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# HOMESTEAD VEGETABLE PRODUCTION: A MEANS OF LIVELIHOOD AND NUTRITIONAL SECURITY FOR RESOURCE POOR HOUSEHOLDS IN BANGLADESH

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## Abstract

Justifiable, nutritious and safe food productions are main challenges for food safety which reduce starvation, meets dietary needs and food preferences for a healthy life. Home gardens can play a significant role in providing better food supply and diversity of food. Studies on niche-based homestead gardening were carried out at FSRD site Atia, Tangail under On-Farm Research Division of Bangladesh Agricultural Research Institute during 2018-19 and 2019-20 to utilize the homestead resources for producing vegetables and fruits and to enhance nutritional security for the farm families. A total of 12 households were selected from marginal (0.021–0.20 ha), small (0.21–1.0 ha) and medium (1.0-3.0) farmer groups and seven production niches were intervened for year-round production following the Palima model. Results revealed that homestead area could be capable of harvesting sufficient and diversified vegetables round the year by utilizing all possible homestead nieches. After intervention, the number of vegetables was produced by medium farmers (630 kg/year) followed by small (510 kg/year) and marginal (408 kg/year) farmers. Yearly vegetable requirements of farmers were largely met by homestead garden with a supply between 30-58 kg/head/year compared with bench mark level of 5-12 kg/head/year. Results suggested that farmers consumed lion share of their products that could meet up nutrition. Utilization of farm resources available in the farm that increased nutritional security, income and improved livelihoods as well. The up scaling of the production model based on ecosystem in different poverty-stricken regions of Bangladesh is recommended to attain food security and lessening malnutrition.

Keywords: Homestead, Palima model, poverty, Malnutrition, Productivity and livelihood.

## Introduction

Bangladesh government has long been striving to increase food safety and to diminish poverty and malnutrition. In this respect, home gardens can play a significant role in providing enhanced food supply and augmented diversity of

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food to some extent. Bangladesh is an emerging country of about 182 million people living in its 147,570 $km^2$ area and is mainly an agriculturally based economy (BBS, 2020). About 20.5% people in Bangladesh live below the food consumption-based poverty line and they could not afford sufficient food to meet a diurnal diet of 2122 kcal/day/person (ADB, 2021). Vitamin-A deficiency badly affects about 25% women of reproductive stage and nearly 20% preschool aged progenies (WHO, 2009). Dey *et al.,* (2012) reported that 93% family in Bangladesh is suffering from vitamin-C deficiency, 85% in riboflavin, 81% in vitamin-A and calcium, 60 % in protein and 59 % in calorie requirement.

There are about 20 million farm households in Bangladesh most of them live in rural areas having a homestead. These homesteads are the most effective and common production units for supplying food, fuel, timber and other family needs and employing family labour. There are 8,77,045 ha homestead area in Bangladesh among which only 11% homestead area is under vegetable cultivation (BBS, 2020). Rural consumption of leafy and non-leafy vegetables has remained more or less same over the past two decades after increasing over the past 30 years. Global food demand is growing rapidly double and sustaining food production at this level are major challenges for worldwide food security (Tilman *et al.*,2011). Home gardens are an integral part of local food systems and the agricultural landscapes of developing countries all over the world have endured the test of time (Galhena *et al.,* 2013). These home gardens can play a vital role in the production of vegetables and fruits throughout the year and can promote household food self-sufficiency. The homestead garden provides multiple products to the household and meets the diversified needs including food, nutrition and energy securities producing a wide variety of fruits, vegetables and spices. It also contributes to household income and saving through sales of vegetables and fruits.

Most of the farmers at the Farming Systems Research and Development (FSRD) site Atia, Tangail, Bangladesh is having poor resources. In this region, arable land is a scarce resource and is generally operated for growing field crops. Most of the farmers have homestead area, but utilized only for growing small number of vegetables for their own consumption. Moreover, the productivity of the homestead garden is low due to inadequate scientific knowledge of crop production and unavailability of good quality seeds and saplings. These improperly managed homesteads would be effective to bring under year-round production for improving the family nutrition and income generation of small holders (OFRD, 1993). On an average, Bangladeshi people consume a total of 126 g of vegetables and fruit from an average national per capita per day

consumption of 23 g leafy vegetables, 89 g non-leafy vegetables and 14 g fruit. This intake is far below the minimum recommended daily consumption of 400 g of vegetables and fruit (Ferdous *et. al*., 2016). To address the problems of household food insecurity and malnutrition On-Farm Research Division (OFRD) of the Bangladesh Agricultural Research Institute (BARI) initiated a homestead vegetable production model known as "Palima model" in 1998. The model was subsequently modified based on the existing ecosystems (niches) of each homestead where different fruits were also included along with vegetables (Ali *et al*., 2006). The impact of home gardens on improving nutrition and household income and the quantity of the household's food production has been widely studied in Bangladesh (Schrein emachers *et al*., 2015). However, scientific evidence for the development of a year-round production model and the utilization of this model for producing fresh vegetables and fruits to enhance the nutritional supplies for the family throughout the year is still limited in Bangladesh.

