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RESEARCH ARTICLE

ASSESSING THE STRUCTURES AND FACTORS AFFECTING ON-FARM AGROBIODIVERSITY IN HOME GARDENS OF FARWESTERN NEPAL

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ABSTRACT

Home gardens is the reservoir of biodiversity and have played great role in on farm conservation and promotion of species. Biodiversity is a crucial component of agricultural system. Therefore, this study focused on assessment of the factors and structures affecting conservation of agrobiodiversity. The study used the techniques of household survey. The result showed that the home garden occupies only 10-16% of the total land. Size of home garden varied from 0.007 ha to 0.31 ha. The Shannon-Weaver's index for rural community (H'=2.44) revealed that the rural community harboured higher plant species diversity in home gardens as compared to urban communities. Total 102 species belonging to 25 families have been taxonomically identified and recorded.

KEYWORDS

Agrobiodiversity, Factors, Food security, Home gardens, Nepal, Structures

1. INTRODUCTION

The traditional land use system around a homestead is the home garden, in which various types of plants are planted and maintained by family members, with motive for family consumption (Shrestha et al., 2002). It is rich in biodiversity and are vital for food and livelihood security as it provides diversified and nutritious products and income at local, regional and global level and also conserve soil (Linger, 2014). Food security is one of the major global challenges of the twenty-first century. Nepal was placed 73rd out of 107 nations in the Global Hunger Index in 2020. One of the most pressing issues is food security. It is past time for Nepalese farmers to diversify their food products and production methods in order to get better market access (Yadav et al., 2022). In this case, it is proven to sustain food and nutrition security, assure food availability for most of the time, availability of food by family members, its use, and production stability (Bhandari et al., 2021).

Home garden has been practiced in Nepal since immortal time and they have ecological, socio-economic, and environmental significance in our context. A multi-layered structure is typical of traditional house gardens to safeguard crops and beneficial insects, newly developed "bio-pesticides" could be employed instead of chemical pesticides (Joshi et al., 2022). Structure of home garden refers to the spatial organization of all the home garden components. Since plants represent the most complex and are spatially predominant, the structure refers the plant assemblages in the home garden (Khanal et al., 2019). Realizing the contribution in insitu conservation of food and nutrition security, the study was focused on assessing the structures, diversity and factors affecting the home garden biodiversity at Bedkot and Bheemdatta Municipality located in Kanchanpur district of Sudurpaschim province.

Study assesses structure, component and factor affecting on-farm agrobiodiversity in home gardens, finding out constituents if homegarden in terai agroecosystem, and assessing the relationship between species richness and socio-economic factors. Home gardens are established next to homestead since prehistoric time (Soemarowoto, 1987). In Nepal, Home gardens has been practiced since immortal time and they have ecological, socio-economic, and environmental significance in our context (Khanal et al., 2019). Home garden consists of large number of plant species from annual to perennial, maintained by the members of household. Fruit trees have been reported as a major component of the home gardens in studies done in other countries (Clerck et al., 2000; Mendez et al., 2001; Zaldivar et al., 2002; Gajaseni and Gajaseni, 1999). Heavy application of organic fertilizers was reported by 100% of the farmers in the home gardens.

However, supplementary application of chemical fertilizers to the organic fertilizers is common to those species/varieties which were cultivated for the market, these include hybrid varieties of crops like cauliflower, cabbage, tomato, potato, cucumber, aubergine, okra, etc (Shtrestha et al., 2004). Home consumption was the principal purpose of home gardening as 60% of total fruits and vegetable consumption comes from the home garden (Gautam et al., 2009). Marketing the home garden surplus produce is common in Nepal. The local market (Haat bazaar/Hatiya) was found to be a dominant market of home garden produce (Sunwar et al., 2006). While marketing of home garden, product is a desirable goal. Besides supporting in family nutrition by supplying fresh vegetables/fruits and dietary diversity, home gardens also contribute to fulfil the basic needs of families by selling the surplus produce (Shrestha et al., 2004).

2. METHODOLOGY

Bedkot and Bheemdatta Municipality of Kanchanpur district were selected for study purpose. Species diversity was one of the major criteria for study site selection.

