Food and Nutrition Security in the Hindu Kush Himalaya: Unique Challenges and Niche Opportunities

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P. Wester et al. (eds.), *The Hindu Kush Himalaya Assessment*,
https://doi.org/10.1007/978-3-319-92288-1_9

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Chapter Overview

Key Findings

1. **Food and nutrition insecurity remains a serious challenge in the Hindu Kush Himalaya (HKH) region; more than 30% of the population suffers from food insecurity and around 50% face some form of malnutrition, with women and children suffering the most**. The insecurity is more severe in remote mountain areas. Challenges to food security in the mountain areas differ from those in the plains due to inaccessibility, fragility, seasonality, limited economic opportunities, poor market access, and harsh biophysical conditions.
2. **The causes of food and nutrition insecurity in the HKH are multifaceted and complex, and influenced by a range of factors including high** poverty, natural resource degradation, climate change, low level of market development, uncertain food support, and inadequate policy and institutional support.
3. **Traditional mountain food systems are currently under threat from rapid socioeconomic and environmental changes including** changing dietary habits, changes towards mono-cropping and commodity crops, loss of water sources, soil degradation, and decline in market value. Mountain agriculture is becoming relatively less competitive and the youth are increasingly abandoning agricultural livelihoods, leading to decreased food production and adversely affecting local food systems.

Policy Messages

1. **To address the unique challenges faced by mountain communities regarding food security, national governments in the region need to pay special attention to integrating a mountain perspective into national policies related to food and nutrition security**. The mountain perspective should take into account exploiting agro-ecological potential and mountain-specific niche opportunities while protecting the environment, delivering institutional services, and improving market access.
2. **Governments in the region can be more effective in addressing issues related to food and nutrition security by adopting a holistic approach that includes** revitalizing local food systems, strengthening social safety nets, enhancing knowledge and awareness about nutrition, and reducing physical and socioeconomic vulnerability. Efforts are also needed to diversify livelihood options and develop non-farm sectors such as tourism and handicrafts to enhance household food purchasing power. Attention also needs to be given to increasing the productivity of traditional crops and local breeds of livestock, and to the development of non-timber forest products (NTFPs), medicinal and aromatic plants, mountain niche cash crops, and organic agriculture.
3. **Increased investment in the management of natural resources, including soil, water, and energy, is critical to increase agricultural production, diversify local food systems, and improve nutrition**. Major investments are needed in soil and water management to revitalize springs, ponds, and other water bodies and to develop irrigation facilities and improve the domestic water supply in an environmentally responsible manner in hill and mountain areas.

The mountain people of the Hindu Kush Himalaya (HKH) face large challenges in food and nutrition security. Although progress has been made in calorie intake, malnutrition remains a serious challenge (***well-established***). About 50% of the population suffers from malnutrition, and women and children suffer more. Ending hunger and achieving food and nutrition security—as articulated in the Sustainable Development Goals—is an urgent need for the governments of the region. Agriculture is one of the region's main livelihood options, but many people depend on limited natural resources and poor soils with agroecosystems of low carrying capacity. The region's population is increasing quite fast at close to 1.4% annually, and the per capita availability of land and other natural resources is declining. Traditional agricultural systems are coming under pressure and failing to provide adequate food and income. As a result, nearly one-third of the population is suffering from food insecurity, and between one-fifth and one-half of children (<5 years of age), depending on country, suffer from stunting, with a high incidence of wasting and underweight. A significant share of women also suffer from various forms of anaemia (***well-established***). Some mountain areas exhibit high nutrition insecurity compared to the national average for the whole country, for example eastern Afghanistan, Meghalaya state in India, Chin and Rakhine states in Myanmar, the high mountains of Nepal, and Balochistan province in Pakistan (***well-established***).

Addressing the challenge of food and nutrition security in the HKH has become increasingly complicated by the rapid socioeconomic, demographic, and environmental changes, including migration and climate change. The prevalence of high poverty, youth out-migration, poor infrastructure and market access, depletion of natural resources, and the increased brunt of climate change are key factors, among others, affecting food and nutrition security.

In the remote rural areas where a majority of the HKH population lives—depending heavily on agriculture for food and nutrition—farming and food production are highly susceptible to climate change, due in part to poor irrigation facilities and a high dependence on precipitation. The drying up of springs and water bodies, erratic rainfall, increased floods, increased dry spells, land degradation, and a rising incidence of pests and disease in crops and livestock all pose additional challenges to food and nutrition security in the region.

Despite these numerous challenges, the HKH region also enjoys comparative advantages in certain products and has a good potential and opportunities for revitalizing local food systems, developing mountain niche products and services, and promoting non-farm livelihood options (***established but incomplete, see Sect.*** 9.4). Local food systems—including neglected and underutilized species (NUS) and local breeds of livestock—have a huge potential to diversify the supply of food and micronutrients in the mountains, while enhancing farmers' incomes and enabling them to access nutritious food (see Sects. 9.4.1 and 9.4.2). The nutritional value of many NUS crops such as millets, sorghum, and buckwheat are high (***well-established, see Sect.*** 9.4.1). These crops and local breeds of livestock are also highly adapted to mountain conditions and resilient to climate-induced stresses like drought and frost. In view of the nutritional, environmental, and economic benefits, NUS are recently relabelled as 'Future Smart Foods'. A growing literature suggests that if provided with the required inputs and market links, mountain areas also offer a good agro-ecological potential for growing various cash crops including tea, coffee, nuts, fruit, and vegetables, which can contribute to food and nutrition security (***well-established, see Sect.*** 9.4.3).

The natural resources of the mountains, such as forests, rangelands, and water resources, also provide many opportunities to increase household income and food security if managed and harnessed sustainably (***well-established, see Sect.*** 9.4.4). Timber and non-timber forest products (NTFPs), medicinal and aromatic plants, other varieties of plants and herbs and honeybees can provide additional sources of income. The potential of rangelands in high mountain areas—the basis for livestock production and food security in pastoral communities—could be developed further by enhancing livestock productivity. Mountains are rich in water resources, but these are not harnessed properly for the benefit of local people (see Chap. 8). Properly managing and harnessing the water in springs, streams, snow, and glaciers could greatly increase agricultural production and help to diversify local food systems. Other opportunities exist in tourism, handicrafts, food processing, and medicinal plants as potential sources of income, which would, in turn, improve food and nutrition security in the mountains (***established but incomplete, see Sect.*** 9.4.5).

Achieving sustainable food and nutrition security in the mountains requires a balanced approach between food self-sufficiency and market dependency and an integrated strategy that entails production enhancement and increasing household income, along with improving rural infrastructure for market access and food transportation. The strategy should focus on addressing existing challenges while helping the region to seize opportunities and realize the potential. Due to different ecological and environmental conditions and different levels of access to institutional services result in different challenges and opportunities across the region, the strategies for food and nutrition security need to consider local agro-ecological features and socioeconomic conditions, including access to markets and other basic services. In this chapter, we identify four types of HKH mountain area based on agro-ecological potential and access to markets, information, and institutional services, and suggests area-specific strategies to enhance food and nutrition security for each of these types:

- High agro-ecological potential, good access to markets and institutional services
- High agro-ecological potential, poor access to markets and institutional services
- Low agro-ecological potential, good access to markets and institutional services
- Low agro-ecological potential, poor access to markets and institutional services.

In areas with high agro-ecological potential and good market access, strategies could focus on tapping the potential through land use intensification and growing cash crops in line with market demand; while in areas with high agro-ecological potential and poor market access, strategies could focus on improving market access, developing local food systems, and promoting high value but low volume and non-perishable products. In areas with low agro-ecological potential but good access to markets and institutional services, strategies could focus on promotion of non-farm and off-farm activities to enhance purchasing power; while in areas low in agro-ecological potential and with poor market access, strategies could focus on subsistence use of

resources, developing incentive mechanisms for conservation of resources, and support for out-migration to increase purchasing power and thus access to nutritious food. Targeted food safety net programmes such as subsidized food may also be required in low potential areas to ensure food security.

In addition, special attention needs to be paid to the following:

- Establishing community food banks to store food at village level so that households in need can borrow from the banks and return the loaned amount after the harvest,
- Managing water resources, especially, springs in midhills and mountains and promoting efficient and equitable hill irrigation infrastructure, where feasible,
- Establishing mechanisms for cross-border food trade and internal movement of food products, particularly cross-border localized trade/food exchange between border communities,
- Strengthening knowledge on nutrition, child care, and food preparation, including traditional Himalayan fermented foods which are nutritionally rich and healthy, and
- Empowering women by improving knowledge and their control of resources to enable them to take decisions on matters related to family health, education, and feeding.

Food and Nutrition Security in the HKH and the Sustainable Development Goals

Six Sustainable Development Goals (SDGs) are closely related to food and nutrition security:

- Goal 1—*End poverty in all its forms everywhere.*
- Goal 2—*End hunger, achieve food security and improved nutrition, and promote sustainable agriculture*.
- Goal 3—*Ensure healthy lives and promote well-being for all at all ages.*
- Goal 6—*Ensure availability and sustainable management of water and sanitation for all.*
- Goal 12—*Ensure sustainable consumption and production patterns.*
- Goal 13—*Take urgent action to combat climate change and its impacts.*

In addition, achieving food and nutrition security has direct and indirect implications for achieving a number of other SDG goals and targets, such as SDG 1 (eradicating poverty) and SDG 5 (achieving gender equality), which depend on eliminating food insecurity and malnutrition.

Though diverse, the SDGs are also mutually related. For example, ending hunger and achieving food security will depend on achieving water and energy security for food production. Similarly, ensuring healthy lives will depend on achieving food and nutrition security. A failure to ensure food and nutrition security in the HKH would thus imperil the region's pursuit of other SDGs such as ending poverty, ensuring healthy lives, achieving gender equality, and reducing inequalities as well as adaptation and mitigation of climate change.

9.1 Introduction

Food and nutrition security is fundamental for living a healthy and productive life and is essential for socioeconomic development. The system of food production and consumption has shaped human society and the environment for millennia (Desor 2017). Food and nutrition security is thus critical for any society and a top priority in national and global development and environmental agendas. It is also a building block for achieving Sustainable Development Goal (SDG) 2 as well as instrumental for achieving other SDGs such as 1 (no poverty), 3 (good health and wellbeing), 6 (clean water and sanitation), 12 (responsible consumption and production), and 13 (climate action). Hunger and malnutrition are widespread in the Hindu Kush Himalayan (HKH) countries. Of the 795 million people undernourished globally, 52% (415 million) are from HKH countries (FAO-IFAD-WFP 2015). In the HKH region, more than 30% of people face food insecurity (Table 9.1) and one-third to one-half of children (below five years of age) suffer from stunting, with a variation across countries (Rasul et al. 2018). Children and women suffer more, and children's growth and development are affected.

9.1.1 Mountain Specificities and Food Security

The nature and causes of food security in mountain areas differ from those in the plains as a result of differences in the physical environment, transportation and communication facilities, remoteness, and seasonality. Mountain environments in the HKH are characterized by limited accessibility, a high degree of fragility, and marginality (Jodha 2000). The people in the HKH face severe challenges in terms of food and nutrition security due to the harsh biophysical environment and relatively low socioeconomic development. The

Table 9.1 Food (in)security in the Hindu Kush Himalaya region

HKH country	Incidence of food insecurity/food poverty in mountain areas (%)	Approximate number of people faced with food insecurity[a] (millions)	Data source
Afghanistan	33	National level statistic in ALCS (2014) used as a proxy for mountains; 29 of Afghanistan's 34 provinces are mountainous or hilly	7.76
Bangladesh	53	Majumder et al. (2012) estimated % food insecure households. Using household size in Chittagong Hill Tracts to convert households to population won't change the incidence of food insecurity	0.95
Bhutan[b]	5.9	GoB (2012)	0.05
China	11	National level prevalence of undernourishment in FAO 2013 taken as proxy for mountains	3.66
India	18	Statistics taken from Rasul et al. (2018) which uses data from two mountain states as a proxy for the mountain area	15.53
Myanmar	09	Mountain statistics aggregated from the state level statistics in IHLCA (2011)	1.08
Nepal[b]	51	NDHS (2011)	14.61
Pakistan	57	Mountain aggregated statistics approximated based on the statistics from FSA (2009) and population projections for mountain areas	29.45
Total	**31**[c]	–	**73.09**[c]

[a]Population data in Box 1.1; Table 1.1 used to approximate food poor population
[b]Entire territories of Bhutan and Nepal included in the HKH region despite Nepal having some plains areas
[c]Approximated number and percentage of food insecure populations in the HKH region are indicative and based on the individual country level statistics on mountain food (in)security
Note Data presented in the table are not recommended for use in cross-country comparisons because all countries follow different methods for food (in)security assessment

Himalaya is one of the youngest mountain ranges in the world with a prehistoric marine origin. The soils are among the most fertile in the world, but fragile and degradable. Steep slopes and unsustainable terrain present severe challenges in the region and make it unsuitable for the conventional green revolution agriculture practised in the plains areas of the HKH countries. This has made mountain communities highly dependent on the plains for food. Thus approaches based on production alone cannot address the mountain food security issues; access to food through means is also important. While theoretically, in a well-functioning competitive market, access to food through cash income is straightforward, mountain communities often face physical difficulties and uncertainties in accessing food due to their physical remoteness, dispersed settlements, high transport costs, imperfect market conditions, high variability in the food price, and frequent natural disasters such as floods, landslides, avalanches, and earthquakes (Rasul and Hussain 2015). In mountain areas, natural disasters often disturb the fragile communication system and hinder food transportation and access to food. Food prices are also influenced by oil prices and transport bottlenecks caused by natural disasters or political turmoil (Hussain and Routray 2012). The challenges faced by mountain communities are often not adequately understood, and the perspectives of mountain communities are not fully recognized in national agricultural development policies in the HKH countries (Jodha 2000, 2009). As a result, despite good intentions, the policies and strategies pursued by the countries to increase food production using the green revolution approach has failed to yield the desired outcome in the HKH region (Rasul 2010).

Agriculture is one of the primary livelihood options available in the HKH region, and key to achieving food and nutrition security. But a considerable proportion of the population depends on limited natural resources with low carrying capacity. Agriculture in the HKH region has remained largely traditional. Research on rainfed agriculture and mountain niche products has been limited and thus agricultural productivity has remained low, while rapid population growth (close to 1.4% annually) is placing additional pressure on food and nutrition security. Limited industrialization and slow growth of the non-farm sector mean that the increasing labour force is also adding to the pressure on the limited and fragile land resources. The per capita availability of natural resources, particularly land, is decreasing steadily, while traditional agricultural systems are

gradually degrading (Adhikari et al. 2017). This has implications for food and nutrition security in the region. Further, the rapid climatic changes currently taking place in the HKH ecosystem may compound the effects on the traditional food and agricultural systems in the region (Aase et al. 2009).

