XV WORLD FORESTRY CONGRESS
Building a Green, Healthy and Resilient Future with Forests
2–6 May 2022 | Coex, Seoul, Republic of Korea

Scientific basis of household practices in agroforestry homegardens: A case study in Matara district, Sri Lanka

Mangala De Zoysa

Department of Agricultural Economics, University of Ruhuna, Sri Lanka. Email: mangalaxyz@yahoo.com

Abstract

Agroforestry in homegardens with high diversity of species which play main agro-ecological roles are complex and sustainable land use systems. Efforts are being made across the globe in valuing and protecting the age-old practices of agroforestry on scientific basis in homegardens. This study analysed the scientific basis of households' practices in agroforestry homegardens in Matara district of Sri Lanka and develop strategies for the promotion of sustainable agroforestry homegardens. Selected households were interviewed measuring their concern using five point Likert scale, and analysed the qualitative data using non-parametric statistics. The study revealed that scientific basis of household practices in agroforestry homegardens are moderate in selection of appropriate trees and plants, and management of trees and plant health care. Households pay little concern on scientific basis in planning and site placement, land preparation and establishment of trees / crops, and implementing proper cultural practices. There is no significant correlation between scientific basis of practices in agroforestry in relation with size of home-gardens, educational level of households, and across the category of their occupations. Resources to use scientific knowledge in practice, and opportunity to improve scientific skills have moderate correlation significantly while availability of scientific information and access to scientific knowledge have significant but low correlation as applying knowledge on scientific basis by the households. The interest to acquire scientific knowledge, and sufficient time to improve scientific knowledge, and other reasons have no significant correlation with scientific basis of household practices. Carefully planned interventions including policy adjustments and effective extension programs for learning and experimenting couple with supportive programs would enhance scientific basis of household practices for agroforestry in homegardens.

Key words: homegarden composition; plants selection; health-care management; resources use; agroforestry policy

Background

Agroforestry homegardens are unique land-use systems involving the deliberate management of multipurpose trees and shrubs in intimate association with annual, perennial, and seasonal agricultural crops within the compounds of individual homes. High diversity of species produce food and a wide range of other products such as firewood, fodders, spices, medicinal plants and ornamentals and play main agro-ecological roles of the homegardens. Scientific basis of practices of households would have further enriched the agroforestry in traditional homegarden system. Due to the inherent diverse strands of knowledge and practice, agroforestry is associated with complexity in development of scientific basis (Mbow et al., 2014). A considerable progress in transferring the age-old agroforestry practices into a scientific basis has been achieved during the recent decades. The World Agroforestry Centre has made significant efforts in developing scientific basis of agroforestry systems during the past three decades (Rao et al., 2007). Agroforestry are being transformed from a practice in search of science into a science-based practice as an integrated applied science

addressing some of the land-management and environmental problems (Nair 2007). Long standing homegardens today are testing grounds of many continuous generation, dissemination and adoption of innovations and improvement of effective strategies. Translation of practice for scientific basis could influence the adoption and dissemination of innovations (Scott et al., 2008). The scientific basis of agroforestry practices in homegardens have to be studied empirically in close interactions with households. Scientific basis of practices in terms of individual needs and individual perceptions used to achieve those needs determine the adoption of new practices (Thangata and Alavalapati 2003).

The area of homegardens in Sri Lanka was estimated at 977,700 ha in 2005 almost 17 % of total lands with the increasing in extent of 1 % per year until 2020 (FAO 2009). Among many national development programs "Hritha (Green) Lanka" program of 2009 has highlighted the importance of promoting the home gardens through application of scientific basis of agroforestry practices (NCSD 2009). Although the modern scientific basis is relatively new, agroforestry in homegardens is an ancient practice with traditional knowledge in Sri Lanka for centuries. It is time to begin to collect cross-sectional data on scientific basis agroforestry practices in homegardens in Sri Lanka with the view of promotion of agroforestry homegardens. Hence the objectives of the study are: to examine households and agroforestry in homegardens; to ascertain the scientific basis of the practices; to analyses the characteristics of households and homegardens affecting scientific basis; and to develop strategies for the improvement of scientific basis.

