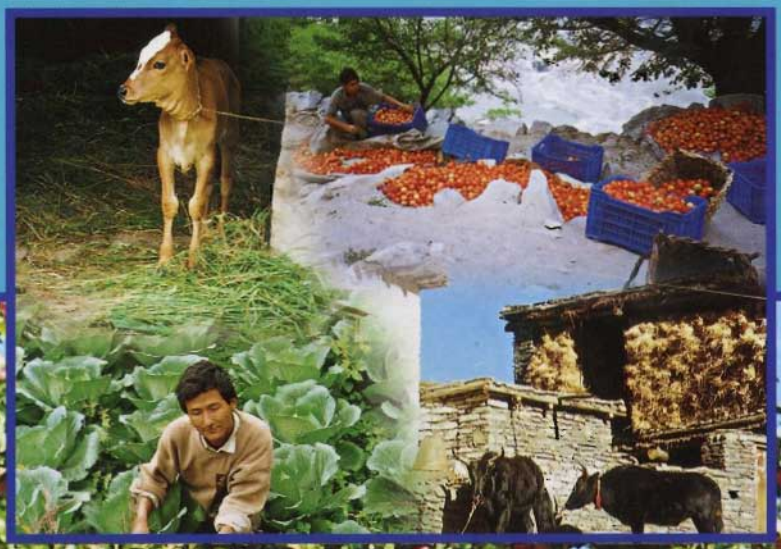
State of Mountain Agriculture in the Hindu Kush-Himalayas

A Regional Comparative Analysis

Pradeep M. Tulachan



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The International Centre for Integrated Mountain Development (ICIMOD)is an international organisation devoted to development of the Hindu Kush-Himalayan region covering all or parts of eight sovereign states, Afghanistan  , Bangladesh  , Bhutan  , China  , India  , Myanmar  , Nepal  , and Pakistan  . The Centre is located in Kathmandu, Nepal. The primary objective of the Centre is to promote the development of an economically and environmentally sound mountain ecosystem and to improve the living standards of mountain populations. The Mountain Farming Systems' Division at ICIMOD was established to promote improvement of farm productivity on small mountain farms without degrading the resource base.

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Tomatoes and cabbages, Ladakh, India - Pradeep Tulachan
Jhopa with barley straw, Mustang, Nepal - Pradeep Tulachan
Apple trees, Himachal Pradesh, India (background) - Pradeep Tulachan

Executive Summary

The state of agriculture in the Hindu Kush-Himalayan (HKH) region was studied by analysing trends in the production of three integral components of mountain farming systems—food grain crops (cereals), horticultural and cash crops, and livestock—using time series data published by national governments.

The results show that overall the area under food grain crops (cereals) in the HKH region has remained steady over the last 10 to 15 years, that yields have declined less than often suggested, and that in some cases crop yields have increased. The results suggest that mountain farmers are maintaining relatively stable production of food grain crops to ensure food security, despite an increasing trend towards diversification into horticultural crops. Thus, there seems to be an opportunity for increasing cereal production through increasing crop yield. The increases in production can occur as a result of increased access to modern inputs such as quality seeds, fertiliser, and irrigation, resulting from favourable government policies. Nonetheless, there seems little prospect for expansion of area under cereal production and the per capita food availability may decline due to increases in population.

The most distinct finding of this study is that there is an increasing trend towards crop diversification with rapid expansion of production and marketing of horticultural crops. Horticultural crops are growing in importance for mountain farming systems and household economies in the region. The present trend of rapid expansion of horticultural crop production will have positive implications for the future development of mountain agriculture in terms of harnessing mountain niches ; this will have positive ecological and economic effects. This could also lead to cultivating more fertile lands with irrigation (lands that are presently under cereal production) with high-value cash (HVC) crops, such as fruit, vegetables, and medicinal plants, which are more dependant on econnomic profitibility and market demand.

However, one problem is the decline in productivity of HVC crops in the mountains, and this raises concerns about the long-term sustainability of these crops. Furthermore, there has been a reported increase in the use of pesticides on horticultural crops. Because farms have small parcels of land, there has been an intensification of land use for multiple crops and excessive use of

chemical fertilisers and pesticides. This has led to concern about environmental pollution, e.g., groundwater pollution and health hazards.

Trends in livestock holdings indicate that there is a potential for increased development of smallholder dairies with improved breeds of buffaloes raised in a stall-fed system in those high pressure areas of the HKH sub-tropics where mixed crop-livestock farming systems are found at present. The number of stall-fed buffaloes and goats is rising, and there is increased use of external inputs such as commercial feed. A growth in dairy farming will relieve the pressure on common property resources, such as forests and community lands, and have a positive impact on the environment. Rearing of buffaloes and goats can also contribute to food security and nutrition in mountain households.

To conclude, there is a great prospect for increasing cash incomes in the HKH. High-value crops, such as fruit and vegetables, and livestock raised for smallholder dairies or meat (fowl, goats, and so on) have the potential to contribute to cash income and hence improve the standards of living of farm communities. Likewise, increasing involvement of women in research and extension programmes and in programmes to improve food security for marginalised mountain households would prove beneficial.

Preface

This study provides a broad, regional picture of the state of mountain agriculture across the Hindu-Kush Himalayas, based on the analysis of the empirical data obtained from national government publications. The mountain farming systems has basically three integrated components; they are production of staple food crops, horticultural and cash crops, and livestock raising. Dr. Pradeep M. Tulachan has systematically collected, collated, organised, and analysed the data related to these key components of agricultural production systems in order to provide broad trends and patterns of mountain agriculture and their implications on long-term sustainability. The data used are from selected mountainous provinces, states, and regions of five Hindu-Kush Himalayan (HKH) countries: Bhutan, China, India, Nepal, and Pakistan.

Thus, this work has focused on empirical analysis to provide broad patterns and trends of mountain agriculture across the HKH region. It is a valuable pulling together of factual information from across the region with a useful comparative analysis. Hopefully many readers will find this not only a valuable introduction to mountain agriculture across the region but also an important source of background statistics for their own analyses. It is interesting to see what the situation is in other parts of the region while pursuing the implementation of any project and programme on the ground.

Acknowledgements

I would like to thank Professor John Mellor, Professor Robert Rhoades, Dr. Mahesh Banskota, Dr. Trilok S. Papola, and Dr. Tej Partap for their comments on the original version of this paper, which was part of a regular biannual report. Sincere thanks are due to Ms. Qian Jie, Dr. Nima Tashi, and Dr. Tang Ya, for translating Chinese Agricultural Statistics into English, and Mr. Arun Neupane and Ms. Vishakha Maskey for data entry and analysis.

Note

The data used for the analysis are from national government sources. The author is responsible for all comments arising from analysis and interpretation of the data and for the views expressed.

Acronyms and Abbreviations

AZRI	Arid-Zone Research Insitute
GDP	Gross Domestic Product
HH	household
HKH	Hindu-Kush Himalayas
HP	Himachal Pradesh
Masl	metres above sea level
NA	not available
NWFP	North West Frontier Province
RNR	renewable natural resource
UNDP	United Nations Development Programme
UP	Uttar Pradesh

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CHAPTER 1
Introduction

The Context

The Mountain Farming Systems (MFS) Division of the International Centre for Integrated Mountain Development (ICIMOD) has already made a considerable effort to improve understanding of the sustainability of mountain agriculture trough micro-level case studies. So far these case studies have focused on the transformation processes taking place in successful farming areas. The purpose of this was to examine how successful experiences in transformed areas can be replicated in other parts of the Hindu Kush-Himalayan (HKH) region in order to improve the livelihoods of mountain households. The case studies on Himachal Pradesh, Sikkim, Illam, and Ningnan County (Liu Yanhua et al. 1993; Partap 1995; Sharma 1996; Sharma 1997; Sharma and Sharma 1997) are good examples. They contain valuable information on how in these areas subsistence agriculture has been transformed into viable commercial agriculture, thus alleviating poverty and improving living conditions. Some of the studies focused on how farming of horticultural[1] crops has increased food security and employment (Partap 1995; Sharma 1996; Sharma 1997; Sharma and Sharma 1997; Tulachan 1997; Badhani 1998). The studies showed that accessibility to a wider market network and strong research and development (R&D) institutions are critical to the commercialisation of subsistence agriculture in the mountains.

Although valuable, these case studies have certain limitations. Each relates to a particular period of time and a specific location within the vast tract of the HKH region. It is not possible to draw broad generalisations from this limited number of micro-level studies unless they are supported by facts at the macro-level (Singh 1992). Equally, the studies have only a limited coverage of other important components of farming systems like the production of food grain (cereal) crops and livestock. The case studies do not in themselves provide a broad or regional picture of the state of mountain agriculture across the HKH region.

There are many issues related to patterns and trends in mountain agriculture that need to be analysed empirically. Only recently, however, have attempts been made to develop an empirical picture of the existing conditions in agriculture in the HKH region, the changes over time, the policies that effect agriculture, and factors related to long-term sustainability (Jodha et al. 1992).

[1]The term horticulture in this text refers to the cultivation of fruit and vegetables for sale.

These attempts have been hampered by the lack of an empirical database on mountain agriculture that can be used to identify long-term trends and their implications. This need has been realised for some time (Jodha et al. 1992). The lack of an adequate database on horticultural crops was cited in an ICIMOD regional consultation meeting (1996) as a major bottleneck to systematic planning and programming of agricultural development in the mountains. The Regional Consultation on Education and Research for Sustainable Mountain Agriculture, held at ICIMOD during 1996, recommended that ICIMOD could be a focal point for the creation of a technical database for mountain agriculture. Similarly, Rhoades (1997), in his review and analysis of the work on mountain farming systems at ICIMOD, identified the lack of an empirical database as a major constraint and also recommended the creation of a systematic database.

In 1997 ICIMOD started to create a systematic database on agricultural systems for the HKH region focusing on socioeconomic data. Data have been obtained from government statistics, project reports, consultancy reports, case studies, and grey literature. A user-friendly computer framework called the 'HKH Farming Systems' Information/Database File' has been designed to enable systematic storage and easy retrieval of information and is being developed to assist those involved in planning and policy formulation for the sustainable development of mountain agriculture in the HKH region.

The Study

This paper describes the results of one of the first studies made as a part of the activities involved in setting up the new database.Patterns and trends related to three key components of agricultural production systems in the HKH region were studied: cereal (food grain[1]) crops, horticultural and cash crops, and livestock. These three are the main components of integrated mountain farming systems and the basis of the livelihoods of mountain households. The issues addressed included the following: what are the patterns and trends in land resource allocation (land use) for cereals and other crops compared to horticultural crops, like fruit and vegetables, and other cash crops? what are the trends in crop yield or productivity for cereals and other crops compared to horticultural crops? what are the crop yields for cereals and other crops compared to horticultural crops? what changes have taken place in livestock population and composition? and which animal species are gaining importance in the livestock economy? The aim was to analyse data from the past ten to fifteen years related to these issues in order to obtain an idea of the sustainability of different components of mountain farming systems across the HKH region.

A broad range of socioeconomic data related to mountain agriculture was collected from government sources. The national governments in the region collect agricultural data annually based on administrative units and publish these in the form of government statistics. These government statistics were collated and analysed to assess the patterns and trends of mountain agriculture from a socioeconomic perspective in selected mountainous provinces, states, and regions in five Hindu-Kush Himalayan (HKH) countries:Bhutan, China, India, Nepal, and Pakistan. Time-series' data were used to estimate growth rates. In addition to the large amount of, often, scattered data and information collected from government sources, other research reports

[1]Cereals and food grains are used interchangeably in the text

were reviewed and analysed to obtain information about land use, farm size, and cropping patterns. Since these data are aggregated from farm household level data, the analysis should reflect the conditions prevailing at farm level.

The emphasis was on analysing the economic agricultural data in order to describe the state of mountain agriculture (farming systems). The analysis provides an inter-regional view of mountain agriculture and farming systems across the HKH. (General characteristic descriptions of the dominant farming systems found in the HKH, by administrative unit, are available in the 'HKH Farming Systems' (FS) Information/Database File' at the Mountain Farming Systems Division, ICIMOD.)

The objectives of this publication are as follow:

- to characterise the present patterns of mountain agricultural systems in terms of land use, landholdings, cropping systems, and crop productivity;
- to analyse present trends and patterns in mountain agriculture in terms of area, total production, and yield of major food crops;
- to assess the trends and patterns in horticultural crops in terms of area, total production, and yield;
- to analyse the trends in livestock population and composition; and
- to summarise the constraints to, and the implications of present trends for, the development of sustainable mountain agriculture.

Methodology

Macro-level data were used to examine the broad patterns and trends in mountain agriculture across the HKH region, in particular in the three sub-systems of cereal crops, horticultural and cash crops, and livestock. Agricultural census data from different time periods over the last 10 to 15 years were obtained from government agricultural statistics for the selected mountain provinces, states, and regions. The government sources for the time series' data used for estimating growth rates are shown in Box 1.1. These data are from different time periods and the methods of data collection were different: for example, census, field survey, and estimates. Also, since the data are based on administrative units, in some provinces/states, data collected include some parts of the plains too.(The raw data are available on request on an ICIMOD CD.)

A comprehensive review was made of relevant secondary sources and data and information from them analysed. Case studies carried out by other organisations were also reviewed and the data and information from them collated.

The study areas are shown in Figure 1.1:Balochistan and NWFP in Pakistan; Himachal Pradesh and the Uttar Pradesh hills in India; Tibet, Yunnan, and Sichuan in China; high and mid-mountain regions in Nepal; and all of Bhutan.

The time series' data were analysed using the econometric tool shown below to estimate the average annual growth rates of food grain crops and horticultural and cash crops. A simple

Box 1.1

Sources of the Time-series Data Used in the Analyses

Pakistan

- Ministry of Food, Agriculture and Livestock, Economic Wing (1995) *Agriculture Statistics of Pakistan.* Islamabad: Govt. of Pakistan
- Bureau of Statistics (1996) *Statistic Handbook of Balochistan (1995).* Quetta: Govt. of Balochistan

India

- Chand, R. (1997) *Agricultural Diversification and Development of Mountain Regions with Special Reference to Himachal Pradesh.* New Delhi: MD Publications
- Mehta, G S (1997) *Development Experiences and Options in a Hill Region: The Case of Uttarkhand, U.P. India.* Kathmandu: ICIMOD
- Himachal Pradesh Horticultural Department (1993) *Horticultural Development in Himachal Pradesh, Statistics at a Glance.* Shimla (India): Himachal Pradesh Horticultural Department
- Jindal, K.K. (n.d.) *Statement Showing Area and Production of Food Grains and Vegetables in Himachal Pradesh from 80-81 to 1995-1996.* Solan (India): YS Parmar University of Horticulture and Forestry (In Hindi)
- Dhar, T N; Gupta, S P (1994) *Development of Horticulture in the Himalayan States of India* Lucknow (India): SHERPA
- Dhar, T N; Gupta, S P (1995) *Development of Agriculture in the Himalayan States of India.* Lucknow (India): SHERPA

Nepal

- Agricultural Statistics Division (1996) *Statistical Information on Nepalese Agriculture 1995/96.* Kathmandu: HMG Ministry of Agriculture
- Agricultural Statistics Division (1997) *Statistical Information on Nepalese Agriculture (1993/94 To 1996/97).* Kathmandu: HMG Ministry of Agriculture
- Agricultural Statistics Division (1996) *Statistical Information on Nepalese Agriculture (Covering 1985/86 To 1995/96).* Kathmandu: HMG Ministry of Agriculture
- Department of Food and Agricultural Marketing Services, Agricultural Statistics Division (1990) *Agricultural Statistics of Nepal.* Kathmandu: His Majesty's Government, Ministry of Agriculture
- Ministry of Agriculture (1997) *Statistical Information on Nepalese Agriculture (1996/97).* Kathmandu: His Majesty's Government of Nepal

Bhutan

- Ministry of Agriculture (1995) *LUPP Dzongkhag Data Sheets for Bhutan.* Bhutan:Land Use Planning Project

China

- Editorial Board of China Agriculture Yearbook (1997) *China Year Book of Agriculture (from year 1984 to 1997).* Beijing: China Agriculture Press

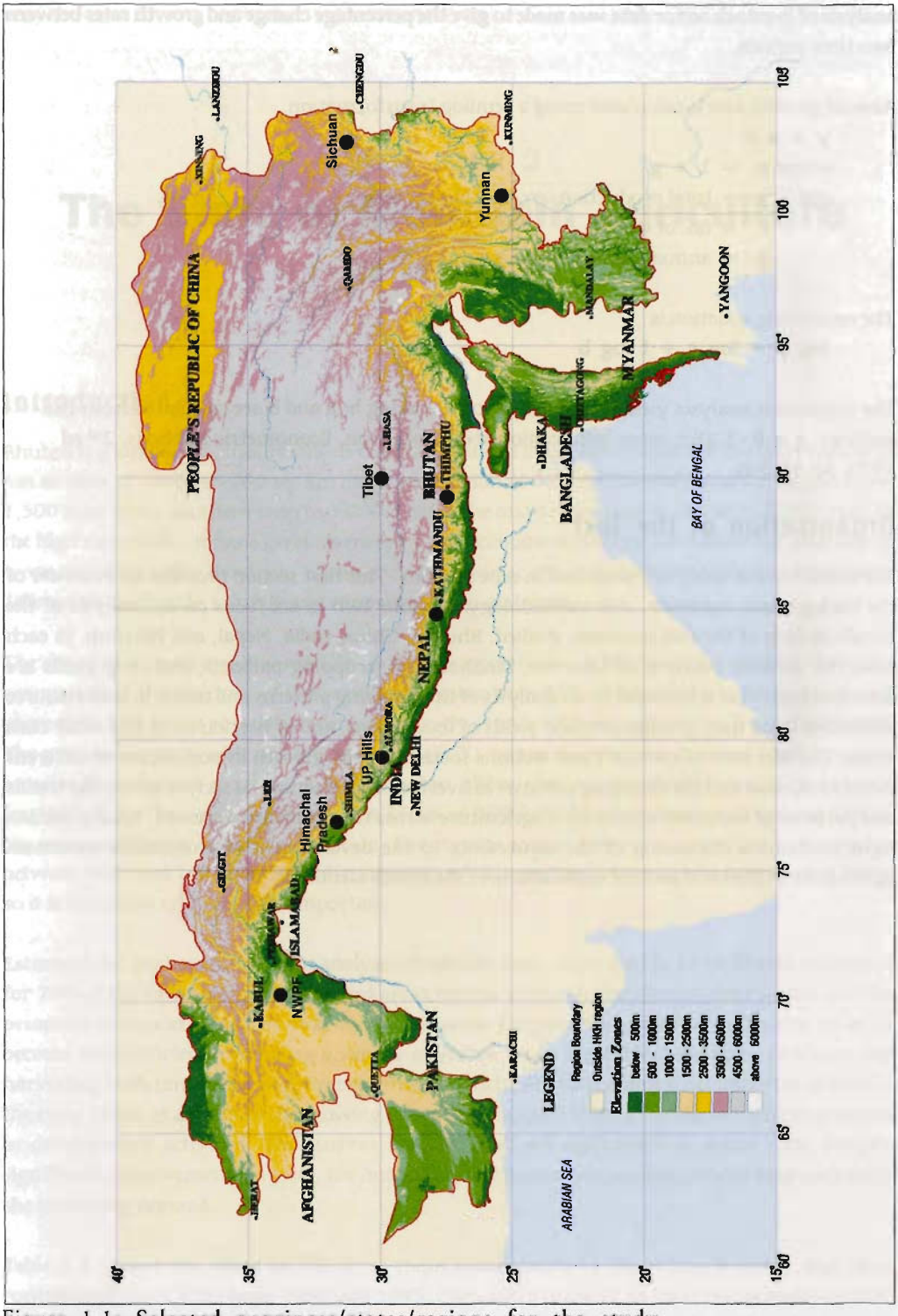

Figure 1.1: Selected provinces/states/regions for the study

analysis of livestock sector data was made to give the percentage change and growth rates between two time periods.

