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FOLK AGRONOMY IN THE HIMALAYAS: IMPLICATIONS FOR AGRICULTURAL RESEARCH AND EXTENSION

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Introduction

Folk agronomy can be broadly described as the traditional art and science of resource management and production evolved and inherited by rural communities through informal experimentation (Jodha,1986). The term can be used interchangeably with indigenous technical knowledge (ITK), rural people's knowledge (RPK), traditional farming technologies and so on. This paper describes some of these practices in the context of the Himalayan mountain region. They are compared or contrasted with modern research and development (R & D) based agriculture in terms of their orientation, mechanisms and implications. Rather than concentrating on specific practices, the paper dwells on the range of measures that have evolved as components of people's adaptations to the complex and harsh circumstances of mountain habitats.

This study, using information from a larger study on sustainable mountain agriculture in the Himalayas (Jodha et al., 1992), finds that despite their greater suitability and relevance, traditional farming practice, are losing their efficacy and feasibility in the face of changing demographics, institutions and technology[1]. However, the rationale, if not the form, of traditional technologies is relevant even today for they constitute potentially ideal input for modern research and development in mountain agriculture. But the latter, for various reasons, has disregarded traditional practices. In addition to discussing the factors behind this disregard, this paper indicates the steps necessary to facilitate the use of traditional knowledge in generating more relevant modern technologies for mountain agriculture.

The locations of the folk agronomic practices discussed in this paper are spread throughout the Hindu Kush-Himalaya regions of Bhutan, China, India, Nepal and Pakistan. However, the majority of the examples are from the Indian Himalayas.

Mountain Habitats: Dominant Characteristics

The important conditions characterising mountain habitats, which separate them from the plains, include inaccessibility, fragility, marginality, diversity, niche and the human adaptation mechanisms (Jodha, 1990; Jodha et al., 1992). In the present paper we briefly introduce them and describe their implications as contexts in response to which mountain people have evolved various production practices and resources management measures.

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[1] 'Mountain agriculture' here includes all land-based activities, including crop farming, horticulture, forestry and animal husbandry; while 'mountains' from the viewpoint of this paper, comprise all upland areas including hills, mountains and valleys.

Inaccessibility

Inaccessibility is a product of altitude and terrain and is a major constraint in most mountain areas (Hewitt, 1988). It obstructs mobility, leads to higher costs of transport and other logistics for interventions, imposes isolation and 'closedness' on production, restricts the scope for higher productivity of resources through enhanced use and intensity, higher use of inputs, resource upgrading, as these changes crucially depend on mobility and external linkages. The sustainability of human welfare or survival under such conditions is closely associated with local resource-centred diversification of activities, and a focus on the regeneration, protection, and recycling of resources and products.

Fragility

Fragility is a product of verticality, steep slopes, and other associated biophysical conditions. Fragility makes mountain areas most vulnerable to degradation, even with a little disturbance (DESFIL, 1988). Mountains thus offer limited resource use/production options, which in turn have low pay-offs. Fragility not only prevents the higher intensity of land use, but also limits both physical and economic input - absorption capacities. There is limited scope for the use of external inputs, as well as for resource manipulation or upgrading, because of physical limitations and high investment and maintenance costs. Fragility, therefore appears to be the most constraining factor in sustainable land use (implying high productivity through high use intensity) in mountain areas. The resource use options in the context of fragility need to focus on: land-extensive systems; a combination of productivity and protection measures; resource upgrading using nature's own processes (eg. use of building/binding plants); and intensification as permitted by adaptations of resource characteristics (eg. terracing steep slopes before using them for cropping).

Marginality

Marginality, like other mountain characteristics discussed here, has both biophysical and socio-economic dimensions. It is a product of both natural and man-made factors (Blaikie and Brookfield, 1987). Marginality shares most of the implications of fragility: limited and low pay-off options, and the high cost of upgrading resources, make the marginality of resources and people a major constraint to sustainable resource use for high productivity. Accordingly, a dependence on nature's processes (including regeneration), diversification, and interlinkages of production activities is essential in such a context.

Diversity

Diversity or internal heterogeneity, resulting from spatial, temporal, physical and biological differences over short distances, is an important feature of mountain areas (Troll, 1988; Jochim, 1981). This is a basis for both current and potential activities with significant interlinkages. However, a key requirement in such resource use systems is the avoidance of narrow specialisations and the use of a range of 'niche'.

Niche

Niche represents the special situations in mountain areas where resource base and environmental conditions of the mountains create potential for products and activities that have a comparative advantage over the plains (Brush, 1988). Most of its implications are quite similar to diversity as it is partly a manifestation of the diversity of mountain resources. 'Niche' offers a number of opportunities for resource and product-centred activities which could enhance both productivity and human welfare on a sustained basis. 'Harnessing with protection' has to be the key focus of interventions addressed to niche. A large proportion of the multiple 'niche' in the mountains is linked to land-based activities.

Human Adaptation Mechanisms

Human adaptation mechanisms cover the traditional methods of adapting to the limitations and potentialities of mountain conditions (Guillet, 1983). They involve either amending the circumstances to suit human need (eg. terracing of steep slopes for cropping) or focusing on activities (eg. mixed farming, intercropping, etc.) which could make efficient use of diverse resources. Besides technological measures, the adaptations include institutional arrangements such as the provision of common property resources, and the employment of social sanctions to regulate the use of fragile resources. This paper, however, focuses on technologically oriented practices rather than institutional measures.

Folk Agronomy in Mountains

The term 'folk agronomy' covers several interrelated aspects of traditional agriculture: land-based activities, input use, production and processing practices, and associated management measures directed to the usage, protection and upgrading of natural resources (Whiteman, 1988; Hewitt, 1988; Brush, 1988). These aspects may be considered as responses to the specific features of mountain areas described in the previous section.