Methodology/approach

Multi-species, multi-storied and multi-purpose vegetation situated close to the homestead are broadly discuss as agroforestry in homegardens in the study area. The 3 villages: Uninduwela in Malimboda, Panatiyana East in Welipitiya and Hikkoda in Akuressa Divisional Secretariat divisions in Matara district were selected for the study through reconnaissance survey conducted with district and agricultural office experts. The primary data were collected from selected households by personal interviews using structured questionnaire containing both open and closed form of questions. The scientific basis of household practices in agroforestry homegardens and strategies for the promotion of scientific basis of household practices for agroforestry homegardens were measured using the "1 ~ 5" 'Five Point Likert Scale". Data collected from the interviews were coded, analysed, interpreted and synthesized.

Results and discussion

1. Households and agroforestry homegardens

Households practice agroforestry in homegardens as sustainable land use systems in Sri Lanka in terms of economic, social, cultural and environmental perspectives. The size of homegardens in the study area is estimated as average 0.37 ha (mean) (Table 1). The study area belongs to the category of peri-urban area according to the administrative divisions in Sri Lanka. Average as well as the majority of the head of households have educational level of Grade 9 (Secondary Schools). Agriculture and agroforestry in school gardens and homegardens are common subject matters in the classroom teaching as well as in practical classes.

Table 1: Household Information

Information	Mean	Median	Minima	Maxima
Size of Home-garden	0.92 Ac (0.37 Ha)	1.00 Ac (0.40 Ha)	0.25 Ac (0.10 Ha)	3 Ac (1.21 Ha)
Education of Households	Grade 9	Grade 9	Grade 6	Grade 12

The main occupations of the households are: 27% farmers; 20% family business, 17% private sector jobs and 17% government sector jobs while 20% households have no proper occupation (Table 2). The households are involving in non-farm occupations (73%) and possess home-gardening on part-time basis utilizing family labour.

Table 2: Occupations of households

Occupations		Number	Percentage
a.	Farmers	18	27
b.	Government Jobs	11	16
c.	Private sector Jobs	11	17
d.	Family business	14	20
e.	No proper occupation	14	20
Total		68	100

Agroforestry homegardens in Sri Lanka are typically multi-strata systems and characterized by a high density of multiple species that exhibit complex structure, both attributes and ecological services. Ornamental plants (23.5%), fruit trees (20.7%) and vegetables (18.7%) dominate the agroforestry composition according to the occupying land extents by each (Table 3). The priority is given for growing food crops including vegetable, leafy vegetables, root crops fruits and spices covering all together 55.8% of the land extent, mainly for household consumption and use. Among the food crops, fruit crops occupy the substantial (20.7%) extent of land producing a main ingredient adding to the daily nutrient supplements. Although the agroforestry products produced in homegardens do not presently improve the income generation or financial status of households, there is a greater potential also for contribution to income generation.

The households rate significantly high and very important relations growing trees in homegardens for ornamental and aesthetic purposes creating relaxing and fresh environment. They give the priority for growing ornamental plants in order to create beauty in their homegardens is a traditional and cultural practice. Timber tree species (11.6%) have been mainly grown in the fences surrounding homegardens for the purposes of demarcation and protection of the land, adaptation to the impacts of blowing winds as well as to produce timber for domestic use. The high species density homegardens in Sri Lanka consists of high accounted mean volume of producible trees (36.68 m^3per ha) and poles (2.12 m^3per ha) (Jeyavanan et al., 2017).

Table - 3: Agroforestry composition in homegardens

Type of Crops/ Trees Species		Average Number of Crops/ Trees per Homegarden	% of Average Land Extent
a.	Ornamentals	12 (18)	23.5
b.	Vegetables	8 (12)	10.3
c.	Leafy Vegetables	4 (6)	8.4
d.	Root Crops	4 (6)	6.3
e.	Fruits	10 (15)	20.7
f.	Spices	6 (9)	10.1
g.	Timber Species	6 (9)	11.6
h.	Others	16 (24)	9.1
	Total	66 (100)	100

*Percentages are in parentheses

2. Scientific basis of households practices

Planning and Site Placement: Agroforestry practices in homegardens are directly connected to multipurpose uses and to satisfy household requirements. Agroforestry homegardens involving practices with concern of a set of techniques developed by households over the decades, based on their observations and experimentations. The mean value (2.3) implies that the households pay overall little concern on scientific basis in planning and site placement of agroforestry in homegardens (Table 4). Biodiversity conservation through planting crops and is one of the important strategy for ensuring diverse productions and ecosystem services.

