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AGRICULTURAL STUDIES

CLIMATE CHANGE ADAPTIVE STRATEGIES FOR FOOD SECURITY AMONG SMALLHOLDER FARMERS IN KIKUMBULYU NORTH WARD, MAKUENI COUNTY, KENYA

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ABSTRACT

Purpose of the study: The study aimed at determining the effect of producing adapted drought-resistant crop species on food security in Kikumbulyu North Ward, Makueni County.

Statement of the problem: Kenya faces persistent food insecurity, worsened by climate change, and despite extensive studies on climate impacts in agriculture, limited research exists on how smallholder farmers' adoption of drought-resistant crop species contributes to enhancing food security.

Research methodology: The study used a survey design with semi-structured questionnaires on 367 smallholder farmers in Kikumbulyu North Ward, Makueni County, collecting both qualitative and quantitative data. Analysis was done using SPSS, with thematic review for qualitative data, descriptive statistics for quantitative data, and Pearson's Chi-square tests to examine associations.

Findings: The findings revealed that drought-resistant crops such as green grams, pigeon peas, sorghum, millet, and especially cassava significantly improved food security. Food security was also higher among female-led households, smaller households, individuals with higher education, and those in the middle-age bracket (36–55 years).

Conclusion: The study concludes that the adoption of drought-resistant crops, particularly cassava, significantly enhances household food security among smallholder farmers in Kikumbulyu North Ward.

Recommendation: The study recommends strengthening seed systems, extension services, and market access to enhance the adoption and impact of drought-resistant crops on food security.

Key words: *climate change, smallholder farmers, drought-resistant crops, food security*

INTRODUCTION

Climate change continues to gain increased attention in Kenya as its impacts become evident. According to Pindyck (2013), climate change refers to sustained alterations in weather patterns over long periods characterized by aspects like fluctuations in rainfall and temperature levels. Changes induced by human activity are referred to as anthropogenic climate change, which are a result of GHG (greenhouse gas) emissions. According to the World Bank (2021), over 70% of all natural disasters in Kenya are related to climate change. The most visible results of climate change in Kenya include irregular precipitation, flooding, prolonged droughts, rising temperatures, and low food security. Food security is the access to safe, nutritious and sufficient food that fulfills the nutritional needs and individual likes for a healthy and productive life (Bjornlund et al., 2022).

The climate effect on food security is due to alterations in agricultural productivity in certain regions. The study area in Makueni county, is significantly impacted by irregular precipitation and increased droughts, leading to food insecurity. In the face of climate change, smallholder farmers are increasing the uptake of drought-resistant crops as an adaptation mechanism. Drought resistance is the capacity of a plant to grow and reproduce effectively under the conditions of limited water supply (Rosero et al., 2020).

Despite the potential of traditional drought-resistant crops such as millet and sorghum, their adoption remains low due to the perception of poor man's crops (Mitra, 2012). Most consumers prefer cereals such as wheat and instant foods, leading to the abandonment of traditional crops that lack demand. Nevertheless, drought resistant crops like sweet potatoes are nutrient rich and high-yielding (Motsa et al., 2015). Sorghum has high nutritional value and high efficiency in water utilization, making it well-suited for climate-impacted dry regions.

Smallholder farmers have also adopted genetically modified (GMO) crops as well as hybrid crops in an effort to adapt to increasing incidences of droughts. GMO and hybrids generate greater appeal due to traits like disease and pest resistance and higher yields (Fita et al., 2015). Some of the local hybrid varieties include maize (H6218, 7m-81, MS44 Gene, Katumani), and beans (Nyota) (Ngome & Templer, 2023). Studies show that the use of GMO and hybrid varieties significantly increases yields. A study by Wossen et al. (2017) on the use of drought-tolerant modified varieties of maize found that yields increased by over 13%, harvest variance reduced by 50%, and negative exposure to drought reduced by 80%. However, the growing adoption of GMOs and hybrids has raised multiple concerns regarding depletion of soil nutrients, increased reliance on fertilizers, high dependence on foreign seed companies, loss of agricultural diversity, and allergenicity (Voronkova et al., 2019; Adhikari et al., 2019; Zhang et al., 2016). This study seeks to determine the impact of utilizing drought-resistant crops on food security.

