



RESEARCH ARTICLE

Climate Information Sources, Adaptation Practices and Barriers among Smallholder Crop Farmers in Kakamega East Sub-County, Kenya

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ABSTRACT

Smallholder farmers need climate information and feasible responses within their production and financial constraints. This cross-sectional household-questionnaire study describes information sources, perceived yield trends, reported adaptation practices and barriers among 196 farmer respondents in Kakamega East, Kenya. Descriptive statistics and five exploratory cross-tabulations were recalculated from respondent-level records. Pearson chi-square statistics and Cramér's V were calculated for each comparison; exact conditional p values were used where expected cell counts were below five. Radio was reported by 110 respondents (56.1%), personal experience by 102 (52.0%) and agricultural extension officers by 64 (32.7%). Yield trends were classified as fluctuating by 113 respondents (57.7%), decreasing by 75 (38.3%) and increasing by eight (4.1%). Reported practices included drought-tolerant varieties (165; 84.2%), adjustment of planting dates (157; 80.1%), crop diversification (137; 69.9%) and irrigation (42; 21.4%). Poverty (167; 85.2%) and high input costs (157; 80.1%) were the most frequently reported barriers. None of the five exploratory comparisons met the 0.05 significance threshold ($p = 0.067-0.976$; $V = 0.034-0.188$). Availability-based recruitment, undocumented ward-level selection and self-reported measures limit population inference. The findings support assessing accessible information and affordable, locally suitable practices; they do not establish climatic attribution, adoption determinants or practice effectiveness.

Keywords: *climate information; climate adaptation; smallholder crop farmers; reported practices; barriers; Kakamega East*

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Introduction

Climate-sensitive crop production exposes smallholder farmers to uncertainty in planting, water availability and harvests. In Kenya, dependence on rain-fed production connects rainfall and temperature variability with agricultural and food-security risks (Kogo et al., 2021). The consequences depend on the farming system and the resources available to respond. Local evidence is therefore needed on the information farmers use, the practices they report and the constraints they face.

Climate change concerns persistent changes in climatic conditions, while climate variability concerns departures from those conditions across temporal scales. Adaptation involves adjustment to actual or expected climate and its effects (Intergovernmental Panel on Climate Change [IPCC], 2022). Here, climate change provides the wider policy context. The survey measures reported information sources, practices, barriers and perceived yield trends. It does not estimate meteorological trends or attribute weather events to anthropogenic climate change.

Information, reported practice and effective adaptation are different constructs. Identifying radio or an extension officer as an information source does not establish scientific knowledge, the accuracy of information received or its use in a particular farming decision. Similarly, reporting a practice does not establish when it began, why it was selected or whether it improved household outcomes. Agronomic adjustments, soil and water management, livelihood activities and cultural responses require distinct interpretation.

Kenyan research documents crop diversification as one response to climate risk, with its suitability varying across agroecological settings (Ochieng et al., 2020). In Busia County, Ndiwa et al. (2024) examined adaptation choices and intensity in relation to information, credit, off-farm income, and household characteristics. An East African review identifies substantial variation in strategies and their socioeconomic context (Ackerl et al., 2023). These studies justify practice-specific comparisons rather than treating all reported activities as a single measure of resilience.

Earlier Kakamega research described adaptation options and constraints on their implementation (Mulinya, 2017). The present study adds a respondent-level description for the area designated Kakamega East. It contributes an account of information channels, practice prevalence and perceived barriers, along with five exploratory comparisons based on paired responses. The analysis is restricted to surveyed farmers and does not establish representativeness across the sub-county.

Four objectives guide this article: (1) describe reported climate information sources and perceived crop-yield trends; (2) describe reported adaptation practices and related livelihood responses; (3) examine exploratory bivariate associations between selected farmer characteristics and reported practices; and (4) identify reported economic, production, market, water and input-quality barriers. Direct climate-awareness prevalence or rainfall or temperature perceptions.

Materials and Methods

Study setting

The study covered six wards in Kakamega County, western Kenya: Isukha North, Isukha East, Isukha South, Isukha West, Isukha Central and Murhandu. The survey used the designation Kakamega East; county administrative records list these wards under Shinyalu (County Government of Kakamega, 2015, 2023). Crop production included maize, beans, vegetables and sugarcane, with livestock and non-farm work also supporting household livelihoods. Rain-fed production makes rainfall timing relevant to planting decisions, while limited cultivated area can constrain diversification and water-management investment.