Table – 4: Scientific basis of households' concern on agroforestry management practices

Household Practices	Mean	Median	St. Deviation
Planning and site placement	**(2.3)**	**(3.0)**	**(0.97)**
a. Access to the sun light	2.3	2.0	1.06
b. Direction of wind	2.5	2.0	0.78
c. Management of soil fertility and conservation	2.6	3.0	0.93
d. Supply of water	1.8	2.0	0.83
e. Convenience for management practices	2.2	2.0	0.97
Land preparation and establishment of crops / trees	**(2.4)**	**(2.3)**	**(0.56)**
a. Arrange water drainage system	2.5	2.0	1.17
b. Amend soil acidity	2.0	2.0	0.74
c. Prepare soil conservation structures	2.5	3.0	0.73
d. Alter light conditions	2.4	2.0	0.89
Selection of appropriate tree / plants	**(2.7)**	**(3.0)**	**(0.59)**
a. Know the requirements of a plant before selection	3.2	4.0	0.76
b. Growing right plant in right place	2.0	2.0	0.89
c. Selecting drought and disease resistant varieties / cultivars	2.7	2.0	1.21
d. Selecting high quality planting materials	3.5	4.0	0.68
Implementing proper cultural practices	**(2.2)**	**(2.0)**	**(0.66)**
a. Moisture management	2.1	2.0	0.74
b. Planting techniques and maintenance	2.1	2.0	0.76
c. Frequency and timing of soil fertility management	2.6	3.0	0.82
Management of tree and plant health care	**(2.8)**	**(3.0)**	**(0.94)**
a. Management of pests	2.8	3.0	0.97
b. Protection of other beneficial organisms	1.2	1.0	0.41
c. Control of weeds	2.6	2.0	1.38
d. Prevention of diseases	2.9	3.0	0.96

Likert Scale: Not concern -1; little concern – 2; Moderate concern – 3; highly concern – 4; and fully concern – 5;

The mean values indicate that the households moderately concern scientific basis on the direction of wind (2.5), and the level of soil fertility (2.6). They consider the direction of blowing wind particularly in planting different type of perennial crop and timber trees in order to minimize wind damages to crops, buildings and other properties in their home gardens. They have experience about improvement of soil chemical and physical properties by multi-cropping systems particularly with legumes. They little concern about the scientific basis on access to the sun light (2.3); convenience for management practices (2.2); and the supply of water (1.8). Higher level of shade inside the homegardens are common with richness of ornamental tree species in agroforestry systems. Although the scientific basis is little concerned by the households in convenience for management practices, and water management, the ornamental and fruit plants are located close to the homestead to make the homegardens more attractive and facilitate their easy care. Family labour requirement for work in homegardens are weeding, and carrying water from the wells and frequent watering mainly the ornament plants, vegetable and other agricultural crops. About how beneficial

different plants and how much water they consume is a gap of scientific basis in area of water management practices in homegardens (Mattsson et al. 2017).

Land Preparation and Establishment of Crops / Trees: The households have overall little concern (2.4) on scientific basis in land preparation and establishment of crops / trees in homegardens. They prepare lands as a usual practice and establish crops and trees based on the availability of preferred and reliable planting materials. They moderately concern the scientific basis on arrangement of water drainage system (2.5) and prepare soil conservation structures (2.5). The households who have recognized soil erosion problems in their homegardens are less likely to understand the scientific knowledge of soil conservation technologies. Agroforestry practices with multipurpose trees and multilayer trees are the major specific approaches for soil conservation hedges. The households pay little concern on scientific basis about amending soil acidity (2.0) and altering light conditions (2.4) in homegardens. They are aware of soil acidity but not experiencing any impacts on the vegetation. They are knowledgeable but pay only little concern about intensity of sunlight and shadiest spots before establishment of crops and trees and have limited possibility to change the shade and light conditions due to less organized agroforestry systems.

