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Innovation as an Expression of Adaptive Capacity to Change in Himalayan Farming

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Recent studies of future food production in South Asia generally agree that the conditions for production will radically change in the years to come, in particular due to climate change and market variations.

However, because we do not know how conditions will be modified and what adaptations will be required by farmers, the article assumes that innovative farming systems will cope best with changes, whatever those changes turn out to be. The challenge, then, is to identify circumstances that either promote or hamper innovation.

A comparative analysis of 2 farming communities in the Himalayas concludes that no single parameter can explain the observed variation of agricultural innovation. Rather than restricting analyses to “innovation systems” that consist of social institutions only, the article proposes an approach that includes social actors, as well as natural resources, in processes that produce “innovative places.” In this study, water availability, farm size, and an active national nongovernmental organization are parameters that encourage innovation.

Keywords: Innovative place; innovation system; agriculture; adaptive capacity; uncertainty; India; Nepal.

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Introduction

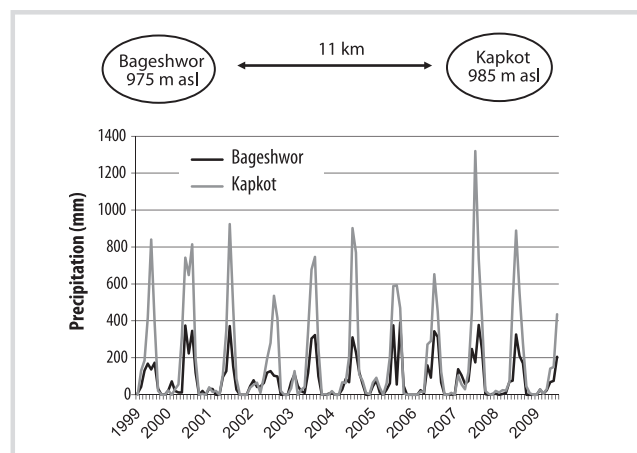
Himalayan farmers, who have always had to cope with the capriciousness of nature, are accustomed to working under uncertain production conditions. However, the degree of uncertainty has increased lately and will most likely continue to increase. Because farmers are now more deeply integrated than their subsistence ancestors in the national economy, they are exposed to market variations on the input side, as well as on the output side. Prices for input factors such as chemical fertilizers and pesticides are closely tied to world market petroleum prices. In addition, remote mountain villages suffer from irregular supplies of such goods (Mittal and Sethi 2011). On the output side, prices for natural resources fluctuate more than other commodity prices, and they are at greater risk of being replaced by cheaper substitutes (Handmer et al 2001).

Climate change constitutes another uncertainty. Even if climate scenarios are becoming ever more exact and convincing, the weather in local places where farming is carried out remains uncertain. In the UK, the Department for Environment, Food and Rural Affairs (DEFRA) refers to “an inevitable level of uncertainty that is inherent in discussion of climate change adaptation” (DEFRA 2010: 7). This uncertainty is even more pronounced in a hilly topography such as the Himalayan foothills, where local variations in temperature and precipitation are dramatic.

Temperature correlates inversely with elevation, and precipitation is largely determined by location relative to mountains. This is illustrated in Figure 1, where 2 meteorological stations at similar elevations and only 11 km apart display substantial differences in volume of monthly precipitation despite similar patterns. Downscaled regional climate models will thus inevitably be approximate and probably dubious.

In line with those who “suspect that environmental and cultural change, far beyond the reach of restoration, is occurring” (Crate and Nuttall 2009: 10), we assume that climate change and variable markets imply radical transformations of the conditions for agricultural production. As a result, agriculturalists have to change their practices. To maintain or preferably increase productivity, farmers have to introduce new crop varieties, try out new farming techniques, and market their products in new ways. The farmers who are best able to adopt such novelties are those who will most successfully cope with changing production conditions. In other words, a farmer’s adaptation to change will largely be conditioned by the farming household’s innovative capacity. The term *innovative capacity* in this article is defined as the capability of production units (ie farm households) to “master and implement the design and production of goods and services that are new to them, irrespective of whether they are new to their competitors, their country, or the world” (Mytelka 2000; cited in World

FIGURE 1 Precipitation (in millimeters) at 2 meteorological stations in District Bageshwar, Uttarakhand State, India. (Source: District Irrigation Department, Bageshwar)