Annual growth rate is calculated using a semilog transformation.

$$y = a\ b^t$$

where $b = 1 + g$

and y = total production/area/yield over time t

t = no. of years

g = annual growth rate

The estimating equation is

$$\log y = \log a + t \log b$$

The regression analysis yields estimates of $\log a$ and $\log b$; a and b are calculated from the antilogs; $g = b - 1$. (For more information see J. Johnston, Econometric Methods, 2nd ed 1972, pp 47-50)

Organisation of the Text

The results of the study are presented in nine sections. This first section provides an overview of the background, rationale, and methodology. Sections two to six focus on an analysis of the trends in each of the five countries studied: Bhutan, China, India, Nepal, and Pakistan. In each case, the existing patterns of land use, landholdings, cropping patterns, and crop yields are described first. This is followed by an analysis of the changing patterns and trends in land resource allocation (land use), production, and yields of food grains, and of horticultural and other cash crops. The last part of each of these sections focuses on the growth in population of different livestock species and the changing patterns in livestock composition. In section seven, the trends and patterns of sustainable mountain agriculture across the region are discussed. Finally, section eight contains a discussion of the constraints to the development of sustainable mountain agriculture in the HKH and the implications of the trends identified.

CHAPTER 2

The State of Mountain Agriculture in Bhutan

Introduction

Bhutan is a landlocked, mountainous country situated in the eastern part of the HKH region. It has an area of about 46,000 sq. km and a population of 0.6 million. The elevation ranges from 1,500 masl in the southern strip to 5,000 masl in the middle mountains, and up to 7,500 masl in the high mountains. It has a great diversity of agro-climatic conditions favourable for a variety of crops and for raising livestock. Each valley has unique climatic characteristics resulting from differences in altitude, rainfall, and exposure to sun and wind.

The country's economy is essentially based on agriculture. Subsistence farming is the main occupation of the majority of the population, more than 85% of whom live in rural areas; and more than 95% of the population depends directly or indirectly on agriculture for its livelihood. The primary, or renewable natural resources (RNR), sector (agriculture, livestock, and forestry) remains the dominant economic sector in Bhutan, although it is currently declining in importance (see Table 2.1). This sector accounted for 37.5% of GDP in 1995 when it employed about 78% of the economically active adult population. The average annual growth in real terms in this sector between 1980 and 1995 was 3.5%. Hence, although it is growing other sectors are growing faster so it is becoming relatively less important.

Estimates for land cover, based on analysis of satellite data, show that in 1994 forests accounted for 73% of the land area, and cultivated areas for 8%. Given the location of their farms and the primitive transportation network, most Bhutanese farmers integrate their activities so as to become self-sufficient, producing a variety of grains, fruit, vegetables, and dairy products and harvesting both timber and non-timber forest products. Bhutan became a net importer of food in the early 1960s as a result of the growing urban population and the growing work force involved in development activities. The current level of food self-sufficiency is about 65%. Despite significant improvements in yield, the output of food grains has not been able to keep pace with the increasing demand.

Table 2.1 shows the share of the three main components in the primary sector and their contribution to GDP between 1980 and 1995. The contribution of all three components to GDP declined by around one third. One of the main causes has been continued social and economic

Table 2.1
Share of the primary sector in the GDP (%)

Sub-sector	Share of 1980 GDP	Share of 1990 GDP	Share of 1995 GDP
Agriculture	/27.8	23.5	20.2
Livestock	12.4	9.4	8.2
Forestry and logging	15.5	11.1	9.1
Total primary sector	55.7	44.0	37.5

Source: UNDP Development Cooperation Report, 1996

improvements, for example, in transportation and communication, which have resulted in a policy shift towards the growth of the secondary (mining, quarrying, construction) and tertiary (trade, transport, finance) sectors. This has led to a significant change in the composition of the GDP.

Of the country's 46,000 sq. km of land, only about eight per cent is considered suitable for arable agriculture and a further four per cent for use as pasture. The largest part is covered by forest. Despite the relatively low population density (15/km^2), the average Bhutanese family in the north owns a farm of only about 0.8 ha. Table 2.2 suggests that the majority of households have landholdings of less than one hectare. Households with insufficient land of their own enter into tenancy contracts and share cropping arrangements to get additional land for food production. An estimated seven per cent of all rural households are landless. Most of the land currently under cultivation lies in small and often isolated pockets along the main river valleys and throughout the southern foothills. Farming in Bhutan is not easy, because the steep slopes of most agricultural land make farming labour intensive and farm mechanisation is often not possible.

Table 2.2
Percentage of farm holdings of different sizes (in ha)

Farm size class(ha)	Lhuntshi % of HHs	Mongar % of HHs	Tashigang % of HHs	Pemagatsel % of HHs
<0.5	21	11	16	16
0.5-1.0	20	23	22	36
1.0-1.5	17	28	17	31
1.5-2.0	9	19	16	11
2.0-3.0	19	12	18	5
>3	14	7	12	2

Source: Ministry of Agriculture (1991)

Farming and Cropping Systems

Most farming in Bhutan consists of subsistence crops and animal husbandry. Subsistence farmers practise shifting cultivation, growing mainly maize as a food security measure. Transhumance pastoralism is prevalent throughout the northern range of Bhutan at altitudes of 2,800-4,500 masl. The migratory communities depend mainly on yak and cattle. Depending on the areas, they also include sheep and goats. The communities lead a semi- nomadic life, moving from one permanent habitation to another, depending on the season and the availability of pasture. They trade livestock products for food crops (rice) and other necessary commodities during the winter,

when they live at lower altitudes. During the summer they cultivate their land with barley, millet, and buckwheat.

Shifting cultivation, 'tsheri', is a predominant form of land use in Bhutan that is practised over an extensive area, especially in the eastern region. The total area under shifting cultivation is estimated at 115, 000 ha (based on satellite imagery, 1983), or 32% of the total cultivated area of the country. However all areas are not under cultivation at a time. In shifting cultivation 30-40% of the land remains as fallow, regenerating areas—and farmers will back land at 4-to 10-year intervals.In eastern Bhutan, up to 79% of the cultivated land is under *tsheri* (Partap and Watson 1994). The type of shifting cultivation practised in Bhutan is a 'montane' variant—practised predominantly on steep slopes—and differs from that in other parts of the HKH (e.g., in Meghalaya). The intensity of land use is also lower as a result of the very low population density.

The crops grown under shifting cultivation depend on the altitude (Table 2.3). The dominant cropping systems are based on potatoes, rice, or maize with wheat, barley, and buckwheat as the predominant winter crops. Maize is the major crop produced (67% of the output). Farming practices are characterised by a minimum application of external inputs and, typically, a five-year fallow. Shifting cultivation is practised to reduce the risk of crop failure and to compensate for food deficits. Almost all shifting cultivators are subsistence farmers.

Farming systems based on food grain crops are found in the valleys and on valley terraces with slopes of less than 30 degrees. The valley terraces are normally irrigated. This type of land accounts for 18% of the cultivated land and is normally used to grow rice in summer and wheat in winter. Potato, buckwheat, mustard, maize, and vegetables are also grown, depending on altitude.

Rainfed farming is quite common on terraces with slopes greater than 30 degrees. Maize is the major summer crop on these terraces. Wheat, barley, mustard, pulses, buckwheat, and potatoes are major winter crops. At present, potatoes are becoming popular as a cash crop.

Table 2.3
Crops grown under shifting cultivation at different altitudes

System	Cycle	Altitude (masl)
Upper temperate regions (rainfed) (Bumthang, Wangdiphodrang, Tongsa)	Fallow 5-15 years Bitter buckwheat (year 1) Sweet buckwheat (year2) Wheat (years 2/3)	2500-3400
Potato based (rainfed)	Potato/sweet buckwheat (year 1) Wheat or same as above (year 2)	2500-2900
Wheat, barley, buckwheat	Various combinations such as: Year 1: buckwheat /wheat Year 2: wheat Year 3: buckwheat/wheat, wheat, or barley followed by buckwheat	2000-3000
Rice based	Rice, fallow Rice, wheat/barley/buckwheat Rice, maize/mustard	1000-2600
Maize based	Maize/buckwheat (same year)	900-2400

Compiled from Roder and Gurung (1990)

Food Grain Crops and Potatoes

Table 2.4 shows the productivity of the major crops in 1981, 1984, and 1995. The reported yields for most of the major staple crops remained more or less constant from 1981 to 1995, apart from a slight increase in rice after 1984 and an increase in the average potato yield between 1981 and 1984.

Table 2.4
Yield of principal crops over time

Crop	Yield (MT/ha)		
	1981	1984	1995
Maize	1.4	1.5	1.4
Paddy	2.1	2.1	2.4
Wheat/Barley	1.1	1.1	1.1
Buckwheat/millet	0.8	0.8	0.9
Potatoes	6.7	8.0	7.7

Sources: CSO (1989A); LUPP (1995)

Table 2.5 shows the latest available data on the area used for cultivation of different food grain crops, the yield per ha, and the total production. Rice and maize are the principal crops and together account for more than half the total weight of the country's annual crop production. While the country is virtually self-sufficient in maize, barley, millet, and buckwheat, it is only 65% self-sufficient in wheat and 64% in rice. To meet the food shortage, rice and wheat are imported from India by the Food Corporation of Bhutan (FCB) and private traders.

Maize is the most important single cereal grown. In 1984, maize occupied 37% of the cultivated land and contributed 46% to the total food grain production of the country; in 1995 it occupied the greatest area of land of any of the staple crops and contributed 35% of the total weight of food grain (without potatoes). Maize is found growing up to altitudes of 2,900 m, although yields are moderate. Maize rather than rice occupies the largest area of land in the east where it forms the staple in the diet. Rice and maize are grown in all zones except the western cool, temperate zone where wheat, buckwheat, potatoes, mustard, and barley are produced instead. Where irrigation is available, wet land crops in winter include wheat, mustard, and potatoes. The only new basic food crop is the potato, which is now cultivated in the temperate zone and is suitable for export, as it has a high yield (Table 2.4).

Table 2.5
Area, production and yields of staple crops in Bhutan, 1995

Crop	Area(ha)	Production (MT)	Yield(kg/ha)
Barley	4,406	4,849	1,100
Buckwheat	7,290	6,443	883
Maize	55,473	75,380	1,358
Millet	10,319	9,159	887
Mustard	4,782	3,686	770
Potato	5,631	43,325	7,694
Rice	45,086	107,877	2,392
Wheat	9,568	10,747	1,123
Total	142,555	261,466	

Source: LUPP (1995)

Horticultural and Cash Crops

The area planted under different cash crops in 1995, the production in tonnes, and the yields are shown in Table 2.6. Apples, oranges, and areca nuts are the main fruit crops with cardamom being another important cash crop. Orchards and plantations are mainly concentrated in the warm temperate zone (apples at higher altitudes) and the humid and wet subtropical zones (oranges and cardamom at lower altitudes). These commodities are exported to Bangladesh and India in substantial quantities. The attractive markets for these cash crops have encouraged farmers to grow more. An estimated 16,250 households now supplement their incomes from them. The area under this production system is increasing by as much as 15% annually, according to some estimates. Fruit trees are mostly grown on gently sloping, rainfed terraces.

Oranges rank first among the fruit tree crops in terms of land use, total production, and yield per ha. Most of the orange plantations are confined to the foothills at altitudes ranging from 200 to 1,500m and the bulk of the produce is exported to India. In 1984, the total area planted with orange trees was about 7,800 ha with an annual production of 38,700 mt (Roder and Gurung 1990), by 1995 this had increased to 8,040 ha and 77,000 mt (Table 2.6). Orange orchards vary from small plots with a few trees to plantations of up to 5 ha.

Apples were introduced to Bhutan about 30 years ago, but it is mainly in the last 10 years that the production has risen to commercial importance. Estimates based on an average yield of 50 kg per tree after eight years indicate that apple production will rise to three times the current level without any further increase in planting. The main variety planted is red delicious, followed by golden delicious and royal delicious. These three varieties account for over 90% of the area of apples. More recently, a greater range of varieties has been made available to cater to more diverse markets.

Cardamom is both profitable and not highly labour intensive and is thus suitable for smallholder production. It contributes to export earnings from India and other countries. However, a substantial amount of firewood is needed when the pods are cured and this has led to controls on the expansion of the area under cardamoms. Unless an appropriate alternative system of drying is found, this limit will remain.

Table 2.6
Area, production and yields of major cash crops in Bhutan in 1995

Crop	Area (ha)	Production (mt*)	Yield (kg/ha)
Apple	1,966	9,266	4,712
Areca nut	112	1,073	9,563
Cardamom	6,973	3,980	570
Chili	683	887	1,298
Ginger	1,140	4,503	3,950
Legumes	1,647	2,098	1,273
Orange	8,040	77,031	9,581
Vegetables	5,990	22,257	3,715
Total	26,551	121,095	

Note: *mt = tonnes
Source: LUPP (1995)

The yields of fresh vegetables and ginger are relatively better than those of legumes and chilli (Table 2.6). Orange and areca nut also show good yields but the yields of apple seem low.

Table 2.7 shows the area planted with various fruit, vegetable, and other cash crops in 1986 and 1995. The area of orange plantations barely changed, whereas that of apple orchards increased by a third. The largest change was seen in the area used for vegetable production—an increase of more than seven times to nearly 6,000 ha. The area under cultivation for ginger and potatoes also increased by two to three times, whereas that used for chillies and cardamom actually went down.

Table 2.7
Area planted with various fruit, vegetable and other cash crops in 1986 and 1995 (hectares)

	1986	1995	Change %
Apple	1,480	1,966	32.87
Orange	7,849	8,040	2.42
Vegetables	737	5,990	723.29
Ginger	464	1,140	145.59
Chilli	975	683	-29.9
Potatoes	2,064	5,631	172.82
Cardamom	8,782	6,973	-20.59

Source: Wangchuk (1993); LUPP (1995)

Livestock

The most important livestock in Bhutan are cattle, mithun, yak, horses, sheep, poultry, and pigs. The livestock census of 1994 counted about 246,000 head of cattle (including 13% cross breeds), 53,000 mithun (including hybrids), 37,000 yak (including yak hybrids), 32,000 sheep, 16,030 goats, 22,071 horses, 158,000 poultry, and 46,000 pigs. Livestock production makes a considerable contribution to GDP, but concerns have been raised about productivity and the impact of growing livestock populations on the sustainability of agriculture and the environment. Livestock provide many essential items like meat, milk, cheese, and wool, which are also used to generate cash income to purchase other household commodities, and animals like yak and mithun are used extensively for the transportation of goods across the steep mountains. In all the agroecological zones in Bhutan, large livestock are an integral part of the farming system, providing draught power; a source of manure, which is used extensively to maintain soil fertility; and a source of livestock products for home consumption. Individual households may own an average of five to six head of large livestock, but most of the animals are assembled in large groups that move between the forests in the winter and alpine pastures in the summer.

Table 2.8 shows the population of various types of livestock in 1986 and 1995. The cattle population declined by 23% and buffalo by 42% over the ten-year period, whereas the goat population increased by 16.4%. The numbers of sheep and yak remained almost constant.

Table 2.8

Changes in the livestock population and composition in Bhutan

	1986		1996		Change in population between 1986-1996	Change in % share in the total population bet.1986-1996
	Population	% share in the total population	Population	% share in the total population		
Cattle	340262	74.5%	261970	64.9	-23.0	-9.6
Buffalo	5037	1.1%	2889	0.7	-42.6	-0.4
Sheep	43771	9.6%	34465	8.5	-21.3	-1.0
Goat	31757	7.0%	66320	16.4	108.8	9.5
Yak	35694	7.8%	37871	9.4	6.1	1.6
Total	456521	100.0%	403515	100.0		

Source: Statistical Yearbook of Bhutan 1996, Central Statistical Organisation, Ministry of Planning, Royal Govt. of Bhutan

CHAPTER 3

The State of Mountain Agriculture in China

Introduction

Mountains, hills, and plateaux occupy 65% of the total land area of China. Most of the mountain areas are located in the western parts of China; they contain one third of both the population and the area of cultivated land. The mountain region of south-west China covers the Tibetan plateau and the Yun-Gui plateau. It covers an area of about 2.4 million sq.km (approximately 25% of the total land area) and contains about 16% of the total population of the country. Southwest China includes the Sichuan, Yunnan, and Guizhou Provinces, as well as the Xizang (Tibet) Autonomous Region. The climate ranges from subtropical-humid in the south-east to frigid-arid in the north-west. This chapter is concerned with three mountain provinces — Tibet, Yunnan, and Sichuan.

Yunnan

Yunnan is a mountainous province with an area of 390,000 sq.km of which 28,000 sq. km or 2.8 million hectares are arable land. The most important crops are grain crops (82.5% of the total arable area in 1987) followed by cash crops (11.1%) and other crops (6.4%). Yunnan is bounded on the north-west by the Qinghai-Tibet Plateau and lies close to the sea in the south. It is strongly influenced by dry continental monsoons in winter and by moist maritime monsoons in summer. This, together with its complex terrain, gives Yunnan a special high-altitude monsoon climate, with year-round temperate weather and neither hot summers nor cold winters. Summer and winter barely exist in the greater part of the province, and spring and autumn follow each other, lasting together for 9 to 10 months.

