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Trends and Prospects of Sustainable Mountain Agriculture in the Hindu Kush-Himalayan Region

A Comparative Analysis

This paper analyses the time-series' data of three integral components of mountain agriculture; food-grain crops, horticultural crops, and livestock of selective mountain provinces/states/regions of Pakistan, India, and Nepal. The purpose is to examine the changes taking place in mountain agricultural systems over the past several years with implications for the future. The results indicate the increasing role of horticultural crops in the agricultural economy of mountain households. Nevertheless, declining productivity has raised concerns for long-term sustainability. On the other hand, the production of cereal food-grain crops has remained relatively stable although the area has not increased. In livestock, buffaloes and goats are increasing, thus providing opportunities to mountain households to generate cash income. Based on the present trends, the implications for future development of mountain agriculture are discussed.

The Context

In the Hindu Kush-Himalayan (HKH) region, the majority of mountain households operate mixed crop farming systems. Over the years, many changes have been taking place in terms of land resource allocation, production, and productivity of cereal food-grain crops, horticultural crops, and livestock structure and composition. Better understanding of these changes can lead to important implications for the development of sustainable mountain agriculture in the future. For example, what have been the trends in land resource allocation (land use) for cereal food-grain crops vis-à-vis horticultural crops such as fruit and vegetables? what has been the productivity trend for cereal food-grain crops vis-à-vis horticultural crops? what are the changes taking place in livestock population and composition or which animal species are gaining importance in the livestock economy? and what could be the future implications of these trends for the sustainable development of mountain agriculture?

Cereal food grains, horticultural crops (fruit and vegetables), and livestock are integral components of farm households and could be the basis for income-generating activities.

In order to examine these trends/changes, this paper analyses the time-series' data of the three integral components (food-grain crops, horticultural crops, and livestock) in selected provinces/states/regions in Pakistan, India, and Nepal (Box 1 on page 5 provides the data sources). The data are used to estimate the annual growth rates of cereal food-grain crops and horticultural crops – fruit and vegetables. For livestock data, a simple analysis is carried out in terms of percentage changes between two time periods.

Trends in Mountain Agriculture – The Findings

Food-grain Crops

An empirical analysis of the time series' data shows that the area under food-grain crops has not increased, but the crop yield has remained relatively stable and, for some crops, it has increased (see Table 1). For example, an analysis of the data for a major food-grain crop between 1975/76 and 1993/1994 in Balochistan shows that while the wheat area increased significantly at an annual rate of 2.1%, the area under paddy and maize remained stagnant

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Table 1: **Trends* in Land Resource Allocation and Productivity of Food-grain Crops in the Hindu Kush-Himalayan Region**

Province/ State/Region	Area under Food-grain Crops			Productivity			Year
	Paddy	Wheat	Maize	Paddy	Wheat	Maize	
Balochistan	0.6	2.1	0.6	0.5	2.0	1.0	1975-93
NWFP	0.1	0.4	1.4	0.1	0.8	0.5	1975-93
Himachal P	-0.38	0.17	0.19	0.53	2.10	1.32	1981-91
Uttarakhand	-0.13	0.01	-0.94	1.48	2.35	-0.26	1980-93
Meghalaya	-0.64	2.17	0.05	2.30	-1.38	-1.46	1984-91
Nepal (Mtns)	0.74	0.85	1.11	0.19	1.77	0.41	1985-94
Nepal (Hills)	0.36	0.55	1.06	0.68	1.03	1.12	1985-94

*Annual Growth Rates (%)

below 1%. Wheat yields also increased significantly at a rate of 2%, but those of paddy and maize remained more or less stagnant. On the other hand, in the North-West Frontier Province (NWFP) of Pakistan, the area under maize grew at a rate of 1.4% annually, but the productivity remained stagnant. The area and productivity of wheat and paddy remained stagnant over an 18-year period between 1975/76 and 1993/94 in the NWFP.

The area under paddy had declined in Himachal Pradesh, the Meghalya States, and Uttarakhand in India. Interestingly, in Himachal Pradesh (HP), although the wheat and maize areas are stagnant, their yields have grown by 2.10 and 1.13 % respectively per annum, but the paddy yield is stagnant. In Uttarakhand, the productivity of both paddy and wheat has increased considerably, although the area under food-grain crops has declined. On the other hand, in Meghalaya, while paddy yields increased, the yields of both major cereal crops - wheat and maize - declined by more than 1% annually.