Statement Of the Problem

Food security is essential for a holistic life. However, the food security status in Africa is low, especially in comparison with other continents. According to FAO (2024), 20.4% of the African population was facing hunger compared to 7.3% in Oceania, 6.2% in South America, and 8.1% in Asia. Although there are concerted efforts at the national, continental, and global levels to end hunger, there has been little progress in the African continent. Despite Kenya's Vision 2030 strategy highlighting the necessity to eliminate hunger and poverty under the social pillar, 80% of Kenyans are food and nutrition insecure while 60% of the population in Makueni county has been facing food and nutritional insecurity (IPC, 2024).

Scholars have highlighted various causes of food insecurity in Sub-Saharan Africa including limited agricultural investments, corruption, slow economic growth, wars and conflicts, and rapid population growth (Wudil et al., 2022; Berhanu and Wolde, 2019). However, the most significant cause of food insecurity is climate change (Dasgupta & Robinson, 2022; Gregory et al., 2005). Affoh et al. (2022) note that the intensification of climate change will result in a rise in the level of food insecurity in the East African nations. In 2024, 45% of the population in Makueni County, Kenya was classified as food stressed while 15% were classified as being in a state of food crisis (IPC, 2024).

The significance of climate change in achieving food security has necessitated the development of various adaptation mechanisms among farmers. While there are multiple studies that show climate change consequences on agriculture, there are fewer studies that show the actual effect of producing adapted drought-resistant crops on food security (Wudil et al. 2022; Myers et al. 2017; Giller, 2020; Berhanu & Wolde; 2019). This study aimed at filling the research gap by exploring how smallholder farmers' use of adapted drought-resistant crop species affected food security.

Research Objective

The objective of this study was to determine the effect of producing adapted drought-resistant crop species on food security in Kikumbulyu North Ward, Makueni County.

Research Hypothesis

H_0: Producing adapted drought-resistant crop species has no significant effect on food security in Kikumbulyu North Ward, Makueni County.

H_1: Producing adapted drought-resistant crop species has a significant effect on food security in Kikumbulyu North Ward, Makueni County.

THEORETICAL FRAMEWORK

The resource-based view theory, originating from the writings of Barney (1991) and Penrose (2009), explains that organizations can cultivate competitive advantages by developing valuable, rare, non-substitutable, and inimitable resources (Acedo et al., 2006; Hitt et al., 2016). In the context of climate change, farmer households respond to climate change depending on the availability of resources as well as social and environmental pressures. According to Ndambiri et al. (2012), resources like irrigation water, extension services, information, and credit access influence farmers' willingness to utilize adaptation strategies. Internal resources include finances, access to climate-related knowledge, and the requisite farm tools. The application of this theory in the study helped to highlight how households function as institutions in climate change adaptation. As institutions, households respond to climate change based on internal competitive advantages as well as external pressures such as communal decisions and government policies.

LITERATURE REVIEW

Rosero et al. (2020) define drought resistance as the capacity of a plant to grow and reproduce effectively under the conditions of limited water supply. According to Aslam et al. (2015), there are various drought resistance mechanisms which include drought escape (early maturing that protects crops from long-term drought stress), and drought avoidance (increasing water absorption or minimizing water losses). Also, drought tolerance (sustenance of physiological functions under drought stress with a higher yield (Aslam et al., 2015). Drought tolerance is more significant for crops because it confers extra ability to survive unpredictable weather. The production of drought-resistant crops is particularly promoted as a viable adaptation measure

(Mati, 2020). Rosero et al. (2020) define drought as the outcome of water flow imbalance between evapotranspiration requirements and the movement of water in the soil root system. Fang and Xiong (2015) define drought as a condition resulting from long periods of dry weather, which causes plant injury.

Fita et al. (2015) define drought tolerance as the capacity of crops to maintain an effective level of physiological functioning during high drought stress by altering multiple gene functions and metabolic pathways to minimize or repair stress damages. Drought-resistant crops have the capacity to survive disruptions in rain and thus increase the chances of getting a harvest even after the rains fail. Fang and Xiong (2015) list three classes of plants based on their capacity for drought tolerance. Mesophytes (found in semi-arid and humid zones), xerophytes (found in arid zones), and hydrophytes (located in areas with adequate water or moisture levels).

