



Original Research

Kitchen Gardening as a Sustainable Approach for Nutrition Interventions in Tribal Families of District Khyber, Pakistan

Maryam Samad¹, Shehzad Elahi¹, Nadia Samad² and Ibrar Hussain^{2,*}

¹ National Integrated Development Association (NIDA), University Town, Peshawar, Pakistan

² Agriculture Research Institute, Tarnab, Peshawar, Pakistan

* Corresponding author. Email: ibrar_horti@yahoo.com

Abstract

Kitchen gardening is a practical intervention for improving household food security, dietary diversity, and access to nutrient-rich vegetables in resource-constrained communities. This study assessed kitchen gardening interventions implemented by NIDA Pakistan in District Khyber, Khyber Pakhtunkhwa Province, Pakistan. A total of 1,000 seasonal kitchen gardening packages, including vegetable seeds and basic gardening tools, were distributed across 10 Village Councils before the winter season in October 2024 and before the summer season in March 2025. Data were collected from 215 beneficiary households through a structured questionnaire and analyzed using frequencies, percentages, means, and percentage-point changes. After the intervention, 96.7% of respondents reported knowledge of new farming techniques. Vertical gardening (92.6%), container gardening (71.6%), and rooftop gardening (35.8%) were the most frequently known modern approaches. The principal climate-smart practices adopted were organic farming (61.4%), crop diversification (56.6%), crop rotation (55.3%), and integrated pest management using pheromone traps (49.3%), whereas 3.7% reported rainwater harvesting. In separate water-management responses, 51.2% reported rainwater collection, 45.6% furrow irrigation, 21.4% efficient watering schedules, and 6.0% drip irrigation. Winter crop success was highest for lettuce (salad) (93.0%), spinach (90.7%), mustard (90.2%), coriander (88.4%), radish (87.0%), garlic (85.1%), turnip (82.8%), peas (77.2%), and carrot (73.5%). Summer production success was comparatively lower: okra (70.2%), tomato (59.5%), chilli (56.3%), cucumber (53.0%), squash (52.1%), French bean (48.8%), pumpkin (45.6%), and bitter gourd (37.7%). The findings show that combining agricultural inputs with practical training can strengthen household vegetable production and awareness of nutrition-sensitive and resource-conserving practices.

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Statement of sustainability: This article describes a sustainable approach to raising awareness among families about feeding their households with nutrient-rich food, using climate-resilient, locally adapted seeds of different vegetables for kitchen gardening, applying rainwater-harvesting methods, and making judicious use of the harvested water through drip irrigation.

1. Introduction

Rapid population growth, urban expansion, and declining access to cultivable land are increasing the need for affordable and nutritious food. Kitchen gardening can help households produce fresh vegetables close to the home and can improve access to vitamins, minerals, dietary fiber, and other essential nutrients. Vegetable cultivation can also reduce household food expenditure and provide a small source of income when surplus produce is sold (Sharma and Singh, 2018).

Pakistan has diverse soils and climatic conditions that support the production of many vegetable crops. Approximately 22.94 million hectares are cultivated nationally, while vegetables and condiments occupy about 0.35 and 0.18 million hectares, respectively. Punjab accounts for the largest reported share of vegetable area, followed by Sindh and Khyber Pakhtunkhwa. Food security has



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therefore become an important policy concern, particularly for low-income and vulnerable households (Abbasi et al., 2014). Earlier assessments also reported substantial levels of malnutrition and food insecurity in Pakistan, highlighting the need for household-level nutrition interventions (Qaisar et al., 2013).

Household food insecurity is intensified by rising food prices, dependence on purchased food, climate-related production risks, and limited access to diverse diets. Kitchen gardening can contribute to local food systems by linking household production with the use, processing, and, where possible, sale of vegetables. It is particularly relevant where families have limited purchasing power but can use small plots, courtyards, rooftops, or containers for food production (Gupta et al., 2021).

A kitchen garden is a small production area established mainly to supply a household with vegetables, herbs, fruits, or other food crops. It may be developed in a backyard, within the boundary of a house, near the home, on a rooftop, or in containers. Community groups may also use shared land when individual households do not have sufficient space (Rana, 2021; Sharma, 2020).

Kitchen gardening provides several potential social and economic benefits, including improved access to fresh food, dietary diversity, household savings, small-scale income generation, physical activity, and community participation (Moore et al., 2022). The use of vacant or underutilized land may also contribute to household food supply and strengthen residents' sense of place and community ownership (Ghazali, 2013).