The mighty glaciers and mountain ranges of the HKH are the source of some of the biggest rivers in South Asia (for more, see Chap. 7 Status and Change of the HKH Cryosphere). But the water resources of the region are not fully harnessed, and the irrigation systems are poorly developed (Bandyopadhyay and Perveen 2008). As a result, agriculture in the HKH has remained largely rainfed, making it prone to the vagaries of the weather and highly vulnerable to climate variability and climate change. Natural water bodies like streams and ponds, on which mountain agriculture and livestock depend heavily, are increasingly drying up. The water regime of the HKH is likely to change rapidly with respect to discharge rates, volume, and availability, which will have adverse impacts on the subsistence agricultural economy (Viviroli et al. 2003) (see Chap. 8). This has serious implications for agricultural productivity and food security, and particularly for food availability, across the entire region (Hussain et al. 2016).

In the HKH agro-ecological system, forests are pivotal to the maintenance of crop production levels. The people of the HKH are traditionally forest-dependent communities, but numerous factors are making such areas prone to risk and uncertainty. High population growth (Table 1.1) and resultant changes in land use are decreasing the forested area and leading to unsustainability of HKH agriculture. The rapidly changing patterns of land use, the resultant decrease in forest area, and decreasing annual rainfall have also disrupted the hydrological regime, with water resources diminishing rapidly, mainly due to reduced groundwater recharge (Tiwari and Joshi 2012a). Such conditions have an impact on most aspects of food and nutrition security.

Transportation and other infrastructure in the HKH is relatively weak and poorly developed, thus there is a frictional market and marketing system. The lack of modern facilities (such as cold storage for short-term storage of fruit, processing, and export quality packaging) combined with neglect of traditional storage and processing methods are having a negative impact on food production. Quality control for grading and facilities for washing and disinfection also need to be developed.

9.1.2 Concept of Food and Nutrition Security

The concept of food and nutrition security is still evolving (Box 9.1). Food security is the fundamental precept of the right to adequate food, which was adopted by the Food and Agriculture Organization (FAO) Council in its 127th session held in November 2004. In that session, governments agreed on some voluntary guidelines to support the realization of economic, social, and cultural rights to food and recommended some workable actions to be pursued during the course of the coming decade for the recognition of the right to food. More than a decade has passed, but the need for practical guidance on developing effective institutional and legal frameworks for the right to food, establishing independent monitoring mechanisms, and implementing these frameworks has not been addressed in mountain regions.

Box 9.1 What is food and nutrition security?

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit 1996). Food security has four dimensions: availability, accessibility, utilization, and stability (FAO 2008). Food availability refers to the physical availability of adequate levels of food in a particular area. Cultural acceptability of food is also an important aspect as different cultures have different food preferences (Jones et al. 2013; Hussain and Routray 2012). Food accessibility refers to the physical and economic access to food. Food utilization refers to food quality, safety, and absorption, supported by an adequate health status. Food stability is ensured when food availability, accessibility, and utilization remain secure throughout the year and over a long period of time (see Fig. 9.1). The concept of food security also needs to be understood from both the national and household perspectives. Although national food security is important as providing a foundation, it may not guarantee household food security. It is therefore important that each and every household—and within it every member—has access to safe, nutritionally adequate, and culturally acceptable food (Gillespie and Mason 1991). Hunger and food insecurity can exist at the household level even when at the national level there is enough food. Food security is a multi-dimensional concept that includes (a) physical availability, which involves food production, stocks, and reserves across multiple scales; (b) physical and economic access, which depends on purchasing power, incomes, food prices, transport, and market infrastructure; (c) food utilization, or the capacity to absorb nutrition according to health, dietary diversity, and intra-household distribution; and (d) stability of food supply and access over time in cases of weather variability, price fluctuations, and other transitory shocks or periodic stresses (FAO 2008).

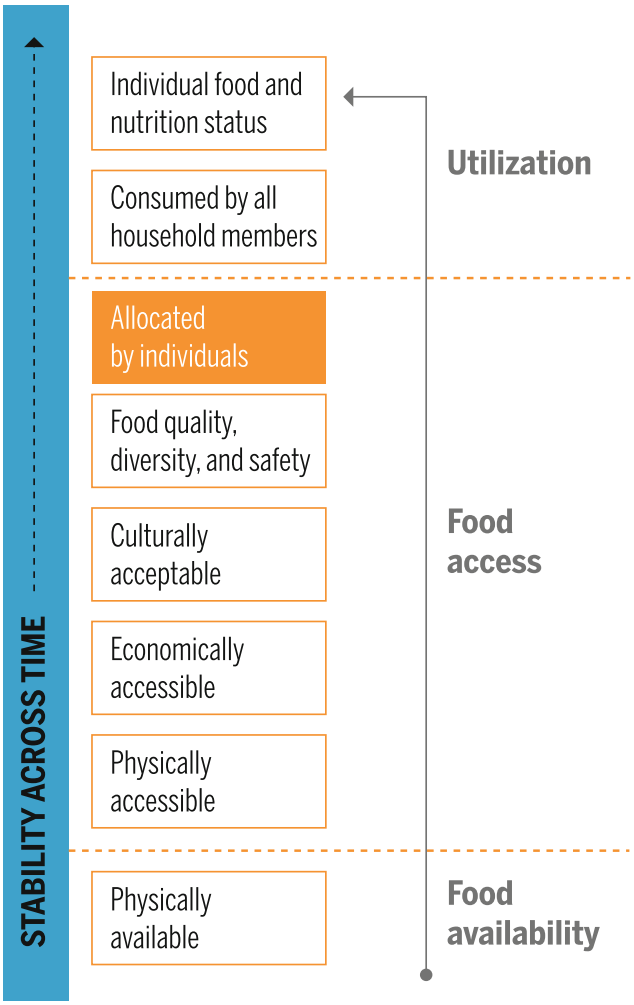

Fig. 9.1 Food security framework (*Source* Adapted from Jones et al. 2013)

The term nutrition security is sometimes used interchangeably with food security, even though nutrition security is much broader as it includes healthcare and hygiene practices (Fig. 9.1). Food security is necessary but not sufficient for nutrition security (Jones et al. 2013). In October 2012, FAO's 'Committee on World Food Security' attempted to define food and nutrition security as *the state that exists when all people at all times have physical, social, and economic access to food, which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services, and care, allowing for a healthy and active life*," (FAO 2012). Undernourishment is a state of food insecurity, where caloric intake is below the minimum dietary energy requirement (Jones et al. 2013).

9.1.3 Objective and Scope of this Chapter

As outlined above, the nature of and factors contributing to food and nutrition security in mountain areas are more complex than those in the plains, in particular, due to the harsh biophysical environment, poor accessibility, and weak market infrastructure (Rasul and Hussain 2015; FAO 2015), and a variety of research questions relating to food and nutrition security in mountain regions still need to be addressed. The core questions are as follows:

- How far do the dimensions and underlying factors affecting food and nutrition security vary across the mountain and plains regions of the HKH?
- What is the gap between food supply and demand in the HKH, and how is this gap being filled? What are the prospects and opportunities for traditional and non-traditional food production systems, and how can the strength of indigenous resources be capitalized on through unique policy options?
- What are the key challenges in the arena of food accessibility, distribution, and utilization, and what ways and means will be available to cope with these challenges through public policies and development programmes?
- What best practices exist at regional and international levels that can be tested and replicated for specific communities in the HKH?
- How can the national and international goals of food and nutrition security be achieved for the mountain regions of the HKH?
- Why should the attention of the international community be drawn to the marginalized communities in the HKH, who are often among the most vulnerable people in the world due to cross-border conflicts and political disturbances?

In order to address these questions using an integrated and holistic approach, this chapter aims to understand the causes of food and nutrition insecurity in its four dimensions and to suggest some actionable policy measures to improve the nutrition status of the people living in the HKH. Both qualitative and quantitative data and information have been collected, assessed, and synthesized, and policy issues and their implications for the mountain regions are briefly examined. The first section of the chapter addresses the status of food and nutrition security in the HKH, the second section discusses key issues and challenges in food and nutrition security, the third section describes emerging opportunities and potential in the region, and the final section presents a strategic approach to achieve sustainable food and nutrition security in the mountain areas. The synthesis aims to provide state-of-the-art knowledge on food and nutrition security in

Table 9.2 Food and nutrition (in)security in Afghanistan

Indicators	National	Region						
		Northeast	Northwest	East	Central	West	Southeast	Southwest
% of households not meeting their caloric needs	33.0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Stunting[a] (%)	40.9	44.6	45.7	52.6	37.4	31.0	35.0	39.9
Wasting[b] (%)	9.5	8.5	5.9	18.0	8.4	5.6	7.9	10.1
Underweight[c] (%)	25.0	27.8	22.6	41.3	24.1	16.7	27.6	23.6
Underweight women[d] (%)	9.2	13.7	14.8	6.2	7.9	10.9	4.4	9.1
% of women (age 12–49) who received vitamin A postpartum	18.6	16.8	16.1	31.5	6.4	5.6	9.4	22.4
% of women (age 12–49) who had no postnatal check-up	71.5	81.2	72.6	70.3	78.0	77.1	69.8	57.2

[a]Height-for-age: children under 5 years < −2 SD from the international reference median value
[b]Weight-for-height: children under 5 years < −2 SD from the international reference median value
[c]Weight-for-age: children under 5 years < −2 SD from the international reference median value
[d]Weight-for-age: women 15–49 years < −2 SD from the international reference median value
Data source ALCS (2014); AMS (2010)
n.d. = no data available

the HKH region which can be used to inform policy decisions on improving food and nutrition security.

9.2 Status of Food and Nutrition Security in the Mountains of the HKH

9.2.1 Prevalence of Food and Nutrition Insecurity

The prevalence of food insecurity and malnutrition in the HKH countries is very high. In view of the differences in the nature and underlying factors of food and nutrition security in the mountains compared to the plains, it is important to examine the disaggregated status of food and nutrition security in these areas. The statistics show that overall mountain areas are more vulnerable to food and nutrition insecurity, although in certain indicators, some mountain areas can be relatively better than plains areas. The mountain areas are also not homogeneous, and variation across the different mountain regions within a particular country should also be considered. The available information about food and nutrition insecurity in the individual countries within the region is summarized in the following.

Almost all of Afghanistan is hilly or mountainous and no comparison can be made between plains and mountain/hill areas. The prevalence of stunting, wasting, and underweight in children is high in almost all regions of the country (Table 9.2), with stunting particularly high in the north and east and underweight and wasting in the east. The percentage of underweight women aged 15–49 years is significantly higher in the north than elsewhere, while close to 80% of women aged 12–49 years in the northeast, central, and west regions did not receive any postnatal check-up or treatment (Table 9.2). This indicates women's limited access to health services.

Bhutan is also almost entirely hilly or mountainous. Only 6% of the population lives below the food poverty line (Nu. 689 per person per month) (GoB 2012), while 96% of households have access to improved sources of drinking water and 63% to improved sanitation facilities. Nevertheless, the prevalence of stunting and underweight is still high, indicating a lack of diversity in diets and deficiencies of micronutrients (Table 9.3).

In China, the average intake of calories is below the national average in the mountain provinces, except in Yunnan (Table 9.4). The prevalence of stunting in children is relatively high in Sichuan and Yunnan, and the prevalence of anaemia in children is relatively high in Sichuan and Gansu (in both cases the only two mountain provinces for which data is available (Table 9.4).

Table 9.3 Food and nutrition (in)security in Bhutan

Indicators	National
% of population below food poverty line[d]	5.9
Stunting[a] (%)[e]	21.2
Wasting[b] (%)[e]	4.3
Underweight[c] (%) [e]	9.0

[a]Height-for-age: children under 5 years < −2 SD from the international reference median value
[b]Weight-for-height: children under 5 years < −2 SD from the international reference median value
[c]Weight-for-age: children under 5 years < −2 SD from the international reference median value
Data source [d]GoB (2012); [e]NNS (2015)

Table 9.4 Food and nutrition (in)security in China

Indicators	National	Mountain provinces				
		Sichuan	Yunnan	Gansu	Qinghai	Xinjiang
Dietary energy intake (kcal/capita/day)	2172	1966	2231	2011	1986	2021
Protein intake (g/capita/day)	65.0	61.4	67.9	60.1	67.2	63.6
Stunting[a] (%)	3.2	8.0	11.5	n.d.	n.d.	n.d.
Wasting[b] (%)	3.2	3.3	n.d.	n.d.	n.d.	n.d.
Underweight[c] (%)	9.0	15.4	8.4	n.d.	n.d.	n.d.
Prevalence of anaemia (Hb < 12 g/dl) in pregnant women above 18 years of age (%)	17.2	10.0	10.0	17.0	15.2	20.1
Prevalence of anaemia (Hb < 12 g/dl) in children (below 5 years of age) (%)	5.0	13.7	n.d.	24.4	n.d.	n.d.

[a]Height-for-age: children under 5 years < −2 SD from the international reference median value
[b]Weight-for-height: children under 5 years < −2 SD from the international reference median value
[c]Weight-for-age: children under 5 years < −2 SD from the international reference median value
Data source NHPC (2015); Ministry of Health (2013); Xiaoping and Minru (2014); Gansu Province Government (2015)

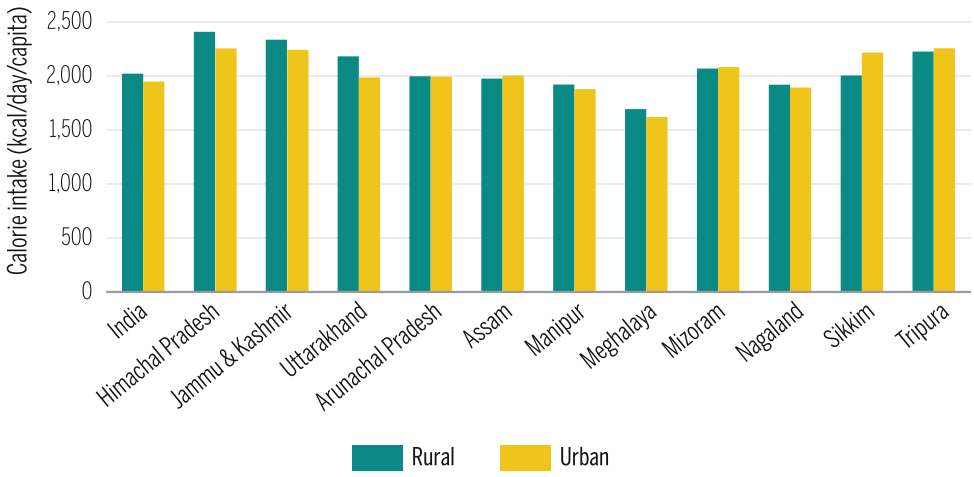

Fig. 9.2 Daily calorie intake in India (*Source* GoI 2010; Schedule Type 1 data from NSS 66th Round, 2010)

In India, the average calorie intake in urban and rural areas of mountain states tends to be slightly lower than the national average, particularly in Manipur, Meghalaya, and Nagaland (Fig. 9.2; Table 9.5). However, the prevalence of stunting, wasting, and underweight in children is lower in the mountains than the national average, possibly due to the presence of extremely poor plains states such as Bihar, Jharkhand, Chhattisgarh, and Orissa in national-level assessments. These states are poor in terms of people's financial capacity (GoI 2014a) as well as health and nutrition status (NFHS 2006). Meghalaya is the only mountain state where the prevalence of stunting, wasting, and underweight children is significantly higher than the national average (Fig. 9.3). In Meghalaya, the area under cultivation of key agricultural crops had declined by nearly 14% in 2011/12 compared to 2002/03 (Roy et al. 2015) which may indicate one factor. Moreover, the shift in Meghalaya from subsistence to commercial farming, multi-cropping to mono-cropping, traditional to modern crops, and food to non-food crops has had an impact on patterns of production and consumption and led to a decline in food diversity that affects nutritional security (Behera et al. 2016). The prevalence of anaemia (by Hb level) in women aged 15–49 years is notably higher in the states of Assam, Sikkim, and Tripura (Table 9.5). Although the overall situation of nutrition security seems slightly better in the mountain states than the national average, the prevalence of malnutrition is still very high.