Study design and population

The study used a quantitative, cross-sectional household questionnaire survey. Ward coverage and availability-based home interviews are treated as non-probability recruitment because random selection within wards was not documented. Eligible participants were smallholder crop farmers aged 18 years or older who had lived in the sub-county for at least ten years and farmed full- or part-time. We targeted household heads as respondents and mainly interviewed them. The respondent farmer was the unit of analysis; household size, cultivated area and livelihood activities described the household farming context. The reported achieved sample was 196 farmer respondents.

Sample size and sampling procedure

Sample size and retrospective numerical reference

The reported survey sample comprised 196 farmer respondents. The 2009 Kenya Population and Housing Census recorded 159,475 residents in Shinyalu, as reported in the Statistical Abstract 2010 (Kenya National Bureau of Statistics [KNBS], 2010) and the county profile (County Government of Kakamega, 2015). This resident count provides geographical context; it is not an eligibility-checked frame of farming households. For a retrospective numerical reference, the finite-population expression of Krejcie and Morgan (1970) is evaluated at 95% confidence, an assumed proportion of 0.50 and nominal precision of seven percentage points:

$$n = \frac{\chi^2 N p(1 - p)}{d^2(N - 1) + \chi^2 p(1 - p)}$$

In this expression, n is the numerical reference sample size; $N = 159,475$ is the resident population used for the calculation; $\chi^2 = 3.841$ is the critical chi-square value for one degree of freedom at 95% confidence; $p = 0.50$ is the conservative assumed population proportion; and $d = 0.07$ is the nominal absolute precision of seven percentage points. Thus, $1 - p = 0.50$ and $d^2 = 0.0049$. Substitution gives:

$$\begin{aligned} n &= \frac{3.841 \times 159475 \times 0.50 \times 0.50}{0.07^2 \times (159475 - 1) + 3.841 \times 0.50 \times 0.50} \\ n &= \frac{153135.86875}{781.4226 + 0.96025} \\ &= \frac{153135.86875}{782.38285} \\ &= 195.7301 \end{aligned}$$

The numerical result rounds upward to 196. This retrospective calculation shows the nominal precision assumption associated with a reference sample of this size; it does not document the sample-size decision made before fieldwork. A population margin of error cannot be assigned to the completed survey because an eligible household frame and probability selection were not established. The calculation is not a power analysis for the individual association tests.

Recruitment and reported survey sample

The survey findings describe 196 farmer respondents. Recruitment and field disposition records are required to establish the numbers selected, contacted, refusing, excluded or providing incomplete questionnaires. The reported sample total does not establish the valid denominator for every item, and no response rate is calculated from the total alone. Conclusions are restricted to the surveyed respondents.

Ward sampling frame and allocation

The six wards defined the geographical coverage. Table 1 gives their historical resident populations and a computed proportionate reference allocation for the reported sample of 196. The ward schedule uses the 2009 KNBS census and totals 159,475 (Independent Electoral and Boundaries Commission [IEBC], 2012,

Schedule, wards 1041–1046). The eligible farming-household frame, the actual numbers selected, and the completed interviews by ward require the household and field registers.

Where a complete, eligibility-checked household list is available, proportionate stratified sampling can allocate a sample of 196 across wards. Each household must appear in one stratum only. Let N_h be the eligible frame in ward h , N_F the sum of all ward frames, p_h the ward's proportion, and q_h its unrounded quota for $n = 196$, provided N_F is at least 196. N_F refers to eligible households, not the resident population of 159,475. This conditional procedure does not establish the design used in the completed survey.

$$p_h = \frac{N_h}{N_F} ; q_h$$

$$= n \times \frac{N_h}{N_F}$$

Reference integer allocations n_h should total 196. One transparent rule is to take the floor of each quota q_h , then assign the remaining places to the wards with the largest fractional remainders; ties require a documented rule. Actual completed interviews by ward must be taken from the field records; calculated quotas do not establish those counts.

For the population-based reference calculation in Table 1, P_h is the resident population of ward h , w_h is its share of the six-ward total and t_h is its unrounded quota for 196. The integer allocation a_h applies the largest-remainder rule to t_h . This calculation assumes that eligible farming households are distributed in proportion to residents; the household frame is needed to assess that assumption. It provides a coverage benchmark rather than a record of implemented selection. The weights and quotas are:

$$w_h = \frac{P_h}{159,475} ; t_h$$

$$= 196 \times w_h$$

Table 1.