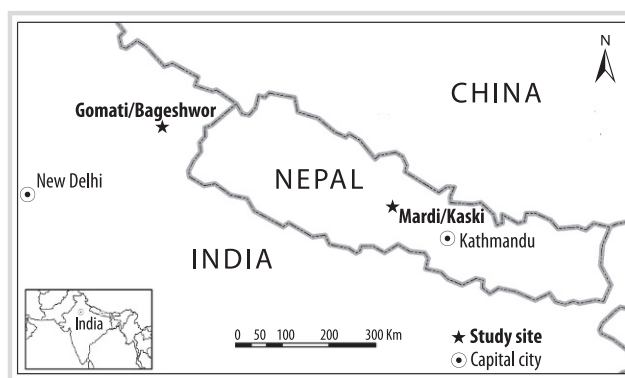
Bank 2006: ix). We thus assume that innovation expresses the capacity to adapt to change.

Current innovation studies agree that innovation is not a result of independent decision-making on the part of the production unit. Rather, innovation must be seen as the joint outcome of interaction among individual decision-makers, social and cultural context, institutional and organizational framework, regulatory systems, infrastructures, and so on (Mytelka and Smith 2001). Together, such interacting individuals, organizations, and institutions make up an “innovation system.” Inspired by management sciences, where the notion of an innovation system is well established, the World Bank advocates the application of a similar approach to the study of agriculture (World Bank 2006).

We aim to follow the recommendation of the World Bank in this article. We studied 2 farming communities in the Himalayan foothills, 1 in India and 1 in Nepal, analyzing which innovative capacities are inherent within the local farming systems. The objective of this endeavor was twofold. First, we hoped to document some local variation in the region and thereby demonstrate the futility of construing present innovative capacity in general terms (although the local variation should not prevent us from searching for circumstances or parameters that promote or constrain innovation in general). Second, we aimed to identify circumstances that affect innovation and thereby adaptive capacity to change.

The following paragraphs provide a comparison of 2 farming communities: 1 in which a great deal of change and innovation is taking place and 1 characterized by skepticism to new crops and modern methods in agriculture. The innovative community is located in Nepal, and the more static one is in Uttarakhand State in India, but it must be underlined that the communities are not representative of the 2 countries. There are innovative rural areas in Uttarakhand and more

FIGURE 2 Location of study villages. (Map by Prem Sagar Chapagain)



conservative ones in Nepal. The twofold intention of the comparison is, as stated previously, to document variation and to identify circumstances that are favorable to innovation.

Data and methods

The study is based on fieldwork carried out by the authors in 2 villages from October 2009 to February 2010. Several methods were used to produce data. First, direct observation of land use and farming activities were discussed with farmers in situ. Second, the authors participated in discussions among farmers about alternative farming strategies and changing production conditions. Third, a survey was carried out among a “purposive” sample of 50 farmer households in each village ($n = 100$) regarding various forms of capital, demographic structure, economic pursuits, and perceptions of bottlenecks in local production. In contrast to statistically random samples, a purposive sample aims at maximizing variation—that is, including all possible kinds of units (Gobo 2004). Thus, rich and poor households, upper and low castes, valley-bottom farms and farms located on the slopes, and large and small landholdings were included in the sample. Lastly, public statistics were obtained on precipitation (District Irrigation Department, Bageshwar; Department of Hydrology and Meteorology, Nepal) and population (Central Bureau of Statistics, Nepal; Central Statistics Office, India).

The study villages

The Indian village is located in Block and District Bageshwar, Uttarakhand State, and the Nepali community is situated in Kaski District in the Western Region (Figure 2). For simplicity, we named the 2 villages after the rivers that drain the catchments: Gomati/India and Mardi/Nepal. The 2010 population in Gomati/India (*panchayat*) was 1555, while 4211 people resided in Mardi/Nepal (Village Development Committee) in 2011.

TABLE 1 Similarities between study villages.

