FARMERS' INNOVATIONS AND AGRICULTURAL TECHNOLOGIES[1]

A.K. Gupta

INTRODUCTION

Mountain regions are characterized by low population densities, weak market infrastructures, high levels of emigration (particularly of males), the predominance of female-headed or female-managed households, money order economies[2], poor linkages between the formal and informal sectors, and low levels of social and political articulation.

The value of traditional skills has gone down over time to such an extent that in many parts of the world these regions are seen as a reservoir of 'unskilled labour'. It is not without significance that the majority of emerging labour occupies a low status employment 'niche' in urban or rural labour markets. Such a low rating of their skills by society leads to a decline in the pride of mountain peoples in their indigenous methods of resource management. Often, their low self-esteem is reinforced by public policies which fail to even recognize (much less to appreciate) the strength of indigenous institutions and traditional technological innovations. Jodha (Chapter 2) and Sanwal (1989) have rightly argued that despite a great deal of talk about integrated mountain development, the approaches are often segmented, sectoralised, and, in some cases, even deillumanizing.

[1] Published in Sustainable Mount Agriculture, entitled, "Farmers' Innovations and Agricultural Technologies" (Eds.N.S.Jodha, M.Banskota and Tej Partap), Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi. pp. 394-412., 1992

[2] The implications of this for the nature of cash flows and attendant patterns of demand have to be carefully worked out. If surplus exists in even a few hands, without suitable opportunities for investment, it can establish wrong role models. The increasing influence of liquor consumption in many of the hill areas receiving inward remittances is a case in point.

Official documents on the development of backward areas in India have, in fact, cautioned against an attempt to stem the migration of people from such regions elsewhere lest the supply of 'cheap' labour for infrastructural development projects be cut off!

It is in this context that we have to look at the strength of innovations developed by mountain people all over the world. Given the high ecological heterogeneity, it is not conceivable that technological transformation through diffusion of standardized technologies can take place. Organizational rewards for developing technologies that can diffuse only in small, localized 'niche' have been seen to be generally poor (Gupta 1985). Thus, eliminating the mismatch between design of R&D organizations and the expectations of the people is the central issue for recasting development strategies for sustainable mountain agriculture. We recognize that not all technological alternatives can be either anticipated or demanded by the farmers.[3] Therefore, we do not believe that future options will increase without simultaneously increasing the responsibility of the supply system to widen the decision-making horizon of the farmers. At the same time, we do recognize that the study of farmers' innovations, both technological and institutional, can broaden the vision of the scientists themselves (Gupta 1987b, 1987c).

This paper presents an analytical framework to look at the eco-institutional aspects of the choice of technology, and then briefly reviews some of the innovative technologies and institutions developed by the farmers and the issues involved in their search and scrutiny.

An Eco-institutional Framework for Analyzing Choice of Technology

Human choices in a given eco-sociological configuration are circumscribed by the historical evolution of institutional structures. Institutions provide a framework of rules, sanctions and

[3]I strongly disagree with those who argue that farmers can always demand what they need. It has to be appreciated that our capacity to demand what we need depends upon our poor experience with the supply side, exposure to various alternatives, the skill to convert a need into a demandable output, and an understanding of the language in which the supply side understands our need as being distinct from a demand.

meanings that is commonly understood by people grouped within a common boundary. In a way, institutional behaviour relies more and more upon internal commands rather than upon external demands. However, a combination of both moral and material sanctions provides legitimacy to an institution. In the present context, we are drawing upon another feature of institutions which, in the context of farming systems research in mountain regions, is extremely vital; that is the assurance provided by the institutions - formal and informal - to individuals and groups about various uncertainties faced over time and space.

We deal with mainly two types of assurances - horizontal and vertical. The former type includes the assurances that provide guarantees about others' behavior vis-a-vis one's own. Thus, if I sow my crop early will others also? Or if I do not graze my animals on common land will others also not do so? Vertical assurances refer to the future returns from present investments. If I plant trees on common or private land will be allowed to harvest them. Or if I apply organic fertilizer to a particular plot of land taken on lease will be allowed access to it next year also (in view of the slower release of nutrients from the organic fertilizer)?

Assurances by themselves however, are not sufficient. If I have assurances of better prices or better returns for certain kinds of collective behaviour but I do not have access to the given resource, or I do not have the skill or ability to convert a resource into an investment, or both, then assurances are of little use.

Assurances help in generating cooperative behaviour when we deal with common properties (Sen 1967, Runge 1986, Gupta 1985). In the case of private resources, assurances may stimulate demand for better access or technical skills or both. Likewise if we have an institution in which people have access to resources and also have assurances, but do not have the skills or abilities, the investments will not follow.

All the three vectors of choice, that is, access, assurances and abilities, must be synchronized to generate appropriate attitudes for change or maintenance of a resource use system. Thus, within a specific spatial, sectoral, and seasonal configuration, portfolios may vary within a given range because of changes in access, assurances, and abilities. As we note in Fig. 16.1, the access to natural resources, to assurances from the institutions, to ability in terms of technology, and to attitudes in terms of culture, collectively influence the household portfolios. This framework also helps in designing interventions. Thus, if we want to introduce technologies that presuppose the existence of certain skills, access modes, or institutional structure, but some or all of these vectors are missing, we should not fault people for not using the given opportunity. It may be useful, therefore, to recognize that this framework can be used as a tool or as a filter to assess available information and generate further choices. If we know the given complexity of access and the abilities of the people in a given system, we should be able to anticipate what kind of assurances will generate or respond to the given attitudes. Attitudes here are both an outcome of historical experiences and inputs into future choices. The culture, I must add, does become modified over a period of time.

