International Master Programme at
the Swedish Biodiversity Centre

Master theses
No. 29
Uppsala 2003
ISSN: 1653-834X

Home gardens in western Nepal:

Opportunities and challenges for *on-farm* management of agrobiodiversity

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CBM MASTER THESES SERIES

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Abstract

The study was conducted in home gardens of western Nepal. Home gardens are defined, as a system of production of diverse crop plant species, which can be adjacent to household or slightly, further away and is easily accessible. There is lack of information on species composition and management system of Nepalese home gardens. Therefore this study was conducted to develop an inventory on composition of crop species and varietal diversity to characterize the Nepalese home gardens of two different ecological zones: Rupandehi (*terai*) and Gulmi (mid-hills) of western Nepal. And to see the species changes over time for last 10-15 years ago in the home gardens of study sites. Semi-structured interviews, direct observations and Focus Group Discussions (FGDs) were employed to collect data. Shannon-Weaver index, Evenness index, and Simpson's index were used to determine the species richness, to describe how equally abundance the species are and to describe the degree that a community is dominated by one or a few very common species, respectively. Principal Component Analysis (PCA) was employed to characterise the home gardens. Shannon-Weaver Index for mid-hill (H'=4.41) revealed that mid-hills harboured higher species diversity in home garden as compared to *terai*. Thus species richness was observed to be higher in the mid-hill (131 species) than *terai* (123 species). Mann-Whitney test revealed this species richness in the mid-hills was significantly higher (p=<0.001) than *terai*. Simpson index for *terai* (λ= 0.018) indicated few species dominates home gardens of the region as compared to mid-hill (λ= 0.014). Evenness Index of mid hill (J=0.90) explained that the species were more equally abundant as compared to the *terai* (J=0.88). PCA revealed that vegetable is major component followed by fruits and fodder species that contributed to the species diversity in Nepalese homegardens. The size of home gardens and species richness was positively correlated (r_s=0.29, p=<0.001). Farmers' reported that the twenty crop species have been lost for last 10-15 years from home gardens and eleven species were threatened. Inaccessibility of local seed crops and deforestation were the major causes associated to this trend. This study suggests that home gardens are production system maintained purposively for harvesting diverse products and are important avenues for species conservation and food security at household level. This study also revealed that self-saved seed contributed as the major source of planting material in home gardens. The current study showed that there is need to study the seed supply system for these home gardens because many crop species were lost and others were threatened in the home gardens mainly due to inaccess of planting materials. Therefore a challenge is to make home gardens as an economically viable and self-supporting through creating mechanism on strengthening local seed supply system for long term sustainability of home garden in agrobiodiversity management.

Contents

Introduction

Home gardens are well-established land use system with in the larger farming systems in Nepal, maintained very close to the homestead (Shrestha *et al.,* 2001). The history of home gardens are not well known in Nepalese context, but the previous studies from other parts of world defines that the home gardens are traditional farming systems which may evolved over time from the practices of hunters/gathers and continued in the ancient civilizations up to modern times, therefore is one of the oldest agro-ecosystems that exist throughout the world (Soemarwoto, 1987; Soemarwoto and Conway, 1992). Species diversity that is of immediate homestead use is the most prominent features of home garden (Hoggerbrugge and Fresco, 1993; Soemarwoto, 1987). Home gardens are living gene banks and reservoir of plant genetic resources that preserve landraces, obsolete cultivars, rare species and endangered species and species neglected in larger ecosystem (Eyzaguirre and Linares, 2001). The Convention on Biological Diversity (CBD, 1992)[1] has given mandate for the *on-farm* conservation of genetic resources (Maxted *et.al.,* 2002). A numbers of conflicting legal issues regarding rights over genetic resource have resulted to difficult situation for exchange and flow of germplasm (Petit *et al.,* 2001). Home garden is one of the components of agrobiodiversity. *According to Heywood (1999) Agrobiodiversity includes all those species and the crop varieties, animal breeds and races, and microorganism strains derived from them that are used directly or indirectly for food and agriculture both as human nutrition and as feed (including grazing) for domesticated and semi-domesticated animal. And the range of environments in which agriculture is practiced. It also includes habitats and species outside of farming systems that benefit agriculture and enhance ecosystem functions*. Wood and Linne (1997) have proposed a research to increase the diversity available to farmers and to enhance farmers' capacity to manage this dynamically. Many studies on home garden in other parts of world have revealed that home gardens are dynamic systems and are highly acknowledged for retaining higher diversity that represents microenvironments within larger farming systems; a mimics the natural, multi-layered ecosystem; and is agro-ecosystem (Agelet et al., 2000; Nair, 2001; Vogl-Lukasser et al., 2001; De Clerck and Negreros-Castillo, 2002; Gessler et al., 1998; Hoggerbrugge and Fresco, 1993; Soemarwoto and Conway, 1992; Padoch and De Jong 1991; Okafor and Fernandes 1987). Therefore rich species diversity of the home garden system would be important for conservation of plant genetic resources. In this case the home garden can be an option for on- farm conservation strategy and contribute to

CBD[1] Article 8 j of Biodiversity Convention those countries signed and ratified the CBD, would obliged to have national legislation for the respect, preserve, and maintaining the knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application.

on-farm conservation of genetic resources at ecosystem, species, and within species level. (Hodgkin, 2001;Gajaseni and Gajaseni, 1999).
The home gardens are an integral part in a typical Nepalese homestead and play a crucial role in supplying household members with diversity of different food crops (Shrestha et al., 2001; Rana *et al.,* 1998). These home gardens are important source for food supply and are also important for their economical, social and cultural use values. Vegetables, fruits, multipurpose trees, herbs, spices are major components of the home gardens on the same land unit in either a spatial arrangement or a temporal sequence. Therefore these home gardens are rich in species diversity. The composition of such species in a home garden is governed by many factors that make home garden a dynamic system. Ecology, local food culture, socio-economic condition, farmer's interest and market forces are some of the important factors that determine the species composition present in home gardens. (Gajaseni and Gajaseni, 1999; Hodel, et al., 1999; Hoggerbrugge and Fresco, 1993; Soemarwoto and Conway, 1992; Jacob and Alles, 1987; De Miguel [on line])
There is lack of in-depth knowledge and information on species composition in Nepalese home gardens. The home gardens have received the least attention from formal institutions, besides that some developmental intervention (Shrestha *et. al*., 2001). The main aim of this study is to understand how the home garden owners maintain and use the species at household and community level. The questions investigated were as followings;

- What are average sizes of home gardens?
- Why farmers grow many species of plants in variable proportion?
- What are the major crops in all home gardens?
- Why these species are maintained in homegarden (Economic, ecological, social)
- How the homegarden owners get the seeds for the species (Source of seed for home gardens),
- What the farmers use to control disease and pest (Chemical or biological pesticides)
- Is there any change in present species composition growing as compared to 10-15 yrs ago?

I prepared an inventory of crop species and compared the species composition in home gardens for two different ecologies i.e. mid-hill and t*erai* of western Nepal. The study also investigated species changes over time for last 10-15 years ago in terms of the lost species and threatened species defined by farmers in home gardens. The study categorised the composition of species into vegetables, fruits, fodder species cereals, medicinal plants, spices, nuts for inventory. Thus excluding for example ornamental species, which do not relate immediately to food security.

Material and methods

Study sites

The study was conducted within LI-BIRD's[1] home garden project site. The altitudinal variation was one of the major criteria for study site selection, however, the ethnicity, accessibility and community interest were also considered. Dudrakshya Village Development Committee (VDC)[2] of Rupandehi *terai*[3] here after referred as *terai* ecology and Darbar Devisthan VDC of Gulmi mid-hill hereafter referred as mid hill ecology were selected for study purpose. In *terai* again two villages (Bharsa and Baikunthapur) with different community settings were selected. The tribal community *Tharu* were the dominants in Bharsa whereas Chhetri/Bramin were predominated dweller in Baikunthapur (Table1)

Ethnicity	*Terai*		Hill
	Bharsa	Baikunthapur	Gulmi
Tharu (Tibeto Burmese)	28 (65.11)†	-	-
Chhettri / Bramin (Indo-Aryan group)	13 (30.23)	36 (73.46)	42 (100)
Newar (Mixed of Indo-Aryan and Tibeto Burmese)	-	2 (4.08)	-
Magar (Tibeto Burmese)	-	8 (16.32)	-
Socially disadvantaged groups (DAGs) (Indo-Aryan)	2 (4.65)	3 (6.12)	-

Table 1. Comparative ethnic composition reported in a survey of home gardens in Terai and mid-hill ecological region of Nepal, 2003. † *Figure in parenthesis column represent percent*

Rupandehi district represents t*erai* region of western Nepal. Bharsa and Baikunthapur are the research villages with in Rupandehi with an altitude of approx 100 m asl. Farming is the main occupation (69.5 %) and rest are engaged with both farming cum services (17.4 %) and farming cum business (13.1%) in the village. Rice (*Oryza sativa),* wheat (*Triticum aestivum*) and maize (*Zea mays*) are the major staple food crops. Similarly, Darbar in Gulmi is located in mid hill region of western Nepal with an altitude range of 800-1500 m asl. Farming cum services (57.1 %) is the major occupation followed by farming (35.7 %), and both farming cum business (7.1%) of the people in the village. Maize (*Zea mays*) is the main staple food crop for livelihood however millet (*Eleusine corocana*) and wheat (*Triticum aestivum*) are also grown in the area. Maize is grown in intercropping system and is mixed with a variety of summer

[1] Local Initiatives for Biodiversity, Research and Development (LI-BIRD), an NGO works in Nepal on participatory research and development in the area of agrobiodiversity conservation.
[2] The smallest geographical political units
[3] Stretching from east to west of Nepal, which is the extension of the Indo-Gangetic plains

legumes such as rice bean (*Vigna umbellata*), cowpeas (*Vigna* spp), and soybeans (*Glycine max*).