Considering the above facts, the research work was undertaken with the objectives i) to utilize homestead resources in scientific way for producing fresh vegetables and fruits over space and time, ii) to meet up the food and nutritional requirements of the farmers' family and improved their livelihood and iii) to create employment opportunity particularly women and children and income generation throughout the year.

## Materials and Methods

The study was conducted at the FSRD site Atia, Tangail, Bangladesh during 2018-19 and 2019-20 cropping seasons in the homestead of 12 selected farmers. Only marginal, small and medium farmers were the target group therefore, four marginal (0.021-0.20 ha), four small (0.21-1.0 ha) and four medium (1.o1-3.0 ha) farmers were selected purposively. (BBS, 2020). Soils in general have good water holding capacity. The area receives an annual rainfall of around 2123 mm with relatively early onset and late cessation. The homestead resources, needs and choice assessments were performed with the active participation of the family members of the selected households. At each homestead, seven production niches were identified and brought under cultivation following the Palima model. The niches were open sunny place, roof top, trellis, tree support, partially shady place, backyard and slightly marshy land (Table 1). Group meeting of farmers was organized to orient them on the utilization pattern and production practices of the homestead vegetables and fruits.

**Table 1. English name, Scientific name, Family and cropping season of homestead garden plant species used by the farmers at FSRD site Atia, Tangail, Bangladesh during 2018-19 and 2019-20**

| Name of Crop* | Scientific name | Family | Cropping period | Uses |
|---|---|---|---|---|
| Radish | *Raphanus sativus* | Cruciferae | Mid Oct–Mid Mar | Open sunny space |
| Tomato | *Solanum Lycopersicum* | Solanaceae | Mid Oct–Mid Mar | Open sunny space |
| Okra | *Abelmoschus esculentus* | Malvaceae | Mid Mar– June | Open sunny space |
| Indian spinach | *Basella alba* | Basellaceae | July–Mid Oct | Open sunny space |
| Brinjal | *Solanum melongena* | Solanaceae | Mid Oct–Mid Mar | Open sunny space |
| Red amaranth | *Amaranthus gangeticus* | Amaranthaceae | Mid Mar–Mid Oct | Open sunny space |
| Spinach | *Spinacia oleraceae* | Chenopodiaceae | Mid Jun–Mid Oct | Open sunny space |
| Kang Kong | *Ipomoea aquatica* | Convolvulaceae | Mid Jun-Mid Oct | Open sunny space |
| French bean | *Phaseolus vulgaris* | Leguminosae | Mid Nov–Mid Feb | Open sunny space |
| Stem amaranth | *Amaranthus lividus* | Amaranthaceae | Mid Mar-Mid Jun | Open sunny space |
| Bottle Gourd | *Lagenaria siceraria* | Cucurbitaceae | Mid Oct–Mid Mar | Roof top/ trellis |
| Ash gourd | *Benincasa hispida* | Cucurbitaceae | Mid Mar–Mid Oct | Roof top/ trellis |
| Sponge gourd | *Luffa cylindrica* | Cucurbitaceae | Mid Jun–Mid Oct | Trellis/Tree support |
| Bitter gourd | *Momordica charantia* | Cucurbitaceae | Mid Oct–Mid Mar | Trellis /Fence |
| Snake gourd | *Trichosanthis cucumerina uraanguina* | Cucurbitaceae | Mid Mar–Mid Oct | Trellis |
| Country bean | *Lablab purpureus* | Leguminosae | Mid Oct–Mid Mar | Tree support |
| Yam | *Dioscorea sp.* | Dioscoreaceae | Mid Mar–Mid Dec | Tree support |
| Ginger | *Zingiber officinale* | Zingiberaceae | Round the year | Partial shady place |
| Turmeric | *Curcuma longa* | Zingiberaceae | Round the year | Partial shady place |
| Panikachu | *Colocasia esculenta* | Araceae | Round the year | Marshy land |
| Banana | *Musa sp.* | Musaceae | Round the year | Backyard |
| Lemon | *Citrus lemon* | Rutaceae | Round the year | Backyard |
| Giant taro | *Alocasia indica* | Araceae | Round the year | Backyard |

