectors and disciplines. Most of the studies on sustainability have neglected the institutional aspect.¹¹

2. The sustainability of a resource use requires development and demonstration of an ethics which guides decisions regarding current versus future consumption of resources. The conception of nature and the relationship between human and non-human, animate and inanimate, born and unborn, etc., are defined if not determined by this ethics. Bio-ethics raise the following choices:
 - (a) Do we draw natural resources at a rate that the resource renews itself within a short cycle.
 - (b) Do we draw as much as we can till it is available and once exhausted, shift or change the resource base.
 - (c) Do we draw less than what can be used without impairing the ability of the resource to renew itself.
 - (d) Do we draw resources only as much as we need simultaneously ensuring that the genuine needs of others are also met.
 - (e) Do we draw as much as possible, hoard it if feasible and then market it at a very high price to ensure some kind of rationing of its use.
 - (f) Do we develop an institution which through its inefficiency generates a constraint on the maximum sustainable yield.
3. Uncertainty and risks—problem of definition vis-à-vis the phenomena. Risks may be defined as a problem of uncertainty when we want to absolve our responsibility (Gupta, 1990c). On the contrary a problem of uncertainty may be converted into risk when we want to exercise control and justify an investment. Nuclear power plants are an example of technology where hazards are 'unexpected' and risk is considered to be too low. The uncertainty about a technology which does not offer methods of safe waste disposal is converted into a problem of risk. On the other hand, a natural hazard like drought or

¹¹ Exceptions are the following studies, Cernia (1987: 21–24) and Gupta (1987).

flood is converted into an uncertainty even though over space, these hazards are very well known and probabilities can be easily assigned.

In nature, several interactions are still not well understood. For instance, harvesting of a particular specie of, say, wood from a natural forest changes the ecological succession and the consequent biomass supply and productivity. The long-term cycles of single specie have shown drastic decline in productivity. Yet the so-called scientific forestry continues in the form of mono-culture cycles. Selective withdrawal of a resource without knowing enough about its consequence on the remaining biomass is a problem of converting uncertainty into risk. The choice is between appraising a technology in a short or long time frame.

4. The right of the unborn. Given the conditions of extreme poverty and deprivation in most developing societies, the rights of the unborn are always discounted. It is seldom recognised that what we bequeath may often influence how we survive. The future may be nearer than we think. The hazards expected in the next generation often prepone their arrival. Declining biodiversity, increasing disease and pest hazards and the consequent increase in vulnerability is a phenomenon which we are witnessing today. We can relate the technological choices with these rights very precisely. For instance, the rate at which soil nutrients are mined may influence and be influenced by the cropping pattern, intensity and partitioning efficiency of a crop plant.

We may not even estimate the various consequences of nutrient imbalance for those elements whose functions are not fully known. The rights of the next generation are thus negotiated through the assumptions made about the present resource use pattern and consequences thereof. The effect of soil mineral properties on disease and pest vulnerability is still being assessed. The right of the unborn can be argued not only on ethical grounds but also on efficiency grounds. These rights imply a very long time frame and most sustainable technologies fail to prove their effectiveness in shorter time frames. For such technologies to be given a fair trial, invocation of the rights of the unborn is a pragmatic political strategy.

5. The sustainability of any technology cannot be assessed at the level of a single enterprise. The portfolio of enterprises through which a household draws its sustenance offers the first level of analysis. However, sustainability of certain technologies cannot be assessed at the household level as well. For example, watershed based technologies would require appraisal to be made at the catchment level. The upstream and downstream interests may not overlap. The proportion of land which different households have in a catchment may vary. Further, the quality of land and the consequent share of surplus it generates for different categories of households may also vary. The

generation of collective rationality would be *sine qua non* for developing sustainable alternatives. The theory of portfolio management at the household and community levels remains to be properly articulated.