Sichuan

Sichuan is another mountainous province with river valleys and river basins suitable for the production of food grains. It is one of China's most important grain producing areas. In 1987, 79% of the total area used for crops (8.5% of the national total) was sown with grain crops and the grain output accounted for 9.7% of China's total, ranking first among all the provinces and autonomous regions. The Western Sichuan Plateau is cold and dry, with a long winter but no summer. The high mountain valleys in the southern part of Sichuan show the most striking differences in climate at different elevations.

Tibet

Tibet lies on the main part of the Qinghai-Tibet Plateau at an average elevation of over 4,000 masl, the 'Roof of the World'. The economy is based on a mix of farming and animal husbandry. In 1987, animal production made up 54.6% of the total value of agricultural production, crop farming 35.4%, forestry 1.5%, and sideline occupations 8.5%. Tibet now has 221,500 ha of cultivated land and 53.3 million ha (1ha=15mu) of grasslands. The Tibetan Plateau extends across four climatic zones from south-east, the subtropical mountain zone to north-west, the high-altitude temperate frigid zone. Generally, it has thin clean air, long hours of sunshine, and intense solar radiation. There is a distinct contrast in winds between winter and spring: the rainy season starts from the south-east in February and spreads gradually to the north-west until it covers the whole of Tibet in June/July

Cropping Systems

Yunnan

Different agricultural systems are found in Yunnan, depending on the altitude and temperature. There are three distinct agroecological zones: highland cold areas; midland warm climate areas; and lowland tropical areas. The different crops grown in these areas are shown in Table 3.1. Rice and corn are the main crops grown in the lowland areas and rice, corn, and wheat in the midland areas, whereas potatoes, barley, and buckwheat dominate at higher elevations.

Table 3.1
Classification of agroecological zones in Yunnan

Zones	Highland cold	Midland warm	Lowland tropical
Elevation (metre)	Above 2300m in the east and 2500m in the west	1300-2300m in the east and 1500-2500m in the west	Below 1300m in the east and 1500m in the west
Maturity system	Almost one season	Almost double season	Double seasons or triple seasons
Main crops	Potato, highland barley, buckwheat, oats, medicinal plants	Rice, corn, wheat, broad beans, rape, cured tobacco, fruit, mulberry for breeding silkworms	Rice, corn, sweet potato, peanut, sugarcane, tea, tropical cash crops, southern medicinal plants
Percentage of total area of Yunnan province	18.4	54.0	27.6

Source: Shi Qing and Hu Ping (1992)

Sichuan

Table 3.2 shows the vertical distribution of agroecological conditions in Sichuan. Only one crop per year (either barley or spring wheat) can be cultivated in the cool mountain areas above 3,000m, whereas two crops per year can be grown in warm mountain areas, and two to three crops in the warm to hot mountain river valleys.

Rice, wheat, potatoes, and maize are the main crops, accounting for about 89% of the total area sown and 95% of the total grain production. Rice is grown mainly in the Sichuan Basin and is the

Table 3.2
Characteristics and crops of agroecological zones in Western Sichuan

Region	Altitude	Temperature			Crops	Number of Crops per Year
		Avg.	Min	Max		
Freezing High Mountain	>4700	<-5	<-15	<5	No crops, livestock, or forestry	
Cold High Mountain	4700-4200	-5 to -1	-15 to -11	5-8	No crops or forestry	
Semi-cold High Mountain	4200-3500	-1 to 3	-11 to -6	8-12	No cereal crops, rapeseed and flax can be grown	1
Cold-cool Mountain	3500-3000	3-7	-6 to -3	12-15	Spring barley and spring wheat	1
Cool Mountain	3000-2500	7-10	-2 to 1	15-18	Mainly spring barley and spring wheat, early mature maize	1, or 2 crops in 3 years
Warm Mountain	2500-2000	10-13	2-5	18-21	Winter wheat, mid-late mature maize	2
Hot River Valley (Upper)	2000-1300	13-17	6-10	21-23	Mid-mature rice, late mature maize, and winter wheat	2 to 3
Hot River Valley (Lower)	<1300	18-21	11-14	24-26	Rice (twice a year), sugar, and bananas	3

most important grain crop, accounting for 32% of the total area sown and 51% of the total production of all grain crops in the province. Wheat is mostly produced in the Sichuan Basin, particularly its northern and western parts. Potatoes are grown mostly in the dry hilly land in the basin and maize in the surrounding mountains and the western plateau.

Tibet

Tibet can be divided into five agroecological zones (Table 3.3). The vast majority of the area is covered by the rangeland found at high altitude. Pastoralism, the raising of yak, sheep, and goats, is the mainstay of the farm economy.

Table 3.3
Agroecological Characteristics of Tibet, China

Zone	Altitude (masl)		Mean Temp. in Warmest Month (°C)	Days over 0°C	Days over 5°C	Lowest Temp. (°C)	Main Livestock	Main Crops	Farming System
	West and Central	East							
Freezing Cold	> 5000	> 4700	<6	<120	<50	-	Yak, sheep, goat	-	Grazing in the summer
Cold	4500-5000	4200-4700	6-10	120-128	50 – 120	< -23	Yak, sheep, goat	Scattered barley distribution	Predominantly pastoral
Cool	4000-4500	3800-4200	10-18	180-330	120-250	> -23	Yak, sheep, cow	Spring barley, spring wheat, rape seed, peas	Agro-pastoral system with one crop per year
Temperate	<4000	3000-3300	10-18	180-330	120-250	> -23	Yak, sheep, cattle, pigs	Spring barley, winter wheat, maize, apple, peach	Cropping dominated system with a spring crop and winter crop
Warm and hot		<3000	>18	>330	>250	-	Cow, pigs, goat	Winter wheat, maize, rice, apples, oranges	Mixed agro-pastoral-forestry system. Multiple cropping

Source: Tibet Bureau of Land Management (1992)(with minor modifications)

Agro-pastoralism is practised in the cool and temperate mountain areas at altitudes of 3,000 to 4,500m. Animals like yak, sheep, and goats are raised and crops like barley, wheat, and maize cultivated. In the warmer lower altitude areas (<3000-4000 m), two crops can be harvested and apples, peaches, and plums are common. Growing of vegetables during the spring and summer seasons is becoming popular following the introduction of the use of plastic for greenhouses. Farmers can make more cash income from the cultivation of vegetables than from other agricultural activities like growing food grain or raising livestock.

Food Grain Crops

Yunnan

The main staple crops grown in Yunnan are rice, maize, and wheat, and others are broad beans and tubers. Rice is a staple food and accounts for 30% of the total area sown with grain and 49% of the grain production . It is grown widely, but mainly in the south. Maize, the second most widely grown crop after rice, accounts for 28% of the area sown with grain, and 27% of the total grain production. Wheat accounts for 13% of the area sown with grain and 8% of the total production. In 1997 Yunnan produced 5.3 million tonnes of rice, 3.7 million tonnes of maize, and 1.4 million tonnes of wheat from cultivated areas of 939,000 ha, 993,000 ha, and 664,000 ha, respectively (See Table 3.4).

Sichuan

Sichuan produced 39.2 million tonnes of staple crops in 1987, including 19.8 million tonnes of rice in husks, 6.6 million tonnes of wheat, 5.2 million tonnes of maize, and 5.6 million tonnes of potatoes. By 1997 this had increased to 21.8 million tonnes of rice, 7.2 million tonnes of wheat, and 7.2 million tonnes of maize from areas of 3 million ha, 2.3 million ha, and 1.8 million ha respectively (See Table 3.4).

Table 3.4
Area and production of cereals in three mountain provinces of China, 1997
(area in 1000 ha, production in 1000 tones)

	Sichuan		Yunnan		Tibet	
Crop	Area	Production	Area	Production	Area	Production
Rice	3020.1	21823.0	939.2	5361.0	1.0	5.0
Wheat	2364.9	7203.0	664.3	1467.0	51.0	249.0
Maize	1762.1	7169.0	993.8	3692.0	3.0	13.0

Sources: 1 Statistical Yearbook of Sichuan 1997
2 Statistical Yearbook of Yunnan 1997
3 Statistical Yearbook of Tibet 1997

Tibet

Grain production is the main crop farming activity in Tibet. In 1987, the area under food grain crops (mostly highland barley and wheat) accounted for 91% of the total, cash crops for 4%, and other crops for 5%. Highland barley accounted for 70% of the total area sown with grain crops and 75% of the total grain production and wheat for 20% of the total area sown with grain crops and 23% of the total production . Rape is the main oil crop and grown extensively. Tibet's major farm products in 1987 included 467,000 tonnes of grain crops (including 107,000 tonnes of wheat); 12,000 tonnes of rape seed; 544 tonnes of tea; and 4,687 tonnes of fruit, including 3,784 tonnes of apples. In 1997 the total food grain production included 5,000 tonnes of rice; 249,000

tonnes of wheat; and 13,000 tonnes of maize; from areas of 1000 ha, 51,000 ha and 3,000 ha for rice, wheat, and maize, respectively (See Table 3.4).

Economic analysis

Table 3.5 shows the average annual growth rate between 1983 and 1997 in the area, total production and yield of rice, wheat, and maize in the three regions.

Table 3.5
Average annual growth rates in the area, production and yield of various food grain crops in the mountainous provinces of China (%)

Province	Rice			Wheat			Maize		
	Area (ha)	Total Production	Yield (per ha)	Area (ha)	Total Production	Yield (per ha)	Area (ha)	Total Production	Yield (per ha)
Sichuan (1983-97)	-0.1	1.4	1.5	0.3	1.4	0.0	0.1	1.4	1.5
Yunnan (1983-97)	-0.6	1.4	1.9	1.4	0.5	2.4	0.0	1.8	1.8
Tibet (1983-97)	2.1	0.5	-1.9	0.5	0.6	0.2	1.6	-0.2	-1.3

In both Sichuan and Yunnan, the area under both rice crops and maize remained constant or declined slightly between 1983 and 1997, but the yield increased significantly so that there was a net increase in the total production of both crops. In Yunnan, both the area under wheat and the growth rate increased significantly. In Tibet, the area under rice and maize increased considerably but the yield decreased significantly, resulting in a minimal increase and slight drop, respectively, in the total production. The area and growth rate for wheat increased slightly.

Horticultural and Cash Crops

The mountainous provinces of China have a range of agro-climatic conditions suitable for growing a large variety of temperate to subtropical fruits such as apples, pears, peaches, plums, apricots, cherries, grapes, almonds, walnuts, pecan nuts, citrus fruit, litchis, guava, *amla*, kiwi fruit, and strawberries. The area of land allocated to total production of, and yields of various fruit and other cash crops is shown in Table 3.6.

Yunnan

The major cash crops in Yunnan are rapeseed, sugar cane, cured tobacco, and tea. Yunnan is one of China's leading tea producers and is known for its *puer, dianhong, dianlu, tuo,* and *quizibing teas,* all of which sell well on the international market because of their delicate fragrance and delightful aroma, richness in caffeine and tea tannins, and sugar content. Oil-bearing crops account for 74% of both the area and the output of cash crops. Tobacco plantations cover 174,930 hectares; the area and output rank second in the country. The area and the output of sugar cane plantations in the province rank third in the country.

The total output of these cash crops in 1997 was 68,000 tonnes of tea; 188,000 tonnes of oil crops; 901,000 tonnes of tobacco; and 11.4 million tonnes of sugar, from 164,000 ha, 149,000 ha, 504,000 ha, and 202,000 ha, respectively (see Table 3.6).

Table 3.6
Area and production of cash crops and horticultural crops in three mountain provinces of China, 1997 (Area in 1000 ha, Production in 1000 tonnes)

	Sichuan		Yunnan		Tibet	
	Area	Production	Area	Production	Area	Production
Potato	584.6	162.5	226.4	651.0	0.8	1.0
Cotton	154.4	1233.3	1.8	0.6	18.3	35.1
Tea	101.0	59.4	164.5	68.2	0.1	0.1
Oil crop	1024.1	1568.2	148.5	188.1		
Sugar cane	34.1	1726.7	202.6	11434.0		
Tobacco	147.3	261.7	503.9	901.9		
Silk(1993)	148.7	185.7	7.0	3.2		
Apple	34.5	138.8	47.2	65.8	1.4	3.0
Orange	202.9	1443.1	15.7	62.4	962.0	
Pears	32.6	209.0	29.0	136.2		
Vegetables	32.6		144.9			

Sources: 1. Statistical Yearbook of Sichuan 1997
2. Statistical Yearbook of Yunnan 1997
3. Statistical Yearbook of Tibet 1997

Less important cash crops include potatoes and other vegetables, various fruits, silk, and cotton. In 1996, 783,000 tonnes of potatoes were produced on 306,000 ha of land. In 1997, 145,000 ha were planted with vegetables other than potatoes and 66,000 tonnes of apples, 62,000 tonnes of oranges, and 136,000 tonnes of pears were produced from 47,000 ha, 16,000 ha and 29,000 ha of orchards respectively. In 1993, 3,210 tonnes of silk were produced from 7,000 ha and, in 1997, 608 tonnes of cotton from 1,800 ha (See Table 3.6).

Sichuan

In Sichuan, the area sown with cash crops is only 13% of the area sown with grain crops. The major cash crops are rape, bast fibre crops, cotton, peanuts, and sugarcane. Rape accounts for 54.3% of the area sown with cash crops and for 83% of the area of oil-bearing crops. The sown area ranks second and the yield (productivity) ranks first in China. Rape is mainly grown on flat land and in the hilly areas of the Sichuan Basin. Cotton is grown mostly on the hilly platforms in the central and northern parts of the basin. Sugar cane is grown mainly in the areas along the banks of the large and medium-sized rivers in the southern and central parts of the basin, especially along the middle and lower reaches of the Tuojiang River.

In 1997, the production of fruit in Sichuan was 139,000 tonnes of apples, 1.4 million tonnes of oranges, and 209,000 tonnes of pears. Areas cultivated with these fruit crops in the same year were 35,000 ha, 202,000 ha, and 33,000 ha respectively for apples, oranges, and pears. The area cultivated with vegetables in Sichuan in 1997 was 33,000 ha. Total output of cash crops in 1997 in Sichuan was 1.2 million tonnes of cotton, 59,000 tonnes of tea, 1.6 million tonnes of oil crops, 1.7 million tonnes of sugar, and 261,000 tonnes of tobacco. Areas cultivated with these crops in the same year were 154,000 ha of cotton, 101,000 ha of tea, 1 million ha of oil crops, 34,000 ha of sugar cane, and 147,000 ha of tobacco. Silk production and area in 1993 in Sichuan were 186,000 tonnes and 149,000 ha, respectively (see Table 3.6).

Four counties in Sichuan (Xiaolin, Maoxian, Yanyuan, and Yuexi) have been selected for high quality apple production for export and for the domestic market, and, in these counties, apple production has now become the main source of income. In 1996, the total apple growing area in the three prefectures Ganzi, Aba, and Liangshan was 24,667 ha and the total output reached 82,327 tonnes. About 500 households achieved earnings of more than US$ 1,200 each per year.

Liangshan Prefecture is the only prefecture in Western Sichuan with a comparative advantage for orange growing. In 1981, a new variety, the Navel orange, was introduced in the prefecture and commercial production of oranges became very popular. Navel oranges command a price one and a half times higher than that of normal varieties and orange growers changed from old varieties of oranges and began to cultivate Navel oranges. The sweet and seedless oranges grown in the prefecture mature early and have a high quality, comparable to that of those produced in the Sichuan Basin, one of the biggest citrus production areas in China. By the end of 1996, the total area under orange cultivation in the prefecture had reached 7,133 ha and the total output 3,567 tonnes.

Until the early 1980's, off-season vegetables were not grown on a commercial scale in western Sichuan because of lack of transportation facilities and markets. Two factors then stimulated development of vegetable cultivation on a large scale: the improvement of transportation, including highways and railways; and an increased demand for vegetables in the big cities, especially in northern China. Now production of off-seasonal vegetables in the hills and mountains of Sichuan is growing each year, providing productive employment and cash income to farm families. Two kinds of off-season vegetables are cultivated in the region: tropical vegetables cultivated in the warm areas in winter and temperate vegetables cultivated in the high altitude areas in summer. Tropical vegetables include tomatoes, sweet pepper, eggplant, garlic bolt, onions, cucumber, pumpkin, and balsam pear; temperate vegetables include Chinese cabbage, cabbage, cauliflower, radish, and tomatoes.

Tibet

In 1996 in Tibet, 3,000 tonnes of potatoes were produced from 1,300 ha of planted area. In 1997, 3,000 tonnes of apples were produced from 1,400 ha of land, 35,000 tonnes of oil crops from 18,000 ha of land, and 123 tonnes of tea from 100 ha of land. An additional 962,000 ha of land was cultivated with other vegetables. As a result of greenhouse technology, growing vegetables has been a practice among local farmers, especially in villages close to Lhasa. The growing demand for green vegetables among the urban and semi-urban population in Tibet has provided local farmers with an opportunity to generate cash income through cultivation of vegetables by themselves or renting out their land to migrants from other parts of China.

Economic analysis

Table 3.7 shows the average annual growth rate between 1983 and 1996 in the area, total production, and yield of apples, oranges, and pears in the three regions. Overall there was a considerable increase in the total production of these three fruits in the region. Yunnan showed the most growth per annum overall in both the area allocated to and the total production of apples (4.9% and 4.4%) as well as the area allocated to and the total production of citrus fruit (4.4% and

Table 3.7
Average annual growth rates in the area, production and yield of various selected fruits in the mountainous provinces of China (%)

Provincee	Apples			Oranges			Pears		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Sichuan (1983-97)	1.5	1.7	0.3	1.3	4.7	3.4	2.6	1.6	-1.0
Yunnan (1983-97)	4.9	4.4	-0.6	4.4	5.3	0.9	1.3	-0.1	-1.4
Tibet (1984-97)	1.1	2.9	1.8	0.0	0.0	0.0	0.0	0.0	0.0

5.3%). In both Sichuan and Tibet, the annual growth rate in the area of apple orchards was more than one per cent. Sichuan showed the greatest rate of increase in area of pear orchards at 2.3% per annum. At the same time there was little or negative growth in yield except for apples in Tibet.

Table 3.8 shows the average annual growth rate between 1983 and 1997 in the area, total production, and yield of various other cash crops in the three regions. The area under tobacco grew considerably in both Sichuan and Yunnan with annual growth rates of 2.3% and 5.3%, respectively. In Tibet, both the area under potatoes and oil crops and the growth rates of both crops increased resulting in a more than 4% average annual increase in production of both. In contrast, there was little increase in either of these crops in Sichuan and Yunnan. Among other cash crops, the area contributing to silk production grew significantly in Sichuan, as did the area of both tea and sugar plantations in Yunnan.

