PART III
HORTICULTURAL DEVELOPMENT IN GORKHA DISTRICT

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1. INTRODUCTION

In the 1960s, His Majesty's Government of Nepal (HMG/N) launched horticultural development programmes all over the country to improve the economic and nutritional status of the people (Gurung 1993). Horticultural farms were established in different locations, reflecting various agroclimatic conditions, within three altitudinal ranges: the *terai* (below 1,000m) the hills (1,000 to 1,800m) and the high hills (above 1,800m). Suitable areas for growing fruits within these zones were defined in the seventh Five-Year Plan (1985-90) by the National Planning Commission (NPC) of HMG/N. Some districts were selected to intensify the commercialisation of different prioritised fruit varieties, i.e., citrus, apples, walnuts, pears, grapes, mangoes, bananas, and pineapples. Citrus, mangoes, and apples were seen as the economically most feasible fruits. None of these fruits farms is located in Gorkha District; still, in addition to other districts, Gorkha was chosen for the implementation of a citrus development programme, including mandarin oranges (*suntala*), sweet oranges (*junar*), limes (*kagati*), and lemons (*nibuwa*).

1.1 Master Plan for Horticultural Development

Horticulture is regarded as an effective means of reducing environmental degradation and improving the economic situation in the hills. In 1990, a Master Plan for Horticultural Development in Nepal, covering the following 20 years, was developed for HMG Nepal. A major concern of the Master Plan is to reverse the environmental degradation processes. The priority for horticultural development is focussed on those areas where degradation is the most severe (Carson 1990:86-94). Horticultural development is further seen as one option for increasing the cash income of poor households, thus at the same time reducing pressure on common resources and decreasing exploitation of forest land.

There is potential for the development of different fruit varieties in Nepal, and twelve fruits were selected by the Master Plan as priority crops. The selection was based on a fruit crop screening methodology, incorporating ecological and subsistence suitabilities and market capacity. Other criteria were the profitability of production and the competitive position of Nepal.

2. CRITERIA FOR HORTICULTURAL DEVELOPMENT ZONES IN GORKHA

MENRIS based its analysis of horticultural development zones in Gorkha, in general, on data/information gathered and compiled by the Master Plan for Horticultural Development (Carson 1990; Ranjit 1990); in particular, requirements for different fruit crops, in terms of climate (altitude, temperature), soils, and soil drainage, were extracted from this plan. Furthermore, information about crop requirements was taken from Rehm and Espig (1991). This information was then linked to the MENRIS/GDP database for Gorkha, i.e., the

- land system data of LRMP,
- land-use data 1979 of LRMP,
- agroclimatic zones,
- altitude (DEM),
- aspect, and
- accessibility of road infrastructure.

The Master Plan identified several constraints to horticultural development on village lands, which could not be included in this study because of its complexity and due to lack of data. Soil fertility may be the major constraint in hill agricultural production. If the soil fertility is too low, the crop yield may not justify investment in horticultural crops. Livestock management practices, e.g., free grazing, hamper horticultural development to a great extent. Stall feeding is necessary, since protection or fencing is too costly.

Microclimatic factors, such as frequency of hailstorms, fog, local winds, air drainage, and low winter night temperatures, may affect horticultural crops considerably (Carson and Sharma 1992:16; Carson 1990:52). Socioeconomic factors were not considered (such as land tenure and its implications on perennial/cash crop production; the economic status of the farm household, including all gender-related issues and changes due to cash crop production; profitability and sustainability of the farming system, e.g., high expenditure on plant protection, degradation of the environment caused by horticultural monocultures or utilisation of pesticides, and new diseases [Partap 1993:352]); and there is a lack of spatial data on local traditional fruit tree production as well as on the distribution of present horticultural pocket areas.

2.1 Land System Requirements

To obtain the greatest benefits in the form of high fruit crop yields (provided accessibility and marketing are not major problems), pressing soil requirements, including soil drainage and slope gradients, must be met. Extreme soil landscapes are not very favourable for fruit production. Further, each fruit species has its particular demand on soil and drainage in the optimum production range (Ranjit 1990). On the other hand, certain land systems (according to LRMP) require different land management practices. Horticultural crops have direct positive effects on the reduction of topsoil erosion and the improvement of soil fertility when horticulture is developed in an overall farming systems' approach. However, orchards/trees alone do not protect the soil from erosion; soil protection is achieved through long-term implemented management practices, e.g., protection of topsoil by applying different systems, intercropping, sowing of grasses, and coverage with litter, stones, etc. This is particularly valid for land system units in which the slope is steep, the infiltration rate of soil is low, and the rainfall intensities are high (Carson 1990:89) (Map 20).

