# Selection of non-timber forest species for community and private plantations in the high and low altitude areas of Makawanpur District, Nepal

T.N. Maraseni
Australian Centre for Sustainable Catchments – Condamine Alliance
University of Southern Queensland, Toowoomba, Qld 4350, Australia
Email: maraseni@usq.edu.au

## ABSTRACT

The domestication of Non-timber Forest Species (NTFS) is receiving increasing attention from developing economies. However, little is known about the selection of NTFS in Nepal for commercial uses. Sixteen selection criteria were developed and NTFS were ranked for community and private plantations in both low altitude and high altitude areas of Makawanpur district, Nepal, by workshops of multiple NTFS stakeholders. The rigorous scoring of 12 ecologically screened NTFS against the 16 selection criteria revealed that *kurilo* and *sarpagandh* are highly preferred NTFS for low altitude areas whereas *chiraito* and *jatamanshi* are highly preferred for high altitude. This finding coincides with the general perception of participants and the contemporary literature. These are the species being rapidly depleted from the natural forests. Rapid declination of valuable species creates strong motivation from stakeholders for planting them on community and private land.

**Keywords:** non-timber forest species, selection criteria, *kurilo, chiraito*

## INTRODUCTION

Nepal, located in the Indo-Himalayan ranges, has diverse topography, with elevation ranging from 56m to 8,848m within a horizontal distance of only 150km. The climate varies accordingly, from subtropical monsoon in the low altitude areas to arctic tundra in the high Himalayas. Because of these unique features, Nepal ranks within the first quartile for global biodiversity importance, although having only 0.1% of the earth's land area (BPP 1995). The collection and trade of non-timber forest products (NTFPs)[1] has played a key role in the economic development of the country (Maraseni 2002). Many people living in hills and remote villages are involved in the collection and trade of NTFPs for their livelihood. Because of inadequate domestic processing facilities, a large quantity of NTFP is exported both legally and illegally to India in raw form (Maraseni *et al*. 2006). This generates export revenue of about US$26.5 M a year (ANSAB 1998), or 4% of the national gross domestic product of Nepal (Kanel *et al*. 1999).

Some non-timber forest species (NTFS) are threatened by extinction, and others are depleting, partly due to inappropriate collection time, method and tools (Subedi 1999) and partly due to overexploitation (Edward 1996; Maraseni *et al*.

[1] Definitions of NTFPs vary, but in Nepal fuelwood, fodder and timber are not regarded as NTFPs (MFSC 1988). The terms Minor Forest Products (MFPs), NTFPs, *Jaributi*, and Medicinal and Aromatic Plants (MAPs) are used interchangeably; for the purpose of this research, NTFPs refer to the traded parts of plants other than timber, fuelwood and fodder.

2002). If the current rate of NTFPs collection continues and if there are no alternative sources of NTFPs then many NTFS and other ecologically related species will disappear from the Nepalese forests (Maraseni 2002). Domestication of NTFS may be part of the solution. It is believed that the declining supplies of the natural NTFPs stock will create strong incentives for domestication and cultivation of NTFS on degraded community forestland and in agroforestry system (Mittleman *et al.* 1998). Domestication of NTFS has advantages over the collection from natural forest; harvest is facilitated by the proximity of planted stocks to settlement, product quality can be improved by using genetically superior planting material, and higher returns to labour from cultivated NTFS tends to discourage collection from natural forests, thereby allowing the natural stock to regenerate (Mittleman *et al*. 1998). Encouraging smallholder farmers to produce commercially important NTFS in their agroforestry system may also help to overcome poverty (FAO 1996).

Considering the importance of NTFPs in the socioeconomic development of Nepal, the *Master Plan for the Forestry Sector*, a major policy document in Nepal, indicates a high priority for the government to develop the sub-sector of medicinal plants and minor forest products, allocating US$80 M for a period of 21 years from 1988-89 (MFSC 1989). Similarly, the 10$^{th}$ five-year-plan of Nepal (2002-2007) emphasized the need for the sustainable utilization of NTFPs from national forests, and cultivation of NTFS on private, community and leasehold land (NPC 2002). Sharma (2000) highlighted the need for identifying suitable NTFS and their market potential for domestication on private and community land. However, research to date has focused on legal (Yonzon 1994, Shrestha and Stoin 1995, Kanel 1999, Maraseni 2002) or marketing aspects (Bhattarai 1995, Edwards 1996, ANSAB 1997, CBED 1999, Kanel 1999, Maraseni *et al*. 2006) of NTFPs. Little is known about the 'development of selection criteria' and 'selection of NTFS' for private and community plantations in Nepal (Sharma 2002). This requires multidisciplinary knowledge of several aspects of NTFS, including ecology, phenology, planting, harvesting, processing and marketing.