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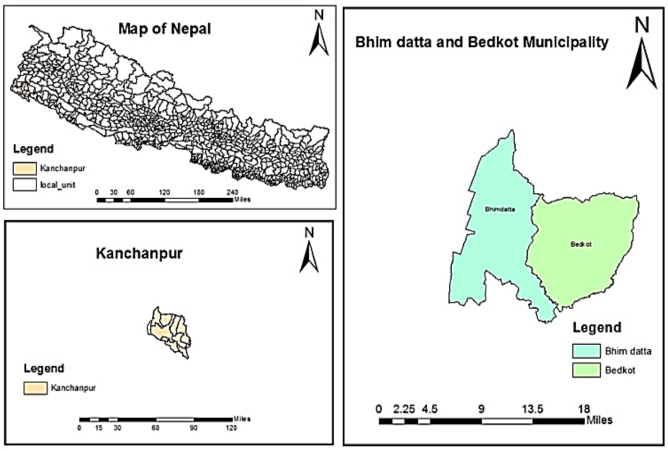

Figure 1: Map of Nepal showing two study areas

The study was conducted through cross sectional survey in the selected wards. This type of information gathers information from selected population, and it is useful in accessing practices, attitudes, knowledge, and beliefs of a population in relation to a particular event (Kipku, 2014). The households were selected using simple random sampling technique. 90 households were sampled from ward number 18 & 4 of Bheemdatta and Bedkot municipality respectively. Data were collected through survey, field observation, inventory preparation and focus group discussion. Close-ended questionnaire with subsequent coding was used to elicit the response of respondents with various occupation as a primary source of income. Data were obtained regarding socio-economic status, characteristics, changes, status and factors affecting the agro biodiversity. Preliminary list of representative species was identified based on criteria given by (Suwal et al., 2005). Two focus group discussion were done, one in each ward to verify and supplement the data gathered from the interviews. The study was carried from December 2019 to February 2020.

In case of inferential analysis, one sampled t test, independent sample t test, Pearson's Chi square test and Pearson's correlation was used to evaluate the agrobiodiversity across two regions and to determine bivariate relationship between plant species richness or diversity variables and biophysical or socio-economic variables. Two diversity indices, Shannon diversity indices and Simpson diversity indices were computed by following formula using MS Excel 2016. Statistical package for social science (SPSS version 23) was used for all other analysis. Before SPSS analysis, the data from Water portal surveyor and MS Excel were coded and tabulated.

i) The Shannon diversity index for plant species was calculated as

$$H = -\sum_{i=0}^{n} p_i * \ln p_i$$

where, n = number of species in the community, and

pi = proportional abundance of species i (= number of species i divided by total numbers in the community)

ii) Sipson index of diversity was calculated using following formula

$$D = 1 - \frac{\sum n(n-1)}{\sum N(N-1)}$$

Where, n = number of individuals of each species

N = total number of individuals of all species

Simpson index of diversity ranges from 0 to 1

- High score (Close to 1) indicates high diversity.
- Low scores (Close to 0) indicate low diversity.

3. Result and Discussion

Among total respondents 56.6% were male whereas 43.4% were female. Out of 45 respondents from each community, majority of the households were headed by male (86.7.3%) in urban communities and similar for rural communities (88.9%). Only 13.3% and 11.1% of households were headed by female in urban and rural communities respectively. Similarly, in urban communities 15.6% were illiterate, 13.3% had primary level of education and 71.1% had secondary and university level of education whereas 31.1% were illiterate, 15.6% had primary level of education and 53.3% had secondary and university level of education in rural communities.

Nuclear families were dominant with average household size of 5.60 ± 1.77 (range 2-11) in urban and 5.82 ± 1.76 (range 4-12) in rural communities. Dependent family members were 39.03% (dependency ratio) & 41.57% in urban and rural communities respectively showing that families had more or less the same number of economically active members. The households were dominated by elite groups (Brahmin & Chhetries) both in urban (75.6%) and rural (53.3%) communities whereas marginalized touchable groups (Tharu, Janjati, Rana) were 13.3% and 35.6% in urban and rural communities respectively. Marginalized untouchable groups (Terai-Dalits) were 11.1% in both communities. Although the contribution of home gardens was significant in both rural and urban communities' majority of the family did off-farm income generating activities like business, services. Only 6.7% & 13.3% of the family depended on agriculture for their primary source of income in urban and rural communities respectively.

