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'Can homegardens assist in enhancing the domestic food security?' A study in Jaffna Peninsula, Sri lanka

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Abstract Due to the combination of trees, crops livestock and poultry, homegardens are well-known in providing socioeconomic and agro-ecological services. This study was conducted to assess the potential contribution of homegardens toward securing domestic food requirement. A questionnaire survey with ground trothing was conducted with 145 households in Jaffna peninsula. Socioeconomic data, floristic and fauna diversity and food consumption data were gathered. Average size of a family and homegarden was 4 members and 0.083 ha, respectively. Sixty-nine plant species were recorded including 10 vegetables, 18 fruit and 43 woody plant species. Approximately 50% of the homegardeners reared livestock and poultry. Food consumption of the households evaluated based on the Food Consumption Score (FCS) of the World Food Program indicated that, 1, 12 and 73% households fell into poor, borderline and acceptable FCS categories, respectively. Expenditure on food and beverages showed a positive relationship with FCS, explaining the dependency of households on market for food necessity. Coconut was the most common income commodity and the most dominant tree species in homegardens, according to Summed Dominance Ratio of tree species. It was revealed that animal proteins and pulses are truly important in securing domestic caloric availability. Except pulses, most of the crops in homegardens were falling into the least important category with respect to FCS. It was found that a household is more secured in terms of caloric availability when homegardens are highly diverse in livestock and poultry and has access to more animal proteins. Growing animals and crops to get valuable components in homegardens will assure enhancement of food security in the future. Thus, homegarden could be a potential approach in assuring domestic food security in the area.

Keywords Homegarden · Food security · FCS · Livestock · Crops

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Introduction

As the world population increases and expected exceed 9 billion, by 2050 (Hossain et al. 2020), and the food demand has become one of the major crises where many researchers argue on diverse approaches to mitigate the issue (Lopez-Ridaura et al. 2019; Mora et al. 2020). One of the main reasons behind this

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calamity has been identified as the global climate change (Pandey et al. 2017; Tyler et al. 2013). Climatic variability and extremities causing changes in rainfall patterns, cropping seasons and destructing crop fields have created a huge pressure globally, to uphold the food security. Being a sustainable and diversified ecosystem, many perceive the optimum utilization of agroforestry to mitigate the food insecurity and identified as one of the options to overcome the food crisis (Getachew 2014; Vibhuti et al. 2019). Therefore, to fulfill the domestic food demand, the studies suggest to move from monoculture agriculture toward agroforestry or homegardens, which are proven to be adaptive to climatic hazards (Pandey et al. 2017; Galhena et al. 2013; Ninez 1985).

In the present era of rapid urbanization, the availability of productive lands for agriculture is gradually being declined (Kumar 2006). Moreover, the climate change affects the plant growth, biodiversity and carbon storage in biosphere. Scientists suggest wherever possible woody perennial-based production systems, or homegardens, to minimize the risk of global warming and effects of climate change. Usually, monoculture systems have a high tendency of getting affected by climatic hazards, which ultimately threat the food security (Linger 2014).

Homegardens have been an important service provider in local households, for centuries (Abdoellah et al. 2020). However, it is observed that the total land area under homegarden concept is gradually increasing over the past years. These ecosystems have been identified as traditionally improved agroforestry systems, which can face upcoming challenges (Pandey et al. 2017; Pushpakumara et al. 2012). It is common for rural and urban areas to have even a smaller garden, besides the provision of same functions and ecological services (Galhena et al. 2013). Although homegarden is a man-made land use agroforestry system, it is the most potential system closer to natural forests (Kumar 2015). Homegardens are one of the oldest land use technologies which involves a deliberate management system among crop-tree-animal unit by family labors (Kumar and Nair 2004; Lope-Alzina and Howard 2012). They have been identified as the most ideal, man-made relationship between trees, crops and animals. The literature shows that the age of the homegarden positively correlates with the diversity, particularly trees and the canopy cover (Pushpakumara et al. 2012). Due to the effective association of crops and trees with animals, homegardens can be considered as a diverse yet sustainable man managed system. Since the land utilization is optimum in tropical homegardens, it can be applied to rural as well as urban areas, where the land space becomes a limiting factor (Ninez 1985). Due to the presence of trees, agroforestry ecosystems function as an ecologically sustainable unit where the high diversity possesses the capability of avoiding occurrence of undesired results due to extreme climatic events (Linger 2014).

