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CONTRIBUTION OF HOMEGARDEN AGROFORESTRY IN LIVELIHOOD OF RURAL FARMERS IN KUMAUN HIMALAYA

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ABSTRACT

Homegardens are intensive land-use systems involving the management of woody species grown in deliberate association with herbaceous species, with or without livestock, managed within the compounds of individual homes. Many of the benefits provided to farmers by these gardens are unknown for lack of quantification of the products used by the households. This study was conducted along an altitudinal gradient in Kumaun Himalayan region of Uttarakhand state, India with an objective to collect the data on plant species diversity in homegardens and their contribution towards livelihoods of rural community. The information was collected through a field survey using semi-structured interview schedules and direct observation in the field. A total of 97 species were identified as being important to rural livelihoods, either for personnel consumption or for income generation by selling them in nearby markets. Vegetables (27 species) and fruits (20 species) were the most used categories. Net return from homegarden ranged between INR 10,944 and INR 22,527 and the output/input ratio for monetary budget was higher for low altitude homegardens (3.31) as compared to mid (2.73) and high (2.16) altitude homegardens. This study suggested that though homegardens provide a small source of income, they are particularly important for poor households to meet their basic needs and overcome adversity.

Keywords: Energy budget, homegarden agroforestry, livelihood, plant utilization.

INTRODUCTION

Traditional agroforestry systems are being practiced in India since ancient time (Bargali *et al.* 2004, 2009). Homegardens are intensively cultivated agroforestry systems managed within the compounds of individual homes (Bargali *et al.* 2015 a) having diversity on the basis of local conditions. They comprise of a wide variety of productive trees, shrubs, vegetables, medicinal plants, herbs, fodder, and sometimes even staples and provide both economic and social benefits that are essential to the nutritional welfare and security of the household. These gardens, with their diversified agricultural crops and trees, fulfill the basic needs of the local population. Growing and maintaining plant species in the vicinity of home and making their products by household members were primarily intended for the family consumption. However, the changing socioeconomic conditions and advent of commercial forces have introduced the concept of cash with homegardens (Bargali

et al. 2015 a). They are one of the best known traditional practices for livelihood, and sustainable development (Kittur and Bargali, 2013; Parihaar *et al.* 2015; Padalia *et al.* 2015). Homegarden agroforestry system plays an important role in the livelihoods of poor rural and in the rural economy of the country. They provide cash income, nutrition, stability, integrity of the household and reflect the cultural and social status of the owner (Parihaar *et al.* 2014; Padalia *et al.* 2015; Bargali *et al.* 2016; Pande *et al.* 2016; Nair and Sreedharan, 1986; Swift and Anderson, 1992; High and Shackleton, 2000; Mendez *et al.* 2001).

In Indian Himalaya, more than 90% people live in villages, which are organized as independent socio-ecological systems. The cultivation of fruits, vegetables, medicine, fodder and ornamentals in homegardens has a long tradition, especially among the rural communities in the state of Uttarakhand. The review of literatures showed that there is a lack of research on plant diversity and economic value of homegardens in the Kumaun Himalaya, India where tradition of homegardens is very old (Padalia *et al.* 2015). This study aims at analyzing the plant species richness and investigates the contribution of homegarden agroforestry systems towards livelihood of rural farmers which may help government agencies and policy makers to develop and review rural development programmes to improve rural livelihood in Kumaun Himalayan region.

MATERIALS AND METHODS

Study Area

The study area was located in Kumaun Himalayan region of Uttarakhand state, India. Villages involved in homegarden agroforestry practices were selected in Nainital district at three altitudes (Table 1). Location of the selected villages is given in Fig. 1.

The study area falls in sub-tropical to temperate climate. The average temperature oscillated between 5.4^{o}C and 40.2^{o}C and the average rainfall was 1407 mm in the study area during the study period.

Data Collection Procedure

Field survey

The study was conducted from 1 January to 31 December 2016 (summer, winter and rainy season). Three complementary approaches were adopted, namely; (a) formal interview with the village headmen (pradhan) and secretary, (b) direct observation, (c) interaction with the head of the selected households through questionnaires (Bargali *et al.* 2007; Pandey *et al.* 2011; Bargali *et al.* 2009 b). The survey was administered to a random sample of 30 households in each village. Homegarden size was measured excluding the area occupied by the house. For plant species inventory, whole homegarden was used as sample plot.