As mountains have the potential for small-scale, specialised farming activities with high payoffs, proper harnessing of comparative advantages can help food security through direct use of products or trade in high-value products.

An analysis of area, production, and productivity of major food-grain crops in the mountains and hills of Nepal between 1985/86 and 1994/95 shows that the annual growth rates in area, production, and yields of paddy are below 1% each, indicating stagnation. However, the growth rates of maize and wheat are significant. For example, maize production increased at an annual rate of 1.52 and 2.17%, respectively in the mountains and hills. Similarly, wheat production increased by 2.62 and 1.58% respectively, annually. While increases in maize production were mainly due to area expansion, wheat production is due to an increase in productivity.

Horticultural Crops

An empirical analysis of the 'trend' data presents significant increases in the area under the production of horticultural crops (see Table 2). For instance, in Balochistan, the areas under apples and apricots grew at a significant rate per annum between 1981 and 1994, but the growth in productivity is less than one per cent. The area under vegetable crops has increased by 2.96% per annum, but the yield has stagnated after a small increase of 0.23% per annum between 1981 and 1994. The area under tomatoes has increased considerably, averaging over 3.5% per year, but the yield has remained more or less stagnant.

In the NWFP, the area under apples and apricots grew by 2.37% and 2.36% respectively, annually but the productivity declined. Although the area under vegetables grew by 1.88%,

Table 2: **Trends * in Land Resource Allocation and Productivity of Fruits and Vegetables in Selected Areas of the Hindu Kush-Himalayan Region**

Province/ State/Region	Area under Horticultural Crops				Productivity				Year
	Apple	Citrus	Tomato	Veg	Apple	Citrus	Tomato	Veg	
Balochistan	4.87	NA	3.59	2.96	0.88	NA	0.61	0.23	1981-94
NWFP	2.37	NA	3.23	1.88	-0.23	NA	-0.29	-0.49	1981-94
Himachal Pradesh	1.6	3.4	NA	2.5	0.4	-2.3	NA	0.0	1981-92
Nepal (Mountains)	2.03			1.8	0.31			NA	1993-96
Nepal (Hills)		2.33				0.36		NA	1993-96

*Annual Growth Rates (%)

the productivity declined by 0.49% annually. Similarly, in the case of tomatoes, the area increased significantly by 3.2% per annum, but the yield declined by 0.29 %.

In Himachal Pradesh, the area under citrus increased at an annual rate of 3.4%. Similarly, the area under apples grew at 1.6% per annum. Nevertheless, citrus yields declined by 2.3% per annum, and the apple yield remained virtually stagnant with a small increase of 0.4%. Although the area under vegetable crops increased by 2.5% per annum, the productivity remained more or less stagnant.

In Nepal, between 1987 and 1997, sizeable expansion has taken place in the area under horticultural crops such as fruit and vegetables. From the end of the Fifth Five-year Plan (1986) to the end of the Sixth Five-year Plan (1991), the percentage increases in area and production are more than 20 and 40% for fruit and vegetables respectively. Similarly, from the end of the Sixth Five-year Plan (1991) to the end of the Seventh Five-year Plan (1997), significant increases in area and production have been observed. While examining the trends of fruit crops in terms of land-resource allocation, production, and productivity, the areas under apples and citrus fruit have increased significantly. While the apple plantation area increased at 2.03% annually, that of citrus grew at 2.33% per annum. However, the yields of these fruit crops remained stagnant.

Livestock

An analysis of livestock data shows that there has been an increasing share of buffaloes in the livestock composition (see Table 3). In Balochistan, between 1984 and 1994, the increase in the buffalo population was much larger than for cattle. Similarly, the same was true in the NWFP between 1976 and 1986, and in Azad Jammu and Kashmir between 1985 and 1995. This suggests the important role of buffaloes in the livestock economy in these provinces.