In terms of food security, homegardens provide a variety of food items as a supplement, including staple vegetables, yams, fruits, medicines, fodder, livestock and sometimes fish (Pandey et al. 2017; Pushpakumara et al. 2012). Hence, agroforestry ecosystems can intervene to minimize the food crisis at domestic level, by providing staple food items at supplement levels; ready to consume food items and ready to trade products (Getachew 2014). Well maintained homegardens carry a comparatively undisturbed food production as a result of the proper combination and management of crops with different life cycles throughout the year (Lope-Alzina and Howard 2012). Therefore, researchers suggest that agroforestry systems are the best opportunity to overcome the food crisis and to improve food security in future (Kumar 2006).

However, the impact of diversity and the contribution of homegarden to acquire food security has not been clarified and measured well enough (Mellisse et al. 2018). On account of that, whether homegardens truly aid in domestic food security with diverse scales of ground level circumstances, is not being answered. Focusing this question, the present study was conducted as a pilot attempt to assess how the homegarden system has been coping up as a remedy to secure domestic food requirement of households in Jaffna peninsula. Thus, the primary objective of the study was to assess the contribution of homegardens toward fulfilling the domestic food requirement in Jaffna peninsula in terms of ready to consume agricultural produce.

Methodology

Location of study

The study was focused on households with homegardens in Jaffna peninsula which is located between 09 40 N and 80 10 E in low country dry zone ecological region. Generally, the most prominent characteristic in Jaffna is smallholder agriculture. There are only two agro-ecological regions in Jaffna; DL3 and DL4. The total cultivatable land was estimated about 12% of the total land area while 50% of the population engaged in farming activities (Jeyavanan et al. 2017).

Four major areas (Fig. 1) were selected based on climatic data, elevation, agro-ecological region and soil type; *Jaffna, Kodikamum, Delft Island and Kankesanthurai*. Each area was consisted of 10–12 identified locations from where 3–4 homegardens were subjected to the survey.

Questionnaire survey

A questionnaire survey was conducted with 145 households during January–March, 2019. The survey was conducted on ground through face-to-face interviews at households, while data on flora and fauna were gathered by multiple visits. The respondent was always the household head or a key decision maker in the family. Each homegarden was photographed to obtain further details regarding the structural arrangements of the homegarden. The survey questionnaire was pretested and digitized to improve accessibility and accuracy in tabulation. The questionnaire consisted of the information on family data, income sources and expenditure, extent, age, diversity and composition of flora and fauna of the homegarden (trees, crops, livestock and poultry, etc.), consumption information of different foods and the contribution of homegarden on domestic food consumption.

Figures on domestic food consumption were recorded under 15 categories which are regularly consumed by Sri Lankan households on a daily basis; i.e., Cereals, Pulses, Coconut, Jackfruit/Breadfruit, Vegetables, Leafy vegetables, Yams, Fruits, Meat, Fish, Dried fish, Eggs, Milk, Condiments and other. These food categories were set with the aim of capturing all the nutritional aspects of the daily domestic food consumption in general. Availability and accessibility of those categories were considered in order to assess the domestic food security. With the intention of capturing them, the total amount consumed, amount produced within the garden and the amount received from other homegardens were recorded as a weekly average. In addition to that, expenditure on food and beverages were also recorded as a monthly average.

Analysis of data

Survey data were analyzed using descriptive statistics. Mean comparisons and linear regression were used to compare different parameters affecting the Food