This study represents a first step for the development of selection criteria and selection of NTFS by organizing multidisciplinary workshops which include forest officers, rangers, District Development Committee Members and Village Development Committee Chairpersons and Secretaries, together with NTF planters, collectors, middlemen and wholesalers. The objective of the study reported here has been to develop criteria for selecting NTFS and hence rank NTFS for community and private plantations in both low altitude (166 to 1000 masl) and high altitude areas (1000 to 2586 masl) of Makawanpur district of Nepal. The next section discusses selection of study area. The justification and process used to develop selection criteria and ranking of NTFS are then presented. Next, research findings are reported, followed by concluding comments.

## STUDY AREA (MAKAWANPPUR DISTRICT) SELECTION AND JUSTIFICATION

The study area, Makawanpur district lies in the Narayani zone of the central region of Nepal, between 27° 21´- 27° 40´ N and 84° 41´- 84° 35´ E (Figure 1). The district is politically divided into 43 Village Development Committees and one Municipality,

where over 390,000 people live (CBS 2001). Over 65% of the total land area (244,488 ha) is forest and another 25% is agricultural land. However, only 66.4% (40,842 ha) of the total agriculture land is cultivated (DFO 2002). Over 75% of the district is hill country and has rugged topography. The Siwalic Range passes along the south of the district and Mahabharat Range along the north. The Siwalik Range is composed of coarsely bedded stones, shale and conglomerates, whereas the Mahabharat Hills are composed of sandstone, limestone, quartzite and gneiss. Climatically, the district varies from sub-tropical in the south to temperate in the north (Nepal Research Associates 1999).

The mean monthly maximum and minimum temperatures over 34 years (1967 to 2000) at Heatuada (capital city, in the low altitude zone) are 29°C and 17°C, and mean annual rainfall is 2125 mm. The rainfall is influenced by the south-eastern monsoon and almost 80% of the rainfall occurs from June to September. The remaining months are influenced by the south-western monsoon, which contains little moisture and results in relatively dry weather. It is estimated that every 200 m elevation, the mean temperature drops by one degree centigrade (Khanna 1989). The average daily temperature of the high altitude sites ranges from -2 to 24 degrees. Higher elevation areas are prone to snowfall during winter.

Makawanpur district was selected for several reasons. It has diverse topography and a high elevation range (166 to 2586 masl), and thus experiences a tropical to cool temperate climate, leading to highly diverse types of NTFS (Nepal Research Associates 1999). It is therefore likely that people will have exposure on various types of NTFS. The district has a long history of NTFPs trading. Since the early 1950s lichen has been traded in district capital of Bhaise (Maraseni 2002), hence residents have indigenous knowledge of phenology, collections, uses, processing and marketing of local NPFs. The quantity of NTFPs traded from this district is high relative to other similar districts of Nepal, due to its proximity to the Indian markets (Maraseni 2002) and connectivity to the two major Highways (Tribhuvan and Mahendra Highways) of Nepal. Altogether 825,000 kg, consisting of 43 NTFS, was traded from the Makawanpur district in the three years 1998 to 2001, generating more than 4.32 M Nepalese rupees (NR) (US$ 56,104) revenue[2] for the government (Maraseni and Shivakoti 2003). This district is home to all levels of NTFS stakeholders, from planters and collectors to wholesalers, allowing workshops of various stakeholders to be organized. Approximately 33% of the agricultural land in this district is uncultivated due to poor site quality (DFO 2002), which could be used for NTF plantation; therefore, the applicability of research outcomes could be wide.

Makawanpur district is a targeted area for both the Community Forestry (CF)[3] and Hills Leasehold Forestry Programs (HLF)[4]. According to the *Master Plan for the Forestry Sector*, 38% (54,932 ha) of the total forest area of this district has potential for community forests (MFSC 1989), with 45% of this already handed over to the local communities (DFO 2002). This district is equally potential for the HLF program mainly due to availability of poor degraded land and presence of poor people, which

[2] US$1 = 77 Nepalese rupees (NR), as in May 2002.

[3] Community forestry is a forest management regime in which local people are organised into a forest user group and take full responsibility for conservation, management and utilization of the government forest handed over to them as per the Forest Act 1993 and Forest Regulation 1995.

[4] Leasehold forestry is a forest management regime in which the degraded land is handed over to the eligible people for 40 years for forest related use of the given land as per Forest Act 1993 and Forest Regulation 1995.

are the basic eligibility criteria to the lease of the HLF program. Both CF and LHF programs focus on the degraded open forestlands which are abundant in the district, where user groups (in CF) and leases (in HLF) are eligible to cultivate and manage NTFS under the forest regulations. Therefore, the NTFS domestication program could be effective in this district.

## PROCESS USED TO DEVELOP SELECTION CRITERIA AND RANKING OF NTFS

The Makawanpur district is divided into the low and high altitude area (Figure 1). A one-day workshop was initially organized for each altitudinal zone – at Palung for high-altitude area and Handikhola for low-altitude area – with the support of forest authorities, which are the business hubs of NTFPs. Forest personnel, community chairpersons and secretaries, and NTFPs collectors and local traders participated in the workshops.

