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EFFECT OF COMMUNITY GARDENS ON NUTRITIONAL INTAKE OF RURAL HOUSEHOLDS IN KATSINA STATE, NIGERIA

Ojetola A. J., Abubakar Y., and Ikwuakam O. T.*

Federal College of Education, Katsina.

*Corresponding Author's Email: ikwuosca@yahoo.com

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ABSTRACT: *The study examined effects of community gardening on nutritional intake among rural households in Katsina State. A descriptive survey design was employed using multistage sampling procedure to select 360 rural household participants across three senatorial districts: Katsina Central (KC), Katsina North (KN), and Katsina South (KS). Data on respondents' socioeconomic characteristics, cultivation patterns, benefits, nutritional changes, and constraints were collected using a structured questionnaire and interview schedule. Majority (43.9%) were middle-aged (30-44 years), males (63.3%) from large households (47.2%) size of >9 members with no formal education (43.9%). Staple crops like millet (96.4%), maize and beans (95.3%, and groundnut (92.5%) were highly cultivated. Leafy vegetables showed strong cultivation patterns (79.2%), while fruit cultivation remained minimal. Fresh food access (75.6%) and fitness (75.8%) emerged as primary benefits with majority (53.9%) experiencing high overall benefit levels. Significant nutritional improvements occurred across multiple food groups, with legumes and nuts (72.8%) showing the strongest positive effects followed by leafy vegetables (75.3%). Grains and root crops also demonstrated substantial improvements. Nutritional changes were distributed between high (48.6%) and medium (50.8%) improvement categories. Cost constraint dominated challenges (93.1%), followed by income limitations (91.7%), though 75.6% of participants experienced overall low constraint levels. Statistical analysis revealed significant district-level differences in involvement ($F=44.74$, $p<0.001$), benefits ($F=37.10$, $p<0.001$), nutritional changes ($F=11.90$, $p<0.001$), and constraints ($F=422.24$, $p<0.001$). Regression analysis identified involvement ($\beta=0.102$, $p<0.01$), benefits ($\beta=0.102$, $p<0.05$), and challenges ($\beta=0.273$, $p<0.001$) as significant predictors of nutritional improvements, with district-specific models explaining up to 50% of variation. Community gardening significantly enhances rural household nutritional intake, despite economic constraints. Government should develop programmes that should aim at addressing each district's specific constraints.*

KEYWORDS: community gardening, involvement, nutritional intake, benefits, and constraint.

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INTRODUCTION

In recent years, community gardens have gained attention as a potential strategy to address food insecurity and improve nutritional outcomes in rural areas of developing most countries. This approach is particularly relevant in a state like Katsina, where a major portion of the population relies on agriculture for sustenance and livelihood (Abdullahi, Mouktar and Abubakar 2019). Reportedly, KatsinaState, has faced persistent challenges of food insecurity, malnutritionand strategies to ensuring adequate nutrition for its teaming rural population (Bedru et al 2022)

However, community gardens, defined as shared spaces where local residents collectively cultivate crops, has shown promise in enhancing food security and dietary diversity in various contexts (Lal, 2020). These gardens can potentially address multiple issues including increasing access to fresh produce, diversifying dietary intake, and improving overall food security (Hume et.al 2022).

Akinkuolie, et al (2024b) The potentials of community-based agricultural as an intervention in improving nutritional outcomes has been revealed. Oluwasola (2020)'s study in southwestern Nigeria revealed that participation in community gardening projects was significant factor that determined increased consumption of fruits and vegetables among rural households. Similarly, Ayantoye (2022) found that community-based agricultural initiatives in northern Nigeria led to improved in dietary diversity scores and overall food security status.

However, the specific impact of community gardens on the nutritional intake of rural households in Katsina State remains poorly investigated. It was against this background that the study examined how the practice in rural communities of State affects the nutritional intake of participating households. The study examined the types of crops grown, changes in dietary diversity, and the overall effect on nutrition-related health outcomes.

The outcomes therefore will provide valuable insights for policymakers and development practitioners on the effect the practice. The findings would also inform sustainable strategies for improving nutrition in rural areas of the state and Nigeria as whole.

Statement of the problem

Food insecurity and malnutrition remain persistent challenges in rural areas of Nigeria, particularly in the northern states like Katsina. Despite the country's agricultural potential, most rural population struggles to maintain adequate nutritional intake (Adebayo et al., 2021). Factors such as erratic rainfall patterns, soil degradation, limited access to agricultural inputs are leading determinants of high poverty rates that negatively exacerbate poor dietary and nutritional outcomes

The earlier study of Abdullahi et al. (2019) has revealed that most rural households in Katsina State experienced moderate to severe food insecurity, with children and women being particularly vulnerable to malnutrition. This has been a reason for the prevalence of stunting among children under five in the state. While various interventions have been implemented to address these challenges, their effectiveness unfortunately has been limited.