Census ward populations and proportionate reference allocation for 196

Stratum / ward	Resident population 2009 P_h	Population proportion w_h	Calculated allocation a_h
Isukha North	23,496	0.1473	29
Isukha East	17,930	0.1124	22
Isukha South	35,807	0.2245	44
Isukha West	19,412	0.1217	24
Isukha Central	34,545	0.2166	42
Murhanda	28,285	0.1774	35
Total	159,475	1.0000	196

Source. KNBS (2010), 2009 census; IEBC (2012), Schedule, wards 1041–1046. Population shares are rounded to four decimal places. Calculated allocations use unrounded shares and largest-remainder rounding to total 196. They assume that eligible farming households are distributed in proportion to residents.

Recorded household recruitment

We administered questionnaires one-to-one at farmers' homes based on respondent availability. The available account does not document the household list, random draw, interval, random start or treatment of unavailable households. It therefore supports the non-probability interpretation used in this article. If the field records establish simple random sampling or another design, the Methods should report that actual procedure.

Selection procedure with a complete frame

If the field records confirm systematic random selection within strata, the procedure should identify the list and the following steps. These steps describe an appropriate probability procedure; they do not establish that it was used in the completed survey.

The researchers first checked eligibility, removed duplicate households and numbered the complete ward list from 1 to N_h . Check that its order does not create periodic patterns related to the outcomes. For each ward with a positive allocation n_h , divide its eligible frame by its allocated sample:

$$k_h = \frac{N_h}{n_h}$$

When k_h is an integer, draw an independent random start r_h from 1 through k_h , then select positions r_h , $r_h + k_h$, $r_h + 2k_h$ and so on until n_h households have been selected (Statistics Canada, 2021). For a non-integer interval, retain k_h and use fractional systematic selection: draw u_h uniformly with $0 < u_h \leq k_h$ and take the ceiling of $u_h + j k_h$ for $j = 0, \dots, n_h - 1$. Record the start, interval and selected household identifiers.

Lastly, record completed and partial interviews, refusals, noncontacts, ineligible cases and unknown eligibility. Retain nonresponding households in the field records and report any replacement rule. When eligibility is known for all selected cases, the completed-interview response rate is $100 \times \text{completed interviews} \div \text{all eligible selected households}$, including refusals and noncontacts. Unknown eligibility requires a stated outcome-rate definition (American Association for Public Opinion Research [AAPOR], 2023).

The allocation table, household list, selection records and field dispositions must agree. A preferred procedure must not be retrofitted to data already collected under a different design.

Questionnaire administration and quality control

We administered the structured questionnaire face-to-face at respondents' homes. Farmers self-reported responses during a one-to-one interview; this was an interviewer-administered questionnaire rather than a form completed independently by participants. The instrument covered respondent and household characteristics, cultivated land and crop types, climate awareness and perceived changes, information sources, reported adaptation practices, alternative livelihoods, and barriers to adaptation.

The reported variables included numeric information such as age and household size; categorical information such as sex, education and land-size bands; awareness indicators; and information sources, crops, practices and constraints. Several reported items include more than one source or practice per farmer. These options are summarised individually rather than treated as mutually exclusive shares of a total. Reported temperature changes referred to the preceding decade, whereas the crop-yield question used a twenty-year reference period. These recalled experiences were not treated as measured climatic trends or independently verified yield records.

The questionnaire was pre-tested among ten small-scale farmers with similar characteristics in a neighbouring sub-county. The pre-test assessed comprehension and question flow, and the instrument was revised in response to participants' feedback. Quantitative responses were entered into Microsoft Excel, cleaned and analysed in SPSS version 22.0.

Variables and operational definitions

Awareness, perceived climatic changes, individual reported practices, and barriers are distinct survey outcomes. The planned comparisons pair education with drought-tolerant varieties and organic farming, age with non-farm activities and crop diversification, and cultivated area with irrigation. Each practice is considered separately; no composite adoption score is created. Table 2 aligns the four objectives with the

available descriptive evidence and the illustrative analysis. The original questionnaire, response coding and missing-value codes still require verification.

Table 2.

