Indian Journal of Agricultural Sciences **91** (12): 1773–7, December 2021/Article
https://doi.org/10.56093/ijas.v91i12.120804

Self-reliant in year-round vegetable production through kitchen garden in Indo-Gangetic Plains

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Received: 22 December 2020; Accepted: 23 September 2021

ABSTRACT

The government of India has long been striving to increase the food and nutritional security of rural and urban households. In this regard, kitchen/homestead gardens of limited available space can play an important role in fullfilling the demand for year-round diversified vegetable requirements. Considering the scope to self-reliant in year-round vegetable production and consumption through kitchen garden model, a field experiment was conducted for consecutive two years (2018–19) at the homestead garden of ICAR - IIFSR Modipuram Meerut. A total of 28 vegetables were selected for year-round vegetable cultivation and were planted in 15 beds varied from 2 to 8 m^2. The year-round vegetable patterns under each bed were grown into 3 to 4 cropping seasons. The fifteen cropping patterns were arranged in 62 m^2 net areas. The total year-round production of vegetables was 568.7 kg from 62 m^2 net areas. Among the different groups of vegetables, 196 kg of root, bulb and tubers vegetables; 160.1 kg leafy and flower vegetables; 184.6 kg of fruit/vegetables and 25.8 kg of leguminous vegetables were obtained from 62 m^2 net areas. In our finding, nearly 163 kg vegetable shortage to fullfills the demand of 5 members household. The shortage quantity of vegetables 163 kg can be obtained from increasing 18 m^2 net areas in addition to exiting 62 m^2. Notably, this model which fullfill the household demands of year-round vegetable requirements in a sustainable way as well as improve the food and nutritional security.

Keywords: Diversified cropping pattern, Kitchen garden, Net returns, Year-round vegetable production

India is a developing country of about 246 million households and the average household in India has nearly 5 individuals (Census 2011). Sufficient vegetables must include in the daily diet to meet the calorie requirement of 2400 for rural and 2100 kcal/day/person for urban areas (Srivastava and Chand 2017). Vegetables are protective food and enrich in nutrients (macro and micro), vitamins, antioxidants and phenolics. The world health organization (WHO) recommended that vegetable and fruit consumption should be more than 400 g/day/person or 146 kg/person/year (WHO 2003, 2010). However, Indian diets are cereals-dominated and limited in the diversity of food like vegetables and fruits (Shankar *et al*. 2017, Tak *et al*. 2019). National Nutritional Monitoring Bureau analysed that the many Indian states showed average vegetable consumption amongst men to be 143 g/person/day for men and 138 g/person/day for women (Shankar *et al*. 2017). Similarly, national nutrition guidelines recommended that average vegetable consumption should be 300 g/day/person with a three-time serving of 100 g each. The composition of vegetables comprises green leafy vegetables 50 g, roots and tubers 50 g and other vegetables 200 g (NIN 2011). Portentous/leguminous vegetables have the potential to meet out challenges of malnutrition (Noopur *et al.* 2019).

A kitchen garden is intensively to cultivate a wide variety of vegetables and fruits around the household or within a walking distance from the family home, known as home or kitchen gardens or homestead garden (Ali 2005, Galhena *et al*. 2013). The important benefits of the kitchen garden include food and nutritional security as well as an increase in rural women's employment (FAO 2004). Considering its importance, the homestead/kitchen gardens address to objective (improve nutritional outcomes for children, pregnant women and lactating mothers) of POSHAN Abhiyaan or National Nutrition Mission program started in March 2018 by the Government of India. A diversified kitchen garden model improves the resource-poor household food and nutritional security in Indo-Gangetic Plains. To address the above challenges, we hypothesized that a small unit of (~62 m^2) kitchen garden ensures self-reliance in the year-round vegetable supply of households consisting of 4-5 family members.