3.1 Demographic and Socio-Economic Characteristics of Respondents

Table 1: Demographic and Socio-Economic Characteristics of Respondents

Characteristics	Bheemdatta Municipality (n=45)	Bedkot Municipality (n=45)
Gender (%)		
Male	32.2	24.4
Female	17.8	25.6
Household Type (%)		
Male Headed	86.7	88.9
Female Headed	13.3	11.1
Education Level (%)		
Illiterate	15.6	31.1
Primary Level	13.3	15.6
Secondary and University Level	71.1	53.3
Average Family Size	5.6 ± 1.77	5.82 ± 1.76
Dependency Ratio	39.09	41.57
Ethnicity (%)		
Elite Group	75.6	53.3
Marginalized and Touchable	13.3	35.6
Marginalized and Untouchable	11.1	11.1
Major Source of Income (%)		
Agriculture	6.7	13.3
Off-Farm Income	35.6	37.8
Government Services	37.8	31.1
Remittance	20	15.6

3.1 Size of Home Garden, Species Richness and Their Relationship

The average size of the home gardens in urban and rural agroecosystem were reported 0.026 ± 0.011 ha and 0.048 ± 0.022 ha respectively but the total land holding of rural agroecosystem reported higher (0.29 ± 0.24 ha) as compared to urban agroecosystem (0.057 ± 0.061 ha). The average species diversity ranged from 26.93 to 31.47 species per home garden. Similarly, the total community species diversity was found 283 in rural agroecosystem whereas 245 in urban agroecosystem. Total of 102 species belonging to 25 families were recorded in the home garden. During the observation, 10 species of fodder, 15 species of fruits, 27 species of medicinal and aromatic plants and 30 species of vegetables were recorded. Out of these species, 25 species had high abundance, 36 species had medium abundance and 41 species had low abundance.

The species recorded in the home garden of study area were from annual to perennial crops. According to some study, typical values of Shannon Weaver Index are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4 (Kerrhoff, 2010). So, in this case overall diversity of 2.44 seems to pertain high biodiversity among the species. Based on the information at table 2, it can be said that vegetable species are highly diverse in both the agroecosystem whereas fodder species are least diverse. In the urban agroecosystem, ornamental plant species constitute the major component followed by vegetables and medicinal plants that contributed to the species diversity. Similarly, for rural agroecosystem vegetables were the major constituent of home garden followed by ornamental plants and fruit species. The structure of home garden was highly diverse, and it can be said that the home gardens are viable option in conserving on farm agrobiodiversity.

Table 2: Home Garden Statistics and Estimates of Crop Species Diversity of Home Gardens

Characteristics	Urban Agroecosystem (N=45) (Bheemdatta Municipality)	Rural Agroecosystem (N=45) (Bedkot Municipality)
Total Land Size (Ha)	0.057 ± 0.061	0.29 ± 0.24
Cultivated Land Size (Ha)	0.037 ± 0.051	0.254 ± 0.20
Average Size of Home Gardens (Ha)	0.026 ± 0.011	0.048 ± 0.022
Shannon-Weaver Indices(H’)		
All Species	2.23	2.44
Vegetable and Spice Crops	2.95	3.09
Fruits	2.01	2.37
Fodder	1.55	2.19
Medicinal Plants	2.57	2.80
Ornamental Plants	3.14	2.97
Simpson Index (Dominance) (Λ)		
All Species	0.82	0.92
Vegetable and Spice Crops	0.94	0.95
Fruits	0.86	0.88
Fodder	0.76	0.86
Medicinal Plants	0.91	0.93
Ornamental Plants	0.95	0.94
Richness		
All Species	88	97
Vegetable and Spice Crops	25	27
Fruits	13	15
Fodder	6	10
Medicinal Plants	17	20
Ornamental Plants	27	25

*Species richness at the home garden level measured as the average number of species per home garden

3.2 Home Garden Components

Study revealed that the vegetables and spices are the major component followed by ornamental plants, medicinal plants and fruits in home gardens of rural agroecology. Similarly for urban agroecology, ornamental plants were the major components of home gardens followed by vegetables and medicinal plants.

