



Barriers to the Adoption and Sustainability of Kitchen Gardening in Informal Settlements: A Quasi-Experimental Study from Goma City, Democratic Republic of Congo

Mafuko Nzamurata^{1*}, Leo Ogallo², Agrippina Lubeka²

Abstract

Background: Kitchen gardening is widely promoted as a strategy to enhance food security and dietary diversity in restricted urban environments. However, there is limited understanding of the factors predicting the adoption and sustainability of these interventions, particularly the role of gender.

Objective: To compare barriers to kitchen-garden establishment and maintenance in informal settlements of Goma City, Democratic Republic of Congo, and their influence on dietary diversity between trained and control households, highlighting possible gender disparities.

Methods: A quasi-experimental mixed-methods design was used to assess 181 intervention and 181 control households at baseline and endline with a survey, supported by 26 focus group discussions.

Results: Trained households identified significantly fewer barriers than control households in all domains ($p < 0.001$). Nonetheless, the lack of water was the main limitation in both groups (22.1% vs 77.3%, $p < 0.001$), followed by the absence of improved technologies and reduced access to planting materials. Overall, most barriers were independently associated with poorer dietary diversity, and the largest deficits were reported in relation to tenure insecurity and socio-cultural constraints. Indeed, restrictive norms were noted by 72.9% of control households and only 2.2% of trained households ($p < 0.001$). By contrast, the focus group discussions highlighted that women's time constraints were the primary concern for households that received training (95.0%). Consistent with quantitative findings, focus group participants identified water, land, and pests as the most pressing limitations, with insufficient time for women being a main constraint for trained households.

Conclusion: Community horticultural training helped secure food production by reducing technical and social barriers to cultivation. Nonetheless, physical and social infrastructure remained severe limitations for growing activities, and the opportunity costs of women's time might undermine the expected dietary benefits from such interventions.

Keywords: Kitchen gardening; Urban agriculture; Household dietary diversity; Gender; Informal settlements

Introduction

Urban and peri-urban informal settlements are the breeding grounds for a large proportion of the region's food-insecure populations. With increased

Affiliation:

¹Higher Institute of Tourism, Goma, Democratic Republic of Congo

²Faculty of Agribusiness and Technology, Great Lakes University of Kisumu, Kenya

*Corresponding author:

Mafuko Nzamurata, Higher Institute of Tourism, Goma, Democratic Republic of Congo

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population density, informal housing, and reliance on highly volatile markets for food, these communities are particularly vulnerable [1,2]. The situation is particularly dire in the Democratic Republic of Congo (DRC) owing to persistent unrest in the east of the country, which has placed displaced populations in serious food insecurity [3,4]. Kitchen gardening has been promoted by various stakeholders as a viable solution to the problem. The practice entails growing vegetables in home gardens and is a cost-effective way of increasing dietary diversity and decreasing reliance on markets while enhancing family resilience [5,6].

The existing literature increasingly recognizes the capacity of appropriately designed kitchen gardening training to improve dietary diversity and food security among participants [6,7]. At the same time, however, few studies identify in detail the range of factors that limit interventions' ability to achieve these goals or the extent to which overcoming them requires a shift in participants' attitudes or behaviours. The studies that do address this topic document a long list of constraints that undermine kitchen gardeners' capacity to increase dietary diversity: limited availability of water, land, and production inputs; pests; and social and cultural barriers [1,8-10]. Very few attempt to quantify the degree to which each constraint reduces dietary diversity or assess how much of it can be eliminated by a targeted household-level intervention. This omission is important because, for many interventions, differentiating between factors that relate to the adoption of new behaviours and those that require policy or institutional action is key to designing effective interventions [11,12].

Gender is another key aspect that needs to be considered. Women are primarily responsible for both food production and care work in informal settlements, yet norms often restrict their access to resources such as land or decision-making roles [13,14]. In addition, programmes that do not take these specific contexts into account may improve household dietary diversity but fail to address gender-specific time constraints and power dynamics [12]. It becomes paramount to distinguish between barriers to kitchen-garden adoption and maintenance that are amenable to changes in attitudes and behaviour, and those related to the distribution of resources and control.

