

Scaling Homestead Gardening for Food Security and Dietary Diversity in Two Climate Hotspot Regions of Bangladesh

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Through action research and development partnerships, the Initiative will improve smallholder farmers' resilience to weather-induced shocks, provide a more stable income and significant benefits in welfare, and enhance social justice and inclusion for 13 million people by 2030.


Activities will be implemented in six focus countries globally representing diverse mixed farming systems as follows: Ghana (cereal–root crop mixed), Ethiopia (highland mixed), Malawi: (maize mixed), Bangladesh (rice mixed), Nepal (highland mixed), and Lao People's Democratic Republic (upland intensive mixed/ highland extensive mixed).

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Abbreviations and acronyms

ABC	Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT)
CIMMYT	International Maize and Wheat Improvement Center
ICARDA	International Center for Agricultural Research in the Dry Areas
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
SDG	Sustainable Development Goals
MFS	Mixed Farming Systems Initiative
WP	Work Package
RQ	Research Question
SD	Standard Deviation
BDT	Bangladeshi Taka

Executive Summary

Homestead gardening is a vital strategy for enhancing food security and dietary diversity in middle- and low-income countries facing climate change. Despite its recognized benefits, limited research explores its effectiveness across socioeconomic groups, particularly in improving dietary diversity in coastal Bangladesh. This research assesses the impact of homestead gardening on food security and diet diversity, identifies implementation challenges, and provides recommendations for policymakers and practitioners. A mixed-methods approach was used to collect data from 600 households across two climate hotspots – the Coastal Zone and the Barind and Drought-Prone Areas. Quantitative data were obtained through stratified random sampling, while qualitative insights were gathered through focus group discussions and in-depth household interviews.

Results show that the average homestead size was estimated at 4.82 decimals. Women play a more dominant role in homestead gardening across most activities. Notable, in homestead gardens women spent more time because of their easy access and can work aside from their domestic chores. But still, social norms restricted women from going into the public sphere which is evident by selling the dominance of men. Women cultivate a variety of crops and vegetables, including maize, green gram, chili, lady's fingers, brinjal, and pumpkin on a seasonal basis to maximize land use. The produce is primarily sold in local markets, although much of it is also consumed domestically. Women express moderate satisfaction with homestead gardening activities, with an average score of 6.5 out of 10, regarding its perceived benefits. Research reveals that participating in homestead gardening significantly boosts food security and dietary diversity. Families involved in homestead gardening tend to have higher scores on food consumption and experience fewer food insecurity indicators such as meals skipping or limiting dietary choices, leading to greater resilience against the effects of climate change. Women played a critical role in homestead gardening efforts, contributing to enhancing resilience. However, challenges such as limited access to resources, educational gaps, and gender biases have hindered the full potential of homestead gardening programs. Additionally, their low level of participation in social activities (61%) reveals an untapped opportunity to build community social capital, fostering the sharing of knowledge and actions, particularly in climate-vulnerable regions.

This study asserts that homestead gardening not only provides food security but also serves as an eco-friendly climate practice that empowers women and strengthens communities. As such, its practical implications require policies that allow access to resources, training, and assistance with gender-inclusive practices to increase homestead gardening as a strategy for increasing food security and dietary diversity.

Keywords: Homestead gardening, food security, dietary diversity, climate resilience, gender dynamics, sustainable agriculture, smallholder farming, household resilience

1. Introduction

1.1 Background

Global food systems are confronted with rising difficulties due to population growth and climate change, which affect the efficiency and sustainability of agriculture. Developing countries in the Global South are disproportionately affected by climate-related hazards, including unpredictable weather patterns, rising temperatures, and water scarcity. Smallholder farmers, essential to the global food supply, face diminishing yields and heightened susceptibility to hunger (Alam et al., 2020). Food security is a fundamental human right and is an essential element of global development; however, with climate change becoming an increasing reality it becomes a challenge to secure food supplies in coastal regions with rising salinity levels, extreme storms, and sea level rise. All this may cause disruption to productive agricultural systems that threaten household incomes and resilience. Finding creative and sustainable local solutions such as homestead gardens has proven effective at increasing food security while building resilience against climate change (Lam et al., 2022).

Homestead gardening is now an essential strategy for addressing global food security issues in addition to adaptation to climate change. Gardens at home are an environmentally sustainable method of combining the production of food with smart agricultural methods, addressing the two threats to food security along with environmental degrading. With temperatures increasing at an unprecedented rate, small-scale agriculture techniques such as homestead gardening may play an integral part in stabilizing food systems while decreasing rural vulnerability – practices that align perfectly with United Nations Sustainable Development Goal 2 (Zero Hunger) and 13 (Climate Action) (Deo et al., 2023). Homestead gardening is one of the key factors in food diversification and micronutrient security as well as small-scale farmers' viability in regions prone to climate variability. Gardeners can utilize effective adaptation strategies like crop diversification to decrease land requirements for market purchases while increasing the nutritional status of their household members (Abdula, 2021). Moreover, these systems provide resilience to rural farming communities through integrated crops, livestock, and agroforestry practices. These practices also help mitigate the effects of climate change by sequestering carbon and increasing soil health (Ullah et al., 2019). Homestead gardening is especially relevant in coastal zones like Bangladesh where salinity intrusion and food insecurity are major problems. Additionally, homestead gardening helps women empower themselves through implementing gender-sensitive practices so that they can be a key player in household decisions and resource allocation. This gendered aspect is critical for building sustainable, fair food systems capable of resisting climate shocks (Abdula, 2021; .Deo et al., 2023).