Attempts to shift farmers towards traditional crops that are drought-resistant, such as millet and sorghum, have not borne much fruit due to the lack of appeal of the crops and their perception as poor man's crops (Mitra, 2012). Moreover, some of the crops, such as sorghum, are less tasty, hence their minimal appeal to consumers. Adhikari et al. (2019) note that more consumers, especially the younger, prefer instant foods and popular cereals (such as wheat) leading to the abandonment of traditional food crops like millet. Other crops with natural capacity for drought-tolerance include quinoa, buckwheat, cowpea, cassava, and sweet potatoes (Fita et al., 2015).

Hadebe et al. (2017) explain that sorghum is suited for ASAL regions due to its high capacity for drought tolerance, nutritional value, and high efficiency in water utilization. Fischer et al. (2016) note that sorghum and millet act as contingency crops that help farmers to deal with rainfall changes. Mohanraj and Sivasankar (2014) advocate for the adoption of sweet potatoes as a means to increasing food security. According to Motsa et al. (2015), sweet potatoes are highly beneficial due to their short maturation period, low nutrient utilization, use of non-edible parts for propagation, and high nutritional value. The plant tubers do not require costly storage as they can be left on the ground and only be harvested when there is need. Sweet potatoes are a rich source of carbohydrates, vitamins (B complex, A, C, E), proteins and lutein (leaves) (Bovell-Benjamin, 2007). Sweet potato yields range from 4 – 9.5 tonnes/ ha compared to 1-3 ton/ha for maize (Motsa et al., 2015).

Apart from crops with natural capacity for drought-resistance, genetically modified crops are also becoming more popular. The emergence of the green revolution in the 1950s led to emphasis on increasing yields through creating of hybrid and genetically modified crops (GMO) with features like disease-resistance and high yields (Fita et al., 2015**)**. The revolution was characterized by an increase in the use of agrochemicals, monoculture practices, and irrigation. Moreover, there arose intensification of farming through the use of greenhouses, reduced crop rotation, and the utilization of synthetic fertilizers (Fita et al., 2015). According to Ebert (2014), the demand for more food and food types due to a growing population and consumer preferences are driving the adoption of higher yielding varieties. Ebert (2014) adds that food production should increase by 70% by 2050 to cater for a 40% rise in global population.

A study by Wossen et al. (2017) revealed that the use of drought-tolerant modified varieties of maize increased yields by over 13%, minimized harvest variance by over 50%, and reduced negative exposure to drought by 80%. Wossen et al. (2017) further note that adoption of the varieties reduced cases of food scarcity by 84%. Dar et al. (2020) explain that the use of drought resistant modified rice variety in India (Sahbhagi dhan), provided yield advantages of 0.8 – 1.5 ton/ ha over other rice varieties during droughts. The fast-maturing rice variety also helped to reduce labour and input costs. Zhang et al. (2016) note that the adoption of GM crops has led to a rise of over 370 million tonnes in average crop yield and an increase of farm income by $116 billion (2006-2012). Other benefits include the ability to modify the chemical composition of food to increase nutritional benefits (addition of probiotics, unsaturated fatty acids and vitamins) as well as the reduction of food waste through slowing the ripening process of fruits and vegetables (Zhang et al. ,2016).

Voronkova et al. (2019) argue that the consequence of intensification in agriculture involving high adoption of genetically modified crops has been the depletion of soil quality, salinization of soil and ground water, and rise of new pathogens. Other impacts include the loss of traditional crops as modified cultivars with high yields and disease resistance become common. Currently, only a few major companies (such as Monsanto and BASF) produce hybrid and GMO seeds and they tend to focus on a narrow scope of genetic pool (Jarmul et al., 2019). Adhikari et al. (2019) contend that the increased uptake of GMO crops has led to a reduction in agrobiodiversity resulting from the decline in traditional food systems. Moreover, excessive focus on use of drought-resistant crops tilts farmers' dependence from indigenous seeds to costly genetically-modified seeds (Jacques & Jacques, 2012). The result may be a loss of productivity and control among smallholder farmers, who still control 85% of all farmland (Jarmul et al., 2019). Such a power shift could lead to widespread hunger as farmers, who were previously food secure, are forced to buy costly seeds and food from commercial agricultural companies