Data collection

The plant species were recorded with the help of homegarden owner and identified with the help of vernacular names and floras of the region. The information on the uses and importance of plant species were collected by using questionnaires and focus group discussion. For calculating energy budget of homegardens information was collected on: i) labour input in terms of bullock days and person days; ii) manure input and iii) seed input. All the information

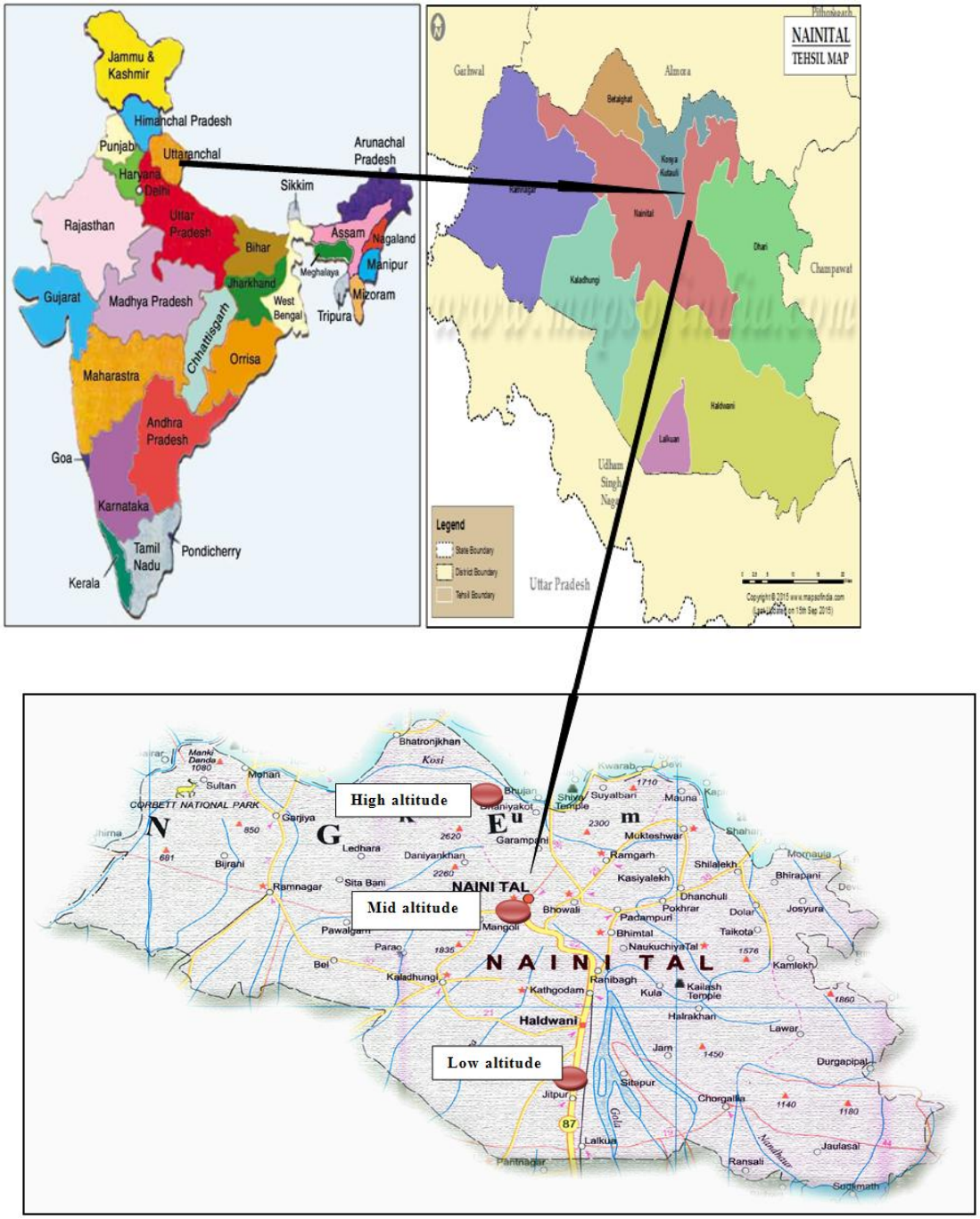

Fig. 1. Location of study sites

Table 1. Description of study sites

Sites	Village	Latitude	Longitude	Altitude (m)
Low altitude	Jeetpur	29°13'59"N	79°30'23"E	453
Mid altitude	Mangoli	29°29'40"N	79°27'7"E	1072
High altitude	Dhaniakot	29°22'26"N	79°25'50"E	1637

was cross checked for confirmation by repeated field visits in the study area. Durations of sedentary, moderate or heavy works by males and females in various activities (ploughing, preparation of seed beds) and bullock power use were noted.

To calculate Household income (monetary budget) from homegarden information was collected on: i) planting material cost ii) manure cost iii) labour cost of different management activities and iv) amount of homegarden products they sold and consumed.

Data Analysis

Computation of energy budget

The input values were calculated in terms of work (human and bullock power) as man-days and bullock days and quantities of seeds and manure/fertilizers. The output was calculated as yield of crops and by products separately. In addition to this green fodder obtained from wild herbs and fodder trees was also considered as an auxiliary output of the homegardens. The energy values of outputs and inputs were calculated based on the caloric equivalents as reported by Mitchell (1979) (Table 2). Hours spent by males and females for sedentary, moderate and heavy works were multiplied by per hour energetic value of a given type of work and the products summed up to obtain total human labour input. Similarly, duration of bullock power use was multiplied by energetic value of bullock power to computed total energy of this input. Energy inputs through seeds and manure and outputs through edible yields, fuel wood, fodder and litter were calculated by multiplying the amount of an input/output related to its standard energetic value.