1.2 Homestead Gardening and Food Security Nexus

Currently, the homestead garden has been found to be an important factor in contributing to resilience to climate change and food security, especially among coastal community members. The research conducted in Bangladesh also shows that families who are attached to gardening at home have a more secure diet. Rahman et al. (2023a) have determined that coastal exposed 9% of households were more likely to experience food security compared to households who did not engage in gardening at home. Gender has an enormous effect on food safety when gardening at homestead gardens (Rahman et al., 2023a). The relationship between gender and food safety in homestead gardens has been extensively investigated and studied (Galhena et al., 2013). Studies demonstrate the important contribution made by women in increasing food security through sustainable gardening practices, especially within agrarian and coastal communities (Clement et al., 2019; De Pinto et al., 2020).

Research indicates that gardens at homesteads can address micronutrient deficiencies, such as vitamin A deficiencies, and increase the overall intake of food in households (Rammohan et al., 2019; Du Toit et al., 2022; Rahman et al., 2024). The COVID-19 epidemic demonstrated the significance of gardening at home during a global supply chain disruption when both urban and rural families relied heavily on gardening at home to maintain food security and nutritional quality during this time (Khan et al., 2020). Such findings show gardens at home can act as flexible resources when faced with crises. People involved in homestead gardening activities tend to diversify their diets more easily and experience better food security than households that don't participate. Furthermore, studies from Indonesia demonstrate the value of gardening for building resilience against threats of food insecurity; gardens serve an integral role in communities vulnerable to environmental or economic stressors (Saediman et al., 2021). Homestead gardening also brings many social benefits, including gender equality improvements thanks to women becoming involved in food production and decision-making processes.

1.3 Objectives of the Study

While homestead gardening is recognized as an effective method for combating food insecurity and increasing dietary diversity, significant gaps remain in the understanding of its wider environment and social impacts. This study seeks to deepen the understanding of the challenges associated with homestead gardening while exploring its potential as an inclusive, gender-neutral approach to improving food security. This study addresses the following research questions.

RQ 1: How does homestead gardening impact on household food security across different socio-economic strata?

RQ 2: What are the specific contributions of homestead gardening to dietary diversity?

RQ 3: What are the barriers to the adoption and success of homestead gardening programs?

This study assesses the extent to which homestead gardening contributes to household food security and dietary diversity. By linking the findings to general methods, this research will assist in scaling gardening in homes across areas that are vulnerable as well as contribute towards SDG 2 (Zero hunger) as well as SDG 13 (Climate Action).

2. Methodology

2.1 Conceptual Framework

Homestead gardening has become an increasingly popular strategy to combat climate change and food insecurity in vulnerable regions. This study provides an environmental-friendly framework involving institutional, socioeconomic, and climate change-related considerations to determine its value in Bangladesh's coastal region from this perspective.

Food security in this context has various facets — including access to, availability of, and consumption of nutritious foods. Homestead gardening is directly addressed to these dimensions because it can give families access to locally grown healthy, diverse, and varied food which is a way to reduce dependence on markets and increase income per household (Adiningsih et al., 2021). In addition, the homestead garden advocates crop diversification and sustainable use of the available resources to reduce the effects of climate variability and contribute to the capacity of the households to adapt to climate variability and change (Deo et al., 2023).

This framework examines both the larger socio-economic context as well as the mediating importance of various variables like income, education, and availability of institutional support such as credit or agricultural extension services which contribute to effective homestead gardening (Figure 1). While these variables influence the adoption of gardening practices, they also impact resilience and food security (Wagah et al., 2021).