MATERIALS AND METHODS

The field experiment was conducted from 2018- 2019

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at the homestead garden of ICAR-IIFSR Modipuram Meerut (29°4' N latitude and 77°46' E longitude and 230 m above msl altitude). The climate of the study region falls under 'Western Plains Sub Zone' of 'Upper Gangetic Plains' as per Planning Commission/NITI Aayog of India. The soil of the research farm is neutral to slightly alkaline and belongs to the Typic Ustochrept group. The climate of the study region was varied with mean monthly maximum temperature between 17.7°C (December) and 39°C (May) and minimum temperature varied between 5.1°C (January) to 25°C (June). The mean monthly minimum and maximum relative humidity varied between 35.5–76.6% and 74.5-94.9%, respectively. During the experimental periods, the study area received an average annual rainfall of 824.3 mm. The diversified vegetable crops included in the kitchen garden were roots and tuber crops [Potato (*Solanum tuberosum*) var. Kufri Chipsona, turnip (*Brassica rapa* sub sp. *rapa*) var. Pusa Kanchan, carrot (*Daucus carota* subsp. *sativus*) var. Pusa Kesar, Pusa Meghalai, radish (*Raphanus sativus*) var. Pusa Chetki and Arka Nishant, Colocasia (*Colocasia esculenta*) var. Sree Rashmi; bulbs [onion (*Allium cepa*) var. Pusa Ridhi]; leafy and flower vegetables [Amaranthus (*Amaranthaceae* spp) var. Pusa Lal Chaulai, methi (*Trigonella foenum graecum*) var. Rajendra Kanti, spinach (*Spinacia oleracea*) var. Pusa Vilayati Palak, cabbage (*Brassica oleracea* var. *capitata*) var. Pusa Mukta, cauliflower (*Brassica oleracea* var. *botrytis*) var. Pusa Deepali, bathua (*Chenopodium album*) var. Kashi Bathua – 2, coriander (*Coriandrum sativum*) var. Rajendra Swati, mustard sag (*Brassica* spp) var. Pusa Sag 1]; fruit green vegetables [Brinjal (*Solanum melongena*) var. Pusa Kranti, tomato (*Solanum lycopersicum*) var. Arka Rakshak, pumpkin (*Cucurbita* spp) var. Arka Chandan, Cucumber (*Cucumis sativus*) var. Ashley, bottle gourd (*Lagenaria siceraria*) var. Pusa Meghdoot, sponge gourd (*Luffa aegyptiaca*) var. PSG 9, okra (*Abelmoschus esculentus*) var. Prbhani Kranti, tinda (*Praecitrullus fistulosus*) var. Punjab Tinda-1, capsicum (*Capsicum annuum*) var. California Wonder, chilli (*Capsicum frutescens*) var. Punjab Red and portentous vegetables [Cowpea (*Vigna unguiculata*) var. Pant Lobia 2, fababean (*Vicia faba*) var. Vikrant, French bean (*Phaseolus vulgaris*) var. Naga Local Selection, garden pea (*Pisum sativum*)] var. Arkel. The dimension of an experimental kitchen garden plot was 31 m × 2 m (62 m^2). The trailing crops like bottle gourd, sponge gourd, pumpkin, tinda and cucumber were grown on bunds/border of the plot. The recommended dose of fertilizers was applied. The source of fertilizer N, P, and K was urea (46% N), single superphosphate (SSP, 16% P_2O_5) and muriate of potash (MOP, 60%, K_2O), respectively. Economics was calculated based on the prevailing price of the local market.

RESULTS AND DISCUSSION

Vegetable composition and area share: A total of 28 vegetables were selected for year-round vegetable cultivation and were planted in 15 beds varied from 2–8 m^2 (Table 1). The year-round vegetable patterns under each bed were grown into 3–4 cropping seasons (Table 1). Some vegetables under each bed were grown only in one season, some were grown in two seasons and some were grown around the year. For example, pumpkin was grown only in *kharif,* whereas radish was cultivated multi times in different beds. In contrast, trailing like vegetable pumpkin, sponge gourd etc. grown at the fence/border of the beds. Panwar *et al.* (2019) reported that vertical cropping with bottle gourd enhanced relative production efficiency. The fifteen-cropping patterns were arranged in 62 m^2 net areas. Notably, the gross area of the 15 cropping pattern was covered 207 m^2 with 334% cropping intensity (Table 1). The maximum gross area covered by radish (19), carrot (18 m^2), potato (14 m^2), cabbage (13 m^2), turnip (12 m^2), spinach (12 m^2), and cowpea (12 m^2). The remaining vegetables gross area varied from 2 to 10 m^2. The gross area increased due to the growing of the same vegetables in multi times under a fifteen-year-round vegetable cropping pattern.

