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Are Mountain Farmers Slow to Adopt New Technologies?

Factors influencing acceptance in Bhutan

Bhutan, a mountainous country where 79% of the population depends on agriculture, has a relatively short history of government intervention in the agricultural sector. The first research and extension activities began only 4 decades ago. Developments over this period are generally seen as positive, although it is impossible to separate the influence of social change and the road network from the influence of activities carried out by the Ministry of Agriculture or by development agencies. Despite positive results, farmers are often seen as resistant to change or slow to adopt new technologies. Researchers and extensionists disappointed by low adoption rates often blame cultural barriers, lack of interest by farmers in economic betterment, or, in the worst case, lack of academic training among farmers. Mountain environments are inherently fragile, leaving farmers less room to experiment with risky innovations. Yet this patronizing approach is not limited to agents working with mountain farmers or subsistence agricultural systems. The present article describes 3 examples in which farmers have adopted new technologies at surprisingly fast rates, mainly for economic reasons: 1) potato production, 2) the use of draft animals for mechanized potato production, and 3) fodder pumpkin cultivation. The author's experience, supported by recent research findings and data from published and unpublished records, is used to describe the technologies, the rate of adoption, and factors affecting adoption. The analysis of potato development covers several decades, while the other examples are limited to periods of a few years.

Potato production

Potatoes may have been introduced to Bhutan in the 18th century. In 1774, an English visitor named Bogle planted a few potato tubers at each place he visited during a voyage to Bhutan and Tibet. Although potatoes probably spread gradually through most parts of the country during the 18th and 19th centuries, they never became a staple food. By the middle of the 19th century, many farmers had abandoned potato cultivation because of the poor yields caused by wart disease. The main impetus for current potato cultivation came from road construction in the early 1960s, which made temperate

FIGURE 1 Potato field in Khaling (Trashigang district). Ten years after the village became accessible by road, almost every household had adopted potato production for export. (Photo by author)

areas accessible to the Indian market. Potatoes produced in the hills of Bhutan at elevations ranging from 1500–3000 m reach the Indian market when prices are at their peak. From 1960 to 1980 potato production increased exponentially, at a rate exceeding 30% annually. Production reached a plateau in the early 1980s and has increased only slightly since then.

In 1974, only 10 years after the village of Khaling (Trashigang district; Figure 1) became accessible by road, almost every household had adopted potato production for export, and continuous potato cultivation was already perceived as a potential constraint to yield and quality. Similar developments were observed in the western part of the country, where Chapcha farmers quickly capitalized on the new opportunities offered by road access.

However, it was difficult to convince the rural population of the merits of eating potatoes in the 1970s. Potatoes were seen as causing digestive problems or even venereal disease. Yet only 3 decades later, as a result of widespread availability, potatoes have become a preferred and frequently eaten vegetable, and are even offered on the altar along with other prestigious foods such as meat and fruit.

Factors affecting adoption

The phenomenal increase in potato production in the late 1960s and early 1970s was primarily the result of farmers' own initiative. Important factors contributing to the rapid adoption of the potato crop were 1) the existence of a good market offering substantial profits, 2) road access to the market, and 3) the introduction of wart-resistant varieties. Starting in 1973, the government, through the Food Cooperation of Bhutan, supported marketing and established price supports for potatoes. The introduction of the auction yard system in 1980 provided a mechanism for optimizing interaction between potato growers and buyers. Initiatives by government research stations and regional projects made high-quality seed of suitable varieties available and encouraged a farmer-based seed production system with "down hill movement" of high-quality seed (produced at higher elevations). More recent projects at the national level, including the Bhutan National Potato Project (1983–1996), have had minimal or no lasting impact and could not sustain the momentum of the 1980s.

Use of animal traction for mechanized potato production

Potato growers use either tractors or draft bullocks for tillage work while all other cultural practices are carried out manually. Potato cultivation is thus relatively labor intensive, requiring repeated weeding and earthing-up operations. As increased labor costs reduce potential profits, animal power for mechanized planting, weeding and earthing up was introduced in the late 1970s. Simple equipment from Switzerland was first introduced in 1975. Initial attempts to introduce such equipment with horses failed because farmers were not familiar with horses as draft animals, and the equipment produced in Bhutan was too expensive. Subsequently, farmer-driven

FIGURE 2 Using bullocks for planting potatoes. (Photo by author)

FIGURE 3 Farmer proudly displaying fodder pumpkin. (Photo by Ugen Lhendup)

research led to use of bullocks as draft animals, modification of implements, and identification and import of appropriate but cheap implements from India. With these changes the technology became easily affordable to most farmers (Figure 2). Within a period of 5 years, more than 50% of potato growers in Bumthang district were using this technology, but it has not been adopted in other regions.

Factors affecting adoption

The technology was developed by potato producers with support from the Bumthang Rural Development Project. Rapid adoption took place during the technology development process. Low investment, and low risk combined with high benefits due to savings in labor costs, were the main factors in adoption. Investigations carried out 10 years later showed that the use of the implements could save 50% of the labor costs. The fact that the technology was not adopted outside Bumthang district indicates that the technical support provided and/or the participatory technology development process were important factors influencing adoption.

