Keynote Speech

Mountain Agriculture, Marginal Lands, and Sustainable Livelihoods: Challenges and Opportunities

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Status of Farming in the Hindu Kush-Himalayan Region

Most of the mountain people in the Hindu Kush-Himalayan (HKH) countries (Nepal, Bangladesh, Bhutan, Pakistan, India, China, Myanmar, Afghanistan) depend upon agriculture for their livelihoods. Land ownership in these societies is not only a symbol of economic status but of social status as well. Shrinking cropland as a consequence of unrelenting demographic pressure and sub-division of holdings is endangering their food and livelihood security. Although a population of about 150 million inhabiting an area of 3.4 million sq.km in the HKH countries gives an overall population density of about 44 per sq km (with a range of 2-200 persons per sq.km), the actual pressure on sloping hills and mountains is better indicated by the number of people per sq km of agricultural land, a figure that is much higher. Table 1 shows that per capita availability of cropland in almost all countries of the region is too small to afford decent livelihoods. The uplands of the HKH region have limited cropland (11% of the total area) to support the livelihoods of rural households. The potential yield of cropland is further reduced because 37% of the cropland is sloping land, with farmers cropping lands with slopes even beyond 25° and 30° (Partap 1999). Unrelenting demographic pressure, thanks to the launching of numerous health and family welfare programmes, and continuous sub-division of holdings due to lack of alternative employment opportunities have further aggravated the scarcity of cultivable land.

The problem of shrinking agricultural land is compounded because new human settlements, urbanisation, industrialisation, and infrastructure developed by government are devouring the flat valley cropland. In his landmark study of global cropland loss, Gardner (1996) warned about the implications of cropland loss to food security and livelihoods. He predicted that hill and mountain areas would suffer most from cropland loss. Almost all countries of South Asia lack laws to prevent the conversion of cropland to non-agricultural purposes.

Table 1: Sloping lands and people in the Hindu Kush-Himalayan region

Country	Mountain area (sq.km)	Sloping land %		Agricultural land (%)	Per capita agricultural land (ha)	Population inhabiting marginal areas (million)	Population density (per sq.km)
		8°-30°	>30°				
Afghanistan	390,475	35.1	41.9	10.0	NA	13.8	35
Bangladesh	13,189	60.5	12.2	7.8	0.10	1.2	57
Bhutan	46,500	12.7	88.4	7.6	0.17	1.2	30
China	1,647,725	10.0	50.7	1.2	0.15	19.6	20
India	482,920	30.7	21.1	8.3	0.29	35.0	73
Myanmar	280,862	37.4	29.1	7.7	NA	5.8	21
Nepal	147,181	12.7	66.3	18.0	0.13	18.5	126
Pakistan	404,195	29.3	35.6	7.8	0.16	22.7	56

Sources: Partap (1998)

This has led to reduced numbers of small farmers, who find it difficult to resist the lucrative land market.

Mountain farmers have adopted multiple strategies in their desperate bid to maintain their livelihoods in the face of an ever-shrinking land base and dwindling crop yields. These include extending cultivation to steep slopes and increasing male migration to the plains. The former practice has accentuated the problems of falling crop yields and environmental degradation, manifested in increasing soil erosion, declining soil fertility, and so on. The studies have documented numerous indicators of unsustainable agricultural practices in different regions of the HKH (Jodha and Shrestha 1994). These are summarised in Table 2. The net result has been increased environmental degradation, abandonment of land, increasing drudgery for women, and impoverishment and endemic poverty. This whole process is aptly described as a poverty-environmental degradation-poverty cycle. This state of affairs poses difficult questions and paints a grim picture for times to come. We are obliged to ask several questions.

- Where do we go from here?
- How do we ensure the livelihood security of the households of upland areas?