The current study addresses this gap by applying a quasi-experimental design to Goma City informal-settlement household kitchens to achieve the following objectives: (i) compare the prevalence of technical, environmental, socioeconomic, institutional, and socio-cultural barriers to kitchen-garden adoption and maintenance between the intervention and control groups; (ii) assess the association between each category of barriers and dietary diversity; (iii) identify gender-specific mechanisms influencing participation in kitchen-gardening activities and potential constraints; and

(iv) analyse the focus group discussion findings in the context of gender-specific livelihood strategies [10] while integrating the Gender and Power framework [12] to understand the role of gender in influencing these mechanisms.

Materials and Methods

Study design and setting

This study is based on a quasi-experimental mixed-methods evaluation of a kitchen gardening intervention conducted among informal settlement households in Goma City, North Kivu Province, Democratic Republic of Congo. A comparison was made between households that received treatment in the form of improved kitchen gardening training and those that did not, based on data collected at baseline and endline within the same cropping season. Data collection started in February, the beginning of Season B (the main rainy season in the area), and ended in early June, when crops harvested during Season B are mature and ready for reaping.

Participants and sampling

In total, 362 households were included in the study: 181 received the intervention (intervention group) and 181 did not (comparison group). The response rate was 100% at both baseline and endline. Table 1 shows the socio-demographic and economic characteristics of household heads by study group. With the exception of the sex ratio and age structure, which were similar in both groups (all $p > 0.05$), no significant differences were found between the intervention and comparison groups for any of the ten socio-economic domains assessed. This suggests that the study has good internal validity and that differences in dietary diversity or barriers between the groups at endline cannot be explained by baseline differences in socio-economic characteristics.

Intervention

The intervention involved training sessions on kitchen gardening comprising bed preparation, planting, management of pests and diseases, water conservation and supplementary irrigation, and seed saving, together with regular follow-up visits. The short-cycle kitchen-garden crops with a harvesting period of up to three months that were encouraged to grow included amaranth, spinach, cassava leaves, bush beans, eggplant, and other crops suitable for the agro-ecological region.

Data collection instruments

A structured questionnaire was used to assess barriers to establishing and maintaining kitchen gardens during the endline survey. The questionnaire had ten sections exploring water, agricultural inputs, pests and diseases, land or space, time and labor, knowledge, extension services, climate, socio-cultural or gender barriers, and market as potential barriers to establishing and maintaining kitchen gardens in

Table 1: Socio-economic characteristics of household heads in the intervention and control groups (N = 362).

Variable	Category	Intervention n (%) (n=181)	Control n (%) (n=181)	df	χ^2	p
Sex of household head	Male	100 (55.2)	97 (53.6)	1	0.08	0.777
	Female	81 (44.8)	84 (46.4)			
Age of household head	18-24 years	10 (5.5)	9 (5.0)	5	2.1	0.836
	25-34 years	35 (19.3)	33 (18.2)			
	35-44 years	72 (39.8)	74 (40.9)			
	45-54 years	42 (23.2)	40 (22.1)			
	55-64 years	15 (8.3)	17 (9.4)			
	≥65 years	7 (3.9)	8 (4.4)			
Education level	No formal education	40 (22.1)	42 (23.2)	3	0.72	0.869
	Primary	78 (43.1)	75 (41.4)			
	Secondary	50 (27.6)	52 (28.7)			
	University	13 (7.2)	12 (6.6)			
Marital status	Single	10 (5.5)	9 (5.0)	3	1.02	0.796
	Married	130 (71.8)	128 (70.7)			
	Divorced	12 (6.6)	14 (7.7)			
	Widowed	29 (16.0)	30 (16.6)			
Main income source	Casual labour	70 (38.7)	68 (37.6)	4	1.88	0.758
	Petty trade	65 (35.9)	67 (37.0)			
	Farming	20 (11.0)	18 (9.9)			
	Formal employment	15 (8.3)	16 (8.8)			
	Unemployed	11 (6.1)	12 (6.6)			
Average monthly income (USD)	51-100	70 (38.7)	72 (39.8)	2	0.54	0.764
	101-150	60 (33.1)	58 (32.0)			
	≥200	51 (28.2)	51 (28.2)			
Type of dwelling	Permanent	60 (33.1)	58 (32.0)	2	0.29	0.865
	Semi-permanent	90 (49.7)	92 (50.8)			
	Temporary	31 (17.1)	31 (17.1)			
Tenure status	Owner	50 (27.6)	48 (26.5)	2	0.41	0.814
	Informal/squatter	30 (16.6)	32 (17.7)			
	Renter	101 (55.8)	101 (55.8)			
Household size	1-3 members	25 (13.8)	27 (14.9)	3	0.67	0.88
	4-6 members	85 (47.0)	83 (45.9)			
	7-9 members	55 (30.4)	54 (29.8)			
	10+ members	16 (8.8)	17 (9.4)			
Children under five years	0 children	30 (16.6)	28 (15.5)	4	1.12	0.891
	1 child	60 (33.1)	62 (34.3)			
	2 children	55 (30.4)	53 (29.3)			
	3 children	30 (16.6)	31 (17.1)			
	4+ children	6 (3.3)	7 (3.9)			