In Myanmar, the incidence of food poverty in the mountain states of Chin, Rakhine, and Shan is very high compared to the national average (Fig. 9.4). The prevalence of stunting, wasting, and underweight are also substantially higher in Chin, Rakhine, and the northern parts of Shan (Fig. 9.4).

In Nepal, the proportion of food insecure households in the mountains is significantly higher than in the plains (Terai) and compared to the national level (Table 9.6). The

Table 9.5 Food and nutrition (in)security in India

Indicators		National	Mountain states										
			Himachal Pradesh	Jammu and Kashmir	Uttarakhand	Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
Calorie intake (kcal/capita/day)	Rural	2020	2407	2334	2179	1995	1974	1919	1692	2067	1918	2003	2223
	Urban	1946	2253	2247	1984	1992	2003	1876	1619	2080	1891	2214	2254
Protein intake (g/capita/day)	Rural	55.0	68.6	61.8	58.6	52.9	48.7	46.4	41.3	49.4	54.2	51.2	55.9
	Urban	53.5	63.1	60.4	55.5	53.2	52.6	45.0	40.7	52.6	55.5	57.8	59.6
Fat intake (g/capita/day)	Rural	38.3	58.9	52.5	48.9	18.1	25.3	14.1	21.2	24.5	13.7	41.5	26.3
	Urban	47.9	61.9	54.7	48.4	26.0	33.5	15.9	22.9	35.1	17.5	44.1	36.1
Stunting[a] (%)		48.0	38.6	35	44.4	43.3	46.5	35.6	55.1	39.8	38.8	38.3	35.7
Wasting[b] (%)		19.8	19.3	14.8	18.8	15.3	13.7	9	30.7	9	13.3	9.7	24.6
Underweight[c] (%)		42.5	36.5	25.6	38	32.5	36.4	22.1	48.8	19.9	25.2	19.7	39.6
Prevalence of anaemia (by Hb level) in children aged 6–59 months		69.5	54.7	58.6	61.4	56.9	69.6	41.1	64.4	44.2	n.d.	59.2	62.9
Prevalence of anaemia (by Hb level) in women aged 15–49 years		55.3	43.3	52.1	55.2	50.6	69.5	35.7	47.2	38.6	n.d.	60.0	65.1

[a]Height-for-age: children under 5 years < −2 SD from the international reference median value
[b]Weight-for-height: children under 5 years < −2 SD from the international reference median value
[c]Weight-for-age: children under 5 years < −2 SD from the international reference median value
Source GoI (2010) (Schedule type 1 data of NSS 66th Round, 2010); NFHS (2006)

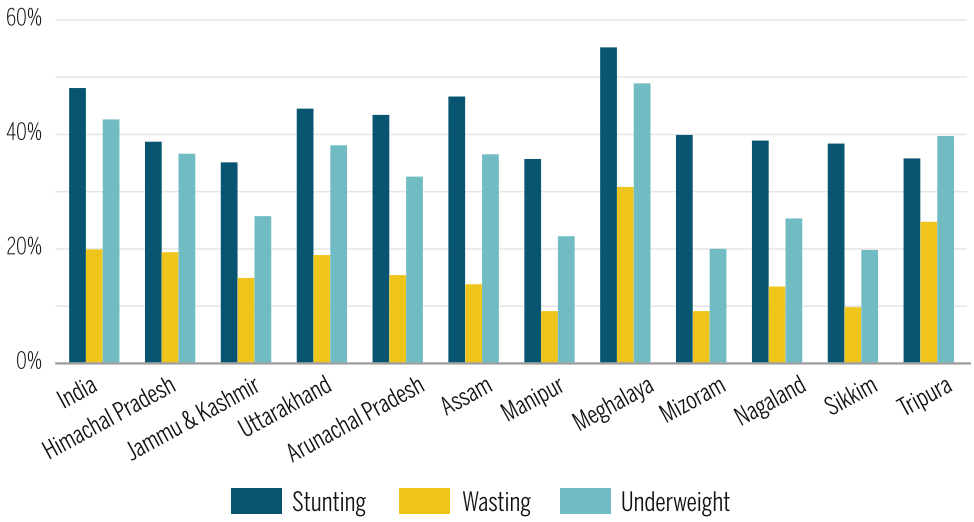

Fig. 9.3 Prevalence of stunting, wasting, and underweight in children under five years of age in India (*Source* NFHS 2006)

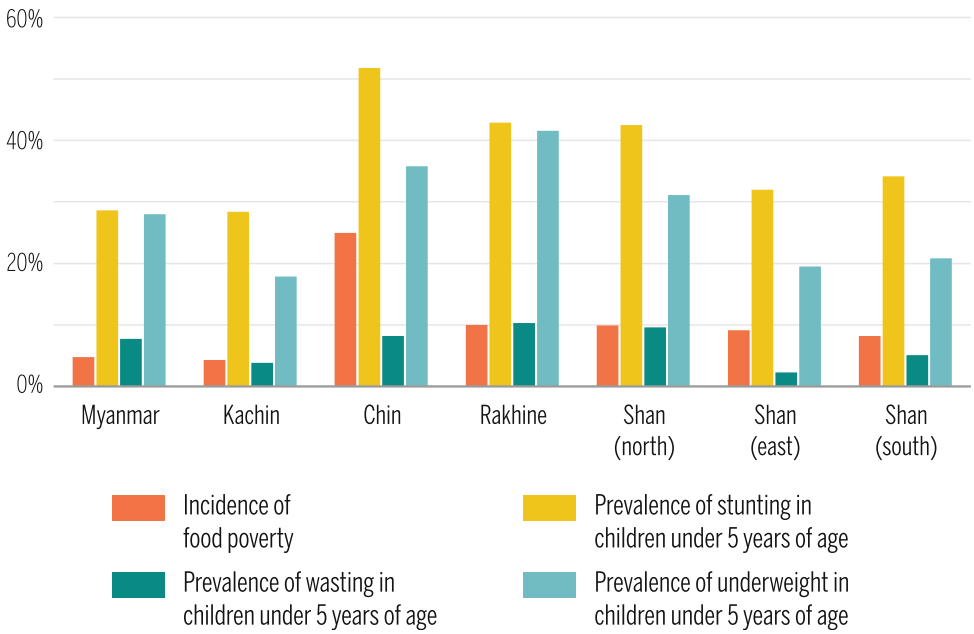

Fig. 9.4 Food poverty and undernutrition in children under five years of age in Myanmar (*Sources* IHLCA 2011; MoNPED and MoH 2011)

Table 9.6 Food and nutrition (in)security in Nepal

Indicator	National	Mountains	Hills	Terai
% of food insecure households	50.8	59.5	52.8	47.9
Prevalence of underweight women (aged 15–49 years)	18.2	16.5	12.4	22.7
Stunting[a] (%)	40.5	52.9	42.1	37.4
Wasting[b] (%)	10.9	10.9	10.6	11.2
Underweight[c] (%)	28.8	35.9	26.6	29.5
Prevalence of anaemia (by Hb level) in children aged 6–59 months	46.2	47.7	41.0	50.2
Prevalence of anaemia (by Hb level) in women aged 15–49 years	34.8	26.7	26.5	41.9

[a]Height-for-age: children under 5 years < −2 SD from the international reference median value
[b]Weight-for-height: children under 5 years < −2 SD from the international reference median value
[c]Weight-for-age: children under 5 years < −2 SD from the international reference median value
Source NDHS (2011)

Table 9.7 Food and nutrition (in)security in Pakistan

Indicators		National	Mountain province/administrative unit[b,c]				
			AJK	Balochistan	FATA	GB	KPK
Prevalence of food insecurity (%)[d]		49	47	61	68	52	56
% of women (aged 15–49 years) facing micronutrient deficiency	Iron deficiency anaemia (NPW)[a]	20	19	16	16	10	5
	Iron deficiency anaemia (PW)	26	28	31	n.d.[c]	30	15
	Vitamin A deficient (NPW)	43	13	50	83	39	72
	Vitamin A deficient (PW)	49	31	62	n.d.	45	85
	Calcium deficient (NPW)	51	6	60	81	45	71
	Calcium deficient (PW)	58	4	63	n.d.	71	61
	Vitamin D deficient (NPW)	85	95	83	85	96	80
	Vitamin D deficient (PW)	86	85	78	n.d.	96	77
% of children (0–59 months) facing growth problems	Severe stunting	22	12	32	36	22	25
	Wasting	17	18	18	10	9	18
	Underweight	31	n.d.	42	13	n.d.	24
% of children (0–59 months, except iodine) facing micronutrient deficiency	Vitamin A deficient	56	37	81	100	82	78
	Zinc deficient	37	49	34	34	33	34
	Vitamin D deficient	41	33	40	26	32	30
	Iodine deficient (6–12 years)	37	65	35	10	70	26
	Iron deficiency anaemia	33	28	23	26	21	13

[a]NPW = non-pregnant women; PW = pregnant women
[b]AJK = Azad Jammu and Kashmir; FATA = Federally Administered Tribal Areas; GB = Gilgit-Baltistan; KPK = Khyber Pakhtunkhwa
[c]n.d. = no data
Source Bhutta et al. (2011); FSA (2009)[d]

prevalence of stunting and underweight in children (<5 years) is also higher in the mountains compared to the plains and national statistics. On the other hand, the prevalence of anaemia and underweight in women (15–49 years) is slightly lower in the mountains.

In Pakistan, the prevalence of food insecurity is significantly higher in the mountain areas when compared to national statistics, with the exception of Azad Jammu and Kashmir (AJK). Almost two-thirds of the population in Balochistan and the Federally Administered Tribal Areas (FATA) is food insecure (Table 9.7), mainly due to lack of financial resources to purchase adequate food (FSA 2009; Hussain and Routray 2012). In line with the higher food insecurity, the majority of mountain people face a higher deficiency in most micronutrients. For example, in Balochistan, FATA, and Khyber Pakhtunkhwa (KPK), vitamin A deficiency among non-pregnant women (aged 15–49) stands at 50%, 83%, and 72%, respectively, while calcium deficiency stands at 60%, 81%, and 71%, respectively. The majority of pregnant women also face deficiencies of vitamin A and calcium in Balochistan and KPK. In Gilgit-Baltistan (GB) and KPK, almost all non-pregnant women have a vitamin D deficiency. The percentage of pregnant women with calcium and vitamin D deficiency in GB is also extremely high (Table 9.2). Almost one-third of children (<5 years) faced severe stunting in Balochistan and FATA. The prevalence of underweight children in Balochistan is also very high in comparison to the national average. All the children in FATA and the majority in Balochistan, GB, and KPK face vitamin A deficiency; and a high proportion of children in AJK face deficiency in zinc and in AJK and GB in iodine.

9.2.2 Seasonality and Vulnerability of Food and Nutrition Security

Mountain communities in the HKH region are highly vulnerable to food and nutrition insecurity as a result of a range of climatic, physical, and socioeconomic factors (Dame and Nüsser 2011; Hussain et al. 2016). A considerable proportion of the population live in remote, high altitude areas and dispersed settlements with limited physical infrastructure and market opportunities (Romeo et al. 2015). People living in such areas often face difficulties in accessing food due to poor infrastructure, weak communications, and limited transportation systems. There is also a seasonal variation in food security; in the winter and rainy seasons, road networks are often disconnected from the plains and food transportation becomes very difficult and highly expensive,

particularly if food needs to be airlifted. High transportation costs also increase food prices to levels that may go beyond the purchasing power of poor people and compromise food quality and quantity, affecting nutritional outcome (Ghosh and Sharma 2016). As a result, mountain regions often experience seasonal shortfalls of food with poor people particularly vulnerable to food and nutrition insecurity (Dame and Nüsser 2011; Hussain et al. 2016). Food security tends to be most compromised during the monsoon and snowy winter months, as well as during periods following natural disasters (Box 9.2).

Box 9.2 Seasonality of food and nutrition security in high mountains

High mountain areas in the HKH often experience heavy snowfall during the winter months (December to March), which result in blocked roads and physical isolation of local communities from other areas (e.g., in Upper Rasuwa in Nepal, Upper Mansehra in Pakistan, Northern Afghanistan, and the northwestern Himalayas in India). As an adaptation measure, people often reduce their food intake in terms of both quantity and frequency, which has serious implications for food and nutrition security in winter. Similar situations may occur after disasters such as landslides and floods. The main reason for food stress at these times is the lack of local storage and food processing facilities. To cope with such situations, governments could establish food storage centres to store both local produce and items brought in from other areas when the roads are functional (before winter and monsoon).

9.3 Issues and Challenges to Food and Nutrition Security

Mountain communities face multiple challenges in achieving nutrition security. In most mountain areas, the amount of available land per capita is too low to support sustainable livelihoods (Tiwari and Joshi 2012b; Hussain et al. 2016). Both the total area available per capita and the net sown proportion will become even smaller as the population increases. But the nature and causes of food and nutrition security are complex and multifaceted and mountain communities face several other biophysical, environmental, and socioeconomic constraints and challenges that affect food and nutrition security (Table 9.8). The key challenges are discussed in the following sections. They include deterioration of local food systems, changing dietary habits, climate change impacts, high rates of poverty, increased rates of outmigration, abandonment of cultivable land, rapid urbanization, inadequate infrastructure and market access, depletion of natural resources, barriers to food movement and trade, inadequate access to improved drinking water and sanitation, and gaps in existing policies and programmes. Climate change-induced hazards and biophysical constraints are further adding to the overall problems of inaccessibility and fragility in mountain areas. The factors constraining and facilitating food and nutrition security in the HKH region can be better understood using the conceptual framework shown in Fig. 9.5. They are discussed in more detail in the following.