The land system data and maps of LRMP still constitute the best source for describing the soil landscapes of Nepal. There are five physiographic regions: the *terai*, the Siwaliks, Middle Mountains, High Mountains, and High Himalayas, where geology, climate, landform patterns, and thus land-use practices and management options are different. Within these regions, land systems and land units were categorised, based on properties significant for land management such as slope gradient, soil depth, and water drainage (Carson 1990:2).

Gorkha lies in three physiographic regions:

- Middle Mountains (Annex 8),
- High Mountains (Annex 9), and
- High Himalayas (Annex 10).

The Master Plan recommends the encouragement of horticultural development within the Middle Mountain Region as a profitable and environmentally appropriate agricultural system. This region, covering the southern part of Gorkha, includes a great variety of soil types and slope gradients, depending on bedrock materials and climate. Most of the cultivated land is located on sloping mountainous terrain with a tendency towards topsoil erosion on sloping terraces. Agriculture is mainly practised on level terraces; nevertheless, in this region, about 19 per cent of the cultivated area is located on sloping terraces, either on slopes with a gradient of less than 30 (13.3%) or on steeper slopes (5.7%).

Three of four land units were classified as having a high agricultural land-use index, i.e., alluvial plains and fans (land unit 9) covering 36sq.km., or 6.6 per cent, of the agricultural land in the Middle Mountain Region of Gorkha; ancient lake and river terraces (*tars*) (10) covering 50sq.km., or 9.2 per cent; and moderately to steeply sloping mountainous terrain (11) having a slope gradient of less than 30° covering 355sq.km., or 65.4 per cent. If these land units, especially units 10 and 11, are well managed, they are expected to undergo only slight topsoil erosion (Carson 1990:90). Steep to very steep mountainous terrain

(12) which covers 102sq.km., or 19 per cent (Table 15), has a low land-use index and is not a logical priority area for horticultural development.

Table 15: Agricultural Land and Land System Categories in Gorkha District

Land systems category	Agricultural land types *Area in hectares* (percentage of land system category)				
	Sloping terraces	Level terraces	Valley floors	Tars	Total
Middle Mountain Region:					
Alluvial plains and fans	133	653	545	2,266	3,597
0 - 5°	(1.1)	(1.5)	(57.7)	(24.9)	(5.4)
Ancient lake and river terraces	406	384	78	4,115	4,983
0 - 5°	(3.2)	(0.9)	(8.3)	(45.2)	(7.5)
Moderately to steeply	7,470	26,668	167	1,220	35,525
Sloping terrain < 30°	(59.4)	(61.4)	(17.7)	(13.4)	(53.8)
Steeply to very steeply	3,206	5,991	95	935	10,227
Sloping terrain > 30°	(25.5)	(13.8)	(10.1)	(10.3)	(15.5)
High Mountain Region:					
Alluvial plains and fans	90	53	47	-	190
0 - 10°	(0.7)	(0.1)	(5.0)		(0.3)
Past glaciated mountainous terrain below the altitudinal limit of arable agriculture					
a) Moderate to steep < 30°	767	5,763	3	-	6,533
	(6.1)	(13.3)			(9.9)
b) Steep to very steep > 30°	146	3,158	8	-	3,312
	(1.2)	(7.3)			(5.0)
Past glaciated mountainous terrain above the altitudinal limit of arable agriculture	254	738	-	-	992
	(2.0)	(1.7)			(1.5)
High Himalayan Region:					
Alluvial, colluvial and morainal depositional, surfaces	84	-	-	544	628
	(0.7)			(6.0)	(1.0)
Steeply to very steeply Sloping terrain	10	-	-	12	22
	(0.1)			(0.1)	(0.1)
Total	12,566	43,408	943	9,092	66,009

Agricultural land in the High Mountain Region of Gorkha is found mainly along and above the three valleys of the Budhigandaki River and the Daroundi and Chepe *khola*(s). Most of the area in this region is not suited for horticultural production because of low temperatures and high slope gradients. Only two of the five land units in this region have a high/medium use index, i.e., alluvial plain and fan complexes (13) which cover 1.9sq.km., or about three per cent, of the agricultural land in this region; and past glaciated mountainous terrain below the upper limit of arable agriculture, with moderate to steep slopes (14a), covering 64.2sq.km., or 59 per cent of the land area.

There is hardly any agricultural land in the High Himalayan Region of Gorkha, apart from 870ha of land along the upper Budhigandaki River in Prok, Lho, and Samagaun VDCs and Shyar *Khola* in Chhekampar VDC. According to the Master Plan these land units, in general, have a low use index, if irrigation is not made available.