6. Survival is not just an economic question. The aesthetics, humour, poetry and drama are part of the human repertoire which provides the syntax for survival. Scientists cannot manipulate this. But they can understand these needs. Once these needs are recognised, it is important to mentally prepare ourselves for witnessing curious experiments being performed by farmers. And one does not look only for an economic explanation for all these experiments. The sustainability of the experimental ethic of the people is very crucial if long-term sustainability of resource management has to be assured. The tendency to provide finished product (seed-pesticide-growth hormone complex) tends to undermine this ethic. Studies have shown that problems not only keep pace with but also move a few steps ahead of the solutions. The experimental ethics thus is subdued but not totally eliminated.
7. Sustainable technologies require a vibrant peer group which does not measure efficiency only in reductionist terms. Peer approval for low external input agriculture or for low or high return, low variance technologies may not always be available. If scientists cannot sustain their motivation, to expect them to develop technologies which are sustainable in nature may be futile.

There are many other dimensions of sustainability which for want of space, cannot be discussed here. For instance, the problem of younger people out-migrating from rural areas poses a kind of challenge very different from what was faced in past. Likewise, adults with an entrepreneurial spirit migrate from rural areas to urban markets. The kind of peer group which evolves through the dynamics of resource allocation among those who choose to stay is very different from the peer group in a society having young and old, conformist and non-conformist living together.

In hill areas, drought-prone areas, forest and flood-prone areas, males often migrate because of limited employment opportunities available locally. As a consequence, the proportion of women headed or managed households are invariably the highest in these regions. Women or children or old people inhabiting these regions may not be able to take animals for grazing long distances as men can. The grazing pressure and the resultant implications for the choice of technology in land use are obvious. Sustainable technologies for women dominated farming systems would not necessarily require a different kind of plant and animal breeding strategy if institutions can complement the inadequacy arising out of male emigration. But when institutions fail to meet the demands of women as a class, the responsibility

of scientists increases although scientists cannot compensate for all the inadequacies of institutional or public policy domains.

Part Five: Socio-Economics of Respect, Reciprocity and Restraint

Four examples are discussed here to highlight how local cultures cope with the issue of collective rationality while dealing with individual incentives or disincentives for resource management.

1. The paradox of parrot.
2. Feeding the birds.
3. Generating positive externality: the case of voluntary quarantine.
4. Collecting shingle wood in Bhutan: multifunctional institutions.

Case One: The Paradox of Parrot

In a drought year, the crop had suffered very badly. A woman was returning from the fields after picking up whatever grains she could. On the way she met a parrot. The parrot stared at her. She asked the parrot why he was looking at her so intently. The parrot replied that he was actually confused looking at her necklace, which had a green agate stone. He mistook it for a grain. Only when the woman came closer, he realised it was just a stone. The woman asked him whether he had something to eat. In reply, the parrot asked that had not she picked up all the grains from the field—even the ones which had fallen on the ground. The woman realised that the parrot was hungry, but she needed the grains for her children. She asked the parrot to come home with her and share whatever she gave to her children. But the parrot flew away, leaving the woman dumb-founded.

It is possible that the parrot realised that if he delayed search for grains other people would pick up whatever grains were left in the fields. He remembered his young ones who were waiting to be fed.

The song has several messages. It speaks about a cultural system in which the right of birds are being debated vis-à-vis the right of human beings particularly during a food crisis in a drought year. Perhaps there was some reason why the traditional varieties of millet or sorghum had loose set grain which was easy for birds to pick. At the same time, there were elaborate designs of bird scaring devices to reduce the loss due to bird attack. Perhaps people were aware that birds would kill insects some of which attacked the crops. How much of the contribution of birds was negative or positive would be reflected in (a) the technology, i.e., selection criteria of local varieties, design and efficiency of bird scaring devices, (b) the spirit of co-existence with other parts of nature, and (c) collective consciousness as well as culturally approved behaviours.

How one interprets this song would also depend upon how one conceptualises the right of different claimants over natural resources. If birds were also considered legitimate stake holders in the natural resources, then the viability, sustainability and effectiveness of any institution would have to be interpreted very differently. Often resource scientists have taken a very limited view of human nature—a view which excludes the rights of other natural beings. The conservation ethic is seldom anchored on such a view. At the same time, giving primacy to any one constituent over the others may violate the very foundation of eco-sociological knowledge system as argued by the Alaskan leader in part one of this paper.