Note: Values are frequencies (n) and percentages (%) within each study group. Pearson's chi-square (χ^2) test was used to compare socio-demographic and economic characteristics between the intervention and control groups. Significance was set at $p < 0.05$.

the study area. Gender-related questions included perceived effect of gender roles on involvement in kitchen gardening activities, ways in which gender roles affected other barriers, and the effect of training on decision-making processes concerning food in the households. The Household Dietary Diversity Score (HDDS) was used to determine the dietary diversity. The HDDS relied on a 24-hour dietary recall interview in which the participants identified and reported all food items consumed. In addition, qualitative information was collected using twenty-six (26) focus group discussions (FGDs) with intervention and control households to allow participants to express their views on various aspects of the research, including barriers to establishing kitchen gardens, gender roles in food production, and sustainability of the interventions.

Statistical analysis

Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to present the prevalence of barriers to establishing kitchen gardens, gender roles, and dietary diversity. The differences in the prevalence of each of the barriers between the intervention and control groups were compared using Pearson's chi-square tests. The odds ratios (OR) and the 95% confidence intervals (CI) were

determined to ascertain the magnitude of the association. In addition, independent-sample t tests were used to establish the relationship between each of the barriers and the HDDS. A statistical difference was considered significant at $p < 0.05$ level with 95%CI. The qualitative data obtained from the FGDs were thematically analyzed to provide in-depth information and supplement the quantitative results on the barriers to establishing kitchen gardens, gender roles, and sustainability of the interventions.

Results

Prevalence of barriers to kitchen garden establishment and maintenance

Table 2 presents the prevalence of perceived barriers to establishing and maintaining a kitchen garden for intervention and control households at endline. Households that received training reported experiencing significantly fewer barriers than their untrained counterparts across all ten domains (all $p < 0.001$). Lack of adequate water was the most common constraint facing both groups, although it was more than three times higher among untrained households (77.3%) than among their trained counterparts (22.1%; OR=12.25, 95% CI 7.28-20.61, $p < 0.001$). Similar reductions were observed

Table 2: Endline barriers to kitchen garden establishment and maintenance among study households by study group (N = 362)

Barrier/challenge	Intervention n (%) (n=181)	Control n (%) (n=181)	χ^2	df	p	OR	95% CI for OR
Lack of adequate water	40 (22.1)	140 (77.3)	108.3	1	<0.001	12.25	7.28-20.61
Limited access to seeds/inputs	30 (16.6)	120 (66.3)	90.17	1	<0.001	9.8	5.85-16.42
High incidence of pests and diseases	50 (27.6)	100 (55.2)	27.33	1	<0.001	3.25	2.05-5.15
Limited land size/space	40 (22.1)	80 (44.2)	18.96	1	<0.001	2.76	1.73-4.41
Limited time/labour	35 (19.3)	90 (49.7)	35.63	1	<0.001	4.09	2.49-6.72
Lack of technical knowledge	20 (11.0)	110 (60.8)	95.07	1	<0.001	12.83	7.26-22.68
Poor access to extension services	25 (13.8)	100 (55.2)	66.91	1	<0.001	7.74	4.54-13.21
Climate variability/weather	60 (33.1)	110 (60.8)	26.63	1	<0.001	3.14	1.99-4.96
Socio-cultural/gender barriers	15 (8.3)	60 (33.1)	32.56	1	<0.001	5.48	2.93-10.25
Poor market access	30 (16.6)	70 (38.7)	21.02	1	<0.001	3.12	1.90-5.12