Gomati/India	Mardi/Nepal
• Agroforestry	• Agroforestry
• 1000–1400 masl	• 1000–1200 masl
• 1 hour to urban market	• 1.5 hours to urban market
• Labor migration	• Labor migration
• Hindu	• Hindu and Buddhist
• Caste society	• Caste society

There are many similarities between the 2 villages. They are situated in the same ecozone at identical elevations (1000–1400 masl) where cultivators practice the traditional agroforestry farming system common throughout the Himalayan foothills (Schmidt-Vogt 2000; Tiwari and Joshi 2011). Agroforestry implies a combination of cultivation and animal husbandry. Paddy (summer), wheat (winter), potato, maize, and a host of pulses and vegetables are grown on irrigated and rain-fed terraces on the hillsides and on flat land in the valley bottom. Livestock are mostly kept for milk, wool, and plowing. Organic manure from livestock is vital for restoration of soil fertility after harvest. Wild grass and foliage are collected daily from nearby forests by women, and the forest supplies bedding for animals, firewood, and plants for eating and medicinal purposes. Cultivated fields and forests are integral to the agroforestry system, tied together by domesticated animals. Without manure, the fields cannot sustain fertility; without forest, the necessary number of animals cannot be kept. On average, 9 biomass units from the forest are necessary to produce 1 unit of food in agriculture (Singh et al 1984).

Both villages are situated 1–1.5 hours from regional market towns, where cash crops are sold and inputs can be obtained (Table 1). Labor markets in Indian cities and in the Gulf States are equally accessible, and migration is substantial in both communities. The population of Gomati/India are all Hindus, with upper-caste Rajputs as the dominant farmer caste (74% of the sample), followed by low-caste Dalits (20%). Mardi/Nepal is more mixed. Upper castes (Hindu Bahun and Chhetri) are most numerous here as well (56%), but a substantial group of middle-caste Buddhist Gurungs has resided in the village for centuries (22%). The population of Dalits is similar to that of the Indian village (18%).

Despite these similarities, there is a remarkable difference in the degree of socioeconomic change in the 2 villages.

Dynamic Mardi/Nepal

Radical social changes have taken place in Mardi/Nepal during the last 30 years, whereby the Gurungs have substituted high-caste Brahmins as the dominant

TABLE 2 Indicators of enterprising farming communities.^{a)}

Indicators	Gomati /India	Mardi /Nepal
New crops sown in past 10 years	14	100
Heir ready to take over farm	0	60

^{a)}% of interviewed households; $n = 100$.

landowner caste (Adhikari and Bohle 1999). Significant developments are also taking place within agriculture. Farmers are experimenting with a number of new crops. Bananas, coffee, tea, new tree species, and a variety of vegetables, pulses, and fruits are being tried in numerous plots and in greenhouses. In addition to such individually managed innovations, 2 major enterprises have been established during the last 10 years. One is a tea factory built and operated by local Gurungs, which receives raw materials from farmers who have converted terraces previously used for cereals into tea gardens. The other novelty is organized milk collection for sale in town. A private dairy in nearby Pokhara town has supplied a cold storage tank in the village where farmers deliver their milk daily. Every 3 days, a car comes from Pokhara to collect the milk and pay the farmers, who organize the accounting themselves. This arrangement has so far provided an incentive to 16 farmers who have bought high-yielding hybrid milk cows from India.

Static Gomati/India

Gomati/India has not seen much agricultural change over the past decades. Rajput farmers mostly practice the agroforestry system in the way of their forefathers. Some chemical fertilizer is supplied to paddy and wheat, but farmers use as little as possible because, they say, it degrades soil structure. The only new farming items in the village are 2 small greenhouses. This is quite significant, because the plastic covers are supplied free of charge by the Agriculture Department in nearby Bageshwar town. The only cost for the farmer is to collect bamboo sticks for the frame. Farmers expressed skepticism toward “artificial” agriculture; no plastic should come between the plants and the sun, they said. Instead of trying new crops and techniques, male farmers grumbled over water scarcity and corrupt government officials, leaving agricultural tasks in the hands of women while they preferred wage labor in town or joining the Indian army.

Gomati/India farmers stand in stark contrast to the enterprising farmers of Mardi/Nepal. Three indicators of enterprising communities are listed in Table 2.

New crops may serve as an indicator of innovativeness at an individual farm level, while the existence of a potential heir expresses the aspirations of the next generation. All farmers in Mardi/Nepal have planted some new crops during the last 10 years, while only 14% have done so in the Gomati/India sample. Furthermore, none

TABLE 3 Farmers' perceived production bottlenecks.^{a)}

Bottleneck	Gomati /India	Mardi /Nepal
More water	98	38
More manure	—	30
More labor	2	14
Better seeds	—	10
Better extension service	—	6
More chemical fertilizer	—	2

^{a)}% of interviewed households; *n* = 100.

of the households interviewed in Gomati/India had sons who wanted to take over the farm; the younger generation obviously saw no future in farming there. Private agriculturally based enterprises like the Mardi/Nepal tea factory and milk tank are absent in Gomati/India.