Zhang et al. (2016) explains that GMO crops are linked to higher incidences of allergenicity, toxicity and genetic hazards. The deletion or insertion of genes on the genetic sequence of traditional crops can lead to new genetic expressions that have substantial effects on human, crop, and soil health. According to FSI (2024), resistance to antibiotics in humans can be traced to the high usage of therapeutic antibiotics in agriculture as well as medicine. FSI (2024) explain that antibiotics are utilized as selection markers in the process of genetically modifying crops, which can lead to the transfer of antibiotic resistance genes to pathogenic bacteria in the body of the consumer of GMO food.

Conceptual Framework

Figure 1: Conceptual framework

A conceptual framework is a research tool that helps the researcher to depict the phenomena being studied. Figure 1 above shows the independent and dependent study variables. The perceived impact of the independent variable (producing adapted drought-resistant crops) on food security was determined in the study. The use of adapted drought tolerant crop species was measured by counting the number of adapted crop species adopted by each farmer as well as acreage per farmer. Food security was estimated using calorie intake. According to Headey and Ecker (2013), Hossain et al. (2019), calorie intake is an indicator of food security status that highlights access to sufficient food.

RESEARCH METHODOLOGY

The study employed mixed methods (quantitative and qualitative) to increase reliability, breadth and depth of data (McKim, 2017). Moreover, a survey research design was applied.

This involved asking participants questions regarding their behaviors, opinions, practices, and experiences. The research design was vital due to its efficiency and capability to provide in-depth perspectives about populations (Moy & Murphy, 2016). The sample population was taken from a group of 4,542 farmers who had been recruited for the Nature Positive Food Systems Project for Resilient Communities being implemented in Kikumbulyu North ward by Utooni Development Organization (April 2022 – March 2026). They were sampled through random sampling from 3 sub-locations (25 villages). An average of 14-15 farmers were selected from each of the 25 villages. Participation in the study was free and voluntary. The researcher applied the Yamane formula to determine the sample size.

$$n = \frac{N}{1 + N(e)^2}$$

Equation 1: Yamane formula (Rahman et al., 2020)

n = 4542/1+ 4542(5%) 2

= 367.62

Approximately 367

Where; *n* = Sample size of farmers within Kikumbulyu North ward

N = Sample population (4542)

e = Margin of error (5%)

Data was gathered through semi-structured questionnaires which were administered by trained enumerators. Both quantitative and qualitative insights on adoption of growing of drought resistant crops were captured. Data analysis involved descriptive statistics and cross-tabulations were performed to determine associations among independent and dependent categorical variables. The associations were tested using Pearson’s Chi-Square tests.

FINDINGS

A total of 335 farmers participated in the study, representing a 91% response rate, which is considered outstanding (Mugenda & Mugenda, 2012). Majority of the participants were between the ages of 46–55 years, accounting for 35.2% of the sample. This age distribution shows that agricultural activities in Kikumbulyu North Ward are primarily carried out by middle-aged and older adults. The advanced age of these small-scale farmers provided them with accumulated practical knowledge and familiarity with farming in dry regions, enabling them to navigate and respond effectively to climate-related shifts. Similar conclusions were drawn by Ndambiri et al. (2012) and Maddison (2006), who found that older individuals tend to be more adept at perceiving and adjusting to climatic fluctuations than younger farmers.

Concerning gender, 260 (77.6%) were female while 75 (22.4%) were male. The results showed that most of the households had female heads who were also likely to be in charge of household food security. The findings align with Wabomba and Kagiri (2020) who indicated that women households are more food secure than men's households.

Moreover, only 1.8% of the participants had no formal education. Education increases people's ability to participate in sustainable agriculture practices that support household food security, especially in rural areas where farming is the primary economic activity. Similarly, Hainzer et al. (2021) emphasized education as a key determinant influencing how households engage in agricultural production. The findings align with the resource-based view theory, which acknowledges knowledge as a key resource.