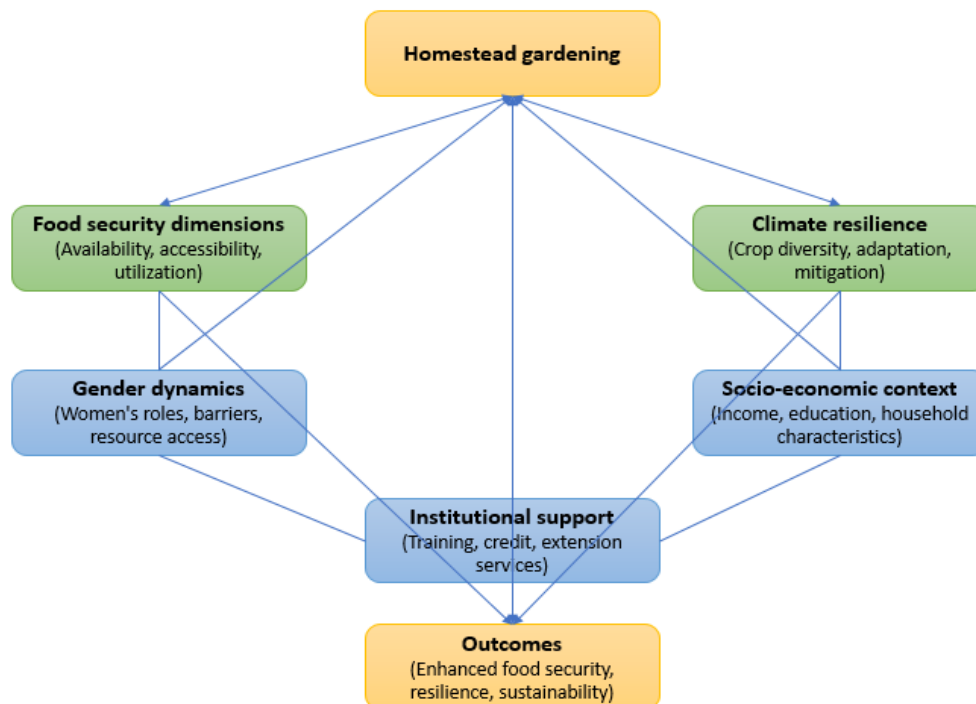


Figure 1: Conceptual Framework

Homestead gardening offers an effective solution for combatting climate change while remaining gender-inclusive in line with the conceptual model. Homestead gardening in this system provides an opportunity to assess its efficacy as a gender-inclusive sustainable solution that is resilient against climate change and can last. It emphasizes the necessity of considering environmental, economic, and social considerations in coastal Bangladesh regions that are vulnerable to climate change, including issues of food security. This framework serves not only for analysis of this study but may be utilized as the foundation of policies and programs to increase household resilience for sustainable growth.

2.2 Study Area and Sampling Design

This research was conducted in two climate hotspot regions of Bangladesh. The first, the “Coastal Zone,” faces frequent cyclones, rising salinity, and other climate stress. The second, the “Barind and Drought-Prone Areas,” experiences increasing temperatures and prolonged dry spells. These regions differ in their vulnerability to extreme climate events, enabling a comprehensive analysis of the environmental and socioeconomic factors influencing homestead gardening, and impacts on agriculture and food security.

Field data were collected using a stratified random sampling technique. Three districts were selected for household surveys—Patuakhali from the Coastal Zone, and Rangpur and Nilphamari from the Barind and Drought-Prone Areas. To ensure the sample reflected a broad socioeconomic range, 600 households were selected, including 400 homestead gardeners (treatment group) and 200 rice producers (control group).

2.3 Data Collection

Primary data were gathered through household surveys. An extensive questionnaire was administered to 600 households in selected coastal villages. The selected villages are Nilgonj, Mithagonj, Tiakhali, and Baliatoli villages under Kolapara upazila in Patuakhali district. Gonggadas, Ishwarpur, and Shahbajpur villages under Rangpur Sadar upazila, Rangpur district, and Khamar garagram, Melabor, Kutipara village under Kishoregonj upazila, Nilphamary district. We documented the responses of both men and women during the household survey. The questionnaire had been extensively tested before the final interview to ensure accuracy, clarity, and reliability in its answers. The questions covered a range of subjects such as demographics of households such as land ownership; different varieties of vegetables grown in homestead gardens for food security reasons; as well as specific questions aimed at women regarding gardening activities as well as accessing resources and involvement in decisions.

The data was gathered over the course of a couple of months by trained enumerators. The ethical considerations, which included the informed consent of the participants, were followed during the entire data collection process. This method of data collection is robust and ensures the data gathered is trustworthy

and reflects the interplay of variables that influence the gardening of homesteads food security, homestead gardening, and resilience to climate change within the study area.

2.4 Data Analysis Techniques

The analysis follows a structured approach that combines descriptive statistics with inferential analyses. Descriptive statistics highlight key characteristics of households, such as demographics, land ownership patterns, crops grown, income sources, and comparisons between exposed coastal zones and interior areas.

Moreover, focus group discussions and key informant interviews were conducted which provide insights into gendered pathways of resource access and strategies for adaptation, complementing and augmenting quantitative findings.

3. Result and Discussion

3.1 Socioeconomic and Demographic Characteristics of Homestead Gardener

3.1.1 Demographic Characteristics

This section offers a thorough analysis of the socioeconomic as well as demographic characteristics of respondents involved in homestead gardening and agriculture in coastal areas of Bangladesh. The study sample consisted of 400 homestead gardeners and 200 rice farmers. The descriptive statistics of the participants' households are presented in Table 1, which highlights the major distinctions in the gender structure, distribution of age, and marital status among both groups (Table 1).