Community gardening however, has emerged as a potential strategy to improving food security and nutrition in various contexts (Otoadese, Kamara, and Onyango 2025). Despite this, there

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is a notable gap in literature regarding the effectiveness of community gardens specifically in the context of rural Katsina State. However, the unique socioeconomic, cultural, and environmental factors in Katsina State necessitated a targeted investigation into how community gardens might has influenced nutritional intake in this setting. Understanding the potential benefits, challenges, and determinants for its success in the state is therefore crucial in developing effective sustainable interventions to remedy the persistent problems of food insecurity and malnutrition. The study, therefore, was aimed at addressing such knowledge gap by examining the effect of community gardens on the nutritional intake of rural households in the state. By doing so, informed policy and interventions will be made towards improving food security and nutrition in the state.

Objectives of the study

The study generally aimed at examining the effect of community Gardens on the nutritional intake of rural households in Katsina State. The specific objectives are to:

1. Identify types of crops produced in community gardens in the State
2. Find out households' level of involvement in community gardens
3. Examine benefits households derived from participation in community gardens
4. Find out effect of community gardens on the nutritional intake of participating households
5. Identify constraints associated with community gardens

LITERATURE REVIEW

Community gardens have gained increasing attention as a potential solution to food insecurity and malnutrition in developing countries. Otoadese, et al (2025). conducted a comprehensive review of community garden initiatives across sub-Saharan Africa, highlighting their potential to improve food availability and dietary diversity. Their study found that community gardens contributed to a 15-20% increase in household vegetable consumption in rural areas.

In the Nigerian context, Folorunso and Makiwin (2022) examined the community gardens' impact on food security in rural communities across three northern states. Their findings indicated that households participating in community garden projects experienced a 30% reduction in food insecurity compared to non-participating households. This study underscores the potential of community gardens as a strategy to enhance food security in regions similar to Katsina State.

Also, the link between community gardens and improved nutritional outcomes has been explored in several recent studies. Hume, et. al (2022) conducted a longitudinal study in southeastern Nigeria, examining the nutritional status of children in households involved in community gardening. They observed a significant improvement in dietary diversity scores and a 25% reduction in stunting rates among children from participating households over a two-year period.

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Similarly, Mohammad, Abu, Rahnuma, Shaila and Raihan (2020) investigated the impact of community gardens on micronutrient deficiencies in rural Kano State, a region geographically proximate to Katsina. Their research revealed that regular consumption of produce from community gardens was associated with a 40% decrease in vitamin A deficiency and a 35% reduction in iron deficiency anemia among women and children. They found that surplus produce from these gardens contributed to household income, with an average increase in disposable income. This economic benefit could indirectly contribute to improved nutrition by increasing the household's capacity to purchase a wider variety of foods.

Udegbunam et. al (2023)'s study revealed the challenges to include issues such as erratic rainfall, soil degradation, and limited access to agricultural inputs. Obi-Egbedi, Hinmikaiye, and Balogun, (2022) have also noted challenges such as water scarcity and the need for better organizational structures to sustain these gardens.

Despite these potential benefits, community gardens face several challenges in rural Nigeria. Majebi, Agbebaku, & Orimaye (2024) identified water scarcity, lack of technical knowledge, and limited access to quality seeds as major obstacles to the sustainability of community gardens in arid regions of northern Nigeria. Their work emphasizes the need for comprehensive support systems to ensure the long-term success of these initiatives.

METHODOLOGY

The study was carried out in Katsina State located in North-Western zone of Nigeria. The state, covers an area of 23,938 sq. km and is located between latitudes 11Â°08'N and 13Â°22'N and longitudes 6Â°52'E and 9Â°20'E (Adewale, Olowu & Ladele2005). Katsina State has 34 LGAs from three senatorial districts, shares common boundary with Niger Republic in the north, Jigawa and Kano States in the east, Kaduna State in the South and Zamfara State in the West. All rural households were the targeted population.

Multistage sampling procedure was used for the study. In the first stage, 16 rural LGAs were selected from the state's three senatorial districts due to the rural attributes they possessed. Of the 16 LGAs selected, five LGAs (30%) (Batsari, jibiya, DanMusa, Kafur and Baure) were selected purposively based on their agricultural activities and the presence of community gardens.

The second stage involved a random selection of 8 villages from each selected LGAs to give 40 villages. In the third stage, snowball technique was used to identify households involved in community gardens. Using systematic sampling technique, three households were selected from the list of identified households in each village to give 120 households. The fourth stage will involve using purposive sampling procedure to sample three household members from each selected households to give 216, 72, and 72 respondents from Katsina Central Senatorial District, Katsina South Senatorial District and Katsina North Senatorial District respectively. This gave a total of sample size of 360 respondents that was used for the study.

A descriptive survey design was adopted for the study due to its high propensity of inclusiveness and ease with which participants' opinions on the variables under study were obtained. A structured interview schedule (for the non-literate) and structured questionnaire were developed, validated and tested for reliability using Cronbach Alpha. A reliability index

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of .085 was obtained and adjudged good for the instrument. The data collection instrument comprised of sections A, B, C and D based on the objectives of the study (types of crops produced in community gardens, households' level of involvement in community gardens, effect of community gardens on nutritional intake of participating households and constraints associated with community gardens).

These variables were measured as follows: types of crops produced in community gardens will be measured on a 4 – point Likert type of scale of always (3), occasionally (2) rarely (1), Never (0). The mean score will be determined and used to rank the crops produced. Households' level of involvement in community gardens will be determined using a three-point scale of Not at all = 0, Occasionally = 1, Always = 2. The mean score and standard deviation will be generated and used to categorize households into low (< mean ± 1SD), moderate (within mean ± 1SD) and high (> mean ± 1SD) levels of involvement.