Himalayan folk agronomy can be seen in a number of different practices. Each is responsive to the conditions of fragility, marginality and diversity found in mountain areas. Each represents a technological adaptation to farmers' aims. The following section highlights measures directed to soil erosion control, soil fertility management, water and moisture management, crop agronomy, crop choice, biomass management and livestock farming. The examples of measures quoted in the following section are based on the field investigations carried out in several countries of the Hindu Kush-Himalayan region over the last five years, under a larger project on Sustainable Mountain Agriculture undertaken by Mountain Farming Systems Programme at the International Centre for Integrated Mountain Development (Jodha, et al, 1992).

Land and Soil Management

The terracing systems of many parts of the Himalayas (India, Nepal, China, Bhutan, Pakistan) represents significant attempts at resource upgrading. The terraces provide a diversity of agricultural niches with increased intensity of management of soil and water in sloping agricultural lands. This results in an increased security in crop production for the farmer.

Shifting cultivation systems, such as the *taungya* system of the Chittagong hill tracts of Bangladesh or the *Bukma* system of the high hills of Nepal is an effective response to the use of fragile and marginal lands. The dependence on limited external inputs and the dependence on natural regenerative processes, through linking annual production with perennial production, ensures sustained agricultural output from such mountain systems.

Local people's land classification systems in mountain areas often relates to the degree of marginality. This may be simply in relation to elevation (as in Kinnaur, Himachal Pradesh, India, Sichuan, China) or through water availability (Nepal and the Indian Himalaya, Ningnan, China) or in relation to the number of stones found in mountain fields (Himachal Pradesh). Farmers make use of the differential availability of resources up and down slopes, requiring an approach to agriculture that rations the use of resources and diversifies activities on a location basis.

Soils in different zones are managed differently using a variety of indigenous techniques. Zero tillage or low ploughing frequency is practised on fallow lands in the high Himalayan zone. This may be complemented by the management of snow (Lahul, India, Tibet, China). Manure and composting practice differs in different agroclimatic zones. Fertility is a major constraint in some Himalayan agricultural systems, and lack of manure for soil fertilisation may result in a shift to crop rotation or other fertility management practices such as composting or plant-centred green manuring (eg. in Himachal Pradesh, Nepal or West Sichuan, China). In some places, land resting has become a necessity due to long term declines in soil fertility (eg. mid hill areas in Nepal). In other places, switches to high input systems have occurred as new opportunities have opened up (eg. Chitral valley, Pakistan).

Soil management is thus a response to the interaction of prevailing agroecological conditions and social and economic conditions. Folk agronomy tends to concentrate on low input systems that make maximal use of available human and environmental resources. The result is a diverse set of strategies that balance intensive and extensive use, resource conservation and upgrading. The focus is on local solutions, with a variety of adaptations effected through local experimentation. For instance, green manuring plants of previously little known value, such as *adhatoda*, have been experimented with in green manuring of rice fields in the Indian Himalaya.

Water and Moisture Management

Water is often limiting in mountain environments, its conservation and use regulation are key elements of adjustment strategies observed throughout the Himalayan zone. These include: the selection of the appropriate locations for fields to conserve water and moisture, the harvesting of spring water, the building of water channels (eg. Ladakh and Lahul), the development of cave tanks (Sarkaghat), the building of low-cost irrigation systems (high hills of the Indian Himalaya); the use of polythene film in hilly areas of China.

Irrigation in the mountain areas of China, Pakistan and Nepal focuses on small-scale systems using local materials resulting in minimal damage to the natural environment. Community level solutions to water management problems are also widely practised.

Agronomic Practice

The marginal environment of mountain areas requires agriculture to adapt to risk and variability. High seed rates are observed as a response to risks. Soil moisture sowing differences between areas and various patterns of line sowing results in a diversification of planting sites and spreading of planting dates to avoid localised crop failure.

Weeding strategies are also responsive to the resource limitations of mountain agriculture. Labour shortages result in synchronised weeding and water schedules (eg. Spiti, India); weeds are controlled through various types of crop rotation; thinning and plant spacing is practised to control particular weeds and much weed biomass is used as sources, such as fodder or fuel.

Field protection systems respond to the harsh environments of the mountain areas. Shelterbelts and live fencing such as of seabuckthorn, a nitrogen fixing multipurpose plant species, are widely found in the trans-Himalayan zone of India, China, Nepal and Pakistan while raised stone and mud walls around fields are found in northern areas of Pakistan, in Ladakh and Lahul, and in Mustang and Dolpa in Nepal. Fencing and wind protection results in micro-niche temperature control. This is most important factor for crop production in the cold dry zone.

Intercropping is widely seen as an approach to local resource regeneration and diversification. A range of intercropping systems can be found, from 'standard' systems of the Indian Himalaya and Nepal to those involving legumes, relay cropping with maize (mid hills in Nepal), to growing different crops of different maturity and season simultaneously.

Post harvest storage systems are vitally important in the cold winters of the mountain areas. The inaccessibility of mountain areas requires long-term food storage capacity especially during the winter months. A range of effective grain storage technologies can be found in the Himalayan region in response to this (eg. wooden compartments in Kinnaur, Himachal Pradesh, underground cells and cave storage systems in China).

Crop Choice

Crop diversity is maintained by hill farmers, as crops are grown in a variety of agroecological conditions in a diversity of niches. Harsh selection pressures in this marginal environment result in a high level of crop genetic diversity in mountain areas. There is thus a diverse and well adapted selection of seed varieties to be found. These include barley (trans-Himalayan areas) and maize (mountain zones of Himachal Pradesh), as well as non-indigenous crops that have been imported (such as rye). In some areas of Himachal Pradesh there has been a widespread adoption of new cash crop varieties.

Biomass Production and Management

The production and management of biomass on non-crop lands is critical to mountain agriculture. Such areas are vital for fodder (cold and dry zone and low and middle hills), for tree growing, and for hay fodder pasture development. Farmers employ several strategies of managing fodder from multiple sources.