Table 3.8
Average annual growth rates in the area, production and yield of various cash crops in the mountainous provinces of China (%)

Province	Potatoes			Cotton			Sugar			Silk		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Sichuan (1983-96)	0.5	1.2	1.4	0.7	0.7	0.0	-1.2	-2.9	-1.6	5.6	2.6	-2.9
Yunnan (1983-96)	0.7	1.7	1.0	-2.2	-1.0	2.8	3.8	5.0	1.1	-0.3	0.6	1.0
Tibet (1983-96)	2.7	4.2	1.5									

Livestock

As in any mountain area, livestock are an integral part of mountain farming systems in China. Cattle[1] (including cows) are commonly raised. Horses are commonly used as draught power in transporting agricultural products using carts with wooden wheels. Male buffaloes are used for draught power for ploughing agricultural land. Pigs are very commonly raised and are popular among Chinese farmers. Sheep and goats are also common.

[1]The author has used the term cattle here to mean strictly cows and bulls and not all domesticated quadripeds, or all species in the *Bos* species.

Yunnan

With some 6.7 million hectares of mountainous and hilly areas under grass, long hours of sunshine and abundant rainfall, Yunnan enjoys favourable conditions for livestock breeding. It ranks third nationally in the number of large livestock found (Table 3.9). Cattle (cows and bulls)are reared widely in the province. The province ranks second nationally in the number of cattle kept. The horse is a vital means of transport in the mountain areas of central and northern Yunnan and the Lijiang horse is one of the best breeds in China. Pig raising is the principal sideline occupation in rural areas. In 1997 Yunnan had 8 million cattle, 2.9 million buffaloes, 23.3 million pigs, 6.5 million goats, 1.2 million sheep, 570,000 mules, 932,000 horses, and 320,000 donkeys.

Sichuan

In Sichuan, livestock raising is common among farming communities. Pig raising and buffalo husbandry are concentrated in the basin area; sheep, horses, donkeys, and mules are raised mainly in western Sichuan; oxen are raised mostly in the surrounding mountain areas and in the hilly areas of the basin; and goats are distributed throughout the surrounding mountain areas and the western part of the province. In 1997 Sichuan had 11.3 million cattle, 3 million buffaloes, 70.8 million pigs, 9.7 million goats, 3.6 million sheep, 67,000 mules, 630,000 horses, and 65,000 donkeys.

Tibet

Tibet is one of China's major pastoral areas; its grasslands make up 18.7% of the nation's total. The northern Tibetan plateau is the principal pastoral area, and, there, yak and sheep are the main animals. Local oxen, mule, donkey, and pig breeds are raised in the valley areas in southern Tibet. Tibetan yaks, known as 'ships of the highlands', are highly adaptable to cold weather and capable of carrying heavy loads; and they are the main draught and pack animals. Milk, butter, and beef/yak meat are staple foods for the Tibetan herdsmen.

At the end of 1987 Tibet had 5.6 million large animals (5.2 million oxen, 308,000 horses, and 122,000 donkeys), 5.8 million goats, 11.7 million sheep, and 156,000 pigs. The province produced 88,000 tonnes of meat, including 44,000 tonnes of mutton and 41,000 tonnes of beef; 185,000 tonnes of milk products, including 141,000 tonnes of milk; 8,900 tonnes of sheep's wool, 960 tonnes of goat's wool, and 3.7 million tonnes of fine wool. In 1997 Tibet had 5.1

Table 3.9
Livestock population 1997, China (population in 10,000)

	Sichuan	Yunnan	Tibet
Cattle	1133.3	802.2	510.0
Cow	817.8	495.9	
Buffalo	296.9	290.3	
Pig	7081.6	2334.4	22.6
Goat	971.7	653.8	583.2
Sheep	363.7	122.8	1109.8
Mule	6.7	57.0	1.0
Horse	62.9	93.2	36.2
Donkey	6.5	32.1	13.6

Sources: 1. Statistical Yearbook of Sichuan 1997
2. Statistical Yearbook of Yunnan 1997
3. Statistical Yearbook of Tibet 1997

million cattle, 230,000 pigs, 5.8 million goats, 11.1 million sheep, 10,000 mules, 932,000 horses and 140,000 donkeys.

Economic analysis

Table 3.10 shows the average annual growth rate between 1986 and 1997 in the total number of various types of livestock in the three regions. The goat population appears to have increased more than the populations of other animals, such as cattle, buffalo, and sheep, particularly in Sichuan. Although the sheep population increased slightly in Sichuan and Tibet, it decreased significantly in Yunnan. The increase in cattle was slightly higher in Sichuan and of buffalo in Yunnan (17% in total over 11 years compared with the other provinces). In Tibet the main change was an increase in the number of pigs.

Table 3.10
Average annual growth rates in livestock populations in the mountainous provinces of China (%)

Province	Cattle	Buffaloes	Horses	Donkeys	Mules	Pigs	Goats	Sheep
Sichuan (1986-97)	0.7	0.1	1.6	1.7	4.8	0.7	2.0	0.4
Yunnan (1986-97)	0.2	0.5	0.0	1.7	2.4	1.3	0.4	4.5
Tibet (1986-97)	0.2	0.0	1.0	1.0	0.1	1.7	0.2	0.1

CHAPTER 4

The State of Mountain Agriculture in India

Introduction

The Indian Himalayas cover an area of 53.8 million ha, approximately 16% of the total geographical area of the country. About 15% of the area is permanently covered with snow and provides a perennial flow of water, 1,200 cu km annually, to the vast Indo-Gangetic plains (Chandra 1994). The Himalayan hill and mountain agro-ecosystem has been classified into five agroecological zones. They represent wide variations in climate from cold arid to warm and humid. Annual rainfall in the region varies from <150 mm to 2,600 mm, and the mean annual temperature from 8°C to 22°C. The growing period for different crops ranges from 90 to >270 days in a year. The major soil groups are skeletal, calcareous to brown forest podzolic, and brown red and red yellow, and are all alkaline.

Socioeconomic characteristics and land-use patterns

The Himalayan region of India is home to 33.8 million people. The region is sparsely populated with an overall population density of 627 per 1,000 ha. Agriculture is the main occupation of the mountain population, providing direct employment to about 71% of the working population. Agriculture is the primary sector of the economy, contributing 45% to the total regional income of the inhabitants. The net cultivated area is higher in the western Himalayan region (15.8% of the total geographical area) than in the north-eastern part (9.8%). The net cultivated area varies from 2.7% in Arunachal Pradesh to 40.9% in the Darjeeling District of West Bengal. Forest is the major land use and accounts for nearly 59% of the total area of the Indian Himalayas.

Himachal Pradesh covers four different physiographic regions (outer, lower, higher, Himalayas). Uttar Pradesh (UP) is predominantly flat but includes the hilly and mountainous region of Uttarakhand which covers an area of 5930 sq. km and is inhabited by 5.93 million people (1991). Approximately 981,000 ha of HP, and 970,000 ha of the U.P. hills, Uttar Pradesh (UP) are cultivated; 17%, and 19% of the total geographical area of each state, respectively.

Table 4.1 shows the average size of landholdings classified into marginal, small, semi-medium, medium, and large. The great majority of the farming households in the Himalayan states are marginal subsistence farmers with landholdings of less than 0.5 ha or small landholders with farms of 0.5 to 1.0 ha.

Table 4.1
Status of landholdings in the Western Himalayas

Size of holding (ha)	Farm category	Percentage of operational holdings		
		J&K	HP	UP hills
Below 0.5	Marginal	45.68	39.4	53.0
0.5-1.0	Small	24.51	22.2	18.0
>1.0-2.0	Semi medium	17.00	20.6	16.0
>2.0-5.0	Medium	11.39	14.3	11.0
>5.0-0	Large	1.42	3.5	2.0

Source: Khosla and Raina (n.d.)

The average landholding size in the HP is estimated to be about 1.2 hectares. The great majority of the farmers have scattered marginal or small landholdings. The main crops are maize, wheat, rice, pulses, and vegetables. The average landholding size in the UP hills is 0.97 ha. The main crops are paddy and millet (small) in summer and wheat and barley in the winter.

In the north-eastern Indian Himalayas the predominant land-use system is shifting cultivation or 'jhum', which supports 1.6 million tribal people over an area of 426 million hectares (Partap and Watson 1994) (Table 4.2). In Nagaland State, an estimated 1,000 sq. km of sloping land is brought under shifting cultivation every decade. As a result of the increased population, the fallow period has dropped from 14 to 5 years.

Table 4.2
Area under shifting cultivation in the Eastern Himalayan states

State	Area under Shifting Cultivation	No. of Families	% of population
Arunachal Pradesh	70,000	54,000	57.69
Assam	69,600	58,000	NA
Manipur	90,000	70,000	27.95
Meghalaya	53,000	52,290	34.58
Mizoram	63,000	50,000	80.74
Nagaland	19,000	116,046	27.95
Tripura	22,300	43,000	6.92

Source: ENVIS BULLETIN (1994)

Cropping Systems

The main cropping systems in the different agro-climatic zones of the western Himalayan states are shown in Table 4.3. The major food crops grown in the area are food grains (rice, wheat, maize, millets, barley, and buckwheat), pulses (beans, peas, kidney beans, black gram, horsegram, black soybean, lentils, green gram, and bengal gram), oil seeds (rapeseed, mustard, sesame seed, and linseed), potatoes and other vegetables, and sugarcane. These are intra and intercropped in various combinations.

Agriculture in the north-east Himalayan region (NEHR) is dominated by shifting cultivation which occupies 85% of the total cultivated area. A diverse mix of 8 to 10 crops is grown, but the productivity and production levels have been declining over the years. The economy is predominantly rural with a low yielding, rice-based farming system followed by wheat, maize, and millet.

Table 4.3
Cropping systems in the Western Himalayan states

Cropping systems	Low Hills Sub-tropical zone	Mid hills Sub humid zone	High hills Temperate zone
Himachal Pradesh			
Dry farming area	Maize-wheat Maize–gram Maize-mustard Sugarcane	Maize –wheat Maize-buckwheat-gram/barley Ginger-wheat/barley Maize-vegetables	Maize-wheat/barley Potato-fallow/potato Potato-peas/fallow
Irrigated area	Maize–mustard/wheat Maize-potato-wheat Paddy-wheat/clover Maize-vegetables Vegetables-wheat	Paddy-wheat Vegetables-wheat Potato-peas/wheat Maize-vegetables/wheat	Beans-cabbage Cabbage-peas Barley-buckwheat-fallow
Jammu and Kashmir			
Dry area	Maize/bajra-wheat Paddy/maize-Mustard/potato-wheat Rice-wheat-moong	Maize-wheat	
Irrigated area	Rice-wheat	Rice-wheat (summer vegetables, chillies, and summer pulses also grown)	Millets, wheat, fodder, pulses barley, oilseeds, and fruit are grown (only one cropping season)
UP Hills	Rice-wheat-barnyard millet-barley Minor millet-fallow-rice-wheat Soyabean-Black gram-horsegram-lentil-rice-wheat-tomato-potato Barnyard millet-mustard	Barnyard millet-wheat-minor millet-fallow Soyabean-Black gram-horsegram-barley-ard millet-wheat Rice-wheat Rice-potato Barnyard millet-lentil/mustard Tomato-barley	Frenchbean-potato-minor millet-fallow Barnyard millet-wheat-Black gram-soyabean Peas (vegetables)-potatoes-cabbage Rice-wheat French beans+amaranth-peas (vegetables) Peas-potatoes Tomatoes-cabbage

Compiled from Khosla and Raina (n.d..). Himalayan Farming Systems – R & D Support for Sustainable Agro-Economy. Dr. YS Parmar Univ. of Horticulture and Forestry, Solan. Himachal Pradesh

Food Grain Crops

In the Himalayan region, 76% of the gross cropped area is under food grain crops. The proportion is highest in Manipur (88%) and lowest in Meghalaya (55%). The remaining area is used to grow vegetable crops, fruit, and oil seeds. Nearly three quarters of the total area under food crops is occupied by grain species. The two Himalayan regions show distinct crop preferences. In the north-east, rice is the staple food and occupies 81% of the total area under food grains followed by maize (12.7%). Wheat is cultivated in small areas in Arunachal Pradesh, Meghalaya, Sikkim, and Tripura. This is in sharp contrast to the western Himalayan region where wheat is the principal crop (36.4% of the area) followed by rice (30.7%) and maize (26.3%).

Valley bottoms and river basins with assured irrigation water are used for growing rice and wheat as summer and winter crops, respectively. Maize is cultivated on upland slope terraces under rain-fed conditions. Millet is confined to the hill region of UP. The cultivation of pulses and

oil seeds is restricted to small areas only. There has been a sharp decline in the area of these crops as a result of outbreaks of pests and diseases and lack of availability of suitable varieties. The hill farmers are adopting more diversified agriculture with a high cropping intensity, ranging from 150 to 170%, as a result of the limited amount of land available for cultivation.

Table 4.4 shows the average yields of food grain crops in the three western regions in 1988-89 compared to the values for India as a whole. The productivity of rice, wheat, and barley in all three Himalayan states was below or well below the national average with the exception of rice in J&K. The yield of maize was somewhat lower than the national average in J&K and the UP hills, but considerably higher than the national average in HP.

Table 4.4
Average yields of food grain crops (Kg /ha) (1988-89)

Crop	Himachal Pradesh	J&K	UP Hills	All India
Rice	963	1599	1049	1541
Wheat	1176	889	1050	2053
Maize	1590	1018	1190	1237
Barley	1100	N/A	940	1460

Source: Compiled from Agricultural Situation in India, various issues, Ministry of Agriculture, GOI, New Delhi

Economic analysis

The general trend in major food grain crops was analysed by estimating the average annual growth rates in the area under cultivation, total production, and average yield per hectare of paddy, wheat, and maize in three states selected as examples—Himachal Pradesh (HP), Uttarakhand, and Meghalaya—using time series' data: the aim was to provide comparative economic indicators of the state of food grain crops over a ten-year period (up to 1991 or 1993) in the Himalayan states. The results are shown in Table 4.5.

Table 4.5
Average annual growth rates (%)of selected food grain crops
In three Indian Himalayan States

Crop	Himachal Pradesh (1981-1991)			Uttarakhand (1980-1993)			Meghalaya (1984-1991)		
	Area	Prod	Yield	Area	Prod	Yield	Area	Prod.	Yield
Paddy	-0.38	0.14	0.53	-0.13	1.35	1.48	-0.64	-1.62	2.30
Wheat	0.17	2.28	2.10	0.01	1.22	2.35	2.17	0.70	-1.38
Maize	-0.19	1.13	1.32	-0.94	-1.21	-0.26	0.05	-0.31	-1.46

The area under paddy and maize declined or remained nearly constant in all three states, and the area under wheat remained virtually constant in two—only increasing in Meghalaya. This reduction in area may have reflected a shift towards cultivation of cash crops such as fruit and vegetables. The yields of all three food grain crops increased in HP as did those of paddy and wheat in Uttarakhand, and of paddy in Meghalaya. But the yields of maize in Uttarakhand, and of wheat and maize in Meghalaya, actually declined.

Horticultural and Cash Crops

The Himalayan ecosystem has a sub-tropical to temperate climate favourable for growing a wide range of fruit, vegetables, and other cash crops. Small areas with their own micro-climatic

conditions can provide suitable sites for growing particular crops. The products include fruit such as apples, citrus crops, walnuts, plums, peaches, bananas, mangoes, and pineapples; vegetables such as tomatoes, radishes, potatoes, peas, cabbages, and cauliflower; other cash crops such as ginger, chillies, cardamom, and saffron; and flowers such as orchids, gladioli, marigolds, and chrysanthemums. The total area under fruit and vegetables in the Indian Himalayan states is estimated to be around 16% of the gross cropped area, which is much higher than the all India average of 4%, but it is not evenly distributed. The proportion of land under horticultural crops is much higher in the western Himalayan states (20% of net cultivated area) than in the north-east (5.0% of net cultivated area).

Himachal Pradesh has witnessed a phenomenal increase in fruit production over the last two decades. Table 4.6 shows the average annual growth rates in the area, production, and crop yield of various fruits and vegetables between 1981 and 1992. The total area cultivated for fruit increased from only 792 ha in 1950-51 to 190,000 ha in 1994-95. During the 20 years from 1974-75 to 1993-94 the area on which fruit crops are grown has increased by about 6% per annum, and that of apple orchards, the main fruit crop, by 6.9% per annum. Most of this growth was in the first decade.Fruit crop areas were as of 1997/98 reported to occupy 4.4% of the total geographical area of the state, with apple orchards about 40% of this. As much as 75 to 80% of the apple crop is exported to other parts of India and other countries. The production of fruit increased from 1,200 MT in 1950-51 to 532,000 MT in 1992.

Table 4.6
Average annual growth rates in the area, production and yield of various fruit and vegetable crops in Himachal Pradesh (1981-1992) (%)

	Area	Production	Yield
Apple	1.6	2.0	0.4
Temp. Fruits.	1.7	0.8	-0.9
Dry Fruits	2.4	3.3	0.9
Citrus	3.4	1.0	-2.3
Potato	-0.4	0.7	1.1
Vegetables	2.5	2.5	0.0
Dry Ginger	3.3	7.0	3.6

During the ten years from 1981 to 1992, the largest annual growth rate in terms of area was for citrus followed by dry ginger (3.3%) and vegetables (2.5%). The area of all other horticultural crops also increased with the exception of potatoes, which showed a slight decline. Dry ginger showed the highest growth rate in total production followed by dry fruits (3.3%) and vegetables (2.5%). Similarly, ginger showed the greatest growth rate in yield. The yields of temperate fruits and citrus dropped somewhat, although in both cases overall production increased slightly as a result of the increase in area cultivated.

The climate of the UP hills (Uttarakhand) is suitable for growing a range of temperate, subtropical, and tropical fruits as well as vegetables, flowers, ornamental plants, mushrooms, and medicinal plants. Table 4.7 shows the values for and growth rates in the area under cultivation, total production, and yield of various fruits and vegetables from 1984 to 1994. There were considerable shifts of land resources towards the growing of fruits and vegetables in this period.