9.3.1 Deteriorating Local Food Systems

Local biophysical and socioeconomic conditions play an important role in mountain agricultural systems. The huge shift from traditional to new crop varieties and from traditional to modern farming practices has led to a decline in local food systems (Adhikari et al. 2017; Gautam and Andersen 2017). A wide range of traditional crops used to be part of the food basket in mountain areas, including millets (*Eleusine* spp., sorghum (*Sorghum bicolor*), buckwheat (*Fagopyrum* spp.), amaranth (*Amaranthus* spp.), sea-buckthorn (*Hippophae* spp.), barley (*Hordeum vulgare*), naked barley (*Hordeum himalayens*), legumes (*Vigna* spp.), yam (*Dioscorea* spp.), sesame (*Sesamum indicum*), niger (*Guizotia abyssinica*), kaphal (*Myrica esculenta*), chiuri (*Diploknema butyracea*), amala (*Phyllanthus emblica*), pomelo (*Citrus maxima*), and jamun (*Syzygium cumini*) (Padulosi et al. 2012). These traditional crops are also known as neglected and underutilized species (NUS) due to the lack of recognition and underutilization of their potential in terms of their biophysical suitability in mountain ecosystems and their high nutritional value. People often consider NUS as 'foods of the poor' (Adhikari et al. 2017; Mal et al. 2010) and are not aware of their potential for production, income, and nutrition security. Previously widespread crops such as millet, barley, oats, and beans are being replaced with rice, wheat, maize, and high-yielding cash crops such as potato, vegetables, and even non-food crops) (Adhikari et al. 2017; Apetrei 2012).

Some of the most important factors contributing to the decline in NUS production are increasing food demand, declining market value of NUS, increasing market value and demand for dominant crops, increasing standardization of agricultural practices and trends towards mono-cropping, inadequate policy support, changing food preferences in response to urbanization, changes in income levels, lack of nutritional knowledge among consumers, and gradual loss of traditional NUS-based recipes (Adhikari et al. 2017). Disappearance or limited cultivation of NUS is leading to a decline in agricultural diversity in agriculture ecosystems

Table 9.8 Challenges to food and nutrition security

Challenge	Consequences	Dimensions of food and nutrition security likely to be affected negatively
Deterioration of local food systems	• Reduced food production • Reduced production diversity	• Food availability • Food utilization
Changing diets	• Reduced dietary diversity	• Food utilization
Climate change	• Risks to agricultural production • Reduced production diversity • Reduced farm income • Constrained food supply from plains due to climate hazards	• Food availability and stability • Food utilization • Food accessibility • Food stability
Lingering poverty	• Reduced food intake • Reduced dietary diversity	• Food accessibility • Food utilization
Increased outmigration	• Labour shortages in agriculture leading to reduced production	• Food availability
Abandonment of cultivable land	• Low returns, labour shortages, and others leading to land being abandoned and loss of production	• Food availability
Rapid urbanization	• Encroachment of agricultural land leading to reduced agricultural production	• Food availability
Inadequate infrastructure and market centres	• Inadequate food distribution • Higher post-harvest losses • Higher prices of external food items	• Food accessibility • Food availability
Depletion of natural resources	• Loss to water resources • Reduced supply of biomass manure from forests • Reduced supply of edible wild plants and fruit from forest, leading to reduced dietary diversity • Degradation of rangelands and pastures resulting in reduced livestock production and income	• Food availability • Food availability • Food availability and utilization • Food availability and accessibility
Constraints to internal food movement and cross-border trade	• Reduced food supply to mountains • Higher prices of available food	• Food availability • Food accessibility
Inadequate access to improved drinking water, sanitation, and hygiene	• Higher prevalence of diseases	• Health status

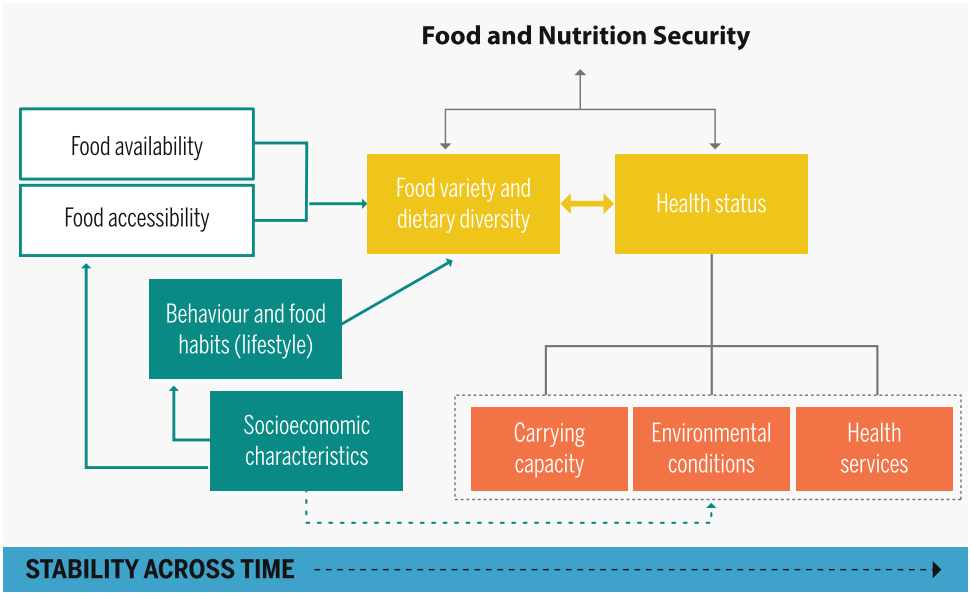

Fig. 9.5 Food and nutrition security: a conceptual framework (*Source* Modified from Gross et al. 2000)

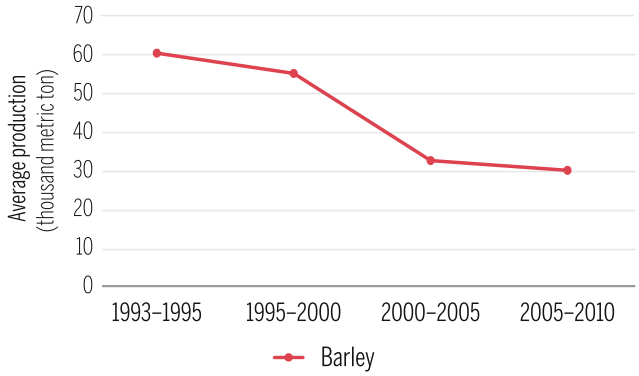

Fig. 9.6 The trend in barley production in KPK, Pakistan (*Source* ASP 2012)

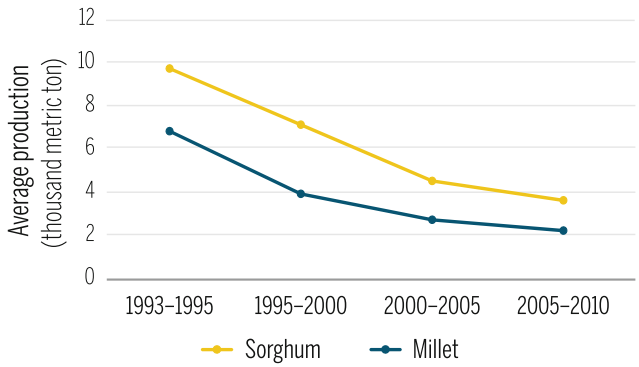

Fig. 9.7 The trend in sorghum and millet production in KPK, Pakistan (*Source* ASP 2012)

and dietary patterns (Mayes et al. 2012), particularly in the HKH (Adhikari et al. 2017; Rasul et al. 2018), with a few commodity crops now dominating food systems at all levels. The loss of agrobiodiversity has become a serious concern and may undermine long-term agricultural sustainability and food security in the region.

The decrease in NUS production has been observed in many areas (Adhikari et al. 2017). For example, the average production of barley in KPK, Pakistan, declined to only 30 thousand metric ton in the late 2010s from more than 60 thousand metric tons in the mid-1990s; while the average production of sorghum declined by nearly 62% and of millet 67% over the same period (Figs. 9.6 and 9.7). In Nepal, the change has already taken place in many areas; the per capita production of millet in 2013/14 was only 10.7 kg, compared to 66, 177, and 80 kg for wheat, rice, and maize, respectively (estimates based on data from MoAD 2015). The change is continuing, although the (low) production of NUS showed a moderate increase between 2007 and 2014 in absolute terms (MoAD 2015), there was a decline or negligible change in terms of per capita production.

At present, protection and promotion of traditional crops is not a top priority in many HKH countries (Hagen 2004) and institutional mechanisms to help local communities either to realize and use the benefits of local agro-biodiversity or to provide market incentives for producers of NUS are inadequate. Policies on food pricing and farm subsidies do not take traditional crops into account, and trade and market policies rarely reflect their nutritional and ecological value (Williams and Haq 2002; Padulosi and Hoeschle-Zeledon 2004). If farmers, do not have supporting policies, appropriate transportation facilities, good market value and chains, or demand, they will prefer to grow dominant crops rather than cultivating traditional crops, particularly when landholdings are very small. This has been the situation over the last two to three decades in the HKH (Adhikari et al. 2017; Sharma et al. 2016). At the same time, local food systems in mountain areas are being further affected indirectly by subsidies provided for new production technologies and inputs, the relatively higher returns of dominant crops such as rice and wheat resulting from the minimum support price policy, and frequent food aid and food supply as remuneration for work (Pingali et al. 2017; Rasul et al. 2018; Maikhuri et al. 2001).

Local food systems face another challenge in human-wildlife conflict. A considerable number of people in high mountain areas live in the proximity of national parks and other protected areas. In these areas, increasing depredation of crops and livestock by wild animals has become a serious issue (Ogra 2008; Manral et al. 2016), again with important implications for people's livelihoods and food and nutrition security.

The deterioration in local food systems is resulting in increased dependence on external food crops (such as fine rice, wheat, and non-organic vegetables) and processed snacks and drinks, in place of traditional crops. This has made mountain people highly vulnerable to food and nutrition insecurity. Price shocks in food, and natural hazards such as floods and landslides, can further restrict food supplies and result in price hikes, leading to short-term food insecurity with long-term impacts. Price hikes and restricted food supplies can lead to a shift from a diverse food culture to a monoculture, reduced overall consumption, high dependence on assistance and aid, and reliance on credit leading to indebtedness (Hussain et al. 2016). Debts may further affect community resilience and sustainable food security in the long-term (Milbert 2009). Further, most food items coming from the plains are non-organic and produced with much use of pesticides and chemical fertilizers. In the recent past, use of chemicals has also been introduced in some mountain areas (e.g., Meghalaya in India) with the shift from traditional to commercial farming (Behera et al. 2016). These non-organically produced food items pose a threat to food safety in the mountains, where people historically cultivated and consumed mainly safe organic food items (Rasul and Thapa 2003; Atreya et al. 2012; Giri et al. 2014).

9.3.2 Changing Dietary Habits

Food habits and diets in the HKH have been undergoing changes in recent years due to socioeconomic developments linked to increased access to roads, schools, and markets, as well as radio, television, and other media (Dame and Nüsser 2011; Finnis 2007). Changes are more prominent in middle and lower elevation villages, where road connections are better and market connections have been established. The consumption of traditional coarse grains, which contain an abundance of micronutrients and fibre, is often considered to be 'backward' in the sociocultural value system (Maikhuri et al. 2001) and refined rice and wheat have become the main food items. The process has been further reinforced by low prices and inadequate incentives for traditional crops and a decrease in production as well as availability of high-yielding varieties of seeds at subsidized prices, and distribution of free or subsidized food (often rice and wheat) by the government (Maikhuri et al. 2001). The replacement of NUS such as millet, barley, beans, and coarse rice, with fine grains and low nutrition processed foods and drinks has important implications for nutrition status in the HKH. While total calorie intake has increased over the years, nutritional status has deteriorated due to micronutrient deficiencies (Rasul et al. 2018). Reduced consumption of diverse foods and decreasing activity levels lay the foundation for obesity and related chronic diseases (Kumanyika et al. 2002; Hill et al. 2003). Foods from NUS, wild vegetable, and fruit species, as well as animal sources, are important sources of micronutrients, yet their consumption has been reduced due to the increasing uniformity of food patterns and changes in dietary habits (Rasul et al. 2016). Globally, changes in lifestyle influencing changes in diet composition and food demand are expected to increase significantly, even with no further population growth (Pradhan et al. 2013). This might have serious implications for the HKH region, as mountain communities depend considerably on national and regional markets for access to food.

9.3.3 Changing Climate

The average ambient temperature in the mountains of the HKH is rising at a rate of 0.06 °C per year, higher than the global average, which has resulted in loss of snowfall and snow cover and rapid melting and shrinking of the majority of glaciers in the region (Shrestha and Aryal 2011) (see Chap. 3 Climate Change in the HKH and Chap. 7 Status and Change of the HKH Cryosphere). Loss of the cryosphere is changing the amount and timing of melt, impacting water availability, and leading to a reduction in food production and food insecurity in the mountains as well as downstream (Rasul 2014). In addition, increasing variability in precipitation patterns and the increased incidence of hazards such as floods and droughts are seriously affecting agricultural productivity and income across the region (Hussain et al. 2016, 2018). Studies conducted in the mountain states of India such as Himachal Pradesh, Jammu and Kashmir, and Uttarakhand (Vishvakarma et al. 2003; Kumar et al. 2006; Negi et al. 2012) have shown that precipitation and temperature patterns have changed in a way that is likely to affect the discharge, volume, and availability of water (Bandyopadhyay and Perveen 2008; Viviroli et al. 2007). For example, in Ladakh, India, farmers are already experiencing a shortage of water for irrigation due to reduced snow and ice (Clouse et al. 2017). Similar experiences are also reported from other high mountain areas in the HKH region (Tiwari and Joshi 2012b). Loss of the cryosphere may have a serious impact on water availability for agriculture (Aase et al. 2009). The changes in key climatic phenomena are also likely to result in more frequent droughts, increased incidence of high intensity rainfall, and more frequent floods (Ailikun 2015; UCCRN 2015), all of which will lead to increased vulnerability and uncertainty in food and nutrition security in the region.

A large survey-based study (over 8,000 households) conducted in the four river basins of the HKH—Upper Indus (Pakistan), Koshi (Nepal), Eastern Brahmaputra (India), and Salween and Mekong (China)—found that the majority of households had perceived an increase over time in the incidence of climate-induced extreme events, including floods, erratic rainfall patterns, high variations in temperature, landslides/erosion, dry spells and droughts, and livestock disease and crop pests (Fig. 9.8). These extreme events affected their agricultural production and income (Hussain et al. 2016).