Table 2. Energetic values of different inputs and outputs in the agroforestry systems in Himalaya, India (Mitchell, 1979)

Category	Energy
Grains	16.2 MJ kg^{-1}
Pulses	17.0 MJ kg^{-1}
Oilseeds	23.07 MJ kg^{-1}
Potato	03.9 MJ kg^{-1}
Leafy vegetables	02.8 MJ kg^{-1}
Other vegetables	02.4 MJ kg^{-1}
Milk	04.2 MJ kg^{-1}
Green fodder	03.9 MJ kg^{-1}
Hay	14.5 MJ kg^{-1}
Straw	13.9 MJ kg^{-1}
Fuel wood	19.7 MJ kg^{-1}
Farmyard manure/compost	07.3 MJ kg^{-1}
Human labour	
Male Sedentary work	00.418 MJ h^{-1}
Moderate work	00.488 MJ h^{-1}
Heavy work	00.679 MJ h^{-1}
Female Sedentary work	00.331 MJ h^{-1}
Moderate work	00.383 MJ h^{-1}
Heavy work	00.523 MJ h^{-1}
One bullock-day	72.7 MJ day^{-1}

MJ = megajoule

Computation of monetary budget

In order to compute the contribution of the homegardens towards farmers' income, gross income was calculated by adding the amount of money earned from all the products collected from homegardens including those used for self consumption and sale. For calculating input and output cost, local market rates of homegarden products and daily wage rate of workers in the study area were used. Cost of seed and manure input was calculated by multiplying

amount used by their market cost and labour cost was calculated by multiplying time spent in homegarden activity by daily wage rate. From gross income the cost of expenditures in maintenance of the homegardens and marketing of plant products was deducted to get net benefits.

RESULTS

Plant Diversity

The homegardens appear to be assorted mixture of tree, shrub, herb, climber and epiphytes. 35 trees and shrubs belonging to 23 families with eight different uses were recorded (Table 3): edible

Table 3. List of trees and shrubs cultivated in homegardens of Kumaun Himalaya

Botanical name	Local name	Uses	Family	*Low	Mid	High
Araucaria heterophylla (Salisb.) Franco	Christmas tree	Or	Araucariaceae	+	-	-
Artocarpus integrifolia L.	Kathal	Ed	Moraceae	+	-	-
Azadirachta indica Juss.	Neem	Me	Meliaceae	-	+	-
Bauhinia variegate L.	Kweral	Fo,Ed,Me	Fabaceae	-	-	+
Biota orientalis L.	Morpankhi	Me, Or	Cupressaceae	-	-	+
*Buddleja asiatica*Lour.	Blu chip	Or	Buddlejaceae	-	-	+
Calotropis procera (Willd.) R. Br.	Madar	Or	Apocynaceae	+	-	-
Carica papaya L.	Papita	Ed, Me	Caricaceae	+	-	-
Cinnamomum tamala (Buch. Ham.) T. Nees&Eberm.	Tejpat	Ed, Me	Lauraceae	+	-	-
Citrus aurantifolia (Christm.) Swingle	Kagjinimbu	Ed, Me	Rutaceae	+	+	+
Citrus medica L.	Bara nimbu	Ed, Me	Rutaceae	-	+	+
Citrus sinensis L.	Malta	Ed	Rutaceae	-	+	+
Debregeasia longifolia (Burm.f.) Wedd.	Tushiyari	Fo, Fu, Me	Urticaceae	-	-	+
Eriobotrya japonica (Thunb.) Lindl.	Loquat	Ed, Me,Cu	Rosaceae	-	-	+
Eucalyptus globules Labil.	Liptis	Fu, Me	Myrtaceae	-	+	-
Ficus auriculata Lour.	Timila	Fo, Cu	Moraceae	+	+	-
Ficus clavata Wall. ex. Miq.	Khasuri	Fo.	Moraceae	-	+	-
Ficus palmata Forssk.	Bedu	Ed, Fo, Me	Moraceae	-	+	-
Grevillea robusta A. Cunn.	Silver oak	Or	Amaryllidaceae	-	+	-
Grewia optiva J.R. Drumm. ex Burret	Bhimal	Fo,Fu,Fi	Tiliaceae	-	+	+
Juglans regia Linn.	Akhrot	Ed, Me	Juglandaceae	-	+	+
Litchi chinensis Sonner.	Litchi	Ed, Fu	Sapindaceae	+	-	-
Mangifera indica L.	Aam	Ed, Fu, Cu	Anacardiaceae	+	+	-
Morus alba Linn.	Shahtoot	Ed, Fo, Fu	Moraceae	-	+	+
Phyllanthus emblica L.	Amla	Ed, Fu, Cu	Phyllanthaceae	+	+	-
Prunus armeniaca L.	Khumani	Ed	Rosaceae	-	+	-
Prunus persica (L.) Stokes.	Aadu	Ed	Rosaceae	-	-	+
Psidium guajava L.	Amrud	Ed, Fu, Me	Myrtaceae	+	-	+
Punica granatum L.	Anar	Ed, Me, Cu	Punicaceae	+	+	-
Pyrus communis Linn.	Nashpati	Ed	Rosaceae	-	+	+
Quercus leucotrichophora A. Camus	Banj	Fo, Fu,	Fagaceae	-	+	-
Rosa multiflora Thunb.	Gulab	Me, Or	Rosaceae	+	-	+
Syzygium cumini (L). Skeel	Jamun	Ed, Fo, Cu	Myrtaceae	+	+	-
Tectona grandis Linn.	Sagaon	Fu, Ti	Lamiaceae	+	-	-
Trachycarpus takil Becc.	Thakal	Or	Arecaeae	-	+	-
Duranta erecta L.	-	Or	Verbenaceae	+	+	-