A response to the shortage of biomass from such lands has included the intensification of agroforestry on farm lands. On farm-tree management practice has increased the annual-perennial link, resulting in the diversification of land use and an increase in the regenerative qualities of agriculture. Agroforestry and biomass development on farms offers an alternative to the more extensive use of non-farm resources, a low cost, in-situ option for self reliance that depends on local resources.

Livestock Farming

In fragile and marginal zones, livestock farming often dominates the farming system. Diversified and integrated livestock farming activities are oriented to the extensive use of land with resultant high total system productivity.

Animal migration and transhumance in mountain areas is a response to local resource conditions and seasonal scarcity. Migration and transhumance allows the extensive use of natural regenerative processes, the management of risk through movement options, and the exploitation of vertical and horizontal spatial linkages created by mountain areas' diverse landscapes.

Problems of general scarcity and low quality winter fodder are met through a range of supplementary feeding options and grazing systems. Winter feeding of oil cake (Himachal Pradesh), of grains (Nepal, China) and of grains and fresh crops (China) are common practices observed along with a range of grazing systems (eg. Chitral, Pakistan; Lahul, India; Tibet; China).

Inaccessibility leads to the extensive use of pack animals in mountain areas. These are low cost, local options with multiple benefits. Also, the environmental diversity of mountain areas results in a wide choice of animals, ranging from the Tibetan horse, to the Tianchang horse, and the Sichuan ass of China.

Niche diversity results in a agroclimatically based livestock breeding, with different equines, cattle and yak being suited to different areas (eg. the Tiulong yak of the Hengduan mountains and the Maiwa yak of west Sichuan, China).

Orientation and Key Focus of Traditional Practices

Although traditional practices reflect a complementarity of resource-centred and product-centred technologies, they can be spelled out separately, the key feature of folk agronomy or traditional practices being their local resource orientation. As indicated above, practices are focused on local resource conservation/protection and upgrading. In terms of resource usage, they emphasise diversification, flexibility and linkages or complementarities (eg. between farming and forestry). Different mountain conditions, such as inaccessibility, fragility and diversity tend to reinforce these orientations.

Most of these attributes apply to land-based activities as well as to the choice of agricultural products and services. Furthermore, because of diversity and internal heterogeneities, most land-based activities are fairly location-specific. Most are characterised by small-scale coverage and production. Finally, most traditional practices are focused on productivity and the stability of the total farming system, rather than on individual components.

Modern R & D Aspects of Mountain Agriculture

Table 1 summarises the practices of modern R & D with reference to the Indian Himalaya. Though focused on a specific state of the Indian Himalaya (GOHP, 1986) Table 2 refers to the issues of R & D that are generally applicable to other mountain areas. Table 1 provides an overview of the orientation of R & D interventions that generally focus on short-term gains, and by and large ignore the imperatives of mountain specificities. To elaborate on this we may compare the orientations (and contents) of folk agronomy and modern R & D based technologies.

Table 1. Some Examples Indicating Key Orientation of Agricultural R & D in Mountain Regions

Table 1a: General Approaches to Crop Research in the Himalayan Region

Actions	Aims	Problems
Focus on increasing crop yields using HYVs	To increase production	Productivity of total system and dependence on local resources ignored
Selection of crop varieties which respond well to energy intensive, external inputs	To improve productivity on marginal farmlands	Unsuitability of high-intensity use of marginal land ignored
Closing the yield gap of HYV crops recorded under ideal conditions and marginal mountain farming conditions	To upgrade the productivity of marginal lands using HYV and high cost, ex-situ fertility-enhancing options	Biochemical, economic subsidisation of marginal lands using high cost, ex-situ options ignoring long term consequences.

Table 1b: Commercialisation of Hill Agriculture

Actions	Aims	Problems
Adaptive research focusing on cash crop with proven demand and value	Transform hill-farming economics using agroclimatic advantage	Diversity of mountain bio resources remains under-utilised
Substitution of traditional crops and varieties with HYV crops	Quick economic gains even if inputs are costly and ex situ	Imperatives such as unsuitability of high-intensity use, balancing of extensive/intensive land uses, diversification and stability/productivity of total system etc. are ignored
Selection of crops responding well to high-energy inputs	Choose crops with much demand outside the mountain area	Focus on low cost, in-situ options missing
Focus on demand-based, agroclimatically suitable crops, even though they may be of high volume and perishable nature	Enhance production and exchange capacities of farmers	Land-use intensification measures promoted through subsidies market-driven, over-extraction of resources; backlash on subsistence crops

Table 1c: AgroclimaticSsuitability

Actions	Aims	Problems
Hill/mountain areas classified into agroclimatic zones and suitability of HYV crops matched for each zone	Harness agroclimatic diversity through imposing externally proven options, rather than evolving them from within	Partial use of niche, only climatic diversity considered, other aspects of diversity and its imperatives missed

Table 1d: Pesticides and Herbicide Application

Action	Aims	Problems
Increased testing and recommendation of potent, poisonous chemicals (eg. benzamidazole, metalazyl, carbendazim, difolatan, blitox, etc.)	Effective protection of crops and produce even though the methods involve high biochemical and economic subsidisation	Stability and productivity of the total system undermined, pollution, unsustainability, potentials of both diversification and indigenous genetic resources for disease control bypassed

Table 1e: Assured Moisture

Actions	Aims	Problems
Research efforts on testing crop for different agroclimates but demanding reliable assured irrigation; medium and large scale irrigation systems being developed in hilly areas (GOHP, 1986; Mulk, 1990)	Identify marginality factors and improve through ex-situ, costly options (subsidy etc.)	Traditional practices using local esource at low cost and simple options disregarded; imperatives of inaccessibility for ex-situ options ignored

Table 1f: Soil Fertility Mapping

Actions	Aims	Problems
Soil fertility and nutrient deficiency mapping of areas such as of Himachal Pradesh (GOHP, 1986) for NPK status; supply of inorganic fertilizers at subsidized rates to encourage farmers to maximise application.	Identify marginality factors and improve through ex-situ, costly options, (subsidy etc.)	Folk practices using local-resource at, low-cost and simple options disregarded; imperatives of inaccessability for ex-situ options ignored.