A knowledge system which generates concern for various parts of the eco-system obviously could not have evolved through just individual innovations. It would have required the evolution of cultural norms, folklores cemented by various kinds of sanctions and rewards for socially approved behaviour.

Case Two: Poaching in the Desert: Feeding Birds as a Punishment

In another case provided by Arun Agarwal¹² a village panchayat (assembly of eldersmen) in Rajasthan devised an unique way of punishing a person who cut branches of trees from common lands where such poaching was prohibited. The person when caught was asked to stand barefoot under the blaring sun in hot summer and feed the birds 2½ kg of grains from morning to evening. It may be difficult to establish the relationship between the cutting of tree branches, decline in bird arrival, increases in pest attack or decrease in the biodiversity because of lack of seeds brought by the birds and the feeding of the birds. This relationship is entirely a speculation. It is quite possible that this punishment would have been interpreted variously by different people in the village with some common meaning but some uncommon meanings too. On the one hand, the culprit was punished and on the other, he was supposed to have been blessed by the gods for having fed the birds in hot weather standing barefoot.

An element of ambiguity characterising such judgment provides a creative ground for exploration and speculation. Institutions seem to be embedded in the socio-cultural and religious world-view of the people. It is quite possible that the access of various social groups or classes to the same common lands may not have been equitable for all the resources. However, to infer from inequitable availability of one resource, say, wild berries from common lands that inequity or indifference should exist in the institutions for other resources, be they of aesthetic or material nature, would be a mistake. In this case the deliberations were guided not only in terms of the interest of human claimants on natural resources.

¹² Personal communication, 1990.

The conflict among religious and other identities has to be resolved through open negotiations rather than through authoritarian interventions. A vast body of traditional ecological knowledge has been retained through codes legitimised by religious or cultural institutions.

The global concern for sustainable development and conservation of biodiversity is dominated by the strategies and styles suitable for essentially degraded environments. Since environmental degradation is inevitably accompanied by degradation of institutions, these policies take absence of institutions as given. Much greater reliance is placed on public interventions which in turn imply bureaucratic interventions.

Case Three: Quarantine as a Collective Institution

In Komathanga village of Wangudi, a very careful arrangement has been worked out to prevent diffusion of a disease. If the village cattle were infected with the disease, two outposts were set up outside the village in the directions from which outsiders usually entered the village. People from the village took turns to man these posts. No cattle from outside was allowed to enter the village lest it should also get infected. Even the people visiting the village had to stay overnight at these checkpoints before entering the village. This was a case where an institution had emerged not to optimise returns to the individual or village, but to generate positive externality. It might be possible that if everybody reciprocated such a gesture, the diffusion of disease would be much lesser.

Case Four: Collecting Shingle Wood in Bhutan: Multifunctional Institutions

Various common property resource institutions in Bhutan illustrate the way people have evolved ways of matching household and resource regeneration requirements. The role of culture, religion and other collective social institutions in modifying individual needs has not been adequately appreciated. For instance, there is a custom that people go to the forest for collection of shingles together on a particular day. There are several implications of this practice.

1. While collecting wood on the steep slopes, if somebody falls down, there are people around to rescue the person.
2. Everybody monitors everybody else's collection of wood.
3. Since collection of wood has to be done keeping in mind the age, health and condition of the tree, corrective restraint helps in maintaining those conditions.
4. Some people may be either too old, handicapped or weak or their requirements may be larger than they can manage on their own; groups help in such cases and carry the extra burden.

5. There are sites which might have suffered some damage due to rain, landslide or otherwise. The fact that such sites are observed together enables mobilisation of the will for corrective action more easily.
6. In addition to the utilitarian dimensions mentioned above, group action is its own reward when there is music, fun and laughter around.