A two-day district level workshop (March 1 and 2, 2002) was subsequently organized; participants included forest officers, rangers, District Development Committee Members, Village Development Committee Chairpersons, NTFPs collectors, planters, processors, middlemen and wholesalers. After in-depth discussion, this workshop:

- identified 24 well-known NTFS found in the district, 12 from each altitudinal zone.
- developed 16 selection criteria applicable for both zones. These criteria were identified on the basis of experiences and literature.
- placed weighs 'W' (i = 1 to 16) on each of the selected criteria based on their importance in decision-making on domestication.
- Assigned a rank 'R' (j = 0 to 11) to each species, based on their performance against each of the selection criteria. The overall score for each NTFS was calculated as follows:

$$\text{Overall score} = \sum_{i=1,\, j=0}^{i=16,\, j=11} (W_i * R_j) \text{..... ..... ..... ....(1)}$$

- ranked each of 12 NTFS from each altitudinal zone based on their overall score. The higher the overall score the higher the rank of species. There was brief discussion to validate that the species rankings were in accord with general perceptions of participants and contemporary research. To stimulate discussion small groups were formed.

## RESULTS AND DISCUSSION

The workshops revealed that people were highly interested in planting NTFS in their marginal private lands, and in the barren land under the CF and HLF programs. The participants selected 12 well-known NTFS from each altitudinal zone, which are available and had been traded in the district for decades, and for which people have reasonable knowledge about their cultivation, harvesting, processing, uses and marking aspects, which could be possible selection criteria. Therefore, it was assumed that these species are ecologically screened for that region. The selected species for the low-altitude zone were *kurilo, jiwanti, sarpa-gandha, amala, pipla, sugandha-kokila, sikakai, bhalekurilo, bjojo, nageswori, nim* and *bel*, while those for

the high-altitude zone were *chiraito, jatamashi, sinkauli, bikhma, jiwanti, nagbeli, pakhan-bed,bishphej, kafal, bhalekurilo, buki phool* and *majhito*. The species are listed in Tables 1 and 2, and their botanical names are reported in Table 3).

After selecting potential NTFS, the workshop participants developed 23 selection criteria and finally come down to 16 selection criteria, and all criteria were given weights, ranging from 1 to 16 (Table 1 and 2). The discussion was held to include the closely related criteria such as 'high national and international demands', 'saleable in the local area', 'has local uses', 'useful for multiple things'. Workshop participants finally agreed unanimously to include all 16 criteria, with the assumption that the various weighs of these criteria will be appropriate to segregate them from each other. Among the 16 criteria, 'high price', 'high national and international demands' and 'easy to plant' received relatively high weighs, whereas 'use in own house', 'saleable in local area, and 'easy to transport' received lower weights than other criteria.

After having weighted the selection criteria, the selected 12 species from each altitudinal zone were ranked (0 to 11) on the basis of their performances against the criteria in the workshops. Scores under each selection criterion for the individual species were summed to obtain overall scores, by which all species were ranked (Table 1 and Table 2).

In low altitude areas, *Kurilo* (asparagus, *Asparagus racemosus*) was selected as the best species for planting with a total score of 1293 (Table 1) and the highest score on most of the criteria. It was ranked third among the rapidly diminishing species from the lower belt areas of the Makawanpur district (Maraseni 2002). The Dabur-Nepal has planted Australian varieties of this species for making ayurvedic medicine in the neighboring district with favorable results. It is a highly traded NTFS from the district in terms of revenue and the second most highly traded species by quantity (DFO 2002). The main tradable part of *kurilo* (asparagus) is the tuber (root), which is used medicinally as a refrigerant, demulcent, diuretic, aphrodisiac, antispasmodic, antidiarrhoeatic and anti-dysenteric (Kirtikar and Basu 1993). Bhattarai (2001) estimated a net income at 80,400 NRs (US$1044) per hectare of plantation in 18 months for this species. The second best species for low altitude areas was found to be *sarpagandha* (*Rowelphia serpentine*), used for making medicine for controlling hypertension and blood pressure, with a total score of 1137. It was ranked first as the most rapidly depleting species from the low altitude area (Maraseni 2002). The third best species for planting was *pipla* (*Piper longum)*, used for spices, with a total score of 1049. In the past, this species was widely distributed in the lower belt of Makawanpur district, but now it is sparsely available.

From the high altitude area, *chiraito* (*Swertia chirita*), *jatamashi* (*Nardostachys jatamansi*) and *sincauli* (*Acacia consinna*) were found to be the first, second and third best species for planting, with scores of 1358, 1288 and 1180 respectively (Table 2). The first two species have been categorized as highly depleting species from the high altitude area (Maraseni 2002). Ten years ago, they were abundant in the forest but their population is now small and distribution localized, as reported by the participants. *Chiraito* is used for the treatment of jaundice, typhoid, eye strain, malaria and other diseases related to blood infection (Kirtikar and Basu 1993). It is also used to give the bitter taste of wine, whisky and beer. The net annual

revenue from one hectare of *chiraito* plantation could be 76,100 NRs (US$988.00) (Bhattarai, 2001). *Jatamanshi* is reportedly used for treating a range of skin diseases, bleaching of hair, and treatment of ulcers, cholera, epilepsy and heart disease, as well as manufacturing soap and scent, and is famous for aromatic oil (Kirtikar and Basu 1993).