In measuring community garden's effect on nutritional intake of households, a 5-point Likert scale of daily = 5, weekly = 4, and fortnightly =3, monthly =2 and never = 1.The mean scores obtained were used to categorize households into scores below the mean value as having low nutritional intake rate, while those whose mean scores equal or greater that the mean score were adjudged as having high level of nutritional intake,

Constraint to involvement in community garden was measured on a 4-point scale of very strong = 4, strong = 3, rarely = 2, not at all = 1. The mean scores and standard deviation so obtained were used to categorize the constraints into low (< mean ± 1SD), moderate (within mean ± 1SD) and high (> mean ± 1SD) levels of constraints. Data analysis was carried out using descriptive (frequency counts, mean, standard deviation and percentages) and inferential (ANOVA and regression) statistics.

RESULTS

Socioeconomic characteristics of respondents

Table 1 presents the socioeconomic characteristics of respondents across the state. The results revealed that respondents were predominantly middle-aged, with the largest group (43.9%) falling in the 30-44 age range, followed by 35.8% in the 45-59 age bracket. Only 14.2% were young adults (18-29), and a small proportion (6.1%) was elderly (60+). There was a striking gender disparity across the districts. KC showed a more balanced gender distribution (61.1% female, 38.9% male), while KN and KS were exclusively male (100%). Overall, males constituted 63.3%, indicating that community gardening was predominantly a male-dominated activity, except in KC. Large households (47.2%) of >9 members were most common followed by households (35.6%) with 5-8 members while households (17.2%) had 1-4 members. Educational attainment varied across districts. KC had the highest proportion of respondents with no formal education (60.6%), while KN and KS showed better educational profiles with more secondary and tertiary education. Overall, 43.9% had no formal education, primary education (21.7%), secondary education (26.1%), and tertiary education (8.3%). Experience in community gardening showed interesting patterns. Most respondents (43.1%) had medium experience (10-24 years), 38.6% had low experience (<10 years), and 18.3% were highly experienced (25+ years). KN and KS communities showed higher proportions of experienced

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gardeners compared to KC. Medium-sized gardens (2-3 hectares) were predominant overall (54.4%), large gardens (4+ hectares) represented 33.1% and small gardens (≤1 unit) accounted for 12.5%. KC showed more large gardens (54.2%), while KN and KS predominantly had medium-sized plots.

Table 1: respondents' socioeconomic characteristics

Variable	KC	KN	KS	Overall
Age:				
18-29	13.9	18.1	11.1	14.2
30-44	42.6	41.7	50	43.9
45-59	34.7	36.1	38.9	35.8
60+	8.8	4.2	0	6.1
Gender:				
Female	61.1	0	0	36.7
Male	38.9	100	100	63.3
Household size				
Large (9+)	53.7	41.7	33.3	47.2
Medium (5-8)	31.9	34.7	47.2	35.6
Small (1-4)	14.4	23.6	19.4	17.2
Education level:				
No formal education	60.6	22.2	15.3	43.9
Primary	25	15.3	18.1	21.7
Secondary	13.4	43.1	47.2	26.1
Tertiary	0.9	19.4	19.4	8.3
Years of experience:				
High (25+ years)	5.6	31.9	43.1	18.3
Low (<10 years)	56.9	11.1	11.1	38.6
Medium (10-24 years)	37.5	56.9	45.8	43.1
Garden Size:				
Large (4+)	54.2	2.8	0	33.1
Medium (2-3)	41.2	73.6	75	54.4
Small (≤1)	4.6	23.6	25	12.5

Involvement

Table 2 presents results on the cultivation patterns of various food crops among community garden participants across the state. From the results, millet (96.4%) showed highest cultivation frequency. The overall mean score was 3.97, with KS showing the highest involvement (4.0). Maize and beans demonstrated very high cultivation rates, with 95.3% of respondents always cultivating these crops. Both crops had overall mean scores of 3.94. Rice (9.4%) was always with 56.9% never cultivating it. The overall mean score was 1.81, with KC and KS districts showing identical means of 1.89, while KN had the lowest at 1.47. Groundnut (92.5%) was cultivated always with overall mean score of 3.91.

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Cassava presented a mixed cultivation pattern with 37.5% always cultivating it and 49.8% sometimes. The overall mean score was 3.2, with KN community showing the highest involvement (3.35). Potato showed moderate cultivation with 22.5% always cultivating it and 36.9% sometimes cultivating it with overall mean score of 2.48.

Leafy vegetables were cultivated always (79.2%). Overall (mean 3.78) cultivated vegetables, with KN and KS showing perfect scores of 4.0 and 3.99 respectively. Cabbage was cultivated by 58.6% always. Overall (mean 3.36) with KN (3.72) and KS (3.99) having higher involvement than KC (3.04). Cucumber (48.6%) was always cultivation. The overall cultivation mean score was 3.09, with variation across districts (KC 2.58, KN 3.69, and KS 3.99). Carrot (47.8%) was cultivated always but 31.9% never cultivated it. The overall cultivation mean score was 2.74, with differences between KC (2.0) and KN (3.71), and KS (3.97).Water melon showed balanced cultivation with 43.9% always cultivating it and 46.4% sometimes with overall cultivation mean score of 3.3.