Note: Values are frequencies (n) and percentages (%). Pearson's chi-square (χ^2) test was used to compare the proportion of households reporting each barrier between the intervention and control groups. Odds ratios (OR) and 95% confidence intervals (CI) quantify the strength of association. Significance was set at $p < 0.05$.

Table 3: Association between selected household barriers and Household Dietary Diversity Score (HDDS) among study households (N = 362)

Barrier/challenge	Mean HDDS (with barrier)	Mean HDDS (without barrier)	Mean difference	t	p
Lack of control over land	4.2	7.1	-2.9	5.82	<0.001
Time/labour burden	4.5	6.8	-2.3	4.91	<0.001
Limited access to credit	4.8	6.5	-1.7	3.65	<0.001
Socio-cultural constraints	4.1	6.9	-2.8	5.23	<0.001
Poor market access	5.2	6.4	-1.2	2.15	0.032

Note: HDDS = Household Dietary Diversity Score. Mean differences represent the difference in HDDS between households reporting each barrier and those not reporting it. Independent-samples t-tests were used. Significance was set at $p < 0.05$.

for the second to fifth largest causes of constraints, namely, limited access to seeds and agricultural inputs, lack of technical know-how, and poor access to extension services; each was affected by the intervention with relative risks ranging from 0.24 to 0.31 (all $p < 0.001$), meaning that they impacted only 11-17% of trained households compared with 55-66% of control households.

Environmental constraints, particularly high pest and disease pressure (27.6% vs 55.2%; OR=3.25, $p < 0.001$) and climatic variability (33.1% vs 60.8%; OR=3.14, $p < 0.001$), were also significantly less prevalent among intervention households, although each was still a major constraint to production. Structural constraints were also lower, although not as dramatically, among trained households: insufficient land or space was reported by 22.1% of trained households and 44.2% of control households (OR=2.76, $p < 0.001$), and limited time or labour was reported by 19.3% of trained versus 49.7% of untrained households (OR=4.09, $p < 0.001$). Socio-cultural and gender-related constraints were reported by only 8.3% of trained households versus 33.1% of untrained households (OR=5.48, 95% CI 2.93-10.25, $p < 0.001$), and poor market access affected 16.6% of trained households versus 38.7% of control households (OR=3.12, $p < 0.001$).

Association between household barriers and dietary diversity

Table 3 presents associations between selected household barriers and HDDS of study households at baseline. Apart from access to credit, all other barriers were independently and negatively associated with dietary diversity. Compared to households not constrained by control over land, those facing a lack of control over land had a mean HDDS of 4.2 versus 7.1, respectively, which reflects a -2.9-point difference in dietary diversity scores ($t=5.82$, $p < 0.001$). This represents the largest dietary cost of any barrier examined. Socio-cultural constraints were similarly associated with a nearly 3-point drop in dietary diversity; compared to households not experiencing these types of constraints, those facing socio-cultural constraints had a mean HDDS of 4.1 versus 6.9 ($t=5.23$, $p < 0.001$). Time and labour constraints were associated with a -2.3-point difference in dietary diversity scores ($t=4.91$, $p < 0.001$), while limited access to credit was associated with a -1.7-point difference ($t=3.65$, $p < 0.001$). Finally, the least costly constraint in terms of its impact on dietary diversity was poor market access, which was associated with a -1.2-point difference in dietary diversity scores ($t=2.15$, $p=0.032$).

Gender dynamics in kitchen garden participation and household decision-making

Table 4 below shows the baseline gender dynamics indicators for the study groups. Fifty five percent (55.2%) of intervention and fifty three percent (53.0%) of control

households felt that gender roles influenced who participated in kitchen gardening. Perceived limitations in gender roles for kitchen gardening were highest among control and lowest among the intervention households for all indicators. While six percent (6.6%) of intervention and twenty seven percent (27.1%) of control households reported that women lacked say in kitchen gardening decisions, thirteen percent (13.8%) of intervention and thirty nine percent (39.8%) of control households mentioned that men have more say in relation to land or resources. Notably, while two percent (2.2%) of intervention households and seventy three percent (72.9%) of control households were unconcerned with cultural beliefs that prevented female involvement in kitchen gardening.