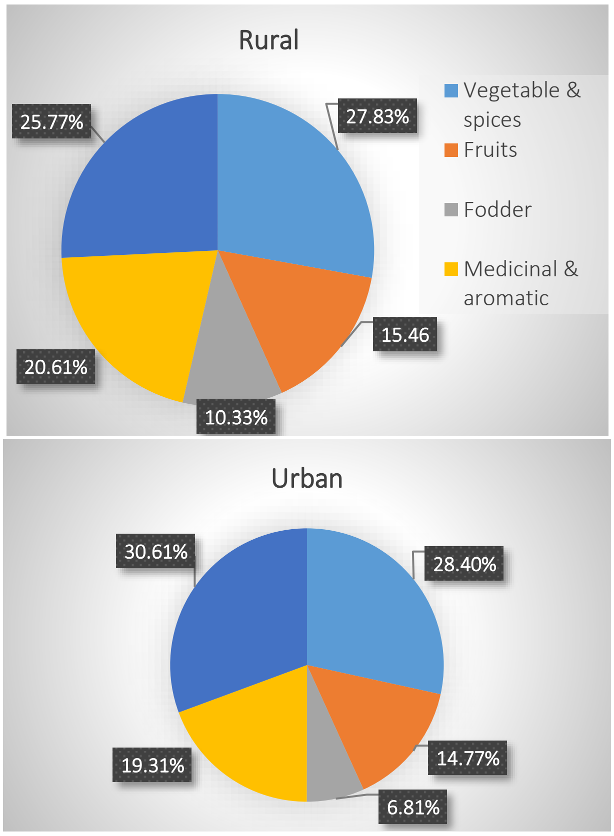

Figure 2: Home Garden components based on frequency of crops

Table 3: Criteria for Identification of Key Species in Home Gardens of Far Western Nepal

Criteria	Plants
Locally important native or traditional plant species	Calocasia, Basil, Ash gourd, Amaranth,
Frequently and extensively grown species	Cabbage, Radish, Coriander, Rose, Onion, Basil, Chilli, Pumpkin, Mango, Aloe vera
Comparative richness	Cabbage, chilli, coriander, Marigold, Broad leaf musterd
Unique or specific ethnic food culture	Tharu Aalu (potato variety specially cultivated by Tharu & Rana’s of Bedkot M), Amaranth, water cress
Traditional & religious value	Basil, Titepati, Cyanodon, custard apple, Calotropis
Economic value	Mango, cotton, Aloe vera, sugarcane

*Criteria adopted from (Gautam et al., 2009)

3.3 Home Garden Management

The study revealed that respondents used different terms and unique names that were known for home garden in study sites. The Elite groups (Brahmin/Chhetri) use Kareshabari (backyard), Gharbari (Home Garden), Fulbari (Flower Garden), tarkaribari (Vegetable Garden), bagaicha (Flower Garden) and Tharu and Rana use term bera (backyard fenced land). Home gardens were close to household in both agroecology and some households of rural agroecology it was a bit farther away within 5-10 minutes of walking distance. The dependency on markets or outside of local community for the vegetable and fruit consumption in rural community was significantly lower as comparison to urban community (MOFALD, 2017). In rural agroecology, the majority of the source for planting materials/seed for home garden was self-saved seed by farmers themselves (55.2%), sharing between and among relatives contributed 23.9% and least dependent on Agrovets (18.4%) for seeds whereas in urban community, most of the households were dependent on Agrovets (44.3%) for source of seed. only 36.6% of the households save their own seed for next year and sharing among the relatives (18%) was also quite low.