Year-round vegetable production: Previous research findings suggested that the malnutrition problem increases due to the lack of nutritional knowledge of rural people, thus reduced the intake of balanced food including green vegetables (Bhuyan *et al*. 2001). Therefore, a scientific model of kitchen garden programs is required, which will provide year-round vegetables and economic benefit to the ultra-poor farmers/households. The scientific model for kitchen gardens will help to increase the consumption of vegetables and improving farmers' livelihoods by improving their nutrition security (Masset *et al*. 2011, Gillespie *et al.* 2012, Weinberger 2013). In this study, irrespective of the vegetable crops, the maximum vegetable production in one calendar year was obtained from cabbage i.e. 60 kg from 13 m^2 gross area. Other vegetables like pumpkin were produced 47 kg/8 m^2 area, carrot (44 kg/18 m^2), radish and spinach production was 42 kg from 19 and 12 m^2 area in one calendar year. In year-round vegetable production, maximum production was obtained in the September and October month (> 76 kg each month from 62 m^2 net areas) followed by May (71.3 kg from 62 m^2 net areas), February and May month ((> 60 kg each month from 62 m^2 net areas) (Table 1). The minimum vegetable production was obtained in June, July, November, March and April (< 35 kg/month from 62 m^2 net areas). This is mainly due to the sowing of vegetables under different cropping patterns. The total year-round production of vegetables was 568.7 kg from 62 m^2 net areas. Among the different groups of vegetables, 196 kg of root, bulb and tubers vegetables; 160.1 kg leafy and flower vegetables; 184.6 kg of fruit vegetables/green vegetables and 25.8 kg of leguminous/portentous vegetables were obtained from 62 m^2 net areas.

Utilization pattern of vegetables: The consumption of vegetables varied among households. The composition of vegetables comprises 50 g green leafy vegetables, 50 g roots and tubers and 200 g other vegetables (NIN 2011). As per WHO and NIN recommendation 730 kg/annum vegetables are required for each household consisting of five family members. We have produced a total of 568.7 kg/annum vegetables from 62 m^2. In our finding, nearly 163

Table 1 Month and crop-wise seasonal vegetable harvest in a calendar year

Crop	Area (m^2)	Production (kg)													Net returns (₹)
		June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	Total	
Root, bulb and tubers															
Potato	14.0					18.5	-	0.5		22.0				41.0	410
Turnip	12.0	2.0	1.0				6.0	6.0	2.0			4.0	4.0	25.0	375
Carrot	18.0	5.5	1.0				3.0	7.5	8.5		3.5	6.8	8.3	44.1	660
Radish	19.0	8.0			8.0	10.0	2.0			3.0	7.0	-	4.0	42.0	420
Colocasia	2.0		8.0	8.0							2.0	2.0	-	20.0	200
Onion	8.0												24.0	24.0	840
Leafy and flower vegetables															
Amaranthus	2.0			1.6	1.8	1.8	0.9							6.1	89
Methi	2.0						3.0	3.0	2.0	1.0				9.0	180
Spinach	12.0	4.6	3.5			2.0	8.0	7.0	3.0	2.0	5.0	4.0	3.5	42.6	426
Cabbage	12.0							2.0	15.0	23.5	7.5	5.0	7.0	60.0	600
Cauliflower	4.0						4.0	8.0						12.0	120
Bathua	4.0										2.5	2.5	0.5	5.5	99
Coriander	6.0		1.2	6.8	6.0									14.0	280
Mustard sag*	9.0								6.0	5.0				11.0	132
Fruit green vegetables															
Brinjal	6.0		4.0	5.0	5.0	2.0								16.0	240
Tomato	6.0	8.5											8.0	16.5	248
Pumpkin	6.0			10.0	17.0	20.0								47.0	705
Cucumber	2.0											6.5	4.0	10.5	158
Bottle Gourd	8.0			4.0	18.0	8.0								30.0	450
Sponge guard	10.0			3.0	9.0	10.0	6.0							28.0	420
Okra	10.0	1.5	6.3	1.0	2.0	1.5							8.0	20.3	305
Tinda	4.0			1.6	2.4	2.5								6.5	117
Capsicum	8.0	3.0	5.0											8.0	280
Chilli	3.0	0.5	0.9	0.4										1.8	44
Leguminous/portentous vegetables															
Cowpea	12.0			6.1	7.2									13.3	293
Fababean	2.0							2.0	1.0	1.5				4.5	113
French Bean	2.0									1.5	2.0			3.5	70
Peas*	4.0									2.0	4.5			4.5	163
Total (kg/₹)		33.6	30.9	47.5	76.4	76.3	32.9	36.0	37.5	61.5	34.0	30.8	71.3	568.7	8434