Table 3: **Trends* in Livestock Population and Composition in the Hindu Kush-Himalayan Region**

Province/ State/Region	Population				Composition				Year
	Cattle	Buffaloes	Sheep	Goats	Cattle	Buffaloes	Sheep	Goats	
Balochistan	81	133	185	87	1.26	0.002	10.50	-9.24	1984-94
NWFP	9.5	68	-39	-10	5.16	5.29	-10	-0.45	1976-86
AJK	35	43	21	31	+0.90	2.14	-3.13	0.08	1985-95
Himachal Pradesh	-1.06	13.64	-8.15	5.25	-0.71	1.62	-1.91	1.00	1982-92
Uttarkhand	-5.2	15.1	-9.1	7.1	-3.0	2.5	-1.0	1.4	1978-88
Nepal (Mtns)	3.17	0.58	-9.59	2.87	0.89	0	-1.70	0.80	1988-96
Nepal (Hills)	5.77	8.30	-2.53	9.37	-0.51	0.21	-9.59	2.87	1988-96

* Percentage change between two time periods

An analysis of temporal changes in livestock population and composition between 1978 and 1988 in the Central Himalayan region (Uttarakhand) and between 1982 and 1992 in the Western Himalayas (Himachal Pradesh) shows that, whereas the cattle population had declined, the buffalo population had increased significantly. Among small ruminants, the population of sheep has declined considerably, and it is interesting to observe a significant increase in goats. Accordingly, in terms of herd composition, the share of cattle and sheep has declined and that of buffaloes and goats has increased.

An analysis of livestock data in Nepal reveals that the most noticeable change in the hills is a significant increase in the population of buffaloes and goats between 1988/89 and 1996/97. The percentages of buffaloes and goats have increased while those of cattle and sheep have declined. The most noticeable change in the mountains is a considerable decline in the sheep population. There has thus been a significant decline in sheep population in both the hills and mountains.

Possible Reasons for Implications of the Trends

The most prominent observation one can make is that although the area under food-grain crops has not increased, their yields have not declined as much as the yields of horticultural crops. Productivity has actually increased for some food-grain crops. The reason for this could be because of a relatively favourable policy of governments towards food grains in an attempt to ensure food security. For example, subsidies for fertilizers are common across the HKH region. Secondly, most of the fertile, valley lands where irrigation is available are under cereals.

The area under horticultural crops, such as fruit and vegetables, has increased significantly over the past several years The main reason for the rapid expansion in areas under horticultural crops is that mountain households can earn cash income from them. The significant growth in area suggests that fruit and vegetables are more profitable economically than cereal food grains. This also implies that the importance of horticultural crops in the farming systems and household economy has increased across the HKH region.

The reason for the rapid expansion of area under horticultural crops mainly lies in the opportunity for mountain households to generate cash income. However, the productivity of horticultural crops has either stagnated or declined more than food-grain crops.

Notwithstanding their value as income-generating crops, the productivity of horticultural crops has either stagnated or declined more than food-grain crops. The reason for this decline in the yields could be linked to the use of marginal lands. For example, in Himachal Pradesh, more than 80% of the fruit farming is on marginal and sloping lands (Verma and Partap 1992). Furthermore, production of low- yielding heterogeneous varieties, poor fruit setting, and fruit drops are common in apple growing areas of the HKH region. In some production pockets, biennial/irregular bearing, poor pollination, heavy rains at fruit maturity, and moisture stress during summer are common problems that result in low, erratic, and poor quality fruit production (Jindal 1996, JMA 1995).

In the livestock sector, growth in the cattle population is not large and, in the Indian Himalayas, it is declining. This could be mainly because of decreasing feed resources and a decline in areas for open grazing. On the other hand, there is an increase in the trend to stall-feed buffaloes because of their multiple uses; mainly for milk and meat. On the whole the sheep population has been in decline across the region (except in Balochistan where its population has grown significantly) and the goat population has been on the increase. The reason for the decline in the sheep population could be owing to limited open, grazing lands and restrictions imposed by communities for open grazing. Goats can be stall-fed and do not need grazing, especially in the high-pressure Himalayan areas of mixed crop-livestock farming systems. The overall implication of these trends is that the roles of buffaloes and goats have increased in the livestock economy. This also implies that, at the farm household level, buffaloes and goats are playing an important role in generating cash income.