*Cu= cultural; Fi= fibre; Fo= fodder; Fu= fuel wood; Ed= edible; Me= medicine; Or= ornamental; Ti= timber. *altitude; (+) sign indicates presence of species; (-) sign indicates absence of species.*

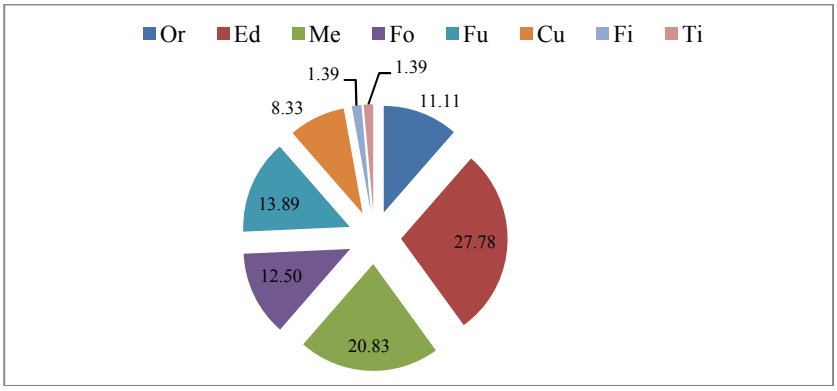

Fig. 2. Utilization pattern of tree and shrub species

Table 4. Cereals and pulses crops cultivated in homegardens of Kumaun Himalaya

Species	Family	Local name	Low	Mid	High
Cereals					
Echinochloa frumentacea (Roxb.) Link.	Poaceae	Jhangora	-	+	-
Eleusine coracana (L.) Gaertn.	Poaceae	Madua	-	+	-
Pennisetum glaucum (L.) R.Br.	Poaceae	Bazra	-	+	-
Oryza sativa L.	Poaceae	Dhan	+	-	-
Triticum aestivum L.	Poaceae	Gehu	-	+	+
Zea mays L.	Poaceae	Makka	+	+	+
Pulses					
Cicer arietinum L.	Fabaceae	Chana	+	-	+
Glycine max (L.) Merr.	Fabaceae	Soyabean	+	+	+
Glycine soja (L.) Merr.	Fabaceae	Bhatt	-	+	+
Macrotylom auniflorum (Lam.)	Fabaceae	Gahat	-	+	-
Vigna mungo (L.) Hepper	Fabaceae	Urd	-	+	-
Vigna unguiculata (L.) Walp.	Fabaceae	Lobia	+	-	-

(27.78%), medicine (20.83%), fuel wood (13.89%), fodder (12.50%), ornamental (11.11%), cultural (8.33%), timber and fiber (1.39%) (Fig. 2). Mid altitude homegardens showed maximum number of species (21 species with 14 families) as compared to low altitude (16 species with 14 families) and high altitude homegardens (15 species with 10 families) (Table 3). The dominant families were Rosaceae and Moraceae (5 species), while Myrtaceae and Rutaceae with 3 species were the co-dominant families. *Citrus aurantifolia* was present in all the three altitudes.

Total 6 cereals and 6 pulses were recorded which belong to 2 families (Poaceae and Fabaceae). At low altitude, *O. sativa* and *Z. mays* were cultivated as major cereal crops whereas, *C. arieitinum, G. max* and *V. unguiculata* were grown as pulse crops. At mid altitude, *E. frumentaceae, E. coracana, P. glaucum, T. aestivum*and *Z. mays* were cultivated as cereal crops whereas, *G. max, G. soja, M. uniflourm* and *V. mungo* as pulse crops. At high altitude, *T. aestivum* and *Z. mays* were cultivated as cereal crops whereas, *C. arieitinum, G. max* and *G. soja* as pulse crops (above Table 4).