Orange had lowest cultivation rate with only 0.3% always and 77.2% never with overall mean score cultivation of 1.24. Pawpaw showed minimal cultivation with 1.1% always and 73.6% never. The overall mean cultivation was 1.32. Guava was cultivated always by 0.8% while 70.8% never. The overall mean score cultivation was 1.34. Mango showed slightly better cultivation than other fruits with 6.1% always cultivating it, though 31.1% never and 30.6% rarely with overall mean score cultivation of 2.13. Table 2b however, presents summary of the level of involvement in community garden crops across state. The result revealed that overall (56.1%) showed medium level of involvement, with variation between districts. KS (80.6%), and KN (61.1%) had high rate of involvement while KC (74.5%) showed medium involvement rate.

Table 2: respondents' involvement

Variable	Always	Never	Rarely	Sometimes	KC	KN	KS	Overall
Rice	9.4	56.9	14.7	18.9	1.89	1.47	1.89	1.81
Beans	95.3	0.6	0.3	3.9	3.93	3.96	3.96	3.94
Maize	95.3	0.3	0.3	4.2	3.94	3.9	3.99	3.94
Millet	96.4	0.0	0.0	3.6	3.95	3.97	4	3.97
Cassava	37.5	5.0	7.8	49.8	3.12	3.35	3.28	3.2
Groundnut	92.5	0.3	0.8	6.4	3.92	3.89	3.93	3.91
Leafy vegetables	79.2	0.3	1.1	19.4	3.64	4	3.99	3.78
Orange	0.3	77.2	21.4	1.1	1.37	1.08	1.03	1.24
Mango	6.1	31.1	30.6	32.2	2.23	1.89	2.1	2.13
Pawpaw	1.1	73.6	21.7	3.6	1.48	1.14	1.04	1.32
Guava	0.8	70.8	23.9	4.6	1.41	1.3	1.15	1.34
Water melon	43.9	4.7	5.0	46.4	3.1	3.36	3.82	3.3
Cucumber	48.6	15.3	9.4	26.7	2.58	3.69	3.99	3.09
Cabbage	58.6	8.1	6.1	27.2	3.04	3.72	3.99	3.36
Carrot	47.8	31.9	10.3	10.0	2	3.71	3.97	2.74
Potato	22.5	34.4	6.1	36.9	2.05	3.14	3.1	2.48

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Table 2b: level of involvement in community garden

Variable	Level	KC	KN	KS	Overall	Min	Max	Mean	SD
Involvement	High	24.5	61.1	80.6	43.1	1.875	3.500	2.844	0.337
	Low	0.9	1.4	0.0	0.8				
	Medium	74.5	37.5	19.4	56.1				

Benefits derived from community garden

Table 3 presents the benefits derived from community garden participation. Results revealed that fresh foods (75.6%) emerged as most valued benefit with overall mean score of 2.75. KS (2.99) showed the highest appreciation, followed by KN (2.93) and KC (2.61). Fitness (75.8%) showed similar patterns to fresh foods. Overall benefit mean score was 2.76, with KS (2.99) and KN (2.94) district showing higher benefit compared to KC (2.62). Plant Knowledge (62.8%) was also rated high with 36.9% considering it a mild benefit. Overall (mean = 2.63) rated it high, with notable variations across districts: KN (mean = 3.0) and KS (mean = 2.99) while KC scored lower (mean = 2.39). Decision making showed moderate benefit perception, with 25% rating it highly beneficial and 74.7% as mild. The overall mean score was 2.25, with KN having the highest score (2.39), followed by KC (2.27) and KS (2.07). Problem solving (20.6%) was perceived as high benefit while 79.2% considered it a mild. The overall mean score was 2.21, with KC having the highest score (2.26), followed by KN (2.21) and KS (2.04). Negotiation skills (80.6%) benefit was rated mild with overall mean score of 2.14, KC (2.26), while KN (1.94) and KS (2.0). Benefit to community was rated high by 59.4%, 39.7% considered it mild benefit with overall mean score of 2.59, KS (2.96) and KN (2.88) compared to KC (2.37).

Table 3b presents also the categorization of level of benefits derived across the study area. The result revealed that overall (53.9%) had high benefits level while across the districts, KS (94.4%) showed the highest benefit level followed by KN (76.4%), and KC (66.7%) had moderate benefit level.