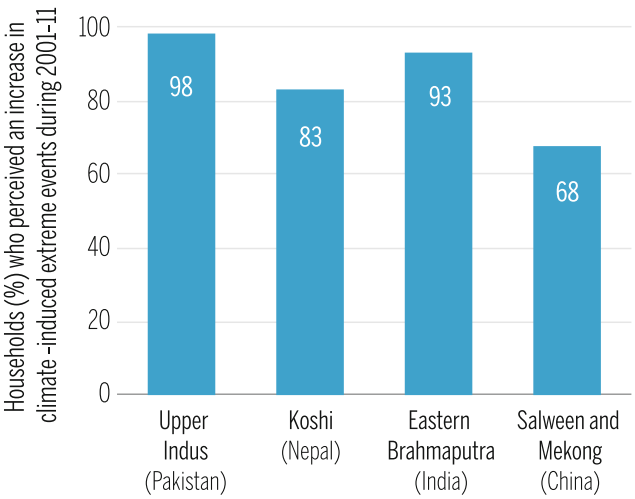

Fig. 9.8 Incidence of climate-induced extreme events during 2001–11 in the HKH (*Source* Hussain et al. 2016)

Some extreme events, such as droughts and floods, have long-term impacts on the food and nutrition security of local communities. Drought is directly and indirectly affecting livelihoods in the mountains and increasing food insecurity through reduced water availability for both agriculture and rangeland production (Xu et al. 2009; Ebi et al. 2007; Joshi et al. 2013; Rasul 2014). Most of the mountain rangelands, particularly in the western parts of the HKH (e.g., Balochistan Province, Pakistan), are facing degradation due to the increased incidence of drought compounded by overgrazing. Degradation of the vegetation cover and deterioration of soil with erosion and loss of nutrients is resulting in a reduction of livestock productivity that further impoverishes pastoral communities (Afzal et al. 2008). For example, a drought from 1998 to 2002 in Balochistan Province of Pakistan resulted in a serious water shortage for agriculture, affecting nearly two million acres of arable land and 9.3 million livestock. Drastic changes in the composition of plant species in the degraded rangeland ecosystem and shortages of fodder and water led to the death of 1.8 million livestock and the destruction of nearly 80% of apple orchards. Food prices rose, and the food security and livelihoods of nearly two million mountain people were affected, resulting in reduced food consumption and the migration of people from drought-affected areas to areas downstream (Shafiq and Kakar 2007). The continued water stress in Balochistan has led to excessive pumping of groundwater, resulting in a further lowering of the water table. In certain parts of Balochistan, this has had a significant impact on local food systems and food security (Rasul et al. 2014).

In contrast, in 2010, frequent fluctuations in the intensity of precipitation in some mountain areas of Pakistan led to an increase in flooding, especially flash flooding, affecting the resource base and infrastructure in both upstream and downstream areas. The devastating floods left around eight million people vulnerable to long-term food insecurity, the majority of them in mountain areas (Rasul et al. 2014). Similar kinds of floods have been observed frequently in Uttarakhand (India) in recent years (2001–2013). Flood events are also increasing in the drier mountain areas, such as Ladakh in India (Ziegler et al. 2016) and Gilgit-Baltistan in Northern Pakistan (Hashmi et al. 2012).

9.3.4 Lingering Poverty

In the HKH, high poverty, both unidimensional and multidimensional, is one of the major causes of food and nutrition insecurity (see Chap. 12 Poverty and Vulnerability in Mountain Livelihoods). Financial resources are needed to afford an adequate diet and ensure food and nutrition security. The choice and consumption of food is largely determined by household income and price of products (Lo et al. 2012). Generally, low income groups prefer low-price high-energy food regardless of its nutritional value (Monsivais and Drewnowski 2007; Kettings et al. 2009). In many mountain areas of the HKH, the incidence of poverty is higher than in the adjacent plains (Khan et al. 2015; Saboor et al. 2015), and local people have a very limited choice of food items due to their low income levels, leading to food and nutrition insecurity. A study conducted in the Mugu district of Nepal revealed that only a few of 198 children studied were getting a nutritious diet including such items as meat, egg, milk, vegetables, and fruit. The main reason for the inadequate dietary intake was the lack of economic affordability of diverse food items (Sharma 2012). Poverty affects all aspects of nutrition—food security, access to safe drinking water, hygiene, housing, health services, and education—further trapping families in poverty from one generation to the next (CPRC 2004).

9.3.5 Increasing Rate of Out-Migration

The inflow of remittances from out-migrants is undoubtedly a potential source for improving local food security and livelihoods through enhanced income, growth of local small businesses, transfer of new technologies, and creation of job opportunities for local skilled and unskilled labour. But out-migration for work has also added to the challenges in mountain areas. Increased out-migration and decreased interest of the younger generation in farming also contribute to low productivity in agriculture as well as abandoning of farmland in some parts of the region, as discussed below. The HKH region faces frequent labour shortages during the critical periods of agricultural activities due to out-migration of active household members, particularly youth, with 70%, 26%, 37%, and 38% of farm households affected in the Upper Indus (Pakistan), Koshi (Nepal), Eastern Brahmaputra (India), and Salween and Mekong (China) river basins (Hussain et al. 2016). The absence of young people is impeding efforts to develop mountain agriculture as a business enterprise. The involvement of youth is very important because they are generally more progressive and more willing to adopt new technologies related to production, harvesting, post-harvest handling, and marketing than older farmers. However, a growing number of reports suggest that despite the problems, migration has become an important source of livelihoods and contributes positively to food security (Crush and Caesar 2017; Gautam 2017). More empirical evidence is required to better understand the relationship between migration and food security.

9.3.6 Abandonment of Cultivable Land

A considerable proportion of cultivable land in the HKH has been abandoned and remains fallow as a result of the low returns, shortage of labour caused by rural out-migration for work, highly unequal distribution of land, limited scope for mechanization, and lack of land ownership by tenants (ICIMOD 2008). In some areas of the Nepalese Himalaya, more than 30% of total cultivated land has been abandoned in the mid-hills districts (Jackson et al. 1998; Thapa 2001; Khanal 2002); close to 30% of agricultural land has been abandoned in the Sikles area of the Gandaki basin in Nepal (Khanal and Watanabe 2006); and cultivated terraced lands decreased by 36% between 1978 and 2014 in the western middle hills of Nepal (Jaquet et al. 2015). Hussain et al. (2016) found that more than a quarter of agricultural land in the Upper Indus was left to serve as pasture and grassland for livestock, because households find it easier and more profitable compared to cultivating crops in the face of labour shortages, while across the Upper Indus, Koshi, Eastern Brahmaputra, and Salween and Mekong river basins, 6% of cultivable land was left fallow without any productive use at all.

9.3.7 Rapid Urbanization

The problems with agricultural land have been further compounded by the fast rural-urban migration and unplanned urbanization. In recent years, several areas in the HKH have experienced rapid, unregulated, and unplanned urban development due to population growth and inadequate land use policies. Expansion of urban areas on agricultural land, especially in the more accessible and fertile areas, placing further pressure on the already shrinking landholdings (Nüsser et al. 2015). Although urbanization is likely to improve market access in adjacent mountain areas, farmers are not receiving any additional benefits due to the lack of production technology and continuation of old practices under the same ecological conditions (Stone 2001). Moreover, urbanization also contributes to changing food habits and dietary patterns with increased consumption of refined cereals, rice and wheat.

9.3.8 Inadequate Infrastructure and Market Access

Adequate and appropriate infrastructure facilities, such as all-weather road connectivity, an easily accessible network of food distribution centres, food storage facilities, and market/collection centres, particularly during the monsoon and snowy winter months (see Box 9.2), are of critical importance for ensuring access to food in the HKH (Partap 1998). Unfortunately, across the region there is still a lack of the infrastructure required for the efficient distribution of food and improving food access, as well as a lack of adequate food storage facilities to maintain food reserves during the rainy and winter months. During the 2013 floods in Uttarakhand in India, food supplies were secured by helicopters and stored in schools due to the lack of storage facilities (Awasthi 2016).

Marketing and processing facilities for agricultural, dairy, and horticultural products are also inadequate in the mountain areas. This not only results in huge post-harvest losses of food crops, fruit, and vegetables, it also makes mountain farming and horticulture economically unviable, particularly for poor and marginalized households. Gilgit-Baltistan (GB) in Pakistan, for example, is an important producer of fruit, but the lack of storage, packing, and transportation facilities, as well as improper handling, result in post-harvest losses of up to 59% of fruit crops, with a particularly high proportion of wastage for perishable commodities like mulberry, peach, and pomegranate (Fig. 9.9). Post-harvest losses of vegetables are also high at up to 40% (Rasul and

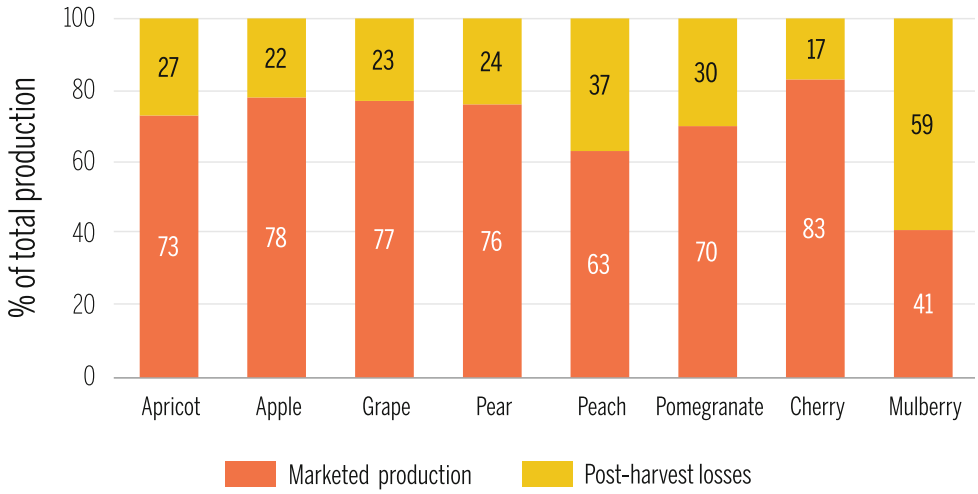

Fig. 9.9 Post-harvest losses in Gilgit-Baltistan, Pakistan (*Source* Rasul et al. 2014)

Hussain 2015). In Balochistan Province, people feed a substantial portion of harvested fruit and vegetables to their livestock due to the limited access to markets (Rasul et al. 2014).

In Nepal, the private sector is heavily engaged in the food commodity trade in the plains, but its role in hill and mountain areas is limited due to the poor transportation infrastructure. Many mountain districts are not yet well-connected to central and regional markets such as Kathmandu and Biratnagar, and even district headquarters are often not well-linked to remote areas in the district. The poor connectivity means that the food trade in hill and mountain areas has been minimal, while the high cost of transportation and relative isolation from functioning markets, means that the prices of major cereals, such as rice and pulses, are generally higher in mountain areas than in the Terai (plains). Due to the lack of functioning markets, low food availability, and low purchasing power, household participation in food markets in hill and mountain areas is limited (WFP and FAO 2007), which makes them vulnerable to food and nutrition security.

A similar situation exists in Bhutan, where much of the agricultural production has very poor access to market outlets. Access to markets is mainly hindered by the remoteness of producers, small production, and difficulty in reaching major market centres. This poor market integration particularly affects the horticultural sector with production of potatoes, beans, chillies, vegetables, and mushrooms, and orchard products such as apples, mandarins, and walnuts.

In the mountain states of India, the viability of food markets also remains challenging (Ghosh and Sharma 2016). First, most mountain areas are poorly connected to the plains. Second, mountain people have low purchasing power, leading to poor access to food. Third, farmers from the mountain states lack market information related to the prices of agricultural products. And finally, natural hazards such as landslides and excessive rain frequently block access to the market systems, affecting food accessibility for many poor and vulnerable communities (Ghosh and Sharma 2016).

The constraints of infrastructure and market services reduce the productivity of agricultural resources, resulting both in seasonal food shortages and restrictions in the development of value-added products. This ultimately restricts both economic growth and improvement of livelihoods in mountain areas (Partap 2011).

9.3.9 Depleting Natural Resources

A large number of people living in rural areas in the HKH region depend heavily on natural resources for their livelihoods and food security (Rasul 2010; Rasul et al. 2014), but rapid urbanization, changes in land use patterns, and increasing rainfall variability have affected the natural resources across the region. Water resources, especially springs, are being depleted rapidly across the HKH region (Tiwari and Joshi 2012a). Although the causes are not yet clear, a range of factors are thought to be responsible, including reduced infiltration and increased runoff, changes in land use (e.g., mixed forest to plantation, forest to agriculture, agriculture to infrastructure, wetlands to drained land), changes in agricultural practices (leading to soil degradation), and changes in precipitation patterns (e.g., from snow to rain, increase in cloudbursts and extreme events) (Tiwari and Joshi 2012a, b; Gautam and Andersen 2017). The amount of surface runoff is also much higher from built-up land than from other land categories, particularly forest and areas under cultivation. The land use changes and resultant hydrological disruptions have had a direct adverse impact on water availability and irrigation potential, which has been considerably reduced over the last three decades, with reduced groundwater recharge leading to drying of springs and streams across the HKH (Rawat 2009). For example, in the Hilkot catchment in Pakistan, 52 of 152 springs were found to have dried up over a five-year period (Merz et al. 2004), and Tambe et al. (2012) observed that spring yields in Sikkim in India had declined by 50%. The loss of basic ecosystem services, and water in particular, has had a negative impact on agricultural productivity across the region.

Forests are critical for maintaining soil fertility and water recharge, but they are depleting all over the HKH. The depletion of forest resources has also had an adverse effect on local agricultural systems through reduced supply of manure (from livestock fed on forest fodder). A study carried out in Uttarakhand, India found that the average supply of manure to agricultural land had declined from 15 tonnes/ha/year in 1980 to 9 tonnes/ha/year in 2010. As a result, the productivity of agriculture had declined by nearly 125 kg/ha (25%). Deforestation has accelerated the process of soil erosion due to increased runoff, and the deforested slopes have become highly vulnerable to slope failures and landslides contributing to the degradation of arable land and declining food production (Tiwari and Joshi 2012b). Depletion of forests has also resulted in reduced availability and consumption of edible wild plant species and fruit in mountain areas.

The increase in prolonged droughts is also contributing to the degradation of rangelands and pastures by reducing vegetation cover and exposing soil, resulting in reduced livestock productivity and further impoverishment of pastoral communities (Afzal et al. 2008).

9.3.10 Hindrances to Internal Food Movement and Cross-Border Trade

Since mountain regions are highly dependent on the plains for food, unrestricted flow of food is critical. However, there are some constraints on internal movement of food and cross-border trade in the HKH that are hindering efforts to achieving food and nutrition security. The constraints include high transportation costs and hazards such as landslides and floods which restrict movement from the plains to the mountains. The high transportation costs lead to higher prices for food items in the mountains, often three to four times as high as for the same items in the plains. The prices of essential food commodities such as pulses, wheat flour, and rice, increased tremendously between 2005 and 2015, reducing the access to adequate food. The food purchasing power of rural people in Uttarakhand decreased by 30–35% over this period, exacerbating food insecurity, and poor and socially marginalized communities either stopped or drastically reduced their purchase of nutritious food products (Tiwari and Joshi 2012b). In Pakistan, the interprovincial movement of food is sometimes halted due to the internal food demand of food-producing provinces (Box 9.3). While food trade and movement between the HKH countries is sometimes affected by economic and geopolitical events, again with serious implications for food and nutrition security as the disruptions induce food shortages and price hikes in the mountain areas (Box 9.4).

