

Plant Diversity and Income Generation of Homegardens in Kilinochchi District, Sri Lanka

¹S. Vinujan, ¹S. Sivachandiran, ²T. Sivananthawerl and ²D.K.N.G. Phuspakumara

¹Department of Agronomy, Faculty of Agriculture, University of Jaffna, Sri Lanka

²Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka

Abstract: Homegardens are considered as one of the sustainable land use systems in Sri Lanka. Sustainable production and good socio-economic condition can be achieved by homegardening. There were no data regarding the available species density and involvement of homegarden in daily needs in Killinochchi district. The district comes under DL3 agro-ecological zone. The study was carried out in three Divisional Secretariat (DS) divisions as proportion of number of Grama-Niladhari (GN) divisions to estimate diversity of plant species in homegardens. Total of 150 households were investigated using structured questionnaires. Data were analyzed by using excel spread sheet and Minitab 2014 and statistical analysis of variance also done. The result of this study shows the fulfillment of needs of households in study area partially achieved by production from their own homegardens. High species density was observed in the areas where sufficient water is available. Average income (73, 756±225) from household was not linearly linked with average size of homegarden (0.35±0.0019). Annual crop such as vegetables (35%) play a greater role in income generation compare with perennials. Mayavanoor Grama-Niladhari division found to be as leading one for having highest percentage of farmers for coconut (93%), banana (73%) and mango (47%). The highest plant species diversity (1108) was found in Ambalnagar Grama-Niladhari division by having more economically important species. The best homegarden was identified by having animal husbandry in small or in large scale. Farmers faced the problems of lack of water availability, climate uncertainty and market failure in their cultivation. Though better choice of crops and different land use patterns adopted make them survive and sustain with their production.

Key words: Homegarden • Income contribution • Species distribution

INTRODUCTION

Homegarden (HG) agro-ecosystems are an example agro-forestry system. “Homegarden” is a complex sustainable land use system that combines multiple farming components, such as annual and perennial crops, livestock and occasionally fish and provides environmental services, household needs and employment and income generation opportunities to the households. Having realized the importance of homegardens, the national development policy Framework of the government of Sri Lanka now includes strategies to expand and improve food and timber productions in the area where there is a potential landscape in the country [20]. Homegarden could also play a significant role in adaptation to change the microclimate, provide permanent cover, diversify the agricultural systems, improve

resource use efficiency, improve soil fertility and reduce carbon emissions and increase sequestration [36] and also rich in biodiversity. Food security in rural part of country and food production in homegardens is intrinsically related; hence, climate change may have significant implications on food security. Homegardens are a time-tested local strategy that are widely adopted and practiced in various circumstances by local communities with limited resources and institutional support because land, water, labor and credit are becoming scarce and costly. It is possible that homegardening could become an alternative for low input farmers with diminishing areas of land and to intensify food production in areas of rapidly growing populations and where the natural conditions of soil fertility and climate are worst. It focuses on providing a combination of products for subsistence and cash. While the provision of additional food and/or cash

constitutes the main function of gardens, they may also be used for small-scale experimentation and leisure and ornamental functions. Because of these characteristics garden systems differ considerably across locations and are referred to by many terms [12], making a comparison of observations extremely difficult.

Homegardens have been identified as the oldest land use activity, next only to shifting cultivation in the tropics [7, 20, 26]. Majority of Homegarden produces the products for consumption and commercial purpose following the constraints such as limitations on land use, climate, market fluctuation and capital. It has been projected that global food production will need to increase by 70% in order to meet the average daily caloric requirement of the world's population in 2050 [15]. In Sri Lanka, homegardens have been an integral part of the landscape and culture for centuries [22, 7, 17]. Homegardens are considered as one of the popular and sustainable land use systems in Sri Lanka. This system in most cases involves the optimum utilization of land and resources around the household, satisfying both the production and environmental functions [34, 14, 39]. Improvement of homegardens in Sri Lanka has been the priority of many development programs implemented in the country over the past five years where development of 375, 000 homegardens were aimed under the “*Api Wawamu Rata Nagamu*” (Let us grow and uplift the nation) program launched in 2007 and strengthening of 1.5 million homegardens is the target of “*Divi Neguma*” (Livelihood Development) program in order to achieve self-sufficiency in vegetables and to reduce vegetable prices. The role of homegardens is multi-faceted and most importantly they have the potential to ensure food needs of both rural and urban communities by providing a year-round source of nutritious food to households who may not access such food [48, 12].