2.2 Horticultural Development Areas

The Master Plan for Horticultural Development defined that the basic area units for horticultural development are (1) the farmstead, with kitchen gardens where horticulture is practised traditionally; (2) privately owned rainfed agricultural land; (3) irrigated land; and (4) the area of community and private forests (Carson 1990:75).

At least in the southern part of Gorkha, most of the area would fall into one of these categories, and it was decided to analyse and delineate the horticultural areas for agricultural land only, which could be expected to be privately owned. The land tenure system could not be considered. Agricultural land includes not only the cultivated area, but also the areas of farmstead, risers and bunds, and non-cultivated land between the fields, e.g., small sections of grassland, shrubland, and forest. There are doubts about whether the farm households are willing to use or to convert intensely cultivated irrigated terraces for horticultural production, even if these crops are more profitable than grain crops, since intense cultivation areas, on both level and sloping terraces (terms used according to the LRMP), are assumed to be the most productive farmland for staple crops in the Middle Mountain Region. These fields are, in particular, located in the valley bottoms, on flat plains or *tars*, and also on steep slopes where the climate, soils, aspect, etc are favourable for cultivation.

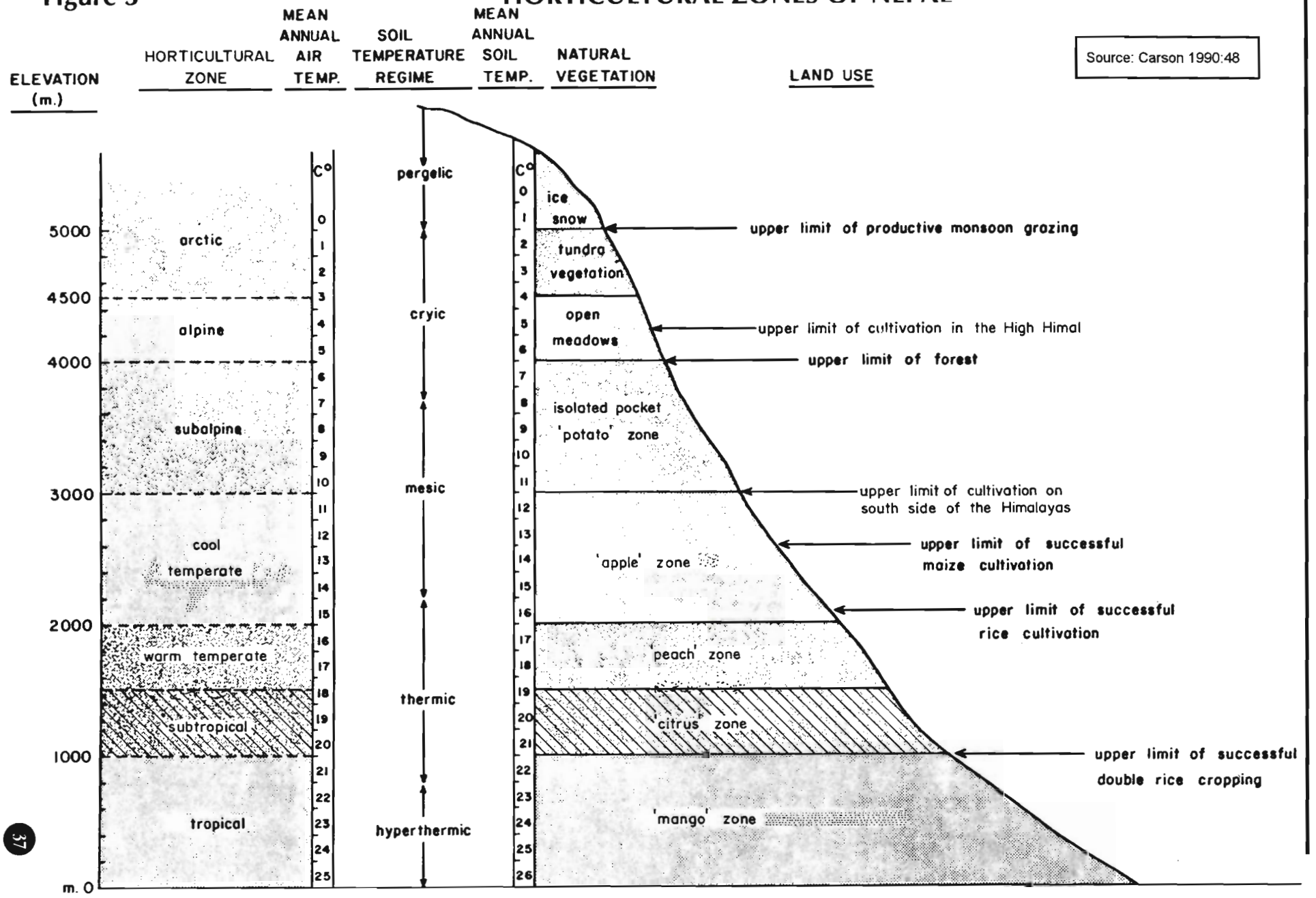
Thus, these areas were also excluded from the analysis, and low- and medium-density cultivated agricultural land on sloping and level terraces were regarded as the potential horticultural development areas. In this study a detailed classification was conducted for these areas, applying parameters of the LRMP land use data of 1979, classes C1/T1 and C2/T2. Agricultural land in the High Mountain Region is scarce, and people rely on it for staple crop production even more than in the mid-hills. Still, the land is not cultivated intensively due to the harsh climatic conditions. To show the potential of horticultural development in this region, it was decided to include all agricultural land delineated by LRMP in the analysis (Maps 21 and 22).