Box 9.3 Interprovincial movement of food in Pakistan

In Pakistan, provincial governments sometimes restrict the movement of food to other provinces if provincial production is only sufficient for local consumption. In 2014, the Food Department of Sindh Province banned the interprovincial movement of wheat flour to Balochistan and Punjab in order to fulfil the local requirements in Sindh (The Nation 2014a). The Punjab government also imposed a ban on the interprovincial movement of wheat in 2014 to achieve its wheat procurement target (a repeat of the ban in 2003 and 2004 [Dawn 2004]); the pace of procurement was far below the wheat procurement target of 4 million tonnes set by the provincial government (The Nation 2014b). These bans on food movement resulted in food shortages and price hikes in the wheat-demanding provinces, particularly in the mountains. Gilgit-Baltistan and adjacent mountain regions have suffered severely in terms of food availability and accessibility amidst such restrictions and legal constraints.

Box 9.4 Constraints to cross-border food trade

Food trade between the HKH countries is sometimes constrained by changes in bilateral diplomatic relationships. For example, the movement of food and non-food items from India to Nepal was affected during the last quarter of 2015 due to political unrest and road blockade in the Terai belt, resulting in food and nutrition vulnerability in remote mountain areas as basic food items, medicines, and cooking fuel became unavailable (WSJ 2015). There is some evidence that food movement from Pakistan to Afghanistan is also occasionally affected due to changes in bilateral relationships. In May 2016, the Torkham border between these two countries was shut, resulting in stoppage of trade of food and non-food items (Aljazeera 2016). A regional mechanism is needed to ensure that bilateral diplomatic relationships between countries do not affect the cross-border movement of food items in order to avoid food crises.

9.3.11 Inadequate Access to Improved Drinking Water, Sanitation, and Hygiene

Nutritional status is strongly influenced by access to adequate quantity and quality of water, as well as to sanitation. Water and sanitation are critical for healthy lives, but despite many efforts, access to safe drinking water and sanitation is still limited in the HKH (Table 9.9). Except in Bhutan, a significant portion of the population in the HKH countries depends on unimproved and unsafe water sources. The situation is quite serious in Afghanistan, where 45% of the population still use unsafe water, and in Myanmar, where 19% of the population use unsafe water.

A large part of the population in the HKH is also deprived of improved sanitation facilities (Table 9.9), especially in Afghanistan where more than half of the population have no or unimproved sanitation facilities. Open defecation also remains common in many countries; and is the common practice for 30% of the population in the mountains of India and Nepal and 23% in Pakistan.

Table 9.9 Access to safe drinking water and sanitation

Country/region	Source of drinking water (%)				Sanitation facilities (%)			
	Improved		Unimproved		Improved		Not improved	
	Piped to premises	Other	Surface water	Other	Individual	Shared	Unimproved	Open defecation
Afghanistan	12	43	6	39	32	12	43	13
Bhutan	58	42	0	0	50	28	20	2
Myanmar[a]	8	73	5	14	80	12	4	4
Nepal	24	68	2	6	46	18	4	32
Mountain states India	–	87	–	13	43	2	23	32
Mountain provinces/administrative units Pakistan	37	48	10	5	61	8	7	23

[a]No mountain specific data for Myanmar available; national level data used as a proxy
Source Rasul et al. (2016); MoNPED and MoH (2011); WHO-UNICEF (2015); UNICEF and PBS (2011)

Water and sanitation are linked to human health and nutrition. Inadequate access to safe drinking water and poor hygiene may lead to water-borne and infectious diseases, which can seriously affect food absorption (Pinstrup-Andersen 2009). It is the poor who do not have capacity to invest in water and sanitation, and they suffer the most in relation to water-borne diseases and malnutrition.

9.3.12 Inadequate Recognition of Mountain Specificities in Existing Policies and Programmes

All the HKH countries have been pursuing policies and programmes aimed at achieving food and nutrition security. Although these policies have contributed to increased food production in the plains areas, poor understanding and inadequate recognition of mountain specificities means that they have been less effective in achieving food and nutrition security in the mountains. There is limited investment in research and development on mountain crops particularly on traditional nutritional crops. As a result, their productivity has remained low compared to that of rice and wheat. Research on traditional crop varieties has largely been neglected by both national and international research agencies and traditional crops have been deprived of the development of improved varieties (Padulosi et al. 2012). Moreover, the limited understanding of the different constraints and opportunities faced by mountain communities due to the specific biophysical environment and socio-economic conditions has resulted in a tendency to use a one-size-fit-all approach to plains and mountain areas (Sati 2015; Ghosh and Sharma 2016). Detailed analysis of existing policies and programmes is beyond the scope of this assessment; however, the following provides a brief country-wise overview of some of the most relevant policies and programmes with implications for food and nutrition security in the mountain areas, starting with India which has one of the more extensive systems.

India has the world's largest social security system and has been implementing a number of food safety programmes including providing subsidized food to poor and vulnerable people through a public distribution system and fair price shops. Although the public distribution system has played a great role in improving household food security in the plains, these programmes have had little impact on improving food and nutrition security in mountain areas due, among others, to insufficient infrastructure, high transportation costs, and poor targeting (Dame and Nüsser 2011; Sati 2015; Ghosh and Sharma 2016). The cost of transporting food to remote mountain areas can be prohibitively high, and weak transportation facilities and poor information exchange between mountain communities and administrative centres in the lowlands often hinder the delivery of subsidized food to remote mountain areas (Sati 2015). A recent study in North East India (Mizoram) found that a large number of households were dissatisfied with the way the fair price shops functioned; of 16 fair price shops, only five were functioning regularly (Sati 2015).

Moreover, the focus of the public distribution system is on meeting calorie targets with less attention paid to nutritional diversity. The aim of the National Food Security Act (NFSA) of India is to provide rice and wheat to low income groups (i.e., people below the poverty line). It does not address the issue of nutrition insecurity by providing diverse food items such as pulses and other traditional food grains, or fruit and vegetables (Burchi et al. 2011; Beddington et al. 2012). The NFSA seems to target eradication of hunger but not malnutrition. Providing only wheat and rice at subsidized prices does not address micronutrient deficiency or hidden hunger and can be counterproductive, as farming households often give up cultivation of nutritious NUS such as millet,

barley, and sorghum due to the availability of subsidized wheat and rice, as reported by Dame and Nüsser (2011) in Ladakh. Further, the national food grain sector will have to grow by 3.8% annually to meet the quantity of food grain required under the NFSA, either through increased production or increased imports (Sengupta and Mukhopadhyay 2016). If India chooses to increase domestic production of rice and wheat, land use patterns are likely to change and a significant proportion of the area under cultivation of crops such as pulses, vegetables, fruit, and traditional crops could be allocated to rice and wheat. It is likely that traditional food crops would be most affected. Another important aspect of food and nutrition insecurity in the mountain areas in India is the inefficiency of food grain procurement, transportation, and distribution via the Central Pool by the Food Corporation of India (Likhi 2014). In the past, food grain under the public distribution system failed to reach the targeted beneficiaries owing to the lack of proper identification of recipients and mismanagement of subsidized food grain at various layers of distribution.

At the same time, there are a number of promising institutional innovations taking place in India that aim to stabilize food supplies and ensure food availability during seasonal shortfalls. For example, Uttarakhand is establishing local grain banks to create buffer stocks against seasonal shortfalls; the banks store food at village level and are managed by trained women from the community. Households in need can borrow from the banks during the lean season, paying the cost of interest on the loan, and return the loaned amount after the next harvest. So far, 55 grain banks have been set up in food-insecure villages in the state (Ghosh and Sharma 2016).

India is a large country with great variation in ecology and topography, and the drivers and level of poverty across the plains, mountains, and deserts vary significantly. Hence, a single solution with uniform policy instruments (like the NFSA) may not be suitable for attaining sustainable food and nutrition security across all regions (Pingali et al. 2017; Landy 2017).

In Afghanistan, the Public Nutrition Policy and Strategy (PNPS) 2009–13 set objectives to increase awareness about nutrition, reduce micronutrient deficiencies, improve health care, and ensure that responses to treat or prevent moderate, acute, and/or chronic malnutrition are timely and appropriate (GoA 2009). The PNPS focused on the supplementation of key micronutrients rather than a sustainable solution through balanced diets. The policy draft does not plan to diversify agriculture systems, despite the huge potential for this.

In Bangladesh, the government supports communities in the Chittagong Hill Tracts (CHT) through the Food Ration Programme, providing 30 kg of rice per family per month at a cost of 10 Bangladeshi taka per kg. The National Food Policy (2006) and the National Food Policy Plan of Action (2008–15) do not, however, suggest specific strategies to promote sustainable agriculture or non-agricultural income opportunities in the region. The CHT is endowed with immense biological, cultural, and environmental resources, but the area remains one of the most disadvantaged and vulnerable in the country and lags behind in almost all key development indicators. The food and nutrition security scenario is weaker in the CHT than in the rest of the country; overall agricultural production is low and requires special attention in future policies and programmes (Rasul 2015).

Food and nutritional security is a national priority for the Bhutanese government. Food security in Bhutan has improved over the years due to land and food acts implemented under the government's Vision 2020 and the National and Nutrition Security Policy of Bhutan 2012. Although Bhutan has very limited arable land (8% of total land), subsistence agriculture and crop diversification are very common resulting in greater food security at the household level (Tobgay 2005). Food and nutritional security at national level mostly depends on imports. Future challenges for food security could come from conversion of the limited productive agricultural land into residential land, loss of productivity, increased reliance on imported food, and loss of food diversity in the local food system (Ura and Kinga 2004). Studies have highlighted Bhutan's vulnerability to these in the context of future food security and policy directions (De Janvry and Sadoulet 2008).

Food production, distribution, and marketing systems are relatively better in China. Recently, China announced its National Programme for Food and Nutrition (2014–20) to further improve the food supply, facilitate balanced nutrition, and coordinate food production and consumption. The aim is to improve the overall health of all Chinese people and lay a solid foundation for building China into a moderately prosperous society (GoPRC 2014). However, the policies and programmes do not suggest separate policy steps for mountain areas, nor do they address standards for food and nutrition intake for different groups of people (based on age, occupation, and gender).

In Myanmar, a National Plan of Action for Food and Nutrition was formulated in 1994, but the prevalence of food and nutrition insecurity remains very high, particularly in mountain areas such as northern Rakhine, Chin, Kachin, and Shan. Food deprivation is inherently linked to issues related to land entitlement, poor agricultural roads and other infrastructure, technology transfer, markets, and even storage facilities (Pedersen 2014).

Nepal has a Multi-sector Nutrition Plan (MSNP) 2013–2017, and a Food and Nutrition Security Plan of Action 2016, as well as various nutrition-related programmes, but a substantial proportion of the population remains food and nutrition insecure. The twenty or so agriculture-related policies and programmes have also failed to address the loss of 10–20% of

food grain due to poor handling and lack of proper storage facilities (Bhandari et al. 2015), and virtually no policies or programmes have region-specific (plains, hills, and mountains) measures. Many hill and mountain areas are suitable for the production of nutritionally rich cereals like maize, millet, barley, and sorghum, as well as other high nutrition crops, but as a result of inadequate supporting mechanisms, farmers do not choose to grow them. The mid- and far-western mountain regions are more food insecure than others owing to their remoteness with poor road networks and poorly developed markets. There is no specific provision such as ration cards for the food insecure population (FAO/Nepal 2010). The government provides food grain in the form of food-for-work programmes with support from the World Food Programme (WFP) and other development partners, but this type of assistance has only increased the dependence of people on food aid, which in the long run is detrimental to food security. Food safety nets such as the Nepal Food Cooperation (NFC) supply cereals and pulses to food insecure areas in Nepal, and there are programmes to provide subsidies on fertilizers, seeds, and transportation of agricultural inputs. The private sector is also involved in distribution of agricultural inputs and services. For example, the Nepal Seed Company supplies improved varieties of crop seeds, the Agriculture Inputs Company supplies subsidized chemical fertilizers, and recently, financial institutions have started providing livestock and crop insurance services. Despite many efforts and an overall increase in calorie intake, stunting and underweight have remained high in mountain areas relative to the national average (Rasul et al. 2018). Development interventions have been less effective in many remote districts, and these regional disparities, coupled with social discrimination against women and other marginalized groups, have remained a major challenge to improving food and nutrition security in many hill and mountain areas.

Pakistan has made significant progress in wheat, rice, and livestock production over the years (ASP 2012). The national Food Security Policy has not yet been implemented, but the country has a number of food and nutrition security programmes implemented by various ministries. Programmes like school food, safe motherhood, and child nutrition implemented by the provincial education and health departments with the assistance of WFP, WHO, UNICEF, and UNESCO have been providing assistance to approximately two million households. Pakistan has placed greater emphasis on addressing the supply side of food security, focusing specifically on maintaining wheat self-sufficiency. The government procures wheat from farmers through the Pakistan Agricultural Storage and Services Corporation Ltd. and bears the cost of storage, handling, and other incidentals. The wheat is then resold through government-owned 'utility stores' at a subsidized rate, together with other subsidized food items such as sugar and oil. Highly subsidized wheat and wheat flour are supplied to some mountain areas such as Gilgit-Baltistan. There are two big challenges to food and nutrition security in Pakistan. First, all programmes have focused on selected food items such as wheat, rice, poultry, and sugarcane, in terms of input supply, support prices, and market mechanisms. Second, the production costs of agricultural commodities are very high, which has led to high consumer prices, even with subsidies. The high levels of poverty in vulnerable areas like the mountains mean that people do not have sufficient purchasing power even for subsidized food items, which again leads to higher food and nutrition insecurity (Hussain and Routray 2012).

There is a need in all the HKH countries to address the specific circumstances of mountain regions in the national agenda and establish specific policy instruments for food security in mountain regions that reflect the vulnerability resulting from the specific climatic, environmental, and socioeconomic conditions. Some countries such as Bangladesh, Myanmar, Nepal, and Pakistan are also in the process of implementing national zero hunger initiatives. These initiatives also need a mountain-specific and nutrition sensitive perspective.

9.4 Potentials and Emerging Opportunities in the Mountain Areas

Although there are several challenges to overcome, there is a wide range of opportunities and potentials that could be tapped to achieve sustainable food and nutrition security in the mountains of the HKH. The main possibilities are summarized in Table 9.10 and discussed in more detail in the following sections.

9.4.1 Tapping the Benefits of Local Food Systems

Integrating NUS such as barley, sorghum, millets, buckwheat, pulses, and beans into local food systems will reduce the climatic and economic risks associated with dominant cereals such as wheat, fine rice, and maize, and cash crops. NUS are richer in micronutrients (Table 9.11) and more resilient to climate stresses (Padulosi and Hoeschle-Zeledon 2004). Dominant cereals and cash crops (food and non-food) are often more input intensive and susceptible to crop failure, seasonality, price shocks, and market forces, and can constitute an unadvisable level of risk for poor farmers (Tulachan 2001; Jenny and Egal 2002; ICIMOD 2008). In addition to diversification of food production, the range of food products prepared from NUS could also be increased to make them more inviting and to improve market demand (Adhikari et al. 2017).