Table 1: Descriptive statistics of respondents' household profiles

Variable	Category	Homestead gardener (N=400)		Rice farmers (N=200)	
		Count	Percentage (%)	Count	Percentage (%)
Household head type	Male	364	91	200	100
	Female	36	9	0	0
Age (Mean: 38.80; Stdev: 8.89)	Young (≤ 35)	159	40	23	12
	Middle (36–50)	203	51	96	48
	Old (> 51)	38	10	81	40.5
Marital Status	Single	1	1	2	1
	Married	387	97	198	99
	Widow	12	3	0	0

All of the respondents for homestead gardeners were women. On the other hand, the majority of rice farmers were men. This distinction is due to the tradition of gender roles in which men primarily cultivate commercial rice, while women concentrate on small-scale, diverse farming activities such as homestead gardens. Homestead gardening families were predominantly led by male-headed households (n= 364) while the remaining 9% (n= 36) were women-headed. It is noteworthy that the majority of the 200 rice farming households were headed by men, highlighting a clear gender gap in household leadership between the two categories.

3.1.2 Educational Status

The study reveals significant variations in literacy levels and education attainment between both types of farms as well as between people living in the coastal areas that are exposed and, in the interior, (Table 2).

Table 2: Educational attainment of respondents

Education Level	Homestead gardener (N= 400)				Rice farmer (N= 200)			
	Count	%	Mean	Std	Count	%	Mean	Std
No schooling	75	18.75	6.5	2.43	39	20	8.55	4.17
Primary	19	4.75			59	30		
Secondary	142	35.5			75	33		
HSC	21	5.25			14	1		
Diploma	5	1.25			8	1		
Graduation (Hons)	28	7.0			-	-		
Post-graduation	8	2.0			1	1		

The median number of years of schooling for homestead gardeners in coastal areas of the interior ranged from 6.5 years (SD = 2.43) in comparison with 8.55 years (SD = 4.17) for rice farmers, suggesting that there is an advantage in education for farmers who raise rice. However, homestead gardeners showed more representation at higher education levels, including Graduation (7%) as well as post-graduation (2%) in comparison to rice farmers.

3.1.3 Family Size

This study explores the size distribution of families between homestead gardeners and rice farmers into three groups: small, medium, and large households (Table 3).

Table 3: The family size of respondents

Category	Homestead gardener (N= 400)				Rice farmer (N= 200)			
	Count	%	Mean	Std	Count	%	Mean	Std
Small (2-3)	91	23	2.77	0.42	36	18	2.75	0.44
Medium (4-5)	219	55	4.49	0.50	107	54	4.40	0.49
Large (6-12)	89	22	6.60	0.97	57	29	6.54	0.80

Homestead gardeners were mostly medium-sized families (4-5 members). The median dimension for these families was 4.49 members with the standard deviation (SD = 0.50). Families composed of 2-3 members made up 23%, with average (2.77)

and SD (0.42) respectively. About 22% of these households comprised 6-12 members each with average dimensions equaling 6.60 members with SD equaling 0.97. Rice farmers were similarly dispersed in terms of population distribution, with most (54% of 107) falling into the middle family size category (mean 4.40 and SD of 0.49), 18% having 2.75 people on average per family (SD= 0.44) while larger families made up 29% (n= 57) as opposed to gardeners who typically had 6.54 members per homestead (SD = 0.80).

Families of medium size are most prevalent across both groups; however, farmers of rice tend to have larger families due to its greater labor demands, while gardeners living on homesteads typically combine farming with household duties, leading them to have an even distribution across medium, small, and large families.

Family size plays an essential role in labor dynamics and resource allocation. Families of medium size are ideal in meeting both labor supply and consumption requirements, while larger households may face difficulties allocating resources evenly among all members but may enjoy greater inputs to labor than with smaller households. Homesteaders who garden may require smaller families while farmers who grow rice may need larger households as this provides opportunities to increase production but can create problems during times of climate-related shocks.

3.1.4 Annual Income

This section presents the annual income distribution of households engaged in homestead gardening and rice farming. The analysis highlights the economic profiles of the two groups, providing insights into income disparities and their implications for food security and climate resilience (Table 4).

Table 4: Annual income distribution of respondents

Category	Homestead gardener (N=400)				Rice farmer (N=200)			
	Count	%	Mean	Std	Count	%	Mean	Std
Poor income group (BDT 10000 to 200000)	169	42	121632.54	52517.96	84	42	123123.81	50929.50
Middle income group (>200000 to 400000)	157	39	298422.29	57766.15	86	43	298702.33	59415.06
High income group (>400000)	74	19	562783.78	265146.39	30	15	628866.67	405861.85

Respondents were classified into three groups of income that included: poor (annual income of between BDT 10,000 to 200,000) and middle (BDT between 200,000 and 400,000) as well as the rich (BDT more than 400000). Homestead gardeners' 400

comprised 42% (n=169) from poor income brackets with annual average earnings ranging between 121,633 (SD 52,517.06) to 121,713.00. A lower proportion of farmers who specialized in growing rice (42% and n=84) fell within this same category with annual earnings approximately at BDT 123,123 (SD = 50,929.50). About 39% (n=157) of gardeners who owned homesteads earned an annual average income of BDT 298,422 (SD = 57,766.15); 43 % of rice cultivators who fell within this income bracket earned BDT 298,702 (SD=59415.06). Homestead gardeners comprised 19 %, with an average annual income of BDT 562783 (SD 265,146.39). Meanwhile, only 15 % (30 out of 145) of rice farmers fit this profile and had an estimated average income of 628866 per annum.