*English name

The vegetable pattern was initiated from *kharif*-2 (mid-June to mid-October) and plantation of a quick growing fruit tree (papaya) was started afterward. Locally adaptable and culturally acceptable vegetables and fruit trees were selected based on year-round production potential with better nutritional value and market demand. The production units of the homestead crops and trees that were utilized and nourished in these homesteads in available spaces are presented in Table 2. Farmers were encouraged to apply organic fertilizers such as cow dung, poultry manure, compost, kitchen ash, vegetable refuse, crop residues and tree litters from their own sources. Irrigation was provided as and when required for normal growth of the crops. Pests were controlled mainly by mechanical ways without any pesticide application unless severe infestations were observed. Before executing of the activities, a household survey was carried out and detailed information of the selected households was documented. Therefore, a work plan for each of the selected household was prepared considering its available resources, needs and choice. The participated farmers of each farm group were provided orientation separately on the program activities prior to execution. Site working group meeting, review workshop, field day cum field visit and training for farmers and field staffs were organized during the implementation of study activities. Many stakeholders were selected as networking group members from different public and private organizations for proper execution of the activities.

**Table 2. Production units of Palima model used by the farmers at the FSRD site Atia, Tangail, Bangladesh during 2018-19 and 2019-20**

| Niche/space | | Round the year homestead vegetables production pattern | | |
|---|---|---|---|---|
| | | *Rabi* (October-March) | *Kharif*-I (April-June) | *Kharif*-II (July-September) |
| 1. Open sunny space | Bed 1 | Tomato/Radish | Okra | Indian spinach |
| | Bed 2 | Brinjal+Red amaranth | Indian spinach | Okra+Red amaranth |
| | Bed 3 | Spinach | Kang kong | Kang kong |
| | Bed 4 | Bush bean | Stem amaranth | Indian spinach |
| 2. House roof | | Bottle gourd | Ash gourd | Ash gourd |
| 3. Trellis | | Bottle gourd | Ash gourd | Sponge gourd |
| | | Bottle gourd | Bitter gourd | Snake gourd |
| 4. Tree support | | Country bean | Potato yam | Potato yam |
| | | Country bean | Sponge gourd | Sponge gourd |
| 5. Partial shady place | | Ginger and turmeric | | |
| 6. Marshy land | | Panikachu (Latiraj) | | |
| 7. Backyard | | Banana, Lemon and Arum | | |

Socio-agro-economic data of all the selected households were collected, analyzed and presented based on the average of each farmer group. The year-round total vegetable production data were collected after harvesting of each crop from each production niche. A pre-designed schedule was used in this purpose and regular monitoring was also ensured. The nutrient contribution from vegetables and fruits was calculated by converting the total edible yield. Means and percentages were used for interpretation of the data by using MS Excel software.

## Results and Discussion

### Year-round homestead vegetable pattern

A total of 10 vegetables were selected for year-round vegetable cultivation and were planted in four beds under the open sunny place (Table 2). The year-round vegetable patterns under the seven production niches were divided into three cropping seasons including *rabi* (mid-October to mid-March), *kharif*-I (mid-March to mid-June) and *kharif*-II (mid-June to mid-October). Some vegetables under each production niche were grown only in one season, some were grown in two seasons and some were grown round the year. In contrast, banana and lemon under the backyard, panikachu under the marshy land and ginger and turmeric under the partially shady place were grown throughout the year. Bottle gourd, French bean and bitter gourd were planted in *rabi* whereas ash gourd, snake gourd and sponge gourd were grown in both *kharif*-I and *kharif*-II on the roof top and trellis, respectively.

Baseline survey revealed that intake of vegetables by farmers was only 4.92-11.60 kg/head/year before conducting the study. After applying the Palima model, the farmers gained knowledge on the year-round homestead gardening and their consumption increased 29.69 to 57.72 kg/head/year (Table 6). Thus, home gardens can contribute to ensure better livelihood and nutritional security. These results are in agreement with Ferdous *et al.* (2016) who reported that the target farmers were able to fulfill their daily requirement of vegetables in most parts of the year by following the Rangpur model. The Palima model of year-round production helped enhance food security and access to safe and nutritious food among the studied farmers of Tangail region in Bangladesh.

### Year round vegetable production by farmers group

The season wise vegetables production was the highest in *rabi* (220.6, 263.1 and 294.6 kg/farm in marginal, small and medium respectively) followed by *kharif*-II 116.2, 148.5 and 204.4 kg/farm in marginal, small and medium, respectively (Table 3, 4 and 5). The lowest amount of vegetables were produced in *kharif*-I season due to poor vegetative growth and production. It was observed that more crops and production units were covered in *rabi* season than *kharif*. Except the open sunny space, it was observed that niche wise vegetable production was the highest in the roof top followed by the trellis for marginal and small farmers

group (Tables 3, 4 and 5). In medium farmers group, the highest amount of vegetables was produced in the roof top followed by the partial shady place. The minimum amount of vegetable was produced in marshy land regardless of the farmers group.