Among the others, *Jiwanti, Sikakai* and *Bukiphul* were found to be the least preferred species for planting (Table 1 and 2).The overall ranking of major species, *kurilo* from low altitude and *chiraita* from high altitude areas, was as per the general expectation of participants. These are the species which have been traded for a decades and value of these species have been recognized from local people since long. Overexploited and highly depleted species including *kurilo, sarpagandha, pipla, chiraita* and *jatamashi* are ranked higher relative to other relatively unexploited species for planting (Table 1 and 2). It appears that declining supplies of highly valuable species from natural forests create strong motivation for commercial cultivation of those species on 'unforested forest land' and agricultural land.

In the mid-hill regions of Nepal, an area of about 1.3 M ha (about 42% of total forestland) of 'unforested forestlands' including shrub land, degraded forests, grasslands and non-cultivated area was reported in 1989 (MFSC 1989). Since the implementation of the community forestry program, the forest condition has improved, but further improvement is needed in such 'unforested forestlands' (Brown and Shrestha 2000; Awasthi *et al*. 2002). In addition to the 'unforested forestland, 33% of the agricultural land in the Makawanpur district is uncultivated due to poor site quality (DFO 2002). Promotion of NTFS in such areas would make a major contribution to the national economy and restoration of the degraded environment. .

## CONCLUSIONS

This study has demonstrated how a workshop with participation of various levels of stakeholders can be useful to develop selection criteria and to rank NTFS for private and community planting. The rigorous scoring of 12 ecologically screened NTFS against the developed selection criteria shows that *kurilo* and *sarpagandh* are highly preferred NTFS for low altitude areas and *chirata* and *jatamanshi* are highly preferred NTFS for high altitude areas of Makawanpur district of Nepal. These results are compatible with the general perception of participants and contemporary literature. These species are being rapidly depleted from the natural forests. Declining supplies of highly valuable species from natural forests creates strong motivation from stakeholders for planting these species on barren forest and agricultural land. This research is directly applicable to those areas of Nepal which have climatic and altitudinal similarities to the research site, but the research method can be applied anywhere in the world for similar types of research questions.

## ACKNOWLEDGEMENTS

I would like to thank the Australian Centre for Sustainable Catchments, University of Southern Queensland, for logistical and other support. My special thanks go to Steve Harrison of The University of Queensland and Jerry Maroulis of

the University of Southern Queensland for their tremendous effort in editing and providing critical comments that assisted in the production of this final version. Most importantly, my cordial thanks go to the forest officers, rangers, District Development Committee Members, Village Development Committee Chairpersons and Secretaries, and NTFS collectors, planters, processors, middlemen and wholesalers of Makawanpur district, Nepal, for their invaluable contributions and discussions to the workshops.

## REFERENCES

ANSAB (Asia Network for Small Scale Bio-resources) 1998. '*Nepal NTFPs Network Newsletter*', March 1998, Kathmandu.

ANSAB (Asia Network for Small Scale Bioresources) 1997. '*NTFP Entrepreneurs*' *Directory*', ANSAB, Kathmandu.

Awasthi, K.D., Sitaula, B.K, Singh, B.R. and Bajacharaya, R.M. 2002. '*Land-Use Change in Two Nepalese Watersheds: GIS and Geomorphometric Analysis*', land Degradation and Development, 13: 495-513.

Beer, J.H.D. and McDermott, M.J. 1996. '*The Economic Value of Non-timber Forest Products in South East Asia*', 2nd revised edition, The Netherlands Committee for IUCN, Amsterdam.

Bhattarai, D.R. 2001. '*Jaributi Manjari*' Herbal Production and Processing Company Limited, Kathmandu.

BPP (Biodiversity Profile Project) 1995. '*Enumeration of the Lichens of Nepal*' His Majestic Government of Nepal and Government of Netherlands, Kathmandu.

Brown, S and Shrestha, B. 2000. *'Market Driven Land-use Dynamics in the Middle Mountains of Nepal'*, Journal of Environmental Management, 59 (3) 217-25.

CBED (Community Based Economic Development Project) 1999. *Sub-sector Analysis of High Altitude NTFPs in the Karnali Zone*, Volume 1, Kathmandu.

CBS Central Bureau of Statistics 2002. '*Statistical Year Book of Nepal*'. His Majestic Government of Nepal, National Planning Commission Secretariat, Kathmandu.l

DFO District Forest Office 2002. '*Records of Traded NTFPs*' Received from Planning and Account Section of DFO Makawanpur, Hetauda, Nepal

Edward, D.M. 1996. '*Non-timber Forest Products from Nepal: Aspects of the Trade in Medicinal and Aromatic Plants*', FORSEC Monograph 1/96, Forest Research Service Centre, Ministry of Forests and Soil Conservation, Babarmahal, Katmandu.