Table 4.7

Area and production of fruits and vegetables in Uttarakhand ('000 hectares and '000 tonnes)

Items	Unit	1984/85	1989-90	1993/94	% Growth 1984-85 to 1989-90	% Growth 1989-90 to 1993-94
Fruit						
Area	'000 ha	142	166	179	16.90	7.26
Production	'000 tonnes	330	398	470	20.61	18.09
Yield	ha/tonne	2.32	2.40	2.63	3.45	9.58
Vegetables						
Area	'000 ha	34	49	65	44.12	32.65
Production	'000 tonnes	130	239	326	83.85	36.40
Yield	ha/tonne	3.82	4.88	5.02	27.75	2.87
Potatoes						
Area	'000 ha	12	16	19	33.33	18.75
Production	'000 tonnes	149	304	392	104.03	28.95
Yield	ha/tonne	12.42	19.00	20.63	52.98	8.58

Source: Mehta (1997)

Different vegetable crops are grown in the area lying between 300 and 1,400 masl. The land used for the production of various vegetables in the region increased from 34,000 ha in 1984-85 to 65,000 ha in 1993-94, 13% of the net area sown. The total production increased from 130,000 to 326,000 tonnes. The total area of potato crops increased from 12,000 to 19,000 ha, and production from 149,000 to 392,000 tonnes within the ten-year period, with a yield increase of 60%.

In Jammu and Kashmir (J&K), the horticultural sector contributes significantly to the state economy. The agro-climatic conditions are favourable for the production of a range of horticultural crops. The agro-climatic zones range from sub-tropical to intermediate to temperate and thus provide tremendous scope for the expansion of fruit and vegetable production. At present about 20% of the total cultivated area in the state is under horticultural crops. The area under fruit cultivation registered an enormous increase from 12,400 ha in the 1950s to 176,300 ha in 1990-91. Apples alone comprise about 40% of the total production of fruit in the state.

Livestock

The Himalayan region of India supports about 50 million domestic animals (1.6 animals/ha) for various purposes such as transportation and production of milk, meat, fur, wool, hide, and manure. The livestock pressure is higher in the Himalayas than in the plains. Stall feeding and settled grazing (kharak) is normally practised in the low and mid-hills, whereas nomadic or migratory grazing is common in the high hills.

A large proportion of livestock species is raised under mixed cropping systems. The landholdings are small and livestock supplement the family income. Animal dung and bedding material provide manure for the crops. Almost the entire energy requirement of hill agriculture is met from bullock or human power (Rao and Saxena 1994). In the Indian Himalayan region, cattle are the most common animals (47.5%), followed by goats (15.8%), buffaloes (12.3%), and sheep (10.4%) (Rao and Saxena 1994).

In Himachal Pradesh (the western region) livestock contribute about 13% of the gross domestic product. The total milk production increased from 529,190 tonnes to 653,850 tonnes between 1993 and 1998. The state now has one of the highest levels of milk availability per capita–320g per capita per day compared to 178g for all India. Livestock pressure is increasing in the mixed crop farming areas. In the low hills, the average number of livestock per household was reported to be 11, 53% cattle and 36% sheep and goats. In the mid-hills there were eight animals per farm under mixed farming systems, and nine under vegetable- based systems (Mahendra Dev 1994).

Table 4.8 shows the trends over time in the number of animals of different species and their proportion of the total in the ten years up to 1988 in Uttarakhand (central region) and 1992 in Himachal Pradesh. In both states the number of cattle declined slightly while the buffalo population increased significantly. Similarly, the number of sheep declined considerably, and the number of goats increased (Table 4.8).

Table 4.8
Changes in the livestock population and composition in Himachal Pradesh and the U.P. Hills, India

	1982		1992[1]		Change in population [1] (%)	Change in % share in livestock population[1]
	Population	Per cent composition	Population	Per cent composition		
Himachal Pradesh						
Cattle	2173663	44.0	2151616	42.7	-1.01	-1.3
Buffalo	616415	12.5	700917	13.9	13.7	1.4
Sheep	1090322	22.1	1074345	21.3	-1.47	-0.76
Goat	1059862	21.5	1115591	22.1	5.26	0.67
Total	4940262	100	5042469	100		
U.P. HILLS						
Cattle	1909929	47.9	1978331	46.5	3.6	-1.4
Buffalo	767461	19.3	846577	19.9	10.3	0.65
Sheep	407838	10.2	352640	8.3	-13.5	-1.94
Goat	901486	22.6	1075658	25.3	19.3	2.68
Total	3986714	100	4253206	100		

[1]1993 in case of U.P. HILLS

Sources: 1 Livestock Census Report (1982 & 1992), Govt. of Himachal Pradesh, India
2 Livestock Census Report (1982 & 1993), Govt. of Uttar Pradesh, India

CHAPTER 5

The State of Mountain Agriculture in Nepal

Introduction

Nepal is a mountainous country. About 1.7 million hectares or 65% of the total cultivated land is used for 'rainfed' (non-irrigated) agriculture, and 62% of this rainfed agricultural land is found in the mid-mountain region. There is a considerable diversity in environmental conditions, from sub-tropical climates at low elevations (<500m) to cold temperate climates at high elevations (<2500m). Agricultural activities in the hill areas are extremely complex with multiple cropping seasons within a year. The mid-mountains are dominated by upland farming systems characterised by a predominance of maize-based cropping systems, intensive cultivation, a high degree of subsistence, a high labour input, and close integration between crops, livestock, and forest. Agricultural activity in the higher mountain areas is dominated by production on steep hill slopes, large areas of which have been extensively terraced. Soil erosion is a continuing problem, particularly where land has been deforested and disturbed. An even more widespread problem in the region is loss of soil fertility and the lack of sustainability of the existing cropping systems.

In general, the number of holdings has increased in the last decade, resulting in a decreased size in the average holding per household. Holdings are also highly fragmented, the average parcel size in the hills is 0.2 ha with a holding of 3.9 parcels, or 0.78 ha, per household (Yadhav and Sharma 1996). Table 5.1 shows the average size of landholdings in the high and mid-mountain regions. The majority of households are classified as 'marginal farmers' with holdings of less than 0.05 ha. Less than a quarter of farmers in both areas are classified as 'small farmers' with landholdings of between 0.051 and 1 ha. About 20 per cent of households have landholdings of more than one hectare.

Table 5.1
Landholding size in the high and mid mountains, Nepal

	High Mountain		Mid Mountain	
Farm Size Class (ha)	% of HHs	HH Size	% of HHs	HH Size
0.025 to 0.051	67.5	5.0	53.6	5.4
0.051 to 1.02	20.6	6.1	24.9	6.6
1.02 +	19.9	7.8	19.9	8.2

Source: Munankarmi (1996)

Cropping Systems

The typical cropping patterns found in the low hills (below 1,000m), mid mountains (1000-2000m), and high mountain areas are summarised in Table 5.2. The most common main crops are paddy, wheat, maize, and potatoes in the low hills; paddy, wheat, maize, and millet in the mid-mountain region; and barley, maize, wheat, and potatoes in the high mountain region.

Table 5.2
Cropping patterns in the low hills and mid and high mountains of Nepal

Low Hills (below 1000m)	Mid-Mountains (1000-2000m)	High Mountains (2000-4000m)
paddy-wheat	maize/millet-fallow	maize/finger millet-fallow
paddy-wheat-maize	maize-potato	maize-wheat or barley
paddy-potato	Upland paddy-wheat	potato-fallow
	Upland paddy-potato	buckwheat-fallow

Food Grain Crops

The data on crop yields for the ten years from 1985/86 to 1995/96 were averaged to facilitate a comparative analysis of crop productivity in the different regions (Table 5.3). The crop yields of the major food grain crops paddy, maize, wheat, and millet, were lower than the national average in both the hills and the mountains, with the exception of millet, which had a slightly better yield in the hills and a lower yield in the mountains than in the hills.

Table 5:3
Average yield of food grain crops (kg/ha) in Nepal (1985-95)

	Paddy	Maize	Millet	Barley	Wheat
Mountains	1,875	1,476	1,032	902	1,045
Hills	2,122	1,491	1,068	896	1,221
Average for Nepal	2,179	1,547	1,050	911	1,358

Source: MOA, HMG (1985/86 to 1995/1996)

The growth rates in the area, total production, and average yield of the major food grain crops between 1985/86 and 1994/95 are shown in Table 5.4. There was minimal growth (stagnation) in the area, production, and yield of paddy, but significant growth rates were observed for maize, wheat, and millet. Maize production increased at annual rates of 1.5 and 2.2% in the high mountain and hill areas respectively, wheat production by 2.6 and 1.6%, millet production by 2.5 and 3.5%, and barley production by 1 and 3%. In the mountains, the increase in maize production resulted mainly from an increase in the area planted, that of wheat from both an increase in area and an increase in productivity.

Although the total production of the major food grain crops in both the high mountain and mid-hill areas outpaced the annual growth in population (1% in the high mountains, 1.6% in the hills between 1981 and 1991), the annual growth rates in crop yields were still well below these rates.

Table 5.4
Average annual growth rates in the area, production and yield of major cereal food grain crops in the mountains and hills of Nepal (%) (1985/86-1994/95)

Area	Paddy	Wheat	Maize	Millet	Barley
Mountains					
Area	0.74	0.85	1.11	1.67	0.18
Production	0.92	2.62	1.52	2.51	1.02
Yield	0.19	1.77	0.41	0.86	0.62
Hills					
Area	0.36	0.55	1.06	2.15	2.17
Production	0.97	1.58	2.17	3.51	3.03
Yield	0.68	1.03	1.12	1.34	0.83

Horticultural and Cash Crops

Production of fruit, vegetables, and other special horticultural crops is gaining commercial importance in Nepal. Horticultural enterprise has increased the possibility of generating employment by over two per cent in addition to self-employment in the hills. Farm household level studies in the Rapti mountains showed that the cost/benefit ratios of horticultural crops are much better than those of food grains . This economic benefit has considerably increased the social acceptability of horticultural crops (Tulachan1997). There was an estimated growth of about 12% in the total production of citrus fruit and 6% in that of non-citrus fruit between 1974/75 and 1992/93 as well as an impressive increase in the production of vegetable crops. The horticultural sector has a strong export potential. Horticultural crops contributed 13% to the agricultural gross domestic product in 1991-92.

Land is the key farm resource. Over the last ten years, there has been a considerable expansion in the area under horticultural crops as a result of both bringing idle land under cultivation and changing the use of fields previously used to grow food grains. Table 5.5 shows the increased allocation of land resources to horticultural crops over the different plan periods (1987-1997). Sizeable portions of land under these crops are from newly cultivated upland (waste, forest, and grass land) and some has been shifted from cereal crops (maize, millet, wheat) to horticultural cash crops. From the end of the fifth five-year plan (1986) to the end of the sixth five-year plan (1991), the percentage increase in area and production was greater 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

Table 5.5
Land allocation for high-value cash crops (horticulture) at the national level

Particular	End of 5th Five Year Plan	End of 6th Five Year Plan	Percentage Increase	End of 7th Five Year Plan	Percentage Increase
Fruits					
Area (ha.)	42,077	51,176	21.6	63,126	23.35
Production (mt)	275,000	343,204	24.8	461,746	34.54
Vegetables					
Area (ha)	96,000	138,000	43.75	140.500	1.8
Production (mt)	5,280,000	743,000	40.7	970,200	30.5

Source: NPC documents (1995)

end of the seventh five-year plan (1997), a significant increase in area and production has been observed.

Table 5.6 shows the average annual growth rates in the area, total production, and average yield of various fruit crops between 1993/4 and 1997/8. The area under the major crops, apple and citrus, increased significantly. There was little increase in yield for any of the crops.

Table 5.6
Average annual growth rates in the area, production and yield of various fruit crops in the mountains and hills of Nepal (%) (1993/94-1997/98)

Crop	Area	Prod	Yield
Apple	2.83	3.24	0.45
Citrus	2.39	2.83	0.31
Pear	0.19	0.65	-0.05
Walnut	1.83	2.10	0.33
Peach	2.09	1.94	1.00

Livestock

Livestock contributed about 32% of the national agricultural gross domestic product in 1991/92. The livestock population in Nepal in relation to the arable land per person is one of the highest in Asia (LRMP 1986). There are an estimated 6.2 million cattle, 3.1 million buffaloes, 5.4 million goats, 0.9 million sheep, and 0.6 million pigs in the country (DFAMS 1997). In the subsistence agricultural system practised by 90% of the population, livestock rearing is an important sector of the farm economy.

In the mountains and hills of Nepal, the livestock production system is integrated with the production of staple crops like paddy, maize, millet, wheat, and pulses as well as fruit and vegetables. The livestock supply draught power, manure, milk, and meat and the crops supply food and fodder. The most common livestock species found in mixed crop farming are cattle, buffalo, and goats. Nearly half of the animal feed comes from crop residues. There is an acute shortage of animal feed during winter and the dry season (Tulachan 1985) and livestock are generally underfed to the extent of one third of the required amount. Nepal as a whole has a feed shortage of 20 to 36% (Sherchand and Pradhan 1997), the problem being more acute in the hills and mountains.

On average, a mountain/hill household has six to ten head of large and small ruminants (Shrestha and Sherchand 1988). The number of standard livestock units (SLUs) per household is about 7.5 in the high mountain areas compared to 5.7 in the mid-mountains and 4.3 in the plains (the *Terai*). The overall number of livestock per capita is also higher in the mountains as is the contribution to the average household income. Livestock contribute close to 50% of household cash income in the mountains, 36% in the hills, and 20% in the plains (Table 5.7).

Table 5.8 shows the trends over time in the number of animals of different species and their proportion of the total between 1988/89 and 1996/97. In the hills, there was a significant increase in the populations of cattle, buffalo, and goats and an increase in the percentage share of

Table 5:7

Average annual livestock contribution to household economies by eco-region (NRs)

Ecological Region	Crops	Livestock	Agriculture Total
Mountain	3549	3190	6739
	(52.7)	(47.3)	(100)
Hill	4495	2495	6990
	(64.3)	(35.7)	(100)
Terai	8224	2057	10281
	(80.0)	(20.0)	(100)
All Nepal	6007	2371	8378
	(71.7)	(28.3)	(100)

Figures in parentheses indicate per cent of total
Source: Shrestha N.P. and Sherchand, L. (1988)

Table 5.8

Livestock population and composition in the mountains and hills of Nepal (1988/89 to 1996/97)

	Mountain		Hills	
Livestock species	% increase in population	% change in composition	% increase in population	% change in composition
Cattle	+3.17	+0.89	+5.77	-0.51
Buffalo	+0.58	0	+8.30	+0.21
Sheep	-9.59	-1.70	-2.53	-9.59
Goat	+2.87	+0.80	+9.37	+2.87

Sources: HMG-MOA1990;HMG-MOA1996/97

buffaloes and goats in the total population. In the mountains there was an increase in the number of both cattle and goats and a slight increase in the number of buffaloes. There was a significant decline in the sheep population in both regions.

CHAPTER 6

The State of Mountain Agriculture in Pakistan

Introduction

Pakistan is an agricultural country and its economy depends mainly upon agricultural production. About 70% of the total population are engaged in agriculture and the agricultural sector contributes 30% of the GDP. The mountain areas of Balochistan, the North West Frontier Province (NWFP), and the Northern Areas (NA) and others constitute about 60-65% of the country (high mountains 22-25% and low mountains 38-40 %) and support about 10% of the total population (130 million)(Siddiqui 1995). Agriculture is the mainstay of the mountain people: most people are poor and depend upon income from farmland and livestock to survive. Many people are landless and work as part of the labour force in other parts of the country or in foreign countries. Landholdings are small and mostly without irrigation facilities.

Most of the mountain areas in Balochistan, NWFP, and NA are classified as dry and cold. Precipitation is very variable, with more in winter than in summer. The mean minimum and maximum temperatures are low, especially at higher elevations where it snows in winter. The growing season for vegetation is usually short.

Balochistan

Agriculture is the main economic activity in Balochistan. In 1987/88 it accounted for some 54 to 60% of the provincial gross domestic product and employed 67% of the total labour force, considerably more than the national average of 51% (Altaf1998). Production of fruit and vegetables increased rapidly during the 1980s. They grew annually by six to seven per cent and gross farm incomes improved annually by more than nine per cent in real terms. Balochistan is a dominant exporter of fruit and vegetables to other provinces in Pakistan. Between 35 and 80% of the total national production of many deciduous fruits, such as apples, apricots, pomegranates, plums, and grapes, is grown in Balochistan (Alam 1996)

The proportion of small, medium, and large farms (0-5 ha; 5.1-20.0 ha; >20 ha); the proportion of the total farm area each category occupies; the average landholding size; and the average area of each farm actually cultivated were investigated in a survey of farmers in central Balochistan (Zone I) and northern Balochistan (Zone II) in 1998. The results are shown in Tables 6.1 and 6.2. The majority of farmers in both northern and central Balochistan had small landholdings of less

Table 6.1
Distribution of farm and farm area in surveyed area, 1998

Farm Category	Zone I		Zone II	
	% of farms	% of total farm area	% of farms	% of total farm area
Small	59.3	18.9	69.8	24.4
Medium	31.5	44.9	22.9	35.4
Large	9.2	36.2	7.3	40.2

Small farms = 0-5 ha; medium farms = 5.1-20.0 ha; large farms = > 20 ha
Zone I includes Quetta, Kalat, and Mastung districts (central)
Zone II includes Qilla Saifullah, Zhob, Loralai, Ziarat, and Pishun districts (northern)
Source: Altaf et al. (1998)

Table 6.2
Average farm area and percentage cultivated in Northern and Central Balochistan, 1998

Farm status (ha)	Zone I		Zone II	
	Average farm area	% cultivated	Average farm area	% cultivated
≤2.0	1.46	89	1.40	95
2.1 to 5.0	3.10	74	2.83	87
5.1 to 10.0	7.20	62	6.72	74
10.1 to 20.0	13.30	51	12.20	59
>20	27.80	42	30.20	46
Overall	7.14	62	5.48	57

Source: Altaf (1998)

than five hectares, these covered 19 and 24% of the total farm area in each zone, respectively. Less than 10% of landholdings were large farms of more than 20 ha, but these covered approximately 40% of the total farm area. The overall average farm size was higher in central Balochistan (Zone I) than in northern Balochistan (Zone II); 7.1 ha and 5.5 ha, respectively. On average less than two-thirds of the farm area was cultivated, ranging from 95% of the area of the smallest farms in the northern zone to 42% of the area of the largest farms in the central zone.

NWFP

The majority of farmers in the NWFP have small farm holdings. The average size is only 2.5 ha, compared to 4.5 ha in Pakistan as a whole (Dijk and Hussein 1994). A high proportion of farms (16%) are 'owner-operated'.

Northern Areas (NA)

The Northern Areas are one of the most rugged regions in the world, more than half the land area is above 4,500 masl. The low rainfall and rugged topography severely limit the expansion of farmed land. Over 90% of the area consists of steep to very steep mountain slopes with thin and patchy soil. These steep slopes are unstable and generally unsuitable for the production of arable crops. Large tracts of the mountain slopes between 900 and 3,300 masl are covered by natural coniferous forest reserves. Only some 54,000 ha of the total area of 7.25 million ha are cultivated. Farms are small; the average farm size is about one ha, of which about 75% is cultivated, and the majority of farmers have holdings smaller than this.