The highest amount of vegetable production before intervention was 76 kg in medium farmers group followed by small (57 kg) farmers (Table 6). The lowest (39 kg) was found with marginal farmers. After intervention under the production model, the highest amount of vegetables (630 kg) was produced by medium farmers group followed by small (510 kg) and marginal (408 kg) farmers (Table 6). This suggests that vegetable production declined towards poor farmers probably due to partial involvement of those farmers in other income generating activities to ensure the daily expenses to some extent. By growing their own households' vegetables were able to supplement their income by lessening the need to purchase food from the local market and used this extra income for other purposes. Berning *et al*. (2008) and Khan *et al.* (2009) are also supported the findings of the study. Talukder *et al.* (2000) reported that the number of varieties and vegetable production was three times higher in the developed garden than traditional garden and child consumption was also 1.6 times higher. When farmers produce higher number of vegetables in their farms their intake of vegetables increase per family and at the same time they rely on less marketing of vegetables from the market. Each farm family sold a portion of their produce to the local market to meet their daily necessities.

**Use of Farm Resources**

Most of the farmers did not use resources in systematic way during the pre-intervention period. Farmers conserved the kitchen wastes, manures, crop residues, animal waste, poultry litter, cow dung etc. at their farm level systematically in integrated farming system. They used these recourses properly in homestead production units which eventually helped to improve soil fertility and reducing environmental pollution. Homestead garden benefits are family nutrition, increase household income and protect habitats. Nevertheless, after intervention full use of both physical and other resources available in the farm were mobilized for food security, income generation and upgrading their livelihoods. All these benefits have significant role towards poverty mitigation.

**Utilization pattern of vegetables by farmers group**

The consumption of vegetables varied among the farm categories. The total consumption was the highest in medium (288 kg/year) followed by small (269 kg/year) and marginal (193 kg/year) farmers (Tables 3, 4 and 5). The vegetable intake/head/year was similar in small (57.72 kg) and medium (57.60 kg) farmers and marginal farmers intake (29.69 kg) per head/year (Table 6). This is probably because of family size and selling greater proportion of vegetables by marginal

farmers in the market to meet their family needs compared with small and medium farmers. The intake of vegetables/head/year before intervention was the maximum (11.60 kg) among medium farmers followed by small (9.66 kg) and marginal (4.92 kg) farmers (Table 6). It is noted that the intake of vegetables/head/year after intervention followed the same trends. However, the intake of vegetables increased almost more than six times higher after utilization of Palima model compared with vegetable intake before intervention. The average vegetables intake per year per farm family was 250 kg after intervention and the increment was 456 %, whereas intake was only 45 kg per farm family per year before intervention. Vegetable intake was increased remarkably and it was about 137 g/head/day. The highest amount of vegetables was distributed by medium farmers (39.0 kg/year) followed by small (35 kg/year) and marginal farmers (25 kg/year) (Table 6). All of the farmers distributed a portion of their produce to the neighbors and relatives to maintain a social relationship. Each farm family sold some vegetables in the market to meet their family needs. The highest quantity of vegetables was sold by medium farmers (303 kg/year) followed by small (206 kg/year) and marginal farmers (190 kg/year) (Table 6). This pattern indicates that selling of vegetables increased towards marginal to medium farmers. Resource poor farmers in some cases might not have selling large amount of vegetables due to meet their family demands compared with resource rich farmers. The overall results suggest that the production, intake, distribution and selling of vegetables increased with increasing farm sizes. It was observed that 49 % of the harvested vegetables were consumed by the farm families followed by sale (45 %) and the lowest amount (6 %) of vegetables was distributed to relatives and neighbours (Fig. 1). Similar results was found with Shaheb *et al*., (2014) who declared that farmers consumed their harvested vegetables, sale some of them and also distributed to other to strengthen social relation. The better utilization of homestead area with optimum management by effective farm family labour can be achieved for optimum vegetable production and subsequent intake, distribution and sell.

**Income divergence**

Result revealed that there was great scope and potentiality of increasing yields of short-term cash crops, like vegetables produced and sold in the nearest urban areas. The income from those activities in the homestead could be used to have access food and improve their livelihood. Homestead production of vegetables delivers the household with direct access to vital nutrients that may not be readily available or within their economic reach. Shaheb *et al.,* (2014) stated that additional income generated by selling of surplus vegetables was utilized to purchase extra food items, in turn increase the divergence of family's diet. Bibliographical evidence advocates that home gardens subsidize to income generation, improved livelihoods and household monetary welfare as well as endorsing entrepreneurship and rural development (Calvet-Mir *et al*., 2012).