FAO Food and Agricultural Organization 1996. 'Asia- Pacific Agroforestry Profiles: Second Edition' Rome.

Kanel, K.R. 1999. 'Policy related issues in non-timber forest products business', in R.B. Rawal, B. Bhatta and A. Paudyal (eds), *Non-timber Forest Products: Production, Collection and Trade of NTFPs in Mid Western Development Region of Nepal*, HMG, USAID, BSP and New ERA, Kathmandu.

Kanel, K.R., Chapagain, D.P. and Regmi, D.C. 1999. Current Policy and Legal Context of the Forestry Sector with Reference to the Community Forestry Program in Nepal, a draft submitted to Nepal-UK Community Forestry Project, Kathmandu.

Khanna, L. S. 1989. 'Principles and Practice of Silviculture', Khanna Bandhu, 7 Tilak Marg, Dehradun, India.

Kirtikar, K.R. and Basu, B.D. 1993. *Indian Medicinal Plants* (2nd ed.), Vol. 1–4, 1935 reprint, Periodical Experts, Delhi.

Maraseni, T.N. (2002) Harvesting Techniques and Market Analysis of Selected Non Timber Forest Products in Makawanpur District, Nepal, a thesis submitted as partial fulfilment of the requirements for the degree of Master of Science, AIT, Bangkok.

Maraseni, T.N., and Shivakoti G. 2003. 'Enhancement of harvesting and marketing policies for non-timber forest products in Nepal', in A.J. Hiremath, C. Gladwi. and R. Uma Shankar (eds), Proceedings of the South Asian Regional workshop on Policies, Utilization and Conservation of Non Timber Forest Products in South Asia Region, 28–30 April 2003, Bangalore, India.

Maraseni, T.N., Shivakoti G., Cockfield, G. and Apan, A. 2006. 'Nepalese Non-timber Forest Products: An Analysis of the Equitability of Profit Distribution across a Supply Chain to India' *Small-scale Forest Economics, Management and Policy*, 5(2): 191 - 206

MFSC (Ministry of Forests and Soil Conservation) 1989. *Master Plan for Forestry Sector*, Main Report, His Majesty's Government of Nepal, Kathmandu, Nepal.

Mittleman A.J., Lai, C.K., Byron, N. Michon, G. and Katz, E. 1998. 'Non-wood forests products: outlook study for Asia and Pacific towards 2010', in *Asia-Pacific Forestry Sector Outlook Study Working Paper Series*, No. 28, FAO, Rome.

Nepal Research Associates 1999. *Makwanpur District Profile*. District Development Committee, Hetauda

NPC (National Planning Commission) 2002. *Draft of Tenth plan 2002-2007*, His Majesty's Government of Nepal, Kathmandu.

Sharma, P. 2000. 'Opportunities in and Constraints to the Sustainable Use of Non-Timber Forest Resources in the Himalayas Mountain Enterprises and Infrastructure' ICIMOD, Kathmandu.

Shrestha, K.N. and Stoin, D. 1995. 'The Forest Rules and their Relevance to the Utilization of Medicinal and Aromatic Plants, Gorkha, Nepal

Subedi B.P. 1999. 'Non-timber Sub-sector in Nepal, Opportunities and Challenges for Linking the Business with Biodiversity Conservation' ANSAB Kathmandu.

Yonzon, P. 1994. 'Jaributi exploitation from Langtang National Park' in Proceedings for the Non-timber Forest Products Seminar Held in Kathmandu on 12 May (1993). Forest Research and Survey Centre, Kathmandu. pp 10-11.

