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Education, Research and Sustainable Mountain Agriculture

Priorities for the Hindu Kush-Himalayas

M. Banskota
T. Partap

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Dr. M. Banskota is the Deputy Director General, ICIMOD
Dr. T. Partap is the Head, Mountain Farming Systems' Division, ICIMOD

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Kathmandu, Nepal

PREFACE

The Mountain Farming Systems' Division of ICIMOD is engaged in a long-term programme of Strategies for Sustainable Mountain Agriculture. Among the four main thrust areas, one focus is on the Institutional Strengthening Needs of the HKH Region for Sustainable Mountain Agricultural Development. Since 1992, the institutional strengthening programme activity has been fully supported by the Government of the Netherlands. The key elements of this programme activity included assessing and strengthening the institutional capacities in regional member countries with respect to their functioning and with relevance to sustainable mountain agricultural development.

Farm education and research were given special attention under the institutional strengthening activity. In addition to reviewing the current situation of the HKH agricultural research and education institutions, different approaches were adopted to strengthen capacities in these institutions. To open up a regional platform for cooperation among education and research institutions of the eight Hindu Kush-Himalayan countries, a **'Regional Consultation on Education and Research for Sustainable Mountain Agriculture'** was organised from January 23rd to 26th 1996 in Kathmandu, Nepal. The eighty-five participants at this meeting included Vice Chancellors of universities in the Hindu Kush-Himalayas; Heads of agricultural research institutions, both national and provincial; and experts from government extension and development agencies, donors, and International Agricultural Research Centres. The main goal of this meeting was to provide an opportunity for sharing experiences and identifying priority areas for regional cooperation. In this respect, the meeting was a great success and recommendations were made for follow-up at both national level and at international level by ICIMOD.

This discussion paper, **'Education Research and Sustainable Mountain Agriculture: Priorities for the Hindu Kush-Himalayas'**, was the key research paper presented at the beginning of the meeting to give the background for other presentations and subsequent deliberations. By publishing this and other issue papers from the consultation meeting in the MFS Discussion paper series, ICIMOD seeks to share the knowledge gained with a wider audience. This current paper should be of interest to all those who are working with or are concerned about the state of education on and research in sustainable mountain agricultural development.

CONTENTS

Introduction

Sustainable development has been almost universally accepted as a desirable development goal, despite many complex problems involved in its operationalisation. Its major achievement so far has been to serve as a questioning framework about the long-term environmental and socioeconomic viability of our present day lifestyles and activities. It has raised significant questions and doubts about present day conditions - the technologies, production systems, material priorities, myopic development vision, etc - touching upon both our day-to-day activities and development framework. Never before has humanity been engaged in such a comprehensive self examination as is being currently demonstrated through various types of global, regional, national, and even local exercises related to the promotion of sustainable development. Humanity has come to recognise that the unbridled continuation and expansion of our present day activities will soon threaten our own futures and, indeed, those of our children. In response to these problems, changes are already being introduced, albeit slowly, in some areas. In other areas, questions and debates have been initiated to find appropriate answers. The advocacy for sustainable lifestyles will go down as a historic landmark, probably as significant as the first industrial revolution, because current debates are highlighting the urgent need for a new environmentally-friendly industrial revolution. Every generation must build on the shoulders of its predecessors, but, in doing so, the wisdom lies in discarding the unsustainable, decaying, and static and holding on to the sustainable, enduring, and dynamic. Probably no other generation has been as lucky, in this respect, as the present one. The capacity, in terms of education and research, that exists for examining these questions and finding the answers has never been so extensive. The problem, as always, is with the will to deal adequately with sustainable development priorities and not to dilute them with other preferences, of which there are many.

Sustainable agriculture obviously has a major role in this debate on sustainable development. There is growing global concern about the unsustainable nature of present agricultural activities. Crucial issues in this discussion have been the inability of traditional farming systems to provide adequately for the increasing population, on the one hand, particularly in fragile, rainfed, remote, and climatically harsh areas, and, on the other hand, the environmental problems generated by the expanded use of modern agricultural inputs, including the mismanagement of natural resources in better endowed areas. Because of the environmental problems arising out of both traditional and modern agriculture, questions of food insecurity and malnutrition are once again appearing as major concerns for certain regions of the world. In addition, the health risks associated with negative environmental effects are also causing growing alarm about the continuing use of certain chemicals, misuse of natural resources, and the deteriorating conditions of the environment.

The challenge before policy-makers, scientific bodies, and development agencies to make agriculture sustainable in better-off areas, as well as in fragile resource zones, has never been greater. While returning to the good old days of the sickle and plough is highly improbable, modern technology cannot be permitted to destroy the biophysical basis on which life is sustained. Consequently, it is imperative that we find

the answers to the questions being raised regarding the sustainability of agriculture. How we can maintain food security and preserve the environment is a dilemma facing each and every ecological belt, including the mountains. While different agencies have their respective roles in facilitating the solutions, a major challenge is obviously before the research and education systems, as these not only determine the nature and type of new technologies but are also responsible for the development of human resources capable of bringing about the changes needed for sustainable agriculture.

This paper attempts to draw attention to the education and research issues in sustainable mountain agriculture. The next section provides an overview of the changing nature of mountain agriculture and the different types of questions that are emerging. This is followed by a discussion of the understanding of sustainable agricultural development in fragile resource zones such as themountains. The conclusion here is that there are still large gaps in our knowledge, and we must develop learning systems that are more sensitive to local conditions. A brief consideration of the main conclusions of the '20-20' vision for international agriculture highlights the need for decentralised research on an ecoregional basis and the importance of greater attention to specific eco-regions, such as the mountains, for global food and environmental security. The third section describes the present set-up for education and research in the Hindu Kush-Himalayas. The last section describes priority areas to be addressed in the fields of education and research to make mountain agriculture more sustainable.

An Overview of Changing Mountain Agriculture

Traditional agriculture in mountain areas has relied primarily on locally available natural resources and their management for meeting food, fodder, fibre, and fuel needs. In most communities, some of the natural resources are privately owned (such as arable land and livestock), whereas others, such as water, grazing, and forest areas, are community- controlled. Crops, livestock, and forestry have formed an integral part of the upland farming system (Carson 1992). In adapting to the specific needs of greatly varying slopes, aspects, climates, and soils over short distances, farming systems in mountain areas had a number of important priorities in natural resources' management.

The first was the maintenance of soil fertility. A number of different measures was employed by upland farmers to maintain soil fertility (Shah et al. 1991). The most important was the use of compost which involved using livestock manure, leaf litter from forests, and crop residues from fields. A principal focus of mountain women's daily work was, and still is, to transfer forest resources to the farm, to feed the livestock (for manure), and to provide leaf litter for compost. Other measures included the use of different crop combinations (intercropping as well as rotation), leaving fields fallow for various periods, and the practice of agroforestry. In many areas, special nitrogen-fixing legumes were also planted. Livestock-dominated systems in colder areas practised transhumance to exploit different seasonal niches. The movement of livestock also served to improve soil fertility in different places.

The second was the control of soil erosion. On sloping areas, it is almost impossible to completely halt soil erosion, at least not at affordable costs. However, in terms of the possibilities from the farmer's side, considerable efforts were made in the past to control soil erosion through different measures (Carson 1985, Shah et al. 1991, and Schreier et al. 1995). Terracing was a very significant capital formation in upland areas in the past. Depending on soil characteristics, geology, slope, and aspect, terraces changed. This reservoir of ethno-engineering knowledge has yet to be properly tapped. The use of different types of biomass - both perennials and seasonal - has also been important for regulating runoff and, thereby, controlling soil erosion (Partap and Watson 1994). Shifting cultivation was another strategy for controlling soil erosion as well as improving soil fertility (Ramakrishnan 1992). Proper drainage of fields was common and a great deal of care was taken to ensure that, as far as possible, soil loss was minimal. In the context of landslides, at least minor ones, in some instances, were deliberately triggered by farmers in order to reduce the slope or expand the agricultural area.

The third was the management of water resources. The movement of water from one place to another on sloping terrain increases the risk of soil erosion, landslides, and slope failures. However, without water there can be no agriculture. In upland areas, the main challenge for water management has been to organise safe discharge during a three-four month surplus period and frugal use of available water over a nine-month dry period. While the traditional engineering works in upland areas were relatively simple, the rich experiences in terms of mobilising a large number of farm households to undertake regular maintenance and to maintain a reasonably equitable water-sharing system have been fairly well recognised (Sowerwine et al. 1994).

The fourth was the management of forest resources. Upland farmers have always recognised the critical role of forests. Once the forests are gone, upland farmers know that farming will not bepossible for very long. Consequently, regulating and controlling mechanisms were established, many of which were well accepted by the community and therefore well enforced. Forest resources have always been a principal source of tension between the government and local people, and governments are increasingly recognising the legitimacy of the rights of local groups to certain forest areas (Chhetri 1992 and Karki et al.1994). Farmers also preserved biodiversity. Variations in altitude and microclimate provided a natural basis for plant diversity. While some were recognised for their economic value, others were integrated into different cultural and religious traditions. Specific crops were required for different types of cultural and religious festivals. Others were raised for their medicinal value as well as for warding off evil spirits (Roder 1995).