Ecology	Traditional	Modern				
Space	Season	Sector	Formal	Informal	Technology	Culture
Public	Private	Communal				
Access						
Assurance						
Ability						
Attitude						

Figurte 16.1 : Eco-institutional framework for analyzing choice of technology
Source: Author’s compilation

The same framework can be used to analyze the supply side that constitutes the response of scientists to various types of problems or social situations. For instance, if scientists do not have (1) assurance of peer approval (collective choice or horizontal assurances) or (2)career rewards (vertical assurances), but have (3)access to the facilities for on-farm research and also have (4) skills for performing experiments, we should not be surprised if they develop attitudes that are conservative or non-enterprising. In the same manner, changes in different parameters may help us to identify the corresponding changes required in other parameters.

The ecological dimension can be further looked at in terms of space, season, and sectoral interactions. Institutions could be traditional or modern, formal or informal, public, or communal. The technology could be based on local inputs or external inputs and culture may reinforce compliance (because of a feudal past), or trigger innovations, or both. For the sustainable development of mountain regions, we have to appraise every intervention through the matrices given in figures 16.1 and 16.2. We can, as a consequence, anticipate the likely changes that will come about in various subsystems if interventions are made to modify access, assurance, ability or attitudes. An important point of departure in this framework is that sustainability is being defined primarily in its institutional context.

The socio-ecological paradigm (Gupta 1984, 1985, 1989, 1990a) provides the basis for understanding the choice of technology through the interaction of ecological, technological, and institutional variables. The eco-institutional framework provides additional linkages to the cultural core of the mountain society or other high-risk environments and the attitudinal basis for their current behaviour. It is accepted that inappropriate policies in the recent past have changed attitudes significantly in several parts of the world.

The 4-S Model

Several studies on farmers' adjustments to risk have shown a multi-market, multi-enterprise, and multi-institutional approach to survival (Jodha 1975, 1978, Jodha and Mascarenhas 1985, Gupta 1981, 1984, 1988, 1990a, Ostrom et al. 1989). The multi-market approach refers to the farmers' attempts to adjust to risk through simultaneous operations in different factor and product markets. The factor markets include land, labour, capital, and even information. The product markets include crops, livestock, and trees as well as various technologies of land and water use. The higher the risk in the environment, the greater the dependence between the decisions made in one resource market and those made in others. These links are important in well-developed regions also but, in these regions, many imperfections in respective markets can be offset through market mechanisms themselves over time and space. In high-risk environments, the cost at which these errors may be corrected will be far higher, and thus there is greater dependence on inter-market adjustments.

The multi-enterprise approach implies that farmers' adjustments to risks or the evolution of portfolios cannot be understood by concentrating on any one enterprise such as crops, livestock, labour, or trees. The 4-S model helps in understanding these linkages at the macro-level.

The multi-institutional perspective is helpful because various resources or enterprises, as mentioned earlier, may be governed by various kinds of property right regimes, in combination or separately. Livestock, for instance, may be managed by some households through biomass derived from private lands only. In other cases, it may be derived from private as well as common and/or open access lands. Thus, various institutional arrangements, whether or not regulated by the State, market, or both, further influence the choices at micro-level. Any framework that ignores the multi-market, multi-enterprise, and multi-institutional dimensions of household portfolios will generate only a partial understanding of the survival logic of the people. The innovative technologies or institutional arrangements are a part of dealing with these complexities. Innovations for survival sometimes may follow rules that are different from innovations for accumulation.

To use the 4-LS model we use a three-dimensional matrix as shown in Fig. 16.2. Each dimension can be dichotomized for the purpose of creating ideal types. The basic principle of logic that we use here is 'compare and contrast'. If we want to understand a phenomenon it is useful to begin by comparing and contrasting the extreme values of its distribution. For instance, 'space' can be dichotomized in terms of high or low land, undulated or plain topography, higher slope or lower slope in the mountain regions. Likewise, 'sector' can be dichotomized as agriculture or industry, public or private, specialized or diversified, and single crop or diversified crop combinations, cash crop or food crop dominated. 'Season' can also be divided into uni- or bi-modal rainfall regimes, arid or humid, low or high rainfall, low or high diurnal temperature variations, or low or high seasonal fluctuations. (This is essentially the dimension or time with which the uncertainty is associated).

Given any two parameters we can speculate about the third. For instance, in a region with low population density and high seasonality (low rainfall and high diurnal temperature variations in the arid plains and low diurnal temperature variations at high altitudes) the sectoral characteristics may be highly diversified. Instead of a single crop, farmers may prefer mixed or intercropping in several plots, if not all. Households may simultaneously pursue many activities such as crops, crafts, and livestock rather than being dependent on any one of these. The social exchange relations in such regions will be quite different from those in the regions with high population density, low seasonality, and specialized sectoral activities or diversification for accumulation rather than survival. Some of the characteristic ways of social exchange relations may include the following: the predominance of kinship and external family networks over the nuclear family system to hedge risks; the preponderance of non-monetary exchanges and the informal mechanisms of pooling bullocks, implements, and inputs[4]; dominance of generalized reciprocities over specific ones;[5] and choice of a much longer time frame to settle accounts[6].