Table 9.10 Opportunities and potential for food and nutrition security

Area of opportunity	Potential improvements	Dimensions of food and nutrition security likely to improve
Potential of local food systems	• Improved food production • Improved food production diversity and dietary diversity • Improved farm income	• Food availability • Food utilization • Food accessibility
Potential of local breeds of livestock	• Improved livestock production, conducive to improved food supply and income	• Food availability and accessibility
Potential for vegetables, fruit, nuts, and tea	• Improved production of vegetables, fruit, and nuts • Improved production diversity • Improved farm income	• Food availability • Food utilization • Food accessibility
Potential for efficient use of natural resources	• Improved watershed and springshed management and improved use of water from springs, snowmelt, and glaciers • Improved rangeland management • Improved production of non-timber forest products (NTFPs), conducive to improved income	• Food availability • Food availability • Food accessibility
Non-farm income opportunities: tourism, handicrafts, and others	• Improved income	• Food accessibility
Productive use of remittances	• Improved income and purchasing power for diverse food items • Improved livelihoods • Improved adaptive capacity to climate change	• Food accessibility and utilization • Food availability and health status • Food availability
Prospects for regional connectivity	• Improved food trade	• Food availability

Table 9.11 Nutritional value of neglected and underutilized food crops

Crop	Botanical name	Nutritive value per 100 g							
		kcal	Protein (g)	Dietary fibre (g)	Thiamine (mg)	Riboflavin (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Amaranthus (seed, black)	*Amaranthus cruentus*	356	14.6	7.0	0.0	0.0	181.0	9.3	2.66
Pearl millet	*Pennisetum typhoideum*	348	11.0	11.5	0.3	0.2	27.4	6.4	2.76
Barley	*Hordeum vulgare*	316	10.9	15.6	0.4	0.2	28.6	1.6	1.50
Sorghum	*Sorghum vulgare*	334	10.0	10.2	0.4	0.1	27.6	4.0	1.96
Quinoa	*Chenopodium quinoa*	328	13.1	14.7	0.8	0.2	198.0	7.5	3.31
Little millet	*Panicum miliare*	346	10.1	7.7	0.3	0.1	16.1	1.3	1.82
Foxtail millet	*Setaria italica*	332	8.9	6.4	0.3	0.2	15.3	2.3	1.65
Finger millet	*Eleusine coracana*	321	7.2	11.2	0.4	0.2	364.0	4.6	2.53
Maize (dry)	*Zea mays*	334	8.8	12.2	0.3	0.1	8.9	2.5	2.27
Wheat (whole)	*Triticum aestivum*	322	10.6	11.2	0.5	0.2	39.4	4.0	2.85
Rice (raw, milled)	*Oryza sativa*	356	7.9	2.81	0.05	0.05	7.49	0.65	1.21

(*Source* Longvah et al. 2017)

NUS offer a good option in terms of bringing a balance to local food systems and improving farmers' income provided proper value chains are developed for these crops. In recent years, increased dependence on external food crops and processed snacks and drinks in place of NUS has made mountain people more vulnerable to food and nutrition insecurity. Price shocks in food-producing areas and natural disasters (such as floods and landslides) may result in restricted food supplies and price hikes. Strengthening local food systems by promoting NUS can help improve the stability of local food supplies and reduce dependence on external food items. In some cases, they can also generate income from increased demand in local markets (Fig. 9.10).

Fig. 9.10 Cultivation of millets and local beans in Gatlang VDC, Rasuwa District, Nepal. Households in Gatlang still depend on NUS for both food and income; they sell NUS to local resorts and small hotels in Guljung and Saybrubesi to prepare speciality local food for tourists (*Photo* Bhuwan Thapa)

Marketing of NUS products has improved in recent times. For example, in Nepal, products like oatmeal, buckwheat flour, and millet cakes can now be purchased in major supermarkets. The demand for such products is increasing steadily with increasing consumer awareness. NUS are recently relabelled as 'Future Smart Foods (FSF)' due to their potential for nutrition enhancement, climate change resilience, and diversification of cropping systems. The FAO Regional Office for Asia and the Pacific and its partners have agreed to recognize, identify, nand promote the complementarities of NUS with existing staple crops in local food systems (FAO 2017).

The more than 250 different types of fermented foods linked to the diverse ethnic cultures in the Himalayan region (Tamang 2009) also offer a potentially valuable source for improved nutrition. These naturally fermented foods support nutrition in a variety of ways including bio-preservation of perishable food, bio-enrichment of food to increase nutritional value, and health benefits such as protective and therapeutic properties (Tamang et al. 2012).

9.4.2 Local Breed Livestock

Historically, local breeds of poultry and livestock were, and often still are, a very important source of food for mountain people. For example, in mountain areas such as upper Chitral and Gilgit-Baltistan in Pakistan and upper Rasuwa District in Nepal, yak and chauri (a cross breed of yak and cow) are the main sources of milk and cheese. Similarly, local breeds of goats and sheep are still important sources of food security and livelihoods for many mountain people (Rasul and Hussain 2015). Overall, the population of local breeds of livestock has decreased over time in high elevation areas due to changing priorities for types of livestock as well as climate-induced degradation of rangelands and

grasslands. In particular, the population of yak is in decline in India, Nepal, and particularly Bhutan (Wu et al. 2016). Policies have favoured the introduction of improved breeds in both mountains and plains, but in mountain areas these breeds can prove more vulnerable to extreme weather conditions, disease, and seasons with poor production of grass and fodder. As with crops, local breeds are adapted to the harsh conditions in mountains and are better integrated into the complex mixed farming system that makes the most of mountain resources while increasing resilience against disaster. In high altitude mountains, agricultural practices can be diversified by including traditional food crops and local breed livestock, which can provide multiple livelihoods to smallholder farmers and secure sustainable and diversified food.

9.4.3 High Value Mountain Crops

Mountain areas have a huge potential for growing vegetables, fruit, nuts, and tea. In Pakistan and Nepal, for example, mountain areas contribute substantially to the national production of several fruits and nuts (Fig. 9.11), and in some mountain areas of China, India, Nepal, and Pakistan, the production of vegetables, fruit, and nuts has increased despite the climatic and socioeconomic changes (Hussain et al. 2016). A substantial proportion of households observed an increase in the production of summer vegetables and fruit, especially apples, cherries, apricots, and walnuts in the Upper Indus basin in Pakistan; of summer potato, onion, and vegetables in the Koshi basin in Nepal; of tea in the eastern Brahmaputra basin in India; and of walnuts, tea, garlic, tobacco, and sugarcane in the Salween and Mekong basin in China. The local people attributed this increase to the changing climate, suggesting that climate change could also have some positive impacts on mountain agriculture.

The climatic conditions in mountain areas are conducive for growing high-quality seed potatoes, vegetable seeds, off-season vegetables, and medicinal plants, which is reflected in the relatively high production. There is also a huge potential for beans, cucumber, ladyfinger, onions, peas, spinach, and tomatoes (Rasul and Hussain 2015). Many mountain areas make a significant contribution to the national production of fruit and vegetables, for example mountain and hill regions in Nepal contribute 42% of total national vegetable production (MoAD 2015), but there is still a huge potential for enhancing fruit and vegetable production and increasing local income across the HKH. Overall, the mountain areas of China (e.g., Yunnan Province) perform much better than mountain areas in the other HKH countries (Hussain et al. 2016). But Balochistan, Khyber Pakhtunkhwa, and Gilgit-Baltistan in Pakistan already contribute substantially to the national production of apples, apricots, cherries, figs, grapes, loquats, peaches, pears, persimmons, pomegranates, plums, walnuts, and almonds, even though the potential is not yet fully realized. Pakistan exports several types of fruit and nuts produced in the mountains, including apricots, cherries, figs, plums, sloes, peaches, pine nuts, and walnuts, and this could increase if production increases (Rasul and Hussain 2015). Particularly in India, the mountain states are still underutilized and their contribution to national fruit and vegetable production is limited (GoI 2014b). There is, for example, a huge scope for the production of apple in Kinnaur district of Himachal Pradesh.

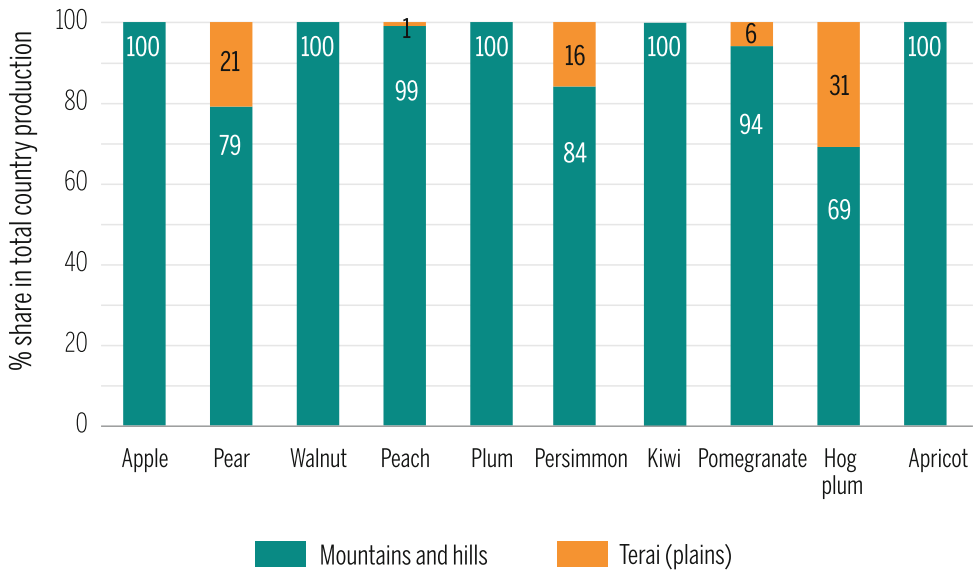

Fig. 9.11 Main fruits grown in the hills and mountains of Nepal (*Source* MoAD 2015)

9.4.4 Sustainable Use of Natural Resources

Mountain areas are rich in natural resources, such as water, forests, rangelands and pasture, biodiversity, and valuable minerals. Sustainable mountain food security cannot be achieved unless the productive resources and the natural environment are conserved and access and optimal utilization ensured.

Rangelands are a very important natural resource for livestock production and food security in high elevation mountain areas, particularly for pastoral communities (Hussain et al. 2016). The substantial rangelands in the mountains of Pakistan, for example, are vital to livestock grazing, one of the main sources of food and income for mountain communities (Table 9.12). Rangelands are the main free-grazing areas for livestock in general and small ruminants (goats and sheep) in particular. In addition, they also provide environmental services such as carbon sequestration, watershed management, biodiversity, and ecotourism (Mirza et al. 2006). However, climate-induced changes in precipitation, combined with overgrazing, are leading to degradation of vegetation cover, deterioration of soil, and lowered productivity for the rangelands themselves and the livestock that feed on them. Corrective actions to conserve and enhance the productivity, sustainability, and ecological health of the rangeland ecosystem would significantly improve food security in the high mountains (Afzal et al. 2008).

Forests are a direct source of food for people in some areas, especially where access to market centres is limited. For example, the tribal communities in Meghalaya and Manipur states in India eat several edible plants and fruits from the forest (Sawian et al. 2007; Gangte et al. 2013). Non-timber forest products (NTFPs) can also play a vital role in food security and livelihoods. The mountains of the HKH are endowed with NTFPs, such as medicinal and aromatic plants and honeybee products. Some mountain plants (e.g., seabuckthorn, wild thyme, black cumin, chamomile, and stevia) and minerals (e.g., salajeet) are widely used for medical purposes across the HKH (Rasul et al. 2014). In the high elevation Skardu valley in Pakistan, 70% of the flora and animal products used for medicinal purposes were from wild species, and 70–80% of local people depended at least to some extent on traditional medicines, using plants to cure common ailments (Bano et al. 2014). Women, especially, can play a pivotal role in preserving unique species of medicinal and other plants if properly trained.

In the HKH, the collection, processing, and marketing of NTFPs suffers from a variety of problems and the problems of poor harvesting practices, poor storage, poor access to market, and over exploitation will need to be addressed in order to tap the full potential of NTFPs and enable mountain communities to reap adequate benefits (Rasul et al. 2008). According to the World Health Organization, the global market for herbal products is over USD 60 billion (Nirali and Shankar 2015). Although a significant portion of the supply of raw materials for these herbal products originates in the HKH, much of the benefit accrues to people and places far away. There is a great potential to generate more income locally by supporting mountain people to develop new livelihood options and derive greater benefits from high value products.

Mountains are also rich in water resources, such as springs, streams, snow cover, and glaciers. These resources are generally underutilized, and there is a vast scope to manage them better to support diversification of agricultural production. For example, construction of micro-irrigation systems for glacial meltwater could provide considerable support for agricultural diversification in Hunza and Nagar (Pakistan). However, meltwater irrigation systems have

Table 9.12 Non-crop options for mountain food and nutrition security in Pakistan

			Mountains					Plains
			Balochistan	FATA	KPK	AJK	GB	Punjab and Sindh
Livestock	Livestock heads per capita		3.7	1.8	1.0	0.9	1.1	0.8
	Livestock units (LUs) per capita[a]		0.6	0.4	0.3	0.2	0.2	0.3
	Sheep and goats	Population ('000)	24,589	4,784	12,962	1,577	1,565	42,723
		Animals per capita	3.2	1.3	0.6	0.5	0.9	0.4
Rangelands	Proportion of rangelands in total geographical area (%)		78.9	48.3		45.1	53.9	46
Forest	Proportion of forest in total geographical area (%)		4.1	13.1		11.6	9.2	4.4
	% share in total revenue generated from forest products		1.9	34.6		13.8	0.1	49.6

(*Source* Rasul and Hussain 2015)

[a]Method for estimating LUs adapted from FAO (2005)

unique characteristics that distinguish them from other types of irrigation system and must be managed with care. Parveen et al. (2015) described a very heterogeneous and unstable situation in Hunza where communities must constantly adapt to drying of channels due to down-wasting, shifting glacier tongues, and sudden changes in flow patterns. Meltwater can also be used for trout fish farming in high mountain areas. Springs and streams are a potential source of irrigation water in various mountain districts of Nepal and India. The most appropriate type of small-scale irrigation system varies across mountain ranges. Piped irrigation systems suit mountain ranges that are steeper and more vulnerable to landslides, while open channel systems suit less steep areas with less chance of landslides. In dry mountain ranges such as Gilgit in Pakistan, Mustang in Nepal, and the western part of Himachal Pradesh in India, solar-powered irrigation pumps may also be used to pump water from streams and springs to upland agricultural fields.