The predominant household size was 4-6 members (46.5%). Households with more members (4-10) may have greater labor capacity for farming activities, which could contribute to higher productivity and efficiency in farming practices. On the other hand, larger households demand greater food quantities than those with fewer members (Oino, 2016). According to Hainzer et al. (2017), larger families face increased challenges in ensuring sufficient food supply compared to smaller ones.

From the findings, 41.5% of the participants had 11-20 years' experience in farming. This level of experience suggests that farmers possess substantial practical knowledge, which likely contributes to their ability to identify and apply viable strategies for addressing the effects of climate change. The findings are related to those of Obaniyi et al. (2020), who highlighted the criticality of farming experience in enhancing adaptive capacity. Mukundente et al. (2020) also found that years of farming experience positively influenced climate adoption but was not statistically significant

Adoption of Drought-Resistant Crops by Smallholder Farmers

The utilization of drought-resistant (DR) crops by farmers is shown in table 1 below.

Table 1: Adoption of DR Crops by Smallholder Farmers

	Frequencies	Percent	Ranks (1-Most grown)
Sorghum	252	19.7	3
Millet	157	12.3	4
Cassava	120	9.0	5
Pigeon peas	287	22.7	2
Green grams	317	27.9	1

Source: Field data (2025) Multiple Responses

Key: 1=Most grown, 5=Least grown

Green grams were the most widely adopted DR crop, cultivated by 27.9% (n=317) of the farmers. This preference may be attributed to the crop's short growing season, high market demand, and suitability for intercropping systems. Pigeon peas were grown by 22.7% (n=287) of respondents, valued for their dual purpose in providing food and enhancing soil fertility through nitrogen fixation. Sorghum, cultivated by 19.7% (n=252) of the farmers, is recognized for its robustness under high temperatures and its ability to produce stable yields under limited water conditions. Millet, grown by 12.3% (n=157) is another vital cereal crop known for its hardiness, nutritional value, and resilience to pests and diseases. Cassava, cultivated by 9.0% (n=120) of the farmers, is a root crop highly favored for its capacity to thrive in marginal soils and its role as a food security buffer during prolonged dry periods. These cropping patterns reflect an intentional shift by smallholder farmers towards sustainable, climate-resilient agricultural practices. Moreover, the cropping practices reflect the utilization of available traditional DR crop resources, which aligns with the resource-based view theory.

Majority (99.7%) of the smallholder farmers who adopted DR crops recorded an increase in food yield while only 0.3% of the farmers recorded no change in yields. The high percentage of farmers who use adopted drought resistant crops species with positive results is an indication of the significant role of the crop species in improving food security (Qomariah et al., 2021). Concerning challenges of adopting DR crops, the most prominent was inadequate rainfall (36.2%), followed by lack of quality seeds (25.7%), pest and diseases (22.4%), and lack of market (15.7%).

Cross Tabulation Analysis of Meal Consumption Patterns Among Households

Table 2 presents the cross-tabulation analysis of meal consumption patterns among households in relation to various factors. The number of meals taken per day is an indicator of daily calorie intake. Further, calorie intake is an indicator of the level of food security.

Table 2 Cross Tabulation Analysis on Meal Consumption Patterns Among Households

Variable	One meal	Two meals	Three meals	More than three meals	Total	Chi-square ($\chi2$)
Age						χ^2=33.669,
18-25 years	0	0	25	0	25	d.f=20,
26-35 years	0	5	43	4	53	P=0.017
36-45 years	0	18	80	6	104	
46-55 years	2	13	102	2	118	
56 and above years	0	0	34	0	35	
Gender						$\chi2$=20.698,
Male	0	4	71	0	75	d.f=10,
Female	1	33	213	12	260	P=0.023
Level of education						χ^2=33.669,
No formal Education	0	0	6	0	6	d.f=20,
Primary	2	25	90	8	125	P=0.015
Secondary	0	10	142	5	157	
Tertiary	0	1	46	0	0	
Household size						χ^2=26.123,
1-3 members	2	15	160	1	178	d.f=15,
4-7 members	0	21	108	12	141	P=0.037
7-10 members	0	0	12	0	12	
Above 10 members	0	0	4	0	4	
Year engaged in farming						χ^2=29.199,
Less than 5 years	0	1	27	0	28	d.f=15,
5-10 years	1	17	11	7	36	P=0.015
11-20 years	27	69	127	0	139	
More than 20 years	1	7	61	7	76	
Drought resistant crops						χ^2=88.456,
Sorghum	0	6	6	0	12	d.f=20,