Furthermore, they are identified as a sustainable and diverse agro-forestry system, that ensure conservation of a diversity of fruits, vegetables, spices and medicinal plants [39]. For centuries, small plots of land near homesteads have been used as homegardens, which have been an integral component of family farming and local food systems [35, 15]. There is a need of much attention towards homegardens as a strategy to enhance household food security and nutrition in order to overcome the problems arising with raised population. Pushpakumara, has reported that the dry zone homegardens are significantly differ from wet zone homegardens by tree density, (dry zone 125 trees/ha, wet zone 260 trees/ha) [40]. Density of a species or tree is how

many of that tree or any species accommodates in a particular size of land. If, that, number is less and high can conclude that as low species density and high species density respectively. Kilinochchi is one of the districts severely affected by civil war recent past. Income, malnutrition, health, education and employment are questioned and vulnerable account higher percentage than other districts of Sri Lanka. At present, vast resettlement programs have been taken by government to secure the people. Hence, establishing homegarden is one of the solutions to secure the people nutritionally and increase the standard of living in such areas.

Problems Statement:

- Awareness about homegarden is very much less
- Lack of information on current status of homegarden.
- Seasonal changes and fluctuation of income
- Poor management of valuable perennials.
- Reduce land holding capacity due to fragmentation and population pressure.
- Unable to process the excess product during seasonal production.

General Objective: The main objective of this study is to evaluate the composition and structure of Homegardens in Killinochi district.

Specific Objectives:

- To study the species distribution within homegardens.
- To study the involvement of homegarden in satisfying the needs of villagers.

MATERIALS AND METHODS

Study Area: Kilinochchi District is located in the north of Sri Lanka in the Northern Province. It has an area of 1, 279 square kilometers (494 sq mi) and its geographical coordinates are 9° 24' 0" North, 80° 24' 0" East. The state is populated with 132, 275 people (statistical information 2013), with a population density of 88/km² (230/sq mi). In Killinochi, Total forest cover is 29.8% (statistical report, 2012) and homegarden cover in this area is 26.5% [40].

Conditions in the Study Area

Climate and Rainfall: The climatic conditions of this District are dry, humid and tropical. The average annual rainfall in this region is 1325 mm and 75 % of the rainfall

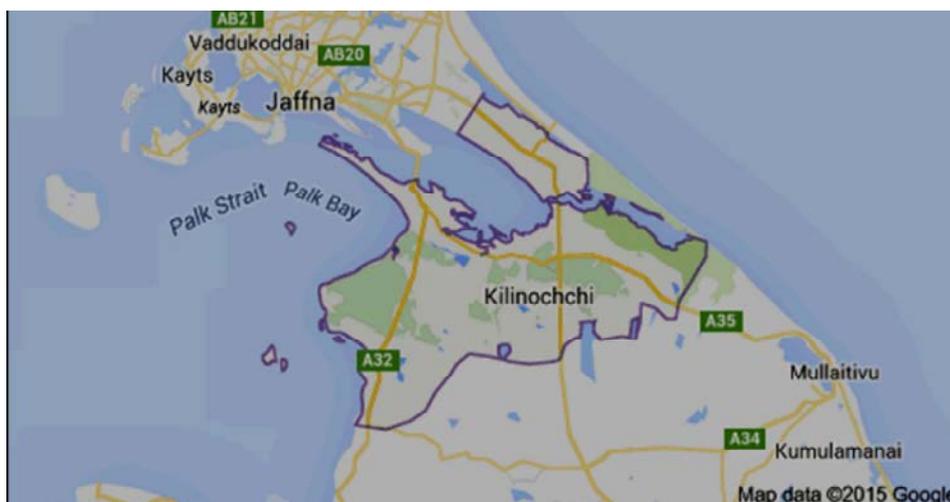


Fig. 2.1: Location of the study area

receives during the period from September to December by North-East monsoon periodical wind. The remaining period of the year is dry and warm. Because, of the warm temperature experiences every year from June to August, this period is considered as dry season. The monthly average temperature range is 25° to 30°C.