Table 1g: Highland Himalayan Pasture and Rangeland Improvement

Actions	Aims	Problems
Artificial seeding of clover seeds and other introduced grasses (DFFAC, 1990)	Improve carrying capacity of grazing land by introducing better quality fodder species	Undermining of local plant resources and their potentials
Introduce fodder tree plantations	Contain degradation of the support lands/wastelands and improve their carrying capacity	Ignoring indigenous species under traditional management systems for improving support lands
Promote tree plantations on wastelands	Enhance biomass production and improve carrying capacity	Interventions insensitive to local ecosystem, resource management and farming needs

Table 1h: Afforestation Strategy

Actions	Aims	Problems
Afforestation in the low and mid hills	Strengthening forestry-farming linkages through increased biomass from support lands or commercial use by revenue generation	Biodegradation of support lands i.e., most afforested/reforested areas being dominated by unpalatable, noxious plant/herb species underneath trees, eg. *Lantana sp*, *Eupotarium sp*. and *Ageratum sp*.; community participation ignored
Focus on timber, trees only plantation	Forestry as source of government revenue, dictating choice of species	Diversity and potential of local resources, multiple usability not considered
Pinus plantations widespread over most subtropical rangelands/wastelands, grazing lands	Soil conservation through planting over-degraded support lands.	Folk knowledge on plants bypassed; user perspective ignored
Plantation of *Acacia catechu* on the support land of low hill areas	Provide tree cover to barrenlands, revenue generation, commercial products	Sometimes goals imposed disregarding user perspective, marginality and fragility of local support lands misjudged

Comparison Between RPK and Modern R & D

Seven central features that can make technology more relevant to mountain conditions are now discussed in detail. These features highlight how conventional R & D might interact with folk agronomy and local people's R & D.

Resource and Product Centred Technologies

Complementary use of resource-centred (eg. terracing) and product-centred (eg. cereal legume intercropping) technologies is a key feature of traditional farming systems in mountains. In fact, they represent two facets of the same process of survival and growth evolved by the mountain communities. As mentioned earlier, traditional technologies reflect a two-way adaptation process, where either human activities (products, management practices etc.) are adapted to the specific conditions of mountain resources, or the latter are amended, upgraded and managed in a way to suit the human activities. Favouring low-intensity land use systems (eg. pasture-based livestock farming) to suit fragile or marginal areas on the one hand, and upgrading these resources through terracing and community irrigation systems on the other, are illustrations of the two-way adaptations.

Another reason for paying attention to the complementary use of technologies is the resulting focus on a total farming system rather than on its individual components. Under the modern R & D-based technologies, however, the primary focus is on product- and crop-centred technologies (eg. yield growth of specific crops). The resource base is treated more as a physical factor, into which product-centred technologies are transplanted. Wherever resource-centred technologies are emphasised they are directed at specific resources, under sectoral programmes, such as afforestation projects, soil-conservation programmes or widely publicised watershed projects. Such projects are detached from the total system and lack the integrated farming-systems perspective. At best, efforts are directed at independent development of crop- and resource-centred technologies, rather than focusing on blending them as an integrated package.

Resource-Centered Technologies

The traditional technologies relating to mountain agriculture focus on different aspects of resources, such as their protection, conservation, upkeep, and diversified usage. They involve not only specific mechanical or biological treatment of resources but also resource-based activities (eg. crop-fallow rotations, cereal-legume intercropping, annual-perennial intercropping or agroforestry) which, besides adding to crop production, contribute to the health of the base itself. In particular the practices involve regeneration (eg. fertility replenishment through following legume cultivation); protection and conservation (through terracing and ridging; and upgrading and recycling of organic matter, through farming, forestry and livestock linkages). The resource-management practices under the traditional systems largely depend on local input (including regenerating, recycling and complementarities of horizontally, vertically, and temporally linked systems of mountain resources) at the farm, village or watershed level.

With the modern R & D-based technologies there is hardly any scope for recycling, regeneration and the primacy of local resources, (as in the use of spatial and temporal resource linkages). This is largely because modern R & D is often designed to suit experimental and administrative convenience so it undermines the resource base, treating the components of a resource (eg. forest, slope, valley bottom) in isolation. A lack of overview of the total system means that the elements that help sustain the resources and its productivity are ignored.

Finally, the goals of modern R & D are different from those of traditional farming systems. They focus on quick growth (eg. using external inputs like chemical fertilisers). Traditional measures (involving natural resource regeneration, recycling, harnessing of resource diversities etc.) prove too slow for this approach.

Diversity and Diversification

Diversification of resource use, as well as resource-based activities, is another central feature of traditional technologies. Activities based on diverse resources have several complementary interlinkages: farming-forestry linkage, annual-perennial complementarities and a variety of intercropping systems are but a few examples. Resource regeneration, recycling, and maintenance of potential are all managed through diversification but under modern R & D-based technologies, diversification is not encouraged. On the contrary, these technologies focus on narrow specialisations, on a single crop and its limited attributes (for example, specialisation in rice farming in the mountain valleys, with focus on yield growth, rather than growth of total biomass, which has multiple uses).

Special Attributes Relating to Input Use

Flexibility is a key feature of input use practices under traditional systems. The emphasis is on local input and recycling of inputs and products. Examples may include biomass first used as fencing material and then used again as fuel or animal bedding material (used as part of compost fertiliser). Self-provisioning (i.e. use of non-market inputs) and periodical resource rationing are other features of traditional systems, which provide greater flexibility in resource use.

Modern technologies largely depend on external subsidisation, involving both bio-physical and economic inputs.