In spite of the many positive aspects of management in upland farming systems, a number of internal and external factors has made changes inevitable. It is these changes that are responsible for the breakdown in traditional linkages between farming systems and natural resources, threatening the capacity of mountain agriculture to provide for the needs of mountain farmers. A number of factors has been important among these changes.

Within the last 30 years, there has been a rapid growth in population in upland areas. It has more than doubled (Sharma 1994). This growth has put more pressure on farming systems to meet food, fodder, and fuel needs and to provide better incomes. Hill resources supported a moderate growth in population in earlier times, but the present rates of growth are exceeding the carrying capacities of many upland areas. Over time, this growth has resulted in the uneconomic fragmentation of land holdings and increasing pressure to further intensify the use of limited natural resources.

The unmanaged growth of livestock has resulted in excessive deforestation and overgrazing, affecting the productivity of livestock in many ways; and this includes the supply of manure - the main reason behind the increasing livestock numbers in upland areas. Many consider the increasing number of livestock and relatively poor management practices to be a major threat to sustainability of hill environments in the future (Jodha et al. 1992).

The penetration of market forces into the hills has brought many advantages, but it has also brought a number of disadvantages (Jodha et al. 1992). Market demands for various natural resources, particularly forests, have accelerated extraction, and the concern is now no longer for sustainable supply but for profits, resulting in the rapid depletion of limited mountain resources. In addition, market mechanisms also tend to weaken local socio-institutional sanctions, especially if the profits that result from breaking these sanctions are high. The extraction of forest products is an important example. The strong response required from the community to change these conditions has been demonstrated by the Chipko Movement in India.

The increase in support services and basic infrastructure has also played an indirect role. Along with services and infrastructure, external (i.e., non-local) contacts and linkages have become more important, for both inputs and outputs, than in traditional conditions in which internal (local) linkages are important. As the dependence on resources from local areas declined, there was also a general weakening in local resources' management systems over time. At the same time, the impact of using external inputs on natural resources was either not known or not adequately monitored.

Changes in land policies have had a significant influence on the conditions of many land-based resources in upland areas. A review of land and forest policies clearly indicates that sustainable management of available land resources has not been the objective of government policy until very recently. Land and forest policies were used for a long time in the past simply to generate more revenue for the government (Regmi 1976).

Ensuring proper land use has not been an important objective. Policies have moved from the stage of total state control over land resources to partial control. In view of the failure of past policies, participatory management is being promoted in some areas, such as forests, but its impact in reversing the overall process of deforestation is still not adequately known.

In response to different pressures over time, upland farmers have made different adjustments. As theextent of the influence of different factors varies greatly, the adjustment processes and presently prevailing conditions are also not uniform.

First let us look at areas with **poor access.** The degree of access has been an important factor in this process of change. This can be further differentiated according to low and high population density. In areas with **poor access but low population density** (where land is still fairly abundant), the influence of modern agricultural technology is limited. This condition is still found in upland pastures and in some upland tropical forests. While the present relationship between access and change may be seen to be stable, there are doubts as to how long it can be sustained (Blaikie 1976 and Banskota 1989). Even remote areas are beginning to experience increasing population and market penetration, both of which take a heavy toll on natural resources. It is only a matter of time before these areas also begin to experience further population growth and depletion of natural resources, even without any improvements in access conditions.

In areas with **poor access but high population density** substantial pressures already exist on available natural resources. Farming has become very land-intensive in contrast to the land-extensive practices earlier. However, as technology is more or less stagnant and soil fertility is not adequately maintained, productivity is declining. There is mounting pressure to extend cultivated areas, resulting in further deforestation and loss of the resources available for agriculture. In view of the difficulties of access, use of modern technology is limited to a few entrepreneurial farmers. The overall conditions appear to be extremely discouraging regarding both farm productivity and the conditions of natural resources in areas with poor access.

Second, regarding those areas with improved access, it can be seen that the improvement in access has had a far-reaching impact on natural resources and farming systems (Sharma 1995). The general effects are the introduction of market-based inputs, commercialisation of agriculture, and strengthening of the privatisation of resources wherever possible. Improved access has also facilitated the introduction of improved technologies for crops, horticulture, livestock, and even agroforestry to some extent. Production is less for farmers' own consumption and more for distant markets. Dependence on external inputs and knowledge increases rapidly.

If support services are relatively well organised to take advantage of comparative advantages and improved technology, switches from traditional crops to new market-based crops are rapid and very lucrative. Farmers also find it relatively more profitable to buy food grains and focus on the most suitable high-value crops. This type of change appears to be economically very desirable from the point of view of the farmer. There are instances of adverse environmental effects arising out of excessive use and misuse of mineral and chemical inputs. In some areas, environmental impacts have become very serious and educating farmers to manage these problems is critical (Sharma 1995).

Insofar as the changing farming system's impact on natural resources in such areas is concerned, this is mixed. The increased use of chemical fertilizers has reduced the need for a large number of unproductive animals, and, consequently, there appears to be some reduction in the pressure on forest resources (Basnyet 1990). Unfortunately, by the time chemical fertilizers arrive, there may not be any forests left. As improved varieties of crops require a reliable water supply, better management of water resources is expected. With the development of horticulture, land is placed under permanent tree crops, and this could have a favourable impact in terms of reducing soil erosion. On the whole, with increased incomes from high-value crops, farmers tend to care more for their own natural resources in order to protect their future incomes (Sharma 1995). The impact on community-managed resources is not very clear. Initially, resources tended to deteriorate, but, gradually, they have also improved in some instances.

In general, if better access improves the performance of farming systems, there are other problems. Access does not come cheaply to upland areas and maintenance costs are very high. The extent to which small farms can actively participate in the development of comparative advantages dependsa great deal on the availability of support services and the affordability of high pay-off inputs. There are also the environmental effects of the increased use of chemical fertilizers. Even more critical is the use of pesticides. The worst scenario is one in which well-off farmers pollute the environment with new chemical and mineral inputs, while poor farmers continue to overexploit limited forests, pastures, and water resources. Thus, mountain agriculture is at a critical juncture. If it is to be made sustainable in the future, the dynamics of changing mountain agriculture must be better understood and improved technologies introduced in such a manner that productivity gains are not at the cost of the environment.

Increasing Understanding of Mountain Agriculture

The most important question is how do we move towards a system of sustainable management? How can we ensure the needs of a growing number of people and, at the same time, not destroy the environment? Sustainable management in the context of natural resources and farming systems refers to decisions and activities that enhance farm output per unit of natural resource, without degrading the resource base. How can this be achieved? Is it practically feasible? Given all the alarming signs that are emerging with respect to growing populations, the declining impact of the green revolution, and the degrading agricultural and natural resources' environment, sustainable management appears to be an extremely difficult task. While there are many serious obstacles to making this transition towards sustainable development of mountain agriculture, the problem appears to lie in the lack of knowledge and skills required for bringing about the needed changes.

Some consensus is beginning to emerge about the broad nature of factors determining sustainability of mountain agriculture. In general, these factors can be broadly grouped into two main categories: (a) non mountain-specific, which have commonalities with non-mountain areas and (b) mountain-specific factors. Moun-

tain-specific factors play a unique role in determining the sustainability of mountain agriculture, while the non-mountain specific ones are identifiable with general policy failures.

Non Mountain-specific Issues

One of the key dimensions affecting the sustainability of agriculture in mountain areas is the **scale of demand for resources.** Rapidly increasing demand, as a result of the **huge growth in population and the increase in livestock population in mountain areas,** is likely to threaten all efforts to ensure sustainability of mountain agriculture. If current trends in growth rates continue, most mountain areas in the Hindu Kush-Himalayas will double their population **in another 15 to 20 years.** This will further increase the pressure on already depleted and degraded natural resources and is unlikely to improve the prospects for sustainable mountain agriculture in the future (Banskota and Jodha 1990b, Sharma and Banskota 1992, Hongbin and Xingquing 1990, and Mulk 1990).

In most mountain areas, the livestock population is equal to, if not greater than, the human population. Current growth rates are clearly unsustainable in the context of widespread deforestation and overgrazing (Pound et al. 1992, Keatinge and Khan 1992, Dafu et al. 1990, and Shrestha and Katwal 1992).

Macro-policies are important instruments, not only for influencing the pace and pattern of development but also for generating micro-level activities. In the HKH Region, most of the negative trends in agriculture can be partly attributed to macro-level policies that were predominantly designed according to conventional practices or experiences in non-mountain areas (Banskota and Jodha 1992a and 1992b). This is true for resource allocation, factor/product pricing, taxation measures, infrastructural development, agricultural R&D, and the choice of technologies for various activities. **Resource extraction policies** are guided by short-term considerations of revenue maximisation rather than by regeneration and sustainable use of resources. Both mechanisms and procedures to extract resources of power potential (e.g., systems for contractors and auction arrangements for forests, irrigation, and development) have overlooked local mountain environmental and community considerations. 'Scale factors', particularly sensitive in mountain areas, are often disregarded as long as payments are forthcoming.

Public sector investments in infrastructure make very few provisions for ancillary activities which could facilitate fuller use of such infrastructure. They have also overlooked potential environmental problems due to infrastructural activities.