[4] Anthropologies have provided rich insights into the pooling mechanisms in various societies living in hill areas, arid regions, or forests. The pooling of bullocks in Maharashtra, for instance, is called 'irjik'. As many as 10 to 12 pairs of bullocks can be seen ploughing the land in a particular catchment area across the fields on a specific gradient. Since the moisture recedes faster near the ridge line, the plots along the contour towards the ridge have to be ploughed first. It is possible that some people may contribute one bullock pair though they may have only half an acre or even no land in that areas, while others may have a much larger tract of land in this area and yet contribute the same pair of bullocks. The obligations for feeding the cattle and the ploughman are also worked out in many diverse ways. What is important to understand is that uncertainties over time and space may generate reciprocities that may be settled over a longer period of time and thus generate rationality of choice in the short term.

[5]The generalized reciprocities refer to exchange of labour for thatching huts with labour contributed for ploughing the land. It is very difficult to work out the equivalence between such related activities. How critical thatching is before the rains, only a poor family living in such a hut can realize. Likewise, the criticality of draft power in receding moisture conditions in light soil regions can be understood by someone who may miss the entire season in the event of failure to sow the crop at the right time. Traditional economic theories are of limited help because equivalence is not just the value of labour as assessed in the market place. sometimes help provided in such a context

The communication systems in thee regions are more metaphorical or analogical than digital. The strategies of technology transfer in on-farm research and extension systems would obviously have to be tailored to the typologies that can emanate from the simple matrix given above. One can make it more complex and generate richer insights but parsimony always has a price. I must acknowledge that the nature of institutions and market interventions can modify the initial conditions that may be predicted by the configuration of spatial, sectoral, and social variables. It might appear that some of the social relations are defined by the ecological variables in a deterministic manner. We have seen that the relationship between pastoral and cultivating communities in the Swiss Alps (Netting 1972), Northern Pakistan (Buzdar 1988), Bhutan, and some other Himalayan mountain regions (Gupta and Ura 1990) have striking similarities, although specific parameters may vary due to cultural and religious differences.

Space
Population Density

High Low

High (Low rainfall or high risks)

Season

Low (Low variability or well spread rains)

Specialised

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may generate an IOU that can be redeemed much later. The specific reciprocities on the other hand refer to exchange of the same goods or services. I have paid for your tea today, you should pay for me tomorrow or I have given you five kilogram of wheat seed and you return the same amount of the same crop later. Commercialized societies when would have a dominance of specific reciprocities. Decision-making with constrained resources cannot be analyzed without looking at these reciprocities.

[6]Studies have shown that IOUs are settled in the regions described here over far longer time periods extending sometimes to several generations. A good or bad turn may invoke a return gesture not necessarily on the same day or in the same month or even the same year. Even the nature of factional leadership remains divided at village level for longer periods than at the State or national level where loyalties can shift quickly without generating problems of legitimacy or social acceptance.

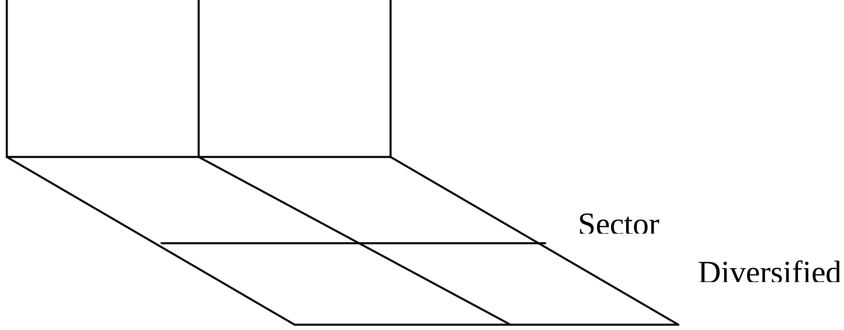

Figure No. 16.2: Three-dimensional matrix

(Gupta, 1989, 1995, Gupta et al, 1996)

Over time, however, formal institutional inroads and market developments do modify these strategies. The availability of walkie talkies means that Swiss pastoralists do not have to develop specific whistling styles as observed in the Andean mountains or in the Himalayan Mountain regions. However, the need for surviving collectively is felt in almost all such socio-ecological conditions.

Socio-ecological Framework

I make two assumptions: (1) ecological conditions define the range of economic choices that can be sustained in a given region and (2) the scale on which different enterprises are selected, however, is a function of the access to factor and product markets; kinship networks, public, private and common institutions; and historical resource reserves. Instead of calling the framework socio-ecological, as I have so far, I shall now call it eco-sociological because of the dominance of the ecological dimensions of the socio-economic processes.

Earlier it was assumed that in any given ecological 'niche' only certain economic enterprises were feasible at the given level of technological and institutional infrastructure. However, I modify this condition to suggest that the ecological endowments of the proximal environment of a particular social community need not be the major determinant of portfolio. Distant environments where the community has customary or traditional rights through migration, or other mechanisms, have also to be taken into account.

Thus, once a mix of enterprises or a portfolio is selected, drawing upon resources from private, public and common priorities, the nature of risk inherent in this portfolio can be analyzed through a matrix of mean or average return and variance in returns. The high mean, low variance portfolios would obviously have different implications for individual and collective behaviour than portfolios with low mean and high variance.

Given an initial portfolio and its mean variance or risk return characteristics, households may respond to a given risk in the environment and any of the following alternative means: household-level risk adjustments; public and market risk-reducing mechanisms; and communal and common property risk adjustments.