Table 3a: respondents' benefits derived from community garden

Variable	High	Mild	Not a benefit	KC	KN	KS	Overall
Fresh Foods	75.6	23.6	0.8	2.61	2.93	2.99	2.75
Fitness	75.8	24.2	0	2.62	2.94	2.99	2.76
Plant Knowledge	62.8	36.9	0.3	2.39	3	2.99	2.63
Decision Making	25	74.7	0.3	2.27	2.39	2.07	2.25
Problem Solving	20.6	79.2	0.3	2.26	2.21	2.04	2.21
Negotiation	16.7	80.6	2.8	2.26	1.94	2	2.14
Benefit Community	59.4	39.7	0.8	2.37	2.88	2.96	2.59

Table 3b: level of benefit

Variable	Level	KC	KN	KS	Overall	Min	Max	Mean	SD
Benefit	High	32.9	76.4	94.4	53.9	1.857	3.000	2.474	0.239
	Low	0.5	0.0	0.0	0.3				
	Medium	66.7	23.6	5.6	45.8				

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Effects of community gardens on nutritional intake of rural households

Table 4 presents results on effects of community garden participation on nutritional intake among rural households in the state. The results revealed that grains (63.6%) showed significant increase, and 33.3% having slight consumption increase. Overall (mean 2.65), had significant effect. KS (mean 2.74) recorded significant effect followed by KC (2.71) and KN (2.38). Legumes and nuts demonstrated positive effects, with 72.8% reporting significant increases and 27.2% reporting slight increases. No respondents experienced decreases or reported no change. Overall (mean 2.73) was significantly high. KS (mean = 2.82) had showed highest appreciation followed by KN (mean = 2.75) and KC (mean = 2.69). Roots (45.8%) and tubers (51.7%) recorded slight increase. Using mean values, significant effect was recorded overall (2.47). KC (2.53) had significant effect followed by KN (2.42) and KS (2.32).

Dairy products (65.0%) intake slightly increased, Overall (mean = 2.27) recorded significant effect in their nutritional intake. KC (2.41) had highest mean intake score followed by KN (2.18) and KS (2.00). Fish consumption (66.1%) showed similar patterns of slight increases. The overall mean score was 2.27, with KC (2.39) performing best followed by KN (2.21) and KS (2.00). Meat (27.2%) consumption significantly increased 61.4% had slight increase. Overall (2.30) had significant increase. KC (2.42) showed the highest mean score followed by KN (2.29), and KS at 2.01 for increased nutritional intake increase. Eggs consumption (26.7%) significantly increases, 62.5% had slight increased. Using mean scores, overall (2.28) recorded significant increase. AT district level, KC (2.41) led in having significant increase, followed by KN (2.25) and KS (2.00).

Vegetables intake demonstrated strongest shift with intake of leafy vegetables (75.3%) significantly increased. Also overall (mean = 2.75) had significant increase. Consumption in KN (2.94) and KS (2.92) also increase more than KC (mean 2.64). Cabbage consumption (62.2%) increased significantly. Overall (mean = 2.62) had significant intake increase with KN and KS both achieving mean scores of 2.97, more than KC (2.39). Carrot showed 55.6% significant increase, and 38.1% had slight increase. Significant increase was reported by overall (mean = 2.54, with KS (2.99) and KN (2.97) having higher scores than KC (2.23).

Potatoes consumption (41.9%) significantly increased while 45.0% had slight increase. It was also significant among overall (mean = 2.35), with KN having the highest score (mean = 2.68), followed by KS (mean =2.36) and KC (2.22). Fruit consumption showed moderate (46.1%) and slight (53.1%) increases. It significantly increased among overall (mean = 2.46). Across the districts, KN (2.69) showed increased mean intake score followed by KS (2.50) and KC (2.38).

Table 4b presents also the categorization of nutritional change level across the study area. The result revealed that overall; nutritional changes were almost evenly distributed between high (48.6%) and medium (50.8%). KN (52.8%) and KS 47.2% showed identical medium while KC (52.8% had high rate of change.

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Table 4a: Effects of community gardens on nutritional intake

Variable	Decreased slightly	Increased significantly	Increased slightly	No change	KC	KN	KS	overall
Grains	2.2	63.6	33.3	0.9	2.71	2.38	2.74	2.65
Roots Tubers	2.2	45.8	51.7	0.3	2.53	2.42	2.32	2.47
Legumes Nuts	0.0	72.8	27.2	0.0	2.69	2.75	2.82	2.73
Dairy	9.7	24.7	65.0	0.6	2.41	2.18	2.00	2.27
Fish	8.1	25.0	66.1	0.9	2.39	2.21	2.00	2.27
Meat	10.6	27.2	61.4	0.9	2.42	2.29	2.01	2.30
Eggs	9.4	26.7	62.5	1.4	2.41	2.25	2.00	2.28
Leafy Veg	0.3	75.3	24.4	0.0	2.64	2.94	2.92	2.75
Fruit	0.8	46.1	53.1	0.0	2.38	2.69	2.50	2.46
Cabbage	0.3	62.2	37.5	0.0	2.39	2.97	2.97	2.62
Carrot	3.1	55.6	38.1	3.3	2.23	2.97	2.99	2.54
Potatoes	4.2	41.9	45	8.9	2.22	2.68	2.36	2.35

Table 4b: level of nutritional change

Variable	Level	KC	KN	KS	Overall	Min	Max	Mean	SD
Benefit	High	45.8	52.8	52.8	48.6	1.917	3.000	2.459	0.214
	Low	0.9	0.0	0.0	0.6				
	Medium	53.2	47.2	47.2	50.8				