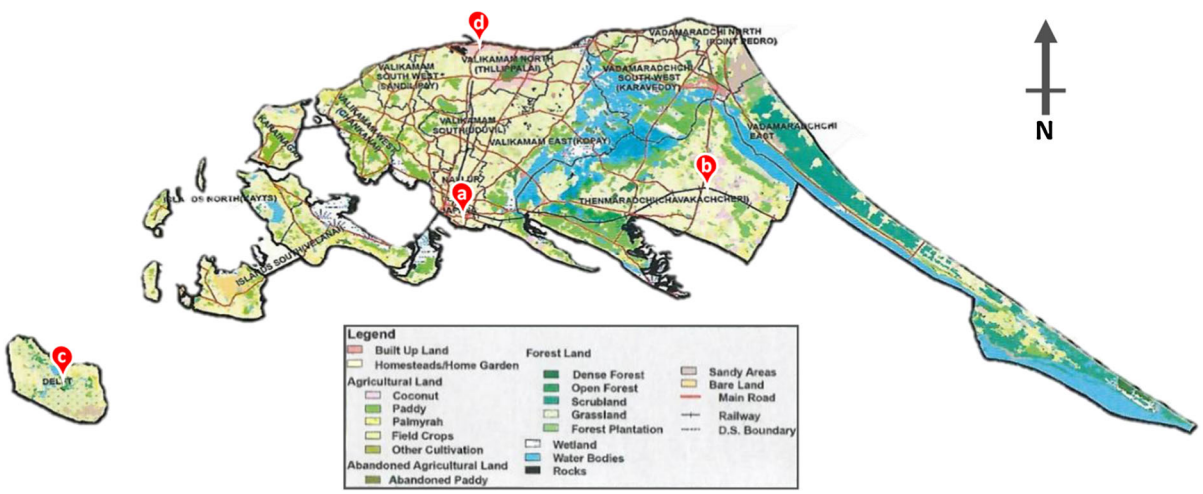

Fig. 1 Land use and land cover of Jaffna: 2019 (**a** Jaffna, **b** Kodikamum, **c** Delft Island, **d** Kankesanthurai) (*Source* LUPPD 2019)

Consumption Score (FCS). Multiple regression was done to construct an equation model for domestic FCS. One-way ANOVA and t-test were used to compare the means, and richness was recorded as the total number of woody tree species, while the abundancy was the total number of individual trees. Analysis tools were Microsoft Excel 2016 and Minitab version 15.

Food Consumption Score (FCS)

The FCS is an index developed by the World Food Program in 1996. The FCS sums household food consumption data in terms of diversity and frequency of food groups consumed over the previous week which is weighted according to the relative nutritional value of the groups. Based on this score, a household's food consumption can be classified into three categories: poor (0–21), borderline (21.5–35) and acceptable (> 35). The FSC is a secondary indicator of household caloric availability (INDDEX Program 2018; Wiesmann et al. 2009). In the study, 18 households were excluded from calculating the FCS due to lack of information.

Summed Dominance Ratio (SDR)

Summed Dominance Ratio (SDR) was calculated using the relative density (RD) and Relative frequency (RF) of the observed woody plant/crop species to identify the most dominant perennial species in a homegarden (Chen et al. 2014; Rahman et al. 2017; Whitney et al. 2018). SDR was used to explain the different growth patterns of plant species and communities by Chen et al. (2014). In fact, this value can be used to identify the most valuable and useful crop species for a cluster or an area (Whitney et al. 2018).

$$\mathrm{SDR} = (\mathrm{RD} + \mathrm{RF})/2$$

where, SDR=Summed Dominance Ratio; RD=Relative Density (Total number of individuals of a crop/Total number of individuals of all crops)RF=Relative Frequency (Total count of homegardens in which a crop occurred/Sum of counts of all crop occurrences in all homegardens surveyed)

Results and discussion

General description of the sample

The survey sample included households with an average family size of 4 (ranged 1–10), a homegarden of 0.083 ha (ranged 0.0025–1.21 ha) and an average monthly income of 32,324.00 LKR. Sixty-nine floral species including 10 vegetable crops and 18 fruit crops were recorded. Around 50% of the households reared livestock (cattle, goat) and poultry, while 4% of homegardens had combination of livestock. This value is consistent with the findings of Jeyavanan et al. (2017) which reported that 53% of the homegardeners involved in rearing domestic animals. Given the fact that homegardens represent woody perennial-based production systems, the homegardens in Jaffna peninsula were represented with a considerable diversity of perennials (Fig. 2). Among the abundance of different woody tree species found in the study area, species such as coconut (*Cocous nucifera* L.) and mango (*Mangifera indica* L.) have made a higher representation than trees which have timber value such as teak (*Tectona grandis*). The study revealed that the homegardens, which had an extent of 0.0631–0.0885 ha, had the highest woody species richness among all homegardens. According to the results, being undersized or oversized in terms of extent may negatively affect the richness of a garden.

Production of food items in homegardens

A variety of food items used for home consumption were born outside homegarden. As shown in Fig. 3, pulses, jackfruit (*Artocarpus heterophyllus* Lam.), breadfruit (*Artocarpus altilis* (Parkinson) Fosberg.) and dried-fish requirement were totally procured from outside. In addition, the households were primarily depending on local market for cereals, meat, fish and condiments too. However, 78% of the coconut requirement and 48% of the fruit requirement was delivered by homegardens, while 17% of the households shared fruits among neighbors. It was also observed that no considerable amounts of fruit vegetables and leafy vegetables were acquired from homegardens for domestic consumption. Field crops were not popular in Jaffna homegardens which verify the fact that households were primarily relying on market for vegetables (Fig. 3). In terms of livestock