On the contrary, women's lack of time was a limiting factor universally reported (95%) among intervention households and to a lesser extent (66.3%) by the control group; the only gender dynamics indicator that was more reported by the trained than the untrained. Overall, almost half (49.2%) of intervention and half (50%) of control households identified at least one cultural, gender, or social barrier. However, while the intervention group cited limitations in time, the control households mentioned norms and values about decision-making or power over resources. Within the intervention group, training was associated with positive perceptions of women's empowerment in food-related decisions with fifty eight percent (57.5%) reporting increased female influence, thirty seven percent (37%) stating more collaborative decisions between spouses, and only five percent (5.5%) observing no changes.

Qualitative perspectives on barrier persistence and gender dynamics

Findings from the 26 focus group discussions (FGDs) converged with the quantitative data. Water scarcity during the dry season was generally perceived as the biggest threat to household garden production despite training:

"The training taught us how to grow vegetables, but during the dry season water becomes our biggest problem because we have to compete with other household needs." (FGD 14, female participant)

Participants attributed changes in pest problems and improved ability to cope with weather variability to the training received, while noting that these challenges could not be fully eliminated:

"Sometimes insects destroy the vegetables, and when there is too much heat without rain, production becomes very low despite everything we learned." (FGD 18, female participant)

Time constraints remained a challenge, particularly for women who had to combine garden work with childcare, housework, and income-generating activities:

“Sometimes there is not enough time because women must combine gardening with household work and caring for children.” (FGD 16, female participant)

By contrast, participants described a shift in socio-cultural attitudes toward domestic gardening, citing tangible household benefits and a concomitant shift in family decision-making:

“At first some husbands thought gardening was only for women, but after seeing the harvest, many now help with watering and fencing.” (FGD 24, female participant)

“Before the project my husband decided everything about the small land we had, but now we decide together what vegetables to plant because we both attended the training.” (FGD 12, female participant)

Table 5 summarises the focus group themes most pertinent to the persistence of barriers to dietary diversity, gender relations, and the sustainability of kitchen gardens, along with the saturation of each theme across the 26 focus groups and a representative quotation. Limited space, inadequate water, pests, theft, and the high cost of seeds were identified as the main constraints to sustainability and scaling up in 23 of the 26 focus groups, while the high cost of animal protein, milk, fish, and fruit was identified as a persistent constraint to overall dietary diversity, despite improved vegetable production, in 25 of the 26 focus groups. All 26 focus groups, however, expressed willingness to continue with kitchen gardening and to recommend it to others.

Table 4: Gender dynamics in kitchen gardening at endline among study households (N = 362).

Variable	Category	Intervention n (%) (n=181)	Control n (%) (n=181)
Perceived effect of gender roles on participation	Yes	100 (55.2)	96 (53.0)
	No	81 (44.8)	85 (47.0)
Ways gender roles affect kitchen gardening (multiple response)	Women lack decision-making power	12 (6.6)	49 (27.1)
	Men control land or resources	25 (13.8)	72 (39.8)
	Women have limited time	172 (95.0)	120 (66.3)
	Cultural norms restrict women's participation	4 (2.2)	132 (72.9)
Presence of cultural, social, or gender-related barriers	Not applicable	0 (0.0)	1 (0.6)
	Yes	89 (49.2)	90 (50.0)
	No	92 (50.8)	90 (50.0)
Perceived change in decision-making following training (intervention only)	Women now have greater influence	104 (57.5)	-
	Decisions more jointly shared	67 (37.0)	-
	No change in decision-making	10 (5.5)	-

Note: Percentages are calculated within each study group (n=181). Multiple responses were permitted for the item on ways gender roles affect kitchen gardening; percentages for that item may therefore exceed 100% of respondents reporting any constraint. The item on perceived change in decision-making following training was administered to intervention households only.