Total 27 species of vegetables distributed in 13 families were recorded (Table 5). Family Cucurbitaceae had the

highest number of species (five) whereas Solanaceae and Brassicaceae had four species each and ranked second. Families like Amaryllidaceae were represented by 3 species while Chenopodiaceae and Fabaceae were represented by two species. Rest of the 8 families was represented by single species. At low altitude, (18 species from 11 families), mid altitude (18 species from 11 families) and high altitude (26 species from 14 families) were recorded.

Total 23 species of herbs belonging to 17 families were recorded (Table 6). Highest number of herbs (17 species with 14 families) was recorded at mid altitude homegardens while lowest number was recorded at low altitude homegardens (9 species with 8 families). Most of the species were wild and used as fodder, medicine and/or miscellaneous while some (*G. communis, H. annuus*, *T. erecta*) were ornamental and cultivated (Table 6).

Live stock

Livestock was an integral part of homegardens in the study area. Maximum number of cow was recorded at high altitude homegardens (60%) while minimum number was recorded at mid altitude homegardens (18.92%). Low altitude homegardens had highest percentage of buffalos (25%) as livestock and lowest percentage was recorded at mid altitude homegardens (8.11%). For overall new born (cow, buffalo and goat), maximum percentage was recorded at low altitude homegardens (25%) while subsidence percentage was observed at mid altitude homegardens (18.92%). Goats

Table 5. List of vegetables cultivated in homegardens of Kumaun Himalaya

Species	Family	Local name	Low	Mid	High
Abelmoschus esculentus (L.) Moench	Malvaceae	Bhindi	+	+	+
*Allium cepa*L.	Amaryllidaceae	Pyaz	+	+	+
*Allium sativum*L.	Amaryllidaceae	Lassan	+	+	+
Allium stracyes Linn.	Amaryllidaceae	Dhungar	-	-	+
Amaranthus blitum L.	Amaranthaceae	Chaulai	+	+	+
Boehmeria oleracea L.	Urticaceae	Gethi	+	+	+
Brassica juncea (L.)	Brassicaceae	Layi	+	+	+
Brassica oleracea var. capitata L.	Brassicaceae	Bandgobhi	-	+	+
Brassica oleracea var. botrytis (L.) Alef.	Brassicaceae	Foolgobhi	-	+	+
Capsicum annum L.	Solanaceae	Mirch	+	+	+
Chenopodium album L.	Chenopodiaceae	Bathua	-	-	+
Colocasia esculenta (L.) Schott.	Araceae	Pinalu/Arbi	+	+	+
Coriandrum sativum L.	Apiaceae	Dhaniya	+	-	+
Cucumis sativus L.	Cucurbitaceae	Kakri	+	+	+
Cucurbita maxima Duch. ex Lam.	Cucurbitaceae	Kaddu	+	+	+
Fagopyrum esculentum Monch.	Polygonaceae	Ugal	-	-	+
Lagenaria siceraria (Mol) Standl.	Cucurbitaceae	Lauki	+	+	+
Luffa acutangula (L.) Roxb.	Cucurbitaceae	Torai	+	-	+
Lycopersicon esculentum (L.)	Solanaceae	Tamater	+	-	+
Momordica charantia L.	Cucurbitaceae	Karela	+	+	+
Pisum sativum L.	Fabaceae	Matter	-	+	-
Raphanus sativus L.	Brassicaceae	Muli	-	-	+
*Solanum melongena*L.	Solanaceae	Baigan	+	+	+
Solanum tuberosum L.	Solanaceae	Alu	+	+	+
Spinacia oleracea L.	Chenopodiaceae	Palak	+	+	+
Trigonellafoenum-graecum L.	Papilionaceae	Methi	-	-	+
Vicia faba L.	Fabaceae	Bean	-	-	+

Table 6. Herb (wild/cultivated) species encountered in homegardens of Kumaun Himalaya