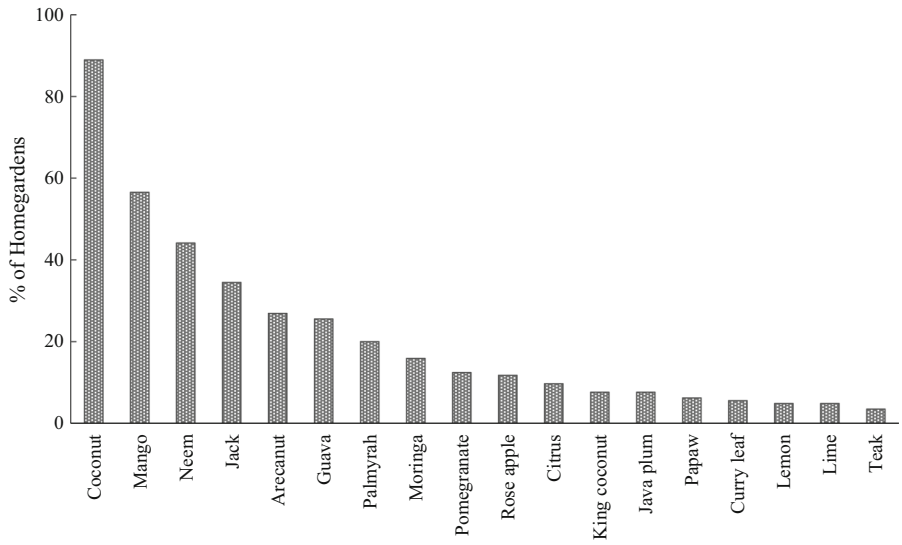

Fig. 2 Most common woody tree species distribution in homegardens in Jaffna peninsula

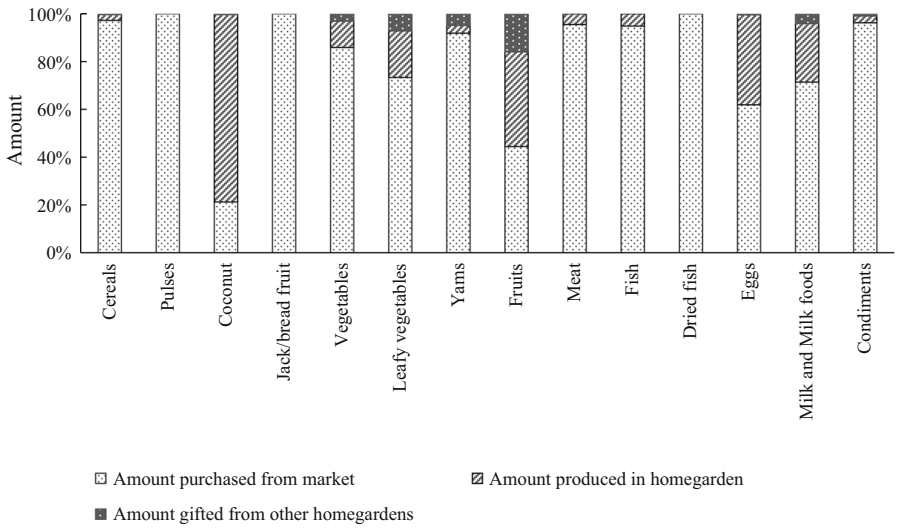

Fig. 3 Average domestic consumption of food items over a week in Jaffna (n = 145)

production, 7% of eggs and 24% of the milk requirement were produced within the homegardens.

Consumption level of food items in homegardens

Apparently, being a staple food, cereal consumption recorded the highest, followed by vegetables and fruits. Jackfruit and breadfruit consumption rate was low, which was less than 2 days per week. Since daily dishes in Sri Lankan households are generally prepared using condiments and coconuts (coconut milk), the frequencies of those occupied the highest values, along with the cereals which comes under staple food category. The average consumption of coconuts was 7 nuts/ household/ week. However, the number of coconuts consumed over a week did not show a significant association with the family size. Pulses, vegetables, leafy vegetables, yams and fruits were consumed at a higher frequency than animal sourced foods (eggs, meat, fish, and dried fish) except milk. Accordingly, the average egg consumption was 7 eggs/household/ week. In contrast, milk consumption frequency was high, which may be due to the cultural influence of the community in Jaffna where milk has

an important place in their dietary and traditional practices. Cow is considered as a sacred animal in Jaffna community and they use cow milk and milk products, which they believe to be having a purifying effect, for dietary and cultural purposes.