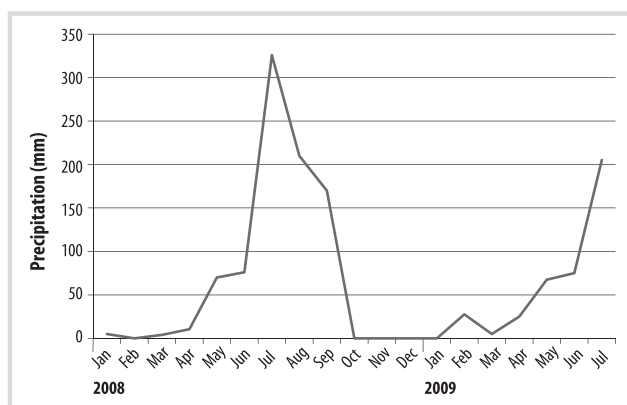
In sum, Mardi/Nepal emerges as an innovative, dynamic farming community when compared to the conservative Gomati/India. If innovativeness is a quality that favors adaptation to change, the future of farming looks far brighter in Mardi/Nepal than in Gomati/India. How can the disparity between the communities be explained?

Dissimilar production conditions

It has been argued that Buddhists are more innovative in business than Hindus due to 2 cultural characteristics (von Haimendorf 1975). While Hindus live in extended families and have to obey decisions made by an aging and conservative patriarch, young Buddhists establish nuclear families and are free to enter into whatever business they find profitable. Also, gender relations are more relaxed among Buddhists, implying that women can take over most agricultural chores while the men tend to business outside the village. Thus, it could be hypothesized that the presence of Buddhist Gurungs explains the higher degree of innovations in Mardi/Nepal.

However, this explanation is not supported by our data. The average household size is 6.30 and 6.32 in Mardi/Nepal and Gomati/India, respectively, while the average size among Gurungs is 9.18. It is Gurungs rather than Hindus who live in extended families, contrary to the contention of von Haimendorf. In both communities, women can carry out most agricultural tasks except plowing, which is the exclusive domain of men. A cultural explanation of the different innovation intensity in the 2 villages must thus be refuted.

Let us turn to the farmers' own explanations of agricultural productivity. When questioned as to what is most needed to produce more crops on the farm, salient differences emerge between the 2 villages (Table 3). Water

FIGURE 3 Monthly variation in precipitation 2008–2009, Bageshwar. (Source: District Irrigation Department, Bageshwar)

is reported to be the most significant bottleneck, restricting productivity in both villages. Water scarcity dominates in Gomati/India, while Mardi/Nepal farmers are more nuanced in their perception of restrictions, also listing manure and labor as significant. These factors restrict productivity, according to farmers' perceptions; can they also explain the different degree of innovation?

Water

Water is a problem in Gomati/India. All farmers interviewed there, except 1, reported water to be the most serious bottleneck in terms of productivity. The average annual precipitation in Gomati/India is 1350 mm, most of it falling during the monsoon season from June to October. Autumn is a particularly critical time in agriculture. If sufficient precipitation does not fall from October to November, the sowing of winter wheat is disastrous, as exemplified in 2008 (Figure 3).

During times of scarce precipitation, farmers have to supply water by artificial irrigation. The case village does not take much water from the main Gomati River due to public restrictions; most irrigation water is diverted from a creek that crosses the village lands. However, of late, villagers have complained of hotter summers and less water. The irrigated land receives 20% less water now than 10 years ago, they maintain. The water scarcity becomes evident during the sowing of winter wheat from late October to early November. Then, only fields on the lower parts of the slope, where evaporation is highest due to sun exposure, are allowed to be irrigated. All other farmers must sow their wheat while hoping and praying for rain to come. When asked why they do not adapt to water scarcity by expanding their acreage under barley, which requires less water than wheat, farmers referred to dietary preferences, because cereals are grown for subsistence purposes only. Rice is mostly broadcast due to water scarcity that gives lower yields than transplanted paddy.

