PART V
POTATO PRODUCTION IN GORKHA DISTRICT

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1. INTRODUCTION

Potatoes have been grown as food crops in Nepal for more than two centuries. Presently, about 86,000ha are under potato cultivation in Nepal, including 60,000ha in the hills and 26,000ha in the *terai* (NPDP 1994). Potatoes are cultivated in different regions, defined according to altitude; in the *terai*, potatoes are grown in winter after paddy; similarly, in the Middle Mountains (800 - 1,500masl), potatoes are cropped after paddy on irrigated terraces; above 1,500m, there are mixed cropping systems with maize and potatoes; and, above 2,500m, potatoes are cultivated in monocropping systems during the summer season. In the northern High Mountain Region, the growing period lasts six months, and potatoes are grown as the predominant crop from April to September (Rhoades 1985:9).

IIDS (1993) distinguished between four categories of potato-growing areas in Gorkha: (1) mountain and snowfall areas (i.e., High Mountain Region), covering the VDCs of Samagaun, Lho, Prok, Bihi, Chumchet, and Chhekampar, where potatoes are the main staple crop; (2) high hill areas (above 2,000masl), where the VDCs of Laprak, Gumda, Uhiya, Sirdibas, Lapu, Kerauja, Kashigaun, Manbu, Barpak, Kharibot, and Simjung are the main traditional potato-growing areas and potatoes are cultivated alongside maize, wheat, and millet; (3) low hill areas (700 - 2,000masl), where potatoes are grown for home consumption and small quantities marketed; and (4) valley bottom areas where potatoes are cultivated in the winter season.

This study applied GIS technology to the analysis of appropriate locations for potato cultivation in Gorkha District. Since potatoes can be grown on all cultivated land during different seasons, the major focus of this study was to define the appropriate growing period for particular locations.

2. POTATO PRODUCTION IN THE MOUNTAINS OF NEPAL

In the mountains of Nepal, potato cultivation has a high socioeconomic value and is practised in a broad sociocultural context. Noteworthy features include (1) the importance of potatoes as a food crop, (2) the demand for seed potatoes for the next growing period, and (3) the marketing and bartering of seed potatoes. Potatoes are eaten as a staple food in the High Mountains and as a vegetable in the Middle Mountains.[12] Rhoades (1990) reported that, in 1985, the potato economy in eastern Nepal was still a non-monetarised, altitudinal, exchange and barter system for lower zone cereals, namely, paddy, finger millet, and maize. About 25 to 50 per cent of the potatoes cultivated in the main growing areas of Gorkha and Lamjung are either sold, exchanged, or marketed on a credit basis[13] in the hills (Pradhanang and Lorenzen 1990). Bartering is the most common marketing system for seed potatoes in Gorkha. The exchange rate of seed potatoes to cereal grain is generally 1:1 by volume, but, depending on the season, potato farmers may get more cereal grain.[14]

2.1 Seed Potato Flow in Gorkha

In Nepal, seed potatoes are never replanted on the plot where they are produced; and seed potatoes are never taken from downhill sites. Farmers in a community exchange seed potatoes, and, every three years, renewal from higher altitudes takes place (Rhoades 1990). In Gorkha District, the main seed potato pockets are in Laprak, Gumda, Sirandanda (Simjung), and Barpak (Pradhanang and Lorenzen 1990:13),

12 The Master Plan for Horticultural Development indicates that potatoes are the main vegetable in urban households; about 28 per cent of the expenditure for vegetables is spent on potatoes (Horton 1990:67).

13 There is a credit system between the farmers of Sirandanda and low-hill growers in the vicinity of the village: seed potatoes are supplied by the up-hill farmers on credit, and they receive rice only after the harvest in winter.

14 Rhoades (1990) observed barter systems of seed potatoes also in the Andes; there the exchange rate for potatoes seems to be based rather on a symbolic than on an economic value.

followed by Lapu, Sirdibas (Philim, Sarsyu, Anga), and Kerauja (IIDS 1993). According to IIDS, the seed potato flow is from Gumda and Laprak to the southern parts of the district and to areas outside the district; while the areas of Sirdibas, east of the Marsyangdi River, supply the south-east of Gorkha with seed potatoes. Pradhanang and Lorenzen provided a more detailed seed flow chart for Laprak, Gumda, and Sirandanda. According to them, high-hill seed pockets[15] and areas in Bhot *Khola*[16] are occasionally[17] used for renewal of seed stocks in Laprak and Gumda. From these areas there is a seed flow to cool and warm areas, i.e., to Barpak, in the west, and Taranagar and Ranishwara, south of Gorkha District Headquarters; Laprak also provides seed potatoes to other cool areas, i.e., Sirandanda (Simjung VDC), Kharibot, Saurpani, and the warmly located Nareshwar; and, from Gumda, further seed potatoes flow, mainly to warm places, i.e., Gaikhur, Masel, Asrang, Arughat (Aru Chanaute VDC), Okhle (Tandrung VDC), and also to the distant village of Ghanpokhara in central Lamjung. Sirandanda (Simjung VDC), which receives seed potatoes from Laprak, itself is a main seed pocket in Gorkha and supplies places in the southwestern district, i.e., Aampipal, Simpani, Chhoprak, Gaikhur, Changli, Bhirsing, and Neupane in Kerabari VDC. In Gorkha, middlemen are not involved in the potato marketing system. IIDS (1993) reported that farmers in the southern subtropical areas of Gorkha received seed potatoes from the *terai* region.