Successful kitchen gardens require planning, suitable seed, regular care, appropriate irrigation, and timely pest and disease management. When these conditions are met, households may benefit from fresh produce, practical agricultural knowledge, physical activity, and possible supplementary income (Chauhan, 2023). These benefits make kitchen gardening a useful nutrition-sensitive intervention rather than only a recreational activity.

Adoption may nevertheless be constrained by poor access to quality seed and planting material, limited knowledge of recommended production practices, inadequate water, small cultivation spaces, and weak technical follow-up (Eric et al., 2014; Ahmad et al., 2007). Household income can also influence adoption because lower-income families may be unable to invest in containers, irrigation equipment, compost, or other inputs (Singh et al., 2020).

In response to these challenges, NIDA Pakistan promoted nutrition-sensitive kitchen gardening through the provision of seasonal seed packages, gardening tools, practical training, and technical guidance. The intervention covered crop planning, organic nutrient management, integrated pest management, water conservation, seed preservation, and vertical, container, and rooftop gardening. This study assessed the socioeconomic characteristics of beneficiary households, the performance of winter and summer vegetables, knowledge and adoption of modern cultivation techniques, and the uptake of climate-smart and water-management practices in District Khyber.

2. Materials and Methods

2.1. Study Area

The study was conducted in the newly merged District Khyber in northwestern Khyber Pakhtunkhwa, Pakistan. The intervention covered 10 selected Village Councils/Neighbourhood Councils (VCs/NCs). The area includes rural and semi-urban households that face constraints related to food access, household income, water availability, and access to extension services.

2.2. Intervention and Training

NIDA Pakistan distributed 1,000 kitchen gardening packages containing seasonal vegetable seed and essential gardening tools. Winter packages were distributed in October 2024 and summer packages in March 2025. Beneficiary tokens were issued before distribution to support transparent verification. Distribution events included technical orientation, information, education and communication (IEC) materials, and video demonstrations on gardening tools, crop establishment, and innovative methods such as vertical and container gardening. Facilitation desks were established for verification, receiving, and the feedback and complaint response mechanism (FCRM).

Training was delivered in collaboration with the Agriculture Extension Department, Khyber Pakhtunkhwa. Qualified Agriculture Officers conducted 40 community-based, two-day technical training sessions for male and female participants. A participatory approach was used, including group discussions, question-and-answer sessions, practical demonstrations, field visits, brainstorming, and audio-visual materials. The training covered vegetable selection, seasonal planning, site selection, land preparation, crop nutrition, organic production, integrated pest management, pre- and post-harvest handling, and vertical, container, and rooftop gardening. Participants were encouraged to discuss local practices and identify practical improvements for establishing and managing household food-diversification gardens.

2.3. Selection of Beneficiaries

Beneficiaries were selected using approved eligibility criteria. The criteria included:

- Permanent residence in the selected intervention area;



- Household vulnerability, including small landholdings, women-headed households, widows, and low-income families;
- Availability of suitable space and an accessible irrigation-water source;
- Willingness to prepare and manage the kitchen garden plot;
- Commitment to vegetable production, knowledge sharing, and visibility of the demonstration plot;
- Endorsement through a community-based organization resolution and verification by the Monitoring, Evaluation, Accountability and Learning (MEAL) team; and
- Allocation of one demonstration plot per household to support equitable coverage.

2.4. Data Collection

Data were collected from 215 beneficiary households selected from the total 1,000 households that received kitchen gardening packages (Table 1). The surveyed households were selected using a beneficiary verification list maintained by the project team. The selection aimed to ensure representation from the intervention areas covered under the 10 Village Councils/Neighbourhood Councils (VCs/NCs). Households were approached based on their availability and willingness to participate during the data collection period. The survey included beneficiaries who had received seasonal seeds, participated in the intervention activities, and could provide information regarding crop establishment, production performance, and adoption of recommended practices. This approach allowed assessment of implementation outcomes among actual beneficiaries while reducing selection bias by including households from multiple intervention locations rather than relying on a single community or a conveniently accessible group. Knowledge was recorded using dichotomous responses (Know = 1; Do not know = 0) across the technical domains included in the training. The questionnaire also recorded vegetable seed receipt, area cultivated, crop establishment and production, adoption of recommended practices, use of produce, household vegetable consumption, and sale of surplus vegetables. Constraints affecting garden establishment and management were explored through focus group discussions and structured ranking exercises.

2.5. Data Analysis

Data were coded, tabulated, and analyzed using descriptive statistics. Frequencies, percentages, means, standard deviations, and percentage-point changes were used to summarize respondent characteristics, knowledge, practice adoption, and crop performance. Multiple responses were permitted for selected questions; therefore, percentages for those variables were calculated using the total sample ($n = 215$) and may exceed 100% when categories are summed. Findings are presented in tables and interpreted in relation to the objectives of the kitchen gardening intervention.