Table 2: Indicators of unsustainable upland farming in the HK-Himalayas *(1954-1991)*

Indicators reflecting problems relating to resource base/production flow & resource management	Range of changes
1. Soil erosion rates on sloping lands	+20 to +30 %
2. Abandonment of agricultural land due to decline in soil fertility	+3 to +11%
3. Appearance of stones/rocks on cultivated land	+130 to +100 %
4. Size of livestock holding per family (LSU)	-20 to -55%
5. Area of farmland per household	-30 to -10%
8. Forest area	-15 to -85%
7. Pasture/grazing area	-25 to -90%
8. Good vegetative cover on common property land	-25 to -30 %
9. Fragmentation of household farmland (in number of parcels)	+20 to +30%
10. Size of land parcels of families	-20 to -30 %
11. Distance between farmland parcel and home	+25 to +60%
12. Food grain production and self-sufficiency	-30 to -60%
13. Permanent out-migration of families	none to 5%
14. Seasonal migration	high to high
15. Conversion of irrigated land to dry farming land due to water scarcity	+7 to +15 %
16. Average crop yields on sloping lands	
maize and wheat	-9 to -15%
millets	-10 to -72%
17. New land under cultivation	+5 to +15%
18. Human population	+60 to +65%
19. Application of compost (organic manure)	-25 to -35%
20. Labour demand for falling productivity	+35 to +40%
21. Forestry farming linkages	weak to weak
22. Foodgrain purchases from shops	+30 to +50 %
23. External inputs' needs for crop production	high to medium
24. Fuel wood or fodder scarcity in terms of time spent in collection	+45 to +200%
25. Fodder supply from	
common land	-60 to -85%
private land	+130 to +150%
26. Emphasis on monocropping	high to high
27. Steep slope cultivation (above 30%)	+10 to +15%
28. Weed and crop herbaceous products' used as fuelwood	+200 to +230 %
29. Conversion of marginal land into cultivation	+15 to +40%
30. Fallow periods	from 6 months to 3 months

Note: A positive sign (+) means increase and negative sign (-) means decline/ decrease
Note: adapted from Partap (1998)

- Are solutions available? Is the technology to support the solutions available?
- How do we preserve the environment and rich biodiversity available in the mountains?
- Are there any experiences of success in the HKH to draw upon?

These and other questions need to be answered to ensure food and livelihood security to mountain people without further degradation of their environment.

The availability of vast marginal lands provides hope in this otherwise dismal scenario. Besides marginal lands, in most South Asian countries a sizeable amount of land is available between the cropland and forest land. This is known by various names, such as wasteland, grazing land, rangeland, shrub land, unclassed forests, and so on. Much of this land provides crucial support to farming and the livelihoods of hill and mountain farmers (Partap 1998a,b). The hope lies in finding ways and devising technologies to use this land productively to both alleviate poverty and improve the environment.

Marginal Lands: Concept and Definition

Marginal lands have been defined in various ways and different terms like marginal, low potential, resource poor, fragile, vulnerable, or degraded lands are currently in vogue, even so 'marginal lands' is the most commonly used term (Partap 1998b,1999; CGIAR 1999). The term resists precise definition, however, because the productivity of such lands depends on their use. For example, a tract of sloping land that is marginal for crop production may be well suited for grazing or fruit farming. It may be prone to degradation under cultivation but can be used sustainably for forestry. Further, productivity not only depends on the biophysical characteristics of land, but also on the socioeconomic parameters of a specific environment. Likewise, technologies may be known but the necessary incentives, institutions, or inputs may be missing. In brief, the possible uses of marginal lands are too wide and socioeconomic conditions of upland, mountain, or highland farmers too diverse to encompass all the relevant factors in a single term.

Marginality of land results from several constraints. For instance, biophysically good land can be marginal due to its isolation from markets, the non-availability of inputs, or the small size of holdings. The nature, composition, and interaction of the factors determining marginality can also differ widely. Accordingly, four broad land types can be identified: (i) relatively favoured lands with high current agricultural value, (ii) lands at low or zero intensity of agricultural use value, (iii) marginal lands with low present agricultural use value, and (iv) lands at low or zero intensity of agricultural use.