Contributions of homegardens

Majority of the homegardens (88%) had at least one coconut tree (range: 1–22), which was basically for domestic use. The households, which were self-sufficient in coconut, had an average of 5 coconut trees. Mango, Neem *(Azadirachta indica* A. Juss.), Jackfruit, Arecanut *(Areca catechu* L.*)* and Guava (*Psidium guajava* L.) were the most popular other perennials found in Jaffna homegardens. Banana (*Musa spp.*) was recorded as the most favored fruit consumed domestically where 77% have consumed banana over the previous week, while 29% produced within the homegarden. This is a favorable observation in terms of nutritional security as banana is one of the best sources of vitamin B-6 (USDA 2016). Mango and Papaw (*Carica papaya* L.) have been consumed with moderate frequencies, while Pineapple (*Ananas comosus* L. https://hort.purdue.edu/newcrop/duke_energy/Ananas_comosus.html), Avocado (*Persea americana* Mill.) and Wood apple (*Limonia acidissima* L.) consumption were recorded in comparatively lower frequencies.

Contribution of homegardens for animal sourced food

Out of 145 households, 75% of the households have consumed at least one form of animal proteins (meat, fish, dried fish, eggs, milk) within a week. Eggs were the most common source of animal protein (45% of the households) followed by fish, meat and milk, where dried fish had noticeably a lower place (13% of the households) in their diet. Meat was mainly purchased from market, while 28% of the households produced and consumed eggs domestically. Milk was produced within the homegarden by only 10% of the households, while 26% purchased milk for domestic consumption.

As revealed by results, households who keep chicken for egg production tend to consume the eggs produced within the homegarden rather than selling. The same trend was observed in milk production too whereas meat production showed the opposite trend. According to the observations of Marsh (1998), the homegardeners who keep livestock animals tend to supplement their animal protein requirement by those animals. In the present study, the most common domestic animal species found in the homegarden was chicken (*Gallus gallus domesticus*), while cattle (*Bos* spp.) and goat (*Capra aegagrus hircus*) were found in lesser numbers. That was mainly due to the convenience of raring; less space and low input, especially on feeding. No swine (*Sus scrofa*) were found in homegardens in the study sample.

Food consumption score

Among the surveyed 145 households, 107 (73%) households had acceptable FCSs (21.5–35), while only 18 (12%) had borderline FSCs (< 21). Among these 18 households, only 7 and 2 households had consumed animal proteins and pulses, respectively. They were spending about 12,000 LKR/ month on foods and beverages, on average. However, those had a mean FCS of 31, which hints that the 18 households who were on borderline FSCs were just below the acceptable level and could attain acceptable FCS by simple changes. Therefore, this 12% could be pushed toward the acceptable level simply by managing their dietary practices in a proper way, such as increasing pulses and animal protein intake. As described in INDDEX (2018), the FCS is calculated by categorizing food items into 5 categories according to their caloric content. Thus, livestock products were assigned the value 4, pulses 3, cereals, tubers and root crops 2, vegetables and fruits 1, and fats, oils and sugars, 0.5. Therefore, in order to increase the FCS, households should consume more foods with high caloric contents (energy dense) or increase the frequency of consuming foods with low caloric content (Fig. 4). Many of these items could easily be supplied from homegardens, thus accessible and affordable. Four major plant components that can support in this regard are jackfruit, breadfruit, drumstick (*Moringa oleifera* Lam.) and yams (*Dioscorea* spp.). All homegarden improvement programs should directed toward expansion of the given plant species so that households can be more food secure. Since condiments do not contribute to the caloric value, they were not included in calculating the FCS although it plays a significant role in Sri Lankan daily dishes.