Cropping Systems

In the Pakistan mountains, the alpine and sub-alpine pastures above 3,300m are used for transhumant summer grazing of a large number of migratory small ruminants. The animals spend the winter in the Pothwar and Indus plains. Arable farming is the most important land use in the piedmont plains, loess plains, and alluvial plains and on lower, gentler slopes of the mountains.

The three major kinds of land use in the dry western mountains are irrigated cropping, dry farming, and grazing. Irrigated cropping is on a small scale but is of great importance. In most places crop cultivation on dry land is not successful because of the scanty and erratic rainfall. Farming is, however, practised in the plains, valleys, and high lying areas at the foot of the mountains.

The crops grown under perennial irrigation include fruit; such as apples, peaches, grapes, pistachio, and almonds; and vegetables or cash crops such as onions, potatoes, turnips, tomatoes, and cabbage. Wheat, barley, and fodder are also cultivated under perennial irrigation. The main crops under dry land farming are wheat and cumin. In areas where rainfed farming is complementary to irrigated cultivation, farmers often grow wheat, maize, barley, potato, millet, and sorghum. The main crops grown in winter and summer in the different agroecological zones are summarised in Table 6.3.

Table 6.3
Cropping patterns by agroecological zone

Crop category	Very cold, arid	Cold, arid,	Cold, sub-humid	Cool, humid	Warm, sub-humid	Hot, Sub-humid	Hot, arid
Main kharif crop	Rice	maize	Rice	maize	sugar cane	Ground nut	sugar cane
Second kharif crop	Maize	rice	Maize	rice	maize	Sorghum/ Millet	rice
Third kharif crop		vegetables		cash crop	cash crop		pulses
Main rabi crop	Wheat	wheat	Wheat	wheat	wheat	Wheat	wheat
Second rabi crop	oil seeds	vegetables	oil seeds	vegetables	sugar cane	Gram	sugar cane
Third rabi crop		oil seeds		Oil seeds	cash crops		pulses
Orchards	fruit and vegetables	fruit and vegetables	fruit and vegetables	fruit and vegetables	some	No	few

Source: Compiled from Diagnostic Surveys of NWFP Agriculture May 1995: Islamic Republic Of Pakistan, Government of North West Frontier Province, Agricultural University Peshawar, Agricultural Research Project Phase-II

Note: kharif—summer; rabi—winter

Maize, sorghum, and pearl millet are the kharif (summer) cereals and are grown for a dual purpose. Sorghum and millet are inter-cropped with some fodder varieties of beans. This mixture gives a high quality fodder that is very useful for dairy animals. The grains are used in poultry and cattle feed.

Wheat is the principal rabi (winter) crop and grown on the greater part of the cultivated area. It is also intra-cropped in orchards. Rapeseed is inter-cropped with wheat and green rape is uprooted and fed to animals. Conola type rapeseed is grown for the extraction of oil. Barley, lucerne, and berseem (clover)are cultivated as fodder crops in the rabi season.

Rainfed agriculture is common in both the valleys and on mountain slopes. Wheat, maize, and oil seeds are the dominant rainfed crops. There are two cropping seasons in areas below 2,250m and one at higher altitudes. Rice is grown up to 1,400m, while wheat and maize grow up to 2,250 m. Fruit orchards and vegetables are cultivated at elevations up to 2,500m. Tropical fruit such as citrus, banana, papaya, mango, and persimmon grow well below 900m. Peaches, pears, apricots, grapes, apples, and walnuts grow well between 1,350 and 2,400m.

Food Grain Crops

Most fertile and irrigated areas, and almost 80% of the agricultural land overall, are used for food grain production.

Balochistan

The cultivable land of Balochistan is estimated to be about 1.66 million ha of which about 0.60 million ha are used for irrigated crops and fruit and 0.16 million ha for rain-fed crops, the rest are fallow. Crops contribute about 45% of the total GDP of the province. Wheat is the most important rainfed crop grown in the highlands, followed by barley and rapeseed. Rainfed crop farming is very risky because of large fluctuations in rainfall patterns from year to year. Even so, local land races of rainfed wheat grown in Balochistan yield good quantities of straw and stubble which are fed to and mostly grazed by small ruminants—sheep and goats.

NWFP

Farming in the NWFP is mainly subsistence oriented and characterised by low inputs and outputs. Wheat is the main rabi crop on both rainfed and irrigated fields. Other rabi crops include barley, chickpeas, rapeseed, and mustard. About 60% of the area used to grow wheat is barani or rainfed land; this contributes about 40% of the total wheat production. The area under wheat increased by 44% between 1975/76 and 1991/92 and is largely the result of incentives provided by the government in the form of a support price.

Maize is the major kharif crop. Over the fifteen years from 1975/76 to 1991/92, the area under maize increased by 27%. The province produces 55% of all the maize grown in the country. Other kharif crops include groundnut, sorghum, and millet. Cultivation of potato as a cash crop has expanded strongly in those mountain areas where maize was a predominant crop because of the high prices paid for quality potatoes.

Economic analysis

The average yields of rice, wheat, and maize in three of the mountain provinces and Pakistan as a whole in 1993/4 are shown in Table 6.4. The average yields of wheat and maize in the mountain provinces were lower than the national average, whereas those of rice were similar or even slightly higher.

Table 6.4
Yields of food crops in three mountain provinces (kg/ha)

Crop	Balochistan	NWFP	Pakistan
Rice	1700	1700	1600
Wheat	830	1200	1700
Maize	640	1400	1300

Source: Govt. of Pakistan (1995)

The average annual growth rates in per cent in the area, production, and yield of various food grain crops in Balochistan and the NWFP over the 18-year period from 1975/76 to 1993/1994 are shown in Table 6.5. The average annual growth rates in total production were higher for wheat, rice, barley, and pulses in Balochistan and for maize in the NWFP. The average annual growth rates for wheat, barley, and pulses in Balochistan were impressive: four, five, and seven per cent for wheat, pulses, and barley, respectively. In contrast, the growth rates in the NWFP were low, from one half to two per cent or less for all crops except barley; barley showed a slight decline. The growth rates in total production resulted as much or more from an increase in the area under crops as from an increase in yields. In Balochistan, the average annual growth rates in yield ranged from 0.5 to 2%; in the NWFP they all lay below 1% with the exception of pulses at 1.4%. Overall production of food was better in Balochistan, possibly as a result of a more favourable policy and strategies for food grain production in the province.

Table 6.5
Average annual growth rates in the area, production, and yield of various food grain crops in Balochistan / NWFP (%)(1975/76 to 1993/1994)

Crop	Area		Production		Yield	
	Balochistan	NWFP	Balochistan	NWFP	Balochistan	NWFP
Wheat	2.1	0.4	4.0	1.3	2.0	0.8
Paddy	0.6	0.1	1.0	0.1	0.5	0.1
Maize	0.6	1.4	1.6	1.9	1.0	0.5
Barley	5.1	-0.1	7.2	-0.7	2.0	-0.8
Pulses	4.0	0.1	5.4	1.9	1.4	1.8

Horticultural and Cash Crops

There are many small pockets in the mountains of Pakistan that are suitable for growing different fruits like apples, apricots, peaches, pears, and almonds; and vegetables, particularly off-season fresh vegetables to meet the demands of people living in the plains where it is too hot to grow vegetables in the summer.

Balochistan

Balochistan produces 60% of the deciduous fruits grown in Pakistan; fruit contributes 39% of the total production value of agricultural crops in the state. Fruit farming provides employment for about 80,000 farmers, and overall about 200,000 people earn their living through this sector. The great majority of orchards lie in the size range of from 3 to 10 ha (80%) and most of the remainder are between 10 and 20 ha. Between 1984 and 1994 the total production of fruit crops, such as apples and cherries, increased by more than 300%. The acreage and total production of

off-season vegetables such as tomatoes, potatoes, and onions almost doubled during the same period (Alam et al. 1996),

NWFP

In NWFP, the total area under fruit production increased by 107% in the fifteen years from 1975/76 to 1991/92. Apple cultivation tripled after 1989/90, mainly as a result of the introduction of high-yield dwarf varieties. In addition to growing fruit crops, the NWFP is highly suitable for growing off-season vegetables because of its diverse physiography and favourable agro-climatic conditions. The total area of vegetables increased by 23% over the same fifteen-year period.

Northern Areas

The construction of the Karakoram Highway has resulted in a gradual transformation of the Northern Areas. A market-oriented agricultural production system is replacing the original subsistence farming system. Increasingly, traders from the lowland plains are making use of the comparative advantage of the Northern Areas to grow specialised crops like seed potatoes. Potato cultivation is replacing wheat, and fodder crops are being grown to support livestock. Fruit orchards are being established on newly cultivated land.

Vegetables are grown near the market centres of Gilgit and Skardu. There are no commercial orchards. Fruit trees are scattered and grown in household compounds or along the boundaries of fields. The major fruit crops grown at present are apples, pears, peaches, plums, apricots, almonds, cherries, walnuts, and grapes. Most of the varieties grown are indigenous and well adapted to local conditions. Apricot is the most common fruit crop because of the suitable climatic conditions. There are as many as 1.17 million trees in the region. The apricot varieties grown are of superior quality, but they are highly perishable and cannot be transported to distant markets. Sun drying in the open is gradually being replaced by solar houses. Every year, about 40,000 kg of apricots are dried in solar houses.

Economic analysis

Table 6.6 shows the average annual growth rates in per cent in the area, total production, and yield of various fruits and vegetables in Balochistan and NWFP between 1981 and 1994.

Table 6.6
Average annual growth rates in the area, total production, and yield of fruit and vegetables in Balochistan and NWFP (%) (1981/82-1993/94)

	Area		Production		Yield	
	Balochistan	NWFP	Balochistan	NWFP	Balochistan	NWFP
Vegetables	2.96	1.88	3.18	1.38	0.23	-0.49
Tomatoes	3.59	3.23	4.20	2.93	0.61	-0.29
Apples	4.87	2.37	5.74	2.15	0.88	-0.23
Apricots	4.18	2.36	4.81	3.53	0.64	1.17
Almonds	1.39	1.87	1.65	6.49	0.27	4.63

In Balochistan, the total production of all the main fruits, fresh vegetables, and tomatoes increased at significant rates of three per cent to six per cent per annum, with the exception of almonds, for which the growth rate was under two per cent. Most of the increase in production resulted from an increase in the area used to raise the crop. The increases in yield were all below 1% per annum,

and for vegetables only 0.23% per annum. Apples showed the highest growth rates for area, total production, and yield.

The growth rates in area under the crop were significantly lower in the NWFP, and the yields of fresh vegetables, tomatoes, and apples actually decreased slightly, so that the rates of increase in the total production of these three crops were markedly lower than in Balochistan. In contrast, yields of both apricots and almonds increased significantly—for almonds, by nearly five per cent per annum. The growth rate in the total production of almonds was more than six per cent per annum, far higher than in Balochistan.

The results show that, although in both provinces the yields of fruits and vegetables are either stagnating or falling, with a few exceptions the area under production has increased significantly and thus led to an increased volume of production. Thus growing of fruit and vegetables seems to be economically viable even when the crop yields are not increasing.

Livestock

Livestock husbandry is the second biggest economic activity in Pakistan after arable and fruit farming. In 1995/96 the livestock sub-sector contributed an estimated 32% of the total agricultural output and 8% of the national GDP (Younas and Raziq 1997). There are no explicit estimates available of the contribution of the livestock sector to the mountain agricultural economy, but livestock clearly play an important role in mountain farming systems and the economy in the mountains of Pakistan. There are considerable areas of rangeland where raising sheep and goats is the main form of agriculture. In other mountain areas livestock play a key role in mixed crop systems of farming contributing draught power and manure to maintain soil fertility, as well as milk and meat for consumption.

Balochistan

The livestock sector contributes an estimated 30% of the GDP of Balochistan. There are 11.1 million sheep and 7.3 million goats in the province, 48% and 24% respectively of the total in the country. The populations of both sheep and goats have increased annually by averages of 7.2 and 7.8% respectively since 1955.

Table 6.7 shows the absolute number and growth in the populations of animals of different species between 1984/85 and 1994/95. The total livestock population grew by 131% in the ten-year period–an average annual growth rate of 13%. Sheep showed the highest growth rate (18% per cent per annum) and the largest increase in absolute numbers; the number of sheep nearly tripled to over 15 million. The number of goats nearly doubled to close to 11 million. In comparison there were few cattle, although their number also nearly doubled to over a million, and very few buffalo. This increase in the number of sheep could be the main cause of the poor condition of the mountain rangelands. The Arid Zone Research Institute (AZRI) estimates that 12 million ha (56%) of rangelands in Balochistan are in poor condition. Balochistan contains about 73% of Pakistan's total area of mountain rangeland. Ninety-three per cent of Balochistan can be classified as rangeland and all of it is mountainous (ICIMOD 1997).

Table 6.7
Population dynamics of livestock in Balochistan (1984-1995)

Livestock	Population 1984/85	Population 1994/95	Population Change 84/85 to 94/95
Cattle	690,000	1,250,000	+560,000 (81%)
Buffaloes	30,000	70,000	+40,000 (133%)
Sheep	5,330,000	15,200,000	+9,870,000 (185%)
Goats	5,750,000	10,780,000	+5,030,000 (87%)
Total	11,800,000	27,300,000	+15,500,000 (131%)

Source: Govt. of Balochistan (1996)
Note: Percentage change over 10 years given in parentheses

NWFP

In NWFP, pastoralism (transhumance) is practised by migratory tribes, mainly the Gujars. Summer is spent in the subtropical and temperate forests (April and May) and subalpine and alpine pastures (June to September) until the downward trek into the foothills and valleys starts in October. The seasonal grazing lands are found in Dir and Swat districts on mountain slopes above 3,300 m; these are covered by snow during the winter and are grazed in the summer.

Under mixed farming systems, livestock are closely integrated with crop production. Farm households maintain between two and six cattle and buffaloes each, as part of the subsistence farming system. Agro-pastoralist households in the mountains may keep up to 20 cattle each. The income from sheep and goats contributes 40 to 70% of farm income in transhumant households and 100% for nomadic pastoralists. As a result of the gradual transformation towards a market-oriented economy, the percentage of lactating female animals in the NWFP increased by 20% between 1976 and 1986 while the percentage of male cattle, used for draught power, decreased by 26%.

Table 6.8 shows the change in the numbers of animals of different species between 1976 and 1986. Overall the livestock population in NWFP declined by 9% over the ten-year period. Only buffaloes

Table 6.8
Population dynamics of livestock in NWFP

Livestock	Population (1986)	Population (1996)	Population Change
Cattle	3,285,000	4237,000	952,000 (29%)
Buffaloes	1,271,000	1395,000	124,000 (10%)
Sheep	2,231,000	2851,000	620,000 (28%)
Goats	4,197,000	6764,000	2,567,000 (61%)

Source: Govt. of Pakistan (1997)
Note: Percentage change over 10 years given in parentheses

showed a marked increase in population, by 68% to 1.3 million, an average annual increase of about seven per cent per year. The cattle population grew slowly at about one per cent per annum. In contrast, the number of sheep and goats dropped, by 39 and 10% respectively, over the ten-year period.

Economic analysis

Table 6.9 shows the changes in the percentage share of different livestock species in the total population of livestock between 1985 and 1995 in Balochistan and between 1976 and 1986 in the NWFP. The share of cattle and buffaloes increased markedly in the NWFP. In the NWFP the share of sheep dropped markedly and that of goats remained nearly constant. In contrast the share of sheep increased by 10% in Balochistan, and that of goats dropped by almost the same amount. In other words, cattle and buffaloes gained in importance in the NWFP while sheep gained in importance in Balochistan.

Table 6.9
Change in percentage share of different livestock species in the total population

	Balochistan change in percentage share (1985-1995)	NWFP change in percentage share (1976–1986)
Cattle	-1.26	+5.16
Buffaloes	0.002	+5.29
Sheep	10.50	-10
Goat	-9.24	-0.45

CHAPTER 7

Trends of Mountain Agriculture in the Hindu Kush-Himalayas

In the mountain areas of the HKH region, over 80% (full or part-time basis) of the population depend on farming for their livelihoods. Thus sustainable development and growth of the farming sector provide the only viable means to reduce poverty in mountain farming communities. In order to initiate this effectively it is first necessary to have a good systematic understanding of the present state of mountain agriculture. In this chapter the patterns and trends over the past ten to fifteen years across the HKH region of three integral components of mountain farming systems—food grain crops, horticultural and cash crops, and livestock—are summarised. The analysis makes use of the time series' data published by national governments. The patterns and trends are examined in terms of shifts in the allocation of land resources (reflecting land-use changes), changes in crop productivity and total production, and transitions in livestock population. Selected provinces, states, and regions in five Hindu-Kush Himalayan (HKH) countries—Bhutan, China, India, Nepal, and Pakistan—are used as examples. The trends identified could have considerable implications for the long-term sustainability of mountain agriculture as practised now.

General Trends and Patterns

The trends identified were not all uniform across the HKH countries, rather they varied somewhat from region to region.

Overall in the region neither the area under food grain crops nor the crop yields changed to a significant extent—small increases in one area were balanced out by decreases in another. Although the yields of food grains changed little, overall the yields in the mountain areas are lower than the national averages. The amount of land allocated to horticultural crops (fruit and vegetables) increased significantly across the region, but the yields of these crops stagnated or declined. These results suggest that at farm household level mountain farmers are maintaining a relatively stable production of food grain for food security reasons but have rapidly expanded the area under horticultural cash crops because of the opportunity to earn cash income and in response to the increased accessibility and demand.

The trends in livestock population and composition were very similar across the HKH. Overall the populations of cattle and sheep have declined, while those of buffalo and goats have increased. This has resulted in an increased share of buffaloes and goats in the total livestock composition, and a rise in their importance in the livestock economy of the HKH.

The trends (average annual growth rates in per cent) in cultivated area under and yields of food grain crops are summarised in Table 7.1 and shown graphically in Figures 7.1 and 7.2. Overall in the region the area under food grains has changed little. The crop yields have also changed little, with minimal or small increases in the yield of paddy in all areas except Tibet, and of wheat in all areas except Meghalaya. Yields of maize increased or decreased slightly in all areas. The overall production is increasing slightly.