A number of factors may shift such land from one category to another. These shifts may be upward through applications of appropriate improved technologies, or downward as a result of land degradation due to its inappropriate use. In net terms, marginality is a dynamic process, and sloping land that is marginal for crops requiring continuous irrigation and moisture for their entire growing period (e.g., rice) could be highly productive for perennial crops that need less moisture and can tolerate bouts of drought. Marginal cropping land may support productive and sustainable livestock production systems. Thus, whether land is 'marginal' depends on several key characteristics like use, biophysical

characteristics, location, institutional and policy context, population pressure, technologies, and so on. A given piece of land may move out of or into marginal status depending on which of the dimensions are considered.

Agriculture on Marginal Lands: Past Neglect and Current Agenda

In the past, because of the perception that cropping is unsustainable on slopes beyond 15°, marginal lands did not figure in the research agenda of national agricultural research systems (NARS). Thus because sloping lands (8%-30%) comprise much of the Himalayan region, most people remained deprived of the technological support necessary to adopt sustainable farming practices (Partap 1998b). One also finds misconceptions about the role of forest in the sustainable management of marginal lands. Forests not only play an important ecological role in maintaining the hydrology and soil movement of sloping lands, but also provide viable, economically sustainable options. This misconception about the role of forests has led to lost opportunities for using sloping, marginal lands in more productive ways.

This past neglect has led to a number of harmful effects.

- First, with the availability of improved technology for producing cereals, the indigenous crops and crop varieties have disappeared, and a rich source of genetic material has either been lost or is on the verge of extinction.
- Second, several potential crops that can be grown in the area remain unexplored.
- Third, although many high-value cash crops eminently suitable to these areas (like medicinal plants) are known and documented, the technology to grow these crops is not yet available.
- Fourth, the available technologies have remained in laboratories and are yet to be experimented on in farmers' fields.

Things have, however, started changing. At the international level, three ongoing developmental processes facilitate the shift in investment and international research towards marginal lands (CGIAR 1999).

- The environmental lobby has promoted a growing concern for vulnerable and fragile lands (because of the global dimension to the problem of degradation of sensitive natural areas), the deterioration of mountain environments, desertification, and destruction of biodiversity.
- The development lobby has promoted a concern for poverty. Because most of the world's poor live on marginal lands in the developing world, concern for making marginal lands more productive has become a proxy for reducing the poverty of those who inhabit these lands.
- The agricultural and environmental lobbies have promoted concern for mountain agriculture, where rainfed sloping farmlands are being marginalised or degraded through their overuse or misuse.

Recently, in its efforts to reorient research priorities and to give more attention to marginal lands, CGIAR (1999) defined marginal lands as marginal agricultural lands (MAL), which include sloping lands currently used for agriculture, grazing or agroforestry. They are characterised by poor soil fertility (nutrient deficiencies, acidity, salinity, poor moisture holding capacity, and so on); inaccessibility (with all its social and economic dimensions);

fragility; and heterogeneity (physical and cultural diversity that bring inherent constraints and opportunities).

Success Stories: Experiences and Lessons

Some of the success stories about the productive use of marginal lands in different regions of the HKH are discussed below. Among the indigenous technologies available, terracing is the most widely known traditional practice used for farming the sloping lands across mountain regions of Asia and the world. Countries like Nepal and Bhutan are outstanding examples of this (Das and Maharjan 1988; Thinley 1991). In the humid middle mountains of the central and eastern Himalayas, terracing is essential for crop cultivation on sloping lands over 20°. In recent decades, some institutions have evolved alternatives to traditional stone walls and terracing systems by using contour hedgerow technology, which uses nitrogen-fixing plants and grasses to build the contour hedgerows. While successful adoption of this has been reported in some cases, wider adoption is yet to come (Partap 1998).

Fruit farming on marginal farms

Small, marginal, subsistence mountain farmers of Himachal Pradesh succeeded in improving their food security and livelihoods by diversifying from crops to fruit farming. Adoption of this niche-friendly production system on large areas of marginal farms in the temperate regions of the state made a huge economic and environmental impact. In economic terms, the net domestic product of Himachal Pradesh increased 200 times, and net per capita income 26 times, between 1971 and 1991. There is hard evidence to show that fruit farming on marginal lands is a superior production option both economically and ecologically. The key benefits that accrued from this production system have been outlined by Partap (1995) and Sharma (1996).