Case studies from China, Pakistan, and Himachal Pradesh in India emphasised the need for strong public investment programmes related to the development of basic infrastructure, such as roads and power, and strong support for technology improvements, marketing, and price incentives. Experience in Nepal, on the other hand, highlighted that, in the absence of a growing demand due to the inadequate growth of ancillary activities, even investments in basic infrastructure are unlikely to bring about major improvements in highland agriculture. Nepal's experience also under-

scored the importance of strong technical support if the comparative advantages of mountain areas are to be harnessed (Banskota and Jodha 1992b).

A comparative review of public sector investments in mountain areas suggested that large-scale investments in mountain areas (particularly infrastructure) become more easily justifiable when mountain areas have access to bigger markets in urban and plains' areas. Where this external demand is lacking, harnessing the comparative advantages of mountain areas is a different matter. The extent to which subsidies had a desirable impact on agricultural transformation needed more careful evaluation, as there were indications that subsidies had been used quite extensively in China, India, and Pakistan, whereas their merit had been questioned at times in Nepal. In view of the fact that comparative advantages in mountain areas are not uniform, in terms of either the activity or its scale of operations, the need to evaluate investment alternatives is urgent.

Inter-regional and intra-regional inequities also influence the prospects of sustainable development. The relatively low development priority accorded to mountain areas, vis-a-vis urban and plains' areas, was a common feature in the past. This in-built bias is reflected through the low levels of investment allocations to mountain areas and also within mountain areas. The distribution of benefits to different groups has also been equitable where spatial inequality has been corrected to some extent (Bhati et al. 1992).

Given the strength of environmental linkages between highlands and lowlands, continued deterioration of highland resources will ultimately affect lowland areas as well. It is, therefore, important that public investments pay greater attention to the issues of equitable distribution of investment resources.

A related issue is the real worth and value of resources' conservation in mountain areas. As the debate on subsidy programmes indicates, unless off-site impacts of mountain development are meaningfully analysed, investments in these mountain areas will continue to be treated as liabilities.

The final issue under distribution relates to intra - or inter-household equity. Though all households have diversified activities in the mountains, the degree of diversification (owing to resource differences) is not uniform. Common property resources, with their relatively equal access, have served to reduce inter-household inequities. However, the commons are rapidly declining. Development interventions designed without a proper understanding of gender issues will lead to further marginalisation of women.

Mountain Specific Components

An important gap in development interventions in the HKH Region is the inadequate consideration of mountain specificities and their implications. This is evident in the cases of overall development strategies, sectoral programmes, specific projects, and farm-level successes/initiatives. Case studies have revealed that successes and failures are largely associated with the consideration or disregard of mountain

specificities. This means essentially **understanding** the nature of **opportunities available** and the **type of constraints** that are operative. The **opportunities** concerned are **diversity, comparative advantage**, and **adaptation mechanisms**, while the major constraints are **inaccessibility, fragility, and marginality.** Policies can play a major role in either promoting the development or reducing the adverse impacts of both opportunities and constraints (Jodha et al. 1992).

Because of mountain specificities, the locational impacts of various investment decisions will be quite different. Locational factors influence the type and scale of investments. Types of investment are influenced by mountain specificities, either individually or in combination. Investments in roads for fragile areas result in huge maintenance costs later on. Diversity makes it imperative that area development programmes have a wide base of improved technology in order to have a beneficial impact upon different groups. Agroclimatic variations have important implications for agricultural development programmes. Understanding the importance of the impacts of mountain specificities is just beginning to influence work in mountain areas. As each investment requires supporting investments, options need to be much more carefully evaluated, especially in terms of ancillary activities. Many investment programmes have overlooked environmental fragility and marginality-related constraints (poor soil, short growing season, steep slopes, etc), and farmers' preferences and adaptation strategies that have evolved over the ages. Unless these are taken into account more seriously in future, investment failures and subsidy burdens are likely to increase.

Investment in infrastructure is vital. But it must be selective to make the best use of limited funds and other resources. Infrastructure, such as roads, can do little to help farmers when soils are poor. In contrast, roads provide good returns in areas with good land and agroclimatic conditions. Thus, unless each investment alternative is carefully considered vis-a-vis the mountain specificities of an area, the impacts of scarce investment resources are likely to be minimal.

Most mountain specificities are interrelated due to their common biophysical causes (e.g., fragility, inaccessibility, or diversity, and niche have common causes). Similarly, treatment of or disturbance to one characteristic may influence others. For example, road construction to improve accessibility may adversely affect the fragile rock alignments and vegetative cover of a tract. It may improve the conditions of marginal areas, but may also increase the rate of resources' extraction beyond their regeneration rate and cause unsustainability. The interrelationships of different mountain specificities and their implications serve as a compelling basis for an integrated approach to mountain development. This implies the need for clear identification and consideration of negative and positive externalities in designing and implementing development interventions.

In order to sensitise macro-level decisions to mountain specificities, greater focus on micro-level realities through understanding farmers' strategies and responses is needed. Farm/village-level documentation provides better insights into the dynamics of sustainability/unsustainability or the pace and pattern of change. Understanding

and quantification of mountain specificities, and people's adaptation to them at the local level, reveal more easily the farm-level and village-level differences in the performance and impact of development interventions.

In view of the increasing realisation of the usefulness of a traditional farming systems' rationale for evolving new and sustainable systems, and the importance of the farmer as the final actor in determining the success of development interventions, it will be useful for development agencies to be in touch with field realities through various types of field studies (e.g., detailed surveys, rapid rural appraisal, and case studies) and regular monitoring systems.

Knowledge Gaps and the Need for a Stronger Mountain Focus

Mountain areas have been neglected by the scientific community in the past and, consequently, there is a relatively poor understanding of the dynamics of changes in agriculture and natural resources. There are several reasons for the relative neglect of mountain areas. The first reason involves the difficulties with access and communications, in mountain areas, and these have greatly hampered the build-up of scientific knowledge. Physical difficulties in terms of movement and communications have created major problems for outsiders, who do not come from the local environment, in settling down. Thus, most scientific expeditions have a very seasonal nature. Thislack of steady, continuing attention has left mountain ecosystems with limited research attention, resulting in a poor database and observations.

The second reason could also be the difficulties created by strong local hostility towards 'outsiders', irrespective of their intentions. Many mountain societies are still very sensitive about interactions with outsiders, although this is changing. This has resulted in insecurity and contributed towards a lack of sustained interest by scientists, mostly from outside institutions. This attitude has also been reflected in government activities in some areas. Not providing adequate priority to improving education and research conditions in mountain areas has been a legacy of this past preoccupation and concern with autonomy and security. This, to a great extent, has been reinforced by inaccessibility.

To date, many of the problems have yet to be properly understood, by acquiring the accurate and reliable data which are lacking. Interpretations of changes are widely varying in many aspects of the environment. The following are some examples.

a) Data relating to firewood consumption and soil erosion vary widely from estimate to estimate, area to area, and country to country. Each set of data may be correct in a particular case, but it is impossible to derive a general idea of the situation in mountain areas as a whole (Thompson and Warburton 1983).
b) Different groups have taken stands on various issues. Some of these are as follow.
   i) Some groups say that deforestation is increasing while others argue that this is not so, at least in some areas (Ives and Messerli 1989).
   ii) Some groups say human activities are destroying the environment, while other argue that this is not so (Ives and Messerli 1989). Both of these positions may be true.

c) Mountain people appear to be rapidly accepting monocropping, urbanisation, commercialisation, and outmigration, although some appear to be sceptical and question the usefulness of some of these changes for mountain people. Mountain people are asking for more modern knowledge and improved technology, while some seem to be in favour of further developing indigenous knowledge and traditional technologies.
d) Mountain policies seem to favour food security while mountain farmers, as do other farmers, prefer income security.
e) Overcoming poverty appears to be a higher priority for mountain farmers than concern for the environment, while many programmes tend to give a higher priority to environmental issues.

In the context of conventional mountain agriculture, mountain specificities have not been given sufficient weight by R&D strategies which could explain our poor understanding (Banskota and Jodha 1992a). In more successful initiatives, such as at the Lumle and Pakhribas Agricultural Centres in Nepal and Himachal Pradesh in India, mountain specificities have played an important role in determining technology options, although this has only been realised through experience after encountering many difficulties in promoting improved technologies (Chand and Thapa 1990 and Keating and Khan 1992). Improvements in access have favoured the adoption of improved technologies that were successful in exploiting comparative advantages through the market. The lack of improved access led to farmers' preferences for technologies that increased local food production. If fragility restricts the scope for land-intensive technology, diversity and niche suggest a need to design improved location-specific technologies based upon an understanding of local farming systems and farmers' practices. A fairly long period of time is needed before the right combination of environmental and economic factors produces a package of improved options that meet farmers' preferences. As part of the system developed to ensure the sustainability of improved technologies, the experience of the Lumle Centre in Nepal highlights the role of mountain specificities more clearly (Pound et al. 1992). It points out the need for: (a) ensuring accurateidentification of problems and farmers'/extensions' feedback; (b) carrying out location-specific verification of technologies; (c) multidisciplinary cooperation in assessing research results; (d) careful selection of technologies and subsequent monitoring of the impact of technologies on the environment; (e) assessment of technologies in the context of the limited resource base of hill farmers; and (f) use of indigenous resources.