3.4 Seed Sources for Home Garden Species

Study revealed that the respondents of Bheemdatta municipality preferred use of chemical fertilizers (54.5%) for the increment of soil fertility of home gardens while households of Bedkot municipality used FYM (63.4%) primarily for their home gardens. Among total respondents 45.6% use pesticide in their home gardens (Hodgkin, 2002). The use of pesticide in home gardens were higher in Bheemdatta (53.3%) as compared to Bedkot (37.8%). Organic pesticides were primarily used by the households of Bedkot. The local resources used as organic pesticides were Neem leaves, tobacco solution, Artimisia solution, cow urine and ash (Hoogerbrelgge and Fresco, 1993; King, 2000).

Figure 3: Planting materials/seed for home gardens in Rural & Urban

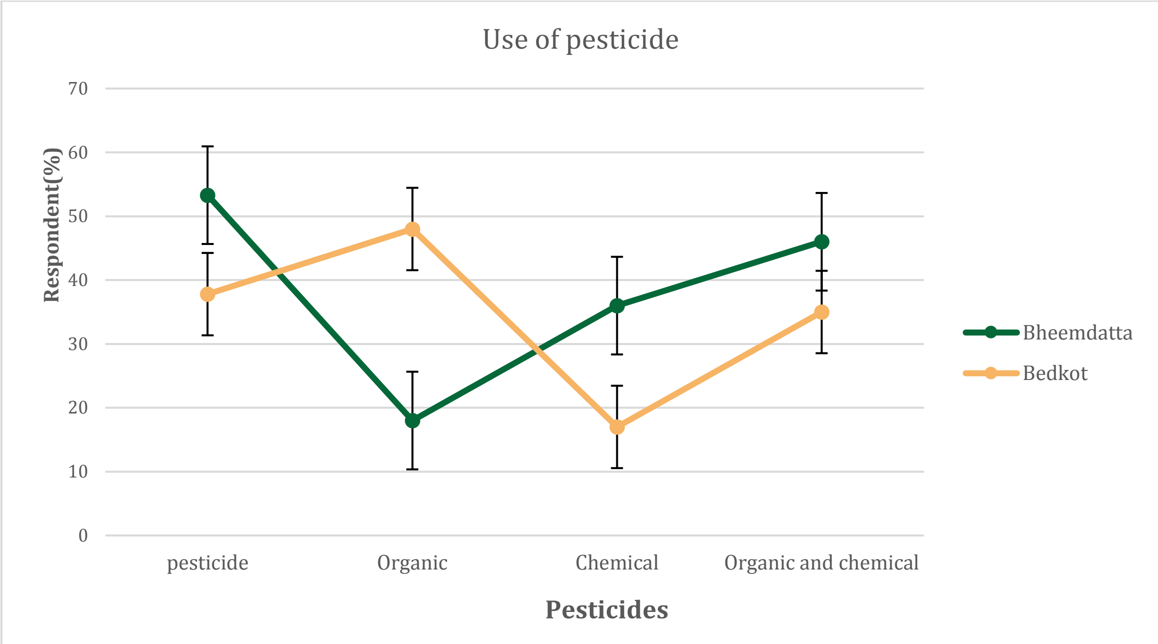

Figure 4: Overall pesticide used, organic pesticides, chemical pesticides and both used in home gardens

3.5 Relationship Between Agrobiodiversity and Food Sufficiency Level

An independent sample t-test analysis, we came to found that there is statistically significant difference between food self-sufficient (0.283±0.198) and food self-insufficient households (0.049± 0.082) with a t-value of -6.78, and the degree of freedom 44.65 with an associated significance level of $p<0.001$. This told us that cultivated area determines the food self-sufficiency level (Agelet et al., 2000). Households having greater cultivated area lead towards food self-sufficiency and vice-versa. Similarly, another hypothesis was created that the agrobiodiversity of food-self-sufficient household and food-self insufficient households was similar. From the t-test we came to found that there was statistically significant difference between food self-sufficient (33.49±5.87) and food self-insufficient (26.21±7.10) households with a t-value of -5.126, and degree of freedom 88 with an associated significance level of $p<0.001$ (Alzina and Howard, 2012). This told us that there was higher agrobiodiversity in the home gardens of food-self-sufficient households, and they used to cultivate higher number of plants in their farm. This finding also indicated that higher the plant diversity the level of food self-sufficiency will increase and vice-versa.