The productive use and management of marginal land resources

More than 80 % of the fruit farming in Himachal Pradesh has been carried out on barren and uncultivated marginal sloping agricultural lands. This has led to an increase in the area of economic forests (areas like orchards that provide cash income from trees excluding from timber) in Himachal Pradesh.

Non-viable subsistence farming can be transformed into viable commercial farming through harnessing the appropriate niche potentials of marginal mountain lands. The percentage of small and marginal farmers in Himachal Pradesh has increased to over 75% during the past three decades, and their cereal-based subsistence farming did not yield adequate incomes to meet their needs. Farming thus became an unviable but inescapable option (Vaidya and Sikka 1992). Fruit farming helped reverse this trend and ensure food security and better livelihoods, particularly to marginal farmers. The fruit-based production system helped not only to alleviate poverty, but also to promote zero tillage on sloping farmlands, which led to diverse economic and ecological benefits.

Forest floor farming production system

Cardamom farming on the forest floor in Sikkim presents an example of developing an economically productive and ecologically sound and sustainable production system on

marginal and sloping lands (Sharma and Sharma 1997). The following factors made cardamom farming on marginal sloping lands compatible with their biophysical features.

- Cardamom is ecologically adapted to farming on sloping lands and forest areas. The plants maintain a permanent green cover on the forest floor.
- Cardamom farming ensures ecological stability to fragile mountain slopes by requiring farmers to maintain a good forest cover of nitrogen fixing alder trees.
- Cardamom is a farmer-domesticated, indigenous, low volume-high value cash crop eminently suited to marginal lands.

Forestry production system

The large-scale planting of seabuckthorn in China is an example of ecological rehabilitation of marginal lands. The plant's fruit provides raw material for agro-industry. It is the best example of strategies by which people can raise and maintain good forest cover on otherwise unproductive marginal lands. For fragile and marginal mountain lands the environmental gains of seabuckthorn far exceed the commercial benefits. The plant has been used to control soil erosion in the loess plateau and Yellow River basin. A major programme of afforestation using seabuckthorn in the mid-1970s was launched in most of the marginal dry areas in these regions. By 1988, lush green seabuckthorn forests had spread over 113,300 sq km, of which 30% were mixed forests rejuvenated by seabuckthorn (Lu 1992). Today, these plantations have successfully rehabilitated the marginal land by converting it into a healthy forest ecosystem. In economic terms, the total value of the seabuckthorn products produced by the Chinese agro industry exceeds US$25 million a year (ICRTS 1997).

Summary

These examples of fruit farming, cardamom, and seabuckthorn reflect the incorporation of a niche-based mountain perspective in planning the development of marginal lands. In all three cases, suitable technological options were identified. The commonalities in the goals and benefits of these three cases are listed in Table 3. The moral of the story is that marginal lands are not constraints to productivity but in fact are huge, untapped potential resources if appropriate technological choices are made. The experiences described above add a new dimension to the process of linking marginal mountain land management to improving livelihoods. The trends unfolded by these examples define a role for leveraging biodiversity and agrobiodiversity to enhance the use value of marginal land for sustainable mountain development. Scholars have indicated the need for adopting this alternative land-use perspective, albeit in other contexts (Critchley and Reij 1996; Jodha 1992, 1996a,1996b, 1997; Partap 1998b).