2.2 Traditional Potato Cultivation Practices

In contrast to modern technology and development efforts for Himalayan potatoes, farmers prefer to plant very small tubers as seed for specific reasons, mainly, (1) to cater to the consumption preferences of the people for these small potatoes; (2) to minimise the risks of production; (3) to secure food; and (4) to decrease the packing volume of seeds for trading. There is always a shortage of food after the winter, and farmers have a strategy of holding back the amount needed for seeds, consuming them if there is a shortage of food.[18] Also, more land can be planted with small seed potatoes, even if the amount (weight) is less than recommended. Furthermore, farmers plant seed potatoes more densely for a greater density of sprouting and thus a higher survival rate. Farmers harvest the tubers at a premature stage (and of small size) before the late blight hits them (Rhoades 1990:300). Experiences of the National Potato Development Programme (NPDP) all over Nepal show that the small tuber size of the local varieties reflects the low soil fertility and the disease infestation of the seed material. Improved varieties and appropriate cultivation technologies could double the potato yield and thus help to sustain the system and make it more flexible for soil fertility measures (personal communication, S. Schulz, NPDP)

In Nepal, about 25-35 potato cultivars are grown. Potato growers maintain potato diversity. They are aware of the agro-ecological zones suitable for particulur cultivars; utilise resistances to diseases, pests, frost, and drought; and adapt the varieties to different zones to minimise the risks of production (Rhoades 1990:296). Nevertheless, Pradhanang and Lorenzen (1990:7 & 17) reported that many farmers in Gorkha are not aware of plant selection techniques for seed purposes. Mainly traditional potato varieties are cultivated in Gorkha; their names are based on tuber colour and shape, e.g., local black *(kalo aalu),* local white *(seto aalu),* and local red *(rato aalu).*[19] The Agricultural Development Office in Gorkha introduced an improved variety, *Kufri Jyoti'*, in Gumda more than 10 years ago, but due to preferences in taste and

15 IIDS (1993) mentioned that Sarsyu and Anga (Sirdibas VDC) are the main pockets for the renewal of potato seed sources in Gumda and Laprak.

16 The location is not described in detail; however, since it takes 10-12 days for a round trip, the areas are probably the upper valleys of the Budhigandaki River and the Shyar *Khola*.

17 According to the experiences of the NPDP (1994), the potato seed degenerates after six years in the hills of Nepal.

18 Also, multiple potato harvesting is practised due to acute food shortages, in April/May (Pradhanang and Lorenzen 1990:18).

19 In Gumda/Laprak, seed purchasers from below prefer the black variety because of its taste, small tuber size, and yield performance. Customers refuse to buy white varieties of seed; therefore these varieties are only used for local consumption and cover a much smaller area; whereas in Sirandanda, farmers have no problem in marketing the local white variety (Pradhanang and Lorenzen 1990).

problems in marketing, the cultivation of these potatoes is insignificant[20] (Pradhanang and Lorenzen 1990:4).

According to the LRMP, in Gorkha the cropping pattern, including potatoes, is mainly potato - fallow (z); maize - relayed potato (x); maize + potato - winter crop (y), and the total cropped area per year covers about 755ha (Trapp 1993:17). For Gumda and Laprak, the main potato pockets in Gorkha, no potato cropping patterns were recorded. Pradhanang and Lorenzen (1990:4) indicated that potato cultivation and potato-based cropping patterns were much more diverse locally than the LRMP had presented. In Laprak, Gumda, and Barpak, various two-year rotations are applied, in particular on *bari* (rain fed agricultural land), i.e.,

- potato - fallow - potato,
- potato - wheat - *silam (Amaranthus spp)*,
- potato - barley - *silam*,
- potato - barley - millet,
- potato - *silam* - maize,
- potato - barley - soybean, and
- potato - *silam* - potato.