Table 1. Socioeconomic characteristics of surveyed kitchen gardening households ($n = 215$).

Variable	Category	Measure	Value
Age of respondent	—	Years (Std. Deviation)	44.04 (13.38)
Respondent gender	Male	Percent (n)	43.3 (93)
	Female	Percent (n)	56.7 (122)
Head of household	Male	Percent (n)	86.5 (186)
	Female	Percent (n)	13.5 (29)
Marital status	Single	Percent (n)	8.4 (18)
	Married	Percent (n)	79.1 (170)
	Separated/Di-vorced	Percent (n)	0.0 (0)
	Widow/Widower	Percent (n)	12.6 (27)
Education of household head	Graduate/Univer-sity	Percent (n)	3.3 (7)
	Intermediate	Percent (n)	18.6 (40)
	Secondary	Percent (n)	6.5 (14)
	Middle	Percent (n)	18.6 (40)
	Primary	Percent (n)	3.3 (7)
	Religious Educa-tion	Percent (n)	13.9 (30)
Average household income	None	Percent (n)	35.8 (77)
	—	PKR (Std. Deviation)	31326.05 (13846.89)
Household member with a physical or mental disability or a chronic illness	Yes	Percent (n)	20.9 (45)
	No	Percent (n)	76.7 (165)
	Not specified	Percent (n)	1.4 (3)

3. Results and Discussion



3.1. Socioeconomic Characteristics and Household Use

The study included 215 respondents with a mean age of 44.04 years (SD = 13.38). Women represented 56.7% of respondents and men 43.3%, although 86.5% of households were headed by men. Most respondents were married (79.1%), while 12.6% were widowed. Educational attainment was generally low: 35.8% of household heads had no formal education, 13.9% had religious education, 3.3% had primary education, 18.6% had middle education, 6.5% had secondary education, 18.6% had intermediate education, and 3.3% had graduate or university education. The average reported household income was PKR 31,326.05 (SD = 13,846.89), and 20.9% of households reported a member with a physical or mental disability or a chronic illness. These findings indicate that the intervention reached households with limited formal education and modest economic resources, groups for whom practical demonstrations may be more accessible than lecture-based extension alone.

Table 2 includes selected multiple-response questions, so its percentages should not be interpreted as mutually exclusive categories. Most respondents cultivated vegetables in fields (82.2%), while some also used space within the household boundary (21.5%) or near the house (8.4%). Household consumption was the main purpose of cultivation (97.7%), confirming the nutrition and food-access orientation of the intervention. Responsibility for garden care was shared mainly by adult men (47.7%) and adult women (45.3%). After the project activity, 82.8% reported knowledge of the nutritional benefits of vegetables, with vitamins being the most frequently identified nutrient category (76.2%). The strong participation of women as respondents and caregivers suggests that kitchen gardening can support household nutrition while also creating an entry point for women's practical involvement in food production.

Table 2. Post-cultivation household use, cultivation location, and nutrition knowledge.

Particulars	Unit	Value
<i>Location of cultivation</i>		
In the field	Percent (n)	82.2 (176)
Within the boundaries of the house	Percent (n)	21.5 (46)
Near to house	Percent (n)	8.4 (18)
Others	Percent (n)	0.5 (1)
<i>Purpose of vegetable cultivation</i>		
For household consumption	Percent (n)	97.7 (209)
For commercial purposes	Percent (n)	3.3 (7)
Other	Percent (n)	0.5 (1)
<i>Need to purchase additional vegetables for household use</i>		
Yes	Percent (n)	20.1 (43)
No	Percent (n)	78.1 (168)
<i>Person mainly responsible for the kitchen garden</i>		
Adult Man	Percent (n)	47.7 (102)
Adult Woman	Percent (n)	45.3 (97)
Male child	Percent (n)	4.2 (9)
Female child	Percent (n)	0.9 (2)
<i>Knowledge of the nutritional benefits of vegetables after the project activity</i>		
Yes	Percent (n)	82.8 (178)
No	Percent (n)	15.9 (34)
<i>Type of nutritional knowledge</i>		
Vitamins	Percent (n)	76.2 (163)
Minerals	Percent (n)	13.6 (29)
Carbohydrates	Percent (n)	19.1 (41)
Proteins	Percent (n)	19.1 (41)

Note: Multiple responses were permitted for selected questions; therefore, percentages may exceed 100% and are calculated based on the total number of respondents (n = 215).