The 20-20 Vision for International Agriculture and Implications for Mountain Agriculture

The increasing concerns about poor agricultural performance were extensively discussed in a recent international meeting, and the issues raised there have important implications for different fragile ecosystems such as the mountains.

The International Food Policy Research Institute (IFPRI), based in Washington, recently organised "A 20-20 Vision for Food, Agriculture, and the Environment" Global Conference in Washington D.C. to discuss the problems of hunger, poverty, en-

vironmental degradation, and the necessary decisions and actions for the next 25 years, in order to deal effectively with the different but related problems (IFPRI 1995). The global meeting was preceded by a series of regional meetings on different continents. Extensive analysis was undertaken, both at IFPRI and outside, to generate a realistic assessment of the food, agriculture, population, and environmental scenario for the region and the world.

It is useful to briefly mention some of the points made by Sartaz Aziz in his presentation on the vision for Asia. He refers to studies by the World Watch Institute and IFPRI. Regarding the conclusion by the Worldwatch Institute, Aziz quotes, *"After nearly four decades of unprecedented expansion in both land-based and ocean-based food supplies, the world is experiencing a massive loss of momentum. The backlog of unused agricultural technologies is shrinking, production of seafood and livestock is approaching its limits, demand for water is pressing against the limits of the hydrological cycle, additional fertilizer in existing varieties has little effect on yields, many countries are losing cropland at a rate that exceeds the rise in land productivity, and social disintegration is undermining efforts to increase food production"* (Aziz 1995). Gaps in food grains for six large Asian countries (Bangladesh, Indonesia, Pakistan, Iran, India, and China) are expected to increase from 17 million tons in 1990 to 340 million tons by 2030 (IFPRI 1995, 112).

IFPRI's projection is somewhat less alarming because of the assumptions relating to population growth and the more favourable coverage of new technology. However, it also comes up with a deficit of around 61 million tons by 2020 (IFPRI 1995, 112). In the South Asian Region, three challenges that needed to be met were: (a) sustaining and improving upon the average annual agricultural growth rate of 3.3 per cent achieved in the past two decades, (b) a major part of the incremental growth having to come from higher productivity obtained by wider application of improved technologies, and (c) policy shifts, in favour of agriculture and within agriculture, in favour of small farmers. What needed to be done would obviously vary from country to country, but a number of common strategies and policies for food security was identified (IFPRI 1995, 116).

In the short and medium run, the following were emphasised.

- Innovative programmes to extend high-yielding technologies to a much wider cultivable area
- Larger investment in small-scale irrigation schemes and improved water management
- Avoiding policy discriminations against agriculture
- Strengthening food security programmes for the poor and the disadvantaged, based upon effective policy research
- Actions to improve maternal and child health and nutrition and policies to improve access to clean water and sanitation
- Protecting the poor and vulnerable from the after effects of liberalisation and structural adjustment
- Strengthening policy-relevant databases related to poverty, nutrition, health, and environment

- In the long run, the following actions and policies were emphasised.
- Agricultural research programmes that focus on generating technologies to enhance employment, income, and access to basic needs
- Promotion of environmentally - sound technologies, such as drip irrigation, community forestry, agroforestry, watershed management, and farmer-managed irrigation systems
- A drastic increase in investment in education, especially for women's education
- Implementation of effective land reform to address problems of inequality a landlessness
- Dismantling of policies that lead to environmental degradation
- Expanding trade in agriculture through trade liberalisation measures

A number of other critical issues were raised by other speakers. The most interesting one was the need for a Double Green Revolution. This nomenclature was introduced by Gordon Conway in his address which referred to *"a new Green Revolution - one that will be as productive as the past revolution but will be environmentally friendly, and hence sustainable"* (IFPRI 1995, 47).

Keith Bezanson, President of the International Development Research Centre (IDRC), referring to the difficulties of achieving the Double Revolution, pointed out, *"In addressing the Double Green Revolution there is a need for new and fresh thinking whether it is multidisciplinary, interdisciplinary or intersectoral groups working together, integrating different kinds of knowledge-the hardest thing about new thinking is getting rid of old thinking"* (IFPRI 1995, p140). Discussing the need for prioritisation, Bezanson noted that one of the main priorities emerging from the conference was **for massive investments in the education of women and girls.**

What is the relevance of this discussion on sustainable international agriculture for mountain areas of the Hindu Kush-Himalayas? First, mountain agriculture cannot be neglected, as in the past, with the belief that lowland agriculture will provide adequately for all the agricultural needs of the mountain people. This has not happened in the past, especially for poor areas, and this is not likely to differ significantly in the future. The possibilities for trade, exchange, and specialisation undoubtedly exist between the plains and mountain areas, but this also assumes a mountain agriculture will be developed that has products and services to exchange with the plains.

Second, today there is a greater need to develop and sustain mountain agriculture than ever before. This is not only because of the growing number of people in the mountains, but also because this growing number is predominantly poor, malnourished, lacking in food security, living in very fragile environments highly susceptible to frequent natural disasters, and has been historically marginalised in terms of development. Sustainable development is simply not feasible when an important segment of society continues to suffer in this manner.

Third, an important reason for a stronger focus on mountain areas, including mountain agriculture as an integral part of the 20-20 Vision, is the realisation that increas-

ing pressures on fragile areas, such as the mountains, only result in degrading those environments and transferring pressures to other areas. In a highly interconnected biophysical system, deterioration in upstream conditions has resulted in catastrophes downstream. Managing mountains and mountain agriculture is, therefore, a critical component of the food security system, particularly for large parts of the Asian lowlands that depend on mountain water resources for their lowland agriculture.

Fourth, with emphasis on the "Double Green Revolution", the experiences of mountain farmers could be critical for improving environmental friendliness, just as mountain farmers could benefit from increased productivity. The emphasis on integrated natural\resources' and agricultural management (INRAM), on women, biodiversity, small-scale water harvesting technology, etc could be mutually beneficial for the mountains as well as the plains, because of the rich experiences of mountain farmers in these areas. There is greater congruence in the new thinking on the practices suited to different ecosystems, and this is a hopeful sign as there are immense opportunities for mountain farmers to learn as well as to pass on to others their very rich farming heritage.

Fifth, if the present state of agriculture in better endowed areas is not satisfactory, even with all the resources and capacities at its disposal, the problems with mountain agriculture are even more worrisome, as it lacks both the resources and institutional capacities required to bring about necessary changes. It is possible to identify and develop opportunities for sustainable mountain agriculture, and some areas are already doing so. However, the big question is in which areas will the efforts be made? The next section will examine these questions from the point of view of education and research in sustainable mountain agriculture.

The Current State of Agricultural Education and Research in Mountain Areas

Agricultural Education

a. Agricultural Education Institutions

The main problems for educational institutions located in the HKH region have been extensively reviewed in the country reports published by ICIMOD in 1995 (Khosla 1995; Partap 1993; ICIMOD and RGOB 1994; CAS 1994). All these institutions, especially the universities, have different organisational structures, curricula, linkages with other components of the agricultural sector, and outreach programmes. Besides the general problem of shortage of funds and trained manpower, most of these institutions suffer from the following problems.

i. Since the institutions have been organised on the pattern of the relatively more successful and older plains' institutions, their organisational structures and curricula emphasise crop production under irrigated conditions. This, of course, is entirely unsuitable for mountain ecological and socioeconomic conditions.
ii. Agriculture in mountainous areas is largely based on integrated crop-livestock-

agroforestry farming systems, whereas the educational system is implicitly based on monoculture of individual commodities, mostly food and cash crops. Horticulture and pasture management, which are very important in mountain areas, are not sufficiently covered in the curricula.

iii. The fragility of the environment in mountainous areas means that sustainable use of the resource base is vital for the growth of agriculture in these areas. Adequate emphasis has not been given to this in the curricula.

iv. The linkages of these institutions with research institutes, extension organisation, and the public sector development system are often quite weak. Educational institutions often confine themselves to on-campus teaching and thesis-oriented academic research.

v. In most cases, there is very little interaction of the teaching institutions with the farmer, and this has serious adverse consequences for the quality, relevance, and usefulness of the knowledge imparted for agricultural development in the region.

Although it is difficult to generalise about the situation of all the agricultural universities/colleges in the HKH region, these institutions have common organisational and operational problems. As a result of these, their graduates in agriculture are considered to be deficient by the main employer-the state agricultural department, in terms of meeting the challenges of sustainable development of the agricultural sector. Some of the problems are listed below.

- The curricula are copied almost entirely from the older Universities of Agriculture, and they are designed mainly for irrigated agriculture in the plains. No concerted efforts have been made to orient these curricula towards the specific needs of mountainous regions.
- Very little emphasis is given in the curricula to livestock, forestry, and range management, and these are important activities in the prevalent mountain farming systems. Most farmers operate integrated crop-livestock farming systems, including horticulture, but the curricula lack training in farming systems' aspects, especially in socioeconomic aspects.
- Colleges have no expertise in agriculture at the senior management level.
- Agricultural education does not receive the priority it deserves in terms of allocation of resources.
- These agricultural colleges and universities generally have no formal linkages with the Stateagricultural departments which have the responsibility for agricultural development (including research and extension). As a result, these institutions have no contact with the agricultural community and are not involved in identifying the problems of the agricultural sector or finding their solutions through research.
- Many of these educational institutions do not maintain their own outreach programmes - the farmers rarely visit the institutions and the faculty and students do not undertake research on farmers' problems.
- Very little funds are provided to the agricultural colleges and universities for research and outreach. As a result, both these activities are virtually non-existent in the many institutions.