2.3 Temperature Regimes and Altitude/Agroclimatic Zones

Temperature is given by most authors as the primary indicator/parameter for horticultural production. The Master Plan for Horticultural Development, for example, describes horticultural (climatic) zones as primarily based on the mean annual air temperature and its relation to the altitude (Carson 1990:47). The Master Plan mainly differentiates between five horticultural zones: tropical (< 1,000m); subtropical (1,000 - 1,500m); warm temperate (1,500 - 2,000m); cool temperate (2,000 - 3,000m); and the subalpine zone (3,000 - 4,000m), with isolated pocket areas and potato-growing agricultural systems. Furthermore, each fruit crop is related to certain temperature requirements. However, the optimum production ranges of various fruit crops, according to temperatures and elevations, do not match the given horticultural zones and the agroclimatic zones (compare Part I). Therefore, the delineated agroclimatic zones could not be used directly for the assessment of horticultural development areas for particular fruit crops in Gorkha. Also, the Master Plan does not refer to the particular temperature requirements of individual fruits, but it provides altitudinal ranges. (It was not made clear which criteria were selected first, the elevation ranges, based on field experience, or the temperature values.) Nevertheless, the optimal elevation ranges for all fruit crops, as given by the Master Plan, were converted to mean annual temperature values (Ranjit 1990:36a) (Figure 3) (Map 23).

Figure 3

HORTICULTURAL ZONES OF NEPAL



There is a great variability in precipitation in the area in relation to seasonal and altitudinal distribution and the orientation of the relief/slopes. In Part I of this report, it was assumed that the precipitation, in general, is one limiting factor to horticultural production, especially on south-facing slopes. However, the database of the moisture regime is not detailed enough to draw area-specific spatial or quantitative conclusions. Still, in accordance with the aspect, qualitative recommendations are given by this study.

2.4 Aspect

There is no doubt that in mountainous areas the aspect has an important influence on the ecosystem. The aspect directly affects the climate, e.g., south-sloping areas receive more radiation than slopes on northern aspects; this is additionally influenced by the slope gradient. Carson (1990) referred to Whiteman (1980) who had reported from the Jumla area that maximum fall temperatures on northern slopes are at least 3°C cooler than on southern aspects. Thus the upper limit of specific crops, including horticultural crops, may vary by 200m. As shown in Part IV of this report, the aspect directly affects the land cover or land-use practices above the subtropical zone. Of course, these practices are also induced by other natural parameters, or the farm households.

Less evapotranspiration and higher soil moisture content on northern slopes create different micro-ecosystems; different soil types may derive from the same parent material on southern and northern slopes, since in the long term the dominant factor of soil genesis is the climate (soil climax). In general, south-facing slopes are drier and have less reproductive strength, which may, in the case of overutilisation of vegetation, e.g., forest and grassland, become critical factors and lead to higher human-induced topsoil erosion (due to a higher soil erodibility; the K-factor of the Universal Soil Loss Equation (USLE). In the subtropical and warm temperate zones, moisture is the limiting climatic factor, and irrigation becomes necessary in horticultural development areas located on south-facing slopes (Map 24).

2.5 Accessibility and Marketing

The Master Plan for Horticulture indicates that horticultural development should incorporate marketing of the products as well as accessibility to markets and road infrastructure. Harston (1993) pointed out that the Master Plan is following a demand-driven approach along with the marketing of fruits at different levels, such as community markets, *haat bazaar*, district headquarters, and city markets. The lack of road infrastructure is recognised as a major hindrance for the economic development of rural areas, in general, and the availability of agricultural inputs as well as marketing of farm surplus products (cash crops), including horticultural products, in particular (Onta 1990:3).