Soil and Natural Resources: The Soil of the District is fertile and having enough minerals for the better growth of any kind of crops. Available Soil structure and types

- Red and Yellow latersol 12.04 %
- Flat to slightly undulating terrain 27.96 %
- Soladized Solonistz of Solo check Flat terrain 25.96 %
- Alluvial soil of various drainage and texture 11.99 %
- Raga soil on recent beach and dourer sand flat terrain 17.99 %
- Eroded land 04.06 % [46]

Data Collection

Selection of Sampling Area: Northern Province has five districts; Jaffna, Kilinochchi, Mannar, Vavuniya and Mullaitivu. The areas were selected from Kilinochchi district comes under DL3 and samples were taken from Kandawalai, Karachchi and Poonakary DS division. Among four divisional secretariat divisions Pachchilaipalli was not included in this study due to logistical difficulties.

Sampling Method: Four GN divisions from Karachchi, three GN divisions from Kandawalai and three GN divisions from Poonakary DS division were selected for sampling purpose.

Table 2.1: Details of GN divisions in Kilinochchi district

DS Division	No. of GN division	No. of villages
Kandawalai	16	103
Karachchi	42	115
Poonakary	19	92
Pachchilaipalli	18	44

Table 2.2: Samples from different DS divisions in study area

DS division	GN divisions	Villages	Total villages	10% of villages	No of selection
Karachchi	42	115	310	31	12
Kandawalai	16	103			10
Poonagari	19	92			9
Pachchilaipalli	18	44			-

31 villages were selected out of 310 villages from 10 GN divisions (10%) as proportional to number of villages.

Measurements: The following field measurements were taken.

- Height of tree (Tree height was measured by using clinometer).
- Diameter of tree (Measure the stem diameter of each tree at 1.3 m above the soil surface using a diameter tape (d-tape) in case of small plant we can use caliber).
- Number of trees
- Variety of species (from questionnaire)

A questionnaire survey was done along with the field measurements. Secondary data was collected in Kilinochchi District secretariat office.

Data Analysis: The raw data from each household by Focus group discussion, questionnaire survey, field observation and field measurement was entered into an Excel spreadsheet. Then these data transferred to various forms as table and chart with possible combinations. Then significant test was done by using Minitab (Minitab 2014).

RESULTS AND DISCUSSION

Socio-Economic Importance of Homegarden: Homegardens are a vital source of income for subsistence economy and contribute to the self-sufficiency of many rural households. Household income from homegarden was calculated by asking the respondent's the amount of homegarden products they sold and how much of income was earned from the year's sale of homegarden products.

Theoretically income will be increase with the size of homegarden, but in this study this kind of relationship couldn't be found between size of homegarden and income because even, higher the average size of homegarden haven't the higher average income ($P < 0.024$).

Even size of garden is high, if management practices behind to homegarden not well adopted that might lead to less output from that garden.

There was relationship between sizes of homegarden between three DS division ($P < 0.015$) and there was significant difference in size between Karachchi and Kandawalai. There was not much difference in the size of homegarden within the GN divisions in Karachchi DS division ($P < 0.366$). Sizes of homegarden have significant difference within Kandawalai DS division ($P < 0.013$).

Table (3.2) shows how income level changes when size of homegarden increases. There is no relationship with land size and income ($P < 0.215$) in study area.

Because of land fragmentation effect land sizes reduced, though with small size some farmers could be identified as best with good management of trees. When the land holding size increases there is more chance to accommodate more trees and can end up with more income. There could be identifiable with each land sizes three different category of farmers (low, middle and high). For the small land holdings nearly 27% farmers comes under low income category and 36% comes under high income category. For middle income category nearly 52% people comes under low income level and only 21% comes under high income level. In the large land holdings 25% and 35% farmers comes in low and high income category respectively. When land holding is small, number of farmers comes under low, middle and income

category increases but in medium land holdings number of farmer decreases in orderly.