Sampling

Individual households represented the sampling units. The households were selected using simple random sampling technique. One hundred and thirty four households were sampled using the following formula according to Shrestha *et al.* (1999);

$n = NZ^2P(1-P)/Nd^2 + Z^2P(1-P)$ where,
n= samples size,
N= number of households in the study village,
Z=the value of normal variable (1.64) for a reliability level of 0.90,
P= the highest possible proportion (0.5),
d= sampling error (0.1)

Ecology	District	Study site	Population Size (HH)	Sample size (HH)	Percent
Terai (approx 100 m)	Rupandehi	Bharsa	120	43	35
		Baikuntha pur	140	49	35
Hill (800-1200 m)	Gulmi	Darbar Devisthan	94	42	44
	Total		***354***	***134***	***38***

Table 2 The sample size of the household surveyed for home garden study in Terai and hill sites of Nepal, 2003.

Survey instrumented of two sections, species information on one section and the demographic information on the other. Enumerators were oriented in participatory way. Finalisation of the questionnaire was made after pre-testing in adjacent village of the research site. Enumerators scheduled the interview with prior informed consent of two days with the respondents. Direct observation of home garden was also carried out simultaneously when interviewed with respondent to make the inventory of plant species grown in home garden. For quality control, the surveyed questionnaires were passed through edition, revision in different tiers first by enumerator himself, then peer review and editing among enumerators and final editing by the researcher on the same date.

Species and varietal inventory

Crop species diversity was measured at household level by household survey and validated by direct observation. Overall crop species diversity is measured

from the species inventory. Varietal diversity was assessed only in species, hyacinth bean (*Dolichos lablab).* Focus Group Discussion (FGD)[4] revealed that the lablab bean is one of the most frequently grown species in both the mid-hill and *terai*. Therefore *Dolichos lablab* was selected as a key species through FGD to study varietal diversity. Farmers defined the criteria while selecting the key species, which was similar to Watson and Eyzaguirre (2002) such that,
Species of economic importance to farmers
Species most preferred by farmers
Species that is cultivated by majority of farmers in both of the studied ecological regions
The varietal diversity to this species was described based on farmers' descriptors and morphological characters, to know the farmers' criteria to differentiate the varieties at community level. However, in many instances farmers give local names, which are very much mixed with genetic identity or genetic distances. The study lacks molecular study due to time and financial limit. This limits to some extent final statement on quality of genetic diversity in home garden studied.

Species change over time in home garden

Farmers' recall method followed by Focus Group Discussion (FGD) was adopted to see the changes in species composition in home garden for last10-15 years ago such that, which species were lost and which are on the way of disappearing and what were the major causes that farmer perceived behind the process. For the purpose, farmers defined the lost and threatened species during FGD. Lost species defined by farmers were those species known in the past but now the community does not know the presence and planting materials/seed is not available in the community. Similarly, threatened species are defined as those species, which still exists in the community but the frequency of occurrence of such species is low. The old aged key informants (above 45 years) were purposively invited in FGD. They were identified through informal discussion with community people during social map preparation. These key informants were identified with certain criteria e.g., knowledgeable, senior and progressive, cooperative and well experienced in home gardening for longer time. Since prior informed consent in this process is essential, the key informants were consulted and agreed respondents were invited for discussion two days prior FGD. They also gave me permission to publish the collected information.

[4] FGD is a participatory tool (King, 2000; Rana, *et al.*, 2000) to draw information on related subject matter from few (10-15 individuals) but with key informants having good knowledge on subject matter. However there is some disadvantage of using this tool such as some individual may dominate the discussion and not all participants may contribute to the discussion. Therefore to overcome this constraint it may be necessary to conduct personal interviews or to use questionnaires too.

Stastical Analyses

SPSS for windows version 10.1 was used for descriptive analysis of survey data. Mann-Whitney U-test was carried out to see the difference in species richness in two ecologies using MINITAB version 13.31. Shannon-Weaver index was used to determine the species richness. The index is used to characterise the species diversity in community. It is calculated through formula $H' = \sum_{i=1}^{s} p_i \ln p_i$

where, s is the number of species in the community, and p_i is the proportional abundance of species *i* (= number of species *i* divided by total numbers in the community). Evenness index ($J = H'/\ln s$) was used to describe the diversity in terms of evenness i.e. how equally abundance the species are. Also, Simpson's index ($\lambda = \sum_{i=1}^{s} (p_i)^2$ was used to describe the dominance i.e. the degree that a community is dominated by one or a few very common species (Powers and McSorley, 2000). Spearman rank correlation coefficients were estimated to explain the relationship among home garden components. Principal component was employed to characterise the home gardens of the study sites using thirteen characters.

Results

Size of home gardens

The average size of the home gardens in *terai* and hill were reported 434 m^2 and 402 m^2 respectively but the total land holding of hill reported higher as compared to *terai*. The home garden size of *terai* had shrunk over last 10-15 years ago whereas the home garden size of the hill increased over the time period (Table 3). The study found that area of home garden in *terai* and mid hill ranges from 1635 to700 sq m.

Ecological region			Home garden area		Total land holding, 2003 (m^2)	Total species 2003
			1988 (m^2)	2003 (m^2)		
Terai	Bharsa and	Mean ± SD	467±350	434±287	5200±4090	27.1±11
	Baikunthapur	Range	1693	1635	26919	49
Mid-hill	Gulmi	Mean ± SD	348±208	402±204	6674±3938	38.7±11
		Range	731	700	16279	45

Table 3 Mean and standard deviation of home garden, total landholding, and species reported in a study, 2003.

In *Terai*, respondent allocated 7.7% area for home garden, which was higher in proportion as compared to 5.7% in the mid-hill (Figure 1)

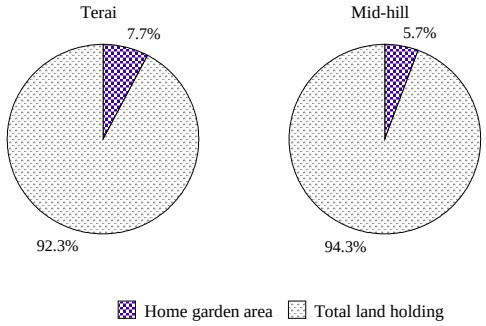

Figure 1: Proportion of home garden area over total land holding

Species composition and species and varietal diversity

Total of 165 different crop species with mean of 30.77±11.9 from 55 families were recorded in 134 home gardens from two ecological study sites (refer appendix 1). The *terai* had 123 crop species (27.1±10.7) whereas 131 species (38.7±10.5) were recorded in mid-hill. The Mann-Whitney test revealed that mid-hill recorded significantly higher total species (p=<0. 001) than *terai*. And within *terai* ecology, the total species of *Baikunthapur* (116 species) was significantly higher (p=<0.001) than *Bharsa* (92 species). Therefore, species richness of home gardens in mid hill was higher (H' = 4.41) than *terai* (H' = 4.25). Zaldivar, *et al.,* (2002) reported differences in species diversity in different settlement using SWI and Evenness index. The dominance measured by Simpson's index (λ = 0.018) explained the *terai* ecology home gardens were with few dominant species as compared to mid-hill (λ = 0.014). The evenness index revealed that the species in mid-hill (J = 0.906) were more equally abundant and distributed as compared to *terai* ecology (J = 0.880) (Table 4)

Ecology	Study sites	Shannon – Weaver Index (H')	Simpson's index (λ)	Evenness index (J)
Terai				
	Bharsa	4.03	0.022	0.891
	Baikunthapur	4.25	0.016	0.896
Terai overall		4.25	0.018	0.880
Mid-hill	Gulmi	4.418	0.014	0.906

Table 4 Shannon-Weaver, Simpson's and Evenness indices estimated for species diversity in Terai and mid-hill ecology, 2003.

The most frequently reported vegetables species were *Luffa cylindrica* L. M. Roem, *Dolichos lablab* L., *Cucurbita pepo* L. and *Brassica juncea* L, in home gardens of both regions. Similarly, *Capsicum annum* L., *Coriandrum sativum* L. *Allium sativum* L.; *Carica papaya L.* and *Mangifera indica;* L. *Leucaena leucocephala* (Lamk.) de Wit. and *Morus alba* L were frequently reported spice, fruit and fodder species respectively in both of the study sites. But *Carissa carandas*, *Cyphomandra betacea* Sendt., *Basella alba* L., *Schleichera oleosa* (Lour.) Merr. and *Trewia nudiflora* L. was the least frequently reported species in the home gardens. But the varietal diversity for *Dolichos lablab* was reported to be higher i.e. twelve varieties in *terai* whereas in mid-hill seven varieties for the species was reported in FGD by farmers (refer appendix 2.1 and 2.2). These numbers were based on farmers' description from FGD and morphological characters. It was observed that *Tharu* group in *terai* used analogies, colour and shape to differentiate among the varieties. But Chhetri/Bramins including Magars and Newars from both ecologies used morphological characters such as colour, shape and the seasonal adaptation to differentiate among the varieties with in the species *Dolichos lablab*.