3.6 Relationship Between Species Richness and Socioeconomic Factors

This study found that home gardens of rural agroecology had statistically significantly higher crop species diversity (31.43±7.43) as comparison to species diversity in home gardens of urban agroecology (26±6.94), t (88) = -2.98, p=0.004. It showed that the increase in proximity to market decrease the biodiversity of home gardens. This finding agrees with previous report (Khanal et al., 2019; Brookfield and Padoch, 1994). Home gardens of households headed by male had statistically significantly higher crop species diversity (29.67±7.66) observed as comparison to home gardens of female headed households (25.91±5.54), t (88) = 1.56, p=0.121. Male tended to cultivate more numbers of crop species in their home gardens. Home gardens of people with higher level of education had statistically significantly higher crop species diversity (31.26±7.10) was observed as compare to home gardens of uneducated gardeners (25.14±6.15), t (42) =3.04, p=0.004. Education helped respondents to conserve more species in their home gardens.

3.7 Factors Affecting Agrobiodiversity of Home Gardens

A positive correlation between size of home garden (ha) and total land size (ha) was found ($r=0.62$, $n=90$, $p<0.001$; Table 4). Size of home garden was larger for the households having greater total land area. This means that the size of total land holding positively influence the diversity of the home garden. Education level of the household head had a positive influence on crop species diversity ($r=0.312$, $n=90$, $p<0.05$), showing that those who had higher level of education had cultivated more numbers of plant species in their home garden. Moreover, farming years positively influenced total species richness of the home gardens ($r=0.13$, $n=90$, $p=0.211$), indicating that species diversity increased depending on the number of years the farm had been cultivated.

Table 4: Pearson's Correlation Coefficient(r) Between Factors Affecting Agrobiodiversity of Home Gardens of Bedkot and Bheemdatta M, 2020.

Factors	Total Land Size (Ha)	Home Garden Size (Ha)	Education Level	Farming Years	Total Species Richness
Total Land Size (Ha)	1				
Home Garden Size (Ha)	0.629**	1			
Education Level	0.084	0.047	1		
Farming Years	0.209*	0.214*	-0.184	1	
Total Species Richness	0.561**	0.456**	0.312**	0.133	1

*Correlation is significant at the 0.05 level (two-tailed), ** at 0.01 level (two-tailed)

Home gardens in Far-western Nepal were characterized by high level of species diversity with a mixture of annual to perennial plants. There were more similarities in between home garden agrobiodiversity of rural agroecosystem (Bedkot M) and urban agroecosystem (Bheemdatta M) of Far-western Nepal. Few species of vegetables, Fruits, fodder, ornamental, and medicinal plants were different in between these two agroecosystems. The most grown plants in home gardens of Bedkot and Bheemdatta were vegetables and ornamental plants. The size of home gardens influences the species richness of home gardens within an area, according to (Kumar and Nair, 2004). We discovered a significant difference in the size of household gardens between rural and urban areas in this study. Although a positive correlation was found between home garden size and total species richness. Other factors like farming years, cultivated area, level of education also had influence on the on-farm conservation of agrobiodiversity.

There may some possible limitation in the study that could be address in future research. First, the study focused on only crops like vegetables and spices, fruits, fodder, medicinal and ornamental plants. Beyond this there may be livestock, microorganisms, high value crops, timber, wild plants that may influence the on-farm conservation of agrobiodiversity. Secondly, the study only addressed the cultivation frequency of crop species in home gardens. It did not highlight the total number of plants of a species and total cultivated area of each species that may have link with on-farm conservation of agrobiodiversity. Thus, further research is needed to address such limitations.

4. Conclusion

The present study imparts the information for home gardens in Far western Nepal. The information could be used in home garden intervention for economic development and possible strategy on the use of home garden for on farm agricultural biodiversity management. The Shannon diversity index of 2.23 in urban ecology and 2.44 of rural ecology showed the higher crop species diversity in Nepalese home gardens. However, the species composition and species richness of urban and rural ecologies were different due to the ethnicity and ecological differences. Higher diversity of plant species was associated with female owner, farm farther from market, higher level of education of HH head and long farming history. 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 home gardens of the study area.

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