Millet	0	7	35	9	42	P=0.000
Cassava	1	11	129	1	142	
Pigeon peas	0	12	72	0	84	
Green grams	1	1	42	11	55	

The results indicate that most of the participants across all age groups reported consuming three meals per day, with the 36–45 and 46–55 age groups recording the highest numbers. The youngest (18–25 years) and oldest (56 years and above) age groups exclusively reported eating three meals per day. A chi-square test of independence was conducted to examine the relationship between age and number of meals consumed per day. There is a statistically significant association between age and the number of meals consumed per day among the respondents ($\chi2 = 33.669$, d.f.=20, $p>0.017$). This result suggests that the 36- to 55-year-old age groups were more food secure than the other age groups.

The analysis shows that most of the male and female respondents reported that their households consume three meals per day, with 71 males and 213 females indicating this meal frequency. A smaller proportion of respondents (4 males and 33 females) reported consuming two meals per day. Very few respondents, specifically one female, reported that their household consumes only one meal per day. Overall, three meals per day is the most common meal pattern across both genders. The test yielded a Pearson Chi-Square value ($\chi2 = 20.698$, d.f.=10, $p>0.023$). Since the p-value is less than the conventional significance level of 0.05, we reject the null hypothesis and conclude that there is a statistically significant association between gender and the number of meals consumed per day. According to these results, female respondents are significantly more food secure than male respondents. This may indicate that women-led households face more pressure to secure food than households with two parents, which is in line with the resource-based view theory.

The analysis reveals that the majority of households, regardless of education level, consume three meals per day. A smaller number of respondents reported consuming two meals per day 25 with primary education, 10 with secondary education, and 1 with tertiary education. These results suggest that higher levels of education tend to correlate with more consistent access to three meals per day, though three meals remain the dominant pattern across all education levels. The results indicate a statistically significant association between education level and meal frequency ($\chi2= 29.199$, df = 15, $p = 0.015$). The results suggest that higher education levels of the respondents significantly increase the chances of the household being food secure.

The analysis indicates that the majority of households across all household size categories consume three meals per day. Specifically, 160 households with 1–3 members, 108 with 4–7 members, 12 with 7–10 members, and 4 with more than 10 members reported consuming three meals daily. A smaller number of respondents from smaller households (1–3 and 4–7 members) reported consuming two meals per day—15 and 21 respectively—while only one household with 1–3 members reported consuming more than three meals, and another reported consuming just one meal. No households with more than 7 members reported eating fewer than three meals a day. These results suggest that household size significantly influences meal frequency, with smaller households showing more variation in the number of meals consumed per day, while larger households consistently consume three meals. The results showed a statistically significant association ($\chi 2$=26.123, df = 15, p = 0.037), indicating that household meal frequency is related to household size. Further, the smaller households are likely to have lower quantities of food requirements hence being more food secure.

The findings show that the majority of households, regardless of the number of years engaged in farming, reported consuming three meals per day. Specifically, 27 respondents with less than 5 years of farming experience, 69 with 5–10 years, 127 with 11–20 years, and 61 with more than 20 years reported three meals per day. Households consuming two meals per day were more common among those with 5–10 years (17 respondents), followed by those with 11–20 years (11 respondents), and more than 20 years (7 respondents) of farming experience. A few respondents in the "more than 20 years" category reported consuming only one meal (1) or more than three meals (6). Notably, those with less than 5 years of experience were the least likely to report any variation in meal frequency, with nearly all consuming three meals per day. The results show a significant association ($\chi 2$=30.418, df = 15, p = 0.011), indicating that household meal frequency varies meaningfully across different levels of farming experience. This suggests that respondents with more experience in farming have acquired the skills and knowledge to ensure sufficient food in their households hence being more food secure. The availability of skills and knowledge constitute competitive advantages in line with the RBV theory, that enable greater adaptation,

Most households consuming three meals daily primarily grew cassava (129 households), pigeon peas (72 households), and green grams (42 households). Fewer households consuming one or two meals grew these crops. This distribution suggests that the type of drought-resistant crop grown may influence meal frequency in households. The test revealed a statistically significant association (χ^2 =88.456, df = 20, p < 0.000), indicating that meal frequency significantly varies by the type of drought-resistant crop cultivated. The results show that cassava is the most effective drought resistant crop in improving food security.