Rice farmers had slightly higher representation in both middle-income (43%) and low-income categories (42%) in comparison with homestead gardeners (40% and 42%, respectively). Farmers who earned rich income had significantly higher average yearly income (BDT 628,866 vs 562,783) as well as greater variation.

The patterns of income distribution highlight the challenges facing gardeners who live in homes as a large portion of households reside in the lowest income brackets. However, homestead gardening is a major income stream for families and contributes to their ability to cope with climate change and improve their food security. The higher degree of income variation observed among rice farmers belonging to the high-income group could be a result of the reliance on the market and the production system that is sensitive to climate change which makes those incomes more volatile as compared to the practices of homestead gardening.

3.1.5 Occupation

This section outlines the job range of homestead gardeners as well as rice farmers. Farming was identified as the main job of 92% (n= 367) of gardeners who work in homesteads, underscoring the importance of farming in the daily lives of families. An impressive 84% also indicated homework as their second job and underlined women's contribution and dualities in society. Secondary jobs were more specialized, consisting of agricultural work (3%), agricultural labor (3%), and various other occupations (5%) as smaller categories. Notable gardeners from homesteads identified non-farming occupations such as jobs (1 %, n= 3) and self-employment (1%), rather than farming occupations. Students, religious work, business, or political participation did not feature prominently indicating a lack of engagement with traditional job descriptions (Table 5).

Table 5: Occupation of homestead gardeners

Category	Main occupation		Secondary occupation	
	Count	Percentage (%)	Count	Percentage (%)
Farming	367	92	33	8
Agricultural Labor	36	9	12	3
Job	3	1	0	0

Homemaker	9	2	334	84
Student	0	0	1	1
Self-employed	3	1	0	0
Others	0	0	20	5

3.1.6 Occupational Distribution of Rice Farmers

About 92% (n= 183) of rice farmers reported farming as their main occupation, underscoring its significance in their lives. Homestead gardeners may have engaged in similar tasks but, unlike farmers, were more focused on agricultural activities. Other major occupations included jobs (5%), business (2%), and self-employment (2%). A very small proportion (1% of the respondents, n=1) identified themselves as students; similarly to gardeners at homesteads, there was no representation in categories like politics or religious activities and no other occupation information was available for rice farmers (Table 6).

Table 6: Occupation of rice farmers

Category	Main occupation	
	Count	Percentage (%)
Farming	183	92
Agricultural Labor	0	0
Business	4	2
Job	9	5
Student	1	1
Self-employed	3	2

Homestead gardeners had an expansive range of skills. In addition to gardening duties, their daily work duties could also include household duties or related tasks. Rice farmers were found to be predominantly engaged in agriculture, with only minimal involvement in non-agricultural occupations or non-farm occupations such as gardening. On homesteads, they frequently played dual roles of gardening work as well as household duties - contributing significantly to climate security by performing these multiple roles simultaneously. On the other hand, overdependence on farming rice made them vulnerable to climate-related shocks given the limited diversification of their activities.

By giving access to training and resources, gardeners are better able to perform multiple duties at the same time and become more resilient against climate impacts. Meanwhile, for rice farmers introducing climate-resilient farming practices can reduce vulnerability while simultaneously improving food security.

3.1.7 Farming Experience

Table 8 highlights the extensive experience of a lot of gardeners at home which is essential for ensuring food security for families and adjusting to the changing climate (Table 7).

Table 7: Farming Experience of Respondents

Category	Homestead gardener				Rice farmer			
	Count	%	Mean	Std	Count	%	Mean	Std
Experience less than 10 years	101	25	4.88	1.71	29	15	8.19	3.19
Experience between 11-20 years	156	39	13.11	2.41	73	37	20.20	3.94
Experience more than 20 years	143	36	24.17	4.79	98	49	36.19	6.03

For homestead gardeners, 25% (n=102) of farmers were with little knowledge. A greater proportion, 39% (n=155) of farmers were with a moderate experience. The farmers with the most experience made up 36% (n=139).

Rice farmers were concentrated among those with medium and high experience levels, with just 15% (n= 29) having low farming knowledge, while 37% (n= 73) possessed medium knowledge; 49% of farmers (n= 98) reported an extensive farming history spanning 36.19 years (SD=6.03) - this suggests their dependence on cultivating rice as their main source of income.

Rice farmers were on average more experienced in all categories than gardeners living at home, particularly their knowledge base in agriculture, with greater years of experience devoted to specific rice farming techniques than gardeners who reside at home. On the other hand, home gardeners may possess more diverse knowledge which allows for the integration of multiple crops and livestock systems for gardening at home.

Experience gained through farming is essential to developing the capacity to adapt. Rice farmers with more experience may be better at handling their primary job more effectively but may lack diversity. Gardeners from homesteads typically have a broader experience base that illustrates their capacity to deal with climate-related risks by employing practices focused on resilience such as diversifying crops and sustainable land management.