This study can only give recommendations at the production level. For the marketing of fruits, e.g., demand for kinds of fruits, consumers' consumption habits, and changes and analyses of prices, the reader should refer to the Master Plan. At this stage, the GIS database can provide some information about transportation of fruits to markets or the road network in Gorkha and the adjoining districts. GDP has initated a District Road Master Plan which is still under consideration by the District Development Council/Committee (DDC). Presently, in terms of access to the road network, the southern part of Gorkha can be split into four corridors, according to the main drainage system. The very southern area, located along the Trishuli Ganga and Marsyangdi rivers, has good access to the Prithivi Highway where there are bridges across the streams. The case is similar in the west, along the Marsyangdi River, where an earthen feeder road links Besisahar, the Lamjung district headquarters, to the national highway. People from the Chepe *Khola* Valley use this road as a linkage as well. The central southern part, along the Daroundi *Khola,* has been opened up through a bitumen road to the district headquarters, Gorkha *Bazaar*, through an earthen motorable road from Gorkha *Bazaar* to Nareswar. Additionally, on the western river bank of Daroundi *Khola,* there is an earthen road under construction which will be linked to the bitumen road.

Only in the east, next to Dhading District, along the Budhigandaki River, is access by road limited, although in Dhading local roads have been constructed or are in the process of being constructed. Only further up the valley at Arughat do the people of Gorkha benefit from these roads. Recent studies have shown (Rapp 1994) that the major commodity flow to Arughat, which previously was by porter and on mules via Gorkha *Bazaar*, has been shifted to motor vehicles operating on the earthen road from Dhadingbesi to Salyantar. This road is still under construction, and it takes about three to four hours to reach Arughat from the present roadhead (Maps 25,26, and 27).

Horticultural development has to be seen from the mountain perspective, which means that specific mountain conditions have to be considered while planning and implementing activities. Especially the northern, but also the central, part of Gorkha, can be characterised by dimensions of mountain specificities: inaccessibility, fragility, marginality, diversity, comparative advantages, and adaptation (Jodha 1992). Inaccessibility is accompanied socially by the isolation of mountain communities; economically by subsistence agriculture and poverty; biologically by underexplored resources; and physically by remoteness and transportation problems. This implies that the focus of horticultural development in remote areas has to be on crops which help to make the areas self-sufficient in food needs and increase nutrition levels. However, agricultural land is scarce in these areas and is needed for the cultivation of staple crops. Also, it is only feasible to promote products of high value and low volume and those that yield non-perishable substances (Partap 1990:362).

3. APPLIED METHODOLOGY

As already mentioned above, the Master Plan differentiates between four horticultural (climatic) zones, according to elevation and temperature, where particular fruits should be promoted (Ranjit 1990:32,35). The fruits recommended by the Master Plan were included in the analysis of horticultural development in Gorkha.

- tropical (mango) zone: mango, banana, pineapple
- subtropical (citrus) zone: mandarin *(suntala),* sweet orange *(junar),* lime, lemon
- warm temperate (peach) zone: peach, plum
- cool temperate (apple) zone: apple, pear, walnut

The analysis was conducted using overlay modules of the GIS software; due to the size of the database, a raster GIS method was applied. The unit size for the assessment was one hectare (100m resolution); the total agricultural land in Gorkha amounted totally to about 66,000 units.

As already mentioned above, some preconditions were set, i.e., potential horticultural development areas were classified only as medium- and low-density cultivated agricultural land of sloping and level terraces in the Middle Mountain Region and all cultivated land in the High Mountain Region. For each fruit crop, suitability classes were defined, including the parameters of temperature and soil conditions, which were used according to the land units of the LRMP (Annex 13). Finally, the suitabilities were clustered into four categories, making the result less complex and better understandable and including the aspect as well.

(1) Suitable Areas

1.1 Northwestern to eastern aspect (NW, N, NE, E)
1.2 Southeastern to western aspect and level land (SE, S, SW, W)

Besides the fact that only agricultural land was considered for horticultural development, the main criteria for suitable areas for each fruit crop were the optimal temperature ranges defined by Ranjit (1990) and

Rehm and Espig (1991); land units, incorporating dominant soils, defined by LRMP; and soil requirements extracted from the Master Plan.

Suitable soils for horticultural development were mainly found on alluvial plains and fans (land units 9a and 9c); ancient lake and river terraces (10a and 10b); and on moderately to steeply sloping mountainous terrain (11).

Aspects were differentiated mainly to reflect the scarcity of water for fruit production on south-facing slopes and level ground areas, which were expected to be more dry than north-facing slopes and, thus, possibly to require irrigation facilities for successful fruit growing.

(2) Moderately Suitable Areas

2.1 Northwestern to eastern aspect
2.2 Southeastern to western aspect and level land

Moderately suitable areas were classified mainly as being steeply to very steeply mountainous terrain (land unit 12) in temperature ranges below and above the optimum level, where fruit crops would survive but would have lower productivity.