Table (3.3) shows the relationship between numbers of farmers have particular annual vegetation with income category.

In the case of lower, middle and higher income category vegetables were the leading component to participate in household income.

The most importance contributors to the economic profit generated by homegarden was annual crops rather perennial trees such banana, coconut and mango.

Given table shows the average income gained from annual and perennial crops for study area in Kilinochchi district.

Mostly, annuals were to be the major contributors of income to family but in Tharmapurum East the average income from both sectors are nearly same. Most probably annuals are related with short term income and perennials related with long term income. Perennials requiring more attention than annual for sustain long years with better production. Here nearly in all Gramaniladhari divisions annuals were the leading components compared with perennials. This may be due to that most of perennials being planted after 2009 (post war) and most of perennials are on spare land with less management. The other important category of economic importance in the homegarden was milk production. In the study area cattle and goat were the main source of milk production rather poultry for egg production and purpose of meat achieved by poultry and goat also.

Mulankavil GN division was the highest position in terms of having highest average income even with less average number of cattle because of improved varieties of Jersey cross and other varieties, but in the case of goat Kandawalai was the leading one in both intense of average number and income because of having well management practices and good species.

Crop Species Composition: A total of 18 species were found in common to all the three sites (Figure 3.1; See Appendix 1 for list of common species among three sites). These common species are important species for food security in all three DS division.

In the study area both of crop species were important (annual crops and perennials). Mango, papaya, Banana, Citrus, Guava and Jack are the major fruit trees in study area. Kumar and Nair suggested that it includes the concept of intimate plant associations of various trees and crops, sometimes in association with domestic animals and consequent multi-storey canopy configuration around homestead [20].

Table 3.1: Description of average size of homegarden (ha) and average income (SL Rs) according to DS and GN division

DS division	GN division	Average size of Homegarden (ha) (+/- standard error)	Average income (+/- standard error)
Karachchi	Ambalnagar	0.24±0.0015	81, 989±0, 982
	Pannankandy	0.18±0.0021	57, 418±1, 796
	Vaddakachchi	0.25±0.0025	72, 932±1, 757
	Mayavanoor	0.36±0.0019	11, 315±2, 387
Mean		0.26±0.0002	55, 914±443
Kandawalai	Uriyan	0.33±0.0018	126, 246±3, 870
	Kandawalai	0.69±0.0020	058, 365±1, 179
	Tharmapurum East	0.34±0.0018	053, 737±1, 377
Mean		0.45±0.0078	79, 449±793
Poonakary	Nallur	0.45±0.0048	081, 978±2, 951
	Pallikkuda	0.36±0.0020	102, 635±1, 864
	Mulankavil	0.19±0.0021	073, 104±3, 097
Mean		0.33±0.0083	85, 906±889
Overall mean		0.35±0.0019	73, 756±225

Table 3.2: Relationship between land sizes (ha) and total income (SL Rs)

Land size	Income (SL Rs)		
	Low <50, 000	Middle 50, 000-100, 000	High >100, 000
Small (<0.2)	20	28	27
Medium (0.2-0.4)	10	5	4
large (>0.4)	14	22	20

Table 3.3: Distribution of farmers having annual components within each income category

Income	Annuals		
	Leafy vegetables	Vegetables	Cereals
<50, 000	31	48	19
50, 000-100, 000	31	50	34
100, 000<	20	38	22

Table 3.4: Income gained from annual and perennial crops with GN divisions

DS division	GN division	Average annual crop income (+/- standard deviation) (SL Rs)	Average perennial crop income (+/- standard deviation) (SL Rs)
Karachchi	Ambalnagar	53, 534±0, 820	09, 633±220
	Pannankandy	41, 092±0, 982	06, 820±554
	Vaddakachchi	45, 673±0, 926	09, 633±239
	Mayavanoor	61, 576±1, 540	23, 616±561
Kandawalai	Uriyan	98, 174±3, 581	14, 137±372
	Kandawalai	37, 458±1, 136	09, 673±264
	Tharmapurum East	18, 735±0, 712	15, 235±500
Poonakary	Nallur	39, 900±1, 044	16, 037±643
	Pallikkuda	80, 429±1, 636	08, 266±297
	Mulankavil	38, 140±2, 081	10, 779±588