Operational definitions and alignment of objectives with analysis

Objective and construct	Indicator or variable	Measurement and analytical role	Summary or procedure
Objective 1 Characterise climate change awareness and perceived changes in rainfall and temperature	Awareness; rainfall timing; temperature changes	Respondent-reported awareness and perceptions; descriptive outcomes	Reported percentages; valid item denominators require verification
Objective 2 Describe reported adaptation practices and livelihood responses	Varieties; planting dates; diversification; irrigation; soil practices; livelihoods	Separate reported responses; selections can overlap	Reported practice percentages and response typology
Objective 3 Explore bivariate associations between selected farmer characteristics and reported practices	Education; age group; cultivated area; practice-specific Yes or No	Planned empirical comparisons; illustrative reporting format	Crosstabs; Pearson χ^2 ; df; N; p; Cramér's V; expected-frequency checks
Objective 4 Identify reported economic, production and institutional barriers	Poverty; inputs; pests; markets; water; seed quality	Separate respondent-reported constraints	Reported constraint percentages; selections can overlap
Household context	Household size; crops; livestock; non-farm activities	Descriptive farming and livelihood context	Mean and SD for numeric items; percentages for categories

Note. Awareness represents self-reported recognition, not a validated knowledge score. Climatic indicators are perceptions. Practices may overlap. Objective 3 uses an illustrative reporting format.

Age is recorded in years and household size in members. Education categories are no formal education, primary, secondary and tertiary. The supplied age groups are 22–39, 40–59 and 60–91 years; these labels were checked against every recorded age and matched in all 196 records. Land under crop production is recorded as less than one acre, one acre, two acres or three acres. These categories were retained without combining sparse groups after inspection of test results. Land owned and cultivated area are different measures.

Perceived yield trend has three recorded categories: fluctuating, decreasing and increasing. It is a subjective assessment rather than measured harvest output. Each practice and barrier is analysed as its own binary indicator. No composite adaptation index is constructed. The irrigation indicator appears in both the production-system and practice fields; their responses agree in all 196 records, so irrigation is counted once in each relevant table. The file has no direct awareness indicator, rainfall- or temperature-perception responses, ward identifier or interview date.

Data preparation and descriptive analysis

The respondent-level Data worksheet was used as the analytical source. Counts and statistics were recomputed rather than taken from the workbook's existing summary formulas. Checks covered unique identifiers, duplicate records, blank entries, permitted category labels, age-group consistency and agreement between irrigation fields. There were 196 unique identifiers, no duplicate records across the 37 non-identifier fields and no blank or invalid entries in the analysed variables. Thus, each displayed descriptive item, and each paired comparison has valid $N = 196$ and zero missing values in the analytical file. The absence of blanks in this file does not establish how unanswered questions were coded during field entry.

Numeric variables are summarised using the mean, sample standard deviation and range. Categorical results report observed counts and percentages calculated as $100 \times \text{count} \div \text{valid item } N$. Percentages are rounded to one decimal place from unrounded values, with ties rounded up. Multiple-response percentages may sum above 100%; mutually exclusive percentages may differ slightly from 100% because of rounding.

No missing values were imputed, no respondent rows were reconstructed, and no record values were altered.

Analytical Model

Five comparisons were specified: education with drought-tolerant varieties; education with organic farming; age group with non-farm activities; age group with crop diversification; and cultivated area with irrigation. The comparisons use each respondent's recorded characteristic and practice response. Cross-tabulation cells show counts and row percentages, with both Yes and No responses and the row total. The tests assume independence of respondents and mutually exclusive categories within each comparison.

Let O_{ij} and E_{ij} denote observed and expected counts in a table with r rows and c columns. Expected counts use row totals R_i , column totals C_j , and valid N . Pearson's statistic is uncorrected, with nominal $df = (r - 1)(c - 1)$; Cramér's V summarises association (SciPy community, n.d.-a, n.d.-b):

$$E_{ij} = \frac{R_i C_j}{N}$$

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^c \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

$$df = (r - 1)(c - 1)$$

$$V = \sqrt{\frac{\chi^2}{N \min(r - 1, c - 1)}}$$

Asymptotic Pearson p-values were used when every expected frequency was at least five. Where an expected frequency was below five, an exact conditional Pearson test enumerated every feasible table with the observed row and column totals. For an $r \times 2$ table, let a be a feasible count vector for one column and K its fixed total. The conditional probability of a is the product of the row-specific binomial coefficients divided by the overall binomial coefficient. The p-value sums the probabilities of all tables whose Pearson statistic is at least as large as the observed statistic, including ties. This uses the fixed-margin null distribution (SciPy community, n.d.-c) and does not alter the respondent records.

$$Pr(a | R, K) = \frac{\prod_{i=1}^r \binom{R_i}{a_i}}{\binom{N}{K}}$$

Here, the entries of a sum to K , with each entry between zero and its corresponding row total. The binomial coefficient counts the combinations of selecting that column's responses within each row. Pearson-tail ordering is used rather than ordering tables by their individual probability.