Households risk adjustments can be further analyzed at intra-household levels and inter-household levels. The intra-household risk adjustments include measures that the household employs by negotiations within the household. For instance, asset disposal, migration and reduction or modification of family consumption. The inter-household risk adjustment strategies include tenancy, borrowing, labour contracts, and group ploughing.

Public risk-adjustment mechanisms imply the availability of drought and flood relief insurance mechanisms, public employment programmes, etc. The market-based risk adjustment option includes forward trading, the interlocking of factor and product markets, insurance cover, and so on.

Communal risk-adjustment strategies refer to the group-based measures that require collective decision-making either to use or to preserve private or common property resources. The pooling of resources, such as bullocks or implements, is also a part of communal risk-adjustment strategies.

Once the range of risk-adjustment options is known the households may modify either their perceptions or their response or both by changing the discount rate or time frame used for appraising returns from each investment. Thus, while discount rates capture the control the household has in a given resource market, the time frame may capture the certainty with which the household views a particular resource stream. In fact, either of the two can be used to derive risk preference. The shorter the time factor in which households (or scientists) appraise their choices, the less likely it is for technology to be sustainable. Development, I have argued, is nothing but widening the decision-making horizon and extending the time frame of disadvantaged households (Gupta 1981). It is obvious that not everybody's choices can be widened at the same time and in the same proportion given the limitations of resources in a developing society. It is at this stage that an eco-sociological framework has to become an eco-political framework. Constraining the choices of some while widening those of others is an institutional issue which is discussed elsewhere (Gupta 1990b).

The uncertainty of an outcome may vary differently for different households depending upon previous experience with a particular enterprise or crop, immediate past experience; successive losses or gains; accumulated defects or surpluses in the household cashflow; future expectations of returns; and complementarity between other assets or enterprises and the proposed investment.

The cashflows of the households resulting from a given portfolio, modified by various risk-adjustment options, may be in surplus, deficit, or subsistence. In addition, the variability in these cashflows may be evened out over space, season, sector and social networks. The stakes of different social groups in the management of ecological systems will vary in each resource market.

The trick is to develop a calculus in which unequal stakers of different groups in various resource systems or regimes generate a set of expectations that are equitable or appear equitable (given differences in cultural and social ways of perceiving returns) at the portfolio level of the households. The group-level estimation of the aggregated effects of individual portfolios may generate rules that modify the conditions for use of resources, technology, and institution. Under extraordinary circumstances, the cultural norms are also modified to accommodate ecological and sociological imperatives[7].

The household budget influences the choices differently than would be the case if the budget was even, that is, sufficient for subsistence, or if it was in surplus, that is, more than more than subsistence. A number of researchers have mistakenly grouped deficit budget groups with surplus ones. A sustained deficit may shift the portfolio in favour of low mean, low risk assets and in some cases low mean, high risk assets, provided the risk is not co-variant. In some cases, low mean, high risk assets can be accommodated in the portfolio also, because much of the cost is transferred on to the open access or common property resources.

Sheep herding is one such example. Stall-feeding is rarely practiced and sheep herds are characteristically maintained by some of the poorest households.

At aggregate level, shifts in the portfolio can be seen by differential growth rates of various species and varieties of crops, trees, and livestock. Public policy at the macro and micro-level influences the portfolio through changes in the access modes, assurances (through various

[7]Aggarwal (personal communication) provides an interesting example of a village in which the punishment for poaching on a common property was to offer grains to the birds while standing barefoot under the sun. Such logic cannot be analyzed in the classical tradition of institutional analysis. Such sanctions cannot be justified on economic grounds at all. The reciprocities here extend to claimants of resources that do not have a vote, that is, the birds. But in the process, suffering in public by standing barefoot in the sun generates a collective responsibility. It is recognized that the moral appeal may have a longer-lasting effect than an economic tax for fine. The public display of the punishment may also generate guilt.

The cultural norms for individual and group behaviour thus do modify the perception and response to the risks and resources. While the fuelwood crisis may generate a tendency to poach, the sanctions generated by institutions may safeguard to some extent, the scarce and depletable common property resource. In Southern Bhutan we came across a case in which a group of villagers had restricted the introduction of a male bull of exotic breed lest the local breed become adversely affected (Gupta and Ura 1990). Even today, many villagers in South Asia follow a similar practice.

risk-adjustment strategies), and abilities. The attitudes are also modified by the expectation of future changes in the various sources of subsistence in future.

Changes in the individual stakes in various resource systems feed back into ecological conditions. Once the ecological conditions are modified, the changes in the enterprise mix become inevitable. It may be necessary to note here that I am not underplaying the importance of changes in the institutional conditions or the technological choices as already mentioned earlier. However, a multi-stage or a multi-plane analysis requires that we do not mix the assumptions necessary for analysis on one plane with the assumptions relevant on another plane. These frameworks can be used to understand the context in which people survive at altitude.

The innovations in hill areas were necessary because the complexity of the environment would not permit any one set of strategies to sustain livelihood indefinitely into the future. Since technology cannot be understood without looking at its ecological, cultural, and institutional context, we will try to isolate the patterns in the innovations that hill people have tried to develop. It is obvious that the systematic taxonomy of innovative strategies in different parts of the world will require a much wiser collaborative effort. This paper only illustrates the legitimacy and the feasibility of such an intellectual adventure. Various dimensions identified by Jodha (Chapter 2), as a part of the mountain perspective, provide a very rich basis to begin the synthesis of the analytical framework, which should be responsive to the strengths of people's own technologies, institutions, and culture. Such a framework will have to explicitly reject the possibility of any person in a high risk environment being thought of as totally 'unskilled'.