Species	Family	Local name	Low	Mid	High
Achyranthes aspera L.	Amaranthaceae	Latjeera	+	-	+
Adiantum sp. L.	Pteridaceae	Kateur	-	+	-
Ageratum conyzoides L.	Asteraceae	Gamlwa	-	-	+
Opium tenuifolium L.	Apiaceae	Afeem	-	+	+
Arthraxon lanceolatus Hochs.	Poaceae	Carpetgrass	-	+	+
Commelina benghalensis L.	Commelinaceae	-	+	+	-
Cynodon dactylon (L.) Pers.	Poaceae	Doob ghas	+	+	-
Drymaria cordata (L.) Willd	Caryophyllaceae	-	-	+	-
**Curcuma longa* L.	Zingiberaceae	Haldi	+	+	-
Euphorbia hirta L.	Euphorbiaceae	Dudhi	-	+	-
Funaria hygrometrica Hedw.	Funariaceae	moss	-	+	+
Galinsoga parviflora Cav.	Asteraceae	Alughas	-	+	+
Gladiolus communis L.	Iridaceae	-	+	-	-
Helianthus annuus L.	Asteraceae	Surajmukhi	+	-	-
Marchantia polymorpha L.	Marchantiaceae	-	-	-	+
**Mentha longifolia* Huds.	Lamiaceae	Pudina	+	+	+
**Musa paradisiaca* L.	Musaceae	Kela	+	+	+
Oxalis corniculata L.	Oxalidaceae	Changeri	-	+	+
Riccia cruciata L.	Ricciaceae	-	-	+	+
Stellaria media (L.) Vill	Caryophyllaceae	Bindu ghas	-	-	+
Tegetes erecta L.	Asteraceae	Genda	+	+	+
Urtica dioica L.	Urticaceae	Bicchu ghas	-	+	+
**Zingiber officinale* Rosc.	Zingiberaceae	Adrak	+	+	+

**Purpose: The products of these cultivated plants are edible and cultivated for own consumption trade*

and bulls (oxes) were maximum at mid altitude homegardens (32.43% and 21.62%, respectively) (Fig. 3).

Energy budget of homegardens

Gross per hectare annual energy input was 8742.28 MJ (megajoule). Maximum energy input was accounted for manure at low (576.7 MJ) and high altitude (1569.5 MJ) homegardens, while it was maximum for seeds at mid altitude homegardens (2114.8 MJ). The energy input in terms of human labour increased with increasing altitude (19.68 MJ, 45 MJ and 49 MJ for low, mid and high altitude homegardens, respectively). Annual energy output from homegarden system was 27490.6 MJ per hectare. Output in terms of food grains was highest at mid altitude (16812 MJ) followed by high (781 MJ) and low altitude (579 MJ) homegardens. Pinnacle of fuel wood collection was observed at mid altitude (295.5 MJ) followed by high and (98.5 MJ) and low altitude (24.7 MJ) homegardens. High altitude homegardens (4050 MJ) had vegetables as top energy output shareholder followed by low (3320 MJ), and mid altitude homegardens (804 MJ). Energy output in terms of fodder was maximum (165.6 MJ) in mid altitude homegardens. Byproducts (milk, straw, fuel, fodder) obtained from mid, high and low altitude site were 176.6 MJ, 147 MJ and 12 MJ, respectively. Maximum net return was obtained in mid altitudinal homegardens (13805.3 MJ) whereas; minimum net return was recorded in high altitude homegardens (1888.7 MJ). Output/Input Ratio was bordered between 4.14-1.57 and was maximum for low altitude homegarden agroforestry systems (Table 7).

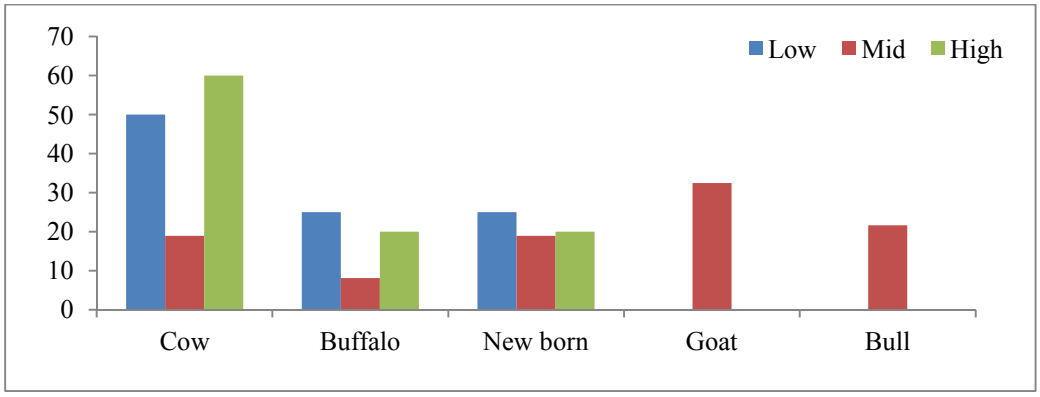

Fig. 3. Livestock population recorded in homegardens of Kumaun Himalaya

Table 7. The energy (MJ/ha) inputs and outputs in homegardens of Kumaun Himalaya

Input/Output	Altitudes		
	Low	Mid	High
INPUT			
Human Power	19.68	45	49
Drought Power	290.8	872.4	581
Seeds	86.2	2114.8	1121
Manure	576.7	1416.2	1569.5
Total Input	**973.38**	**4448.4**	**3320.5**
OUTPUT			
Food Grains	579	16812	781
Vegetables	3320	804	4050
Byproducts	12	176.6	147
Fuel wood	24.7	295.5	98.5
Fodder	92	165.6	132.7
Total output	**4027.7**	**18253.7**	**5209.2**
Net Return	3054.32	13805.3	1888.7
Output/Input Ratio	**4.14**	**4.10**	**1.57**