From the country perspective, one finds that the priority given to agricultural education has not been uniform. It has received very high priority in China, although the emphasis within agriculture has changed quite drastically in different periods (CAS 1994). In addition, agricultural education in China has focussed principally on promoting technical and scientific skills through regular universities, colleges, vocational agencies, and adult education systems that use television and radio services extensively. Over the years, China has been relatively successful in producing a wide range of technical experts to support the development of science and technology-led agriculture.

However, in spite of this national emphasis on agriculture and the reasonable success that has been achieved, this success has been mainly in the plains. In most mountain areas, peasant families are still predominantly illiterate (Ruizhen and Yuan 1992, p257). Education in China's poor mountain areas is limited to primary education. The development in adult and vocational education seen in other areas has not yet reached mountain areas. Commenting on the difficulties of expanding education in rural mountain rural mountain areas. Ruizhn and Yuan point out, *".. the most difficult tasks is in mountain areas, where villagers live so far apart from each other that it is not uncommon for students to travel seven or even dozen kilometres to school on a daily basis, where the dropout rate runs high as parents want their children to stay home to help increase family income"* (Riuzhan and Yuan 1992, p259). Other common problems relate to the lack of qualified teachers, poor equipment, and shortage of funds.

Regarding other countries of the Hindu Kush-Himalayas, in those lying south of the Himalayas, agricultural education presents an anomalous situation, with problems appearing to be far more severe in the mountain areas. First, despite the fact that these are mainly agricultural economies with a fair share of the population still dependent on agriculture, agricultural education has not received the priority it deserves. Second, most agricultural teaching agencies are relatively new, having started only within the past five decades, and are still learning ways to integrate teaching, research, and extension. Third, in spite of the increasing number of agricultural teaching institutions and diversification of subjects, agricultural education is not a preferred subject if other alternatives are available. Rarely does one find a farmer who willingly supports higher education in agriculture for his son. Fourth, there is also a strong preference for supporting urban-based agriculture rather than working in rural and mountain areas. These are general comments applicable to agricultural education (Bernardo 1985). The situation in mountain areas is even worse.

Chart 1 illustrates some of the points noted above about the North West Frontier Province (NWFP) Agricultural University in Pakistan. Clearly, there is need for a much stronger mountain orientation in the curriculum and research work of the university. The important point is that these gaps are being realised, and, hopefully, some change in direction towards mountain areas may be seen in the future.

In Himachal Pradesh (India), the Y.S. Parmar University of Forestry and Horticulture is the only one of its kind that focusses significantly on mountain agriculture and related areas. There are a few other general-purpose universities in the other

Chart 1: NWFP Agricultural University, Peshawar

This Agricultural University was created in February 1981. The current enrollment of the University is about 700 students with an annual intake of about 120. The NWFP Agricultural University holds the key to making the agricultural system in NWFP effective. All the leadership positions in the system are manned by graduates from this University. The system is weak largely because agricultural education has been weak. If agricultural education is improved and agricultural research is merged with it, the combination will improve agricultural production and the living conditions for farmers. The main points for increasing the mountain focus are given below.

- Though rural women contribute greatly to agricultural production, their role has neither been recognised nor has any attempt been made to increase their efficiency and improve their lot.
- The Research Programme and the university's research institutes/stations lack an agroecological zone perspective. Commodity improvement and discipline-oriented research need to be balanced with increased research on natural resources' management and a new spirit of partnership has to be adopted, particularly to achieve sustainable improvement in mountain ecosystems.
- Different agro-ecological zones in the uplands and mountains should be clearly delineated, and this will facilitate the identification of potential production zones based on agroclimatic and soil characteristics.
- The NWFP Agricultural University is in an ideal position to play a leading role in directing R&D efforts for sustainable development of mountain agriculture.

Extracted from Dr. Zafar Altaf, Dr. Noor Mohammed, Dr. A.A. Hashmi and Zafar Uddin, "Strengthening Institutions for Agricultural Development in the Northern Mountains of Pakistan", ICIMOD, Kathmandu. 1993.pp. 43-50.

Himalayan states of India. While there is some research focussed on mountain areas, the extent to which the overall curriculum addresses the needs of mountain areas is not very apparent. This is probably less of an issue for the universities and more for general policy-makers, as the gap between available jobs and the number of university graduates in all the major subject areas is increasing rapidly. In mountain areas, where opportunities for economic expansion are even more limited, it is difficult to argue that mountain universities should focus on mountain relevant subjects only, as the opportunities to absorb their skills may be very limited.

As a result of the above institutional shortcomings, and especially as a result of their isolation from practical farming, the faculty and students feel quite demoralised since their academic and research activities are not entirely relevant to local conditions, and they do not have the confidence of the farming community. This unsatisfactory situation needs to be rectified urgently, drastically revising curricula to bring them in line with the prevalent farming systems and entrusting responsibility for research and outreach to them. Above all, the agricultural educational institutions must develop close two-way linkages with the farmers and devote maximum efforts to improving the net incomes of farmers and conserving natural resources.

Agricultural Research[1]

Almost all the HKH countries have agricultural research institutes/stations located in mountainous areas to solve the emerging problems and develop improved production technologies. There isconsiderably diversity in the organisational patterns of these institutions in various countries, but they do have some common characteristics. Most of the research institutions devote much of their efforts to field crops, especially cereals-- wheat, maize, rice, and, in some cases, potatoes. The research is limited mainly to evolving higher yielding varieties and to pest management problems. Research on livestock management, fodder production, pasture management, horticultural crops, and agro-forestry, especially as components of integrated farming systems based on several commodities, is often not included in the research agenda of these institutions. Most of the research efforts are limited to biological and agronomic aspects, while research on farm machinery, sustainable use of the resource base, soil conservation, and socioeconomic aspects is almost entirely neglected.

One of the main problems in the mountain areas is lapses in **post-harvest processing and marketing** of the produce. As a result of this, the net income of the farmers is quite low even if the yield is high as a result of using improved production technology. Most research institutions in the region neglect the crucial processing, storage, and marketing aspects almost entirely. This results in sizable losses of perishable produce and a great variation in commodity prices.

Women play an important role in the household economy of mountainous areas, especially in livestock management, small farmer poultry production, harvest and post-harvest management of most field crops, production and processing of horticultural crops, and several other aspects of agricultural production and marketing. In spite of this, very little attention is given to training women in different aspects of agriculture and to research on gender-specific problems.

Different countries have followed different approaches in developing their agricultural research systems. Bhutan is currently reorganising its agricultural R&D institutions under what is now called the RNR (Renewable Natural Resources) Strategy (ICIMOD and RGOB 1994). Under this system, R&D institutions have been categorised into six groups to fit into the prevalent production systems, viz., dryland plantation and orchards, wetlands, livestock, forests, and *Tsheri* land. This type of categorisation indicates a mixture of the commodity approach and the production systems' approach. Another important feature of the RNR strategy is the creation of an institutional mechanism at district level for implementing R&D programmes and providing feedback for planning and identifying/revising priorities. A mechanism has been provided in the institutional structure and mandate for a participatory approach and a role for farmers in deciding priorities. The present system has been

[1] Based Upon Partap, T, "Institutions dealing with Agricultural Research and Development: How they look and How they Perform" in the International Workshop on Institutional Strengthening for Sustainable Mountain Development

a response to the drawbacks and inadequacies perceived in the earlier system. It is, however, in the early stages of operation.

In China (Ningnan county), agricultural extension work is effectively managed at the county level and is a unique example of a decentralised system in the HKH Region (CAS 1994). The County Management Committee selects the research priorities and invites national and provincial research institutions to work on research projects in which the county is interested. Scientific teams have to prove the value of their recommendations on farm before the contractual obligations of the county are fulfilled. In China, programmes and funding can also flow from national and provincial development institutions. When the county engages national and provincial research institutes to carry out research work on a programme basis, it avoids the necessity of creating its own infrastructure. Farmers contribute financially to county management and also to particular research programmes. The R&D system is designed to reflect the priorities of the farmer in its agenda. In keeping with the above R&D orientation, provincial and national governments create research stations to address research aspects of regional interest. The Chinese system of R&D seen in Ningnan county is a model of a bottom-up R&D approach which is very sensitive to local circumstances.

The R&D system used by Himachal Pradesh in India is commendable for its performance in terms of facilitating the commercialisation of hill agriculture (through horticulture) (Singh et al.1995). The system is conventional in its structure and mandate. For instance, it is very centralised and follows atop-down approach with little leeway for using people's knowledge. The strong point in favour of the R&D system is that it has received political patronage from the State, ensuring adequate funding for manpower, infrastructure, and research activities. Moreover, different farming communities working as pressure groups (representing different interests) have played important roles (through political channels) and influenced the choice of research programmes.