Thus, emphasis on only the economic aspect of a resource would not provide sufficient information or insights for building institutions that can help in managing resources sustainably. Development is possible only through creative institutions which constrain individual choices to some extent and yet provide scope for entrepreneurship.

The combination of individual sanctions and collective rewards perhaps could be sustained through moral institutions and a bio-ethics in which long-term survival is preferred over short-term maximisation of return. The innovation by peasants whether in the field of technology or institutions requires production of knowledge. But reproduction of knowledge takes place through institutions which have to be renewed over a period of time.

The first case of the parrot helps us understand the role of culture, folk heritage in shaping the perception of individuals on an issue concerning future generations or sentient living beings. It is difficult to derive such norms through an exchange economics which does not take into account ecological principles.

In the second case, the sanction can neither be generated through public choice framework or game theoretic perspective nor can it be derived through demand and supply equilibrium. This is a good example of how societies generate processes of rule making rather than legislating rules for all possible contingencies. The example also highlights the importance of unsaid, unexplained or implicit meanings. How different people interpret the sanction against the poacher is left ambiguous. By leaving it ambiguous, the culture also assigns tremendous responsibility at the individual level. The process of figuring it out through informal interactions sets into motion a dynamics which no explicit rule book can ever substitute.

In the third case, generating a system of quarantine and a positive externality can be justified only in a very long time frame. Otherwise such institutions will fail to invoke commitment and compliance.

In the fourth case, one can notice how even small micro level institutions may serve so many diverse functions and hence may be embedded in the local ecological and cultural knowledge system. To delink the institutions of governance from their cultural context will nullify any effort to conserve the environment and provide, say, the local people a place in the structure of governance.

On the basis of these four examples drawn from a large repertory of such institutional solutions for sustainable resource management (Gupta, Capoor

and Shah, 1990; Gupta, 1990a) the following lessons, paradoxes, concerns and issues can be concluded.

**Part Six: Lessons for Sustainability and Paradoxes for
Expanding Disciplinary Boundaries**

1. The eco-institutional perspective requires looking at all the four vectors of sustainability, i.e., ecological resources, institutions, culture and technology in a manner that short-term calculus can be generated from long-term goals of resource management.
2. While ecological conditions define the range of economic enterprises that can be sustained in a given region, the scale of investment and composition of portfolio is a function of access to factor and product markets, non-monetised exchange relations, kinship networks, cultural institutions, intra- and inter-household risk adjustment options.
3. Different categories of households may use varying discount rates for appraising their returns in different resource markets (Gupta, 1981) depending upon their control over these resources. The time frame accordingly would co-vary with the extent of control. Thus the higher the control, the longer may be the time frame. However, in the absence of public accountability and popular control, the time frame can be shortened despite higher control. This is particularly true in an inflationary environment. The mechanisms for reversing this preference would require generation of long-term assurances and short-term returns.
4. The excessive emphasis of various popular protest movements on improving access in isolation of generating accountable and participative institutions may result in resource degradation even after the conflict is resolved in favour of the disadvantaged. In the process the long-term sustainability of short-term improvement in access may be very poor. On the other hand, the evolution of sound institutions cannot take place in the absence of totally ambiguous or ill-defined 'rights to resource'.
5. Sound policies and weak institutional capacities are a common refrain in the field of environmental management. Strong institutions can correct weak policies incrementally over a period of time but not vice versa. The process of institution building requires a recognition of cultural and emotive dimensions of life. The generation of internal command as against the response to external demands requires sensitivity to values and personal beliefs.
6. Diversity in nature is preserved through diversity in culture, languages, rituals and belief systems. Unless this diversity is accompanied by institutional diversity, sustainability in resource management is unlikely to be achieved. Institutional diversity requires recognition of

different rules of social organisations being equally valid and ethically sound so long as these rules have legitimacy and sanction. Thus, a centralised conference like the Earth Summit would be unthinkable in this framework. Both the arena of discourse and the nature of dialogue were typically similar to most other international conferences as if different cultural traditions could not be respected unless they used a centralised arena. It has been argued elsewhere that nothing can be termed as a greater paradox than the centralisation of the arena of articulation and protest.