Table 5: Qualitative thematic findings on barriers, gender dynamics, and sustainability of kitchen gardening (n = 26 FGDs)

Theme	Sub-themes	Saturation	Illustrative quotation
Persistent barriers to a fully diverse diet	High cost of meat, fish, milk and fruit; limited household income	Very high (25/26 FGDs)	“Vegetables are no longer our biggest problem, but meat, milk and fish are still too expensive for many families.” (FGD 22, male participant)
Challenges affecting kitchen garden sustainability	Limited space; lack of water; pests; theft; expensive seeds	High (23/26 FGDs)	“The garden has helped us, but lack of water, pests and small space make production difficult during some seasons.” (FGD 18, female participant)
Gender roles in food preparation and household decision-making	Women continued to lead meal decisions; increasing joint decision-making after training	Moderate (21/26 FGDs)	“Women still decide what will be cooked, but now there are more vegetables available for preparing healthier meals.” (FGD 05, female participant)
High acceptance and sustainability of kitchen gardening	Willingness to continue; recommending the practice; desire for continued support	Universal (26/26 FGDs)	“Kitchen gardening has changed our lives. We would encourage every household to practice it because it improves nutrition and reduces food expenses.” (FGD 25, male participant)

Note: FGD = Focus group discussion. Saturation indicates the number of the 26 focus group discussions in which the theme was identified. Illustrative quotations are representative participant responses corresponding to each theme.

Discussion

This article presents one of the first quantitative assessments of the dietary diversity burden of specific constraints to kitchen gardening in informal settlements of Central Africa, going beyond mostly descriptive findings of earlier studies [1,8]. The main findings can be grouped into four categories.

Firstly, the study confirms that structured participatory training was an effective intervening variable that reduced most of the barriers to kitchen gardening in the experimental group both directly and indirectly (see Table 5). The fact that technical knowledge and access to extension services were almost entirely absent in the control group but almost entirely present in the trained group demonstrates the immediate benefits of such training as well as its moderating capacity in terms of other barriers. Access to agricultural advisory services emerges as a critical priority in informal settlements as traditional extension services have limited reach and do not respond to the immediate needs of the local population [9,14].

Secondly, most of the structural constraints, including access to water, tenure security, and access to credit, remained disproportionately high even among the trained respondents. Notably, water scarcity emerged as the most common constraint overall. This finding is consistent with similar research conducted in Kibera informal settlement in Nairobi, Kenya, which also identified access to water as the main constraint [14,15]. Training may help the population implement water-saving measures and utilize other alternative sources, but these are only short-term solutions. The problem of limited and unreliable water supply during the dry season still persists and negatively impacts the dietary diversity of the population. Another constraint to home garden development found disproportionately in Goma but also reported in other informal settlements in sub-Saharan Africa, is the lack of arable land and space for gardening [10,16].

Thirdly, the assessment of gender-dynamics constraints is complex due to conflicting trends seen in Table 4. While norms and male dominance were less prevalent in the trained group, the burden of time use increased in line with the overall prevalence of gender-dynamics constraints. This finding suggests that while participatory training may have had a limited impact on specific gender-dynamics constraints such as norms and male predominance, it did not account for the overall time use by women. Such an observation may be explained by the fact that training promoted food production via home gardening as the objective but did not address the limitations and specifics of implementation, including the burden of time use by women. This way, the positive impact of training is manifested in an increase in time spent on productive activities without a corresponding change in the overall time budget.

Fourthly, while being mostly descriptive, the dietary diversity costs of the constraints identified (see Table 6) provide important implications for the design of interventions. Tenure insecurity and socio-cultural constraints had the highest individual dietary diversity costs per household, approximately on par with each other and significantly higher than credit and market constraints. This finding highlights the importance of addressing tenure and socio-cultural barriers to home gardening in informal settlements of Central Africa, which is somewhat at odds with the common prioritization of material constraints over social ones in similar contexts [12,14]. Addressing these constraints may be challenging, especially tenure insecurity, which is a deep-seated issue in the informal settlements of Goma City [3]. Nevertheless, the observed trends suggest that policies targeting socio-cultural norms and home-garden-specific tenure issues should receive adequate consideration alongside credit and market-related barriers.