Himachal has also experimented in combining education, research, training, and extension activities under the university system and technology transfers under development departments. These have demonstrated the ability to facilitate improvements in farming in Himachal Pradesh.

It has been recognised that the R&D system in Himachal Pradesh needs to develop capabilities to meet the new challenges of environmentally-sound agricultural systems.

The structures of agricultural and forestry research and development institutions in the mountain areas of Pakistan are well developed for the plains, but not for the mountains. Since only part of the area is mountainous, most R&D systems reflect a plains' orientation. However, one can find regional research stations established in specific mountain areas, and they work under the CAREPLAN (Coordinated Agricultural Research Planning System). Provincial development departments act as organs both for Technology Generation (TG) and Transfer of Technology (TOT) (Altaf et al. 1993).

Institutionalised R&D in Nepal is still in the evolutionary stage. Structurally, it has been designed to meet the great diversity of mountain areas, but its problems lie in meagre resource allocation, lack of manpower and infrastructure, and the lack of clear cut priorities for the agricultural development needs of the country's different regions (Acharya et al. 1995).

Good examples of successful R&D institutional systems in Nepal are represented by the Lumle and Pakhribas regional agricultural research centres. These two institutions work on the basis of a fully internalised participatory approach, effective on-farm demonstrations, and designing research programmes based on the needs and resources of regional farming systems. However, questions have been raised about the heavy budgets of these centres compared to other R&D institutions in Nepal.

Research and development in Bangladesh and Myanmar are based on conventional structures and mandates. Problems facing these areas indicate that efforts are needed to strengthen their mandates and structures to meet new challenges. Resource constraints and manpower limitations are critical factors curtailing their growth and achievements.

There is a noticeable lack of effective linkages between the different organs of research systems and the farmer. There is a visible absence of both mechanisms and mandates for a participatory approach. This makes farmers passive partners, receiving ideas and technologies imposed from outside.

An overview of agricultural R&D in the HKH countries reveals that some areas are encouraged, whereas in others further development is needed. Also, most of these systems are either extensions of plains' based research institutions or are controlled and influenced by them. Thus, the question arises as to how far these R&D systems are responsive to the conditions of mountain habitats and to mountain agriculture.

The practical realities of hill and mountain areas impose certain imperatives in the form of potentials and limitations, which, in turn, demand a specific orientation and structure of R&D institutions to suit mountain areas.

An understanding of mountain specificities makes one realise that R&D institutions for mountain agricultural development need to have broader and more diversified mandates, strong intersectoral and interdisciplinary linkages, and mechanisms for multidisciplinary teams of scientists to work on the problems, with regular feedback from the farmer. The outcome of research has to be relevant to the local farming community. Some salient features of the R&D impact assessment in Himachal Pradesh are quite instructive, with regard to the opportunities as well as to the gaps, as shown in Chart 2.

Almost all countries have an R&D focus on commodities' research. In some areas, such as Ningnan and Himachal Pradesh, agricultural research has visibly succeeded in making significant impacts. One key factor behind their success is their ability to

Chart 2
Salient Features of Impact Assessment of the Existing R&D Institutional System in Himachal Pradesh (India)

Mountain agriculture has been affected positively as well as negatively with the inception of R&D activities. The positive impacts have been changes in cropping patterns in favour of HYV cash crops, i.e., from subsistence agriculture to market-oriented production. The negative effect is reflected in the widening intra-regional disparities due to the comparative advantage of high-value cash crops

A technological breakthrough has a special relevance for hilly areas which are in the embryonic stage of development. There has been a breakthrough in fruit production. Farmers are no longer reluctant to accept new ideas and technologies.

R&D initiatives have resulted in need-based manpower generation. Trained, skilled, and qualified manpower is now emerging from the hill farm universities for development programmes. Need-based and location-specific farm education have also infused confidence among State Monitoring Services (SMSs) for effective feedback and sound interactions with scientists. The quality of manpower produced in hill farm varsities can further be improved by incorporating hill ecology components in the curricula.

Biodiversity plays a crucial role in maintaining the uniqueness of a mountain environment and the survival of mountain societies. Mountain people have now lost their links with mountain bioecology. The traditional gene pool is declining. Ethnobotany is on the brink of extinction.

The survey showed that, although people have become aware of modern inputs, the main problem confronted is the untimely and inadequate supply of inputs. Most farmers are still ignorant of the use of improved inputs.

Some of the local people's perceptions of R&D work, highlighted in the survey, are: provision of irrigation facilities, reducing the cost of fertilizers, timely provision of vital inputs, facilitating agricultural loans on easy terms, seed and fertilizer distributing centres, arrangement of more *kisan mela* (farmers' fairs), training and workshops, broadcasting of farming messages on radio and television, training of villagers for extension services, use of the local language for extension, and providing continuity in extension services.

Information on new technological inputs seldom reaches women because of the gender bias in extension services. There is a need for women Village Level Workers (VLWs). Women cultivators also reported having problems with credit. The need for NGOs' help in demanding equal wages was expressed.

Some of the women's perceptions regarding R&D, highlighted in the survey, are: identification of suitable and viable schemes, training women in non-traditional skills, free and accessible loans to different women's organisations, and the identification of women contact farmers.

Khosla, P.K., "Review of Agricultural Research and Development Systems in the Indian Himalayas. A Case Study of Himachal Pradesh," In ICIMOD, *Review of Institutional Capacities for Sustainable Mountain Agricultural Development*, ICIMOD, Kathmandu, 1995, p.88.

match their activities with the niche and agroclimatic conditions of the mountains. In other countries, such as Nepal, the focus so far has been on cereal crops (maize, wheat, rice), and this has only benefitted a few better-off farming communities with relatively fertile lands. There has been no impact on othercrops/products. The experiences of all countries indicate that there is a strong need for an alternative approach to R&D, especially one that integrates the past commodity focus with natural resources.

Motivated, well-educated, and properly-trained manpower is an equally important prerequisite to R&D institutions making impressive achievements. Concerns have been voiced in India and Pakistan about inbred and poorly-motivated scientific manpower. Solutions, such as reorienting educational materials by incorporating the mountain perspective, linking educational institutions to western universities, and maintaining contact with and ensuring exposure to external scientific work, have been suggested by some reports. This is a positive sign.

A few things become clear at this stage. First, educational facilities for developing human resources, which are especially designed for mountain agriculture, do not exist at present. Second, the existing professional manpower has been working in compartmentalised systems with little interdisciplinary interaction, and this probably favoured the commodity approach. Emphasis on the development of environmentally-friendly agricultural systems calls for manpower with broader training and good interdisciplinary knowledge. Should it be necessary to broaden the R&D mandates in order for mountain agriculture to accommodate resource management concerns, it will call for reorientation or retraining of most of the scientific manpower.

The traditional art and science of resource management and production were evolved and inherited by rural communities through centuries of informal experimentation. One finds that, despite their greater suitability and relevance, modern R&D institutions working for the development of mountain agriculture have given very low priority to institutional mechanisms that can retrieve rural people's knowledge (RPK) from the farmers. Although this neglect is part of the modern R&D culture worldwide, the intensity of the disregard for RPK in mountain areas is perhaps greater than elsewhere. Whatever the factors behind the neglect, the rationale, if not the form, of traditional technologies is very relevant today for they could constitute the most useful input into R&D in mountain agriculture. The institutional dimension of this blending of RPK with modern R&D, however, poses several questions involving collaboration of R&D scientists and farmers in interdisciplinary problem-focussed, location-specific work.

Yet another equally important issue is how much resource allocation is necessary to make institutions effective in development and delivery-relevant technologies? Existing experiences show that institutions, such as Lumle and Pakhribas, that are operating on very high budgets (by Nepalese standards), are very effective in performance and impact. The budgets of these two foreign-supported institutions, in com-

parison to locally-supported R&D systems, are very high, and the government R&D institutions are working on very low budgets. Reports from most other countries speak of poor resource allocation, particularly to research programmes and extension activities. In India, Himachal Pradesh reports higher resource allocations and better manpower facilities than the Uttar Pradesh Hills (3.5:1), and it is argued that it achieves better performance in and impact on agricultural development because of better resource allocation.

It is true that many of our R&D institutions are under-funded, but how much more is needed in terms of funds? What should the optimum scale of investment be? Can countries afford the Lumle/Pakhribas type of model?

An equally important question for national R&D planners and donors is that, in view of the diversity, location-specificity, high cost of logistics, etc should there not be different norms and yardsticks for research resource allocations in mountain areas? Questions that R&D scientists should look into are how much extra will it cost to reorient their work to involve the farmers' perspective, introduce diversification, and integrate resource-regenerative components in their technology? What do they think of low-cost technologies? How far can they follow the Ningnan (China) model in which agricultural R&D is a local, community-funded activity?

There is an urgent need to critically review the research programmes of these institutions and orientthem towards solving the priority problems with a strong emphasis on optimising the farm incomes from small holdings through sustainable use of natural resources. Most of the institutions have never been subjected to **external peer review** and continue to carry out research on the same topics, sometimes for decades. This results in considerable misuse and wastage of precious human and financial resources.