There were some differences between areas, for example, both the area growing and the yield of food grains increased more in Balochistan than in the NWFP, possibly indicating more favourable production policy strategies in the former. The area under all food grain crops increased in

Table 7.1
Trends* in land resource allocation and productivity of food grains in the Hindu Kush-Himalayan Region

Province/ State/Region	Area under Food grain Crops			Productivity			Year
	Paddy	Wheat	Maize	Paddy	Wheat	Maize	
China							
- Sichuan	-0.1	0.3	0.1	1.5	0.0	1.5	1983-97
- Tibet	0.4	0.5	1.6	-1.9	0.2	-1.3	1983-97
- Yunnan	-0.6	1.4	0.0	1.9	2.4	1.8	1983-97
India							
- Himachal P.	-0.4	0.2	0.2	0.5	2.1	1.3	1981-91
- U.P. Hills	-0.1	0.0	-0.9	1.5	2.4	-0.3	1980-93
Nepal							
- Hills	0.4	0.6	1.1	0.7	1.0	1.1	1985-94
- Mountains	0.7	0.9	1.1	0.2	1.8	0.4	1985-94
Pakistan							
- 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

*Annual Growth Rates (%)

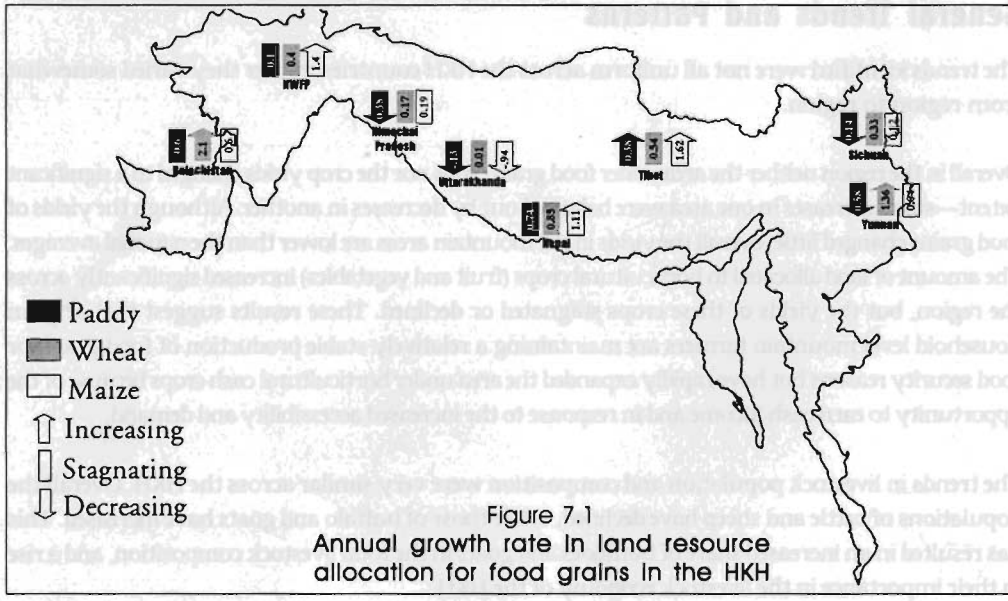

Figure 7.1
Annual growth rate in land resource allocation for food grains in the HKH

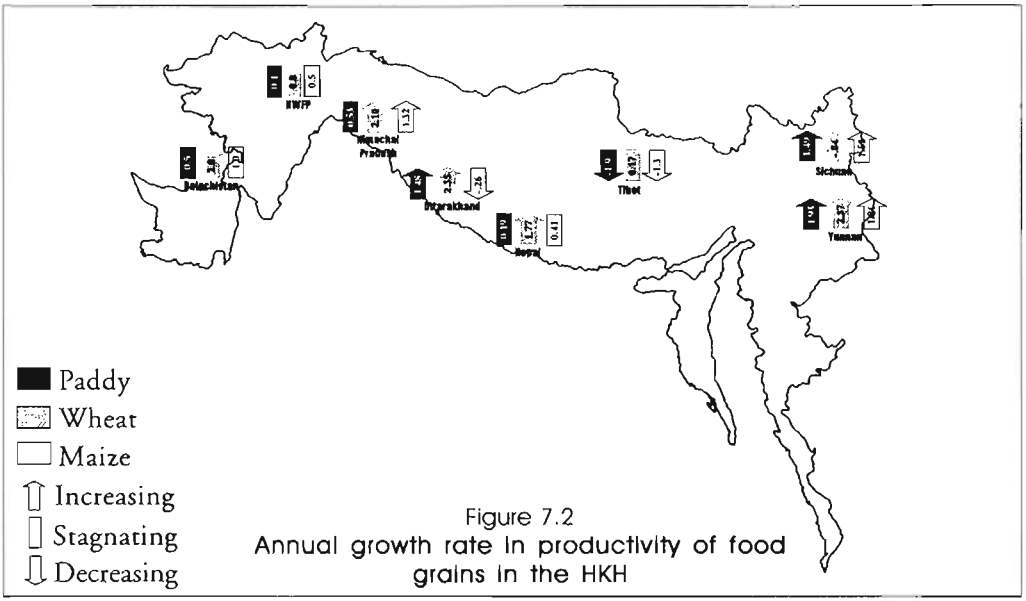

Figure 7.2
Annual growth rate in productivity of food grains in the HKH

Balochistan, NWFP, Nepal, and Tibet, but remained stagnant or decreased in Himachal Pradesh and Uttarakhand. Both Sichuan and Yunnan showed a decrease in the area under paddy in favour of an increase in the area growing wheat. The total production of paddy in these areas increased, however, as a result of the marked increase in yields. Although yields increased for most crops in most areas the increases were more marked in Balochistan than in NWFP, and in Yunnan compared to Sichuan. Yields decreased for both paddy and maize in Tibet and wheat and maize in Meghalaya, although the area under these crops in both places increased markedly, possibly indicating inappropriate choice of land to grow these crops in some parts.

Horticultural and cash crops

The average annual growth rates in per cent (trends) in land resources allocated to various fruits, vegetables, and other cash crops are shown in Tables 7.2 and Figure 7.3. The trends for land resources allocated to, and yields of, apple, citrus fruit, and tomatoes are illustrated

Table 7.2
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				Period
	Apple	Citrus	Tomato	Veg.	Apple	Citrus	Tomato	Veg	
China									
- Sichuan	1.4	1.3	-	-	1.2	2.5			1985-97
- Tibet	1.1	-	-	-	-2.0	-			1984-97
- Yunnan	4.9	4.4	-	-	-0.6	0.9			1983-97
India (Himachal Pradesh)	1.6	3.4	-	2.5	0.4	-2.3		-	1981-92
Nepal (Hills & Mountains)	2.8	2.4		-	0.5	0.3	-	-	1993-97
Pakistan									
- Balochistan	4.9	4.5	3.6	3.0	0.9	2.6	0.6	0.2	1981-94
- NWFP	2.4	0.8	3.2	1.9	-0.2	0.1	-0.3	0.5	1981-94

*Annual Growth Rates (%)

diagrammatically in Figure 7.3 and 7.4. There have been significant increases in the land allocated to the production of horticultural crops, particularly fruit, across the HKH region, indicating an increasing diversification towards cash crops. In many cases the overall yields of the horticultural crops either stagnated or declined, however. Even so, the total production of apples, citrus fruit, vegetables, potatoes, sugar cane, tobacco, and silk increased slightly to markedly in all areas for which figures were available with the exception of sugar cane and tobacco in Sichuan. The most significant increases in total production in percentage terms were observed in apple and/or citrus fruit in Balochistan, Sichuan, and Yunnan; potatoes in Balochistan, the UP hills, and Tibet; sugar

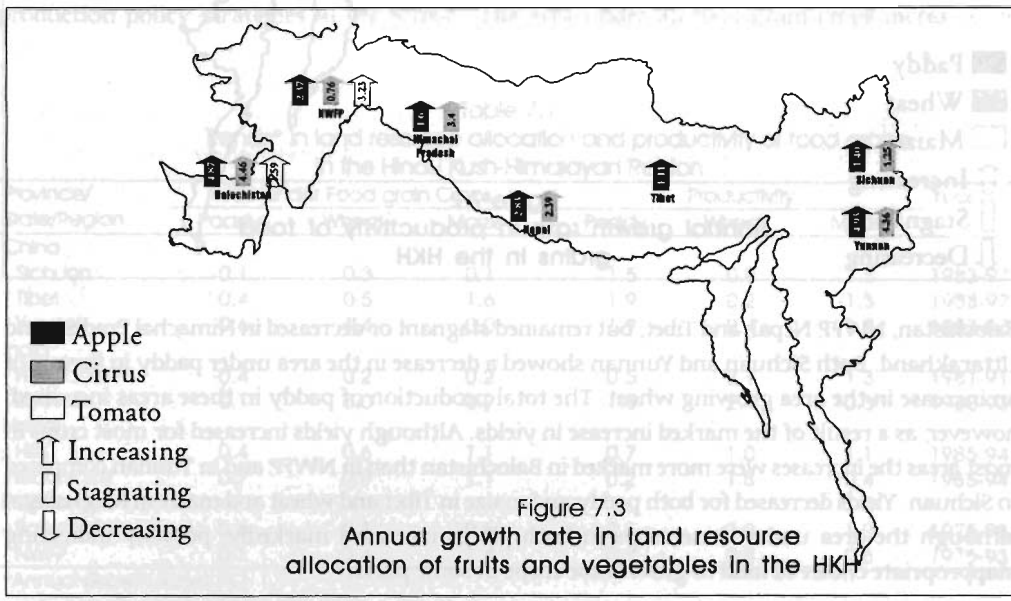

Figure 7.3
Annual growth rate in land resource allocation of fruits and vegetables in the HKH

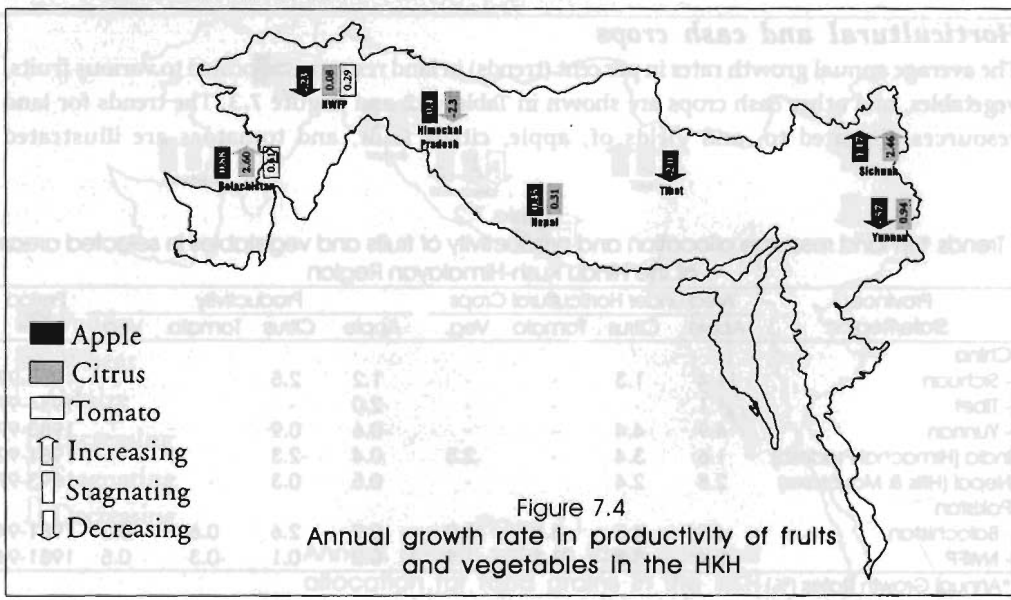

Figure 7.4
Annual growth rate in productivity of fruits and vegetables in the HKH

cane in Balochistan and Yunnan; tobacco in Yunnan; and oil crops in Tibet (the production of which decreased in most other areas).

Livestock

The percentage change in the population of different types of livestock and their percentage share in the total livestock population in selected areas of the HKH over the given time periods are shown in Table 7.4 and illustrated diagrammatically in Figure 7.5. Overall the share of buffaloes and goats in the total livestock population has grown across the region, whereas that of cattle and sheep has decreased. The exceptions were an increase in the proportion of cattle as well as buffalo in the NWFP at the expense of both sheep and goats; a decrease in the proportion of buffalo as well

Table 7.3
Trends* in livestock population and composition in the Hindu Kush-Himalayan Region

Province/ State/Region	Population				Period
	Cattle	Buffaloes	Sheep	Goats	
Bhutan	-23.0	-	21.3	108.8	1986-96
China					
Sichuan	20.6	4.4	7.0	81.0	1986-97
Tibet	2.2	-	2.3	8.0	1986-97
Yunnan	9.6	17.3	-25.6	13.8	1986-97
India					
Himachal Pradesh	-1.1	13.6	-8.2	5.3	1982-92
UP Hills	-5.2	15.1	-9.1	7.1	1978-88
Nepal					
Hills	3.2	0.6	-9.6	2.9	1988-96
Mountains	5.8	8.3	-2.5	9.4	1988-96
Pakistan					
Balochistan	81.0	133.0	185.0	87.0	1984-94
NWFP	9.5	68.0	-39.0	-10.0	1976-86

* Percentage change during the period indicated in the last column.

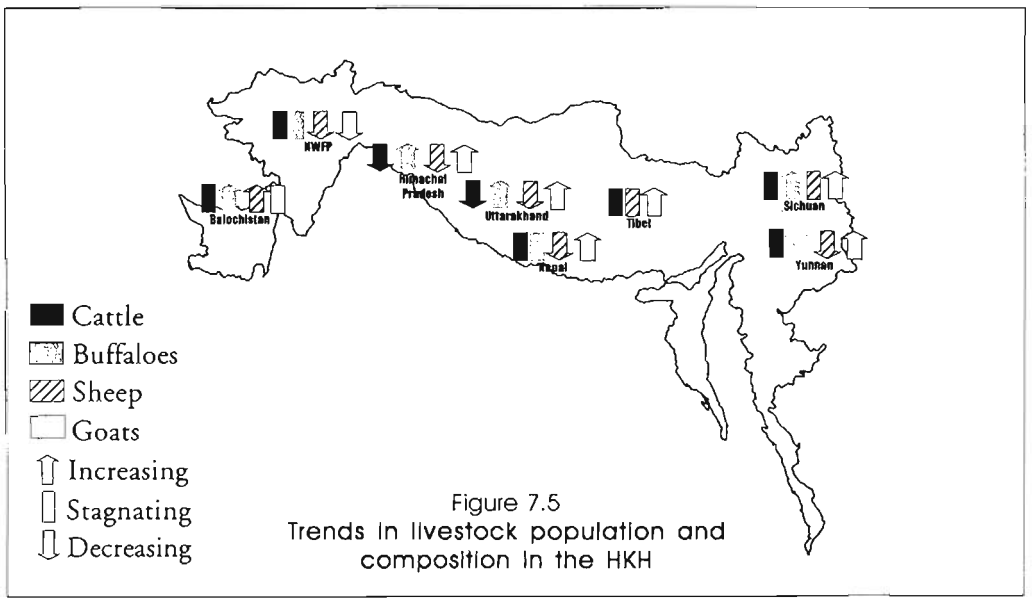

Figure 7.5
Trends in livestock population and composition in the HKH

as cattle and sheep in Sichuan to the advantage of goats; and an increase in the proportion of sheep in Balochistan at the expense of both goats and cattle. Overall the total population of cattle, buffaloes, and goats increased in most areas (with the exception of Uttarakhand and HP where the cattle population decreased and NWFP where the goat population decreased), whereas the population of sheep only increased in Balochistan, Sichuan, and Tibet

Possible Reasons for the Present Trends and Patterns of Mountain Agriculture

Although the area under food grains has not increased, the yields in many cases have—in contrast to horticultural crops. This could be because of the introduction of favourable government policies for food grains in the effort to ensure food security; for example, subsidies for fertilisers which are common across the HKH region. Secondly, most of the fertile valley lands where irrigation is available are under cereals. Thirdly, the development of roads could be contributing to the timely supply of modern inputs such as fertilisers, improved seeds, and pesticides.

The area under horticultural crops (fruit and vegetables) has increased significantly over the past years. The main reason for this rapid expansion is that these crops provide mountain households with a cash income. With increasing accessibility and a growing road and transport network, farmers have easier access to major centres of consumption in both the mountains and lowlands, including cities. As a result of the increasing income of urban dwellers the demand for fruit and vegetables has also increased. The significant growth in horticultural crops suggests that fruit and vegetables are more profitable than cereals, and that the importance of horticultural crops in the farming systems and household economies of the HKH region has increased.

In most areas the actual yields of horticultural crops have either stagnated or declined, however; the increase in production has resulted from increased acreage. This could be linked to the increased use of marginal lands. For example, in Himachal Pradesh, more than 80% of fruit farming is on marginal and sloping lands (Verma and Partap 1992). Cultivation of low-yielding heterogeneous varieties and, particularly for fruit, problems associated with the variable climatic conditions during fruit setting and maturation, also restrict improvements in yields (John Mellor Associates 1995; Jindal 1996).

The overall growth in the number of cattle has not been large and in the Indian Himalayas there is a general decline. The number of buffalo has increased more. This could be the result of decreasing feed resources and a decline in areas for open grazing for cattle. Equally there is a trend towards keeping stall-fed buffaloes because of their multiple uses and cash income generation through the sale of milk and live animals On the whole the sheep population has gone down across the region (except in Balochistan where the population has grown significantly) and the goat population has increased. The decline in the sheep population could be the result of a reduction in open grazing lands and restrictions imposed by communities on open grazing. For example, a case study carried out in the mountainous areas of China (Yanhua et al. 1992) discovered that in livestock dominated farming systems (LDFS) (at county level), the grassland available per sheep decreased from approximately nine mu (0.6 ha) in 1976 to approximately six mu (0.4 ha) in 1986. The

grassland available per capita (at village level) decreased from 458 mu (30 ha) in 1982 to 376 mu (25 ha) in 1988. In horticulture dominated farming systems (HDFS) (at village level), the cultivated land per capita decreased from 1.84 mu (1.84 ha) in 1982 to 1.25 mu (0.08 ha) in 1988. In crop-dominated farming systems (CDFS) (at county level), the crop land available per capita decreased from 1.7 mu(0.11ha) in 1978 to 1.3 mu (0.09ha) in 1986. In contrast to sheep, goats can be stall-fed and do not need grazing land, especially in the high-pressure Himalayan areas of mixed crop-livestock farming systems.