Home garden components

Study revealed that vegetable component is the major component followed by fruits, fodder and spices species in Nepalese home gardens. The figures below illustrate the average numbers of species for the components and the proportion for the component based on their frequencies respectively (Figure 2 and 3).

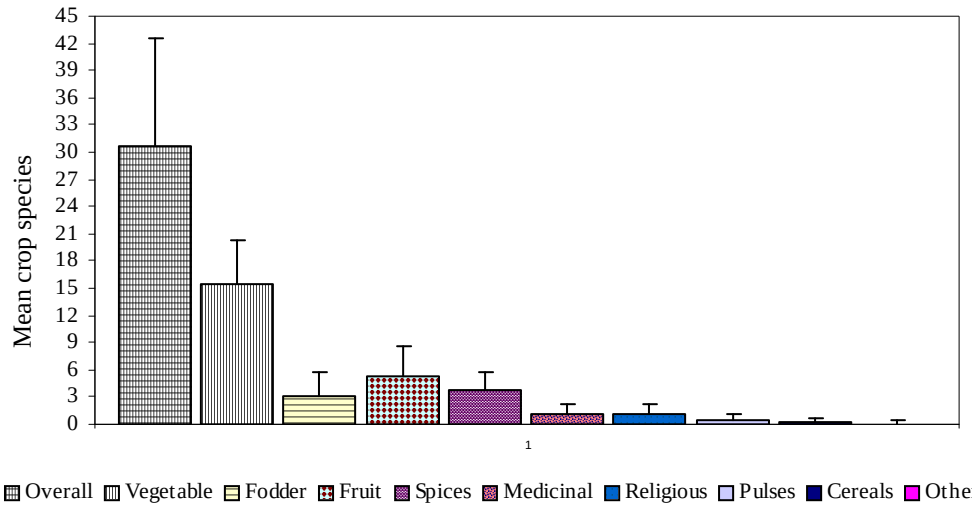

Figure 2: Mean of overall species and components species recorded in a survey conducted in Rupandehi and Gulmi study sites in 2003.

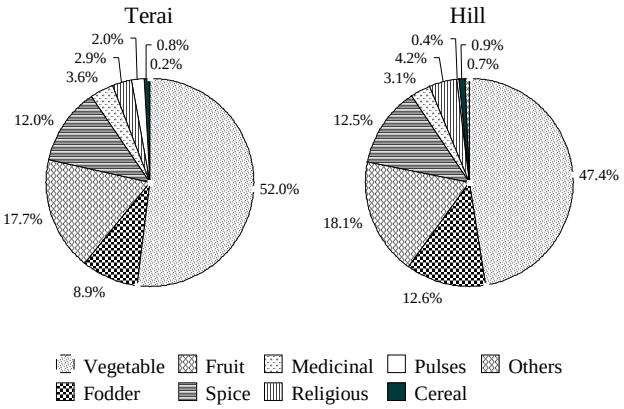

Figure 3: Home garden components based on frequency of crop species.

The majority of species grown in home gardens were annuals followed by perennial growth habit in both of the *terai* and mid-hill ecologies (fig 4). And the majority of species grown are seed propagated (fig 5). The first preference of growing diverse species in home gardens is because of economic importance to the households such as, food and nutritional and medicinal value (fig 6). And then second preference goes to social and cultural importance crop species such as religious (*Ocimum sanctum* L., *Ficus religiosa* L.) (*Perilla frutescens* (L.) Britton.

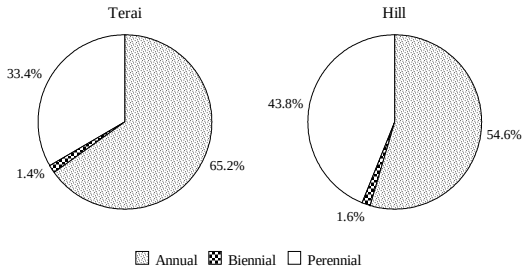

Figure 4: Growth habit of home garden species reported in *Terai* and mid-hill ecology, 2003.

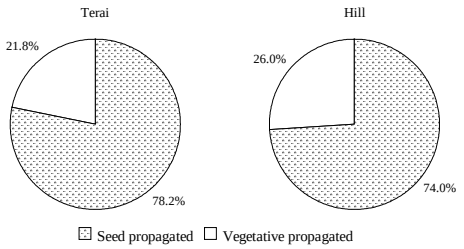

Figure 5: Propagation proportion of planting materials in home garden species reported in Terai and mid-hill ecology, 2003.

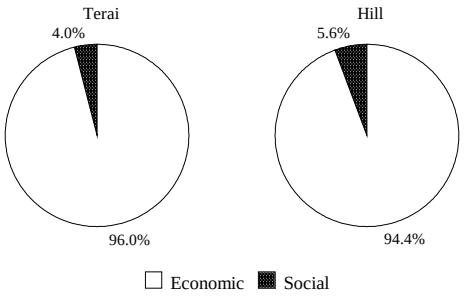

Figure 6: Use values of home garden species reported in Terai and mid-hill ecology, 2003.

Characterisation of home garden based on Principal Component Analysis *(PCA)*

The Principal Component Analysis (PCA) was employed to characterise the Nepalese home gardens in terms of species used. For which, first four principal components explained 64% of the accumulated variability (Table 5) in which, the first principal component explained 37% of the variation, which incorporate to over all total species, vegetables, fruits, fodders and spices species. The second component explained 11% of the variability and is associated with ecology, pulses species and home garden size. Similarly third component explained 8% and is associated with home garden size and livestock. Finally the fourth component explained 7% of variability associated with medicinal and religious species (Table 6). Thus, PCA suggests that vegetables, fruits, fodder and spices are the key component of the Nepalese home gardens.

Table 5. Eigenvalue, percent of the variability explained by each component and accumulated variability.

Principal component (PC)	PC1	PC2	PC3	PC4
Eigenvalue	4.82	1.44	1.126	0.99
Proportion	0.37	0.11	0.08	0.07
Accumulated variability (%)	37	48.2	56.8	64

Table 6: Eigenvectors of each variable with respect to its principal component (PC).

Variables	PC1	PC2	PC3	PC4
Ecology	0.242	-0.544	0.030	0.120
Home garden area	0.119	0.347†	0.599†	0.007
Vegetable species	0.380†	0.031	0.027	0.093
Fodder species	0.320†	-0.118	-0.07	0.165
Fruit species	0.365†	0.056	0.108	-0.156
Spice species	0.319†	0.011	-0.053	0.088
Medicinal plant species	0.270	0.205	-0.114	-0.491
Religious species	0.270	-0.065	-0.277	-0.449
Pulse species	0.063	0.593†	-0.341	0.113
Cereal species	0.163	0.068	-0.403	0.621†
Nut species	0.197	-0.296	0.278	0.075
Overall species richness	0.448†	0.043	-0.048	-0.008
Livestock number	0.170	0.272	0.416†	0.265

† *important variables for explaining the respective component*

Correlation of home garden components

There were positive correlations between home garden area and overall species. Also the spearman correlation analysis revealed that there is positive relation between home garden size and other components (Table 7). Study found that livestock play important roles in home garden for fodder species and Farm Yard Manure (FYM) and the spearman correlation for livestock size and total species was also found positive and significant (n=134, p=<0.001) Similarly with fodder species and livestock population size has positive correlation. (n=134, p=<0.001). According to Fowler *et al.,* (2001) these correlations are weak but are significant.

Table 7. Spearman correlation coefficients (rs) measured for home garden components and home garden area, total species and fodders of Nepalese home gardens (n = 134).† Figure in parenthesis is spearman correlation p-value

Home garden components vs. hg area/ fodder/total species		**(r_s)**
Total species	Home garden area	0.28 (0.00) †
Vegetable species	Home garden area	0.24 (0.00)
Fruit species	Home garden area	0.34 (0.00)
Fodder species	Home garden area	0.11 (0.19)
Livestock	Total species	0.29(0.00)
Livestock	Fodder species	0.25 (0.00)

Home garden management

The study revealed different terms that were used and known for home garden in the study sites. The tribal groups *Tharu* use term *bera* (fenced land area), and Chhetri/Bramin groups use *Mulabari (*radish land area), *karesabari* (backyard), *gharbari* (home garden), *fulbari* (flower garden), *tarkaribari* (vegetable garden) and, *bagaincha* (fruit garden). Home gardens were near to household or a bit further away in 5-10 minutes walking distance in both of the two ecological regions. The home gardens were observed with opened area (49 %), fenced (34 %) and semi-fenced (16 %). Live fence, wood stakes and bamboos were the most frequently used materials for fencing for home gardens in both of the ecological regions. The majority of source for planting materials for home garden was self-saved seed by farmers themselves (77 %), sharing between and among farmers contributed 5.4 % and 1.4 % from the forest. On an average, 15 % of the home garden species is obtained from market or outside the local community. However, the external dependency for the seed varies among crops (see figure 7). It was reported that self saved seed for; vegetables (58 %), fruits (90.4%) and fodder (85.0%) species in home garden. This shows that for majority of crop seeds in home garden were mainly dependent for self-saved ones though was quite low for vegetables.