The findings on the burden of constraints to livelihood strategies correspond to the Sustainable Livelihood Framework in which constraints to adopting a particular strategy can emerge at multiple levels, ranging from external shocks and seasonal cycles to institutional capacities and cultural norms [10]. Table 7 provides an overview of the constraints to home-garden development identified in this study alongside the key domains and indicators used in the Sustainable Livelihood Analysis. In this perspective, constraints to accessing extension services correspond to the resource domain, while gender-norm barriers reflect cultural norms. The observed differences in the extent to which individual constraints responded to the intervention correspond to the differential role of community-level institutional (extension services) and cultural (gender norms) assets in facilitating livelihood strategies. At the same time, the lack of responses in terms of physical infrastructure (water access), the distribution of natural and physical capital (land), and the allocation of domestic and productive activities (time-use burdens) highlights the limited role of community-level physical infrastructure and institutional capacities in these areas.

The findings also correspond to the Gender and Power framework, specifically the need to intervene in gender norms to address the multiple constraints to women's control over productive resources [12]. The initial set of constraints to accessing inputs, which were almost universally reported by the respondents in the control group but nearly absent among the trained women, as well as the positive attitude towards home-garden development reported by the focus group participants, can be used as evidence of shifting gender norms at the community level. The decrease in the prevalence of gender norms as a constraint reported by the focus groups corroborates this point. At the same time, the unchanged burden of time use by women indicates that these norms

still prevent women from achieving a satisfactory balance between their domestic and productive activities. This way, the community-based women's training can be considered as addressing women's practical gender needs, defined as their immediate needs for skills, resources, and support to improve their households' food security without transforming their strategic gender needs, that is, the need to restructure their roles and responsibilities and develop long-term strategic aims [14,16].

This conclusion is supported by findings on similar community-based women's training programs in informal settlements in East and Southern Africa, which also report limited long-term benefits due to the high burden of domestic duties by women unless additional community-level interventions are made [15,17].

Overall, the study findings have several implications for the design of similar programs and policies in other informal settlements. Community-based kitchen gardening training can be considered a successful intervention that lowers initial barriers to home-garden development, increases the adoption of such practices, and helps normalize the status of kitchen gardening as a legitimate activity. Other interventions, however, are needed to ensure long-term increases in yield and address the dietary diversity burden of the constraints to home-gardening in informal settlements of Central Africa. These include engineering interventions targeting water access and alternative water sources, interventions to promote tenure security for informal settlers, and policies supporting the availability of intermediate inputs on credit. As far as the empowerment of women in informal settlements is

Table 6: Ranking of household barriers by dietary diversity cost, training responsiveness, and primary programmatic domain.

Rank	Barrier/challenge	Mean HDDS difference	p	Training-responsive?	Primary programmatic domain
1	Lack of control over land	-2.9	<.001	Not measured directly	Structural / tenure policy
2	Socio-cultural constraints	-2.8	<.001	Yes-largely resolved	Socio-cultural / gender norms
3	Time/labour burden	-2.3	<.001	No-persisted	Structural / gendered domestic labour
4	Limited access to credit	-1.7	<.001	Not measured directly	Economic / financial services
5	Poor market access	-1.2	0.032	Yes-substantially reduced	Market infrastructure

Note: Mean HDDS difference and p-values are drawn from table 3. Training responsiveness for land control and credit access could not be assessed directly because these two barriers were not included in the endline barrier-prevalence module (Table 2); the closest proxy indicators, limited land/space and poor market access, are reported for reference in Table 2 but reflect related, not identical, constructs.