Table 3.5: Average income per year for average number of animals for different GN Division

DS division	GN division	Cattle		Goat	
		Average Number	Average Income/yr (+/-standard error)	Average Number	Average Income/yr (+/- standard error)
Karachchi	Ambalnagar	4	43, 067± 277	2	12, 167±513
	Pannankandy	2	24, 500± 118	-	-
	Vaddakachchi	2	22, 800±2, 701	-	-
	Mayavanoor	5	08, 571± 357	-	-
Kandawalai	Uriyan	2	19, 000± 189	2	15, 667±103
	Kandawalai	3	32, 000±1, 253	10	50, 000±829
	Tharmapurum East	3	40, 600± 304	3	23, 300±642
Poonakary	Nallur	5	41, 250± 549	2	20, 000±186
	Pallikkuda	1	29, 000±2, 215	2	21, 250±613
	Mulankavil	2	44, 350±1, 303	2	18, 000±757

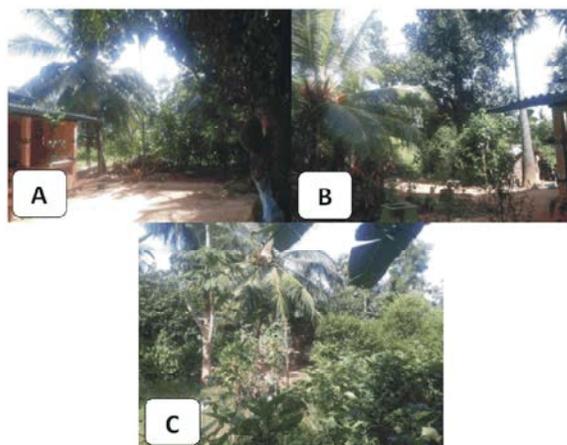


Fig. 3.2.1: Diversity of homegarden in Karachchi (A), Poonakary (B) and Kandawalai (C)

Table 3.6: Number of total species and species density in Kilinochchi district

DS division	GN division	Total species	Species density	Tree/100m ²
Karachchi	Ambalnagar	261	1108	11
	Pannankandy	138	789	8
	Vaddakachchi	127	508	5
	Mayavanoor	240	667	7
Mean of Karachchi	192	768	8	
Kandawalai	Uriyan	264	795	8
	Kandawalai	286	413	4
	Tharmapurum East	198	589	6
Mean of Kandawalai	249	599	6	
Poonakary	Nallur	200	442	4
	Pallikkuda	174	478	5
	Mulankavil	126	670	7
Mean of Poonakary	167	530	5	
Overall mean	203	632	6	

In average more than half of study area had more than 500 species, among them some were planted and others regenerate naturally. Fruit based, Vegetable based, Timber based trees were found in homegarden.

Average size of homegarden in Kilinochchi district varies with GN divisions and maximum average size was found in Kandawalai GN division due to less population density when compare with other GN divisions (Table 3.6). Reason for least average size of homegarden in Pannankandy GN division is the dense of marginal land availability. In this study average number of trees/100m² vary between 4 and 11. Maximum of 11 was found in Ambalnagar GN division and minimum of 4 was found in Kandawalai and Nallur GN divisions.

Management of tree species in Kandawalai and practice of fewer species are the reason for lower species density in Kandawalai GN division even average size of homegarden is high.

Maximum of 1108 species density was found in Ambalnagar GN division and minimum of 413 was found in Kandawalai.