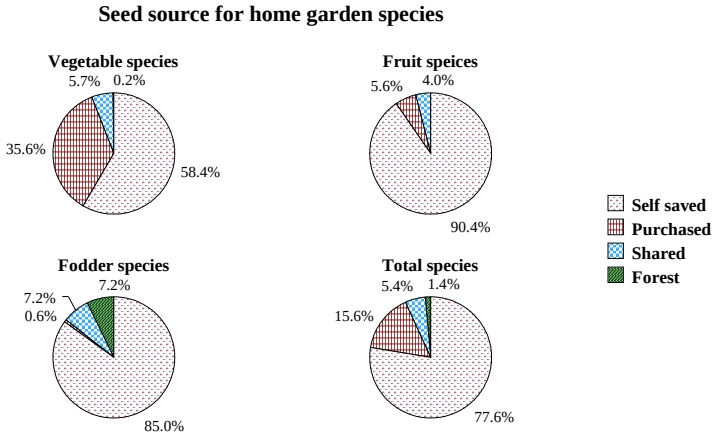

Figure 7: Planting material source for vegetables, fodder fruits and in over all species

Study revealed that the 53 % of respondents use pesticides in home garden (figure 8). And the use of local resources pesticides in mid-hill is more than *terai* ecology. The local resources used as pesticides were tobacco solutions, soap water spray, *Artemisia* solution, cow urine and ash. The reported chemical pesticides used in home garden were Malathian, Hexachlorocyclohexane (BHC), Metacid and Phenol. These pesticides were mostly used to control the aphids in cruciferous vegetables and some fruits like, *Mangifera* spp, *Litchi* spp. Similarly it was observed that in mid hill home garden the entire respondent used FYM but observed that very limited amounts of urea were used in home gardens as compared to *terai* (Figure 9).

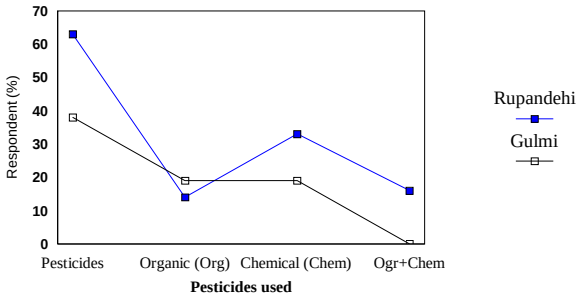

Figure 8: Overall pesticides used, organic pesticides, chemical pesticides and both organic and chemical pesticides used in home gardens in Gulmi and Rupandehi, 2003.

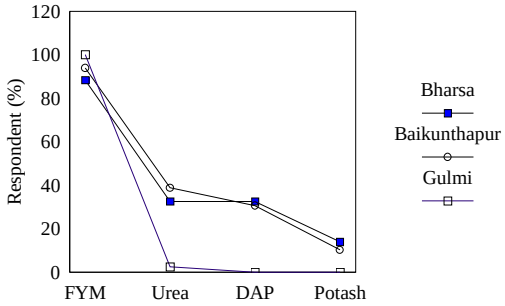

Figure 9: FYM and fertilizers used in-home gardens in Gulmi and Rupandehi, 2003

Species change over time in home garden

Farmers discussed the changes of species for 10-15 years ago in terms of lost and threatened species in the home gardens of the study sites. They reported that twenty species were lost from home gardens of the study sites (refer appendix 3.1 and 3.2). And eleven species they perceived as threatened. (refer appendix 4.1 and 4.2). FGD revealed that the majority of lost and threatened used species are for local[5] vegetables, fruits and fodders as well. An in depth enquiry revealed the major causes associated with these are; inaccessibility of seed or planting materials, lack of local seed in market, deforestation, fragmentation of home garden land, difficulty to maintain planting material, introduction of new and competitive improved[6] crop/varieties and lack of market incentives for local crops.

Discussion

Size of home garden and species

The home garden size for *terai* ecology was found bigger as compared to mid-hill ecology. Because of more terraces with *bari*[7] land in the hill whereas in *terai* the *khet* [8] land is predominant. But the size has shrunk for 10 – 15 years ago mainly due to increased land fragmentation trend in *terai* within the family holdings. This showed the smaller home garden size with increased altitude and more terrace land in Nepalese conditions. Karyono (1981), Soemarwoto and

[5] Crop that has been cultivated in the area long ago since the respondent knew and that the community has saved seed by themselves and has not bought from market, merchant or any governmental or non-governmental organisations

[6] Crop that has been introduced recently in the area from merchant, governmental and non - governmental organisations

[7] Unbunded and unirrigated upland

[8] Bunded and irrigated/rainfed land mainly puddled rice is grown

Conway (1992) also reported that the smaller home garden size with increased altitude. The overall home garden size of *terai* and mid-hill of current study sites were found smaller as compared to Vietnam (Trinh *et al.,* 2003), Thailand (Gajaseni and Gajaseni, 1999), Nicaragua (Mendez *et. al.*, 2001) and Srilanka (Jacob and Alles, 1987). Rich species diversity was observed in the Nepalese home gardens but the area allocated for each species within home garden was observed very small during survey. However the current study lacks the examination of the minimum population size that maintains natural evolution in home gardens and/or at community level. Therefore the study suggests the need for further examination on the population size of crop species in home garden.

Species/varietal inventory and diversity

The higher species were reported in mid-hill ecology (800-1200 m) as compared to *terai* ecology (approx 100 m), which disagree with Hodel and Gesslar, (1999). The mid-hill of Nepal represent the transition zones in between *terai* and high hill ecology; therefore this particular region harbours the species from both *terai* and high hill. For example temperate fruits like; apple, peach, walnut as well as tropical fruits like; mango, guava, litchi were reported in mid-hill ecology. In *terai* ecology, *Chhetri/Bramins* reported more species than *Tharus*. *Chettri/Bramin* nurtured many species of religious and cultural importance such as *Aegle marmelos, Gossipium arborium, Ocimum sanctum* and *Perilla frutescens*. Shrestha *et al.,* (2001); Soemarwoto and Conway (1992) and Hodel *et al.,* (1999) reported many species are maintained for socio cultural and religious importance in home gardens. The current study showed significant correlation with livestock rearing and species diversity in the Nepalese home gardens (Table 7). And the livestock rearing is reported higher in these communities. Although, *Tharu* community reported less species as compared to other ethic groups, the reported species *Basella alba* and *Trewia nudiflora* were local and distinct to this group. And the livestock rearing was also noted very low in *Tharu* than others indicating these ethnic groups maintained less species diversity.

However, the varietal diversity was reported higher in *terai* ecology when examined for the key species *Dolichos lablab*. This diversity was based on farmers' descriptor and crop morphology, which may not be fully identical to the genetic level, and thus an area for further study. However, the study revealed that farmers could differentiate these varieties based on; seasonal adaptation, morphological traits viz. pod shape, size and colour (refer appendix 2.1 and 2.2), which showed that farmers have their own system of varietal characterization. It was found that the farmers maintained the varietal diversity of *Dolichos* because the varieties are produced in off-season i.e. in March-April when the other vegetables are in short supply. It was evident that the market opportunity for species in the *terai* was one of the motivating factors to grow

more numbers of varieties for the *Dolichos* bean provided that the crop was produced in off-season and can fetch good price through selling the surplus production.
Therefore, the market opportunity for the species in *terai* was higher due to which farmers were maintaining the rich varietal diversity for the species. Also these crop varieties were found resistant to biotic and abiotic stresses (disease and insect pest and cold injuries) and ease of seed storage. Furthermore these varieties can fetch good prices because of the difference in consumers' preferences and farmers strongly argued that there were no improved varieties available for *Dolichos* in the market. However, in the case of mid hill ecology, farmers maintained relatively less varietal diversity for the species as compared to *terai* it may be because of lack of inaccessibility of market. Present study suggests that home gardens retain intra varietal diversity provided that market incentives, easy seed storage or easy access to seed and varietal adaptation to particular ecology and season. Rana *et al.,* (1998) also reported that the market incentives would motivate the farmers to conserve the local crops especially when the seed source is easy to maintain, low production cost and disease pest resistance. Trinh *et al*., (2003) reported the similar result in Vietnamese home garden.

Seed management in home garden

The information on informal seed management in home gardens is lacking in most technical and biological studies so far. In previous studies, the seed management mechanism for home gardens were poorly studied and considered. The current study revealed that local seed sources are important for plant genetic resource management at community level in home gardens. Self-saved seed by farmers themselves are the first source of planting materials and has the highest contribution to all of the major home garden components; vegetables, fodder, fruits, and spices in the study sites. The purchased seed contributed second important source whereas sharing between and among home garden owners contributed to third important source except the fodder species (fig 7) Vogl-Lukasser (2002) reported that purchased seed is the first major source for planting materials in Austria. Rana *et al.,* (1998) has also reported that the self- saved seed contributed the first source of planting materials for indigenous vegetables in Kaski, Nepal. Subedi *et. al*., (2003) reported that in cereal crops certain nodal farmers within a community maintain higher diversity and are instrumental in the seed flow through farmers' network. But such a study is lacking for home garden crop species and for who maintains diversity to home garden species and varieties. Therefore, local seed management through informal seed system needs to be strengthened to manage crop diversity in home gardens. Furthermore, farmers should be recognized for their roles played for utilising, domesticating, conserving, improving and developing the crop resources to meet their needs since long

time ago. However, many crop species are lost and many of them are threatened in their gardens due to many reasons such as, due to inaccess of the seed material, deforestation, land fragmentation etc. Therefore, such threatened crop species could be placed to *ex-situ* conservation unit from where the formal institution could further improve the crop quality and resend them back to the community. But most home gardens crops found in this study however do not have a corresponding gene-bank/*ex-situ* facility like for example as regards cereals and roots and tubers. Therefore, policy makers, donors ought to initiate measures towards *ex-situ* conservation for threatened home garden species.