Constraints to rural household nutritional intake

The Table 5 presents constraints to nutritional intake of rural household participating in community gardening across in Katsina State. Results showed that cost (93.1%) emerged as a serious constraint, while 5.8% considered it mild and 1.1% did not. The mean scores also showed it was a serious constraint among overall (2.94). Across the districts, KN and KS both showed maximum mean cores of 3.0, while KC scored 2.9. Income (91.7%) was also a serious constraint. Across the district, KN and KS, both mean scores of 3.0 considered it serious than KC scored 2.87. Religion showed mixed constraint levels, with 22.8% considering it a serious constraint, 15.6% mild, and 61.7% not a constraint. Using mean scores also overall (2.59) considered it a serious constraint. KN (2.87), followed by KS (2.31) and KC (2.2) also considered it serious. Food access was also rated serious constraint 46.9%, 37.2% as mild, and 15.8% not a constraint. Overall (mean 2.56) view it a serious constraint. KS (2.99) showed the highest mean score , followed by KN (2.9) and KC (2.21). Health and allergies showed balanced constraint perception, with 26.9% considering it serious, 27.8% mild, and 45.3% not a constraint. Overall (mean = 2.49) reported it as serious constraint also. KN (2.97) showed the highest mean score, followed by KC (2.13) and KS (2.33). Crop diversity (39.7%) was seen as serious constraint, mild by 45.6%, and not a constraint by 14.7%. Overall (mean = 2.47), KS (2.97), followed by KN (2.72) and KC (2.13) reported it as serious. Tradition showed low constraint levels, with only 14.2% considered it serious, 25% mild, and 60.8% not a constraint. Using mean score, overall (2.36) reported it serious constraint. In KN, it had the highest mean

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score (2.58), followed by KS (2.16) and KC (2.0) as mild constraint. Household size was a serious constraint to only 8.6% of respondents, while 49.4% mild and 41.9% did not. Overall (mean = 2.15) had it as serious constraint. In KC, it recorded the highest score (mean = 2.2), followed by KN (2.09) and KS (2.0) as mild constraint. Garden size showed the lowest constraint levels, with only 9.4% considering it serious, 60.6% viewed mild, and 30% not a constraint. It was also mild among overall 2.13, with KC having the highest score (2.2), followed by KN (2.09) and KS (2.04). Household background was the least serious constraint, with only 2% considering it serious, 40.3% as mild, and 57.8% not a constraint. Overall (mean = 2.04) reported it not a serious constraint with KC showing highest score (2.07), followed by KN (2.03) and KS (2.0).

Table 5b shows the categorization of constraint level across the state. The result revealed that overall; majority (75.6%) experienced low constraints to nutritional intake. However, variation existed between districts. KC had low constraints (97.7%), KN had high constraints (88.9%), and KS showed moderate constraint levels (73.6%).

Table 5a: Constraints to rural household nutritional intake

Variable	Mild	Not a constraint	Serious	KC	KN	KS	Overall
Income	8.1	0.3	91.7	2.87	3	3	2.92
Religion	15.6	61.7	22.8	2.2	2.87	2.31	2.59
Tradition	25	60.8	14.2	2	2.58	2.16	2.36
Crop Diversity	45.6	14.7	39.7	2.13	2.72	2.97	2.47
Health Allergies	27.8	45.3	26.9	2.13	2.97	2.33	2.49
Household background	40.3	57.8	2	2.07	2.03	2	2.04
Cost	5.8	1.1	93.1	2.9	3	3	2.94
Food Access	37.2	15.8	46.9	2.21	2.9	2.99	2.56
Household Size	49.4	41.9	8.6	2.2	2.09	2	2.15
Garden Size	60.6	30	9.4	2.2	2.09	2.04	2.13

Table 5b: level of constraint

Variable	Level	KC	KN	KS	Overall	Min	Max	Mean	SD
Benefit	High	2.3	88.9	26.4	24.4	2.000	2.800	2.354	0.192
	Low	97.7	11.1	73.6	75.6				
	Medium	0.0	0.0	0.0	0.0				

Test of differences

The ANOVA analysis examined differences involvement, benefits, nutrition changes, and constraints across the three districts. The results revealed significant differences in involvement levels across the districts ($F(2,357) = 44.74$, $p < 0.001$). The between-group sum of squares was 8.15, while the within-group sum of squares was 32.53, with a mean square error of 0.09. Benefits derived also showed significant differences across the districts ($F(2,357) = 37.10$, $p < 0.001$). The between-group variation (sum of squares = 3.53) was substantial compared to

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within-group variation (sum of squares = 16.99), with a mean square error of 0.05. Nutrition changes showed significant differences ($F(2,357) = 11.90$, $p < 0.001$). The between-group sum of squares was 1.03, while the within-group sum of squares was 15.39, with a mean square error of 0.04. Constraint showed pronounced differences across the districts ($F(2,357) = 422.24$, $p < 0.001$). This showed the largest F-value among all composites, with between-group sum of squares of 9.32 and within-group sum of squares of 3.94, indicating substantial district-level differences in constraint experiences.