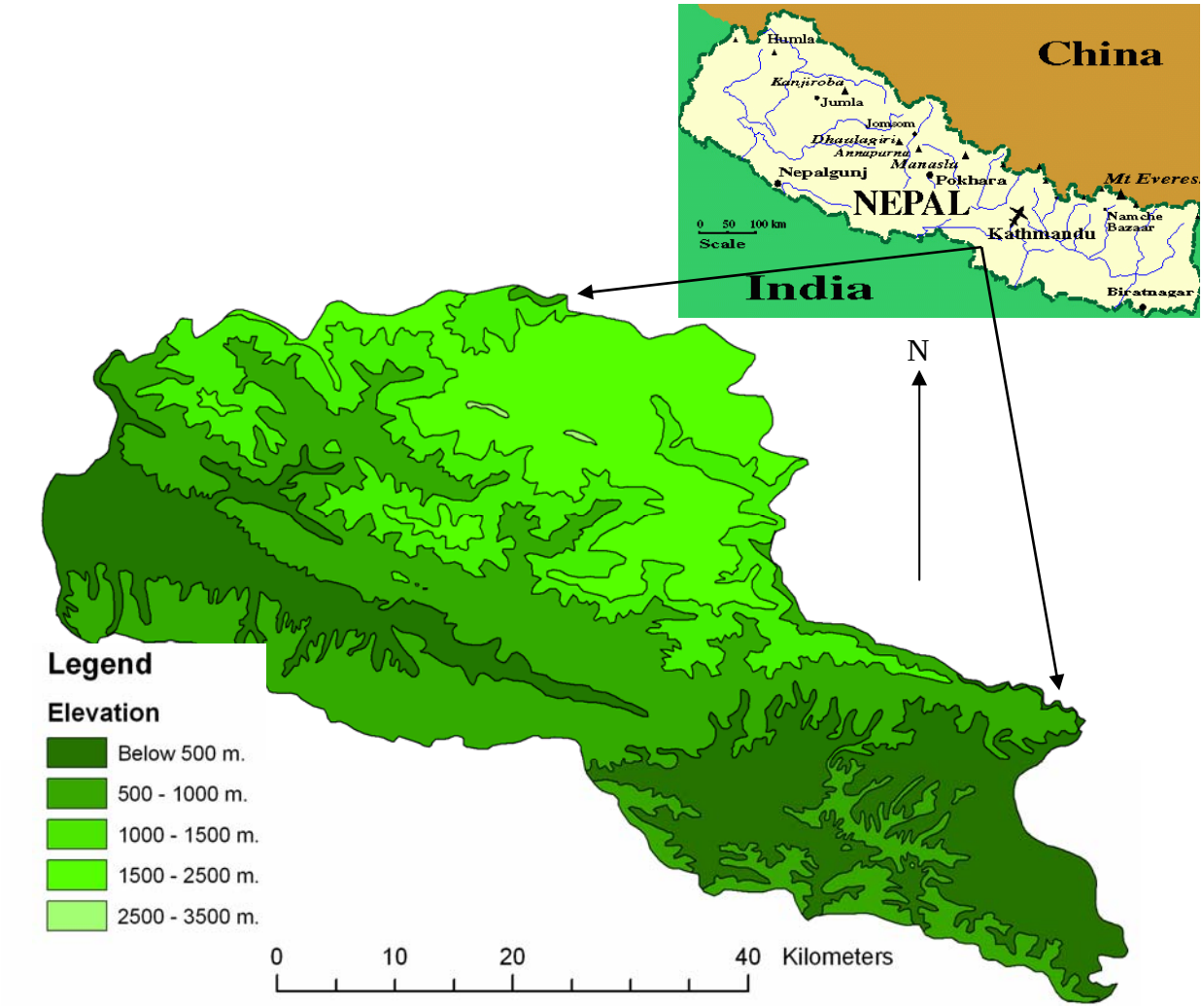


Figure 1 Elevation map of Makawanpur district (inset, the Map of Nepal)

Table 1 Criteria and their weightages for the selection of non-timber forest (NTFS) species, and ranking of NTFS against the selected criteria in the low-altitude areas of Makawanpur district, Nepal