Home garden components

Vegetables are the major component of the home gardens in both the *terai* and mid-hill ecology followed by fruits, fodder and spices species in Nepalese home gardens (Table 8). Vegetables, fruits and spices are mainly cultivated in home garden for daily home consumption whereas fodder species are included for livestock. Fruit trees have been reported as a major component of the home gardens in studies done in other countries (Clerck *et al.,* 2000; Men`dez *et al.,* 2001; Zaldivar *et al.,* 2002; Gajaseni and Gajaseni, 1999). Farmers strongly argued the importance of livestock integration in home garden, for the only source of FYM for soil fertility management in home gardens. But it is interesting that livestock is not considered as home garden component rather as separate component of farming system. Cattle and goats are major livestock reared in gardens followed by chicken, ducks and pigeon. However, livestock were reported important components of home garden in San Jose (Levasseur and Olivier, 2000) Javanese home garden (Soemarwoto and Conway, 1992) Kerla, India (Nair and Sreedharan, 1986), and Tanzania (Fernandes *et al.,* 1984). Although livestock is not considered as a component of home garden, it played important role in species diversity and soil fertility management in Nepalese home gardens.

Species change over time

The study revealed the change of species over time in Nepalese home gardens are mainly due to inaccessibility of local seeds through informal seed supply system, market and deforestation. Many of the participants in FGD recalled and reported that they used to cultivate many more local crop species and varieties in home gardens in the past and now no more cultivated in the area. The reported lost species were mostly local crops and wild species because farmers were not been able to access the seed locally and were not possible for them to store planting material for long term. Furthermore farmers strongly mentioned deforestation has caused habitat destruction for both plant species and the seed disperser e.g. birds. For example, farmers explained how the birds' eye chilly was lost from their home garden in mid hill ecology and threatened in *Terai* ecology. A kind of birds used to bring the seed of the birds'

eye chilly (*Capsicum microcarpum (L.) DC*) from the forest to the home gardens. But in recent years, they don't see these birds and the birds' eye chilly in their home gardens. They explained the dispersal mechanisms have been disturbed due to deforestation. Consequently the birds' eye chilly was lost in Gulmi mid hill ecology and threatened in Rupandehi *Terai* ecology (refer appendix 3.2 and 4.1). It was perceived that the forest was an important source for seeding material for many wild vegetables, fruit trees and fodder species. Study suggests that home gardens and forests are very much interlinked in Nepalese context. The forest is the source of seed or saplings for home gardens and these home gardens are important avenues for utilisation of species from the forest. Therefore seed supply system of home gardens species needs to be further studied in depth and should be strengthened. The current study also suggests for the need of linking forest conservation programme to agrobiodiversity management in home gardens. Nepal's recent experience in Community forestry programme for forest management had shown the importance of peoples' participation in sustainable use of forest resources. Today there are more than 12 thousand user groups managing thousand of hectares of lush and lively forests. The crucial thing here is, these are the same community people owing the home gardens using forest as source of planting materials for most of the home garden species along with other needs. Thus there should be instruments created at the policy level for linking these both home garden and community forestry programme so that could be useful for the conservation and food security at household and community level.

Conclusion

The present study imparts the information for home gardens in western Nepal. The information could be used in home garden intervention for economic development and possible strategy on the use of home garden for agricultural biodiversity management. The crop species diversity in Nepalese home gardens is high because of greater ecosystems diversity**.** However, the species composition and species richness of *Terai*and mid hill ecologies were different due to the ethnicity and ecological differences. Home gardens are system for producing diverse products such as vegetables, fruits, fodders, spices, and medicinal plants for home consumption. The vegetable is the most important component followed by fruit, fodder and spices species in Nepalese home gardens. Unlike the home gardens composition of other countries, fodder species are one of the important components of Nepalese home gardens. These home gardens could be considered as potential units for maintaining species diversity and conserving plant genetic resources and would become very important for food security. Self-saved seed contributed as the major source of planting material in home gardens. The current study showed that there is need to study the seed supply system for these home gardens, because

the study revealed that many crop species were lost and others were threatened in the home gardens mainly due to inaccess of planting materials. Therefore, farmers' needs and interest along with the seed security, good market incentives and risk management strategies are indispensable prior to consider home gardens as *on-farm* conservation unit. The challenge, to make home garden as economically viable and self-supporting through developing mechanism, is to strengthen local seed supply system for long-term. Therefore, agrobiodiversity managers, policymakers, researchers and other concerned stakeholders should focus on developing the most appropriated approach through which these home gardens could be best used in managing agricultural biodiversity *on-farm* for future harvests.

Implications of the findings

The information collected on species diversity and the components of Nepalese home gardens has opened the area of targeting for the conservation and utilisation. Similarly, the information on species diversity in home garden revealed that home garden could be used as management and conservation unit for agrobiodiversity in Nepal. Furthermore, it can be a source for diversifying the nutrition of rural people through promoting home gardens at policy level. These home gardens are fulfilling the subsistence need of farmers, which means these subsistence farmers do not maintain the diversity just for the sake of conservation alone the value of conserving the diversity lies in its use. It is worth noting that the conservation is not possible without the utilization of resources and also that no conservation means no utilization. Therefore, these gardens could be used for the organic products to cash production and benefit those subsistence farmers with market incentives. The government of Nepal is giving emphasis on organic products in its national agricultural plan; similarly emphasis should be given for the home gardens promotion and production at policy level so that home garden could be used for household food security and crop conservation.

Recommendations

- Further in-depth study and strengthening local seed supply system for home garden species are very important for long-term *on-farm* management of agricultural biodiversity.

- Study on the minimum population size that maintains natural evolutions of the crop species in home garden species is important to understand species dynamics over space and time.

- It is important to monitor the home gardens species regularly, which are threatened and needs to identify the causes on why the species are

in threatened status. For this, links between local community and *ex-situ* conservation is important. The species, which are threatened from home gardens, could be placed in an *ex-situ* conservation unit i.e. gene bank such as Asian Vegetable Research and Development Centre (AVRDC). But the AVRDC does not include all the crop species referred to in this study, therefore may one need a separate gene bank for threatened home garden species in the future from where the formal institutions could improve the quality of the cultivars and again resend it back to the community for utilisation.

Acknowledgement

I gratefully acknowledge my supervisors, Associate Professor Carl-Gustaf Thornström from the Swedish Biodiversity Centre (CBM), Sweden and Anil Subedi from LI-BIRD, Nepal for their untiring supports, continuous guidance, constructive comments and timely suggestions. I am grateful to the Directors and the staffs of CBM for their all kinds of supports. I sincerely acknowledge Åke Berg, for his statistical input and Dharma Raj Dangol for the taxonomic input for plant species and varieties. Thanks are due to LI-BIRD for providing me an opportunity to carry out my study in its home garden project sites. Special thanks go to the home garden project team, Community Organisers and other staffs of LI-BIRD for their technical, secretarial services and necessary supports during my study period. I sincerely thank Marie Byström, Pablo Eyzaguirre and Bhuwon Sthapit for their constructive comments. I am indebted to CBM for providing me an opportunity to be a part of the International Masters Programme 2002 and for financial support to carry out this study. I sincerely acknowledge the support from the Nepalese farmers who were the key players of this research and freely shared their time and knowledge at each home garden site. Last but not the least, I would like to thank Sanjaya, my husband, for his continuous encouragement, support and statistical input in this manuscript.

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Appendices

Appendix 1: Home garden species inventory for Gulmi mid-hill and Rupandehi *Terai* agro- ecology. Nomenclature from HMG/Nepal. 2001; Regmi, P.P., 1982; HMG/Nepal, 1982 and HMG/Nepal, 1976.

Sn	Nepali name	English name	Scientific name	Plant Family	Growth Habit	Use value	Gulmi	Rupandehi
1	Fapar	Buckwheat	*Fagopyrum esculentum Moench.*	Polygonaceae	Annual	Cereal	x	x
2	Jau	Barley	*Hordeum vulgare L.*	Poaceae	Annual	Cereal	x	x
3	Junelo	Sorghum	*Sorghum vulgare (L.) Pers.*	Poaceae	Annual	Cereal	x	
4	Makai	Maize	*Zea mays L.*	Poaceae	Annual	Cereal	x	x
5	Amriso	Broomgrass	*Thysanoleana maxima (Roxb.) Kuntze*	Poaceae	Perennial	Fodder		x
6	Badahar		*Artocarpus lakoocha Wall. ex Roxb.*	Moraceae	Perennial	Fodder	x	x
7	Bedulo		*Ficus subincisa Buch.-Ham. ex Sm.= Ficus clavate Wall. ex Mill.*	Moraceae	Perennial	Fodder	x	x
8	Bohari		*Cordia dichotoma J. R. Forst.*	Cordiaceae	Perennial	Fodder	x	x
9	Chuletro		*Brassaiosis glomerulata (Blume) Regel*	Araliaceae	Perennial	Fodder	x	
10	Chutro	Berbery	*Berberis aristata DC.*	Berberidaceae	Perennial	Fodder	x	
11	Dabdabe		*Garuga pinnata Roxb.*	Burseraceae	Perennial	Fodder	x	x
12	Dudhilo		*Ficus neriifolia var. nemoralis (Wall. ex Miq.) Corner = Ficus nemoralis Wall. ex Miq.*	Moraceae	Perennial	Fodder	x	x
13	Dumri		*Ficus racemosa L.*	Moraceae	Perennial	Fodder		x
14	Faledo		*Erythrina stricta Roxb.*	Leguminosae	Perennial	Fodder	x	
15	Ipilipil		*Leucaena leucocephala (Lam.) de Wit.*	Leguminosae	Perennial	Fodder	x	x
16	Kabro		*Ficus lacor Buch.-Ham.*	Moraceae	Perennial	Fodder	x	x
17	Kaulo		*Machilus gamblei*	Lauraceae	Perennial	Fodder	x	
18	Kutmiro		*Litsea monopelata (Roxb.) Korth.*	Lauraceae	Perennial	Fodder	x	x
19	Nimaro		*Ficus auriculata Lour.*	Moraceae	Perennial	Fodder	x	
20	Paiyun		*Prunus cerasoides D. Don.*	Rosaceae	Perennial	Fodder	x	
21	Phusuro		*Lindera pulcherrima Benth.*	Lauraceae	Perennial	Fodder	x	x
22	Saj	Lourel tree	*Terminlia alata Heyne ex Roth.*	Combretaceae	Perennial	Fodder		x
23	Simali		*Vitex negundo L.*	Verbanaceae	Perennial	Fodder		x