Precipitation was not used as a main parameter in the first place, but it was considered in the analysis, as was accessibility to roads and marketplaces.

4. RESULTS

4.1 Potential Horticultural Development Areas

There seems to be a considerable potential for horticultural development in the district, within the focus of the agricultural area, which, in terms of density, is under low or medium cultivation. Level terraces under medium cultivation cover the largest part of the agricultural area and amount to more than 50 per cent of the potential horticultural development areas (Map 22).

Apart from humidity, which may affect fruit production in Gorkha, no other climatic restrictions, such as the threat of hail or poor air drainage, are indicated by the Master Plan for the district; this is, in part, due to the poor climatic data available (PACMAR 1990:13).

4.2 Tropical Fruits

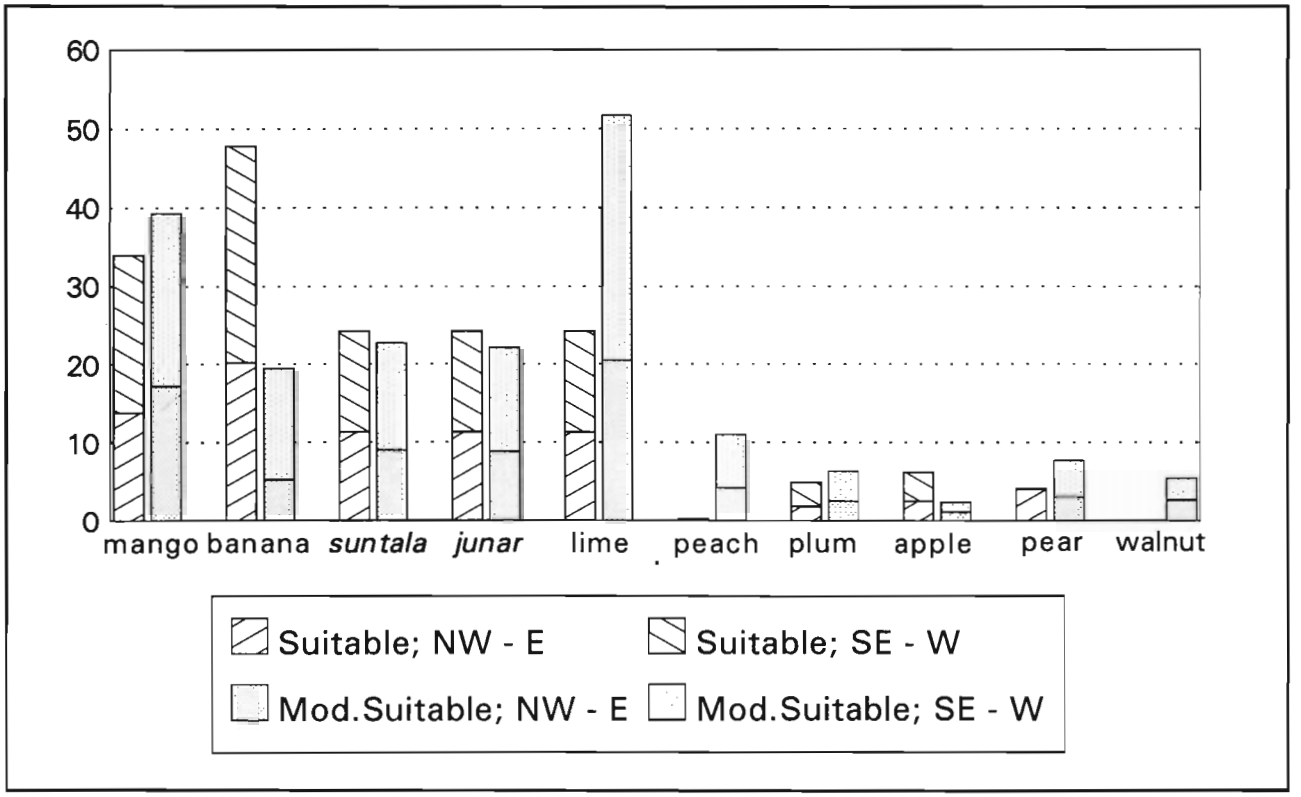
In terms of temperature and soil requirements, mangoes, bananas, and pineapples are seen as the most suitable fruit crops for horticultural development in Gorkha District. Mangoes, bananas, and pineapples have similar needs in terms of soil conditions and can be planted in the same areas. The agricultural area suitable for banana production is larger due to the fact that banana trees grow better than mangoes or pineapples and also grow in cooler climates.