FARMERS' INNOVATIONS: SEARCH AND SCRUTINY

Several researchers have identified the barriers to scientific perception (Chambers 1983, Chambers et al 1989) and curiosity (Gupta 1985, 1987a, 1988a, 1988b and Richards 1989). The assumption that the low level of literacy is responsible for the backwardness of such regions is critized by Richards (1989). He argues that such an approach discounts heavily the oral and practical skills that have been developed over hundreds of years. The success of technological change in high-growth regions should not blind us to the richness of the ethnic basis of local knowledge systems. Studies have shown that the more diverse the environment and the lower the population density, the greater the need for social networking. Box (1988) argues that knowledge networks provide a platform for farmers to satisfy their curiosity about the different innovations being tried by different people, not always successfully. It is important to note that communications among people about innovations very often are not purposive. Often, the search for innovations is a set of continuous events rather than discrete events, accidents, or milestones.

The process of innovation involves constant experimentation, improvisation, adaptation, and simultaneous rejection of certain results either partly or completely depending upon individual or collective feedback. Many times, while searching for innovations, people have drawn negative inferences about the innovative potential of peasants. They were either looking for the wrong things, or looking through inappropriate prisms, or asking the wrong questions in the wrong places.

The interest in indigenous innovations in the Indian subcontinent and China has been there for several centuries, although the intensity of the interests has varied (ICAR 1964), Munshi (1952), in his lecture 'The Gospel of Dirty Hand' to agricultural scientists, highlighted the relationship between soil and soul. He emphasized the need for close cooperation between farmers and scientists. More recently, Verma and Singh (1969) and Verma (1967) provided a rich account of the indigenous innovations that animal husbandry farmers had developed in the hill areas of Himachal Pradesh as well as the then Punjab. Verma (1967), Dharampal (1983), and several others have done considerable work in India on local innovations. It is a pity that scholars in the third world have often ignored the paths opened by local studies and have tried to follow a trail only when it emerged from the West. Even so, nothing much would be lost if that were to happen in a proper manner. The damage is really done when, in place of culturally rooted concepts and terms, we try to analyze or catalogue the innovative genius of local peasants in alien concepts or categories. Such an approach often results in the indigenous knowledge of the people becoming inaccessible to us.

The lack of interest among scientists (biological or social) concerning innovations could be a function of the evaluative criteria. The scales by which they evaluate local innovations may be calibrated by the cultural inherent in western philosophy. Tillman (1988), Warren (1986), and Dharampal (1983) highlighted the scientific and technological strengths in the Indian subcontinent which were acknowledged to be superior to some of the western technologies available in the 18th century. part of the reason for the decline of some of the traditional, more sustainable technologies could be that innovations of a collective nature (Osti 1988), concerned with survival through collective action or sharing (Gupta 1988), were generally less well integrated into the formal networks of institutions. We know much less about what worked and much more about what did not.

Prain (Rhoades and Bebbington 1988) described the case of a farmer in Chicche village in Montoro Valley who developed the hypothesis that varieties expressing apical dominance would yield fewer but larger potato tubers. The market price for such tubers was also higher. There are several other examples which Rhoades gives about the curiosity experiments pursued by farmers, sometimes alone but sometimes collectively. He also illustrates the problem-solving and adaptation experiments pursued by farmers. The former included an attempt by farmers to drive away the Andean weevil by sunning the potatoes (as noted by Prain). The fact that aphids were attracted to green sprouts and not to red sprouts was another observation. The diffused light method of storing potatoes is too well known to warrant a repetition as an illustration of adaptive experiments.

An important conceptual contribution made by Rhoades and Bebbington (1988) is that wherever a transition between two major vegetative communities or biomes exists, the probability of experimentation by farmers is much greater. This has an operational implication for studies on innovation (Fig 16.3) Innovations could possibly come about through 'comparing and contrasting' the opposites, i.e. farmers with extremely divergent practices (possibly using ecological maps).

What Rhoades suggests can be linked to the 'compare and contrast' idea. It would thus be useful to pursue such explorations from the traditional boundaries towards the centre of the niche. Verma (1967) described several practices with regard to navel cutting, disposal of the placenta, and therapeutic measures against ingestion of the placenta.

Recognizing that even the availability of human health service is scarce in various developing countries, the possibility of providing animal husbandry services in mountain regions would definitely be an even more distant goal. In a way there may be a virtue in this vice. Indigenous innovations that evolved to manage pasturelands over large stretches are equally fascinating. Our accompanying paper (Chapter 23) provides an example about the way yak and cattle herds coordinate their movements so that the two herds do not meet (because some disease may be transferred from the cattle to the yak). The paper also discusses imaginative institutional rules that nomadic peoples or communities have evolved in consultation with settled communities to manage the access to pastures and the exchange of livestock goods. Equally rich illustrations are available regarding cropping systems, forestry systems, and the interactions among crops, livestock, trees and totols.

Disadvantaged households should never be called resource-poor, as long as we believe that knowledge is a resource. Formal institutions may not price this knowledge properly or build upon it adequately.