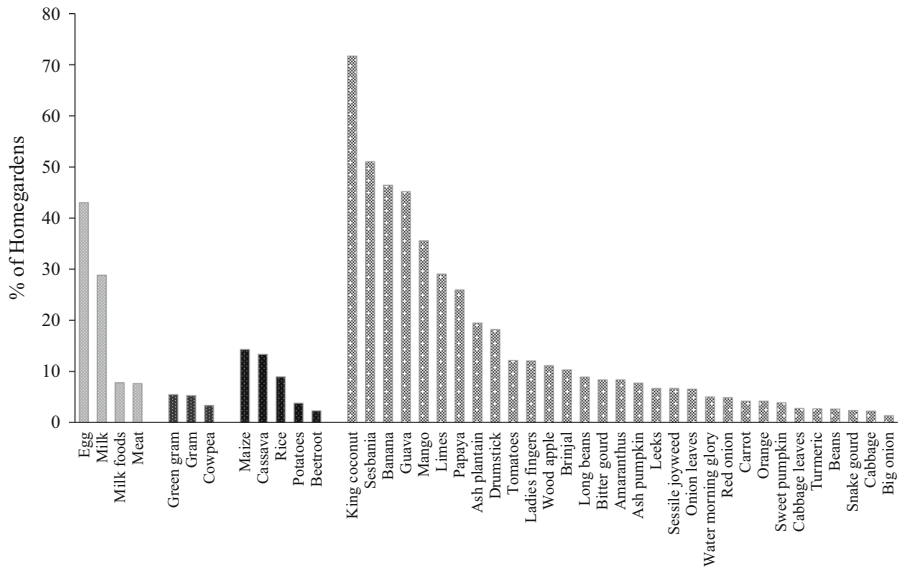

Fig. 4 Percentage of homegardens producing different categories of food items by caloric value

Majority of homegardens (73%) with acceptable level of FCS found in Jaffna peninsula is a result of the pattern of consumption which consists of energy dense food items or low caloric food items with high frequency.

The nutrient supply channels of homegardens come under two categories, i.e., plant-based products, and animal-based products (Daulagala et al. 2013). In the study sample, most of the food items consumed by households fell into low weightage category with respect to FCS, which were mostly plant-based products. As pointed out by Talukder et al. (2000), most of the lower income families tend to depend on fruits and vegetables for micronutrients, although livestock products are the best in providing micronutrients in daily meals. Further, Marsh (1998) reported that field crops usually supplement a bulk of energy requirement of rural households. However, their contribution to the total domestic calorie requirement is comparatively lower. Consequently, increasing the consumption of livestock and poultry products, pulses or roots by making them available in the homegarden could lead to better FCSs. Thus, homegardens could be used as one of the best approaches in overcoming malnutrition in low income groups and could also be used as a supply mechanism of micronutrients (Mitchell and Hanstad 2004).

According to the consumption diversity of vegetables, Drumstick, Plantain (*Musa* × *paradisiaca* L.), Ladies Fingers (*Abelmoschus esculentus* (L.) Moench) Brinjal (*Solanum melongena* L.), Carrot (*Daucus carota* L.) and Tomato (*Solanum lycopersicum* L.) were widely consumed. Sesbania (*Sesbania grandiflora* (L.) Poir.) and Cabbage leaves (*Brassica oleracea* L.) were popular as leafy vegetables, followed by Onion leaves (*Allium cepa* L.), Sessile joy weed (*'Mukunuwenna'- Alternanthera sessilis* L. DC.) and Water morning glory (*'Kankun'- Ipomoea aquatica* Forssk.). Potatoes (*Solanum tuberosum* L.) were consumed by 105 households (72%), and native yam species such as '*Kiri-ala'* and '*Innala'* were not recorded from any household in the study area. Except for few items (such as potato and carrot), almost all the widely consumed vegetable items could be supplied within the homegardens.

The expenditure on food and beverages showed a positive correlation with the FCS according to a linear regression analysis (R^2 = 4.6%, p = 0.009). This implies the dependency of modern households on local market for domestic food requirement. Still, if properly managed, homegardens can improve the diversity of daily meals by supplementing vegetables and fruits, rather than depending on market (Talukder et al. 2000). The results further revealed that some households tend to share the excess produce among neighbor households, which also ultimately contribute to the FCS of the household. However, the majority were spending less than 15,000 LKR/ month/ family on foods and beverages (mode = 15,000.00; mean = 14,793.00).

Homegardens have also been identified as a sustainable income generation source as it allows selling the surplus of the production (Marsh 1998; Mitchell and Hanstad 2004). Results of the present study also confirmed this observation and recorded that the most popular income generation commodity was coconuts, followed by fruits. Thirty-three percent of the households had generated income from coconuts while 28% from fruits. Sale of animals, eggs and milk (livestock and poultry produce) was recorded as an income source from 20% of the households. The income generated from homegarden has indirect contribution to household food security by enhancing the affordability of food items generated outside the homegarden. However, raring livestock stated no significant effect on the total household income, which indicates that the livestock are being kept for other values but income, such as aesthetic value and improve the nutritional value of food plate, ready to trade property.