Monetary budget of homegardens

The average annual gross monetary input per homegarden was INR 27691 in homegardens of Kumaun Himalaya. Maximum input was accounted for manure/fertilizers at mid (INR 5120) altitude while minimum input was recorded for seeds (INR 300) at low altitude homegardens. Total input was maximum at mid altitude homegardens and minimum for the low altitude homegardens. Total output followed same pattern as described for input. Food grains contributed maximum for the livelihood of rural farmers at low and mid altitude, while at high altitude it was contributed by vegetables (Table 8). Output/ input ratio increased with decreasing altitudinal range. This may be due to the better facilities and proper maintenance of homegardens in low altitudes.

Contribution of homegarden products to rural livelihoods

Major food products were divided in four classes in which maximum shared for

varied human needs *i.e.* food, energy, fodder etc. was recorded for vegetables whereas minimum shared was recorded for by products (Fig. 4).

DISCUSSION

Plant Diversity

Total 97 plant species were recorded in the study area. In a homegarden, species diversity less than five (Ahmed and Rehman, 2004; Abdoellah *et al.* 2006) and more than 100 (Hemp, 2006) have been reported. These plant species provide a number of services in terms of not only food, fodder, firewood and medicine but also cultural and aesthetic services (Tynsong and Tiwari, 2010; Bargali, 2016). Previous research on trees in Kumaun Himalaya also showed a wide range of uses, indicating that households have a broad knowledge of trees and their uses (Bargali, 2016). Das and Das (2005) reported that growing a few individuals of many species in a small area may not only enhance the dietary diversity of the home garden's owner but also maintain the fertility of soil. In the homegardens, the selection of species was based on the ecological requirements of the species as determined by the local people through centuries of experimentation. Growing number of species together in homegardens not only make resources available for food and other purposes but also provide invisible social mechanisms and related resilience strategies resulting in reduced vulnerability as may be noticed in single crop cultivation. Seasonality and adaptability of plant responses were some other aspects of Traditional Ecological Knowledge that have accumulated by local people through trial and errors. In general, the practice of raising homegardens is based on the cumulative traditional knowledge, practices and beliefs with respect to the species and its environmental and ecological requirements (Kala, 2010).

Livelihood Benefits of Homegardens

Present study observed that the diversity of crop species and production cycles in homegardens enables year-round production of different products, reducing the risk of production failure and homegarden products were consumed within the home, buffered households

Table 8. Monetary budget (INR) of homegardens in selected villages in Kumaun Himalaya

Input/Output	Altitude			Average
	Low	Mid	High	
INPUT				
Human Power	3000	3500	3100	3200
Seeds	300	4345	2226	2290
Manure/Fertilizer	2030	5120	4070	3740
Total Input	**5330**	**12965**	**9396**	**9230**
OUTPUT				
Food Grains	8900	21730	8800	13143
Vegetables	7700	10150	9710	9186
Byproducts	200	1596	1250	1015
Fuel wood	750	1800	400	983
Fodder	120	216	180	172
Total output	**17670**	**35492**	**20340**	**24500**
Net Return	12340	22527	10944	15270
Output/Input Ratio	3.31	2.73	2.16	2.73