Nepali farmers in Mardi/Nepal are blessed with triple the precipitation of Gomati/India; the annual average

from 2003 to 2007 was 4221 mm. Mardi/Nepal may also suffer from occasional scarcity of rain, but the slopes are rich in creeks from which irrigation water is diverted to farmland. Most villagers are content with that. Those who complain about too little water are located upslope, where creeks run in deep gorges. There are also some problems in diverting water from the main Mardi River to fields in the flat valley bottom during winter, but that is caused by lack of labor to repair canal intakes after monsoon floods. In Mardi/Nepal, sufficient water is available throughout the year.

Manure

Gomati/India farmers do not complain about lack of manure, although Mardi/Nepal farmers do. In both villages, farmers prefer organic manure to chemical fertilizer. Once chemical fertilizer has been applied to a field, the soil becomes “addicted” to it, in farmers’ terminology. Even so, 92% of Gomati/India farmers and 50% of Mardi/Nepal farmers use some chemical fertilizer, mostly on rice and wheat. The lower application of fertilizer in Mardi/Nepal may be explained by the higher number of livestock there, resulting in a richer supply of manure. The average farm herd (buffalo, cow, ox, and goats) in Mardi/Nepal is 3.32, compared to 2.54 in Gomati/India. Nonetheless, Mardi/Nepal farmers list manure as the second most significant bottleneck in terms of increased production.

Labor

Migrants from both study villages work in the booming Indian construction industry, many join the Army, and others obtain labor contracts in oil-producing Gulf countries. Some migrants bring their families and establish separate households in a city, but in most cases migrants are men who leave their wives and children behind in the village. More than half the households (56%) in Gomati/India and one third (32%) of Mardi/Nepal households have one or several male members on labor migration. This massive emigration drains the villages of labor, which is perceived to be a major problem by 14% of Mardi/Nepal farmers.

One possible explanation of the different degree of innovation could be found in a combination of migration and gender. If men are more willing to take risks and thereby are more innovative than women, whose prime priority is to feed the family, Gomati/India should be expected to be less innovative, because the rate of migration (which is predominantly male) is higher there than in Mardi/Nepal. However, our data do not support the hypothesis that households with a higher presence of males are more innovative than female-dominated households.

Labor shortage must be seen in relation to other reported production bottlenecks. Canal maintenance has been mentioned, and there are not enough farm hands to collect all available manure from pastures. Of all farmland

in Mardi/Nepal, 37% is left abandoned due to lack of manpower. In Gomati/India, the share of abandoned land is only 14%. There, farmers do not report labor to be a serious production bottleneck even if migration is more comprehensive. The reason is probably that labor capacity is relative to farm size, which also differs between the 2 villages.

Farm size

The average farm size in the Mardi/Nepal sample is 0.4 hectares, while Gomati/India farms are on average half that size, 0.2 hectares. This difference may explain why Mardi/Nepal farmers are more innovative and why their sons are more apt to go in for agriculture than the young generation in Gomati/India. If this explanation is correct, the larger Gomati/India farmers should be expected to be more innovative than the smaller ones. Assuming that the planting of new crops is an index of innovation, this explanation is supported by the survey data. There is a significant positive correlation between farm size and planting of new crops in Gomati/India ($P < 0.01$), which lends support to the hypothesis that farm size matters when it comes to innovation: within the framework of small-scale peasant household farming, larger units tend to be more innovative than small ones. The reason may be that smallholders often have to sharecrop extra land to make ends meet. Sharecropping in both villages implies that the sharecropper must carry all expenses of inputs yet hand over half the harvest to the landowner, a disincentive to try out new crops or technologies.

Institutions

Farmers must comply with nature in their economic pursuits, but they also have to relate to institutions. If we look at local institutions and their interactions with farmers, there is a salient difference between the case villages. While farmers in Gomati/India mostly interact with markets and Indian governmental departments, an additional actor is present in Mardi/Nepal in the shape of an effective and influential national nongovernmental organization (NNGO). Paradoxically, the NNGO was originally established to protect nature *against* farming, but it probably has had a substantial impact on the *development* of farming as well.