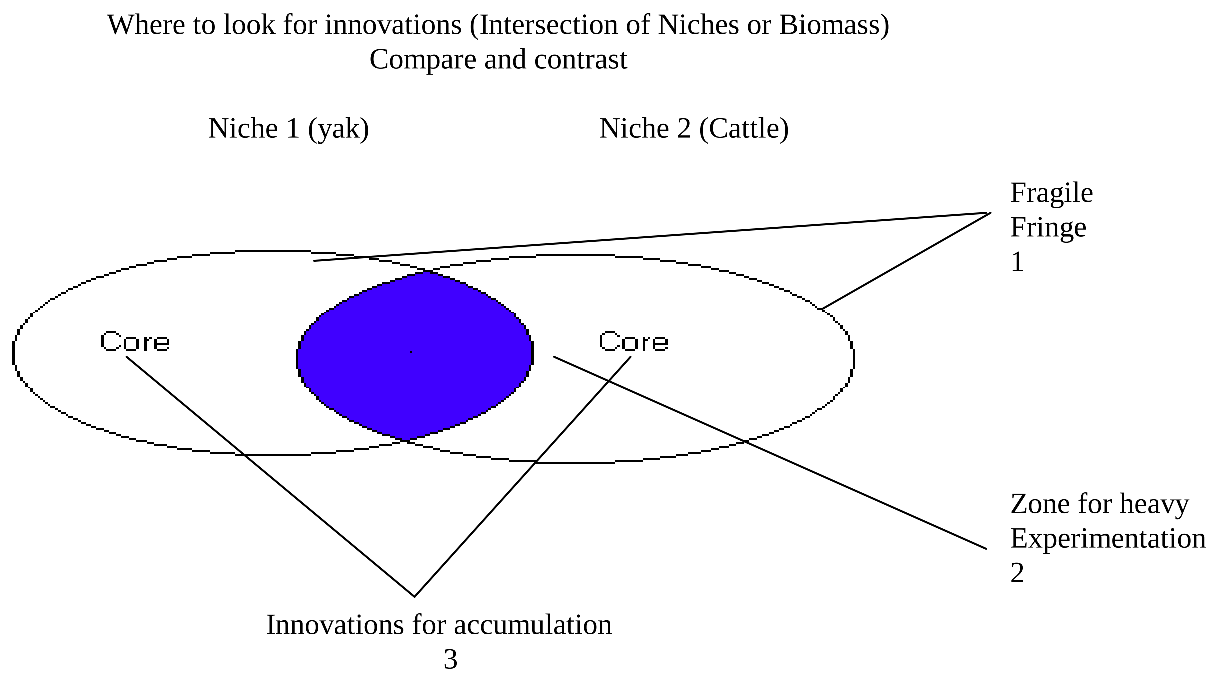

Figure 16.3 Where does one look for innovations?

Interaction between Scientists and Innovating Farmers

Recently we analyzed the linkages between demand and supply through the following interfaces (Gupta et al 1988, Gupta 1987a, 1987b, 1987d 1989).

1) The needs of the well-endowed areas and sections of society often merged with the objectives of the research system because market forces were there to steer. Input selling agencies cannot sell many inputs in hill areas, or in flood or drought-prone regions. With all the uncertainties of transportation and insurance costs, why should these institutions locate distribution points in the mountains? In the absence of distribution points for various inputs, located nearby, the real price of using many technologies becomes very high and farmers rationally avoid trying otherwise useful technologies. There is an essential need to modify the policies of public finance for this purpose, for example, with

freight equalization policies aimed at reducing the transportation costs or incentives for smaller packages (of fertilizers, for example) through rebate in excise and sales tax.

The markets acted as monitors for only certain types of links. For example, suggestions from the association of industries or the chambers of commerce are often heard by finance ministers before they finalize their budget proposals. Such a consultation is unlikely to take place with disadvantaged households inhabiting mountain regions. As if to compensate for the isolation from the market and the public institutions, people evolve knowledge networks embedded in very strong kinship networks. Policy makers will have to appreciate the dynamics of these knowledge networks if strategies for sustainable technological change in mountain areas are to evolve.

2) Given the poor articulation of their needs, farmers do not even demand a different type of technology when the opportunity for such dialogues emerges. Scientists can then 'safely' believe that since there was no demand or complaint nothing much needed to be done. However, with the increasing concern for the environment, migration, and sustainability of even the valley production systems, the attitude of the supply-side agencies is slowly changing.

3) The link between the skills of disadvantaged households and their resources is sometimes weak because of the time frame in which they want to use the skills available for managing the resources efficiently. Their time frame does not match with the time frame of public institutions. The government expects that an innovation that evolved in a particular period of time, with the support of institutional systems, could be scaled up or multiplied almost mechanically even without such institutional support. The time frame used by any decision maker is the function of the control he or she has on the respective

resource market. The choice of species, the combination of tree, livestock, or other components, and the available market stimuli are all influenced by the time frame. If scientists ignore this dimension they may miss the fundamental basis of some of the survival technologies.

4) To deal with the State even the more articulate, well-endowed urban people need advocates. The link between the farmers and scientists may be quite strong or only through intermediaries who may play the role of a bridge, broker, advocate, or even bania (money lender). If new links have to be forged, some of the debilitating links will have to be broken or weakened. The role of extension machinery is quite different in mountain regions. In the early years, they will have less to transfer from the lab to the land and more from the land to the lab or from the tiller to the technologist. The training of disadvantaged people needs careful conceptualization. The training and visit system is singularly unsuitable for mountain regions, notwithstanding the millions of dollars that the World Bank invests in it.