Exact enumeration covered 5,309 feasible tables for education with drought-tolerant varieties, 12,749 for education with organic farming and 1,555 for cultivated area with irrigation. Conditional probabilities summed exactly to one using integer combinatorial weights. Expected frequencies, Pearson statistics and Cramér's V were also checked independently using direct arithmetic and SciPy 1.17.0 with NumPy 2.3.5. The five p-values are exploratory and unadjusted for multiple comparisons; 0.05 is the reporting threshold. No regression, causal interpretation or population-level precision claim is attached to these comparisons.

Results

Respondent and farming characteristics

The analysis included 196 farmer respondents. Mean age was 49.4 years (SD 13.7; range 22–91), and mean household size was 6.8 members (SD 3.1; range 1–19). Female respondents numbered 103 (52.6%) and

male respondents 93 (47.4%). Of the respondents, 150 (76.5%) cultivated less than one acre, 195 (99.5%) reported predominantly rain-fed production, and 42 (21.4%) reported irrigation (Table 1).

Table 1.

Respondent and farming characteristics

Characteristic	Category or measure	n (%) or summary
Age in years	Mean (SD); range	49.4 (13.7); 22–91
Household size in members	Mean (SD); range	6.8 (3.1); 1–19
Sex	Female	103 (52.6)
Sex	Male	93 (47.4)
Age group	22 to 39 years	49 (25.0)
Age group	40 to 59 years	98 (50.0)
Age group	60 to 91 years	49 (25.0)
Education	No formal education	18 (9.2)
Education	Primary	80 (40.8)
Education	Secondary	77 (39.3)
Education	Tertiary	21 (10.7)
Farming experience	1 to 5 years	24 (12.2)
Farming experience	6 to 10 years	38 (19.4)
Farming experience	11 to 15 years	42 (21.4)
Farming experience	16 to 20 years	39 (19.9)
Farming experience	More than 20 years	53 (27.0)
Land owned	Less than 1 acre	98 (50.0)
Land owned	1 acre	56 (28.6)
Land owned	2 acres	23 (11.7)
Land owned	3 acres	19 (9.7)
Cultivated area	Less than 1 acre	150 (76.5)
Cultivated area	1 acre	34 (17.3)
Cultivated area	2 acres	8 (4.1)
Cultivated area	3 acres	4 (2.0)
Production system	Predominantly rain-fed, Yes	195 (99.5)
	Reported irrigation, Yes	42 (21.4)

Note. Valid $N = 196$ for every variable; missing entries in the analytical file = 0. SD is the sample standard deviation. Rain-fed production and irrigation are separate indicators and can coexist. Land owned and land cultivated are distinct. One acre is approximately 0.405 hectares.

Information sources and perceived yield trends

Radio and personal experience were the most frequently recorded information sources (Table 2). Agricultural extension officers were reported by 64 respondents (32.7%). These responses identify information channels; they do not measure information quality, frequency of extension contact or a validated level of climate awareness. Fifteen respondents recorded No for all seven listed sources. This describes their coded responses and does not establish lack of access to every possible source.

Table 2.*Reported climate information sources*

Information source	Yes n	Valid N	Missing n	Yes %
Radio	110	196	0	56.1
Personal experience	102	196	0	52.0
Agricultural extension officers	64	196	0	32.7
Seminars	34	196	0	17.3
Television	30	196	0	15.3
School	21	196	0	10.7
Public barazas	8	196	0	4.1

Note. Multiple sources can be reported by the same respondent. Each percentage uses its own complete Yes or No item with N = 196. A baraza is a public community meeting.

Yield trends were described as fluctuating by 113 respondents (57.7%), decreasing by 75 (38.3%) and increasing by eight (4.1%). These three categories classify all 196 records (Table 3). The results concern perceived direction or variability of yields and provide no numerical estimate of harvest change or its cause.

Table 3.*Perceived crop yield trends*

Perceived trend	n	Valid N	Missing n	%
Fluctuating	113	196	0	57.7
Decreasing	75	196	0	38.3
Increasing	8	196	0	4.1
Total	196	196	0	100.0

Note. These are mutually exclusive recorded categories. The three displayed category percentages sum to 100.1% because each is rounded independently; their unrounded sum is 100%. No residual category or missing-response percentage is inferred.