3.2. Winter Vegetable Performance

All 215 sampled households received seed for nine winter vegetables (Table 3). Lettuce (salad) recorded the highest crop success (93.0%), followed by spinach (90.7%), mustard (90.2%), coriander (88.4%), radish (87.0%), garlic (85.1%), turnip (82.8%), peas (77.2%), and carrot (73.5%). The consistently high success of leafy vegetables indicates that these crops were well suited to the winter growing conditions and household-scale management practices. Root and pod crops also performed positively, although carrot and peas showed comparatively lower success and may require more focused guidance on soil preparation, sowing depth, irrigation, and crop protection.



Table 3. Winter vegetable seed receipt, area cultivated, and crop success.

Vegetable	Seed Rate Used	Approx. Area Covered (marla)	Received, n (%)	Crop success, % (n)
Turnip	40 g	6.5	100.0 (215)	82.8 (178)
Radish	200 g	8	100.0 (215)	87.0 (187)
Carrot	200 g	4	100.0 (215)	73.5 (158)
Garlic	3 kg	2	100.0 (215)	85.1 (183)
Spinach	200 g	1.8	100.0 (215)	90.7 (195)
Coriander	200 g	4	100.0 (215)	88.4 (190)
Lettuce (salad)	20 g	6.4	100.0 (215)	93.0 (200)
Mustard	20 g	2.4	100.0 (215)	90.2 (194)
Peas	250 g	1.4	100.0 (215)	77.2 (166)

3.3. Summer Vegetable Performance

All 215 households received seed for eight summer vegetables (Table 4). Establishment was highest for okra (93.5%) and pumpkin (88.4%), while bitter gourd had the lowest establishment rate (74.4%). Production success was highest for okra (70.2%), followed by tomato (59.5%), chilli (56.3%), cucumber (53.0%), squash (52.1%), French bean (48.8%), pumpkin (45.6%), and bitter gourd (37.7%). The production gap may reflect high summer temperatures, pest and disease pressure, irrigation constraints, and variability associated with open-pollinated seed. The results support the need for stronger seasonal follow-up, improved crop-specific management, and assessment of locally adapted or higher-performing seed options.

Table 4. Summer vegetable seed receipt, crop establishment, and production success.

Vegetable	Seed Rate Used	Approx. Area Covered (Marla)	Received Percent (n)	Crop success, % (n)
Pumpkin	10 g	2	100.0 (215)	45.6 (98)
Squash	100 g	25	100.0 (215)	52.1 (112)
Bitter Gourd	30 g	6	100.0 (215)	37.7 (81)
Cucumber	30 g	6	100.0 (215)	53.0 (114)
Tomato	20 g	20	100.0 (215)	59.5 (128)
Chilli	20 g	6.4	100.0 (215)	56.3 (121)
Okra	50 g	5	100.0 (215)	70.2 (151)
French Bean	100 g	1	100.0 (215)	48.8 (105)

3.4. Seasonal Comparison and Interpretation

The combined results demonstrate a consistent seasonal pattern: winter vegetables achieved substantially higher production success than summer vegetables. The mean production success across the nine winter crops was approximately 84.3%, compared with approximately 52.9% across the eight summer crops. This difference is not simply a difference between “winter” and “summer” labels; it reflects differences in the physiological requirements of the crops included in the two seasons. The winter group contained several cool-season leafy and root vegetables, whereas the summer group was dominated by fruiting vegetables whose marketable yield depends strongly on successful flowering, pollination, and fruit or pod development.

The literature supports this physiological interpretation. Cool-season vegetables such as spinach, mustard, turnip, and lettuce are generally adapted to moderate temperatures, whereas high temperatures can accelerate development and cause quality or yield losses. In fruiting vegetables, however, temperature stress can be especially consequential during reproductive development because pollen viability, fertilization, flower retention, and fruit set are temperature-sensitive processes. Tomato is particularly sensitive during flowering and fruit setting, while cucumber and other cucurbits can experience impaired growth and fruit development under excessive heat. Therefore, the higher winter success observed in this study is consistent with the greater seasonal suitability of cool-season crops, while the lower and more variable summer success is consistent with the greater physiological sensitivity of fruiting crops to heat and associated water stress.

Nevertheless, these mechanisms should be interpreted cautiously. The present study was designed primarily as an intervention and household production assessment and did not include continuous measurements of temperature, relative humidity, soil moisture, pest incidence, disease pressure, or crop-specific physiological responses. Consequently, the observed seasonal differences cannot be attributed quantitatively to heat stress alone. Instead, the literature provides a biologically plausible framework for interpreting the pattern observed in the field. Future monitoring should combine crop performance records with weather and soil-moisture data to identify the relative contribution of heat, water availability, and biotic stresses to summer crop losses.