Selection of Appropriate Trees and Plants: Scientific basis of the selection of appropriate trees and plants in overall are moderately concern (2.7) by the households. Majority of the households have the concern of scientific basis on the right tree species that can be used to integrate properly in their homegardens. Ecologically adapted and complementary species are generally featured in home-gardens with low capital inputs and simple agroforestry technology. The households are highly concern about the scientific basis in selecting quality of planting materials (3.5). They are knowledgeable and have experienced on the methods of successful propagation, selection appropriate planting material and utilization of healthy planting materials of most of the plants they usually grow. The households are moderately concern scientific basis about requirements of a plant before selection (3.2) and selecting drought and disease resistant varieties or cultivars (2.7). They are often experiencing prolong droughts and rainy periods from recent past as a result of the climate change impacts. They pay especial concern on selecting drought and disease resistant plants in order to minimize the difficulties associate with watering and management of healthy vegetation. The households pay little concern scientific basis in growing right plant in right place (2.0). Almost all the homegardens in the area are not properly organized agroforestry systems. They often change plant composition the through gap-filling strategy using available planting materials or finding space for a favourite species selected on personal interest.

Implementing Proper Cultural Practices: The households are little concern about the scientific basis of the overall implementation of proper cultural practices (2.2) due to complex combination of crop biodiversity. The agroforestry systems are not properly organized and their cultural practices are often conducted on ad hoc basis. They moderately concern scientific basis about the frequency and timing of soil fertility management (2.6). Although the agroforestry is an attractive and sustainable pathway to improve soil fertility, without adequately fertilizing or fallowing the land while nutrient mining from continuous harvesting in agroforestry homegardens is the main constraint to increase in productivity. They apply mainly composted pruned branches of tress and domestic wastes mainly for plants that shows urgent fertilizer requirement. They are well aware that high levels of on-site nutrient conservation generally create stable and partially self-generating ecosystem through mixture effects by improving the soil fertility. The households little concern about the planting

techniques and maintenance (2.1); and moisture management (2.1) during the performing of main cultural practices. Planting of different crops and tress in agroforestry system is a common practice in Sri Lanka to rehabilitate the degraded lands in homegardens experiencing soil erosion, soil fertility degradation as well as soil water conservation.

Management of Trees / Plant Health Care: The overall households are moderately concern about scientific basis of the management of tree and plant health care (2.8). The less input intensive agroforestry homegardens with woody perennial based mixtures are less productive and difficult to manage. The composition and density of the constituent species are determined in in order to manage the biodiversity and healthy environment. They pay moderate concern on scientific basis about the prevention of the diseases (2.9); management of pests (2.8); and control of weeds (2.6). Intercropping with nitrogen fixing trees and crops, mulching to preserve soil moisture and control weeds as well as maintain compost pit for household wastes are common practices in homegardens. The households are able to manage the incidence of pests and diseases even though they utilize lands of the homegardens for unplanned agroforestry practices. They remove damaged crops and vegetative parts of trees as well as change spatial arrangements to avoid spread of pest and disease. Protection of other beneficial organisms is received no concern on scientific basis (1.2) by the households. They are little knowledgeable about the role of agroforestry in homegardens for optimizing nutrient cycles and impacts on improving chemical and physical properties of soil.

3. Scientific basis of households practices with size of homegardens, educational level and categories of occupation

There is no significant correlation between the size of homegardens and scientific basis of agroforestry practices of households (r = 0.055, and p = 0.656) (Table 5). Size of the homegarden is not an important concern for the scientific basis of practices of households for agroforestry. All the households have main intension to maintain beautiful homegardens through experiences without considering the size of the lands.

Table 5: Relation between size of the home-gardens, and scientific basis of knowledge and practices of households

Factors	Mean Value	*Pearson Correlation - r	Sig. (2-tailed)	N
Size of Home-gardens	0.37			
Scientific basis of practices	2.20	0.055	0.656	68
Educational Level of household	9.0			
Scientific basis of practices	2.20	0.123	0.316	68

*Pearson correlation coefficient

**Significant at P<0.05

There is no significant correlation between the educational level of households and scientific basis of agroforestry practices (r = 0.123, and p = 0.316). Even though the human capital is improved with better education, the households concern scientific basis of agroforestry practices differently on their level of education. All the households interviewed have not been motivated positively according to the level of their education to use the scientific basis of agroforestry in homegardens practices. There is no significant difference in scientific basis of practices (χ^2 = 3.668, p = 0.453) of the households on agroforestry homegardens across the category of their occupations (Table 6). The distribution of scientific basis of practices have no significant difference across the category of their occupations as farmers, government jobs, private sector jobs, family business, and no proper

occupation. The level of involvement of the households make no difference across the category of their occupations.