Reported adaptation practices and related responses

The most frequently reported agronomic practice was using drought-tolerant varieties (165; 84.2%), followed by adjusting planting dates (157; 80.1%) and crop diversification (137; 69.9%). Irrigation was reported by 42 respondents (21.4%) and mulching by 39 (19.9%). Indigenous chicken rearing (172; 87.8%) and non-farm activities (148; 75.5%) were common related livelihood activities. Table 4 separates these responses by broad function and does not treat their reported presence as evidence of effectiveness or a climate-specific reason for uptake.

Table 4.*Reported practices and related responses*

Response domain	Practice or response	Yes n	Yes %
Agronomic	Drought-tolerant varieties	165	84.2
	Adjustment of planting dates	157	80.1
	Crop diversification	137	69.9
	Changing crop types	29	14.8
Soil and moisture	Reduced chemical use	147	75.0
	Organic farming	49	25.0
	Mulching	39	19.9
Water management	Irrigation	42	21.4
Livelihood	Indigenous chicken rearing	172	87.8

Response domain	Practice or response	Yes n	Yes %
	Non-farm activities	148	75.5
Farming location	Relocation for farming	20	10.2
Cultural or religious	Prayers for rain	16	8.2

Note. Valid $N = 196$ and missing entries = 0 for every practice item. Responses can overlap. Livelihood and cultural responses are listed separately from crop, soil and water practices. Indigenous chicken rearing does not measure all livestock keeping. The irrigation practice and production-system fields agree for every respondent.

Bivariate associations between selected farmer characteristics and reported practices

We cross-tabulated education with drought-tolerant varieties and organic farming. Neither exact conditional comparison met the 0.05 threshold (Table 5).

Table 5.

Education cross tabulations with reported practices

Education level	Drought-tolerant varieties Yes n (%)	Drought-tolerant varieties No n (%)	Organic farming Yes n (%)	Organic farming No n (%)	Total n
No formal education	17 (94.4)	1 (5.6)	2 (11.1)	16 (88.9)	18
Primary	66 (82.5)	14 (17.5)	23 (28.8)	57 (71.3)	80
Secondary	61 (79.2)	16 (20.8)	17 (22.1)	60 (77.9)	77
Tertiary	21 (100.0)	0 (0.0)	7 (33.3)	14 (66.7)	21
Total	165 (84.2)	31 (15.8)	49 (25.0)	147 (75.0)	196

Note. Row percentages; total-row percentages use $N = 196$. Both comparisons: valid $N = 196$, excluded $n = 0$; $V = \text{Cramér's } V$. Drought-tolerant varieties: $\chi^2(3) = 6.963$, exact $p = 0.06706$, $V = 0.188$; minimum expected 2.847, 2/8 cells (25.0%) below five. Organic farming: $\chi^2(3) = 3.580$, exact $p = 0.31432$, $V = 0.135$; minimum expected 4.500, 1/8 cells (12.5%) below five. Neither table has an expected count below one.

Non-farm activities were reported by 32 of 49 respondents aged 22–39 (65.3%), 77 of 98 aged 40–59 (78.6%) and 39 of 49 aged 60–91 (79.6%). Crop diversification was reported by 38 of 49 (77.6%), 64 of 98 (65.3%) and 35 of 49 (71.4%), respectively. Irrigation was reported by 31 of 150 farmers cultivating less than one acre (20.7%), eight of 34 cultivating one acre (23.5%), two of eight cultivating two acres (25.0%) and one of four cultivating three acres (25.0%). The small two- and three-acre groups require cautious interpretation (Table 6).

Table 6.

Age and cultivated area cross-tabulations with reported practices

Panel A Age group and reported livelihood or crop practices

Age group	Non-farm Yes n (%)	Non-farm No n (%)	Diversification Yes n (%)	Diversification No n (%)	Total n
22–39 years	32 (65.3)	17 (34.7)	38 (77.6)	11 (22.4)	49
40–59 years	77 (78.6)	21 (21.4)	64 (65.3)	34 (34.7)	98
60–91 years	39 (79.6)	10 (20.4)	35 (71.4)	14 (28.6)	49
Total	148 (75.5)	48 (24.5)	137 (69.9)	59 (30.1)	196

Panel A tests. Non-farm activities: $\chi^2(2) = 3.697$, asymptotic $p = 0.15747$, $V = 0.137$; minimum expected count 12.000, 0/6 cells below five. Crop diversification: $\chi^2(2) = 2.401$, asymptotic $p = 0.30110$, $V = 0.111$; minimum expected count 14.750, 0/6 cells below five.