Planting and harvesting times vary considerably depending on location, year, and individual needs, e.g., the availibility of labour in the household. In general, the planting time in Laprak, Gumda, Barpak, and Sirandanda starts from November/December and continues until February/March, and the harvesting of potatoes usually is in July but may last until October/November.

3. REQUIREMENTS FOR POTATOES

There are several physical factors which influence the growth of potatoes: weather and climate, soils and relief, and pests and diseases (Horton 1987:36).

Weather and climate. Day length and temperature affect the growth of potatoes. In general, the daily bulking rate of potatoes is related to the hours of daylight; there is a great variety of subspecies cultivated under different day-length regimes. Different aspects of temperature are important for potato production. Due to the potato's physiology, the most favourable soil temperature is between 15 to 18°C for common potato varieties; daytime air temperatures below 25°C are preferable; and the night temperature should remain below 20°C. Potatoes are well adapted to cool climates, but frost can damage potato plants and decrease yields. Hail can also damage the plants. The potato plant is sensitive to moisture, and any drought period during the growth cycle may harm the plant as well.

Soils and relief. Potatoes grow best on deep soils with good water drainage. Compacted soils or dense soil layers limit water availability during dry periods, become wet after heavy rainfall or irrigation, and damage the potato plant. In general, potatoes should be planted on level land rather than on slopes, to reduce soil erosion. Still, due to the scarcity of flat land, farmers are forced to cultivate potatoes on sloping land in the mountainous area of Gorkha. Compared to valley floors, slopes are less endangered by night frost.

20 *Kufri Jyoti* is an early seed potato variety and may be an option for food deficit areas where farmers give priority to earliness and food security rather than taste. Other recommended potato varieties for the Western Region are *Desiree* and *Achirana Inta*. All recommended varieties are resistant to wart disease and are at least tolerant to late blight (NPDP 1994).

Pests and diseases. The potato is exposed to several pests and diseases that lead to extensive losses in yield. In the mountainous areas of Gorkha in particular, fungal diseases, i.e., late blight *(Phytophthora infestans)*, to some extent black scurf *(Rhizoctonia solani)*, and also viral diseases have been observed. Fungal disease wart *(Synchytrium endobioticum)* and bacterial wilt *(Pseudomonas solanacearum)* may become serious problems in the future. Various insects are damaging potato plants in the area but seem to be a minor problem.

Besides diseases and pests, other factors are seen as major problems for cultivating potatoes in the high mountain area of Gorkha, i.e., lack of soil fertility, small seed size, high plant density, curing and drying after harvest, planting time, desprouting/pre-sprouting, and multiple harvests. Pradhanang and Lorenzen (1990) recommend potato planting in December in the high mountains in case desprouting has been practised before; otherwise March/April may be the appropriate planting time. Irrigation is not feasible in the high mountains, but monsoon rains seem to be sufficient if there is no long drought during the spring season. In lowland, subtropical areas, potatoes are grown during the winter season. Soils must be well drained, and enough moisture should be secured during the growing period through irrigation (Horton 1987:124).

4. APPLIED METHODOLOGY

To define the appropriate growing period for particular locations in Gorkha, agronomical parameters and requirements of potatoes were considered. Socioeconomic factors and values were not included in the analysis; however, an attempt was made to gather data on seed flow and, thus, the location of commercial potato production. Temperature was taken as the main indicator for potential potato growing areas. Mean annual maximum temperature data of Gorkha District were extracted from the available climatic database of Nepal. A mean maximum temperature range of 14°C[21] to 25°C was selected as the most favourable temperature for potato cultivation, and for each month the areas suitable for potato growing were identified using the Arc/Info raster GIS method (unit size 150 x 150m). Secondly, all agricultural land was taken into consideration except sloping terrace areas (C) on very steep slopes where potato cultivation would cause heavy soil erosion (see Annexes 8 & 9: land units 12; 142; 152).

Water availibility was not considered in the analysis at all, although moisture is one of the most restricting factors during the winter cultivation of potatoes. Irrigation facilities are necessary, at least in lowland areas where soil moisture is more in deficit. There are no data available yet about irrigation systems in the district. Nevertheless, the moisture regime data of the area may provide some information on water availability.

Since the main potato growing areas in Gorkha were known (Pradhanang and Lorenzen 1990; IIDS 1993), the data on agricultural land use and cropping patterns, gathered by the LRMP, were evaluated using the overlay technique.