Appendix 1: Continued

Sn	Nepali name	English name	Scientific name	Plant Family	Growth habit	Importance	Gulmi	Rupandhei
24	Tote	Vegetable smart weed	*Polygonum molle D. Don*	Polygonaceae	Perennial	Fodder		X
25	Tuni	Red cedar	*Cedrela toona Roxb.*	Meliaceae	Perennial	Fodder	x	
26	Baans		*Bambusa spp.*	Poaceae	Perennial	Fodder	x	x
27	Lebaans			Poaceae	Perennial	Fodder	x	
28	Nigalo		*Arundinaria falcata Nees*	Poaceae	Perennial	Fodder	x	
29	Kimbu	Mulberry	*Morus alba L.*	Moraceae	Perennial	Fodder	x	x
30	Bakaino		*Melia azedirach L.*	Meliaceae	Perennial	Fodder	x	x
31	Barro	Bastard myrobolan	*Terminalia bellirica Roxb.*	Combretaceae	Perennial	Fodder		x
32	Khaniu		*Ficus semicordata Buch.-Ham. ex Sm.*	Moraceae	Perennial	Fodder	x	x
33	Kadam		*Anthocephalus chinensis A. Rosh. & Walp.*	Rubiaceae	Perennial	Fodder		x
34	Simal	Silk cotton tree	*Bombax ceiba L.*	Bombacaceae	Perennial	Fodder		x
35	Sisso	Sisso	*Dalbergia sissoo Roxb.*	Leguminosae	Perennial	Fodder		x
36	Napier	Napier	*Pennisetum purpureum Schum.*	Poaceae	Perennial	Fodder	x	
37	Bhimsenpati	Butterfly bush	*Buddleja asiatica Lour.*	Longaniaceae	Perennial	Fodder	x	
38	Chilaaune		*Schima wallichii (DC.) Korth.*	Theaceae	Perennial	Fodder	x	
39	Chiuri	Nepal butter fruit	*Bassia butyracea Roxb.*	Sapotaceae	Perennial	Fruit	x	
40	Aanaar	Pomegranate	*Punica granatum L.*	Punicaceae	Perennial	Fruit	x	x
41	Aangoor	Grape	*Vitis vinifera L.*	Rutaceae	Perennial	Fruit	x	
42	Aanp	Mango	*Mangifera indica L.*	Anacardiaceae	Perennial	Fruit	x	x
43	Aaru	Peach	*Prunus persica (L.) Seib. and Zucc.*	Anacardiaceae	Perennial	Fruit	x	x
44	Aarubakhada	Plum	*Prunus domestica L.*	Anacardiaceae	Perennial	Fruit	x	
45	Amala	Indian goose berry	*Emblica officinalis Geartn.*	Euphorbiaceae	Perennial	Fruit		x
46	Amba	Guava	*Psidium guajava L.*	Myrtaceae	Perennial	Fruit	x	x

Appendix 1: Continued

Sn	Nepali name	English name	Scientific name	Plant Family	Growth habit	Importance	Gulmi	Rupandhei
47	Bayer	Indian plum	*Zizyphus spp.*	Rhamnaceae	Perennial	Fruit		X
48	Bhogate	Pummelo	*Citrus maxma Merr.*	Rutaceae	Perennial	Fruit	x	x
49	Bhuinkatahar	Pineapple	*Ananas comosus (L.) Merr.*	Bromeliaceae	Perennial	Fruit	x	x
50	Bimiro	Citron	*Citrus medica L.*	Rutaceae	Perennial	Fruit	x	x
51	Imili	Tamarindus	*Tamarindus indica L.*	Leguminosae	Perennial	Fruit		x
52	Jamun	Black plum	*Syzygium cumuni (L.) Skeels*	Myrtaceae	Perennial	Fruit	x	x
53	Kafal	Bay-bery	*Myrica esculenta Buch.-Ham. ex D. Don*	Myricaceae	Perennial	Fruit	x	
54	Kagati	Lime	*Citrus aurantifolia Swingle*	Rutaceae	Perennial	Fruit	x	x
55	Karuna		*Carissa carandas*	Apocynaceae	Perennial	Fruit	x	
56	Kera	Banana	*Musa spp.*	Musaceae	Perennial	Fruit	x	x
57	Kusum	Honey tree	*Schleichera oleosa (Lour.) Merr.*	Sapindaceae	Perennial	Fruit		x
58	Litchi	Litchi	*Litchi chinensis Sonn.*	Sapindaceae	Perennial	Fruit	x	x
59	Mayl		*Pyrus pashia Buch-Ham ex. D. Don*	Rosaceae	Perennial	Fruit	x	
60	Mewa	Papaw	*Carica papaya L.*	Caricaceae	Perennial	Fruit	x	x
61	Naspati	Pear	*Pyrus communis L.*	Rosaceae	Perennial	Fruit	x	
62	Nibuwa	Lemon	*Citrus limon (L.) Burm. f.*	Rutaceae	Perennial	Fruit	x	x
63	Ramphal	Custard apple	*Annona reticulata L.*	Annonaceae	Perennial	Fruit		x
64	Suntala	Orange	*Citrus reticulata Blanco*	Rutaceae	Perennial	Fruit	x	x
65	Syau	Apple	*Malus sylvestris L.*	Rosaceae	Perennial	Fruit	x	
66	Tiju				Perennial	Fruit	x	
67	Rukhkatahar	Jackfruit	*Artocarpus heterophyllus Lam.*	Moraceae	Perennial	Fruit		x
68	Ashuro		*Adhatoda vasica L.*	Acanthaceae	Perennial	Medicinal	x	x
69	Babri		*Ocimim basillicum L.*	Labiatae	Annual	Medicinal	x	x
70	Bojho	Sweet flag	*Acorus calamus L.*	Araceae	Annual	Medicinal		x
71	Chiraito	Chiretta	*Swertia chiraita (Roxb. ex Fleming) Karsten*	Gentianaceae	Annual	Medicinal	x	

Appendix 1: Continued

Sn	Nepali name	English name	Scientific name	Plant Family	Growth habit	Importance	Gulmi	Rupandhei
72	Ganja	Ture hemp	*Cannabis sativa L.*	Cannabinaceae	Annual	Medicinal	x	x
73	Ghiukumari	Indian Aloe	*Aloe barbadensis Mill.*	Liliaceae	Annual	Medicinal	x	x
74	Ghortapre	Water Pennywert	*Centella asiatica L.*	Umbelliferae	Annual	Medicinal		x
75	Kalo haledo	Black zedoary	*Curcuma longa L.*	Zingiberaceae	Annual	Medicinal		x
76	Marhatti	Basil	*Ocimum basilicum L.*		Annual	Medicinal	x	x
77	Neem	Indian curry leaf tree	*Azadirachta indica A. Juss.*	Rutaceae	Perennial	Medicinal		x
78	Pudina	Mint	*Mentha arvensis L.*	Labiatae	Annual	Medicinal	x	x
79	Satyajivan				Annual	Medicinal	x	
80	Surti	Tobacco	*Nicotiana tabacum L.*	Solanaceae	Annual	Medicinal	x	x
81	Titepati	Mug-wort	*Artemisia indica Willd.*	Compositae	Annual	Medicinal	x	x
82	Tulsi	Basil	*Ocimum sanctum L.*	Labiatae	Annual	Medicinal	x	x
83	Nariwal	Coconut	*Cocos nucifera L.*	Palmae	Perennial	Nut		x
84	Okhar	Walnut	*Juglans regia L.*	Juglandaceae	Perennial	Nut	x	
85	Supari	Areca nuts	*Areca catechu L.*	Palmae	Perennial	Nut		x
86	Coffee	Coeffee	*Coffea arabica L.*	Rubiaceae	Perennial	Beverage	x	
87	Masuro	Lentil	*Lens culinaris Medic.*	Leguminosae	Annual	Pulses	x	
88	Rahar	Pigeon pea	*Cajanus cajan (L.) Huth*	Leguminosae	Annual	Pulses	x	x
89	Rajma	Kidney bean	*Phaseolus vulgaris*	Leguminosae	Annual	Pulses		x
90	Chana	Chick pea	*Cicer arientinum L.*	Leguminosae	Annual	Pulses	x	x
91	Bar	Banyan tree	*Ficus benghalensis L.*	Moraceae	Perennial	Religious		x
92	Bel	Bael fruit	*Aegle marmelos (L.) Corr.*	Rutaceae	Perennial	Religious		x
93	Kapas	Cotton	*Gossypium arboreum L.*	Malvaceae	Perennial	Religious	x	x
94	Kush	Kush grass	*Desmostachya bipinnata L.*	Poaceae	Perennial	Religious	x	
95	Pipal	Ficus	*Ficus religiosa L.*	Moraceae	Perennial	Religious	x	x