Cross Tabulation Analysis on Household Food Shortages

Table 3 presents the cross-tabulation analysis examining the relationship between various factors and the occurrence of food shortages in households. Occurrence of food shortage is also an indicator of the level of food security.

Table 3: Cross Tabulation Analysis on Household Food Shortages

Variable	Never	Occasional (1-3 months per year)	Frequently (More than 3 months per year)	Total	Chi-square (χ2)
Age					χ^2=90.453,
18-25 years	19	6	0	25	d.f=8,
26-35 years	2	51	0	53	P=0.000
36-45 years	33	71	0	104	
46-55 years	2	13	102	118	
56 and above years	12	17	6	35	
Gender					χ^2=19.414,
Male	16	53	6	75	d.f=4,
Female	63	185	11	259	P=0.001
Level of education					χ^2=79.738,
No formal Education	0	6	0	6	d.f=6,
Primary	12	95	18	125	P=0.000
Secondary	38	119	0	157	
Tertiary	29	18	0	47	
Household size					χ^2=41.807,
1-3 members	66	106	6	178	d.f=6,
4-7 members	11	118	12	141	P=0.000
7-10 members	2	10	0	12	
Above 10 members	0	4	0	4	
Year engaged in farming					χ^2=45.788,

Less than 5 years	15	13	0	28	d.f=6,
5-10 years	13	79	0	92	P=0.000
11-20 years	29	104	6	139	
More than 20 years	22	42	12	76	
Drought resistant crops					χ^2=84.572,
Sorghum	0	12	0	12	d.f=8,
Millet	24	18	0	42	P=0.000
Cassava	48	82	12	142	
Pigeon peas	0	84	0	84	
Green grams	7	42	6	55	

The occurrence of food shortages in households varied by age group. Among respondents aged 18–25 years, the majority (19 out of 25) reported never experiencing food shortages. In contrast, food shortages were more commonly reported among older age groups. In the 46–55 years group, 93 out of 118 respondents reported occasional food shortages (1–3 months per year), while 12 respondents in this age group experienced frequent food shortages (more than 3 months per year). In the 36–45 years category, the majority (71 out of 104) reported occasional shortages, and 33 reported never experiencing them. Among the 56 and above group, 12 out of 35 experienced frequent shortages, and 17 experienced occasional shortages. Results revealed a statistically significant association between age group and food shortage frequency ($\chi^2 = 90.453$, df = 8, p = .000), indicating that the frequency of food shortages significantly varies by age group. The implication is that the elderly people have lesser capacity to secure sufficient food and are, therefore, more prone to food insecurity. The lack of competitive advantages among the elderly reduces their ability to adapt, which is in line with the RBV theory.

Food shortages differed by gender among respondents. Most males (53 of 75) experienced food shortages occasionally (1–3 months annually), while 16 never faced shortages, and 6 reported frequent shortages (over 3 months per year). Among females, the majority (185 of 259) also faced occasional shortages, 63 had no shortages, and 11 encountered frequent shortages. The single respondent without specified gender reported frequent food shortages as well. A Chi-Square test of independence revealed a statistically significant association between the two categorical variables being analyzed ($\chi^2 = 19.414$, df = 4, p = .001). Since the p-value is less than the standard significance level of 0.05, we reject the null hypothesis and conclude that there is a significant relationship between the variables. The results indicate that females are more likely to suffer from food insecurity due to various probable factors such as lack of access to resources and opportunities for work.