Systems Orientation

We have already referred to the importance of the total system overview of traditional technologies. In addition to this, the goal of the traditional farmer is to have stability of *total* products from the system, rather than one individual item. It is not only the performance of different products, but also the protection, conservation and productivity of the resource base which is addressed.

Under the modern technologies system, despite the recent rumpus about farming systems approach, the focus on individual activity and individual component persists. Furthermore, where different components *are* integrated, this is done after they are (individually) perfected, rather than being evolved as integral and complementary elements to begin with. For example, modern crop varieties are developed for high yield under sole-crop cultivation, and then they are put into intercropping systems. In many cases, even when several components are integrated from the very beginning, they fail to incorporate the user perspective because the farmer is not familiar with experimenting and verification. This is largely a product of modern R & D culture, which will be commented on later.

Product attributes

Traditional technologies are not confined merely to resource base and choice of activities and products. Product attributes are also emphasised, so as to make the product appropriate for mountain conditions. From the perspective of local human consumption, the products have to meet the diverse demands of the habitat where dependability of external supplies is very low. One example of this is the elevation differences in the products, ranging from buckwheat and potato to upland rice. To facilitate petty trading and regional exchange, a few products with low volume/weight and high value (eg. hops, caraway, saussurea) low perishability, (eg. pulses, coriander), local processibility (eg. milk products), and some comparative advantage such as vegetable seeds are emphasised. Harnessing small-scale niches has been the basis of barter and agricultural exchange systems in mountain. Under the modern technologies system, high-yield and bulk production rather than diversity are emphasised. Scant attention is given to crop attributes suited to inaccessibility and diversity of resource base, as most of the new crop technologies are transferred from the plain to mountains. Unlike the traditional system, modern technologies focus only on selected activities (eg. horticulture) to serve the external markets and disregard the petty but diverse and multiple niches. This approach leads to narrow specialisation, with all the associated risks, and creates dependence on external inputs (eg. fertiliser, pesticides, etc.). Moreover, due to unequal terms of exchange, the mountain people get only a small part of the total advantage of harnessing mountain niches.

Technology and Institutional Support Systems

The various features of traditional technologies described above are strongly reinforced by informal institutional measures; they relate to social sanctions, group action about usage; regulation of resources (eg. more fragile areas kept under natural vegetation through provision of common property resources), rotational grazing, regulation on tree felling, collective risk sharing, collective efforts at seed selection and their distribution, and so on. Modern technologies do not have enforcement mechanisms, partly because they are not evolved by the people, and many do not have a stronger user perspective. They are sustained by government sponsored institutions such as extension agencies, input cooperatives and the like, which often focus on subsidisation of processes that help adoption and continued use of modern technologies. Furthermore, most of the legal and administrative measures substituting the traditional arrangements are evolved and imposed from outside and have little concern for the technological problems of mountain agriculture.

Decline of Traditional Technologies

Despite their suitability to mountain condition, many traditional technologies are rapidly losing their efficacy. What has been described above may amount to a discussion of RPK that is gradually dying out. There are number of reasons for this decline (Jodha, 1991b).

Key attributes of folk agronomy/traditional agriculture:

- Complementarity of resource and product centred technologies;
- Balancing extensive intensive land uses, conservation, resource upgradation;
- Diversification, linkages, focus on total system;
- Regeneration, recycling of resource/product; local input use, flexibility.

Manifestations of the Decline in Folk Agronomic Practices

- Decline of farming forestry linkages, intercropping, soil building, binding crops; increase in single crop-specialisation, separate sectoral focus on resource centred projects eg. afforestation soil conservation;
- Extension of cropping to fragile slopes, decline of agroforestry, and common property resources, overgrazing, focus on intensification, overextraction;
- Reduced range of crops, crop combinations, focus on individual crops and limited attributes (eg. crop yield); reduced emphasis on biomass products with multiple uses, narrow specialisation;
- Focus on grain yields, using external inputs; reduced use of organic matter, home produced input, recycling and flexible input use.

Major Causes and Processes of Decline

- Population induced emphasis on products (not resources), commerce induced products specialisation, state support and technology induced focus on limited goals leading to the marginalisation of RPK, especially in land extensive systems;
- Population, market, and technology induced pressures to focus on short term crop/product goals lead to marginalisation of land extensive systems;
- Market, technology and state subsidies favouring narrow specialisation and lack of support for the traditional system have led to marginalisation of the latter;
- Technologies, external input, and state subsidies detrimental to traditional practices; need for energy intensive inputs has marginalised traditional practices.

Potential Strategies for the Future

- Rationale of combining resource product centred measures through R & D; focus on relevant cultivars and management practices;
- Integration of sectoral approaches with focus on total farming systems;
- Re-examination of modern practices with mountain perspective, and diversified and internal linkages of resource use and products;
- Focus on local resources, their complementarities and application of new leads (eg. in biotechnology etc.).

Folk agronomy evolved in the context of low pressure on resources and limited external institutional and technological interventions. However, these circumstances are fast changing and tend to make some practices redundant. Improved accessibility and market penetration reduces the local resource centred diversification of products and internal management of demand. Increased pressure of population has strengthened the focus on short-term considerations, giving priority to product centred options and ignoring resource centred processes. The increased pressure for food has reduced the diversity of resource use, so that dependence on local resources alone is not enough. The institutional arrangements that helped resource regulation are also substituted by formal institutions and interventions, which are insensitive to these practices, since they are designed to promote modern technologies which substitute the traditional ones.

Various development interventions and external market forces have broken the integrity of the system, by selectively patronising some activities and substituting external linkages for the internal systemic linkages. For instance, traditional farming-forestry-livestock linkages are disintegrating because modern dairying (using the external market for input and product sale) is able to survive without being fully integrated into the system. Related to this is the backlash effect as modern technologies, supported by extension efforts and subsidies, induce people to focus on individual components, disregarding the totality of the system.