Diversity in species is the most striking features of homegardens. Table indicates what percentage of farmers have mostly occurred species in their homegarden. Another way to approach the importance of species grown is through the percentage of farmers growing a given crop in homegardens [5, 10, 11, 17]. Mayavanoor GN division is found to be as leading one for having highest percentage of farmers for Banana, Coconut and Mango. Nearly 52% of farmers in Karachchi were identified with banana (60 families), 48% and 38% of proportion for Kandawalai (50 families) and poonakary (40 families) respectively. About 77% of farmers in Karachchi, 66% in kandawalai and 58% in poonakary were observed with coconut. Between 30 – 40% of farmers were only observed with mango in three DS divisions. This may be due to destruction of trees by civil war and less care by people in study area.

Table 3.7: Distribution of Banana, Coconut and Mango trees in study area

DS division	GN division	Percentage of farmers		
		Banana	Coconut	Mango
Karachchi	Ambalnagar	40	56	24
	Pannankandy	50	90	20
	Vaddakachchi	50	90	30
	Mayavanoor	73	93	47
Kandawalai	Uriyan	60	80	53
	Kandawalai	55	55	15
	Tharmapurum East	27	67	53
Poonakary	Nallur	40	60	33
	Pallikkuda	40	53	27
	Mulankavil	30	60	20

Table 3.8: Occurrence of food trees in 150 homegardens

Food trees	Total no.
Banana	341
Papaya	84
Drumstick	37
Wood apple	21
Coconut	391
Mango	207
Jack	32
Palmyrah	89
Guava	37

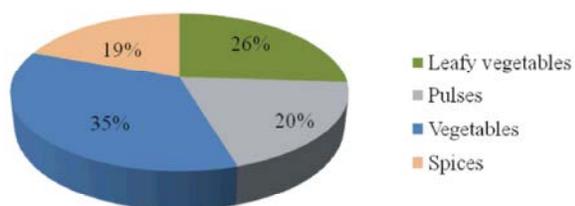


Fig. 3.2.2: Proportion of annual components in 150 homegardens

Above table shows in study area the major food trees were identified. Among those trees Banana, Coconut and Mango were found in higher frequent.

Within the sampled area vegetable were occupied largest proportion (35%) by farmers followed by leafy vegetables, pulses and spices.

Within the sampled area vegetable were occupied largest proportion by farmers followed by leafy vegetables, pulses and spices.

Mostly in case of perennial components there were identified of fruit tree, shade tree, food tree and timber tree in sampled area.

Above table shows the occurrence of important species found in homegardens generally. According to frequency of occurrence of species (Table 3.8) most prominent species were Coconut, Banana and Mango. Ambalnagar GN division has the more

economically important crops according to farmers and occurred in most surveyed area. In study area papaya, pomegranate and jack were observed in very less number.

Potentials and Constraints

Constraints: Major constraint mainly in arid region was lack of water for growth and survival of trees. Annuals crop cultivation of homegardens has been limited by seasonal rainfall. Irregular distribution of rain as well as prolonged drought periods enhances the frequent soil moisture deficits. It related with immature fruit generation, flower falls, drying and etc.

Effects of soil physical and chemical characters have caused several problems. In certain places sudden death in some perennial trees due to presence of gravel layer, rocks, salt water and low water table reduces the chance for use ground water for development.

Lack of marketing facility of seasonal product was another constraint for homegarden development due to seasonality in fruit production, market price fluctuation during harvesting period and giving low returns to householders due to intervention of middle mans.

Scarcity of labor in some households were severe problem even they having greatest potential to expand production. Even better availability of labor; climate might be a dangerous one in some times less favor the production. For most of homegarden source of labor from family member, but in some household number of members were low due to war, moved to abroad and less preference to work.

The farmers in study area had less preference to invest in farming activities due to vast obstacles and they prefer to invest their investment in rebuild their house and move to abroad. In some area interference of wild animals also created problems. Even fences fail to protect gardens from such animals.

Potentials: There is greatest potential for water source as a big tank namely “Iranaimadu” and tree density near the areas to water tank were high compare with areas which far away from tank. Expansion of timber and perennial trees are better option for such areas for increase productivity or marginal production.

Most of personal and common lands were to be as spare land and not good for any vegetation and practice of vegetation in such areas may be increase the production.