Appendix 1: Continued

Sn	Nepali name	English name	Scientific name	Plant Family	Growth habit	Importance	Gulmi	Rupandhei
96	Rudrakshya	Utrasum bead tree	*Elaeocarpus sphaericus (Gaertn.) K. Schum.*	Elacocarpaceae	Perennial	Religious	x	
97	Silam	Perilla	*Perilla frutescens (L.) Britton*	Labiatae	Annual	Religious	x	x
98	Ukhu	Sugarcane	*Saccharum officinarum L.*	Poaceae	Annual	Religous	x	x
99	Aduwa	Zinger	*Zingiber officinale Rosc.*	Zingiberaceae	Perennial	Spices	x	x
100	Besaar	Turmeric	*Curcuma domestica Valet.*	Zingiberaceae	Perennial	Spices	x	x
101	Chhayapi	Shallot	*Allium ascalonicum L.*	Liliaceae	Annual	Spices	x	x
102	Dhaniya	Corriander	*Coriandrum sativum L.*	Umbelliferae	Annual	Spices	x	x
103	Jaiphal	Nutmeg	*Myristica fragrans Houtt.*	Myristicaceae	Annual	Spices	x	
104	Jimbu	Nepal aromatic leafgarlic	*Allium hypsistum Stearn.*	Liliaceae	Annual	Spices	x	x
105	Jire khursani	Birds' eye chilly	*Capsicum microcarpum (L.) DC.*	Solanaceae	Perennial	Spices		x
106	Jwano	Lovage	*Carum copticum Benth. and Hook.*	Umbelliferae	Annual	Spices	x	
107	Jyaanmara khursani	Cherry peppery	*Capsicum frutescens L. var. cerasiforme Bailey*	Solanaceae	Perennial	Spices	x	
108	Khursani	Capsicum chilly	*Capsicum annum L.*	Solanaceae	Annual	Spices	x	x
109	Lasun	Garlic	*Allium sativum L.*	Liliaceae	Annual	Spices	x	x
110	Methi	Fenugreek	*Trigunella foenum-graecum L.*	Leguminosae	Annual	Spices	x	x
111	Pyaaj	Onion	*Allium cepa L.Var cepa*	Liliaceae	Annual	Spices	x	x
112	Souph	Fennel	*Foeniculum vulgare Mill.*	Umbelliferae	Annual	Spices	x	x
113	Timur	Nepal pepper pricklyash	*Zanthoxylum armatum DC.*	Rutaceae	Perennial	Spices	x	
114	Barela	Balsam apple	*Momordica balsamina L.*	Cucurbitaceae	Annual	Vegetable	x	x
115	Bhanta	Egg plant	*Solanum melongena L.*	Solanaceae	Annual	Vegetable	x	x
116	Bhindi	Ladys' finger	*Abelmoschus esculentus (L.) Moench.*	Malvaceae	Annual	Vegetable	x	x

Appendix 1: Continued

Sn	Nepali name	English name	Scientific name	Plant Family	Growth habit	Importance	Gulmi	Rupandhei
117	Bihee		*Solanum indicum L.*	Solanaceae	Perennial	Vegetable	x	
118	Chichinda	Snake gourd	*Trichosanthes anguina L.*	Cucurbitaceae	Annual	Vegetable	x	x
119	Eskus	Chyote	*Sechium edule (Jacq.) Swartz*	Cucurbitaceae	Perennial	Vegetable	x	
120	Ghiraula	Sponge gourd	*Luffa cylindrica (L.) M. Roem.*	Cucurbitaceae	Annual	Vegetable	x	x
121	Kubhindo	Ash gourd	*Benincasa hispida (Thunb.) Cogn.*	Cucurbitaceae	Annual	Vegetable	x	x
122	Kundru/Kunuru		*Coccinea grandis (L.) Voigt*	Cucurbitaceae	Annual	Vegetable		x
123	Lauka	Bottal gourd	*Lageenaria siceraria (Mol.)*	Cucurbitaceae	Annual	Vegetable	x	x
124	Pharsi		*Cucurbita maxima*	Cucurbitaceae	Annual	Vegetable	x	x
125	Pidar	Edible Emetic nut	*Trewia nudiflora L.*	Euphorbiaceae	Perennial	Vegetable		x
126	Rukhtamatar	Tree tomato	*Cyphomandra betacea Sendt.*	Solanaceae	Perennial	Vegetable	x	
127	Local tamatar	Cherrry tomato	*Lycopersicon*	Solanaceae	Annual	Vegetable		
128	Tamatar	Tomato	*Lycopersicon esculentum L.*	Solanaceae	Annual	Vegetable	x	x
129	Tiroi	Ridge gourd	Luffa acutangula	Cucurbitaceae	Annual	Vegetable	x	x
130	Titekarela	Bitter gourd	*Momordica charantia L.*	Cucurbitaceae	Annual	Vegetable	x	x
131	Jukini	Summer squash	*Cucurbita pepo*	Cucurbitaceae	Annual	Vegetable		x
132	Amaro	Golden apple	*Spondia pinnata (L. f.) Kurz*	Anacardiaceae	Perennial	Vegetable		x
133	Bethe saag		*Chenopodium album L.*	Chenopodiaceae	Annual	Vegetable	x	x
134	Chamsur	Garden cress	*Lepidium sativum L.*	Cruciferae	Annual	Vegetable	x	x
135	China saag				Annual	Vegetable		x
136	Lattee saag		*Amaranthus sp.*	Amaranthaceae	Annual	Vegetable	x	x
137	Ludesaag	Pigweed	*Amaranthus virids L.*	Amaranthaceae	Annual	Vegetable	x	x
138	Palak	Spinach	*Spinacea oleracea L.*	Chenopodiaceae	Annual	Vegetable	x	x
139	Poisaag	Indian spinach	*Basella alba L.*	Basellaceae	Annual	Vegetable		x
140	Rayo	Leaf musard	*Brassica juncea (L.) Czern. & Coss.*	Cruciferae	Annual	Vegetable	x	x
141	Siplegan	Garlic pear	*Crataeva unilocularis Buch.-Ham.*	Capparidaceae	Annual	Vegetable	x	x
142	Swiss saag	Swisschared	*Beta vulgaris var. cicla*	Chenopodiaceae	Annual	Vegetable	x	x
143	Torisaag	Indian rape	*Brassica campestris L. var. toria Duth. & Full.*	Cruciferae	Annual	Vegetable		X

Appendix 1: Continued

Sn	Nepali name	English name	Scientific name	Plant Family	Growth habit	Importance	Gulmi	Rupandhei
144	Bakulla	Broad bean	*Vicia faba L.*	Leguminosae	Annual	Vegetable	x	x
145	Bhatmas	Soyabean	*Glysine max Merr.*	Leguminosae	Annual	Vegetable	x	
146	Bodi	Cowpea	*Vigna unguiculata L.*	Leguminosae	Annual	Vegetable	x	x
147	Hiunde simi	Hyacinth bean	*Dolichos lablab L.*	Leguminosae	Annual	Vegetable	x	x
148	Laure/Ghiu simi	Pole/butter bean	*Phaseolus lunatus L.*	Leguminosae	Annual	Vegetable	x	x
149	Matarkosa	Peas	*Pisum sativum L.*	Leguminosae	Annual	Vegetable	x	x
150	Swasta	Cowpea	*Vigna spp.*	Leguminosae	Annual	Vegetable	x	x
151	Aalu	Potato	*Solanum tuberosum L.*	Solanaceae	Annual	Vegetable	x	x
152	Gaajar	Carrot	*Daucus carota L. var. sativa DC.*	Umbelliferae	Annual	Vegetable	x	x
153	Mula	Radish	*Raphnus sativus L.*	Cruciferae	Annual	Vegetable	x	x
154	Pindaalu	Taro	*Colocia antiquorum Schott. var.esculenta*	Araceae	Annual	Vegetable	x	x
155	Sakharkhanda	Sweet potato	*Ipomoea batatus (L.) Lam.*	Convolvulaceae	Annual	Vegetable	x	x
156	Salgam	Turnip	*Brassica rapa L.*	Cruciferae	Annual	Vegetable	x	
157	Simaltarul	Cassava	*Manihot esculentus Crantz.*	Euphorbiaceae	Annual	Vegetable	x	x
158	Bandakobi	Cabbage	*Brassica oleracea L. var. capitata L.*	Cruciferae	Annual	Vegetable	x	x
159	Kauli	Cauliflower	*Brassica oleracea L. var. botrytis L.*	Cruciferae	Annual	Vegetable	x	x
160	Kalo kauli	Local cauliflower	*Brassica spp.*	Cruciferae	Annual	Vegetable	x	
161	Bhyakur	Cush cush yam	*Dioscorea deltoidea Wall.*	Dioscoreaceae	Perennial	Vegetable	x	
162	Ghar tarul	Greater yam	*Dioscorea alata L.*	Dioscoreaceae	Perennial	Vegetable	x	x
163	Gittha	Air potato	*Dioscorea bulbifera L.*	Dioscoreaceae	Perennial	Vegetable	x	
164	Kankra	Cucumber	*Cucumis sativus L.*	Cucurbitaceae	Annual	Vegetable	x	x
165	Sitalchini	Drumstick-tree	*Moringa oleifera* Lam	Moringaceae		Vegetable		x

Appendix 2.1: Name of different varieties for *Hiunde Simi* (*Dolichos lablab* L.), farmers' description, characters of varieties and morphological characters known through Focus Group Discussion (FGD) conducted in study site Bharsa and Baikunthapur, *Terai* ecology, 2003.