**Table 3. Round the year vegetables production from different niches and disposal pattern by marginal group of farmers at the FSRD site Atia, Tangail, Bangladesh (average of 2018-19 and 2019-20)**

| Niches | | Vegetable Production (kg) | | | Total (kg) | Disposal pattern of vegetable (kg) | | |
|---|---|---|---|---|---|---|---|---|
| | | *Rabi* | *Kharif*-I | *Kharif*-II | | Consumption | Distribution | Sale |
| 1. Open sunny place | Bed 1 | 24.3 ± 2.4 | 16.0 ±2.0 | 21.2 ± 2.3 | 61.5 ±5.2 | 32.5 ± 0.6 | 3.5 ± 0.3 | 25.5 ± 0.8 |
| | Bed 2 | 15.0 ± 2.7 | 14.0 ±2.7 | 24.3 ± 6.1 | 53.3 ± 8.4 | 27.5 ± 0.3 | 2.0 ± 0.4 | 23.8 ±1.5 |
| | Bed 3 | 25.0 ± 3.5 | 10.0 ±2.5 | 12.0 ± 2.3 | 47.0 ±7.6 | 17.2 ± 1.6 | 4.0 ± 0.7 | 25.8 ±2.7 |
| | Bed 4 | 26.0 ± 3.5 | 07.0±2.3 | 06.1 ±1.2 | 39.1 ± 4.8 | 16.0 ± 0.3 | 2.0 ± 0.2 | 21.1 ±1.8 |
| 2. Roof top | | 40.0 ± 5.5 | 06.0 ±1.2 | 11.0 ± 0.7 | 57.0 ±7.2 | 28.8 ± 1.3 | 3.5 ± 0.5 | 24.7 ± 1.5 |
| 3. Trellis | | 26.5 ± 4.6 | 09.0 ±1.8 | 10.3 ± 0.8 | 45.8 ±5.3 | 23.0 ± 4.1 | 3.0 ± 1.4 | 19.8 ±2.5 |
| 4. Tree support | | 08.0 ± 2.6 | 05.0 ±1.2 | 08.0 ±1.5 | 21.0 ±4.6 | 10.0 ± 5.1 | 1.0 ± 0.2 | 10.0 ±2.3 |
| 5.Partial shady place | | 24.0 ± 2.1 | 04.2 ±1.1 | 11.3 ±3.2 | 39.5 ± 7.7 | 21.5 ± 3.8 | 2.0 ± 1.2 | 16.0 ± 2.1 |
| 6. Marshy land | | 09.3 ± 1.9 | - | - | 09.3 ± 2.5 | 04.2 ± 3.1 | 1.0 ± 0.5 | 04.1 ±0.8 |
| 7. Backyard | | 22.5 ± 3.2 | - | 12.0 ± 2.3 | 34.5 ± 4.4 | 12.3 ± 3.6 | 3.0 ± 0.9 | 19.2 ±2.5 |
| Total | | 220.6 | 71.2 | 116.2 | 408 | 193 | 25 | 190 |

**Table 4. Round the year vegetables production from different niches and disposal pattern by small group of farmers at the FSRD site Atia, Tangail, Bangladesh (average of 2018-19 and 2019-20).**

| Niches | | Vegetable Production (kg) | | | Total (kg) | Disposal pattern of vegetable (kg) | | |
|---|---|---|---|---|---|---|---|---|
| | | *Rabi* | *Kharif*-I | *Kharif*-II | | Consumption | Distribution | Sale |
| 1. Open sunny place | Bed 1 | 27.3 ± 3.8 | 24.1 ± 3.1 | 21.3 ± 2.9 | 72.7 ± 3.5 | 39.2 ± 1.9 | 3.5 ± 0.4 | 30.0 ± 3.1 |
| | Bed 2 | 27.6 ± 1.8 | 17.2 ± 2.1 | 26.2 ± 2.2 | 71.0 ± 2.8 | 37.0 ± 1.3 | 3.5 ± 1.0 | 30.5 ± 3.1 |
| | Bed 3 | 26.0 ± 1.4 | 12.0 ± 1.7 | 11.7 ± 0.8 | 49.7 ± 3.9 | 25.7 ± 2.9 | 4.0 ± 2.1 | 20.0 ± 3.9 |
| | Bed 4 | 19.3 ± 2.2 | 9.0 ± 0.7 | 4.0 ± 0.8 | 32.3 ± 3.3 | 16.3 ± 1.4 | 3.0 ± 0.8 | 13.0 ± 1.2 |
| 2. Roof top | | 47.0 ± 4.3 | 10.3 ± 1.1 | 15.1 ± 0.5 | 72.4 ± 5.9 | 36.4 ± 2.3 | 5.0 ± 0.8 | 31.0 ± 1.6 |
| 3. Trellis | | 23.5 ± 1.8 | 11.2 ± 2.1 | 13.2 ± 0.6 | 47.9 ± 4.1 | 25.4 ± 1.7 | 4.0 ± 0.9 | 18.5 ± 2.8 |
| 4. Tree support | | 5.5 ± 0.5 | 8.3 ± 0.7 | 9.0 ± 1.4 | 22.8 ± 1.2 | 12.3 ± 4.1 | 2.5 ± 1.6 | 08.0 ± 3.4 |
| 5.Partial shady place | | 41.6 ± 4.3 | 6.3 ± 1.2 | 25.8 ± 2.7 | 73.7 ± 8.1 | 40.2 ± 4.7 | 3.5 ± 0.8 | 30.0 ± 1.8 |
| 6. Marshy land | | 19.0 ± 2.5 | - | - | 19.0 ± 2.5 | 9.0 ± 2.5 | 2.0 ± 1.2 | 08.0 ± 2.5 |
| 7. Backyard | | 26.3 ± 2.2 | – | 22.2 ± 2.5 | 48.5 ± 2.7 | 27.5 ± 4.9 | 4.0 ± 0.8 | 17.0 ± 2.1 |
| Total | | 263.1 | 98.4 | 148.5 | 510 | 269 | 35 | 206 |