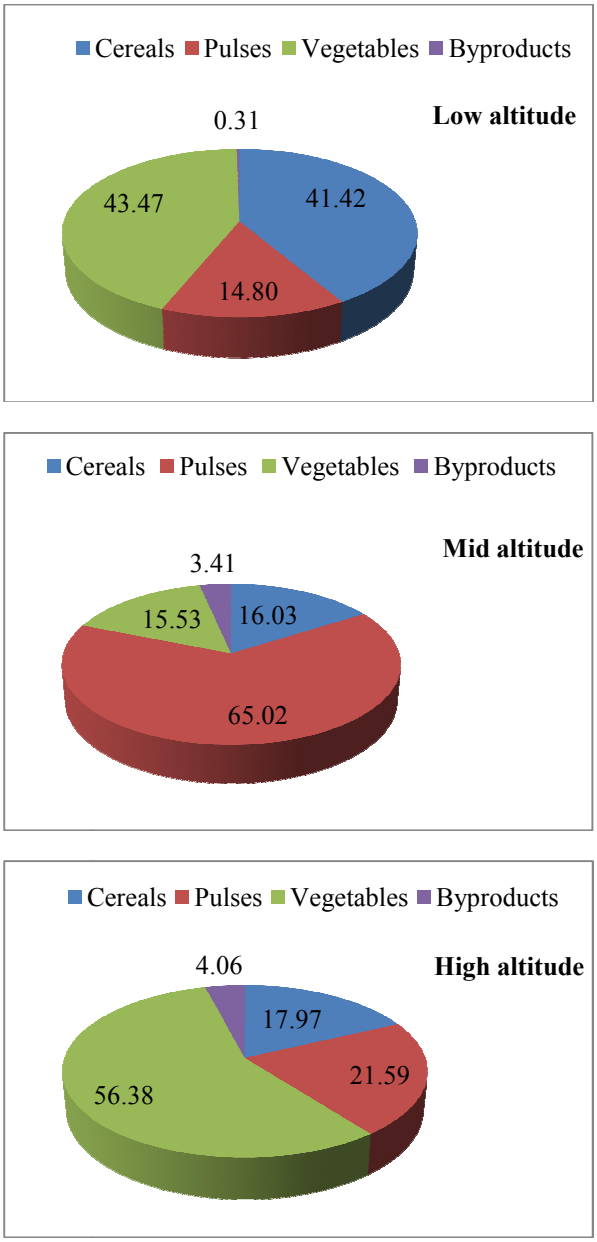

Fig. 4. Contribution of homegarden products in livelihood of rural farmers in selected villages in Kumaun Himalaya

during times of stress. In India, many studies determined the importance and role of homegardens in the life of local people, especially in terms of livelihood and

economic significance (Tangjang and Arunachalan, 2009; Tynsong and Tiwari, 2010; Bargali *et al.* 2015). They are a vital source of income for subsistence economy and contribute to the self sufficiency of many rural households in remote places often secluded from markets and modern production centers (Tynsong and Tiwari, 2010). Most of the homegarden plants were edible and make significant contributions to the nutritional well being. Because of high plant diversity in the homegardens (Kala, 2010), a wide spectrum of multiple-use plant products can be generated with relatively low labour, cashor other inputs. In seasons of scarcity homegardens with their diverse products available year round, contribute towards food security (Tynsong and Tiwari, 2010). Traditional vegetables are often cited as having and providing vitamins such as B, C and even higher amounts of some minerals such as iron and calcium as well as proteins (Bargali, 2016). In the study area, the people were aware of the nutritious properties of some important plant species; hence they have cultivated these plants in their homegardens such as *Musa* Spp. *M. indica, L. esculentum, C. sativum* etc.

During the survey it was observed that villagers cultivate and maintain plants in their homegardens mainly for household consumption and surplus vegetables and fruits were sold in the nearby market for monetary benefits. The most marketed vegetables were chilly (*Capsicum* sp.), tomato (*L. esculentum*), beans (*Phaseolus* sp.) cabbage (*B. oleracea*). Some household give homegardens products like fruits, vegetable and milk products to their neighbours and relatives that give strength to neighbor and family relationship called social capital. Plants grown in the home gardens were also used in various cultural practices. Mango (*M. indica)* and banana (*M. paradisiaca*) are the important religious plants and their leaves and fruits are used for religious ceremonies of Hindu religion.

The average annual gross income generated by homegardens in Kumaun Himalaya was INR 15270 which was much higher than the Kandyan Gardens in Sri Lanka (INR 1621) and much lower than homegardens in South Meghalaya (Tynsong and Tiwari, 2010) (INR 44,241) homegardens of South Africa (High and Shakleton, 2000) (INR 16520).The percentage contribution of homegardens towards peoples' average annual gross income was 10 to 20%, which was lesser than the contribution of homegardens in Indonesia (21.1%) and higher than the homegardens in South West and North-east Bangladesh (15.9% and11.8%, respectively) and South Meghalaya (7%) (Tynsong and Tiwari, 2010). In terms of energy and monetary budget, low altitude homegardens were more efficient as compared to mid and high altitude homegardens as indicated by high output/input ratios as they are highly productive and the nutrient status of soil is more in low altitude homegardens (Parihaar, 2016; Padalia, 2017).

CONCLUSION AND RECOMMENDATION

The present study on homegardens reflects the traditional and sustainable use of land by the local people of Kumaun Himalaya for day to day requirement of resources for their subsistence. Homegardens in the study area not only enhance the livelihood of the rural people by providing food, fodder, medicines but also contribute to the gross annual income of the household. The potential benefits of homegardening as part of the farming system were raising income and thus

improving livelihoods of the poor. The sale of products from homegardens significantly improves family financial status, because cash income can be used by the household to buy food, clothing, pay school fees, etc. In hill areas, where agricultural fields are generally far off and travel to the fields is difficult and time consuming, they ensure availability of products within the homestead. On the basis of the present study it is recommended that promotion of homegardens should be included in the policies and programmes of government to enhance the livelihoods of rural poor on sustainable basis.

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AUTHORS' CONTRIBUTIONS

First author designed the study, second and third author collected data, managed the literature searches and wrote the first draft of the manuscript, and fourth author managed the preparation of the final draft of manuscript. All authors read and approved the final manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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