The Forest Nationalization Act of 1957 transferred management rights to all Nepali forests from local communities to governmental institutions. In effect, this implied a change from locally managed common property regimes to open access resources, because public forest rangers were not able to control local exploitation. The transference of management rights contributed to an alarming rate of deforestation and degradation in the Middle Hills, moving the World Bank to state in 1979 that “Nepal has lost half its forest cover within a thirty year period (1950–80) and by AD 2000 no accessible forests will remain” (World Bank 1979, cited in Ives 2006: 231). In

response to the increasing problem of degradation, the Annapurna Conservation Area (ACA) was established in 1986 by an NGO, the King Mahendra Trust for Nature Conservation (later renamed the National Trust for Nature Conservation). Instead of imposing a strictly protected national park, the trust chose a model that returned a substantial part of management to local communities, called the Annapurna Conservation Area Project (ACAP). Conservation area management committees (CAMCs) consisting of 10 locally elected members and 5 members appointed by the trust were set up in communities affected by the conservation area. The CAMCs were authorized to withdraw forest resources, make rules for withdrawal, dispose of parts of the fees paid for withdrawal, and exclude others from using the forest. The CAMCs thereby became “proprietors,” which, according to Ostrom and Agrawal (2010), is a precondition for sustainable use of common pool resources.

The ACAP model of nature conservation has allowed farmers to continue their traditional agroforestry farming system, albeit with some restrictions imposed. Rules for forest resource withdrawal had to be shaped within the framework set by the government, and some pastureland was lost to reforestation. To compensate for these inconveniences, ACAP initiated various development projects, some of which were aimed at agriculture.

In 1992, Mardi/Nepal was included in the ACA, which also meant that farmers became eligible for assistance from ACAP. The project started out in Mardi/Nepal by selecting 9 farmers to try out vegetable nurseries. ACAP supplied the model farmers with high-yielding variety seeds for cauliflower, cabbage, and onion. The selected trial farmers sold seedlings to other farmers, and by 1994 all farmers in Mardi/Nepal were using the new seeds. ACAP continued to introduce new varieties. In 1994, it supplied 500 orange seedlings at half the market price. ACAP also invited farmers on a study trip to Ilam, the most prominent tea-growing region in Nepal, and brought back 7000 tea seedlings. Back in Mardi/Nepal, farmers paid 1.5 rupees per seedling, which was subsidized by the same amount by ACAP. The Ilam visit and the subsidized seedlings gave rise to a flowering tea business. More recently, ACAP has also supplied seeds for coffee, beans, and tomatoes at subsidized rates, and these are popular among local farmers.

Gomati/India has not enjoyed the attention of a similarly competent and resourceful NGO. There, farmers mainly interact with government officials, who are allegedly dilatory and occasionally outright corrupt.

Discussion

The analysis of farming in the 2 case villages has uncovered 3 factors that are vital for innovation and thereby for capacity to adapt to change. They are summarized in Table 4.

TABLE 4 Differences between production conditions in the study villages.

Production conditions	Gomati /India	Mardi /Nepal
Water	Scarce	Sufficient
Farm size (average)	0.2 ha	0.4 ha
Resourceful NGO	0	1

First, the water situation is dramatically different in the 2 villages. Water is scarce in Gomati/India, which may explain lower productivity there, but it cannot explain the lack of innovation. On the contrary, according to the logic that “necessity is the mother of innovation,” Gomati/India farmers should be expected to be the most innovative ones.

Second, farm size correlates positively with innovation in Gomati/India; but again, farm size cannot explain the whole picture, because all farmers—big and small—are innovative in Mardi/Nepal.

Third, the presence of the active NGO and 2 food-processing private enterprises make Mardi/Nepal part of a wider innovation system, which is, according to the World Bank, “a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance” (World Bank 2006: vi–vii). However, a single focus on networks of organizations emits the self-evident fact that farmers have to cope with nature too.

Conclusion

We contend that all 3 factors influence farming innovation. To understand farming practices, we have to take into consideration the interplay among natural resources (water and climate), individual farm resources (land and labor), and network of organizations (NGOs, government, and private enterprises). Because farming is conditioned by natural, as well as social parameters, the term *innovative place* covers the situation better than *innovation system*, which focuses on social aspects only.

The innovative and dynamic farming system in Mardi/Nepal confirms that there is capacity for adaptation to change in the Middle Hills of Himalaya, thus modifying the most pessimistic scenarios for the future of food production in the region (Cline 2008; Sud 2009; Mittal and Sethi 2011). However, that capacity is conditioned by policies that grant farmers a certain degree of flexibility instead of recommending fixed prescriptions inferred from uncertain climate projections and other scenarios. Adaptive capacity to change for farms is encouraged if policy-makers succeed in producing innovative places where a range of possible production decisions is left open to farmers, thus enabling them to cope with variable weather and uncertain markets.

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