Mangoes *(Mangifera indica)* and pineapples *(Ananas comosus)* are well suited for the southern part of Gorkha District, especially the southwest. About 35 per cent of the potential horticultural development could be met by both fruits, considering temperature and soil requirements; approximately 40 per cent of the area is moderately suitable for cultivation (Figure 4) (Map 28). The mango grows best in tropical summer rainfall regions; a dry period of several months encourages flowering and fruit setting (Rehm and

Espig 1991:186). This indicates that the mango is adaptable to the summer monsoon climate in the area. Pineapples grow well with precipitations of 1,000 - 1,500mm/year, which can be expected in the area. In contrast to mangoes, however, pineapples may need additional sprinkler irrigation in the dry season.

Almost 50 per cent of the potential horticultural development area is well suited for banana *(Musa spp)* production, considering temperature and soil conditions; approximately 20 per cent of the area might be moderately suitable for these fruits (Figure 4) (Map 29). Bananas need evenly spread rainfall of about 2,500mm/year and cannot tolerate waterlogged conditions (Rehm and Espig 1991:183, Ranjit 1990). This implies that, in general, bananas could be grown commercially in Gorkha under humid conditions only, though, on south-facing slopes, irrigation facilities might be necessary. On level terraces, which are used for paddy production, only the risers are suitable for banana growing, due to the compaction of soils which results in waterlogging. Only about 20 per cent of the potential area for banana plantation lies in the humid zone, and approximately 70 per cent is located on level terraces where medium and low densities of cultivation occur; this might restrict the total potential area considerably and make irrigation necessary on a very large scale on southeastern to western aspects and on level ground areas (Table 16).

Figure 4: Suitable Areas for Fruit Crop Production in Gorkha



Potential area: 467sq.km. = 100%

Note: *Junar* : sweet orange; *Suntala:* mandarin

Table 16: Potential Development Area for Banana Crops

Suitability category	Total area	Humid area sq.km.	Area of level terraces
Suitable area			
NW - E	94.3	15.9	64.6
SE - W & level ground	128.7	17.5	89.9
Moderately suitable area			
NW - E	24.1	3.2	14.4
SE - W & level ground	66.7	25.0	46.4

4.3 Citrus Fruits

In addition to tropical fruit crops, citrus species, i.e., *suntala (Citrus reticula), junar (Citrus sinensis),* and lime *(Citrus aurantiifolia),* are the most suitable crops for the district. All three species have similar requirements for temperature and soils in the suitable categories. Almost 25 per cent of the potential horticultural development area might be well suited to citrus fruits. *Suntala* and *junar* could be grown in an additional 22 per cent of the area, whereas the area moderately suitable for lime cultivation is much larger due to its resistance to tropical temperatures (Figure 4) (Map 30). Citrus crops may not grow successfully in a subhumid moisture regime without irrigation, especially on south-facing slopes and in areas where the dry period is more than two months before fruit ripening (Rehm and Espig 1991:178). Only about 38 per cent of the suitable and moderately suitable citrus areas are located in the humid area, providing enough moisture for appropriate fruit cultivation (Table 17).

Table 17: Potential Development Area for *Suntala* and *Junar* Crops

Suitability category	Total area Sq.km.	Humid area
Suitable area		
NW - E	52.9	25.4
SE - W & level ground	60.2	25.1
Moderately suitable area		
NW - E	41.0	12.2
SE - W & level ground	63.0	19.9

4.4 Warm Temperate Fruits

The warm temperate fruit crops mentioned by the Master Plan for Horticultural Development, such as peaches *(Prunus persica)* and plums *(Prunus salicina/Prunus domestica),* are less suitable for Gorkha. There is only a limited area of agricultural land in the temperature zone suited for both crops; and the soil conditions are also not favourable since warm temperate fruit trees prefer deep soils (Figure 4) (Map 31).

Especially in spring, though also in winter, water supplies for warm temperate fruit crops must be guaranteed to grow quality fruits. Therefore, in summer monsoon areas, the trees must be irrigated before the beginning of the rains and after the monsoon (Rehm and Espig 1990:202). Nevertheless, more than

70 per cent of the area, suitable or moderately suitable for plum fruit trees, lies in the humid zone, thus securing enough moisture during the year (Table 18).

Table 18: Potentials Development Area for Plum Crops

Suitability category	Total area	Humid area
	sq.km.	
Suitable area		
NW - E	8.5	7.4
SE - W & level ground	14.3	11.1
Moderately suitable area		
NW - E	11.5	7.9
SE - W & level ground	17.9	10.6

4.5 Temperate Fruits

According to the Master Plan, humidity affects the production of fruit crops in the cool temperate/humid zone. High cloud cover and wet conditions have undesirable effects, e.g., diseases and poor fruit quality, particularly on horticultural crops. Only proper selection of varieties can overcome this problem (PACMAR 1990:13).