Table 6: Distribution of scientific basis of practices of households across the category of occupation

	Test – Statistics [a, b]			
	N	**Chi-square (χ^2)**	**Degree of freedom**	**Asymp. Sig. (2-sided test)**
Distribution of scientific basis of practices across the category of occupation	68	3.668	4	0.453

a - Kruskal-Wallis Test H

b - Grouping Variable: Occupation

**Significant at P<0.05

4. Improvement of scientific basis of household practices in agroforestry homegardens

The values of Pearson Correlation Coefficient "r" indicate that the concerning resources to use scientific knowledge in practice (r = 0.362, p=0.002), and opportunity to improve scientific skills (r = 0.343, p=0.004) have moderately significant correlation for the improvement of practices based on scientific basis in agroforestry homegardens by the households (Table 7).

Table 7: Improve scientific basis of agroforestry practices

Households Concerns	**Mean**	**Median**	**St. Dev.**	***r**	**Sig.**
1. Availability of scientific information	2.38	2.0	0.55	0.282	0.020**
2. Access to scientific knowledge	3.96	4.0	1.31	0.244	0.045**
3. Interest to acquire scientific knowledge	2.47	2.0	0.72	0.115	0.349
4. Opportunity to improve scientific skills	2.63	3.0	0.60	0.343	0.004**
5. Sufficient time to improve scientific knowledge	1.94	2.0	1.06	0.164	0.183
6. Resources to use scientific knowledge in practice	4.04	5.0	1.27	0.362	0.002**
7. Other requirement	1.69	2.0	0.47	0.022	0.861

Likert Scale: Not concern -1; little concern – 2; Moderate concern – 3; highly concern – 4; and fully concern – 5;

*r - Pearson Correlation Coefficient

**Correlation is significant at the 0.05 level (2-tailed).

Resource endowments of the households determine the scientific basis of agroforestry practices in homegardens. Households are not empowered through provision of agricultural inputs such as seeds and seedlings, agricultural credit, subsidy fertilizers etc., as given to agriculture sector to improve the production quantities of homegardens. There is no proper extension and training program, and other facilities available for the households to improve their scientific skills. Provision of extension services, knowledge skills, training and incentives on homegardens management, could be used to improve agroforestry systems and enhance the homegardens productivity. Sri Lanka has no government policy to support implementation of strategies and enhance adoption of scientific basis of homegardens.

Availability of scientific information (r = 0.282, p=0.020) and access to scientific knowledge (r = 0.244, p=0.045) have significant but low correlation as applying knowledge on scientific basis. Development projects concentrate on homegardens in Sri Lanka make very little scientific effort due to lack research findings and updated knowledge to increase the productivity of the agroforestry systems. They often change the agroforestry composition and management practice using their long-term experiences or advises from the neighbours to face particularly the environmental and ecological hazards. Lack of extension service to disseminate technical know-how specially designed for agroforestry in homegardens create poor access to scientific knowledge and constraint to attain

to scientific practices. They often use a blend of traditional knowledge and some scientific knowledge developed through long-term trails and errors using experiences. There is no properly organized institutional initiative in Sri Lanka to promote homegardens despite some researcher-motivated individual efforts.

Interest to acquire scientific knowledge ($r = 0.115$, $p = 0.349$), and sufficient time to improve scientific knowledge ($r = 0.164$, $p = 0.183$), and other reasons ($r = 0.022$, $p = 0.861$) have no significant correlation with practices on scientific basis by the households. Unless there is an organized program, the households have no special interest to acquire scientific knowledge making special effort and intentionally develop the scientific basis of agroforestry systems. An opportunity to develop a household society has not yet been emerged for sharing and expansion of the scientific basis of their knowledge and skills for the management of flowers, shrubs, herbs, vegetables. The households do not find any relationship between the time availability and the acquiring of scientific basis for their agroforestry practices in the homegarden. They often spend their leisure time in the homegardens, enjoying aesthetic values and relaxing in fresh environment. However, they do not disagree that they would find time to read any printed materials or watch media program disseminating scientific knowledge on home gardening.