**Table 5. Round the year vegetables production from different niches and disposal pattern by medium group of farmers at the FSRD site Atia, Tangail, Bangladesh (average of 2018-19 and 2019-20)**

| Niches | | Vegetable Production (kg) | | | Total (kg) | Disposal pattern of vegetable (kg) | | |
|---|---|---|---|---|---|---|---|---|
| | | *Rabi* | *Kharif*-I | *Kharif*-II | | Consumption | Distribution | Sale |
| 1. Open sunny place | Bed 1 | 28.5 ± 2.6 | 30.2 ±3.4 | 33.5 ± 3.9 | 92.2 ±4.1 | 40.2±0.4 | 5.0 ± 1.0 | 47.0 ±0.8 |
| | Bed 2 | 30.2 ± 2.5 | 24.5 ±1.4 | 35.2 ± 3.6 | 89.9 ±3.6 | 40.4 ± 0.3 | 4.0 ± 0.5 | 45.5 ±1.2 |
| | Bed 3 | 28.3 ± 0.8 | 16.0 ±0.8 | 23.6 ± 1.7 | 67.9 ±2.2 | 26.9 ± 2.3 | 5.0 ± 0.5 | 36.0 ±1.0 |
| | Bed 4 | 32.2 ± 3.1 | 11.0 ±1.1 | 15.5 ± 1.2 | 58.7 ±3.2 | 25.2 ± 0.9 | 3.0 ± 0.4 | 30.5 ±2.6 |
| 2. Roof top | | 54.0 ± 3.6 | 13.2 ±1.6 | 13.1 ± 0.2 | 80.3 ±2.4 | 34.3 ± 0.8 | 5.0 ± 0.4 | 41.0 ± 1.1 |
| 3. Trellis | | 25.0 ± 1.5 | 14.4 ±1.5 | 14.3 ± 0.9 | 53.7 ±3.1 | 30.2 ± 3.2 | 4.0 ± 1.1 | 19.5 ±2.1 |
| 4. Tree support | | 7.70 ± 0.5 | 12.3 ±0.9 | 18.7 ± 1.2 | 38.7 ±2.3 | 15.2 ± 4.1 | 4.0 ± 1.1 | 19.5 ±2.5 |
| 5.Partial shady place | | 35.5 ± 4.1 | 9.4 ± 1.2 | 25.1 ± 3.3 | 70.0 ±4.4 | 33.0 ± 2.1 | 3.0 ± 1.0 | 34.0 ±1.7 |
| 6. Marshy land | | 24.2 ± 1.1 | – | – | 24.2 ±1.2 | 10.2 ± 2.7 | 2.0 ± 1.6 | 12.0 ±2.2 |
| 7. Backyard | | 29.0 ± 2.8 | – | 25.4±2.6 | 54.4 ±3.4 | 32.4 ± 5.2 | 4.0 ± 1.1 | 18.0 ±1.1 |
| Total | | 294.6 | 131 | 204.4 | 630 | 288 | 39 | 303 |

**Table 6. Disposal pattern and intake by different farm categories before and after intervention at the FSRD site Atia, Tangail, Bangladesh during 2018-19 and 2019-20).**

| Farm Category | Average family size | Before intervention (2017-18) | | | | | After intervention (2018-2020) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total production (kg) | Disposal pattern (kg) | | | Intake/ head/ year (kg) | Total production (kg) | Disposal pattern (kg) | | | Intake/ head/ year (kg) |
| | | | Intake | Distribution | Sale | | | Intake | Distribution | Sale | |
| Marginal | 6.50 | 39 | 32 | 02 | 05 | 4.92 | 408 | 193 | 25 | 190 | 29.69 |
| Small | 4.66 | 57 | 45 | 04 | 08 | 9.66 | 510 | 269 | 35 | 206 | 57.72 |
| Medium | 5.00 | 76 | 58 | 04 | 10 | 11.60 | 630 | 288 | 39 | 303 | 57.60 |
| Mean | 5.39 | 56 | 45 | 3.33 | 7.67 | 8.35 | 516 | 250 | 33 | 233 | 46.38 |

Before intervention data were collected by interviewing the concerned farmers at the FSRD site Atia, Tangail.