3.2 Land Holdings, Farm Production and Marketing Farm Product

3.2.1 Homestead Area Statistics of Homestead Gardeners

The homestead, which is the space used for both residential and agriculture, was classified into small, medium, and high categories. The results highlight the crucial importance of the size of the homestead in determining the outcomes of food security and also the potential to integrate sustainable methods (Table 8).

Table 8: Homestead area statistics of homestead gardeners

Category	Count	Percentage (%)	Mean	Std
Small (1-3 decimal)	65	16	2.77	0.46
Medium (4 – 6 decimal)	119	30	4.58	0.50
Large (>6 decimal)	216	54	7.11	1.10

About 16% (n=65) of gardeners with homesteads fell into the category of small homesteads with an average measurement of 2.77 decimals. Due to limited space constraints in this category, farmers have only limited options when it comes to farming practices, prompting new strategies such as high-intensity cropping or vertical gardening as solutions. The medium category represented 30% (n=119) of gardeners living on homesteads with an average of 4.58 decimals. This group can perform moderate jobs to integrate food production and livelihood-related activities. A majority (54%) of gardeners who resided in homesteads were classified as having high homesteads with an average size of 7.11 decimals. Households that possess such areas have greater capacity to implement integrated agriculture systems that combine livestock, crop, and agroforestry practices for improved resilience and food security.

The wide range of homestead areas indicates the different capabilities of the households involved in producing food. Homes with larger areas are more flexible when it comes to adopting sustainable practices, but those with smaller areas require special assistance to improve efficiency and ensure food security (Lam et al., 2022). Accordingly, statistics on homestead and cultivated land areas demonstrate their significance as indicators of both efficiency and resilience within gardener homesteads. Specific strategies like efficient land utilization, resource optimization programs and capacity-building programs play a vital role in aiding small landowners while strengthening food security in vulnerable coastal regions (Panezai et al., 2022).

3.2.2 Production, Market and Utilization Patterns

Data revealed a wide array of crops and vegetables, such as maize, rice, and green gram as well as chili, brinjal, and pumpkin. Aman rice led the pack, yielding up to

15,400 kilograms for household use while pumpkin and chili sales helped generate income through market sales.

Cultivars are produced across seasons to maximize land utilization. Maize and green gram are two examples of sequential planting methods that increase yield, while lady's fingers and brinjal vegetables help increase household diet variety thanks to homestead gardening.

Chili and turmeric crops provide substantial income, while subsistence crops, mainly sold in local markets, are primarily consumed domestically to enhance food security. However, seasonal fluctuations and limited landholdings continue to pose significant challenges. Homestead gardening can help ensure food security and dietary diversity, providing better seeds, technical support, and market links can increase yield and profitability while supporting smallholder farmers to be resilient and ensure sustainability in their operations.

3.2.3 Gendered Participation in Homestead Gardening Activities

The result highlights that, unlike traditional agriculture which requires outdoor labor, women are heavily engaged in homestead gardening.

Tasks like pesticide and fertilizer application, and fencing, with these activities largely performed by men, were sales of produce. In contrast, women are more involved in seed preparation, transplanting, irrigation, weeding, supervision, harvesting, and post-harvest processing. Notably, women spend more time on homestead gardening due to its accessibility, allowing them to work alongside their domestic chores. However, social norms restrict women's participation in the public sphere, as evidenced by the fact that men dominate vegetable sales. Only 32% of women sell vegetables, and even then, it is typically through vendors who purchase from their homes.

Gender-sensitive policies are essential for improving productive efficiency and empowering women. (Chakma & Ruba, 2021). Capacity building for women through training and access to resources can encourage year-round vegetable production (Ashrafuzzaman et al., 2022). Facilitating women's access to markets will allow for more equal participation in sales of produce. Recognizing and encouraging women's vital contributions, particularly those specifically related to food security and resources will encourage sustainable and inclusive practices for gardening at home (Rahman et al., 2023b).

Table 9: Gendered participation in homestead gardening activities

Activity	Male mean (%)	Female mean (%)	Mean difference
Field Preparation	55	46	9
Seed Preparation	33	67	-34
Transplanting	31	58	-27
Fencing	59	42	17

Activity	Male mean (%)	Female mean (%)	Mean difference
Fertilizer Application	63	37	26
Pesticide Application	69	29	40
Irrigation	33	67	-34
Weeding	39	61	-21
Supervising	30	66	-37
Harvesting	28	71	-43
Post-Harvest Processing	24	75	-51
Selling	62	32	30
Other Tasks	13	16	-3

3.2.4 Homestead Garden Satisfaction Rate of Women

Women engaged in gardening at home were investigated to determine their levels of satisfaction with this activity and its perceived benefits and rewards. Satisfaction levels were classified into low, medium, and high categories according to individual satisfaction scores which ranged between 0-10 for each woman participant (Table 10).