The Post-hoc analysis results revealed that KC showed higher involvement than KN (mean = 0.25, $p < 0.001$), KC had higher involvement than KS (mean = 0.35, $p < 0.001$). No significant difference occurred between KN and KS (mean = 0.10, $p = 0.098$). On benefits, KC had higher benefits than KN (mean = 0.22, $p < 0.001$) while KC showed higher than KS (mean = 0.18, $p < 0.001$). No significant difference was observed between KN and KS (mean = -0.04, $p = 0.554$). Also, result on nutrition changes showed that KC experienced greater nutritional changes than KN (mean = 0.14, $p < 0.001$). No significant difference was found between KC and KS (mean = 0.05, $p = 0.237$). KS had greater nutritional changes than KN (mean = -0.09, $p = 0.023$). Constraint was higher in KC than KN (difference = 0.39, $p < 0.001$) and higher than KS (mean = 0.23, $p < 0.001$). Between KN and KS, the result showed that KN experienced barriers higher than KS (mean = -0.16, $p < 0.001$).

Table 6a: ANOVA on involvement, benefits, nutritional changes and constraints

Varibles	Source	Df	Sum_Sq	Mean_Sq	F_value	Pr_F	Sig.
Involvement	Senatorial District	2	8.1546	4.0773	44.7427	0.000	***
	Residuals	357	32.5327	0.0911			
Benefits	Senatorial District	2	3.5324	1.7662	37.0979	0.000	***
	Residuals	357	16.9962	0.0476			
Nutrition Changes	Senatorial District	2	1.0264	0.5132	11.9044	0.000	***
	Residuals	357	15.3898	0.0431			
Barriers	Senatorial District	2	9.315	4.6575	422.2411	0.000	***
	Residuals	357	3.9379	0.011			

Table 6b: Posthoc analysis

Comparison	District Comparison	Difference	p_adj	Significance
Involvement	KC-KN	0.2477	0.000	***
	KC-KS	0.3519	0.000	***
	KN-KS	0.1042	0.0975	ns
Benefits	KC-KN	0.2196	0.000	***
	KC-KS	0.1819	0.000	***
	KN-KS	-0.0377	0.5542	ns
Nutrition Changes	KC-KN	0.1373	0.000	***
	KC-KS	0.0459	0.2365	ns
	KN-KS	-0.0914	0.0233	*

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Barriers	KC-KN	0.3912	0.000	***
	KC-KS	0.2329	0.000	***
	KN-KS	-0.1583	0.000	***

Determinants of nutritional changes

The regression analysis results revealed that KS model demonstrated the strongest explanatory power, accounting for approximately 50% of the variation in nutritional changes, while KN model was not statistically significant. The overall sample results revealed that involvement ($\beta = 0.102$, $p < 0.01$), benefits ($\beta = 0.102$, $p < 0.05$) and challenges ($\beta = 0.273$, $p < 0.001$) predicted nutritional changes. Age, household size, years of experience, garden size, and all education levels showed no significant associations with nutritional changes in the overall model. District-specific results revealed that in KC, involvement ($\beta = 0.126$, $p < 0.01$), benefits ($\beta = 0.147$, $p < 0.01$) predicted nutritional improvements. Other variables including barriers, age, and education showed no significant effects. In KN district, the model was not statistically significant ($p = 0.430$), indicating that the included variables did not adequately explain nutritional changes in this district. In KS district involvement ($\beta = 0.220$, $p < 0.05$), age ($\beta = 0.006$, $p < 0.05$), household size ($\beta = -0.014$, $p < 0.05$), benefits ($\beta = 0.586$, $p < 0.001$): constraints ($\beta = 0.270$, $p < 0.01$) determined the nutritional changes.

Table 6: Regression analysis on determinants of nutritional change

Variable	Overall	KC	KN	KS
(Intercept)	1.2223 (0.2145)***	1.31004 (0.36745)***	1.76716 (0.96142)	-0.45124 (0.48987)
age	0.00208 (0.00142)	0.00267 (0.00160)	-0.00796 (0.00624)	0.00569 (0.00281)*
Household size	-0.00273 (0.00281)	-0.00286 (0.00318)	0.00958 (0.01119)	-0.01364 (0.00677)*
Experience	-0.00045 (0.00153)	-0.00160 (0.00265)	0.00483 (0.00521)	-0.00100 (0.00212)
Garden size	0.00140 (0.00222)	0.00131 (0.00224)	0.01626 (0.05157)	-0.00519 (0.02179)
Involvement_composite	0.10228 (0.03753)**	0.12599 (0.04469)**	-0.05263 (0.12811)	0.21967 (0.09486)*
Benefits_composite	0.10216 (0.04944)*	0.14745 (0.05480)**	-0.09977 (0.21738)	0.58622 (0.11939)***
Barriers_composite	0.27343 (0.07974)***	0.14917 (0.14459)	0.49676 (0.30620)	0.27009 (0.10164)**
Edu_primary	-0.03095 (0.02666)	-0.01950 (0.02937)	0.07956 (0.10893)	0.02931 (0.04231)
Edu_secondary	0.05182 (0.02904)	0.04298 (0.03468)	-0.00255 (0.09954)	-0.06645 (0.04765)
Edu_tertiary	-0.00805 (0.03458)	0.06447 (0.04839)	0.04981 (0.11080)	-0.02285 (0.05247)

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R_squared	0.13342	0.13987	0.14444	0.49757
Adj_R_squared	0.10603	0.09349	0.00419	0.4152
F_statistic	4.87066	3.01579	1.02986	6.04097
p_value	5.16E-07	0.00095	0.429815	2.63E-06

DISCUSSION OF FINDINGS

The study investigated the effects of community gardens on nutritional intake among rural households in Katsina State. The predominance of middle-aged participants and large household size of above nine people suggest that community gardening attracted households with food security responsibilities and productive capacity. The gender disparity, with males constituting majority overall, but with more balanced participation in KC reflects cultural and social dynamics in the state where women's agricultural participation varies by location and preferences. These results conform to Ikwuakam & Iyela (2015)'s findings on rural women's involvement in crop production in Malumfashi and Kaita Local Government Areas of Katsina State.