3.5. Knowledge and Adoption of Modern Techniques

Post-intervention awareness of new farming techniques was high, with 96.7% of respondents reporting knowledge of these approaches (Table 5). The most widely known methods were vertical gardening (92.6%), container gardening (71.6%), and rooftop gardening (35.8%). Overall, 95.3% reported practicing at least one new technique. Among the specific methods practiced, vertical gardening was most common (87.4%), followed by container gardening (37.7%), rooftop gardening (15.8%), drip irrigation (10.2%), and hydroponics (3.7%). The difference between awareness and practice, particularly for container and rooftop gardening, suggests that knowledge alone may not be sufficient where households face constraints related to materials, cost, space, or water.

Awareness of climate-smart and resource-conserving practices was reported by 94.0% of respondents. The most frequently adopted methods were organic farming (61.4%), crop diversification (56.6%), crop rotation (55.3%), soil conservation techniques (52.5%), integrated pest management using pheromone traps (49.3%), mulching (34.9%), and off-season vegetable cultivation (19.5%); rainwater harvesting was reported by 3.7%. For water management, 51.2% reported rainwater collection, 45.6% furrow irrigation, 21.4% efficient watering schedules, and 6.0% drip irrigation. The relatively low adoption of drip irrigation and formal rainwater-harvesting systems indicates that low-cost water-saving technologies, demonstrations, and follow-up support should receive greater attention in future interventions.

Table 5. Post-training knowledge, adoption of modern techniques, and climate-smart and water-management practices.

Particulars	Unit	Value
<i>Knowledge of new techniques for farming</i>		
Yes	Percent (n)	96.7 (208)
No	Percent (n)	0.9 (2)
<i>Modern techniques known</i>		
Vertical gardening	Percent (n)	92.6 (199)
Rooftop gardening	Percent (n)	35.8 (77)
Container gardening	Percent (n)	71.6 (154)
Others	Percent (n)	0.5 (1)
<i>Practicing new techniques</i>		
Yes	Percent (n)	95.3 (205)
No	Percent (n)	2.3 (5)
<i>Techniques practiced</i>		
Vertical gardening	Percent (n)	87.4 (188)
Drip irrigation	Percent (n)	10.2 (22)
Rooftop gardening	Percent (n)	15.8 (34)
Container gardening	Percent (n)	37.7 (81)
Hydroponics	Percent (n)	3.7 (8)
<i>Awareness of climate-smart and resource-conserving practices</i>		
Yes	Percent (n)	94.0 (202)
No	Percent (n)	5.1 (11)
<i>Adopted climate-smart farming methods</i>		
Rainwater harvesting	Percent (n)	3.7 (8)
Crop diversification	Percent (n)	56.6 (121)
Soil conservation techniques	Percent (n)	52.5 (112)
Mulching	Percent (n)	34.9 (75)
Crop Rotation	Percent (n)	55.3 (119)
Off season vegetable cultivation	Percent (n)	19.5 (42)
Organic farming	Percent (n)	61.4 (132)
Integrated pest management (pheromone trap)	Percent (n)	49.3 (106)
Others	Percent (n)	1.4 (3)
<i>Water-management methods</i>		
Drip irrigation	Percent (n)	6.0 (13)
Rainwater collection	Percent (n)	51.2 (110)
Furrow irrigation	Percent (n)	45.6 (98)
Efficient watering schedules	Percent (n)	21.4 (46)

Note: Multiple responses were permitted for questions on techniques and practices; therefore, percentages may exceed 100% and are calculated based on the total number of respondents (n = 215).

4. Conclusion

The NIDA Pakistan kitchen gardening intervention improved household access to seasonal vegetable seed, practical training, and knowledge of modern gardening techniques in District Khyber. Field days, monitoring visits, and post-distribution monitoring (PDM) confirmed that beneficiaries adopted improved practices and achieved satisfactory household-level production and consumption of both winter and summer vegetables. The vegetables were shared freely or sold at nominal prices in local markets within the community, strengthening social cohesion and encouraging wider replication. The activity contributed to improved nutrition, reduced household vegetable expenses, and increased awareness of sustainable gardening practices, with strong potential



for continued impact in the coming years.

Author Contributions

Maryam Samad: Conceptualization, Methodology, Investigation, Resources, and Writing – original draft; Shehzad Elahi: Conceptualization, Methodology, Investigation, and Resources; Ibrar Hussain: Conceptualization, Data curation, Formal analysis, and Writing – original draft; Nadia Samad: Investigation.

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Declaration

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