5) The link between the individual and collective rationality of the scientists and the farmers often poses the biggest challenge. The ability of scientists to deal with the farmers in groups rather than individually has not been built up over the years because of the individual-oriented approach of technology transfer. Given the fact that the common property resources and even open access resources, managed through collectives, play a pivotal role in the survival mix of the poor people, we have to learn to deal with collective choice problems (Gupta 1989).

The household’s portfolio of resources, skills, and opportunities has to be carefully understood and analyzed before embarking upon technological interventions. The more diverse the environment, the greater the linkage between different subsystems and the need for scientists to talk across disciplines.

IMPLICATIONS FOR THE FORMAL R&D ORGANIZATIONS

The learning at individual and organizational level can be strengthened if the emphasis is on monitoring the context in which the scientists work rather than the content. The barriers to learning in any developmental organization (whether in a mountain region or otherwise) could include the following propositions (Gupta 1984, 1987c and 1987d).

1) My learning is not enough, others must also learn.
2) The benefits assumed from learning are not sure and sufficient
3) The cost of my not learning is borne by others, why does it matter if I do not learn?
4) Learning takes time, one is always in a hurry while planning, who has the time to review past experiences and learn from previous mistakes?
5) Learning from below and outside (i.e. from juniors, farmers and extension workers for researchers and vice versa) requires the capacity to acknowledge the lack of correlation between status and skills.
6) Replicating success rather than the process of discovering the rules or the grammer of success is most admired in bureaucracies. Allowance for learning the process may mean providing room for decentralized designing. Who will take the risk of having diversify in programme content? Will it not increase the burden of monitoring?

Learning implies being accountable both horizontally (towards the clients) and vertically as well as taking care to monitor client satisfaction or creativity at lower levels. In the mountain regions, the excessive emphasis on budget exhaustion as an indicator of project success will invariably lead the researchers, administrators, and extension workers to concentrate their efforts on the valley regions. Thus, as I have argued earlier (Gupta 1987c), a change not monitored in a change not desired.

To overcome various barriers, several strategies have to be tried depending upon the institutional and political economic context.

1) Creation of demand groups of the ‘farmers on the fringe’ by the scientists may help to counteract the demands made by already well-endowed and articulate farmer groups. Let us recognize that such dispersed, disadvantaged, and inarticulate farmers cannot be expected to demand different types of technologies from scientists in the short run.

2) There are several other pressures that scientists have to face, including pressure from parliament, media, donors and public administrators The strengthening of a research management system cannot take place unless we study these pressures and ways of coping with them. Too much emphasis on the technical aspect, disregarding management and organization, might meet the same fate as many five years plans have met in India in terms of the goal of poverty alleviation or balanced regional development.

3) When resources are scarce, the need for networking is higher. However, which scientists’ group will network with whom will often depend upon the way the top leaders of the R&D system monitor performance. If the purpose is to reorient forestry or watershed development, appropriate arrangements for networking and inter-organizational coordination will have to accompany the technology development and transfer. For far too long, the institutional issues have been taken as constraints for which adaptations have to be made. If technologies and institutional arrangements for managing the natural streams or ‘kools’ have to be modified then the strategic linkages will be of a

qualitatively different type than would be the case if scientists were responsible for most of the functions over a given spatial unit (as is the case in on-station research). The need for on-farm research is higher when ecological diversity is higher and technologies developed at one location cannot be replicated at another location even a short distance away.

4) The links among farmers and scientists have to be placed in the ecological context by use of a mean-variance matrix (Fig 16.4). The eco-institutional perspective requires scientists to take care of the vertical assurances and the horizontal assurances while providing either new resources or new skills or both. In other words, even if scientists are trying to strengthen an already existing indigenous innovation they should make the boundaries of their role very clear. Undue expectations can lead to mutual distrust and disrespect.