Also, that most participants had no formal education, yet actively engaged in community gardening indicates that community gardens served population with limited formal education but significant indigenous practical knowledge and motivation to improve household food security. This result is in tandem with Machida (2019)'s finding that traditional agricultural knowledge and experiential learning play crucial roles in food production systems across sub-Saharan Africa. The phenomenon is particularly relevant given that food insecurity remains a persistent challenge in rural Nigeria (Udegbunam et al. 2023)

The impressive levels of involvement from medium to high engagements indicates a remarkable crop diversification, with staple crops like millet, maize and beans being predominant. The scenario is in conformity with Abdullahi et al. (2024), who emphasized the critical role of millet cultivation in the Sudano-Sahelian region, in addressing climate change impacts on food security. This implies that farm production diversity is associated with household dietary diversity in the state, and supports Muhammad-Lawal's (2023) finding on diverse nature of achieving food security in Nigerian contexts.

The high cultivation rates of leafy vegetables and other vegetables were another indication that community gardening was associated with higher fruit and vegetable intake. This finding resonates with Lal's (2020) observations on how home gardening and urban agriculture advance food and nutritional security, particularly in response to food system disruptions. The moderate cultivation of fruits like orange, pawpaw, and guava suggests potential areas for intervention, as fruits are crucial for micro-nutrient adequacy and overall dietary quality.

The study's most significant finding was the substantial nutritional improvements. Overall, most households experienced medium to high nutritional changes, with strong effects on vegetable consumption. This finding supports the systematic review by Hume et al. (2022), which demonstrates that community gardens have positive effects on diet, health, and psycho-social outcomes, with fruit and vegetable intake being the most frequently reported improvement.

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Improvements in legume and nuts consumption are noteworthy, as these foods are critical protein sources in plant-based diets common in rural Nigeria. The finding is significant given the context of food insecurity in Katsina State, as documented by Abdullahi et al. (2019), who identified various determinants of food insecurity in the region. The enhanced consumption of plant-based proteins provides a viable pathway for addressing possible protein deficiency in households with limited access to animal-source foods. Moderate improvements in animal-source foods (dairy, fish, meat, and eggs) reflect both economic constraints and the primary focus of community gardens on plant-based foods. This is consistent with Bedru et al. (2023) who found that food insecurity and dietary diversity challenges in Nigeria are often compounded by economic factors, especially in rural areas.

The regression analysis results revealed that involvement, benefits and constraints predicted nutritional changes in the overall sample. Such multi factorial determination of outcomes indicates the complex pathways through which community gardens influence nutrition outcomes. The strongest performance in KS suggests that certain contextual factors created more favorable conditions for community garden success, possibly related to climatic conditions, infrastructure, or social dynamics that vary across the state's ecological zones. This variability corroborates with Obi-Egbedi et al. (2022)'s work on how climate change adaptive strategies and food security outcomes vary across different rural contexts in Nigeria. The variation however, implies the need for location-specific strategies when implementing community garden interventions.

CONCLUSION

This study provides compelling evidence that community gardens can improve nutritional intake among rural households. The high levels of involvement, benefit, and improvements in vegetable and legume consumption, suggest that community gardens is a viable option in addressing nutritional challenges in Katsina State. The district-level variations indicate the importance of considering local contexts when implementing interventions. Similarly, the identification of key constraints provides guidance for programme improvement. The multidimensional benefits as observed in the study support the value of community garden as a robust development interventions worth exploring even in other states. As Nigeria keep grappling with persistent food security and nutrition challenges, community gardens offer a promising approach that builds on local knowledge, strengthens community capacity, and provides tangible improvements in household dietary quality. The evidence from Katsina State therefore suggests that with appropriate support and context-sensitive implementation, community gardens can make meaningful contributions to nutritional security in rural Nigerian communities.

RECOMMENDATIONS

Based on the findings of the study, the state government should:

1. Promptly develop tailored programmes for each district (KN and KC) based on their specific conditions, building on the success seen in KS district

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2. mainstream community gardens into state food security and agricultural development policies to ensure sustainable support
3. support adult literacy programmes combined with agricultural extension services, using visual/audio materials and farmer-to-farmer knowledge sharing
4. prioritize fruit growing through subsidized seedlings, specialized training, and processing/preservation education to improve micro-nutrient intake
5. explore combining crop production with small livestock (poultry, rabbits) to enhance protein sources while maintaining plant-based focus
6. create women-specific garden groups with flexible scheduling to accommodate domestic responsibilities and increase female participation

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