The average FCS was recorded significantly ($P < 0.05$) higher in homegardens with livestock than those without livestock; 45 and 39, respectively. This justifies that the homegardens with livestock provide more chances for animal protein intake contributing to high FCSs. Talukdar et al. (2000) reported that animal-based food items in the diet provide a rich source of micronutrients than plant-based foods, highlighting the benefit of having livestock as a component of protein sources found within the homegarden. The most common animal food item produced within homegardens was eggs, followed by milk, which reflect the composition of animals in homegardens as well. Majority of the homegardens had layers/ broilers (23% of the homegardens), while 18% and 15% houses had goats and cattle, respectively (Table 1).

Table 1 Contribution of homegardens to Food Consumption Score (FCS) in Jaffna peninsula

Status of homegarden (Livestock)	Mean FCS
With livestock	45[a]
Without livestock	39[b]
Number of food items supplied from homegarden	
Producing 2 or more food items	47[a]
Producing at least 1 food items	49[a]
No food items produced	24[b]

Different superscript letters indicate significant difference ($P < 0.05$)

Regardless the food item or source, the number of different food items produced within the homegarden also significantly ($P < 0.05$) affect the FCS. According to the findings, contribution of even one food item from homegarden can positively affect the FCS. However, it is noteworthy that increasing the number of food items from homegarden within a food category contributing to food plate has no influence on FCS (No foods produced in homegarden; FCS 24, 1 food item produced; FCS 49, more than 2 food items produced; FCS 47). This implies that rather than increasing the diversity within food categories, it is advisable to diversify food categories in the homegardens to enhance FCS (pulses, roots and tubers, livestock and poultry, etc.). Therefore, paying attention on promoting homegardens including crops and livestock and poultry is essential. In addition, many studies have shown that consideration on species diversity and seasonality during planting is advisable to ensure food accessibility and availability from homegardens at any time of the year (Ferdous et al. 2016; Mitchell and Hanstad 2004; Pandey et al. 2017; Talukder et al. 2000).

The average consumption of pulses was recorded significantly higher ($P < 0.05$) in homegardens with livestock. Given the observation of significantly high FCSs in homegardens with livestock and poultry, it appears that there is a tendency that the households which consume comparatively high levels of animal proteins also consume more pulses than their counterparts. The most popular pulse types consumed in Jaffna peninsula were Green gram, Black gram and Cowpea. Pulses are known as good sources of protein with a low fat content. In addition, common pulses such as Peas usually provide higher amounts of essential minerals such as Zinc, Phosphorus and Magnesium (USDA 2016).

As shown in Fig. 5, the most common food item produced within homegardens was coconut (64%), followed by fruits (29%) and eggs (28%). Eggs are one of the most important food commodities contributing to FCS. According to the present findings, it was clear that having livestock and poultry in the homegarden positively affects the FCS. Being one of the easily managed backyard animals, keeping poultry in homegardens could be highly beneficial. However, raring cattle and goats in homegardens indicated no effect on

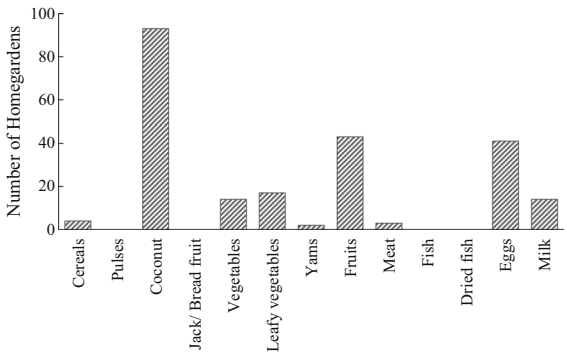

Fig. 5 Frequency of production of different food items/ categories within homegardens

milk and milk-based food consumption in Jaffna homegardens, indicating that consumption of milk-based products does not get affected by the availability of dairy animals in homegardens in the study area. Thus, interventions on promoting backyard chicken in homegarden could help enhancing the FCS, thereby address the issues of protein malnutrition in general. Further, the present findings confirm the report of Marsh (1998), who declared that homegardening is a viable approach which provide direct access to nutritious foods, supporting to overcome food insecurity. As the number of animal protein sources has a significant effect on FCS, diversifying homegardens to incorporate both crop and animals could be a beneficial option when the food and nutritional security of households is considered. However, the absence of the effect of number of food producing woody species in the homegarden on the FCS could be due to comparatively low weightage given for fruits and vegetables in FCS estimation.