7. Institutional rules require observance of a boundary. However, unlike boundaries which are characterised by what they include or exclude, the boundaries of sustainable institutions attach more importance to the gates of entry or exit. What distance did one traverse before reaching a gate becomes more important than a person being inside or outside the gate. The legitimacy of sanctions is derived through a process by which institutions are evolved and not by the boundaries they create. This is the most important distinction between the framework proposed by me and the one proposed by Ostrom (1990).
8. The rules of resource management cannot be appraised only in the light of economic basis of exchange, resource extraction and compensation. The rights of those who cannot vote (birds, beasts and the unborn) are given equal importance, if not in entitlements, then through compensation.
9. The search for sustainable institutions has to begin with the study of indigenous ecological knowledge systems as being attempted through the *Honey Bee* network. To understand local knowledge systems, new terms and categories may have to be evolved which can capture the generosity inherent in the concern for nature. The study of folk literature becomes necessary for understanding the local belief systems, values and norms exercising restraint in the short-term and the reciprocity in the long-term.
10. The economic principles of prices, transaction costs and externality must be enriched by taking into account non-economic considerations that make life worth living. At the same time, there may be reluctance to expand the boundaries of the concept because new categories may emerge from non-western tradition. Given the citation behaviour already exemplified, new norms may evolve only after a considerable struggle.
11. The portfolio of economic and non-economic enterprises has to be appraised in a manner that diversity by itself gets priced. In a study of banks portfolios in a drought-prone region, it was noticed that diversification measured through Herfindall index was directly correlated with the extent of finance. The higher the investment, the

- greater was the expectation of diversification. The data are still being analysed. By using banks' portfolios as a measure of institutional response to local ecological diversity, we have developed a measurable method of analysing sustainability of public investments. We have tried to match household portfolios with those of commercial banks to study the interface in an eco-institutional perspective.
12. The specie choice in most afforestation projects is slowly becoming wider than it was in the late 1970s and the early 1980s. Chipko and Appikho are two of the many movements which have helped in modifying the perception of public bureaucracies. However, it is still a distant dream to expect these projects to provide as diverse choice as would have been preferred by the people pursuing different portfolios of activities. It is possible that with greater participation of voluntary groups in ecological movements, public bureaucracies would withdraw to the core areas.
 13. Industrial pollution and its effect on biodiversity has not been systematically pursued except in the case of oil spills in sea, industrial effluents in rivers and, to a marginal extent, through air pollution in some horticultural regions. This is an area which is likely to become more important in times to come. Various alternative ways exist to involve the state, markets or other self-design institutions to bring about harmony in developmental and environmental objectives (Gupta and Prakash, 1992). However, which kind of institutions will be best suited for the externalities which involve high uncertainty, low measurability and high irreversibility, as is the case in biodiversity, remains to be identified.
 14. Voluntary organisations have received considerable support from both national and international agencies, particularly in the field of environment in the last two decades. This has had both positive and negative impact on the environmental policy. Since international and national agencies want to provide some space for dialogue to NGOs, they often involve and incorporate only the large metropolitan NGOs. And since such NGOs speak a language which is similar to that of public bureaucracies, mutual cooperation and co-optation is understandable. Certain dimensions of the environmental policy, however, are ignored in the process. For instance, the issue of indigenous creativity and support to grass-roots innovations has not received much attention in the ecological movements. Similarly, while concern has been expressed against the Dunkel Draft on Intellectual Property Rights, no effort has been made to create pressure on national institutions to recognise these rights. It is necessary that the national policy is critically appraised from the perspective of creative innovators at the grass-roots level so that new institutions do not come into being, even in those NGO sectors which are not amenable to local control.

An attempt is made in this paper to cover a large ground ranging from the principles of ecological complexity, simultaneity and diversity in nature as well as in society. There are several loose ends which need to be brought together. Sustainability is like having one's cake and eating it too. This paper describes the process by which one can do it if one eats slowly, by sharing and over a long period of time.

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