Looking Ahead: Some Policy Options

In recent times, global efforts have been initiated for reducing poverty, enhancing food security, and promoting the sustainable use of natural resources in upland areas. Technological and institutional innovations have been made to enhance the productivity and sustainability of marginal land and other natural resources. Contextual specificities in technology generation are the key to targeting agricultural technology research that will mitigate poverty in upland areas. Focusing research on technological innovations for

Table 3: A comparative view of sustainability factors of success stories of upland farming

Marginal land use experiences, goals, and impacts	Fruit farming Himachal	Cardamom farming Sikkim	Seabuckthorn forests China
Protecting and improving marginal farmlands for productive use	*	*	-
Improving support lands for productive use	*	*	*
Better soil water & nutrient management	*	*	*
Economically productive farming system as primary goal and ecological benefits are byproduct	*	*	-
Ecological restoration/rehabilitation as primary goal and economic benefits are byproduct	-	-	*
Emphasis on biomass production	-	-	*
Stability oriented location specific choice	*	*	*
Harnessing niche for tradeable item	*	*	*
Use of indigenous knowledge practices systems	-	*	-
External R & D inputs, public interventions triggered successes	*	-	*
Sole dependence on local resources	-	*	*
Replicated successful experience from similar environment	*	-	-
New generation crops from local wild biodiversity adapted to marginal lands	-	*	*
Larger scale community level participation a prerequisite to upgrade scale of niche product	*	*	*
Land ownership necessary prerequisite for success	*	*	*

Source: Partap (1999)

marginal and sloping lands would be an effective way to reduce upland poverty. R&D focused on marginal lands promises to yield high returns.

CGIAR (1999) has made four recommendations for reshaping international agricultural research efforts to meet the needs of marginal uplands and sloping lands. First, sharpen the focus on poverty alleviation, particularly in setting priorities for research related to marginal and sloping lands. Second, establish new forms of partnership to effectively address poverty alleviation strategies to those who live in marginal areas. Because many factors determine poverty in these areas, a multi-pronged strategy that reaches beyond agriculture is required. There is an urgent need to promote participatory research that incorporates gender issues to identify the technology and institutional innovations for on-farm and off-farm employment of the upland poor.

In view of the above, the international and national agricultural research systems should focus on the following.

- Targeted research on marginal and sloping lands at the eco-regional level
- Drawing lessons from the success stories that identify factors complementing R&D efforts to enable poor farmers to adopt technological innovations in marginal areas.
- The innovations focusing on poor and marginal lands may promise higher rates of return for sloping lands and marginal areas. For example, biotechnological innovations that complement pesticide use (genetic resistance), fertiliser (nitrogen fixation), tillage and water practices (drought resistance), and possibly genetically modified organisms (GMOs) raise new hopes for evolving productive and sustainable practices for marginal lands.
- The comparative advantages of the sub-regions and landscapes need to be carefully identified and established. Evidence gathered from Asian uplands (Chang 1998; Gim

1998; Kim 1998; Partap 1998b, 1999; Takatsuji 1998) points at the potential of agroforestry and the production of cash crops to help harness the comparative advantages of sloping and marginal lands.

- Research should focus on the potential of sloping lands, defined in relation to water, infrastructure development, and markets. It is therefore important to address water/sloping land/poverty linkages beyond soil conservation programmes. Water insecurity appears to be a feature in hill, mountain, and highland areas, where sloping lands dominate. Efforts should be made to manage the excess supply of water to tide over periods of water scarcity and ensure access to water, especially to the poor farmers who work sloping land.
- While planning the above, the ongoing process of globalisation and its implications for mountain marginal lands need to be explicitly considered to minimise any harmful effects.

Governments and NGOs will have to take new roles in designing and implementing strategies. Governments may need to formulate policies favouring use of marginal lands for certain types of agricultural production systems that can support livelihoods of local people. More secure land rights may be a necessary precondition to stimulate farmers to invest in these areas.

The solution to the cropland crisis in the mountains appears technically possible, economically viable, and environmentally benign. Given the political commitment, food insecurity driven by the scarcity of cropland, and the poverty of small and marginal farmers, can be mitigated and farming can be made an economically viable and environmentally sustainable enterprise on marginal lands. There are a variety of potential niches and production systems suitable to marginal mountain lands, and their development can go long way to conserving a rich biodiversity. Two of the above-mentioned success stories, seabuckthorn and cardamom, indicate that investing in local bio-resources based enterprises and agro-industrial technologies can transform local and regional economies. Finding ways and means for productive and sustainable use of available marginal sloping lands remains a major challenge for planners, policy makers, scientists, and technologists across the globe.

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