Constraints to the Sustainable Development of Mountain Agriculture: Implications of the Present Trends

Constraints to Mountain Agriculture

CHAPTER 8

Constraints to the Sustainable Development of Mountain Agriculture: Implications of the Present Trends

Constraints to Mountain Agriculture

There are several physical constraints to agriculture in the mountain areas of the HKH region: remoteness and inaccessibility, marginality, and fragility in terms of moisture stress and poor soil conditions and a short growing season. Added to these are socioeconomic constraints such as small landholdings, poor productivity, poor production management, labour shortages, poor post production management, poor marketing and marketing networks (lack of market development), and lack of entrepreneurship. All these have led to under utilisation of the resource bases in the mountains and limited the generation of surpluses in the agricultural sector that could be used to invest in and support the growth of the mountain economy. Nevertheless, the mountain areas also have specific advantages that can be harnessed to good effect, in particular the wide diversity and the presence of niches particularly suited to certain crops. Harnessing these advantages and promoting investment in high-value cash crops can lead mountain areas to a prosperous and sustainable path of development.

Due to growing population, landholdings are becoming increasingly fragmented and smaller in size; unable to sustain the basic family livelihoods from farming alone. On the other hand, it has also necessitated bringing marginal and waste land under agricultural production. It has led to the encroachment of forest land, thus reducing forest areas. Because local farmers cannot sustain their livelihoods with farming alone, there is an increasing trend of outmigration in search of off-farm employment or employment in the agricultural sector of other prosperous regions. For example, each year thousands of hill/mountain people from Nepal outmigrate to Himachal Pradesh and the Punjab in India and work there as agricultural labour. This has created a unique situation in which women are heading farming households in many mountain areas of Nepal. Women are carrying out the traditional tasks of farming and child raising in these areas. Thus, in many mountain areas, e.g., in Uttarakhand, local people survive on remittances. This is true in many mountain areas of Nepal too.

On the one hand, in the areas that have better access to roads and communications and market links, e.g., Himachal Pradesh, local farmers have been able to harness the local mountain niches and diversity in terms of producing and marketing fruit and off-seasonal vegetables. This type of farming has led them to earn cash income and hence to economic prosperity. In these areas there

is increasing intensification of land use with multiple cropping patterns leading to over-extraction of soil nutrients and increase in incidents of diseases and pests.

Therefore, mountain farming has both constraints and opportunities. Apart from the physical, there are technology constraints in terms of lack of appropriate technology. Local knowledge and indigenous techonlogies are completely ignored. In the past, and even today, the research and development (R and D) focus is oriented towards the plains and mountains are neglected. In the majority of cases, the national R and D institutions made simple attempts to transfer high input technological packages in the mountain farming systems, and in many cases this has failed or created second generation problems. Instead of selecting appropriate, local crop varieties and animal breeds, national governments attempted to introduce exotic varieties of crops and exotic breeds of animals in the mountain environments which are harsh, fragile, and with limited land and animal feed resources. In the majority of areas, such attempts have failed.

Food grains, horticultural crops, and livestock form integral parts of mountain farming systems. Improvements in one sub-system can lead to improvements in the others, similarly constraints to one may result in constraints to another. The constraints to the sustainable development of each component may vary from place to place, however. In the following passages, each is discussed separately.

Food grain crops

Mountain farms in general are small and fragmented. Although there are some fertile valleys and river basins, the majority of mountain farming areas are marginal, rainfed upland slope areas, some steep and fragile. High mountain areas have a short growing seasons and are remote and inaccessible. The majority of these uplands are food deficit areas where incomes are low and farming practices poor. In order to increase the yield and production of food grains it will be necessary to introduce suitable technologies such as improved crop varieties, irrigation, and fertiliser, and ensure the timely availability of adequate amounts of fertiliser and quality seed materials. Lack of these is a major constraint to increasing yields. There are some regional differences in the problems farmers confront.

Although poor infrastructure and lack of timely and adequate amounts of inputs, such as fertiliser and quality seeds, inhibit improvements in productivity in the Indian Himalayan states, this is not the only problem. The majority of householders are marginalised farmers with no irrigation facilities, and they are unable to invest in improved seeds or modern farming technology. Shifting cultivation, which is common, also inhibits adoption of improved agricultural technologies such as high-yielding varieties (HYVs), chemical fertilisers, and modern implements (Kholsa and Raina n.d.). The situation in the mountains of Pakistan is similar. Landholdings are very small and most farmers are very poor and cannot afford to purchase the essential farm inputs; lack of essential inputs in time and availabilty at reasonable prices are serious constraints (Shah and Basti 1995). Other factors also contribute to the low productivity: viz., fragmentation of the small landholdings, and poor communication and marketing facilities (Sharif 1994).

Landholdings in Nepal and Bhutan are also small and operate mostly on a system of low input-output subsistence agriculture. In Nepal little fertiliser is used for food grain crops in the mountain region as a result of inadequate institutional services, poor transport infrastructure, and farmers' low buying capacity (Pandey et al. 1995). There is a further problem associated with the relative overuse of subsidised nitrogenous fertiliser like urea, which leads to an imbalance in the soil. In Bhutan, agricultural production is generally based on a low level of purchased inputs. The maintenance of soil fertility depends primarily upon the use of farmyard manure. The intensification of production needed to increase returns to labour and land will require the use of more chemical fertiliser.

Horticulture

The major constraints to improving horticultural crops are poor orchard management practices; lack of timely availability of adequate amounts of inputs such as quality plant materials, quality seeds, and fertiliser; inadequate access to agricultural extension services and advice, particularly for women who are the actual performers of many important agricultural operations; and lack of marketing information services. Across the HKH, poor post-harvesting and value-adding skills (for example, grading standardisation, packaging, storage, and transport) also aggravate the problem of achieving high-value agricultural outputs. Furthermore, development of markets and trade is limited in the majority of areas. These problems have greatly constrained the ability to harness the comparative advantages of mountain niches to their maximum advantage. Furthermore, many of these are new crops and intended for markets, thus farmers do not have the indigenous knowledge on optimal growing techniques or the awareness of market outlets and market requirements.

Cultivation of low-yielding heterogeneous varieties, poor fruit setting, and fruit drop are common in apple growing areas of the HKH. In some apple production areas, farmers are faced with problems of frost and hail during flowering and fruit development; biennial/irregular bearing; poor pollination; heavy rains at the time fruit matures; and moisture stress during summer, all of which contribute to low, erratic, and poor quality fruit production (Jindal 1996; John Mellor Associates 1995). Inappropriate training, pruning, and fertilisation of fruit trees are common.

Because of the lack of regular markets and reliable marketing, hill farmers find it too risky to switch to more lucrative high-value crops and continue with subsistence farming. Many of the high-value crops that are grown are grown for export markets, particularly vegetable seeds, ginger, and cardamom. Even these are produced in small and isolated mountain pockets with poor market links and inadequate market support in terms of information, processing, and marketing. This has resulted in high transaction costs, market risks, uncertainty, and vulnerability to price fluctuations and the external market (Tulachan et al. 1998).The specific problems vary slightly within the region.

In Pakistan, poor orchard management has been identified as one of the factors contributing to the wide variability in the productivity and quality of marketable products. Heavy intercropping has shortened the productive life of mandarin and apple trees. Various pests and diseases are seriously damaging fruit and other cash crops, e.g, codling moth in apple and viruses and minor leaf pests

which are serious threats in Gilgit and Hunza (Ahmed 1995). In the Northern Areas, apple yields are low and biennial bearing is a problem. The local apple varieties have soft flesh with a poor shelf life. In Balochistan, orchard farming has led to a rapid depletion of groundwater. (Prior to the 1970s most wells were dug manually). Availability of electricity led to the introduction of deep tube-wells, over 10,000 were in use to irrigate orchards by 1988/89. Whereas the water tables fell by about 15 cm per annum between 1900 and 1980, they are now falling in the Quetta Valley at an estimated rate of 30 to 300 cm per annum depending on the source of the data (World Bank 1996).) Farmers in the Quetta Valley actually over-irrigate the orchards, using two to three times more irrigation water than required, despite its being a water scarce area.

Post-harvesting problems also pose constraints to the development of horticulture. There is a lack of adequate fruit processing and packing facilities and there are no proper arrangements for the efficient marketing of farm produce. In 1993-94, the total value of post-harvest losses of fruit and vegetables was estimated to be about Rs 5.7 billion from the Quetta market alone (Ahmed 1995). There is a need to improve post-harvesting technology at both the household and community level and to establish agro-industries that can process large quantities of low-grade fruit and vegetables. Furthermore, appropriate transport facilities are required to minimise spoilage of perishable products produced in temperate and sub-temperate regions but sent to sub-tropical or tropical regions for marketing.

The problems faced in India are similar. According to Khosla and Raina (n.d.), horticultural development in the Indian Himalayan state of Jammu and Kashmir is characterised by low productivity due to the lack of good quality planting material; unscientific management of orchards; lack of marketing facilities close to the areas of production; inadequacy of post-harvest management technology; and lack of irrigation facilities. In Himachal Pradesh, the cultivation of horticultural crops has been taken up in an unscientific manner. At present, 150 to 200 fruit trees are planted per hectare compared with the 1,000 to 1,500 fruit trees that could be planted using modern technology. Most of the orchards are too old and at least one-third of the apple orchard area needs replanting. The old orchards have low productivity and produce poor quality fruit. The poor quality produce from old orchards is one of the main factors leading to the huge quantities of culled fruit, an estimated 25% of the total production in the state.

In the mountains and hills of Nepal, production of horticultural crops is seriously constrained by post-harvest problems such as poor grading and packaging and lack of storage and processing facilities to increase value. Physical damage and losses are high as a result of inappropriate handling during harvesting, packaging, loading and unloading, and transportation. The loss in fresh vegetables can be as high as 30%. Although efforts have been made to develop cellar storage facilities at some production sites, they are grossly inadequate. The lack of adequate processing and storage facilities means that there are wide price fluctuations over short periods. Horticultural crops are mostly produced on a small scale in distant and dispersed pockets in the mountains. The lack of volume coupled with poor infrastructure increases marketing costs considerably, and farmers' risks are high. The lack of information on pricing and market windows limits farmers' ability to plan production decisions. In Mustang and Jumla, the sustainability of apple production is seriously constrained by lack of the infrastructure needed for marketing—roads, ropeways,

and storage facilities. Similarly, production of seed potatoes in the high mountain regions may not be sustainable if production cannot be linked properly with lowland areas through appropriate marketing and market infrastructures((Tulachan et al. 1998).

Bhutan suffers from similar problems to the other areas: poor orchard management practices; the impact of insects, diseases, and animals, which cause a drastic reduction in the quantity and quality of apples and lead to premature fruit drop in citrus orchards; and post-harvesting problems. The problems are compounded by the limited size of the domestic market.

Livestock

Scarcity of fodder during the winter is a crucial problem for raising livestock across the HKH region. Steep slopes, difficult access, lack of water, and erosion of grasslands, force the animals to graze in denuded forests. The frequent moves from place to place in the search for food compels the animals to spend more energy. Overall the major constraints to livestock raising can be summarised as:

- shortage of animal feed and fodder during the winter;
- shortage of vaccines;
- a disorganised marketing system; and
- lack of market information services.

Again the problems differ slightly between areas.

The rangelands of Pakistan are largely in poor condition as a result of mismanagement and years of overgrazing. The Forestry Master Plan has estimated that 86 % of the rangelands in the country are in very poor condition and degraded. In Balochistan, the Arid Zone Research Institute (AZRI) estimated that 12 million ha (56%) of rangelands were in poor condition (Sharma et al. 1997). In the NWFP, overstocking and excessive grazing are causing serious environmental degradation. Of the five million ha of grazing lands, 4.3 million ha are so depleted that there are no or few signs of evergreen vegetation.

In the Indian Himalayas many grasslands produce only about one-fourth of their productive potential. The result is an acute fodder and feed shortage, estimated to be 40 to 60%. The causes of deterioration of pastures and grasslands are overstocking, continuous and overgrazing leading to a proliferation of unpalatable grasses and weeds and a decline in the proportion of leguminous forage, movement of migratory animals to highland pastures too early in the season, soil erosion, lack of manuring, and mineral deficiency (Bhargava 1990; Dhar 1997). Overgrazing and open grazing are often given as major causes of poor regeneration in degraded forest areas. This is probably because the livestock density per unit of land area in the Himalayas is much higher than in the lowlands, although farms rarely produce fodder crops. Although a significant proportion of animal feed is derived from crop residues and waste, the increasing growth of an already large livestock population has far exceeded the carrying capacity of forests and other grazing lands. In Himachal Pradesh, up to 80% of fodder requirements are met by forests. The average landholding size is small so crop residues are not sufficient as animal feed, and fodder cultivation is not popular. The intensity of grazing and browsing is very high, about five livestock

units per ha of grazing land compared with the 0.5 units that can be supported sustainably at the present level of production (Singh 1994).

Nepal faces an estimated 20-36% feed shortage overall, but the situation is much worse in the mountains as a result of the small size of landholdings, limited support land for grazing, and restriction on grazing of animals in forest areas by community forestry users' groups. Underfeeding leads to late maturity, high mortality, poor lifetime performance, and infertility of cattle and buffalo stocks. Reproductive disorders seem to be the main factor contributing to the continuous decrease in local livestock germplasm (Sherchand and Pradhan 1997).

Similarly, in Bhutan lack of animal feed during the winter months is an acute problem for almost all farmers. The shortage results from open and uncontrolled animal grazing on pasture rangeland as well as traditional animal feeding practices. In winter, animals feed on dry and matured native grass, bamboo shoots, tree bark, and millet and oat residues. It has been claimed that thousands of yaks die in the high mountain areas, where there is snow cover for three to four months a year due to lack of food. In the southern hills, maize, rice, and wheat are grown on terraced land and along river banks, and crop residues make up the bulk of the animal feed. The productivity of communal pastures is decreasing every year, despite the implementation of various fodder and pasture development projects. Thus crop residues, which are locally available, have become the most reliable animal feed during the periods of feed scarcity (Bajracharya 1992).

Implications of the Present Trends for the Sustainable Development of Mountain Agriculture

The analysis shows that the production of food grains in the HKH has not declined as much as is often thought. In some cases, the production has actually increased as a result of increased productivity. With favourable government policies to support the development and improvement of the road infrastructure in mountain areas, there is a prospect that production of food grain can be increased. The increase in production would result from increased access to modern inputs such as quality seeds, fertiliser, and irrigation. There seems little prospect that the area under food grain production will increase, however, and the per capita food availability may decline as a result of increases in the population.

The analysis also suggests that there is increasing crop diversification and introduction of horticultural and cash crops. There are good prospects for the development of niche-based horticultural crops in the HKH. Mountain areas have certain comparative advantages and a potential for small-scale, specialised farming activities with high payoffs. Proper harnessing of niche-based farming can contribute towards ensuring food security, through both direct use of products and trade in high-value products (Jodha 1991 and 1995). The present trends towards rapid expansion of horticultural crops will have positive implications for the future development of mountain agriculture. It would be possible to irrigate a greater proportion of the more fertile land and use it to grow high-value cash (HVC) crops such as fruit, vegetables, and medicinal plants, instead of cereals as at present.

Case studies on agricultural transformation in some of the mountain areas have shown that farming of HVC crops has increased food security and employment, and thus improved the living conditions of mountain people (Partap 1995; Sharma 1996; Sharma 1997; Sharma and Sharma 1997; Tulachan 1997; Badhani 1998). They have also shown that accessibility, a wider market network, and strong R&D institutions are critical to the commercialisation of subsistence agriculture through greater emphasis on HVC crops. Nepal's twenty-year Agricultural Perspective Plan (APP) has emphasised the development of high-value agriculture in the mountains of Nepal as a way to improve the livelihoods of mountain people. Development of HVC crops and further diversification in mountain agriculture will increase trade between upland (mountain) and lowland (plains) areas. Mountain people can specialise more in HVC crops such as fruits, vegetables, flowers, and medicinal plants and lowland farmers in cereal crops. Development of an effective exchange mechanism can lead to improvement in the balance of trade in favour of the hills and mountains.

One possible problem is the declining trend in the productivity of HVC crops in the mountains, which raises concerns about the long-term sustainability of these crops. Jodha (1991, 1995) pointed out that reckless exploitation of mountain niches might result in their elimination. A study of niche-based farming of horticultural crops in the mountains of Nepal has shown both spatial and temporal dimensions in terms of sustainability. High economic benefits induce a spatial dimension: a particular crop spreads quickly over time. Resulting soil nutrient losses and the appearance of diseases introduce a temporal dimension, with a reduction in the cultivation of a particular crop over time (Tulachan et al. 1998). Furthermore, there has been a reported increase in the use of pesticides on horticultural crops. As a result of the small size of farms, there has been an increasing trend towards intensification of land use involving multiple cropping and excessive use of chemical fertilisers and pesticides.

The trend towards introduction of HVCs has raised concerns about environmental pollution, e.g., groundwater pollution and health hazards; about equity, who benefits most who loses; and about gender issues. Thus with the development of HVC crops many second generation issues are emerging. According to Rhoades (1997):

> "perhaps, more importantly, the 'second generation' problems of ecological and social issues need to be understood prior to wholesale promotion of high-value cash crops. Impacts on equity of class, gender, and ethnicity, in particular, need to be further explored".

Thus, the key challenge facing HKH policy-makers, planners, researchers, and field workers is how to address these emerging environmental and socioeconomic issues in order to ensure that the production of HVC crops can be sustained on a long-term basis. Also, increasingly concerns are being raised on the issue of globalisation. How might globalisation affect the processes of harnessing the mountain niches in terms of growing HVC crops that have comparative advantages agroecologically or agro-climatically. Will it promote further harnessing of mountain niches leading to enormous benefits to mountain people or provide disincentives to mountain people?. This is a critical issue that needs to be studied in the near future.

The livestock trends indicate that there is a potential for greater development of small-holder dairies that keep improved buffaloes in a stall-fed system in those high pressure areas of the HKH sub-tropics where mixed crop-livestock farming systems exist at present. The number of stall-fed buffaloes and goats is rising, and there is increased use of external inputs such as purchased feed. Increasing dairy farming in this way will relieve the pressure on common property resources, such as forests and community lands, and have a positive impact on the environment. Farming of buffaloes and goats can also contribute positively to the food security and nutrition of mountain households.

about the author

Pradeep Man Tulachan has a BSc (Hons) in Agriculture from Haryana Agricultural University, Hissar, India, an MSc from the University of Illinois, USA, and a PhD in Agricultural Economics from Cornell University, USA. He began his career as a Lecturer at the Institute of Agriculture and Animal Science, Rampur, Nepal, worked in Papua New Guinea as a Senior Farming System Economist, and then for the US Agency for International Development (USAID) as a Senior Project Manager and Agricultural Economist. Since 1995 he has been working as a Farm Economist at ICIMOD. At present he is involved in various research projects including research into the main issues and options for marginal farms in the HKH (funded by ACIAR) and an eco-regional project funded by ISNAR under the ICIMOD Regional Collaborative Programme (RCP II).

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