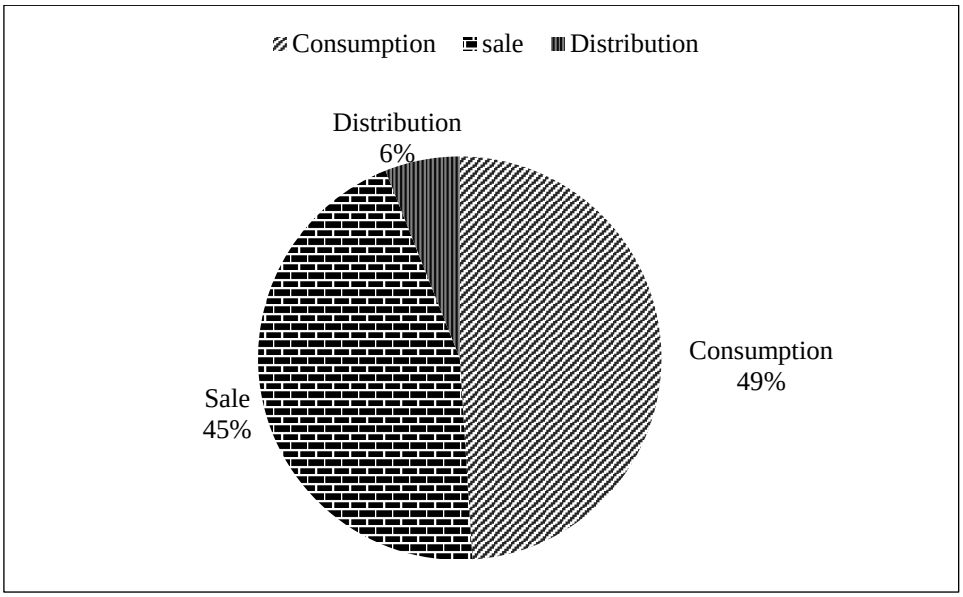


**Fig 1. Disposal pattern of vegetables harvested by the farm households.**

## Nutrient contribution

The highest quantity of vegetables (55, 67 and 77 kg) was produced in the month of December from marginal, small and medium farmers, respectively followed by January (45, 56 and 70 kg) and May (40, 53 and 65 kg) and the lowest (19, 23 and 34 kg) in October (Table 7). It might be due to more production of winter vegetables in *rabi* season. Uddin *et al.* (2009) reported that the recommended dietary allowances (RDA) of vegetables is 220 g/person/day. The highest quantity of vegetables (79, 106 and 118 % of RDA) was intake in the month of December followed by January (59, 82 and 88 % of RDA), while the lowest amount of vegetables was consumed in October (29, 35 and 47 % of RDA) compared to RDA (Table 7). It is also mentionable that 62, 97 and 126% more vegetables produced in the month of December compared to recommended RDA of that month followed by January (32, 65 and 106 %) of RDA from marginal, small and medium farmers. Shaheb *et al*. (2014) declared that children consumed more vitamin 'A' rich foods, such as green leafy vegetables and yellow fruits more frequently from homestead garden than did children in households without a garden or with a traditional garden. It was evident from the literature that home gardens are a part of agriculture and food production systems in many developing countries are widely used as a remedy to lessen hunger and malnutrition (Johnson *et al*., 2000).

**Table 7. Month wise vegetables production and intake against RDA by different farmers group at FSRD site Atia, Tangail during 2018-19 and 2019-20 (average of 2 years)**

| Months | Marginal farmers | | | Small farmers | | | Medium farmers | | |
|---|---|---|---|---|---|---|---|---|---|
| | Production (kg) | Intake (kg/family) | % Intake over RDA | Production (kg) | Intake (kg/family) | % Intake over RDA | Production (kg) | Intake (kg/family) | % Intake over RDA |
| January | 45 | 20 | 59 | 56 | 28 | 82 | 70 | 30 | 88 |
| February | 40 | 18 | 58 | 47 | 24 | 77 | 58 | 25 | 81 |
| March | 27 | 13 | 38 | 34 | 18 | 53 | 46 | 21 | 62 |
| April | 25 | 12 | 36 | 30 | 17 | 52 | 39 | 17 | 52 |
| May | 40 | 19 | 56 | 53 | 28 | 82 | 65 | 27 | 79 |
| June | 37 | 17 | 52 | 45 | 23 | 70 | 49 | 21 | 64 |
| July | 34 | 15 | 44 | 40 | 21 | 62 | 43 | 20 | 59 |
| August | 30 | 14 | 45 | 44 | 23 | 68 | 55 | 26 | 76 |
| September | 22 | 11 | 33 | 27 | 14 | 42 | 38 | 17 | 52 |
| October | 19 | 10 | 29 | 23 | 12 | 35 | 34 | 16 | 47 |
| November | 34 | 17 | 52 | 44 | 25 | 76 | 56 | 28 | 85 |
| December | 55 | 27 | 79 | 67 | 36 | 106 | 77 | 40 | 118 |
| Total | 408 | 193 | 48 | 510 | 269 | 67 | 630 | 288 | 72 |