| Criterion | Wt. | *Kurilo* | | *Jiwanti* | | *Sarpa-gandha* | | *Amala* | | *Pipla* | | *Sugandh-kokila* | | *Sikakai* | | *Bhale Chiraito* | | *Bhojo* | | *Nage-swori* | | *Nim* | | *Bel* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S |
| Easy to plant | 14 | 10 | 140 | 5 | 70 | 10 | 140 | 7 | 98 | 9 | 126 | 5 | 70 | 2 | 28 | 1 | 14 | 11 | 154 | 2 | 28 | 5 | 70 | 8 | 112 |
| Easy to grow on marginal land | 11 | 11 | 121 | 0 | 0 | 8 | 88 | 9 | 99 | 6 | 66 | 5 | 55 | 4 | 44 | 7 | 77 | 4 | 44 | 0 | 0 | 7 | 77 | 7 | 77 |
| Agroforestry species | 10 | 11 | 110 | 0 | 0 | 10 | 100 | 8 | 80 | 5 | 50 | 11 | 110 | 0 | 0 | 7 | 70 | 6 | 60 | 8 | 80 | 10 | 100 | 10 | 100 |
| Easy to establish | 13 | 10 | 130 | 4 | 52 | 8 | 104 | 3 | 39 | 4 | 52 | 9 | 117 | 0 | 0 | 2 | 26 | 11 | 143 | 1 | 13 | 9 | 117 | 9 | 117 |
| Fast growing | 8 | 11 | 88 | 7 | 56 | 6 | 48 | 1 | 8 | 9 | 72 | 1 | 8 | 1 | 8 | 9 | 72 | 11 | 88 | 1 | 8 | 6 | 48 | 1 | 8 |
| Easy to harvest | 7 | 8 | 56 | 1 | 7 | 9 | 63 | 5 | 35 | 10 | 70 | 1 | 7 | 2 | 14 | 11 | 77 | 8 | 56 | 0 | 0 | 5 | 35 | 1 | 7 |
| No need to cut tree | 9 | 11 | 99 | 7 | 63 | 10 | 90 | 0 | 0 | 9 | 81 | 0 | 0 | 0 | 0 | 8 | 72 | 8 | 72 | 0 | 0 | 0 | 0 | 0 | 0 |
| High production | 12 | 10 | 120 | 6 | 72 | 8 | 96 | 11 | 132 | 8 | 96 | 8 | 96 | 5 | 60 | 10 | 120 | 8 | 96 | 7 | 84 | 11 | 132 | 11 | 132 |
| Easy for processing | 6 | 1 | 6 | 2 | 12 | 10 | 60 | 3 | 18 | 11 | 66 | 10 | 60 | 8 | 48 | 9 | 54 | 7 | 42 | 7 | 42 | 11 | 66 | 3 | 18 |
| Easy to store | 4 | 3 | 12 | 11 | 44 | 10 | 40 | 8 | 32 | 6 | 24 | 7 | 28 | 4 | 16 | 8 | 32 | 8 | 32 | 8 | 32 | 10 | 40 | 10 | 40 |
| Easy to transport | 3 | 3 | 9 | 1 | 3 | 9 | 27 | 8 | 24 | 10 | 30 | 8 | 24 | 2 | 6 | 2 | 6 | 5 | 15 | 11 | 33 | 2 | 6 | 8 | 24 |
| Saleable in the local area | 2 | 11 | 22 | 5 | 10 | 6 | 12 | 10 | 20 | 8 | 16 | 2 | 4 | 2 | 4 | 9 | 18 | 5 | 10 | 0 | 0 | 3 | 6 | 8 | 16 |
| Good national and international demands | 15 | 11 | 165 | 5 | 75 | 8 | 120 | 10 | 150 | 10 | 150 | 8 | 120 | 4 | 60 | 10 | 150 | 8 | 120 | 7 | 105 | 2 | 30 | 6 | 90 |
| Use for multiple things | 5 | 7 | 35 | 0 | 0 | 4 | 20 | 10 | 50 | 6 | 30 | 3 | 15 | 1 | 5 | 2 | 10 | 4 | 20 | 7 | 35 | 8 | 40 | 10 | 50 |
| Use in own house | 1 | 4 | 4 | 0 | 0 | 1 | 1 | 11 | 11 | 8 | 8 | 0 | 0 | 0 | 0 | 1 | 1 | 4 | 4 | 0 | 0 | 10 | 10 | 8 | 8 |
| Good price | 16 | 11 | 176 | 4 | 64 | 8 | 128 | 5 | 80 | 7 | 112 | 10 | 160 | 1 | 16 | 3 | 48 | 2 | 32 | 9 | 144 | 0 | 0 | 6 | 96 |
| Total score | | | **1293** | | **528** | | **1137** | | **876** | | **1049** | | **874** | | **309** | **99** | **847** | | **988** | | **604** | | **777** | | **895** |
| Overall rank | | | **1** | | **11** | | **2** | | **6** | | **3** | | **7** | | **12** | | **8** | | **4** | | **10** | | **9** | | **5** |

Note: 'Wt.' is weight of selection criterion (1 to 16), 'R' rank of NPFs (0 to 11) against each of the selection criteria and 'S' score (W × R)

Table 2. Criteria and their weightages for the selection of non-timber forest (NTFS) species, and ranking of NTFS against the selected criteria in the high-altitude areas of Makawanpur district, Nepal