Panel B: Cultivated area and irrigation

Cultivated area	Irrigation Yes n (%)	Irrigation No n (%)	Total n
Less than 1 acre	31 (20.7)	119 (79.3)	150
1 acre	8 (23.5)	26 (76.5)	34
2 acres	2 (25.0)	6 (75.0)	8
3 acres	1 (25.0)	3 (75.0)	4
Total	42 (21.4)	154 (78.6)	196

Panel B test. Irrigation: $\chi^2(3) = 0.232$, exact $p = 0.97614$, $V = 0.034$; minimum expected count 0.857, 3/8 cells (37.5%) below five and 1/8 (12.5%) below one. Each comparison in Table 6 has valid $N = 196$ and zero excluded records. Cell percentages use row totals; total-row percentages use 196. V denotes Cramér's V ; df are nominal Pearson degrees of freedom.

Across the five comparisons, p values ranged from 0.06706 to 0.97614 and Cramér's V from 0.034 to 0.188. None met the stated 0.05 threshold. This indicates insufficient statistical evidence against independence in these comparisons; it does not establish equivalence between groups or rule out relationships that a larger or differently recruited sample could identify.

Reported barriers

Poverty was reported by 167 respondents (85.2%) and high input costs by 157 (80.1%). Other commonly recorded barriers were pests and diseases (137; 69.9%), poor agricultural practices (127; 64.8%) and limited market access (118; 60.2%). Lack of water for irrigation was reported by 98 respondents (50.0%) and low-quality seeds by 88 (44.9%) (Table 7). These are respondent-reported constraints; no independent poverty threshold, agronomic assessment or seed-quality test was applied.

Table 7.

Reported economic production and access barriers

Barrier domain	Reported barrier	Yes n	Yes %
Economic	Poverty	167	85.2
	High input costs	157	80.1
Production	Pests and diseases	137	69.9
	Poor agricultural practices	127	64.8
Market access	Limited market access	118	60.2
Water access	Lack of water for irrigation	98	50.0
Input quality	Low-quality seeds	88	44.9

Note. Valid $N = 196$ and missing entries = 0 for every barrier item. Responses can overlap. Percentages show the frequency of reporting, not the causal contribution of a barrier to non-adoption. Cultivated area is reported separately in Table 1.

Discussion**Information channels and perceived yields**

Radio and personal experience were prominent information sources, while about one-third of respondents identified agricultural extension officers. This supports considering both broadcast communication and farmer-service contact when assessing local information provision. Research in Gilgil distinguished media, interpersonal contacts and extension pathways (Waaswa et al., 2021), while evidence from northern Ghana shows that source use and information utilisation vary across farming contexts (Alhassan et al., 2025). These comparisons provide context; the present source indicators do not measure utilisation intensity or communication effectiveness.

Information-source reporting should not be treated as direct climate awareness. A farmer may name a source without understanding a forecast, and a farmer who does not select a listed channel may use another source. The analysis therefore does not reproduce an awareness prevalence estimate. Future measurement should distinguish source access, understanding, trust and use in a farming decision, with the survey instrument and coding documented.

Most respondents perceived yields as fluctuating or decreasing. This is evidence about reported production experience, not an estimate of long-term yield change. Independent harvest records and relevant meteorological observations would be needed to assess the relationship between weather and production. Research comparing farmer perceptions with measured rainfall and temperature demonstrates why these evidence streams should be examined separately (File & Nhamo, 2024). The present study cannot attribute perceived yield trends to climate rather than soil, pests, inputs or other conditions.

Reported practices and livelihood responses

Drought-tolerant varieties, planting-date adjustment, and crop diversification were reported more often than mulching. These options have different resource requirements, and a high reporting frequency should not be interpreted as proof of suitability or effectiveness. Research in Busia identifies financial and informational considerations in adaptation choices (Ndiwa et al., 2024). The present data show which options were recorded but do not identify the reason an individual farmer used or did not use them.

Diversification was reported by 69.9% of respondents, most of whom cultivated small areas. Diversification may spread production risks, but its performance depends on the crops, land allocation and agroecological context. Kenyan panel research cautions against applying diversification uniformly across settings (Ochieng et al., 2020). Crop-specific portfolios and their effects on output, costs and food availability were not measured here.