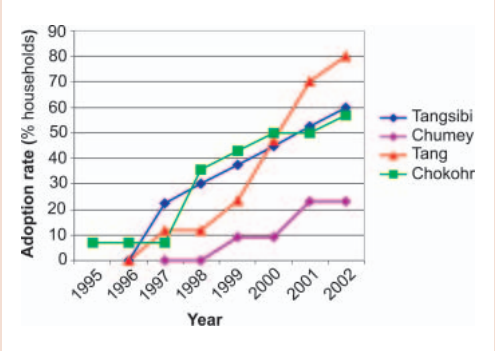

FIGURE 4 Adoption rate of fodder pumpkin in 4 selected blocks of Bumthang and Trongsa districts, Central Bhutan. (Source: RNR-RC Jakar)

Fodder pumpkin for the winter

Availability and quality of fodder during the dry winter months is considered a major constraint on large ruminant production in temperate areas of Bhutan. Farmers with large cattle herds traditionally used seasonal migration to lower areas to reduce the impact of fodder shortage during the winter season. The newer system where smallholder farmers have fewer, but more productive animals, requires new winter feeding strategies. Fodder pumpkin, usually planted near the house or the cattle shed on otherwise unproductive land, is a winter fodder adapted to the given conditions. Farmers like the crop because it is easy to cultivate, does not normally require weeding or protection from stray animals, and can be stored easily (Figure 3). Provided the environment is conducive, the crop has a relatively high yield potential, with an average production of 68 tons of fresh pumpkin per hectare. Farmers are fully aware that pumpkin fodder quality is lower than that of white clover. At the same time, they consider easy storage, limited labor input, and lower seed requirement as major advantages compared with white clover. Although planted on small areas only, at 40% annually the rate of adoption per number of households was very high (Figure 4).

Factors affecting adoption

These advantages, and the need for winter fodder to maintain animals with increasing production potential, were probably the most important reasons for farmers to plant pumpkin. The extension program had no influence on the adoption rate, as pumpkin was not included in their program. Most of the households (86%) growing pumpkin had received their first seeds from a neighbor. Some households that did not adopt pumpkin mentioned that it could be harmful to cattle because of its hard shell.

Economic incentives: an important factor

Although limited in geographical and temporal scale, the adoption of animal traction for mechanized potato cultivation and the use of fodder pumpkin were more rapid than expected. Similarly, the increase in potato cultivation despite high investments and high risks due to market fluctuations was spectacular. The 3 examples above clearly show that Bhutanese mountain farmers can respond quickly to new opportunities. They readily adopt new production methods or new crops, provided there are sufficient economic benefits. In this, they are no different from lowland farmers and farmers fully integrated in the world market. If the economic incentives are sufficiently attractive, they are prepared to take high risks. The risk is especially high for potato production where, on average, 1 out of 10 years' production costs are not covered by

TABLE 1 Adoption rates for technology packets, and factors affecting adoption in Bhutan. For "animal traction" and "pumpkin," the adoption rates are measured in % households per year; for "potato cultivation" and "rice varieties" in % increase in production per year (CSO 1994; Report Impact assessment rice, RNR-RC Bajo/IRRI, 2003, unpublished); for "temperate fodder" in % increase in total area.

	Technology					
	Animal traction for potato	Fodder pumpkin	Potato cultivation	Temperate fodder	Potato cultivation	Rice varieties
Timeframe	1975–1985	1997–2002	1965–1983	1987–1997	1983–today	1988–today
Sample size	Bumthang district	Bumthang, Trongsa districts	Country	Country	Country	Country
Adoption rate	**50%**	**40%**	**35%**	**5%**	**<3%**	**<2%**
Impact on income	Medium	Small	Very high	Medium	Very high	Medium
Risk	Small	Small	Very high	Medium	Very high	Small
Investment by farmer	Equipment	Land, labor	Land, labor, seed, fertilizer, storing facility, marketing	Land, labor, fertilizer, cattle	Land, labor, seed, fertilizer, storing facility, marketing	Land, labor, fertilizer
Subsidy cost (US $/ha)	<1	Nil	<5	60	50	10
Major driving force	Economic benefits	Economic benefits	Economic benefits	Extension	Extension	Research & extension
Research input	Some	Nil	Very minor	Some	High	High
Technology flow	Farmer to farmer	Farmer to farmer	Farmer to farmer	Extension to farmer	Extension to farmer	Extension to farmer
Influence of extension	Some	Nil	Minimal	High	High	High

the market price. During such years farmers run the risk of considerable financial losses.

Considering the contribution of the potato to individual household income, the adoption of this cash crop has no doubt had the most important impact on the socioeconomic condition of rural households in the higher regions of the country. Potatoes have also played a major role in the transformation from a subsistence to a market-oriented system. In a study carried out in 1988, potatoes were the first farm produce ever sold for cash for 57% of the households interviewed in Bumthang and Wangdu districts. For many households, potatoes were the only source of cash income.

By comparison, 3 other examples of successful adoption of technologies promoted by the extension program under the Ministry of Agriculture are summarized in Table 1. Comparison of 6 technologies shows that the adoption rate was higher when there was little or no input from research and extension, with limited or no interventions through subsidies. However, this is not to say that research or extension are not required. Technology flow from farmer to farmer is very effective and efficient, but there is often a need for initial input or stimulus. Thus, farmers benefit from research and extension, but only if the processes are participatory and the farmer is an equal partner. Similarly, subsidies may influence certain processes but they need to be used with caution. It must also be noted that all technologies adopted will reach a saturation level. The low increase in potato production after 1983 is an indication that the level of cultivation may be nearing the saturation level.

Mountain environments may require more careful approaches to innovation, but in the Bhutanese context they also offer advantages in providing opportunities for niche production and reducing the potential impact of globalization. High transport costs for imported goods and the demand for specialized products sought by the Bhutanese consumer result in prices substantially above the world market level.

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