## Profits from homestead gardening

After intervention, the maximum. cash income from selling vegetables was recorded by medium farms (Tk. 3098/year) followed by small (Tk. 2168/year) and marginal farms (Tk. 1944/year) whereas before intervention the cash income of medium, small and marginal farmers was Tk.130, 104 and 65 per year, respectively. The mean cash income was 23 times higher than before intervention (Table 8). It is revealed that among the seven production units, the highest gross return (Tk. 6446, 5216 and 4181) and gross margin (Tk. 4529, 3420 and 2833) were recorded from medium, small and marginal farmers, respectively. After intervention, marginal, small and medium farmers gross return were 723, 603 and 552 % higher, respectively over before intervention, while the gross margin also followed the similar trend (Table 8). The findings of the study are conformed by finding of Khan *et al*. (2009). The mean vegetables yield (516 kg/year), gross return (Tk. 5281/year) and gross margin (Tk. 3594/year) was received by three groups of farmers (Table 8). The annual income levels of the beneficiary farmers improved after execution of the year-round homestead vegetable production model. Women are the main caretakers of the home gardening activities which empower them resulting in better utilization of the income and improvement in family welfare.

**Table 8. Monetary benefit by different farm groups before and after intervention at FSRD site Atia, Tangail, Bangladesh during 2018-19 and 2019-20**

| Farm category | Before intervention (2018-19) | | | | After intervention (2019-20) | | | |
|---|---|---|---|---|---|---|---|---|
| | Cash Income (Tk.) | Gross return (Tk.) | TVC (Tk) | Gross margin (Tk.) | Cash income (Tk.) | Gross return (Tk.) | TVC (Tk.) | Gross margin (Tk.) |
| Marginal | 65 | 508 | 160 | 348 | 1944 | 4181 | 1348 | 2833 |
| Small | 104 | 742 | 214 | 528 | 2168 | 5216 | 1796 | 3420 |
| Medium | 130 | 988 | 256 | 732 | 3098 | 6446 | 1917 | 4529 |
| Mean | 99 | 746 | 210 | 536 | 2403 | 5281 | 1687 | 3594 |

## Household labour use and women empowerment

Results indicated that homestead production system gave an opportunity for female employment and empowerment. The idle family labour was mostly used in home garden production system. Male farmers participated more in hard working such as land preparation, planting, weeding, fencing and crop protection while female had a good involvement in intercultural operation, harvesting and marketing of vegetables. Children were also participated in all the works and helped their parents (Table 9). Shaheb *et al*. (2014) reported about more participation of male compared to female while Khan *et al*. (2009) reported that

participation of male and female labour was almost equal in home gardening. So, it was found that homestead gardening has created a good opportunity to utilize idle family labour properly. The higher participation of women in agricultural activities made positive impact on equity issues within the family and also in the community as well.

**Table 9. Household labour participation in homestead vegetables production at FSRD site Atia, Tangail during 2018-19 and 2019-20**

| Work area | Male (%) | Female (%) | Children (%) |
|---|---|---|---|
| Land preparation | 63 | 33 | 4 |
| Seed/seedling | 66 | 34 | 0 |
| sowing/planting | 54 | 39 | 7 |
| Intercultural operations | 42 | 54 | 4 |
| Harvesting | 56 | 42 | 2 |
| Marketing | 76 | 21 | 3 |
| Cooking | 0 | 99 | 0 |
| Mean | 51 | 46 | 3 |

## Conclusion

The results of the study highlighted the status of utilization of homestead by year-round vegetable production in Bangladesh for marginal, small and medium farm households. There is sufficient scope available to bring the remaining homesteads of Tangail region under proper and effective usage following the Palima model. Farmers usually grow diverse vegetables and fruits in the adjacent area of their households in unplanned and traditional system. The "Palima model" for homestead vegetable production was developed on local conditions and cultural context and intervention could be a sustainable means to improve household food and nutrition security. Homestead vegetable production program can be implemented successfully and cost-effectively on a national-scale using a collaborative model that fits local conditions. The findings of the study would positively help the scientists, extension personnel, policy makers etc. to articulate livelihood enhancement, food and nutrition security related sustainable agricultural program at farm level.

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