However, the key message of the change in RPK, whatever the process and mechanisms underlying it, is that traditional systems were protective and conducive to sustainability, but they also proved to be resource-extensive, slow and low in productivity. Pressure on the system is too great to allow time to evolve appropriate adaptations; in the absence of means and knowledge, other than their traditional RPK, farmers intensify the resource use, leading to rapid resource degradation. Thus, the vicious circle of poverty-resource-extraction-degradation operates, despite attempts to break it.

Modern technologies have elements of intensive resource use with high productivity, but lack resource protection and sustainability. Some appropriate option could perhaps be identified by blending the rationale (not the form) of traditional technology with modern R & D. Before we discuss this, it would be useful to discuss why modern R & D does not already incorporate the RPK.

Why Modern R & D Ignores RPK

Despite the sound scientific rationale and potential usefulness of many components of folk agronomy, these are persistently ignored by the formal R & D for mountain agriculture. This indifference is a product of several interrelated factors. Some are generic, in the sense that they are universal features of modern R & D systems in developing countries, irrespective of their agroecological contexts. Others are more specific to mountain areas.

Factors such as a 'top-down' approach, narrow specialisations, disintegrated priorities, disregard of a user perspective, wide gaps between performance of technologies at the research stations and the farm, narrow and short-term resource-extractive focus, generally characterise modern technology development in mountains as elsewhere. They are largely products of the research culture underlying modern R & D for agriculture. The philosophical and psychological foundations of formal R & D culture have three key elements: ignorance, arrogance and patronage. A mix of the three elements obstructs the understanding and internationalisation of RPK by technology planners, developers and promoters alike.

Although the underlying processes and operational mechanisms of these elements may vary, their emergence and growing predominance in some developing countries can be traced to colonial rule . Traditional skills and knowledge were often deliberately marginalised by the imposition of views, biases, and processes favoured by the colonial rulers (Jiggins, 1989). Even in the post-colonial era, most developing countries inherited and perpetuated the patterns and culture of R & D and state-sponsored development interventions further strengthened the element of patronage. The undeclared use of knowledge as power, further induced the promotion of formal science-based technologies at the cost of folk knowledge in these countries (Long, 1989). There are of course honourable exceptions epitomised by a few scientists who are highly sensitive to RPK, but our discussion relates to the general situation.

Ignorance

- Failure to examine and recognise traditional systems;
- Failure to understand multiple goals of the farmers;
- Failure to see total farming systems;
- Focus on apparent forms of traditional practices in place of their rationale;
- Blindness to informal experimentation by the farmers;
- Application of narrow and inappropriate yardsticks to evaluate traditional systems;
- Approving knowledge of a traditional system without fully understanding it;
- Inability to experiment complex, diversified trials (unlike informal trials by the farmer).

One extreme situation of ignorance about RPK is reflected in the fact that scientists or R & D workers often view the farmer as a conservative, unthinking person who simply extracts from nature through whatever methods are available or offered to him/her.

Traditional farming practices are not seen as scientific measures as they have not passed through formal procedures (involving theory, hypothesis, formal experimentation, verification etc.) and peer reviews. This view ignores the repeated trial and error behind informal experimentation (often without set procedures) that underlie farmers' practices (Rhoades, 1987).

Another form of ignorance involves observing the form, rather than understanding the rationale behind traditional practices. In this process scientists also ignore the multiple and integrated goals of traditional farming systems and base their judgements on a partial understanding of individual components of traditional technologies. This ignorance is largely a result of product training of researchers, which focuses on received theories and formal experimentation rather than the field work experience where real technologies are evolved, adapted, and used. They focus more on knowledge about the issues than on an understanding of the issues.

Arrogance

- Superiority complex due to theoretical and verifiable experimental base of R & D; visible performance and transferability of results;
- Scientists skill levels, eloquence, and access to high levels judged superior;
- Traditional systems judged inferior for lack of procedures of high science;
- Failure of traditional systems to meet increasing demands for agricultural products.

A major impact of formal eduction and training procedures that serve formal R & D is the development of a superiority complex on the part of scientists vis-a-vis the farmer and his or her production system. However, in some cases, despite knowledge about farmers' systems, scientists do not use farmers' methods because they are complex and time consuming. Consequently, technology that emerges through the procedures of formal science is treated as superior (notwithstanding the reduced performance outside controlled conditions). Eloquent scientists with formal qualifications, who have access to resources and make high-level decisions are considered superior researchers (despite their degree of ignorance of the user perspective).

Within formal education, ignorance is converted into power and this helps to breed arrogance. RPK becomes marginalised and the farmer is perceived as the user of whatever is dispensed to him, rather than as a partner in technology development. The whole education process that produces scientists, as well as the R & D superstructure that uses them, contributes to these tendencies (Ison, 1990; Chambers, 1986; Warren, 1991).

Patronage

- Disruption of people's initiatives by the state through development interventions (including formal R & D);
- Marginalisation and increased dependency of people on state sponsored R & D;
- Control of knowledge as a power in dynamic social-economic processes;
- 'Top-down' approach projecting indispensability of patronage.

The above tendencies are reinforced by the culture of public intervention in the name of rural development. In the post-colonial period a multitude of institutional and technological interventions have been promoted in rural areas of developing countries. Without belittling their contributions, it should be admitted that their underlying perceptions have undermined the role and application of RPK. The state has usurped the initiatives and activities that belonged to the people. For example, the substitution of informal, participatory arrangements for natural resource management with formal, legal and administrative measures; the substitution of collective self-help and local resource mobilisation with formal public relief; the replacement of local regenerative processes with external resource flows and subsides. The underlying assumption in such cases is that the rural people were incapable, requiring state intervention to educate, activate and help them. Such misplaced and patronising tendencies have several negative side-effects on rural communities.