Like warm temperate fruits, the development of temperate fruits is not very relevant in Gorkha District. Temperate fruits, such as apples *(Malus domestica),* pears *(Pyrus pyrifolia/P. communis),* and walnuts *(Juglans regia),* are suited for less than 10 per cent of the potential horticultural development area. Among the temperate fruits, nevertheless, apple production has the greatest scope due to its hardiness in winter (Figure 4) (Map 32). The main potential growing areas for apples are located in the VDCs of Kerauja, Uhiya, Laprak, Barpak, and Kharibot. Water availability is the biggest constraint to temperate fruit cultivation. Apples do well in areas with dry summers and wet winters (Ranjit 1990:38). However, the situation in the mid-hills of Nepal is just the opposite, with heavy monsoon rains in summer and, usually, rather dry winters. The Master Plan recommends irrigation for both apple and pear fruit trees in the subhumid moisture regime and in the humid areas at least during the establishment phase (PACMAR 1990:8). About 40 per cent of the potential apple-growing areas are located in the subhumid zone and need irrigation facilities, and the other 60 per cent are possibly too wet for apple growing (Table 19).

Table 19: Potential Development Area for Apple Crops

Suitability category	Total area	Humid area
	sq.km.	
Suitable area		
NW - E	11.7	3.4
SE - W & level ground	17.2	11.0
Moderately suitable area		
NW - E	5.1	4.9
SE - W & level ground	5.9	5.7

4.6 Accessibility and Marketing

Harston (1990:67) has pointed out that the fruit consumption by urban households in Nepal (expenditure in NRs) is mainly of bananas (29%) and oranges (20%), followed by apples (17%), mangoes (13%), and guavas (7.5%). This information may be important in considering the marketing aspect.

The Master Plan indicates that marketability, e.g., cost of transportation, should be considered before commercial production of horticultural crops is started (PACMAR 1990:16). It was added that the further the production area is from the existing road network, the greater will be the difficulties in transporting and marketing fruits. The Master Plan distinguishes between (1) areas within a day's walk to road collection centres and (2) remote areas. For the first category it was found feasible to produce and market perishable fruits of high weight and low value. The horticultural production in the second category should emphasise (i) local consumption only to meet the basic requirements of the people, (ii) producing fruits/crops of low weight and high value, and (iii) processing fruits locally in order to produce a high-value product for the market (PACMAR 1990:16).

The accessibility analysis of roads and bazaars in Gorkha shows that the main potential areas for tropical fruits – mangoes, pineapples, and bananas – lie within only four hours' walking distance of, or one day to and from, the existing road infrastructure and roads that are under construction. Development areas for subtropical, citrus fruits are located within one day's walk to the road network. Also, almost all areas with a potential for warm temperate fruits – peaches and plums – are found within one day's walk from the roads, and transportation should not be a major constraint. The main potential area for apple and pear production lies within two days' walk of Gorkha *Bazaar* and Arughat. At least the marketing and transportation of apples could be economically feasible, due to their storage capabilities and the fact that, in Gorkha *Bazaar* and Arughat, private wholesalers are already dealing with agricultural products. Also, transportation facilities are available on the three road corridors to the north, which are by now mainly used for importing goods.

5. CONCLUSIONS

There is a considerable potential for horticultural development in southern Gorkha District. Temperature and soil conditions are favourable for tropical and citrus fruits in this part of the district. Water availibility might be a problem locally, especially on south-facing slopes, where irrigation becomes necessary. Road infrastructure is going to be fairly well developed compared to other parts of the mid-hills in Nepal; also, mule trails are currently being improved. Still, the cost of transportation of fruits to markets and roads is a major constraint, although villagers may have access to the road network within a one-day walk. Besides cultivation and transportation aspects, marketing of fruits is the crucial point in the commercialisation process. As indicated by the Master Plan, horticultural development should be demand-driven; horticultural programmes need to support fruits for marketing that people want to consume and are willing to pay a reasonable price for. Considering this, there seems to be good scope only for banana, citrus, and mango production on a larger scale. Horticultural development in the middle part of the district has to be seen from a different angle. There, the potential fruit-growing area is rather small. Furthermore, accessibility and transportation are the major constraints. Nevertheless, there is some potential for apple growing in these areas, since apples are storable fruits. A two days' walk - as is necessary from these areas - seems to be economically feasible, especially since apples are a high-value cash crop. The High Mountains, i.e., the upper valley of the Budhigandaki and the valley of the Shyar *Khola*, are remote areas and development of horticultural cash crops is rather limited. However, the promotion of fruit cultivation for local consumption and improvement of the diet is recommended.