Table 10: Homestead Garden satisfaction rate of women

Satisfaction category	Count	%	Mean	Std
Low (0 – 4)	23	8	3.21	0.59
Medium (5 – 7)	146	57	6.39	0.46
High (≥8-10)	89	35	9.13	0.32

About 8% of respondents indicated dissatisfaction, with an average satisfaction score of 3.21. They represented households that are facing significant challenges such as low yields, limited resources, or lack of support that prevent them from reaping all the benefits that gardening at home could bring them. About 57% (n= 146) reported moderate satisfaction with gardening; their average was 6.39, though there is room for further improvement. Many households reported some satisfaction and stability with gardening, yet further enhancements are possible. About 22% (n= 89) had the highest degree of satisfaction, scoring 9.13. This indicates that households were very satisfied with their garden outcomes and benefited from increased yields, improved food security, and other socioeconomic improvements.

Previous research underscores the role of homestead gardening in empowering women and enhancing household resilience (Parvin et al., 2023). Families that fall within the high satisfaction category tend to benefit from effective agricultural practices and accessing resources effectively; as well as receiving institutional or community aid. In contrast, households with low satisfaction may require targeted interventions, such as education, access to quality products, or financial support, to overcome challenges and improve their satisfaction. Homestead gardening has been proven to be effective in improving resilience and ensuring food security for women near the coastline of Bangladesh especially those who live by themselves in

coastal zones (Rahman et al., 2024). To ensure equitable benefits, it is crucial to address the needs of those with lower satisfaction and ensure that all participants can equally benefit from home gardening initiatives.

3.2.5 Perceived Benefits and Challenges of Homestead Gardening

This section explores the perceived benefits and challenges associated with homestead gardening based on participants' responses. The analysis highlights the multifaceted contributions of homestead gardening to food security, income generation, and women's empowerment while identifying critical challenges that limit its effectiveness (Table 11).

This table provides respondents' perspectives on the advantages and challenges of homestead gardening, along with its significant advantages in food security, income generation, nutrition, and women's empowerment. However, significant challenges also remain. Gardening at home was found to improve food availability, nutrition, and income with respondents showing widespread agreement in its benefits such as decreased cost of food and improved social relationships. Resources effects were noted regarding women's ability to make decisions and autonomy, however accessing resources such as seeds, fertilizers, and pesticides were identified as major barriers; many respondents strongly disagreed or strongly differed about accessibility. Challenges such as land shortages, insufficient water, and a lack of training and financial support have hindered the effectiveness of the program. Additionally, social barriers and limited access to markets have been significant obstacles. These issues highlight that while homestead gardening offers considerable benefits, addressing these challenges is crucial to fully unlock its potential.

Table 11: Perceived benefits and challenges of homestead gardening

Perceived benefits and challenges	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
Benefits					
Increase food availability	0	0	1	18	81
Increase nutritional intake	0	1	2	21	77
Increase income opportunity	0	1	5	34	60
Increase spending on child education	2	3	10	34	41
Increase spending on livestock management	1	6	12	39	40
Use of leisure time	0	2	4	46	49
Reduce expenditure on food cost	0	0	2	32	67
Increase social relationships in exchanging vegetables	0	0	3	35	62

Perceived benefits and challenges	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
Increase women's participation on decision making	0	2	5	51	42
Increase women's autonomy in cultivation	2	12	7	40	35
Increase production knowledge	0	0	2	41	58
Challenges					
Access to seed and planting materials	3	31	2	44	22
Access to fertilizer	4	29	6	41	21
Access to pesticide	4	33	4	40	20
Shortage of land	1	20	6	47	26
Inadequate access to water	11	28	5	38	19
Increase female workload	6	23	5	43	24
Reduces leisure time	7	22	5	51	16
Lack of training	7	23	2	49	19
Lack of finance	2	14	5	53	26
Social and cultural barriers	23	29	11	30	6
Lack knowledge, and advisory services	6	18	2	52	23
Limited market opportunities	15	38	2	30	16

3.3 Food Security and Dietary Diversity

3.3.1 Experience of Household Food Security

This section presents the food security experiences of homestead gardeners, highlighting the frequency of food insecurity indicators such as worry about food availability, dietary diversity, and meal skipping (Table 12).

Table 12: Household food security experience

Food Security experience	Never (%)	In 1 or 2 months (%)	In some but not every month (%)	In almost every month (%)
Worried	62	33	4	1
Eat healthy	42	45	12	1
Ate few kinds of foods	59	31	9	2
Skip a meal	83	12	6	0.5

Ate less than	86	12	2	0.25
HH ran out of food	90	8	2	0.25
Hungry	89	6	3	0.75
Without eat whole day	95	4	1	0.25

The results underscore the vital significance of gardening at home to address food security concerns and mitigate food insecurity. Regarding availability, most (62%) households never worry about food, while 33% experience occasional anxiety about this topic. In terms of eating healthily, 42% reported no difficulties while 45% reported difficulties over several months; lack of diversity in diet was rarely an issue, with 59% not consuming just a few types of foods while 31% experienced it occasionally.

Research also indicates that homestead gardens help reduce food insecurity (Bahta et al., 2018). While most households never suffer from severe indicators of food insecurity, periodic concerns like anxiety over availability and diversity in diets do arise periodically. To address these difficulties, access to inputs, education, and market opportunities can increase homestead gardening's importance in providing constant resilient food supply and security. Gardening at home has long been recognized as an effective strategy to increase food security (Rammohan et al., 2019), specifically through decreasing extreme food insecurity issues like hunger or deprivation of nourishment.