Indirectly, they have encouraged greater ignorance and contempt about RPK on the part of scientists (Chambers, 1983; Warren, 1991). The perceived performance of traditional technologies (evolving in the context of different demographic, institutional and technological environments), under changing circumstances has undoubtedly strengthened the decision-makers' perceptions about RPK.

R & D Culture and Mountain Context

The indifference of formal R & D towards RPK can be identified in different developing countries-irrespective of their ecological setting, (Chambers et al., 1989; IDS, 1979; Rhoades, 1987; Gupta, 1991; Warren, 1991; Jodha 1991a, 1991b; and many others). However, the intensity of disregard for RPK in mountain areas is perhaps greater. The ignorance of scientists and modern R & D widens in the mountain context, due to factors such as: inaccessibility that restricts the communication and exchange between scientists and field realities; fragility and marginality, which calls for low cost, local resource-regenerative, and low resource intensity options, as opposed to the high input/energy intensive focus of modern R & D; diversity and mountain niches, which call for location-specific technologies to encourage diversified and interlinked activities. Human adaptation mechanisms in the harsh and complex mountain environments are reflected through various folk agronomic and ethno-engineering practices, and constitute the largest area of ignorance in modern R & D. These factors contribute to the failure to use RPK (Jodha, 1991a).

Linking RPK and Modern R & D Technologies

The discussion so far has highlighted some elements of traditional technologies which could be incorporated into modern R & D for mountains. We have also alluded to circumstances that are detrimental to the recognition and use of RPK by scientists. The steps which must be taken to integrated RPK into modern R & D can be divided into two categories:

- Internalise RPK elements in scientific work under R & D;

- Increase awareness about RPK and its potential usability in R & D.

The second category means minimising the role of ignorance, arrogance and patronage. This calls for a change in the perspectives of R & D planners, policy makers and other scientists. The first category would emphasise hitherto neglected elements of RPK, so that they get higher priority in modern technologies. These are concrete measures relating to research priorities, experimental designs and goals.

Internalising RPK Elements

The potential complementarity of traditional systems and modern R & D-based technologies and related interventions is shown in Tables 2a-e.

In order to increase the sustainability of mountain agriculture, we need to ask a number of key questions:

- How to enhance use-intensity and input-absorption capacity of mountain lands without degrading them?;

- How to manage low-use capability fragile lands productively?;

- How to harness and enhance diversity of mountain land resources without overextraction?;

- How to strengthen resilience and capacity of mountain land to sustain rising pressure of demand?;

- How to enhance equitable links between mountain and other areas, and to benefit from inter-system linkages for sustainability?

Tables 2a-e summarise the different approaches of traditional systems and modern R & D and other interventions in handling the above problems. RPK has outstanding features in terms of relevance, low external dependency and sustainability of resource use and production system. However, due to their often land-extensive nature and stable but relatively low productivity, traditional technologies are unable to meet increasing demands on agriculture. Hence, the need to address resource use intensification questions. This element can be provided by modern R & D. However, the latter are too focused on short-term, productivity raising aspects rather than long-term sustainability issues.

Table 2 **Comparisons between RPK/Indigenous Systems and R & D/Intervention Measures**

Table 2a Enhancement of use intensity/input absorption capacity of land	
Traditional Systems	Conventional Development Interventions
<u>Measures</u> Resource amendments by ethno-engineering measures: terracing/trenching/ridging, moisture conservation/drainage management/shelterbelts/agroforestry, etc.	Selective resource upgrading through irrigation/other infrastructure, biophysical changes (eg. new introduction; R & D activity/pilot projects for range lands, watersheds etc.)
<u>Sustainability Attributes</u> Local resource centred, community-oriented and supported, small-scale, diverse and adapted to local situation; linked to other activities	Science and technology input, strong logistical/resource support, advantage of scale
<u>Limitations</u> Reduced feasibility with rising pressure on land and weakening of local collective arrangements; lack of new high-productivity components	Side-effects of massive interference with fragile resource (waterlogging, landslides); inequities between transformed (eg. irrigated) and leftover areas; insensitivity of R & D-based initiatives to local resource diversity and user perspective.

Table 2b Enhancement of use intensity/input absorption capacity of land	
Traditional Systems	Conventional Development Interventions
<u>Measures</u> Folk agronomy involving activities with low-land intensity and low (local and affordable) input regimes; integration of low intensity/high intensity land uses (based on annual perennial plants, crop fallow rotations, indigenous agroforestry, common property resources) social sanctions, resource use regulation; migration/transhumance	Sectorally separated production programmes; high intensity uses through new technology inputs/incentives/subsidies; focused conservation oriented initiatives (forests/pastures/watersheds) in large projects mode
<u>Sustainability Attributes</u> Diversified, interlinked activities with different levels of intensity, community participation, control on local demand	New technological input, resource support and legal sanctions introduced externally
<u>Limitations</u> Reduced feasibility and effectiveness due to population growth, decline of collective arrangements, and side effects of technological and institutional interventions	General indifference to resource limitations, user perspective; 'Technique and Project Mode' domination

Table 2c Options to harness diversity and niche	
Traditional Systems	Conventional Development Interventions
Measures Folk agronomy, diversified cropping focus on multiple-use species; complementarity of cropping, livestock, forestry/horticulture; emphasis on biomass in choice of land use and cropping patterns; complementarity of spatially/temporally differentiated land-based activities; stability oriented, location specific choices; harnessing niche for tradeable surplus	Sectorally segregated programmes and their support systems (R & D, input supplies, crop marketing); focus on selected species and selected attributes (eg. monoculture, high grain: stalk ratio); extension of generalised development experience of other habitats with high subsidy
Sustainability Attributes Diversity, linkages as dictated by resource characteristics; locally renewable resource focused	Initiative with strong technological and logistic components, high potential for generating new options
Limitations Low productivity, land extensive measures incompatible with highland-population ratio, and changed institutional environment	Indifferent to the totality of farming system and diverse resource potentialities; high subsidisation