5. RESULTS

The potential potato growing area in Gorkha was fairly large. Most of the agricultural land in the district could be used for potato cultivation. Still, there were constraints in terms of water availability which could hamper development considerably. Only about 5.5 per cent of the total potential area located in the High Mountains was cultivated during the summer season. Also, there was a considerable potential for the cultivation of early potato varieties in the upper valleys of the Chepe and Daroundi *Khola*(s) and the Budhigandaki up to Philim (Sirdibas VDC). Regardless of other main cropping patterns in the district,

21 Soil temperature in topsoils is usually expected to be 1°C higher than air temperature.

winter potato production could eventually play a bigger role in southern Gorkha if water becomes available through irrigation (Tables 24 and 25) (Map 33). The analysis showed that the major summer potato growing areas were located in the VDCs of Laprak, Barpak, Kharibot, Lapu, and Uhiya, west of the Budhigandaki, and in the VDCs of Manbu, Kashigaun, Kerauja, Sirdibas (Philim, Sarsyu), and Chumchet (Lokwa), east of the river. The agricultural land in Gumda VDC and the ridge at Sirandanda were shown to be particularly suitable for early potato varieties.

The cropped area of the two main seed pockets, Gumda and Laprak, covered an area of about 890ha. Assuming the cropping patterns mentioned in Chapter 2.2 to be applied on all cultivated land, the actual potato growing area per year amounted to approximately 570ha. Assuming an average productivity of 10mt/ha[22], the potato production would be 5,700mt per year in these two VDCs. IIDS (1993) mentioned that farmers from Gumda and Laprak sold about 50 per cent of their potato harvest. The estimated seed flow of 2,850mt to various VDCs in the cool and warm zones of Gorkha resulted in a potential potato cultivated area of approximately 1,900ha, considering a seed requirement of 1.5mt/ha in the middle mountain areas of Nepal.

Table 24: Potential Agricultural Land and Potential Cropped Area in Gorkha Suitable for Potato Cultivation during Various Potato Growing Periods

Optimal growing period	Agricultural land (ha)	Cropped area (ha)
Winter growing areas		
September - April/May	2,920	1,340
October - March/April	7,930	3,690
November - February/March	28,380	13,350
December - February	19,480	10,220
Sub-total	58,710	28,600
Summer growing areas		
February - December	1,460	650
March - November	1,470	600
April - October	150	60
May - September/October	390	230
June - September	200	120
Sub-total	3,670	1,660
Area with no potential	3,629	1,420
Total	66,009	31,680

22 Rhoades (1995:23) estimated an average yield of 6.6mt/ha in Ilam District, Eastern Region. Whereas Pradhanang and Lorenzen (1990:8), in general, found it difficult to get accurate yield data due to multiple harvesting practices; but they estimated an average yield of 22.3mt/ha in Sirandanda. NPDP (1994) monitors potato yields in Nepal on a yearly basis; for local varieties and non-potato programme areas, the yield varied from 8.5 to 11.4 mt/ha in hill areas of the Western Region in 1994.

Table 25: Potential Agricultural Land and Potential Cropped Area in Gorkha Suitable for Potato Cultivation during One Year

Month	Agricultural land (ha)	Cropped area	
		(ha)	% of total
January	58,710	28,600	90.2
February	60,170	29,250	92.3
March	42,160	19.360	62.0
April	12,930	6,360	20.1
May	6,390	2,880	9.0
June	3,670	1,660	5.2
July	3,670	1,660	5.2
August	3,670	1,660	5.2
September	6,590	3,000	9.5
October	14,320	6,570	20.7
November	42,160	19,630	62.0
December	60,170	29,250	92.3

6. CONCLUSIONS

The cultivation and bartering of potatoes in the High Mountain Region of Gorkha are based on indigenous knowledge systems. The influence of modern practices in cultivating this crop, e.g., use of improved varieties and application of recent agronomical technologies, is very limited. As has been pointed out, there are many constraints in these traditional systems, such as low yields due to lack of soil fertility and inappropriate cropping patterns, which may cause or increase problems with diseases and pests and, in the longer term, lead to unsustainability of the farming system. Therefore, for selected aspects of cultivation, intervention or guidance is necessary – offering options to farmers, e.g., improved varieties and appropriate cultivation technologies. This is regarded as an economically viable system, although one should keep Horton's (1987:57) comment in mind that in developing countries, "*where potatoes are already a low-cost staple food because they grow well in the local environment with minimal use of purchased inputs, economic development is likely to erode their competitive position relative to higher value crops.*"

The potato analysis confirmed the relevance and usefulness of GIS technology and its application in the agricultural production fields. The results obtained, showing the locations of particular potato seed pockets for summer cultivation in Gorkha, corresponded to the information gathered by different survey teams. Linking the available knowledge and data with an information system could save time and effort and, if applied to a larger area, zone, region, or the whole country, could be a useful tool and database for planning, implementing, and monitoring particular area-based programmes and projects like the National Potato Development Programme at the Nepal Agricultural Research Council (NARC).