Long-term Implications for the Development of Mountain Agriculture

Empirical analysis of some of the areas of the HKH region shows that production of cereal food-grain crops has not declined as much as is often perceived. In fact, in some cases, it has increased due to increased productivity. It implies that, in the future, due to increased access to modern inputs such as quality seeds, fertilizer, and irrigation, resulting from favourable government policies, the total food production in the mountains could be increased. However, the per capita food availability may decline due to increases in population resulting in persistent food deficit.

Nevertheless, better prospects do exist for the development of niche-based horticultural crops. As mountains have the potential for small-scale, specialised farming activities with high payoffs, proper harnessing of niche-based farming can help food security through direct use of products or trade in high-value products (Jodha 1992 and 1995). This is demonstrated by the present trends of rapid expansion in areas under horticultural crops. This trend will have positive implications for the future development of mountain agriculture in terms of harnessing mountain comparative advantages; advantages that have positive ecological and economical implications. This also implies that there is a possibility of cultivating more fertile lands with irrigation (lands that are presently under cereal food-grain production) under high-value cash (HVC) crops such as fruit, vegetables, and medicinal plants.

Increased access to modern inputs, such as quality seeds, fertilizer, and irrigation, resulting from favourable government policies, could increase the total food production in the mountains.

Case studies on agricultural transformation of some of the mountain areas have shown how farming of HVC crops has increased food security and employment, thus improving the living conditions of mountain people (Partap 1995, Sharma 1996, Sharma 1997, Sharma and Sharma 1997, Tulachan 1997, and Badhani 1998). They also show that accessibility and the wider market network and strong R&D institutions are critical to the commercialisation of

Box 1
Selected Data Sources for the Analysis

Pakistan

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- Statistics Hand Book of Balochistan (1995), Bureau of Statistics, Govt. of Balochistan, Quetta, 1996
- AZK at a Glance (1995), AZK State Government, 1995

India

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Nepal

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- Statistical Information in Nepalese Agriculture, 1995/1996, Ministry of Agriculture, His Majesty's Government of Nepal, Kathmandu

subsistence agriculture in the mountains through intensification of HVC crops. In view of future prospects, Nepal's twenty-year Agricultural Perspective Plan (APP) has emphasised the development of high-value agriculture in the mountains of Nepal in order to improve the livelihoods of mountain people.

An increasing use of pesticides on horticultural crops has been reported. This has raised concerns about environmental pollution, e.g., groundwater pollution and health hazards.

Development of HVC crops in the mountains will also increase the trade between uplands (mountains) and lowlands (plain areas) in terms of mountain people specialising in HVC crops such as fruit, vegetables, flowers, and medicinal plants and lowland farmers specialising more in cereal crops. Thus, by developing an effective exchange mechanism, possible improvements in terms of trade in favour of the hills and mountains can occur.

However, there has been a decline in the productivity of HVC crops. This raises concerns about the long-term sustainability of these crops. In this context, Jodha (1991 & 1995) points out that reckless exploitation of mountain niches can result in their elimination. A study of niche-based farming of horticultural crops in the mountains of Nepal shows both spatial and temporal dimensions in terms of sustainability. High economic benefits induce a spatial dimension so that a particular crop spreads quickly over time. Nevertheless, the temporal dimension of niche-based farming is manifested by soil nutrient losses and diseases over time (Tulachan et al 1998). Furthermore, it has been reported that there has been an increasing use of pesticides on horticultural crops. This has raised concerns about environmental pollution, e.g., groundwater pollution and health hazards. Thus, the key issue here is how to address the long-term sustainability of HVC crops without causing environmental damages. These issues need to be addressed by the appropriate R&D institutions in the region.

The trends in livestock indicate that in future there is a possibility of greater development in small-holder dairies with improved buffaloes in the high pressure Himalayan areas where mixed crop-livestock farming systems are present. The number of stall-fed buffaloes and goats is rising with increased use of external inputs-purchased feed. This will thus put less pressure on Common Property Resources such as forests and community lands, leading to positive impacts on the environment. Also, farming of buffaloes and goats will contribute positively to the food security and nutrition of mountain households.

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