3.3.2 Household Dietary Diversity

This research revealed gender differences in dietary patterns, particularly concerning vegetables and staple foods. Most individuals primarily consume cereals (99% of males and 100% of females), while the consumption of tubers and roots is nearly equal (80% for males and 79% for females) (Table 13). Women tend to eat more leafy green vegetables (77%) compared to men (72%), while both genders consume vitamin A-rich vegetables at relatively low rates (25% for males and 24% for females). The consumption of organ meats is low for both genders (3% for males and 4% for females), while flesh meat consumption is higher among males (40%) than females (37%). Fish and eggs are consumed regularly by both genders, and legumes are widely eaten (75% for both males and females). However, milk consumption is relatively low, with males at 21% and females at 24%. Oil consumption is nearly universal (98% for males and 99% for females), but sweets are consumed more frequently by males (87%) than females (75%). These findings highlight key areas for improving nutrition, particularly in the consumption of dairy, fruits, and vitamin A-rich foods. These findings are essential for creating gender-sensitive nutrition programs and policies to increase the diversity of diets and food security (Rammohan et al., 2019).

Table 13: Household dietary diversity and gender comparison of food group consumption

Food Group	Male (%)		Female (%)	
	Yes	No	Yes	No
Cereal	99	1	100	0
Roots & Tubers	80	20	79	21
Vitamin A Vegetables	25	75	24	77
Green Leafy Vegetables	72	29	77	23
Other Vegetables	34	66	34	66
Vitamin A Fruits	20	80	19	81
Other Fruits	61	39	61	39
Organ Meat	3	97	4	96
Flesh Meat	40	61	37	63
Eggs	68	32	67	33
Fish	66	34	69	32
Legumes	75	25	76	24
Milk	21	79	24	77
Oil	98	2	99	1
Sweets	87	14	75	25

These findings provide insight into important eating patterns and gender-specific eating habits. Although the consumption of cereal and oil is equally shared between males and females however, the intake of Vitamin A-rich foods, such as fruits, vegetables, and milk may indicate possible nutritional differences between males and females. Females are more likely to eat green and leafy vegetables whereas males are more inclined to sweets, suggesting that individual or cultural preferences affect the diverse diets (Rahman et al., 2024).

3.3.3 Institutional Roles

This section explores access to essential agricultural resources, including credit, extension services, training, and involvement in social work-related activities. This gives insight into their support systems externally as well as the involvement of communities that impact sustainability on homestead gardening as a strategy against climate change (Table 14).

Access to credit was split across all categories and 51% of the respondents were in a position to obtain credit, which highlights the need for a more accessible financial system to boost the investment in agriculture. Training in agriculture was offered to 77% of the respondents. Social worker participation was minimal at 26% and the majority of participants (61%) did not take part in this field, which could be due to time constraints or inadvertent disregard for its potential to increase the community's cohesion (social capital) and resilience.

Table 14: Access to resources and participation in social work

Variable	Category	Homestead gardener (N=400)	
		Count	Percentage (%)
Receive information/advice from extension agents	Yes	261	65
	No	139	35
Access to credit	Yes	202	51
	No	198	50
Agricultural training	Yes	309	77
	No	91	23
Participation in social work	Yes	103	26
	No	243	61
	Unknown	34	9

Results demonstrate that while many gardeners at home do benefit from extension services such as training, or credit, many others don't have access to these essential resources (Bahta et al., 2018). By increasing outreach efforts and guaranteeing access for all, homestead gardening will become even more resilient and effective. Access to resources for agriculture and social involvement are the primary determinants of the effectiveness and resiliency of gardening in the homestead (Resurreccion et al., 2019). The low level of participation in social work-related activities indicates an untapped possibility to create communities of social capital that encourage the sharing of learning and action particularly in climate-vulnerable regions.

4. Conclusion

This study demonstrates the transformative potential of homestead gardening as a strategy to improve food security and dietary diversity in climate-sensitive areas such as coastal Bangladesh. The results show that families engaged in home gardening experience better food security outcomes, evidenced by more diverse diets and lower levels of food insecurity indicators, such as meal skipping and reliance on a limited variety of food items. Additionally, gardening at home contributes to ensuring climate resilience by fostering environmentally sustainable practices in agriculture, reducing dependence on external food markets, and increasing the capacity to adapt to climate change.

Gender dynamics are an important component of home gardening projects. Women play an important part in gardening activities, such as crop cultivation and resource management, which have a substantial impact on their families' nutrition and food security. However, obstacles such as restricted access to resources, a lack of agricultural education programs, and societal hurdles prevent women from fully participating. Overcoming these hurdles is critical to maximizing the benefits of home gardening and guaranteeing its long-term viability.

This research offers valuable insights for policymakers and practitioners to develop comprehensive, climate-smart strategies that can contribute to enhancing livelihoods and ensuring food security in vulnerable regions. Expanding homestead gardening programs, along with addressing existing barriers, will help build resilient food and nutrition systems, promote equitable distribution, improve livelihoods, and empower marginalized communities.

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