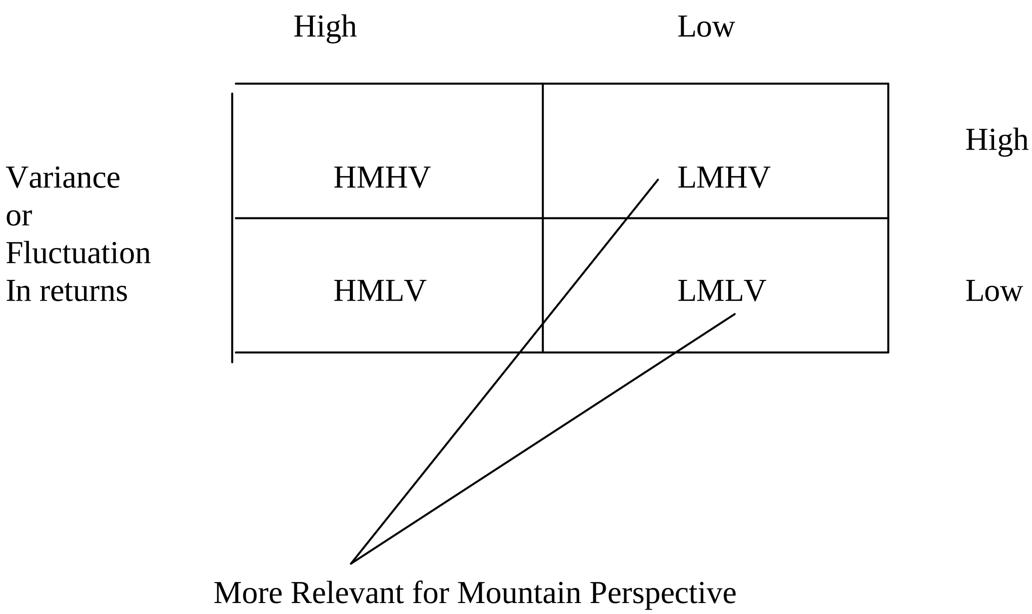

Figure 16.4 : Average or mean return
Source: Author's compilation

We can understand how different types of linkages will need to be forged in different types of regions having a varying combination or portfolio of endowments. For example, if the household portfolios of various enterprises comprising their farming system generate a high average or mean income with high variance, one can anticipate the availability of market channels. Public interventions can be restricted to regulation. The extension system could be commodity-based rather than household or region-based. In such a context there may not be any need for village-based extension workers but there would be a need for focussing on the issues of sustainability. Farmers may try in the short run to reduce their risks by excessive use of chemical inputs. The households with such portfolios may perhaps be served through contractual services rather than through a mandatory public supply system.

Farmers having high mean and low variance portfolios would really be the best-endowed farmers whose goals would be to move towards value-adding technologies. In such cases, farmers' groups can even hire the scientists rather than relying on public or private channels. The government should provide tax concessions to promote such organizations and reduce the size of the public bureaucracy. In the case of households with low mean and low variance or low mean and high variance portfolios the role of scientists has to be much more evident. Given the high vulnerability in the case of high variance portfolios around low mean returns, the risk-bearing systems are necessary for technological trials on farmers' fields. We have argued that there will be limited use of the transferral of ready-made technologies in such a context. One has to transfer scientific principles so that farmers can develop their own technology. However, there would be areas such as biological pest control or the management of synchronized sowing or other farm operations which need institution building support.

5) Horizontal links among farmers and scientists cannot be built without weakening the vertical links among junior and senior scientists. The accountability to peers, including farmers, at local level can be strengthened only if top-level scientists recognize the need to be accountable towards the lower levels in the organizations. This principle is valid even in other cases, but in mountain and other risk regions it is critically important. Decentralized experimentation in collaboration with farmers will not take place if there is tolerance of such a process at a higher level. Given the communication system, there is no way innovations can be general in a tightly coupled or linked system.

6) Reinforcing the pride of mountain people is important. If the pride of the people is a major casualty of wrongly designed policies in the recent past, then restoration of that pride should be the first priority now. Awards for innovative systems and technologies developed by farmers and pastoralists must be given. Scientists should give due acknowledgement to farmers in their publications when their ideas provide the precursor for research insights or experimental design.

7) Recognition for developing technologies for limited diffusion is essential. If sustainability of technology is fragile regions depends upon compatibility with diverse ecological systems, then the possibility of developing technologies that diffuse widely is limited. Organizational rewards for work that cannot be measured in terms of numbers of farmers, or acreages under cultivation of a new technology, may be necessary.

8) There is a need for a larger number of experimental sites and higher budgets. The higher the risks and the greater the variability in the production environment the greater will be

the number of observations required to verify any experimental research. The challenge before scientists is to develop a network of experiments that are sufficiently broad-based to produce good results.

Ethical and Moral Issues in Knowledge Transfer

It is unfortunate that, while looking for alternatives for the sustainable development of high-risk environments, we often ignore the ethical and moral issues involved. For instance, if the major resources of hill regions are herbal medicines, honey, and other such products, how do we ensure that the interest of the corporate world (national and international) will not lead to reduction of biodiversity and the extinction of certain species?

How do we apportion responsibility for taking undue risks at the farmer's cost? Do we educate the farmer about the various implications of a particular experiment? Do we do it individually or in groups? How do we bear the cost of our mistake, e.g. recommending a variety that has not been tested adequately or bringing seeds without proper processing so that new weeds or diseases come into the region with disastrous long-term consequences.

When we do learn from farmers' innovations we expect rent, royalty, or profit for documenting or sharing their knowledge. How do we share part of the rent with the provider of the knowledge? What are the institutional mechanisms to monitor their sharing? Should judgements on the above issues be left to individual choices? and if so how do we evaluate the morality of such freedom? How do we judge the ethics of the assumption that farmers can always guide the direction of the research that scientists should take? Can farmers demand when they do not even know what scientists can deliver? How do we incorporate the innovating farmers as a part of the educational system in which they also teach and we also learn? How can postgraduate curricula be modified so that future resource managers in high-risk environments develop sensitivity to the above concerns?

In this paper we have discussed the dilemma that we face when we try to develop a system of lateral learning and mutual monitoring among farmers and scientists. There is no doubt that there is a tremendously rich reserve of innovations available with the farmers which can guide or influence the direction of research. There may be an equally rich reserve of ideas available with the scientists who crave different sets of rewards than the ones available within the organization.

The challenge is to generate institutional innovations which can link such scientists with innovative farmers in marginal regions. We have no doubt that these links cannot be forged unless the legitimacy of such linkages is established. There is no escape from recognizing that the sustainable development of mountain regions requires that we rethink the very basis of the ethics and politics of resource management. The experimental ethics of mountain peoples need to be nurtured and their skills need to be properly priced A viable strategy will require that we not only improve their access to resources and upgrade their skills but also provide assurances to them that their restraint in resource use will be valued. Why should they conserve genetic diversity, technological skills, and ecological balance if the benefits accrue only to the people in the plains?