kg vegetable shortage to fullfills the demand of 5 members household. The shortage quantity of vegetables 163 kg can be obtained from increasing 18 m^2 net areas in addition to exiting 62 m^2. In this study, we have obtained more than 1.50 kg vegetables/day in August, September, October, February and May as per higher than the recommended dose of vegetables per household (consisting 5 family members) (Fig 1). Hence, we have obtained 2, 41.1, 39.0, 31.7 and 34.7% higher vegetable production in a respective above-mentioned month. In rest of the months have a shortage of 34.1 (June), 50.5 (July), 36.8 (November), 29.2 (December), 24.0 (January), 36.8 (March) and 46.3% (April) to fulfill the requirements per household consisting of 5 adult family members (Fig 1). The remaining requirement of vegetables can obtained from either increasing an additional 18 m^2 area or can be purchase from the market. Notably, adoption of this model, the intake of vegetables will increase almost as per the requirement of the recommended quantity of vegetables and increasing 18 m^2 in the net area after utilization of this model fullfill the requirement of vegetable/annum/household. An adequate supply of year-round vegetables will also help reduce the malnutrition problem especially for children and women and improve the nutritional problem faced by a majority of rural people.

Economic returns of kitchen gardening: The crop-wise net returns were varied from ₹44 (chili) to ₹840 (onion).