Educational and research programmes should be closely linked. Farmers need to be fully associated with both the teaching and research functions, and their perceptions should be reflected in the curricula as well as in the prioritisation of the research agenda. Finally, the institutions should be funded adequately so that qualified researchers do not feel constrained to undertake their approved research programmes owing to deficiencies in laboratory, library, or farm facilities. Because of the relative isolation of mountain areas, it is even more essential to provide adequate support to keep the morale reasonably high.

Most of these issues are of concern to the respective countries, but there are areas in which the role of ICIMOD can be envisioned as a catalytic institution; e.g., in facilitating the reformulation of R&D mandates, in taking up the responsibility for giving orientation-training to existing manpower, generating and disseminating information/literature, and cooperating with national institutions to strengthen their capabilities wherever they feel it possible. These are, however, very broad bases for cooperation between ICIMOD and the national institutions, and their specifics would vary from country to country.

Priority Areas for the Future

The challenge for sustainable agriculture in the future is to control and reverse the degradation of natural resources and continue to maintain growth in food production. Compared with the conditions of the 60s, the world faces a vastly changed set of circumstances. Although there have been significant expansions and growth in national investments for agricultural research over the years, the negative factors have been rapid population growth, limited potential for expanding irrigation, cultivation in marginal areas, soil erosion and depletion of soil fertility, overdependence on chemical fertilizers and pesticides which pollute the environment, and overall reduction in biodiversity. Equity aspects have also emerged significantly, as green revolution technology was scale neutral but not resource neutral. Poorer farmers simply could not afford the inputs without strong support services, and these were largely inaccessible. The need to integrate gender has been an important lesson from the past. Whereas comparative advantage arguments are well recognised, it must also be accepted that subsistence requirements force farmers to grow foodgrains even when this is not optimal. Small farm sizes result in many "farm practices that induce erosion by decreasing the use of compost and increasing the use of chemicals." Major gaps in infrastructure and support systems make it difficult for farmers to switch to more optimal cropping patterns, while the unsolved problems of land tenure and land distribution lead to the marginalisation of small holders and improper land use.

Sustainable agriculture is not possible without addressing these problems, as is clear from the conclusion of the 20-20 Meeting (IFPRI). In view of the fact that a generalised approach (good lands, irrigation, improved seeds, and chemical inputs) is no longer adequate to sustain growth in agricultural output and productivity, a more flexible approach that attempts to deal with the problems of specific areas or agroecosystems is needed. It is urgent to begin looking at the specific agricultural problems and opportunities of rainfed areas, mountains, semi-deserts, grasslands, etc. It is only by addressing specific problems that one can begin to integrate different issues, such as increasing production, with reducing soil fertility or biodiversity. It is in this context that there is now serious concern about the sustainability of mountain agriculture. Emerging areas of consensus for future action in the field of education and research are as follow.

Overcoming the Past Neglect of Mountain Agricultural Education and Research

There is little doubt about the great ingenuity of mountain farmers. In the past, they have succeededin training a most difficult environment. Today, in spite of all its past achievements, mountain agriculture is in a state of crisis and is suffering from many serious problems. Just as the world succeeded, through concerted attention and effort, in producing the first Green Revolution, similar commitment is needed to overcome the past neglect, isolation, and damage to mountain agriculture. This commitment cannot be *ad hoc,* as education and research capacities do not develop overnight and, without investments in education and research, the necessary solutions cannot be developed. It is for a group such as this to identify measures to make this possible.

A Consortium or Partnership Approach

As the problems being encountered today are complex (intersectoral, intertemporal, interinstitutional, and interspatial), no single agency has the resources or capacity to deal with these alone. Individuals and agencies must work together. As past experiences clearly indicate, isolated efforts seldom achieve the needed results. It is also important to understand that resources are extremely limited and that we need to work together not only to mobilise the necessary resources but also to use them efficiently. For the consortium to be effective, there must be flexibility in innovative approaches through the active participation of different contributors to mountain agricultural education and research.

Better Integration of Research and Education

Great efforts are needed to integrate agricultural research and education in mountain areas, if they are to contribute to sustainable mountain agriculture. The constraints and opportunities before mountain areas differ widely from place to place. There is a constant need for adaptation and modification. It is evident from the earlier discussion that, at present, there is inadequate integration between agricultural education and research in terms of problems, as well as institutionally. If education is seen to be only a degree with little practical relevance, it is because research has remained isolated inside an enclave, and the sophistication inside research farms contrasts sharply with the primitive nature of farms located outside. In the long run such a dichotomy is very costly for any society and is therefore clearly unsustainable. It is not only a question of merging institutions. The earlier model of the American Land Grants' Agricultural Colleges attempted to promote this integration. But it has not been achieved in new experiments in the region. Research has become the domain of government institutions, while educational institutions have been left to mass produce certificate-holders with little concern for the worth of their certificates. It is the poor quality of agricultural graduates that may be responsible for the diminished preference of agriculture as a chosen subject among younger groups. A major effort is needed to integrate research and education once again, because so many of the educational skills needed in mountain areas are related to refined abilities to examine new problems and situations as they come (and less to the practice of recipes learned from text books).

Redesigning Agricultural Education and Research for Sustainable Mountain Agriculture

A careful assessment needs to be made of the content, curriculum, methods of learning, etc if agricultural education and research are to become more relevant for sustainable mountain agriculture. To attain agricultural sustainability, people must think ecologically and economically. Solutions are not permanently defined. If much of the agricultural teaching focusses on fertilizers, pesticides, motor vehicles, replacing internal inputs with external ones, and these degrade the environment, then this type of teaching and research should be seriously questioned. If teaching and research do not understand or involve the farmer who should ultimately benefit from these activities, then the value/utility of such teaching becomes very questionable.

Teaching and research should not overlook the problems and priorities of women farmers. New methods of learning are emerging, and it is time to be as flexible as possible without being burdened by the dead weight of past systems. This applies to curriculum, participants in the process (farmers, researchers, women, and others), places of learning (farmers' fields in addition to others), and indeed a whole range of related activities, including the use of computers, remote sensing, etc.New areas have emerged, both in socioeconomic aspects as well as in biophysical ones. If we talk about biotechnology and genetic engineering, we are also discussing ownership of policies and projects by stakeholders, the need for better understanding of social cohesion, greater transparency and accountability, and empowerment of the poor and disadvantaged. All of these have become as relevant for sustainable mountain agriculture as in other areas of development. Agricultural education and research in mountain areas should begin to address these through the development of new innovative methods of participatory learning. There is little value in trying to simply replicate the earlier systems if the present problems have little impact from these.

Capacity Creation and Capacity Building

Without organisations specifically working for these purposes, there will be little progress in this area. Once a few of these are established, they can begin to 'light the torch' in other agencies. The first problem is, therefore, the creation of this capacity in different parts of the HKH Region. The second problem would be the systematic building up of capacities in different agencies and programmes. There is an important role in this for national agricultural research centres (NARCs), international agricultural research centres (IARCs), universities, and other organisations - such as the donors committed to mountain development. To identify the concrete steps needed for the future would be a useful exercise for the present group.

Cooperation with International Agriculture Research Centres

Convinced of the tremendous impact of the IARC model of improving food production in the developing countries, the donor community, led by the World Bank, UNDP, and FAO as co-sponsors, decided to form a Consultative Group on International Agricultural Research (CGIAR) in 1971. The main objective of this Group is to organise research on major food crops, livestock, and forestry at well organised and funded international agricultural research centres, located mainly in the developing countries to generate improved technologies to substantially increase agricultural productivity and net incomes of small farmers in the developing countries. As a result of considerable expansion of the CG system, the number of IARCs has increased to 16 (Table 1) and the annual budget of IARCs in the system increased from $19.5 million in 1972 to $342 million in 1994.

Initially the CG centres focussed primarily on generating improved technology to enable increased, sustainable production of various commodities, especially under small farmers' conditions. The research agenda of the CGIAR has gradually increased emphasis on sustainable production, resource conservation, equity, gender issues, and development of national capabilities to organise research in national institu-