The experience of food shortages varied according to education level. Among those with no formal education, six respondents reported occasional food shortages, while none reported either never experiencing or frequently experiencing shortages. In the primary education category, 12 individuals never experienced food shortages, 95 faced occasional shortages, and 18 experienced frequent shortages. For respondents with secondary education, the majority (38) never faced food shortages, 119 reported occasional shortages, and none had frequent shortages. Among those with tertiary education, 29 reported never experiencing shortages, 18 encountered occasional shortages, and none reported frequent shortages. These results indicate that higher education levels are linked to a lower occurrence of frequent food shortages. The Chi-Square test showed a significant association between education level and the occurrence of food shortages ($\chi^2 = 79.738$, df = 6, $p < 0.001$), suggesting that education plays an important role in reducing the likelihood of frequent food shortages. The results suggest that lower education levels reduce the capability for securing sufficient food. Lower education levels implies reduced capability to access useful climate information, which is a vital resource for enhancing adaptability as explained using the RBV theory.

The occurrence of food shortages varied according to household size. Among households with 1 member, 66 reported never experiencing food shortages, 106 experienced occasional shortages (1–3 months per year), and 6 experienced frequent shortages (more than 3 months per year). In households with 2 members, 11 never experienced shortages, 118 reported occasional shortages, and 12 faced frequent shortages. For households with 3 members, 2 never experienced shortages while 10 reported occasional shortages. Among households with 4 members, all reported occasional shortages, with none reporting either no shortages or frequent shortages. Based on the Chi-Square analysis, there is a statistically significant association between household size and the occurrence of food shortages ($\chi^2 = 41.807$, df = 6, $p < 0.000$). This indicates that the frequency of food shortages varies meaningfully across different household sizes. Larger households are likely to be food insecure due to high consumption rates of available food stocks. On the other hand, smaller households with lower consumption tend to be more food secure.

Results showed that among those with less than 5 years of farming experience, the majority (15 out of 28) reported never experienced food shortages, and none reported frequent shortages. Households with 5–10 years of farming showed a shift, with 79 out of 92 reporting occasional food shortages and 13 reporting none. Among households with 11–20 years of farming experience, 104 out of 139 reported occasional shortages, while 6 experienced frequent shortages. In the group with more than 20 years of experience, 42 out of 76 reported occasional shortages, 22 never experienced shortages, and 12 experienced frequent shortages. Chi-Square was performed to confirm if these differences are significant. Based on the Chi-Square results, there is a statistically significant association between the number of years households have been engaged in farming and the occurrence of food shortages ($\chi^2 = 45.788$, df = 6, $p < 0.000$). According to the results, households with extended farming experience were likely to have experienced more diverse factors (such as weather cycles) that impacted their food security negatively compared to those with shorter farming experience (less than 10 years). Moreover, households with more than 20 years farming experience were likely to have elderly people with reduced capacity for farming activities, hence food insecure.

Households growing cassava reported the highest number of respondents who never experienced food shortages (48 out of 142), followed by millet (24 out of 42) and green grams (7 out of 55). Households growing pigeon peas and sorghum reported no cases of never experiencing food shortages. In terms of occasional food shortages (1–3 months per year), the majority of respondents were from households growing cassava (82), pigeon peas (84), and green grams (42), suggesting that food shortages were more common among these groups. For frequent shortages (more than 3 months per year), cassava growers reported 12 cases, and green gram growers reported 6. No frequent shortages were reported among households growing millet, pigeon peas, or sorghum. Chi-Square test confirmed this association to be significant ($\chi^2 = 84.572$, df = 8, $p < 0.001$), indicating that crop diversification and selection play a critical role in mitigating food shortages among smallholder farmers. The results indicate that reliance on a single crop does not eliminate food insecurity, while crop diversification is essential for eliminating food insecurity.

CONCLUSION

This study established that adopting drought-resistant crops such as green grams, pigeon peas, sorghum, millet, and cassava significantly boosts household food security in Kikumbulyu North Ward. The crops' suitability to semi-arid conditions underscores their role in reducing hunger and building resilience through crop diversification. Guided by RBV theory, the findings show that education, farming experience, household size, and access to seeds are key resources shaping successful adaptation.

RECOMMENDATION

The study recommends an integrated approach that strengthens seed systems, expands extension services, improves market linkages, and addresses climate risks to maximize the potential of drought-resistant crops. Public and private sector interventions should prioritize increasing farmers' access to drought-resistant and drought-tolerant seeds, enabling smallholder farmers to enhance food security and resilience in the long term.

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