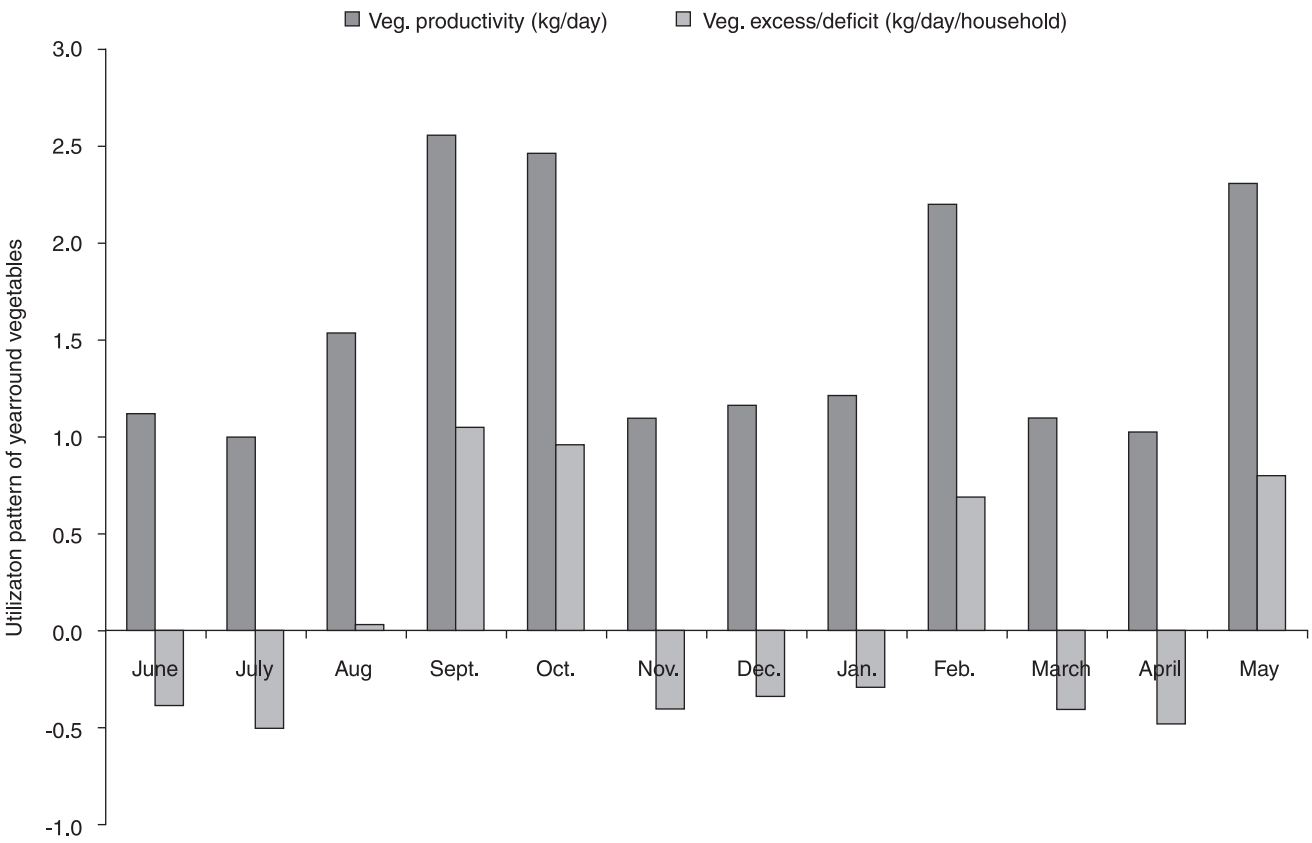

Fig 1 Month wise vegetable production and excess/deficit for per unit of household (5 family members) (@300 g vegetables requirement/ person/day).

The total year-round net returns from vegetable production were ₹8434/annum from the net area. The maximum net returns were received in May (₹1478) followed by October (₹999) due to higher vegetable production in this month. Notably, this study suggested that when household produces a higher amount of vegetables in their homestead garden, their intake of vegetables increase per person as per recommended quantity and at the same time they rely less on buying vegetables from the market. If the kitchen garden net area will more than 80 m^2, the farmers can sell a portion of their produce to the local market to meet their daily necessities. Similarly, it has been also observed from previous studies that poor and marginalized families are unable to afford expensive animal products to fulfill their nutritional needs, especially proteins, essential amino acids, some vitamins and minerals (Ali *et al.* 2005, Ansari *et al*. 2013, 14, Srivastava and Chand 2017). Thus, the kitchen/ homestead garden offers an inexpensive source of nutritious foods. Home gardens can contribute to household money-making security, thus ensure better livelihood and food and nutrition security. In another study, over 2000 families across 53 villages of Bhavnagar, Dahod, Mahisagar and Panchmahal district of Gujarat have set up kitchen gardens with a unique sharing policy, ensuring more than 7500 rural families are getting fresh, chemical-free vegetables (Anonymous 2020).

There are plenty of scopes to adopt this homestead/ kitchen garden in a limited available space with efficient utilization of resources and land for getting maximum productivity. Most of the farmers/household generally grows different vegetables and fruits in the surrounding area of their households in an unplanned and non-scientific manner. Scientific production and utilization of the homestead garden can reduce the expenditure of expensive vegetables from an outside source, earn small cash income by selling vegetables and ensure more intakes. By adaptation of this model, a household consisting of five adult family member's daily requirements will fullfill with the extended area of 80 m^2. Notably, this model with fully fill the household demands of year-round vegetable requirements in a sustainable way as well as improve the food and nutritional security to increase the agroecosystem resilience.

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