Table 7: Mapping of documented barriers onto Sustainable Livelihoods Framework and Gender and Power Framework dimensions

Barrier category	Sustainable Livelihoods Framework dimension	Gender and Power Framework dimension	Nature of constraint (this study)
Water insufficiency	Vulnerability context (environmental shock, seasonality)	Resource (access to a productive input)	Structural; reduced but not resolved by training
Seeds/input access	Physical capital; structural trend (supply chains)	Resource	Largely addressable; substantially reduced by training
Pests and disease	Vulnerability context (biological shock)	Not primary	Partially addressable; adaptive capacity improved
Land/space constraints	Natural and physical capital; structural trend	Resource (land control)	Structural; persisted among trained households
Time/labour burden	Structural trend (gendered domestic labour)	Agency	Structural; training-resistant
Technical knowledge gaps	Human capital	Not primary	Addressable; near-eliminated by training
Extension access gaps	Institutional structures and processes	Not primary	Addressable via community-based training substituting for formal extension
Climate variability	Vulnerability context	Not primary	Partially addressable; adaptive capacity improved
Socio-cultural/gender norms	Institutional structures, processes and cultural norms	Agency and achievement	Addressable; norm shift observed
Market access	Structural trend (market integration)	Not primary	Partially addressable; dependence reduced for vegetables only

Note: SLF = Sustainable Livelihoods Framework, as applied by Tama et al. [10]. Gender and Power Framework dimensions (resource, agency, achievement) follow Meinzen-Dick et al. [12].

concerned, the findings suggest that the introduction of labor-saving technologies or community-based day-care facilities for children and elderly people can reduce the overall burden of time use by women and have positive downstream effects on their empowerment.

The factors shaping the adoption of kitchen-gardening practices in Goma City are multi-faceted and multifactorial, reflecting the complex political economy of this provincial capital. Armed conflict has hampered the development of private-public partnerships and disrupted agricultural extension services, while also creating adverse conditions for tenure security. Such a context requires a comprehensive response that combines community-based empowerment with infrastructure development at the municipal level to ensure increased farm yields and improved nutritional outcomes.

Limitations

This study has several limitations. First, the quasi-experimental design renders non-randomized confounding a possibility; although equivalence in ten domains was established, it cannot be as strongly relied upon as randomization would allow. Second, the prevalence of perceived barriers was self-reported, making socially sensitive domains such as socio-cultural norms and gender issues potentially subject to recall and response biases. Third, in table 3, the land-control and credit-access items were taken from a different sub-component module used to develop the ten-domain barrier checklist that appears in table 2; the two matrices are not directly comparable, as shown in table 6. Fourth, because the intervention was only followed up after one cropping season, it remains to be seen how long lasting the observed effect will be, especially for socially embedded norms. Finally, although these findings come from an informal settlement in Goma City, generalizability is limited to other similar informal urban settings.

Conclusion

Structured participatory kitchen gardening training reduced technical, informative, environmental, and socio-cultural constraints to home food production for informal-settlement households in Goma City and facilitated a change in gender roles and decision-making pattern around women's involvement in food production at the household level. The study also found several barriers that hindered the informal-settlement households from embracing kitchen gardening, including a lack of access to water, tenure insecurity on land, and the high proportion of time that women have to dedicate to kitchen gardening in addition to their existing roles. For kitchen gardening to promote food security and dietary diversity in informal settlements, there is a need to invest more in water, tenure, credit, and labor-saving technologies

in addition to household-level training. Addressing socio-cultural factors related to gender should also be given due consideration alongside economic support. In addition to training, gender roles in relation to division of labor need to be challenged and alternative approaches that take cognizance of the prevailing gender norms adopted.

List of Abbreviations

CI: Confidence interval; DRC: Democratic Republic of Congo; FGD: Focus group discussion; HDDS: Household Dietary Diversity Score; OR: Odds ratio; SLF: Sustainable Livelihoods Framework.

Declarations

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Conflicts of interest

The authors have no relevant financial or non-financial interests to disclose.

Ethical approval

This study was performed in accordance with the principles of the 1964 Declaration of Helsinki and its later amendments. Approval was granted by the Great Lakes University of Kisumu Scientific and Ethical Review Committee (GLUSERC) [date and approval number to be inserted by the author].

Consent to participate

Informed consent was obtained from all individual household respondents and focus group participants included in the study.

Consent to publish

Not applicable. No individually identifying data, images, or case details are presented in this manuscript; focus group quotations are anonymised and attributed only by discussion number and participant sex.

Data availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Author contributions

Mafuko Nzamura: Conceptualization, Methodology, Data acquisition, Writing-original draft. Leo Ogallo and Agrippina Lubeka: Supervision, Validation, Writing-review and editing.

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