According to the results of multiple regression analysis, the variables contributing to FCS of households in the study area are shown in Table 2. The contribution of three significant variables to FCS could be expressed by Eq. 1.

$$\begin{aligned}\text{FCS Total} = {} & 20.6 + 1.35\text{Richness} \\ & + 2.80\text{kg of pulses consumed per week} \\ & + 5.73\text{Number of animal protein sources}\end{aligned} \quad (1)$$

Summed Dominance Ratio (SDR)

According to the importance of woody species with reference to SDR, the most common species recorded in Jaffna homegardens are shown in Table 3. This information could be useful as a guidance in making policy decisions for promotion of homegardens in the area of study as a meaningful intervention in securing food and nutritional safety. According to Whitney et al. (2018), plant species with the highest SDR values (SDR $>$ 0.01) were considered as the most important species.

As revealed by the present results, coconut is a vital tree species in a homegarden. Being a multipurpose tree (food, timber and leaves), its value has been highlighted in many aspects, especially in context of household food security. The results revealed that coconut, jackfruit and drumstick which were ranked higher in the study were the most common and showing year-round production in Jaffna. Considering the prevailing diversity of tree species, it shows a potential to incorporate some other food producing species into homegardens in Jaffna, such as Breadfruit and Cassava (*Manihot esculenta* Crantz.). According to Ragone (2006), Breadfruit shows a wide range of adaptability in different environmental conditions. It is a staple food with a remarkable value in terms of food security (Gloster and Roberts-Nkrumah 2012), which was observed, yet rarely in Jaffna homegardens. Cassava was also observed hardly in the study area which is another highly resilient and sustainable staple food in developing countries. It requires minimum inputs and can be grown in extremely challenging environments due to its tolerance (El-Sharkawy 2004). Traditional yam species can also play a significant role in provisioning staple foods to households, which requires further research in the study area. However, farmers should pay attention on managing the diversity of the garden to be balanced; livestock and crops, less seasonal, but year-round. In other words, both richness and abundance are critical factors to be considered when managing a garden, especially in terms of woody species, to maintain a continuous production.

Table 2 Status of variables contributing to Food Consumption Score (FCS) in homegardens in Jaffna peninsula

Significant variables ($p < 0.05$)	Non-significant variables ($p > 0.05$)
Species richness	Extent of the homegarden
Number of animal protein sources consumed	Expenditure on food and beverages
Total amount of pulses consumed/week	Family size
	Education level of the household head
	Total income of the household
	Number of livestock animals species
	Existing number of coconut trees

Table 3 Summed Dominance Ratio (SDR) values of woody perennial species in Jaffna

Woody species	Botanical name	Family	SDR	Rank
Coconut	*Cocos nucifera* L	Arecaceae	0.318	1
Mango	*Mangifera indica* L	Anacardiaceae	0.125	2
Neem	*Azadirachta indica* A. Juss	Meliaceae	0.090	3
Arecanut	*Areca catechu* L	Arecaceae	0.081	4
Jackfruit	*Artocarpus heterophyllus* Lam	Moraceae	0.068	5
Guava	*Psidium guajava* L	Myrtaceae	0.049	6
Palmyra	*Borassus flabellifer* L	Arecaceae	0.040	7
Drumstick	*Moringa oleifera* Lam	Moringaceae	0.033	8
Pomegranate	*Punica granatum* L	Magnoliaceae	0.024	9
King coconut	*Cocos nucifera* L	Arecaceae	0.020	10
Citrus	*Citrus sinensis* Pers	Rutaceae	0.018	11
Rose apple	*Syzygium jambos* L	Myrtaceae	0.016	12
Java plum	*Syzygium cumini* L	Myrtaceae	0.015	13
Curry leaf	*Murraya koenigii* (L.) Spreng	Rutaceae	0.010	14
Lemon	*Citrus limon* (L.) Osbeck	Rutaceae	0.010	15

Conclusions

The study revealed that majority of the households in Jaffna primarily depend on local market for their domestic food necessity, where the contribution from homegarden was less significant. Except for coconut, fruits and eggs, the contribution from homegarden for the rest of the food items was less than 24% (0–24%) on average. A positive association was observed between the FCS and the expenditure on food and beverages at domestic level. The most popular woody species was Coconut, followed by Mango, Jackfruit, Palmyra and Drumstick. Coconut was the most abundant and common species which contributed largely on domestic food requirement where eggs were the most popular livestock product followed by milk. Majority of the households were in the acceptable FCS level, where the borderline households could be improved by simply changing their dietary habits, in the short run. Most of the food items produced within the homegardens were falling into the least weighted category, such as vegetables and fruits, in estimation of FCS. Therefore, it is crucial to introduce potential food producing species with a high caloric values such as jackfruit, breadfruit, pulses, roots and tuber crops, livestock and poultry, to homegardens in order to improve the domestic food security in the long run.

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