| **Criteria** | W | *Chiraito* | | *Jatamashi* | | *Sinkauli* | | *Bikhma* | | *Jiwanti* | | *Nagbeli* | | *Pakhan-bed* | | *Bishphej* | | *Kafal* | | *Bhale Kurilo* | | *Buki phool* | | *Majitho* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S | R | S |
| Easy to plant | 14 | 12 | 168 | 11 | 154 | 10 | 140 | 1 | 14 | 5 | 70 | 1 | 14 | 1 | 14 | 1 | 14 | 10 | 140 | 9 | 126 | 1 | 14 | 1 | 14 |
| Easy to grow on marginal land | 11 | 6 | 66 | 8 | 88 | 9 | 99 | 3 | 33 | 0 | 0 | 6 | 66 | 12 | 132 | 5 | 55 | 9 | 99 | 11 | 121 | 8 | 88 | 7 | 77 |
| Agroforestry species | 10 | 12 | 120 | 11 | 110 | 10 | 100 | 5 | 50 | 0 | 0 | 1 | 10 | 1 | 10 | 1 | 10 | 9 | 90 | 8 | 80 | 4 | 40 | 1 | 10 |
| Easy to establish | 13 | 9 | 117 | 10 | 130 | 11 | 143 | 1 | 13 | 4 | 52 | 1 | 13 | 1 | 13 | 1 | 13 | 12 | 156 | 8 | 104 | 1 | 13 | 4 | 52 |
| Fast growing | 8 | 11 | 88 | 10 | 80 | 1 | 8 | 8 | 64 | 7 | 56 | 9 | 72 | 12 | 96 | 7 | 56 | 1 | 8 | 8 | 64 | 10 | 80 | 7 | 56 |
| Easy to harvest | 7 | 3 | 21 | 5 | 35 | 11 | 77 | 2 | 14 | 1 | 7 | 7 | 49 | 10 | 70 | 4 | 28 | 12 | 84 | 3 | 21 | 8 | 56 | 10 | 70 |
| No need to cut tree of forest tree | 9 | 10 | 90 | 11 | 99 | 1 | 9 | 8 | 72 | 7 | 63 | 10 | 90 | 10 | 90 | 8 | 72 | 1 | 9 | 10 | 90 | 10 | 90 | 2 | 18 |
| High production | 12 | 10 | 120 | 6 | 72 | 11 | 132 | 2 | 24 | 6 | 72 | 5 | 60 | 9 | 108 | 4 | 48 | 7 | 84 | 8 | 96 | 1 | 12 | 5 | 60 |
| Easy for processing | 6 | 9 | 54 | 8 | 48 | 10 | 60 | 6 | 36 | 2 | 12 | 8 | 48 | 7 | 42 | 8 | 48 | 11 | 66 | 3 | 18 | 10 | 60 | 6 | 36 |
| Easy to store | 4 | 10 | 40 | 11 | 44 | 12 | 48 | 10 | 40 | 11 | 44 | 8 | 32 | 9 | 36 | 10 | 40 | 12 | 48 | 10 | 40 | 6 | 24 | 6 | 24 |
| Easy to transport | 3 | 4 | 12 | 7 | 21 | 8 | 24 | 12 | 36 | 1 | 3 | 5 | 15 | 8 | 24 | 11 | 33 | 10 | 30 | 10 | 30 | 4 | 12 | 3 | 9 |
| Saleable in the local area | 2 | 12 | 24 | 11 | 22 | 10 | 20 | 7 | 14 | 5 | 10 | 8 | 16 | 9 | 18 | 7 | 14 | 10 | 20 | 11 | 22 | 2 | 4 | 9 | 18 |
| Good national and international demands | 15 | 12 | 180 | 11 | 165 | 10 | 150 | 7 | 105 | 5 | 75 | 8 | 120 | 9 | 135 | 7 | 105 | 10 | 150 | 11 | 165 | 2 | 30 | 9 | 135 |
| Use for multiple things | 5 | 11 | 55 | 10 | 50 | 8 | 40 | 1 | 5 | 0 | 0 | 7 | 35 | 12 | 60 | 6 | 30 | 6 | 30 | 9 | 45 | 1 | 5 | 3 | 15 |
| Use in own house | 1 | 11 | 11 | 10 | 10 | 2 | 2 | 1 | 1 | 0 | 0 | 3 | 3 | 12 | 12 | 8 | 8 | 9 | 9 | 1 | 1 | 1 | 1 | 1 | 1 |
| Good market price | 16 | 12 | 192 | 10 | 160 | 8 | 128 | 10 | 160 | 4 | 64 | 2 | 32 | 4 | 64 | 6 | 96 | 5 | 80 | 9 | 144 | 2 | 32 | 3 | 48 |
| Total score | | | **1358** | | **1288** | | **1180** | | **681** | | **528** | | **675** | | **924** | | **670** | | **1103** | | **1167** | | **561** | | **643** |
| Overall rank | | | **1** | | **2** | | **3** | | **8** | | **12** | | **7** | | **6** | | **9** | | **5** | | **4** | | **11** | | **10** |

Note: ‘W’ weight of selection criteria (1 to 16), ‘R’ rank of NPFs (0 to 11) against each of the selection criteria and ‘S’ score (W × R)

Table 3 Nepalese name and botanical name of ecologically screened non-timber forest species

| Nepalese name | Botanical Name | Nepalese name | Botanical Name |
|---|---|---|---|
| *Amala* | *Emblica officinalis* | *Kurilo* | *Asparagus racemosus* |
| *Bel* | *Aegal marmelos* | *Majitho* | *Rubia cardifolia* |
| *Bhale kurilo* | *Asparagus officinalis* | *Nagbeli* | *Lycopodium clavatum* |
| *Bhojo* | *Acorus calamus* | *Nageswori* | *Mesua ferrea* |
| *Bikhama* | *Aconitum bisma* | *Nim* | *Azadirachta indica* |
| *Bisphej* | *Polipodium vulgare* | *Pakhanbed* | *Berginia ciliata* |
| *Bukiphul* | *Gnaphalium affine* | *Pipla* | *Piper longum* |
| *Chiraito/Bhale Chiraito* | *Swertia chirita* | *Sarphagandha* | *Rauwolfia serpentine* |
| *Jatamansi* | *Nardostachys jatamansi* | *Sikakai* | *Acacia consinna* |
| *Jiwanti* | *Dendrobium macraei* | *Sinkauli* | *Cinnamomum tamala* |
| *Kafal* | *Myrica esculenta* | *Sugandhakokila* | *Cinnamomum glaucescens* |