Table 3.9: Occurrence of Species in the study area

Species	Ambalnagar	Pannankandy	Vaddakachchi	Majavanoor	Urijan	Kandawalai	Tharnapuram East	Nallur	Palikuda	Mulankavil	Total
Banana*	34	15	19	42	52	66	29	27	35	22	341
Papaya	10	7	1	11	26	2	2	6	13	6	84
Drumstick	7	7	1	6	1	7	7	3	2	3	37
Neem	12	4	5	6	7	2	2	6	5	5	54
Nelli	4	1	0	2	0	2	2	2	1	0	14
Wood apple	8	1	1	2	2	2	2	2	2	1	21
Coconut*	60	36	32	76	67	3	39	50	35	32	391
Teak	8	4	8	5	3	2	2	4	2	2	37
Navel	7	1	3	2	2	1	1	3	4	3	25
Mango*	21	6	7	19	16	43	43	27	17	8	207
Jack	4	1	6	3	8	2	2	3	2	2	32
Palmyrah	12	18	8	10	5	10	10	10	10	6	89
Eucalyptus	0	2	0	0	1	1	1	1	0	1	7
Pomegranate	6	1	2	0	7	7	7	5	3	2	40
Lime	7	1	3	9	8	8	8	5	6	0	55
Arecanate	8	6	6	10	8	7	7	8	3	7	70
Guava	4	3	3	4	6	3	3	4	3	4	37
Tamarind	5	3	4	1	3	2	2	2	1	3	26
Total	217	109	109	208	215	170	120	168	144	107	1567

SUGGESTION AND CONCLUSION

Conclusion: Overall, the literature review supports the inclusion and promotion of home gardens as an eco-friendly sustainable agricultural practice to improve food security and enhance economic growth. Food security in Kilinochchi district of the Northern Province according to the results of the study shows that home garden play a crucial role in rural household. However improving household income and making use of home gardens will yield a large improvement in agricultural production and reduce household food insecurity.

Strategies that enhance household income and practicing of home gardens need more attention when it comes to reducing household food insecurity. Through home gardening the problem of food insecurity can be addressed since households can participate in home gardening in order to supplement their household's food basket. But this can only happen if home gardens can be taken as a strategy to help with the food insecurity problem amongst rural inhabitants.

There are benefits that are attained from engaging in this activity such as employment creation, reduction of household expenditure on food, income generation and recreation. There are constraints as well that prohibit rural as well as in urban households from taking part in home gardening such as lack of land, water and Knowledge. Home gardens can be improved through improving education level of household heads, having access to land especially in rural areas where land for home garden is limited. This requires a joint effort of government, municipalities, households, non-governmental organizations and private sector role players.

Suggestions: Well adopted species should be selected and they want to be incorporated into the areas where enough water sources or enough soil moisture. Regenerate suitable species into marginal land areas could decrease the problems of survival arise from introduced species.

Use the improved techniques or traditional techniques to improve the soil moisture retention. Either government or non government organizations may be responsible for deliver such kind of skills.

Following of management practices such pruning, budding and grafting specially for fruit trees is another better option for sustainable production. Some farmers have developed such skills and want to be transfer to others also.

Protect the fields with well managed strong fences may support to reduce the wastage of production and crops by wild animals. Fencing with live fences may support the production by giving shade to reduce direct effect of heat.

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Appendix:

Appendix 1: Occurrence of economically important Species in survey area

Vegetables (including leafy vegetables)	Trees	Cereals	Medicinal plants	Animals
Cassava	Coconut	Green gram	Shirukurinja	Cattle
Sting bean	Papaya	Black gram	Karpuravalli	Goat
Okra	Drumstick	Ground nut	Thuthuvali	Poultry
Onion	Neem	Maize	Thulasi	
Tomato	Nelli	Finger millet		
Pumpkin	Wood apple	Gingelly		
Snake gourd	Coconut	Cowpea		
Bitter gourd	Teak			
Brinjal	Navel			
Chilli	Mango			
Spinach	Jack			
Vallari	Palmyrah			
Pasali	Eucalyptus			
Murunga	Pomegranate			
	Lime			
	Arecanate			
	Guava			
	Tamarind			