9.4.5 Non-farm Income Opportunities: Tourism, Handicrafts, and Others

It is difficult for mountain regions to become food self-sufficient due to the biophysical constraints (Rasul et al. 2014). To achieve food and nutrition security, it is critical to increase the income of farmers so that adequate food can be purchased in accessible areas. Mountain areas have a huge potential for non-agricultural activities. In areas with low agro-ecological potential, in particular, non-farm income opportunities can be promoted to help secure income and improve purchasing power. Tourism is one of the most viable industries in the HKH, although its full potential has not yet been explored due to lack of know-how, as reflected in the national policy agendas of governments in the region. Other industries may grow together with the development of tourism, especially hotel and restaurant businesses. Tourism can contribute significantly to the local economy if hotels and restaurants promote and offer menus prepared from local NUS, vegetables, fruit, and nuts (Adhikari et al. 2017). Without proper planning, tourism can negatively affect the local economy and food systems, due to the excessive inflow of instant and highly processed food items. But it also offers many opportunities, with a huge potential for handicraft and souvenir cottage industries (embroidery, wood carvings, shawls, blankets, carpets, baskets, gemstones, and many others) if integrated in tourism planning (Rasul and Hussain 2015).

9.4.6 Productive Use of Remittances

Increased out-migration is adding some challenges to mountain agriculture by creating labour shortages and increasing the workload on women (Hussain et al. 2016). However, it also brings new opportunities in the form of higher remittances. There is a huge potential to capitalize on the remittances through effective investment in small and medium local non-farm enterprises, agricultural development (for example, irrigation systems, improved seed and inputs, plantation of fruit trees, fish farming, and medicinal and aromatic plants), and food processing. Such efforts will also generate income opportunities for local youth, which in turn may lower the rate of future out-migration and strengthen food security. A study conducted in the high mountain region of Gojal, Gilgit-Baltistan of Pakistan showed that out-migration and remittances had a positive impact on modernization of farming, improving livelihoods, and achieving sustainable development in the mountains (Benz 2016).

9.4.7 Improving Food Transportation Through Regional Connectivity

Regional connectivity plays an important role in cross-border trade and food transportation and food security. Cross-border trade and transportation facilities can influence food transportation costs and food prices (Pyakuryal et al. 2010). In Nepal, the internal transportation cost of food in the mountain region is seven to eight times higher than that in the plains areas (Pyakuryal et al. 2010). There can also be marked price differences in food across borders in mountain areas. For example, a recent study by Agarwal et al. (2017) found that the price of various vegetables in Agartala in Tripura, a hill state in India, was more than double that across the border in Brahmanbaria, Bangladesh, as a result of inadequate cross-border trade facilities (Agarwal et al. 2017). There are a number of opportunities for localized cross-border trade between mountain communities (Box 9.5).

Box 9.5 Localized cross-border trade

In general, trade between countries is driven by competitiveness, comparative advantage and differences in technology, economies of scale or preferences, natural resources, climatic conditions, and in some circumstances strategic trade policies (Nanda 2012). In mountain areas, the physical isolation of communities due to remoteness and limited accessibility is also a key determinant of localized cross-border trade. Mountain areas, although divided by political borders, are often logistically better connected to each other than to downstream cities in their own countries. Accessibility to main cities is further reduced in winter and following damage caused to

infrastructure by landslides, floods, avalanches, and others. Localized cross-border trade could contribute substantially to food and nutrition security, particularly in stressful times, but the exchange of agriculture and livestock goods needs to be facilitated, and if necessary legalized, through formal mechanisms.

People living in the high elevation areas of Rasuwa District in Nepal, for example, may have easier access to Tibet Autonomous Region (TAR) in China for exchange of goods and services than to market centres in Rasuwa such as Syabrubesi and Dhunche. Farmers in the high areas of Rasuwa grow traditional food crops such as barley, millet, and beans, and raise livestock such as goats, sheep, yak and chauri and could either sell or exchange these products for other food products with people in Tibet if cross-border arrangements were in place. This localized trade could reduce the vulnerability of local communities on both sides of the border and help improve food and nutrition security. Similar areas can be identified along the borders of Nepal and India, Pakistan and China, and other HKH countries.

There is also a potential for more distant cross-border trade. A number of fruits, vegetables, handicrafts, and other products from mountain regions of the HKH are quite popular across the world. If incentives for trade liberalization and market competitiveness can maintained through appropriate regulation, and proper value chains established that ensure that an appropriate part of the benefits of products accrue to the producers, then the livelihood patterns of mountain people can be improved. For example, cherries grown in Gilgit (Pakistan) are being exported to the Middle East through the establishment of a well-connected and regulated supply chain. Similarly, there is high potential for creating supply chains for other perishable and non-perishable commodities to a whole range of different markets in Europe, America, the Middle East, and others.

9.5 Sustainable Food and Nutrition Security in the Mountains: Towards a Strategic Approach

Food and nutrition security remains a major challenge in the HKH region. The problem is more severe in remote mountain areas, where agro-ecological potential is low, accessibility is poor, and market infrastructure is weak and fragile. The majority of people live in remote rural areas and depend heavily on agriculture for food and nutrition, but mountain agriculture is highly vulnerable to climate change as a result of erratic rainfall with increased floods and increased dry spells, changing temperatures and seasons, and higher incidence of pests and disease. Rapid socioeconomic and environmental changes, including increased out-migration, shortage of labour, limited mechanization, changing food habits, decline of traditional nutritious crops, and depletion of natural resources, are intensifying the challenge of achieving food and nutrition security.

Challenges to food security in the mountains of the HKH differ from those in the plains as a result of the constraints imposed by harsh biophysical conditions, inaccessibility, fragility, seasonal incomes, low economic opportunities, and poor access to markets and other institutional services. The HKH region needs special attention and mountain-specific approaches to address the issues of food and nutrition insecurity. Achieving food security and addressing malnutrition are fundamental to meeting the SDG-2 goals as well as to achieving the goals of other SDGs, including ending poverty and improving human well-being.

Sustainable food and nutrition security cannot be achieved in the mountains without implementing a holistic approach that works to cope with the challenges specific to the region, while simultaneously realizing its potentials and opportunities. The HKH region needs a balanced strategy between food self-sufficiency and market dependence that not only encompasses a focus on enhancing production and increasing household incomes, but also targets the improvement of rural infrastructure for market access and food transportation. Such a balanced strategy is laid out below.

9.5.1 Location-Specific Approach

The type and level of challenges and opportunities vary across the mountain areas in the HKH due to differences in the ecological and environmental conditions and in access to institutional services. Given the heterogeneity and diversity, formulating strategies for food and nutrition security requires developing a location-specific approach, that takes the ecological and environmental conditions into account and considers access to markets, information, and other institutional services. The mountain areas of the HKH can be divided hypothetically into four classes in terms of agro-ecological potential and access to markets, information, and institutional services; area-specific strategies for these classes are presented in Table 9.13.

In **areas with high agro-ecological potential and good access to markets and services,** the focus should be on exploiting existing potential as much as possible through land-use intensification, efficient water use, improved adaptations to climate change, crop diversification, development of commercial dairies, and growing of cash crops that offer higher incomes. Private investment in production and post-harvest facilities should be encouraged. In **areas with**

Table 9.13 Area-specific approaches based on agro-ecological potential and access to markets, information, and institutional services

Agro-ecological potential and suitability	Access to markets, information, and institutional services	
	Good	Poor
High	**Areas with high potential and good access to markets and services** • Promote intensive food production (where possible multiple cropping), horticulture, and commercial dairy and poultry farming • Enhance support for high value cash crops, e.g., fruit, nuts, tea, and vegetables • Integrate traditional food crops, e.g., millets, barley, beans, local maize, in cropping systems, particularly in areas above 2000 masl • Promote resilient crop varieties and adaptation measures in areas with higher climate change impacts • Establish fruit processing and storage facilities • Encourage private investment in irrigation, fish farming, renewable energy, land management, storage, and the agro-processing industry through institutional support • Improve supply of inputs, credit, insurance facilities, and environmentally-friendly machinery (e.g., solar powered pumps) for agriculture • Encourage spring water management in hills and low mountains, and snowmelt/glacial melt water management in high mountain ranges • Provide incentives for overseas workers to invest remittances in small and medium agribusiness in mountain areas • Encourage women as entrepreneurs/managers in agriculture business	**Areas with high potential but poor access to markets and services** • Improve marketing, storage and transport facilities, information systems, and extension and credit services for fresh fruit, nuts, dried fruit, vegetables, and livestock products • Strengthen local food systems with a focus on NUS • Extend institutional support to promote traditional food crops and support value chain development • Improve transportation facilities, ICT access, and others • Promote high-value non-perishable agricultural products such as pulses, medicinal plants, and honey • Develop infrastructure to enable utilization of the mountains' high agro-ecological potential • Promote livestock and livestock products and by-products • Improve credit, extension, and insurance facilities for livestock
Low	**Areas with low potential but good access to markets and services** • Promote local products such as crafts (e.g., woodcarving, shawls, carpets, caps) and services for markets • Promote conservation technologies that enhance agricultural potential and utilize local niches and provide incentives for conservation • Encourage agroforestry, tree farming for timber and NTFPs, and medicinal plants • Develop local off-farm employment opportunities to reduce outmigration • Encourage local breeds of livestock such as yak, goats, and sheep (mainly pastoralism) in high mountain ranges (>2500 masl)	**Areas with low potential and poor access to markets and services** • Provide incentives for conservation and sustainable use of resources and develop mechanisms for payments for ecosystem services • Establish institutional mechanisms to supply subsidized food items • Encourage non-farm activities, e.g., tourist guides, resorts, hotels, and handicrafts • Promote subsistence agriculture with zero-tillage, mixed cropping, and livestock production • Promote ecotourism and recreation • Develop and harness environmental services

Adapted from Rasul et al. (2014)

high agro-ecological potential but poor access to markets and services, the focus should be on removing marketing constraints and developing infrastructure and institutional support to help exploit existing potential both optimally and sustainably. **In areas with low agro-ecological potential but good access to markets and services,** strategies should focus on better use of existing facilities to promote local breed livestock and non-farm activities, and provision of economic incentives and appropriate regulations to support sustainable use and management of resources. In **areas with low agro-ecological potential and poor access to markets and services,** subsistence use of resources and facilitation of out-migration should be targeted to reduce dependence on local resources and ensure food security. Agricultural extension services and incentive mechanisms need to be structured accordingly in the different areas.

9.5.2 Developing Local Food Systems

A few general recommendations can be made in addition to the area-specific approaches suggested above which may apply to all four classes of mountain area. The first is to strengthen local food systems, which is very important for improving the diversity and quantity of local food production and reducing the dependence on food from outside the

region. It may not be possible to achieve complete food self-sufficiency in mountain areas due to land and environmental constraints, but revitalizing the local food systems will reduce the dependence on external food supplies. Emphasis should be placed on nutrition-rich traditional crops (NUS) and hygienic processing of value-added products. Steps should be taken to enhance nutritional knowledge about NUS among both farmers and consumers, to build farmers' capacity for NUS production and value addition, and to establish community seed banks. Formal guidelines could also be given to local hotels and resorts in tourist areas to help them include food items prepared from traditional food crops in their menus. This will enhance the demand for traditional food products and augment income for NUS farmers. Efforts are also needed to promote organic agriculture and establish a participatory guarantee system to support marketing of organic products, and to strengthen support for livestock production. Technical assistance and institutional support need to be strengthened to increase livestock productivity and improve rangeland management in order to improve the food security of livestock-dependent communities. Bio-fortification of selected cereal crops could be considered to meet micronutrient needs, where appropriate.

9.5.3 Strengthening the Agricultural Marketing System and Infrastructure

Local infrastructure and the agricultural marketing system need to be strengthened to reduce crop loss and vulnerability to food insecurity. Approaches include the use of ICTs such as mobile telephones, local FM radio, e-information systems, and other mechanisms to improve farmers' access to market information, and improving processing, storage, and distribution systems to reduce post-harvest food losses (also linked to SDG 12). Local food storage facilities such as community food banks could be established to avoid seasonal food shortfall in high elevation areas where snowfall or hazards can result in physical isolation. Export competitiveness needs to be enhanced through strengthening of technical support and making financial assistance available to improve the production of organic products, and processing, packaging, and marketing. Special incentives and support might be given to transporting high value perishable products that are in high demand in export markets. Attention needs to be paid to establishing a mechanism for cross-border food trade and internal movement of food products to facilitate food trade across borders. It is also necessary to formalize cross-border localized trade/food exchange between border communities with limited access to market centres in their respective countries, particularly during the winter and monsoon seasons and after natural disasters.

9.5.4 Managing Water Resources and Other Ecosystem Services

Forests, rangelands, and water resources are an integral part of the livelihood and food security of mountain people. They provide food, wood, fodder, fuel, medicine, water, and many more goods and services. Mountain watersheds need to be properly managed in order to cope with climate-induced water stresses and ensure the continued flow of water and other ecosystem services to downstream areas. Wherever possible, hill irrigation systems could be developed in the mountains to capitalize on the potential of water from springs, snowmelt, and glaciers. In addition, appropriate incentive mechanisms, such as payments for ecosystem services and access to benefit sharing of genetic resources, need to be developed to encourage mountain communities to use and manage the genetic resources and watersheds sustainably. As we have argued elsewhere (Rasul 2010, 2014), mountain communities also deserve special attention and some compensation for the ecosystem services they provide to downstream through water and ecological services, and their effects on food production in the plains. Efforts need to be made to engage communities in natural resource management, including water, irrigation, forests, and rangelands.

9.5.5 Promoting Rural Non-farm Economic Opportunities

Rural non-farm economic opportunities, such as wage-earning activities, self-employment in commerce, manufacturing, and small businesses involving handicrafts, tourism, and services, are an important source of income for farmers and rural mountain households. Rural non-farm income can be an important part of household income and helps to secure nutrition status as it allows greater access to food. This income may also help to slow rapid or excessive urbanization as well as degradation of natural resources through overexploitation. All possible non-farm income opportunities should be encouraged and supported through institutional mechanisms, including capacity building and vocational training. Efforts could be made to involve local government institutions and the private sector to improve the productive use of remittances as investment in local areas, which can generate further income opportunities and contribute to food security.

9.5.6 Strengthening Knowledge on Nutrition, Child Care, and Food Preparation

Improved knowledge of general health, child care, maternal health, improved drinking water, sanitation and hygiene,

food safety, and food preparation can help to improve the nutritional status of mountain people. It would be beneficial to establish a large-scale training programme for women in the preparation of nutritious diets and to promote ethnic Himalayan fermented food. Food and water can carry infectious agents; thus, increasing knowledge about them and improving practices for the safe handling, storage, and cooking of food is also important to reduce risk of food and waterborne diseases. Nutrition education should be included in the curriculum in primary and secondary schools, and special efforts should to be made to empower women, as their knowledge and position in decision-making will improve the nutrition status of children and families.

9.5.7 Strengthening Social Safety Nets for Remote Mountain Areas and Poor and Vulnerable Groups

At present, social safety net program includes mostly rice and wheat commodities. Pulses, millets, and other NUS could be introduced into public (food) distribution systems to improve the nutritional quality of the food provided. Introduction of a minimum support price for nutrition rich mountain crops need to be considered.

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