Conclusions and policy implications

The relatively small homegardens are managed by the households headed by the majority who have upper secondary education and involving in non-farming occupations. The extents covering agroforestry components are dominated by ornamental plants, fruit trees and vegetables respectively. The households moderately concern scientific basis on requirement of plants, and drought and disease resistant varieties / cultivars. They moderately concern scientific basis on prevention of diseases, management of pests and control of weeds, management of soil fertility and conservation as well as the direction of wind. Arranging water drainage system, preparing soil conservation structures, frequency and timing of soil fertility management is moderately concerned on scientific basis. The size of home-gardens, educational level of households, and across the category of their occupations have no correlation with scientific basis. Policy adjustments and effective extension programs with resources, opportunity to improve scientific skills, availability of scientific information, and access to scientific knowledge would enhance scientific basis.

"The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO."

References

FAO, 2009. Sri Lanka Forestry Outlook Study. Asia Pacific Forestry Outlook Sector Outlook Study II, Working Paper No. APFSOS II/WP/2009/29, Bangkok, FAO Regional Office for Asia and the Pacific. Available at: http://www.fao.org/3/am624e/am624e00.pdf

Jeyavanan K, Sivachandiran S, Pushpakumara DKNG. 2017. Ecosystem Services of Homegarden Agroforestry in Jaffna Peninsula. Journal of Dry Zone Agriculture, 2017, 3: 56 – 68. Available at: https://www.researchgate.net/publication/328701498

Mattsson E, Ostwald M, Nissanka SP. 2017. What is good about Sri Lankan homegardens with regards to food security? A synthesis of the current scientific knowledge of a multifunctional land-use system, Agroforestry Systems, 2017. Available at: http://dx.doi.org/10.1007/s10457-017-0093-6

Mbow C, van Noordwijk M, Prabhu R, Simons T. 2014. Knowledge gaps and research needs concerning agroforestry's contribution to Sustainable Development Goals in Africa. Current Opinion in Environmental Sustainability, Volume 6, 2014, Pages 162-170. Available at: https://doi.org/10.1016/j.cosust.2013.11.030.

Nair PKR. 2007. Perspective: The coming of age of agroforestry. Journal of the Science of Food and Agriculture 87:1613–1619 (2007). Available at: https://doi.org/10.1002/jsfa.2897

National Council for Sustainable Development (NCSD), 2009. National action plan for Haritha Lanka Programme. National Council for Sustainable Development. Presidential Secretariat, Colombo 1, Sri Lanka. Available at: https://policy.asiapacificenergy.org/node/2744

Rao KPC, Verchot LV, Laarman J. 2007. Adaptation to Climate Change through Sustainable Management and Development of Agroforestry Systems. An Open Access Journal published by ICRISAT (SAT eJournal; ejournal.icrisat.org) December 2007, Volume 4, Issue 1. Available at: http://oar.icrisat.org/2561/1/Adaptation_to_Climate_Change.pdf

Scott SD, Plotnikoff RC, Karunamuni N, Bize R, Rodgers W. 2008. Factors influencing the adoption of an innovation: An examination of the uptake of the Canadian Heart Health Kit (HHK). Implementation Science 2008, 3:41. Available at: https://doi.org/10.1186/1748-5908-3-41

Thangata PH, Alavalapati JR. 2003. Agroforestry adoption in Southern Malawi: the case of mixed intercropping of Gliricidia sepium and maize. Agricultural Systems, 78, 57-71. Available at: https://doi.org/10.1016/S0308-521X(03)00032-5

Whitney CW, Luedeling E, Nyamukuru AT, Hensel O, Gebauer J, Kehlenbeck K. 2018. Crop diversity in homegardens of southwest Uganda and its importance for rural livelihoods. Agriculture and Human Values 35, 399–424 (2018). Available at: https://doi.org/10.1007/s10460-017-9835-3