Table 1: International Agricultural Research Centres of CGIAR

Institute	Founded	Headquarters	Research Relevant to HKH region
1. IRRI (International Rice Research Institute)	1960	Manila, Philippines	Upland rice production, especially under cold conditions (varieties agronomic practices)
2. CIMMYT (Centre Internacionale de Mejoramiento de Miaz y Trigo)	1966	Mexico City, Mexico	Maize, wheat, barley and triticale
3. CIAT (Centro Internacional de Agricultura Tropical	1967	Cali, Columbia	Beans, forages and pastures
4. IITA (International Institute of Tropical Agriculture)	1967	Ibadan, Nigeria	
5. WARDA)West Africa Rice Development Association)	1970	Bouake, Cote d'Ivoire	
6. CIP (Centro Interncional de la Papa)	1971	Lima, Peru	Potato and Sweet Potato
7. ICRISAT (International Crop Research Institute for the Semi-Arid Tropics	1972	Patancheru, Andra Pradesh, India	Sorghum, millet, chickpea, pigeonpea and groundnut. Farming Systems' Research
8. IPGRI (International Plant Genetic Resources' Institute)	1974	Rome, Italy	Conservation and use of plant genetic resources and health
9. ICARDA (International Centre for Agricultural Research in the Dry Areas)	1977	Aleppo, Syria	Wheat, barley, chickpea, lentils, pasture, legumes, small ruminants. High elevation environment
10. IFPRI (International Food Policy Research Institute)	1975	Washington D.C. USA	Food and Agri. policy analysis
11. ICRAF (International Centre for Research in Agro-forestry)	1977	Nairobi, Kenya	Integrating trees in land-use systems
12. ISNAR (International Services for National Agricultural Research)	1980	The Hague, Netherlands	Strengthening and dev. of NARS
13. IIMI (International Irrigation Management Institute)	1984 (1992*)	Colombo, Sri Lanka	Irrigation Management
14. ICLARM (International Centre for Living Aquatic Resources' Management)	1977 (1992*)	Manila, The Philippines	Sustainable dev. of aquatic resources
15. CIFOR (Centre for International Forestry Research)	1992	Bogor, Indonesia	Forest management, tree germ plasm, breeding of improved trees, biodiversity
16. ILRI (International Livestock Research Institute)	1995	Nairobi, Kenya	Livestock production & health
17. ILCA (International Livestock Centre for Africa)	1974	Addis Ababa, Ethopia	Livestock production in Sub-Saharan Africa
18. ILRAD (International Laboratory for Research on Animal Resources)	1973	Nairobi, Kenya	Major livestock diseases in Sub-Saharan Africa

tions. The CG centres have contributed substantially to the development of trained manpower in the national agricultural research systems (NARS), provision of research materials, and linking national institutions in problem-oriented regional research networks. CG institutes are also a model of research management, including highly effective external programme and management reviews. Some of the management practices of the CG can be profitably adapted by the NARS to bring about increased efficiency of their research investments.

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Several of the above IARCs already have active research programmes in the HKH region in collaboration with national institutions. Since ICIMOD has the primary responsibility as an international institution for development of the HKH region, it would be desirable for this centre to play a coordinating role to package technology for improving the region's agriculture, in close association with the relevant national institutions and the IARCs. The comparative advantage of the three sets of institutions can be incorporated in devising a cost-effective strategy for organising research specific to the problems of agriculture in the HKH region. The networking approach that has often been used very productively by several IARCs would be appropriate to link institutions for such collaboration.

ICIMOD Initiatives for Regional Cooperation

As a first step towards fostering regional cooperation for sustainable development of mountain agriculture among the agricultural research and educational institutions located in or concerned with mountain agriculture in the HKH, ICIMOD took the following initiatives:

i. organised a Regional Consultation on Education and Research for Sustainable Mountain Agriculture and
ii. established a Fellowship Programme in the field of Mountain Agriculture in Tibet.

The regional consultation on education and research was organised in Kathmandu in January, 1996, to provide a platform for sharing experiences, discussing issues of common concern, and identifying areas of action at national and regional levels. Among the eighty-five participants, who were representing agricultural education, research, extension, and development institutions from HKH countries, 20 were Vice-Chancellors from Universities based in the HKH. A similar number of high-level functionaries from National Agricultural Research Systems (NARS) took part. Another 20 participants represented Ministries of Agriculture, NGOs, and other organisations with a mandate in agricultural extension.

The deliberations at this consultation were focussed on assessing the extent to which mountains are a focus in agricultural research, education, and training within academic and research institutions; to identify the strengths in the HKH; to identify priority areas of research, teaching, and training in sustainable mountain agriculture; and to identify mechanisms for cooperation and sharing knowledge and information.

The highlight of this consultation was the general consensus that, for sustainable mountain agricultural development, regional cooperation among institutions of the HKH is necessary in order to overcome institutional marginality within the national contex. For operationalising such an arrangement, ICIMOD may have to play a pivotal role. The priority area for this network will be facilitation of the reorientation of farm education and research to suit local farming systems. This will have to be achieved through extensive efforts in human resources' development, exchange of knowledge and experiences across countries, and facilitating other institutional

strengthening needs. A number of recommendations has been made for follow-up at institutional level, national level, and by ICIMOD.

As a follow-up to the recommendations, ICIMOD made initial efforts by starting a FellowshipProgramme in Tibet to help improve the academic qualifications (M.Sc and Ph.D) and research training in the field of mountain agriculture. In addition, the Tibet College of Agriculture and Animal Sciences, located in the county of Ninje Bye in eastern Tibet, has been given both technical and financial support to train a critical number of teachers to start regular course work on mountain agriculture. This also necessitated supporting the translation of relevant literature produced by ICIMOD into Chinese and Tibetan.

These examples of recent initiatives at the regional and national levels bring home the point that there is increased awareness about the need for making farm education and research in mountain areas more relevant to the local environment and farming communities. Further, the experiences of small localised initiatives at different levels need to be shared and combined with a major effort in this respect.

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ICIMOD

ICIMOD is the first international centre in the field of mountain development. Founded out of widespread recognition of environmental degradation of mountain habitats and the increasing poverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983 and commenced professional activities in 1984. Though international in its concerns, ICIMOD focusses on the specific, complex, and practical problems of the Hindu Kush-Himalayan Region which covers all or part of eight Sovereign States.

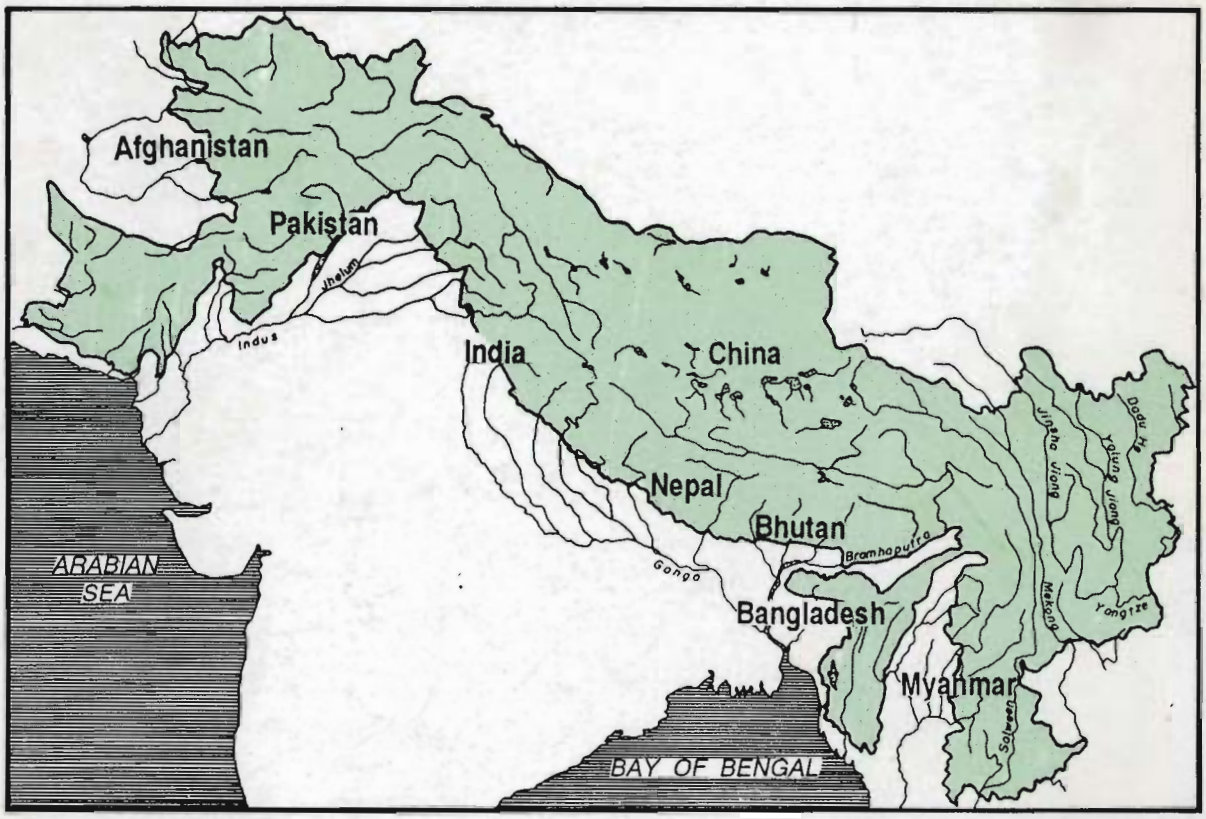
ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs and the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

Mountain Farming Systems' Division

Mountain Farming Systems constitutes one of the thematic research and development programmes at ICIMOD. The medium-term objectives of the programme include i) Appropriate Technologies for Sustainable Mountain Agriculture, ii) Institutional Strengthening for Mountain Agriculture, iii) Integration of Gender Concerns into the Development of Sustainable Mountain Agriculture, iv) Agricultural Research Networking, and v) Better Understanding of Sustainability Dimensions.

Participating Countries of the Hindu Kush-Himalayan Region

* Afghanistan
* Bhutan
* India
* Nepal
* Bangladesh
* China
* Myanmar
* Pakistan



International Centre for Integrated Mountain Development (ICIMOD)

4/80 Jawalakhel, G.P.O. Box 3226, Kathmandu, Nepal

Telex : 2439 ICIMOD, NP
Telephone : (977-1-525313)
e-mail : dits@icimod.org.np

Cable : ICIMOD, NEPAL
Fax : (977-1) 524509
(977-1) 536747