Name of varieties given by farmers	Farmers' descriptor	Characters for varieties given by farmers	Morphological characters
Gaanthihawa†	Analogies to knot for fruiting style	Reddish purplish bean, short in size	Indeterminate, creeper, purplish flower, purple stem colur,
Goitihawa †	Analogies to shape of fish	Reddish purplish bean and long size. Good culinary quality	Indeterminate, creeper, pinkish purple flower, purple stem
Gudrihawa †	Analogies to peas	Whitish green pod colour	Indeterminate, creeper, white flower, light green leaf, stem light green
Ghiuu sim chappar †	Analogies to ghee colour and flat shape	Ghee colour flat bean not so good taste	Indeterminate, creeper, white flower, light green colour
Chamra sim †	Analogies to taste	Greenish short, and not good taste	Indeterminate, creeper, white flower, dark green stem and leaves
Rani sem gol †	Analogies to queen and round shape	Margin with pinkish colour with round shape	Indeterminate, creeper, Purple pink flower, purple stem dark greenish leaf
Ujara simi †	Morphology: white colour	Bean pod is whitish colour, slightly long and good culinary quality	Indeterminate, creeper, white flower, light green stem and leaves
Seto chaite simi ‡	Morphology: white colour and seasonal adaptation		
Raato simi ‡	Morphology: red colour	Purplish pod and good culinary quality	Indeterminate, creeper pinkish purple flower, purple stem and leaf colour
Malkihawa †	Analogies to fish	Shape like bam fish. Soft, dark greenish pod colour and good culinary quality	Indeterminate, creeper, white flower and dark green stem, leaf and pod.
Hariyo simi gaadhaa ‡	Morphology: dark green colour		
Rani sem chapar †	Analogies to queen and flat shape	Margin with pinkish colour, with flat shape	Indeterminate, creeper, pinkish purple flower, green stem and leaf
Hiunde simi ‡	Seasonal adaptation		
Hariyo simi fikka ‡	Morphology: light green colour	Similar to fish but light green pod colour with medium length	Indeterminate, creeper, white flower, dark green leaf and stem
Rato dalle ‡	Morphology: red colour and small size	Small short red coloured bean, medium taste	Indeterminate, creeper, purple red flower, dark green leaf and stem, small red purplish small pod

†Reported by *Tharu* community; ‡Reported by mixed community

Appendix 2.2: Name of different varieties for *Hiunde Simi* (*Dolichos lablab* L.), farmers' description, characters of varieties and morphological characters known through Focus Group Discussion (FGD) conducted in study site Gulmi mid-hill ecology, 2003.

Name of varieties given by farmers	Farmers' descriptor	Characters for varieties given by farmers	Morphological characters
Hiunde hariyo lamo†	Seasonal adaptation/Morphology: colour and length	Winter green long bean, grow in high moisture and high fertility condition, harvest whole year	Indeterminate, creeper, white flower, green leaf and stem, pod length 9-10cm, green and flat pod shape,
Hiunde hariyo tate chepto†	Seasonal adaptation/morphology: colour and shape	Winter green long flat bean, grow in high fertility condition, medium culinary quality	Indeterminate, creeper, white flower, green leaf and stem, pod length 7-8 cm, green and flat pod shape
Hiunde seto thoulo	Seasonal adaptation /Morphology: colour and size	Winter green long bean, grow in high moisture and high fertility condition, harvest whole year	Indeterminate, creeper, white flower, green leaf with whitish vein colour, round whitish pod.
Hiunde rato chepto lamo	Seasonal adaptation /morphology: colour and shape	Winter red flat long bean, soft culinary quality, high fertility demanding crop	Indeterminate, creeper, Purplish red flower, purplish green leaf, purple leaf vein, purple stem, flat long purple pod.
Hiunde rato dolo	Seasonal adaptation /morphology: colour and shape	Winter red round bean, high fertility and moisture demanding	Indeterminate, creeper, purple flower, green leaf/ leaf margin/stem/, purplish green flat round pod.
Hiunde seto sano	Seasonal adaptation /morphology: colour and shape	Winter white small bean, fertile soil demanding	Indeterminate, creeper, whitish flower, greenish leaf/leaf margin/stem, whitish small round pod.
Cheringo hariyo seto	Seasonal adaptation /morphology: colour and shape	Green bean, fertile soil demanding	Indeterminate, creeper, white flower, green leaf/leaf margin/stem, flat green pod.

† Similar morphology except for pod length

Appendix 3.1 Scientific name, local name, use value and perceived reason for lost species of home garden identified through Focus Group Discussion (FGD) conducted in a study in Bharsa and Baikunthapur villages, Rupandehi, *Terai*ecology 2003.

Scientific name	Local name	Use value	Perceived reasons
Psidium guajva	Amba	Fruit	Disease infestation and dieing back disease of fruit trees
Zizyphus spp	*Local Bayer*	Fruit	Land fragmentation and lack of sapling
Schleichera oleosa (Lour.) Merr.	*Kusum*	Fruit	Deforestation, and land fragmentation
Mangifera spp.	Local *aanp*	Fruit, fuel	Lack of saplings in market
Musa spp	Local *kera*	Fruit	Inaccess of sapling
Terminalia chebula Retz	Harro	Medicinal/ fodder/fuel	Deforestation, Lack of saplings
Terminalia bellirica (Gaerth.) Roxb.	Barro	Fodder	Deforestation
Lindera pulcherrima Benth	Phurso		Lack of seeds and saplings, difficult to maintain seed
	Bidelno	Good fodder	
Litsea monopelata (Roxb.) Korth.	*Kutmiro*		
Ficus clavate	Bedulo		
Zingiber officinale Rosc.	Aduwa	Spice	Low production and storage problem
Momordica cochinchinensis Spreng.	*Chathail*†	Vegetable	Deforestation and inaccessibility of seed and saplings in market
Solanum tuberosom L.	Local *aalu*	Good vegetable	Lack of seed in the market
Brassica oleracia L.	Local *cauli*		
Trichosanthes anguina L.	Local *chichinda*		

†wild vegetable reported by *Tharu* communities in Bharsa, *Rupandehi Terai* ecology

Appendix 3.2: Scientific name, local name, use value and perceived reason for lost species of home garden identified through Focus Group Discussion (FGD) conducted in a study in Gulmi mid-hill ecology, 2003.

Scientific name	Local name	Use value	Perceived reasons
Solanum tuberosum L.	Local aalu	Vegetable and good cooking quality	Lack of access to seed in market
Raphanus sativus L.	Local *mula*	Vegetable	Lack of access to seed in market, Low yield, storage problem, and degraded quality Easy access to improved seed
Capsicum microcarpum (L.) DC.	*Jire khursaani*	Spice, very pungent	Deforestation and habitat destruction of disperser the birds and caused the lost of chilly
Moringa oleifera Lam.	Sitalchini	Sweetening agent	Less interest in growing the species

Appendix 4.1 Scientific name, local name, specific use value and perceived reason for threatened species of home garden identified through Focus Group Discussion (FGD) conducted in a study in Bharsa and Baikunthapur villages Rupandehi, *Terai*ecology, 2003.

Scientific name	Local name	Use value	Perceived reasons
Aloe vera	Ghiukumari	Medicinal (eg burning)	Lack of knowledge and less interest among young generation
Spondias cytheria Sonm	*Annwara*	Fruit (eg.) making pickle	Lack of saplings in market, deforestation and propagation problem
Lycopersicon pimpineliumfolium	Local *tamatar*	Vegetable, very good taste	Lack of seed in market, easy access to improved varieties
Luffa cylindrica Roem	Local *lauka*	Vegetable, very good taste	Lack of access to seed in market and easy access to improved seed varieties
Colocasia esculenta L.	Pindaalu	Vegetable and good crop to make *maseura* †	Lack of market incentives, poor quality such as high irritation
	Sital chini	Vegetable	Insect infestation
Capsicum microcarpum (L.) DC.		Spice, pungent chilly	Deforestation and habitat destruction of dispersers the birds

† *Maseura* a kind of product made through drying leaves, stem and rhizome and mixed with black gram etc

Appendix 4.2 Scientific name, local name, use value and perceived reason for threatened species of home garden identified through Focus Group Discussion (FGD) conducted in a study in Gulmi, mid-hill ecology, 2003.

Scientific name	Local name	Specific use value	Perceived reasons
	Satyajivan	Medicinal (eg cure fever and cough)	Less interest among young generation
Brassica	Local rayo	Good leafy vegetable with good culinary quality	Lack of seed in market difficult to preserve seed. Easy access to improved seed in market
Brassica spp	Local *cauli*	Vegetable with good culinary quality	Lack of seed in market, difficult to preserve seed and easy access to improved seed in market
Cajanus cajan Mill.	Arhar	Pulse crop	Insect pest infestation and unfit to cropping pattern
Colocasia esculenta L.	Pindaalu	Vegetable and good crop to make *maseura* †	High insect infestation, seed not available in market, high allergic to some persons

† *Maseura* a kind of product made through drying leaves, stem and rhizome of taro and mixed with black gram.