Table 2d: Resilience of the system and mechanisms to handle high pressure of demand	
Traditional Systems	Conventional Development Interventions
Measures Diversification and linkages of land- based activities; flexibility in scale, operations, input use; locally renewable resource focus, recycling of inputs/products, self-provisioning, crisis period collective sharing arrangements, common property use and protection of fragile resources; release of periodic/seasonal pressure by migration, transhumance, remittance economy	Public relief and support during crisis/scarcities; public interventions replacing traditional self-help strategies and informal regulatory measures; highly individual focused interventions eg. privatisation of common property resource, crisis period cushion promoted by increased private-resource productivity by HYVs etc. occasional linking of relief measure with productivity
Sustainability Attributes Range of options to match specific constraints of the habitats; emphasis on community centred and regulated activities; rationing of demand on fragile resource	Resource transfer from better-off areas to scarcity prone areas; possibility of linking relief initiatives with resource conservation/production programmes
Limitations Reduced efficacy of collective self-help measures and folk agronomic devices, due to changed demographic, institutional and technological environment	Dependency on external resources; encouragement for perpetual growth of pressure on fragile resource; indifference to local self-help initiatives

Table 2e Linkages with other systems, including markets	
Traditional Systems	Conventional Development Interventions
Measures	
General state of relative inaccessibility and isolation from mainstream market; limited linkages agriculture/through tradable surplus from harnessing niches; crisis period external dependence through transhumance, migration, and remittance economy	Improved physical and market linkage; integration of fragile resource economy with other systems; focus on special area development programmes, transformation of limited demonstration effects
Sustainability Attributes	
A few positive side effects of isolation, local demand centred, socially controlled extraction of fragile resources, better links between the resource users and the resources	Improved opportunities for relaxing internal constraints through technology, resource transfer, interactions with other systems; inducement for fuller use of niches through external demand; closer integration with mainstream
Limitations	
Persistent neglect and marginal status of mountain areas; slow pace of transformation of agriculture, unfavourable terms of exchange for mountain areas and products	Unless guarded against: high chances of extending irrelevant external experiences (including technologies); external demand induced heavy extraction of niches; unfavourable terms of exchange; distortion in local demand patterns and resource use

Table adapted from Jodha et al. 1992a.

Institutional Questions: RPK and Modern R & D

The above discussion has concentrated on the technical possibilities of incorporating RPK into modern agricultural technologies. The institutional dimensions of the problem are considerable and remain a barrier to linking RPK and modern R & D. The problem stems from the distorted perceptions of decision-makers who neither encourage an understanding of RPK nor facilitate its use in technology development (Table 3). Hence, the first problem to address is the recognition of the value of RPK, and its documentation and synthesis, with a view to identifying elements usable by R & D.

Much of the work carried out by anthropologists, rural sociologists, and agricultural economists on traditional farming practices is rather romantic. Furthermore, most of the information gathered by ethnoscientists is not synthesised in a form directly usable by R & D scientists. Such information may have significant gaps, since social scientists often do not generally collect detailed agronomic, botanical or ecological information. Collaboration of R & D scientists in interdisciplinary work involving farmers is an essential first step in facilitating recognition and use of RPK (Chambers, 1987). However, the R & D planners, whose decisions often influence the priorities of field scientists, have to be sensitised to this initiative. A reward system that favours practical science more than high science also deserves encouragement (Chambers and Jiggins, 1987).

Table 3. Strategies to incorporate RPK into formal R & D for mountain agriculture

Steps	Present Status, Trends, Prospects
Goal:	
Changes in perspectives of R & D planners, policy-makers on potential of RPK and its internalisation in formal R & D; incorporation of mountain perspective	Prevailing R & D perspectives blind towards RPK, persisting focus on top-down approach, substituting traditional practices with modern ones with short-term goals
	Focus on importing new technologies, developed in non-mountain context, at best (with some exceptions)
Mechanics:	
Generation of awareness/understanding of technologies, target environment, user groups (farmers)	Farming systems studies, farm surveys, largely to assess economics or performance of new technologies, with little emphasis on understanding RPK
On-farm research, participatory methods of technology development, verification	Extension system top-down; some efforts through operational research projects or national demonstrations compelling biophysical scientists to share the activities with social scientists and farmers
Incorporation of mountain perspective into R & D activities, designing goals, experimental priorities incorporating key elements	Mountain perspective unrecognised at different levels reflected through resource allocation and experimental priorities, goals etc.
	Regeneration, diversification, totality of farming systems not high priority areas in sectorally determined approach to narrow goals

It should be noted that attempts to generate awareness of RPK are not new; a number of initiatives have already taken place. Descriptions of traditional practices have been an important element of ethnographic studies, conventional farm management surveys, and focused village studies, as well as case-study monographs accompanying census reports, in countries like India for some time. However, the focus of this work has been on describing the situation, instead of presenting detailed analyses and useful information to R & D scientists.

One of the constraining features of present studies has been the predominance of social scientists as key actors. In most cases, biophysical scientists have been only peripherally involved. In some instances, despite joint involvement of social scientists and natural scientists in fieldwork or on farm trials, the gap between their perceptions persists. There is room for optimism, however, as greater emphasis is now being placed on interdisciplinary research. What is clear is that wherever communication between physical scientists and social scientists is good, the understanding and use of RPK for improving R & D is better.

The situation will improve further as more attention is paid to the technological and ecological, as well as the ethnographic and economic aspects of traditional agriculture (Walker and Ryan, 1990). Nevertheless, much research still focuses on projecting constraints and possibilities at farm level vis-a-vis appropriateness and introduction of modern technologies. Future work must concentrate on both socioeconomic *and* biophysical processes and interrelationships across a range of spatial scales (local, regional and national). Analysis and action must follow description. Only then will R & D activities be able to respond to the complex and dynamic changes taking place in these marginal mountain environments.

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