Reduced chemical use and organic farming were recorded as different practice indicators. Lower chemical use may reflect management preference, cost or product availability and cannot automatically be interpreted as improved soil quality. Similarly, the drought-tolerance label was self-reported and was not verified through seed characteristics or field performance. Indigenous chicken rearing and non-farm work describe livelihood activities; their timing and climate-specific motivation were not measured. Prayer is retained as a cultural response and is interpreted separately from biophysical changes to crop, soil and water management.

Interpretation of the exploratory comparisons

The five cross-tabulations show differences in observed reporting proportions but no comparison met the 0.05 threshold. The education comparison for drought-tolerant varieties had the largest observed association ($V = 0.188$; exact $p = 0.06706$). This should not be described as a confirmed educational gradient: all tertiary-educated respondents reported the practice, but the proportions did not rise consistently across every education category, and the small groups produced sparse expected cells.

The age and cultivated-area comparisons likewise do not demonstrate that these characteristics are irrelevant to practice choice. Broad age categories can conceal variation within groups, and the cultivated-area distribution is highly concentrated below one acre. Only eight and four respondents were in the two- and three-acre categories. Exact testing addresses the reference distribution for sparse cells; it does not increase information in small groups or correct selection bias.

Regional reviews and the Busia study examine socioeconomic circumstances alongside adaptation choices (Ackerl et al., 2023; Ndiwa et al., 2024). Their measures, sampling and models differ from these bivariate comparisons. A non-significant unadjusted test in this sample cannot overturn those findings or establish a causal explanation. Joint modelling would require adequately measured candidate variables, sufficient information for each outcome and a defensible recruitment account.

Barriers and implications for support

Poverty and high input costs were the most frequently reported barriers. These findings identify affordability as a concern for the surveyed respondents, consistent with earlier Kakamega work describing financial constraints (Mulinya, 2017). They do not measure poverty using income or expenditure thresholds or estimate how much uptake would change if input prices fell.

Production, market, water, and seed-quality concerns indicate that support may need to go beyond information provision. Half the respondents reported lack of irrigation water, but the file does not identify water sources, seasonal reliability, infrastructure costs or environmental limits. Technical and financial feasibility must therefore be assessed before recommending a particular water investment. Likewise, reported seed-quality and market problems require direct assessment before judging an intervention effective.

County agricultural and meteorological services could assess how radio messages, extension contact and community meetings provide farmers with useful, understandable information. Such an assessment should measure comprehension and use in planting or management decisions, including whether different educational backgrounds are reached. Source prevalence alone cannot identify the best communication format.

Agricultural services, researchers and farmer groups could evaluate affordable seed, crop-diversification and soil-management options suited to small cultivated plots. Variety advice should distinguish drought tolerance from early maturity and assess local performance. Poverty and input-cost reports justify assessing affordability, while evidence of effectiveness should come from monitored outcomes rather than practice counts alone.

Supplementary irrigation or water harvesting should be assessed where water availability, costs and environmental conditions allow. Reported market and seed-quality concerns also support investigating collective marketing arrangements and reliable input access. These proposals are linked to recorded concerns; their benefits were not tested in this survey.

Limitations

The cross-sectional design cannot establish temporal ordering, causal effects or practice effectiveness. Information sources, practices, barriers and yield trends are self-reported and may be affected by recall or social-desirability bias. No meteorological series, measured harvests, income records or objective input-quality measures were analysed.

Availability-based recruitment and undocumented within-ward selection restrict inference to the surveyed respondents. Actual ward counts and clustering could not be evaluated because the analytical file lacks ward identifiers. The tests assume independent respondent records, an assumption that the available recruitment information cannot establish fully. The reported target of 384, the reasons for the achieved sample of 196 and field response dispositions remain undocumented. Model-based exploratory p-values do not provide design-based population inference or a population margin of error.

Conclusion

Among the 196 surveyed farmers, radio and personal experience were the leading recorded climate information sources, and perceived yields mostly fluctuated or decreased. Drought-tolerant varieties, adjustment of planting dates and crop diversification were frequently reported, while irrigation was less common. None of the five exploratory comparisons provided statistically significant evidence against independence at the 0.05 threshold. Poverty and high input costs were the most frequently reported barriers. These findings support assessing accessible information and affordable, locally suitable practices

for the surveyed farming context. They do not establish sub-county prevalence, adoption determinants, climatic attribution or improved outcomes from the reported practices.

Declarations

Data availability

De-identified respondent data, the recalculated analysis workbook and a reproducible analysis script accompany the revised manuscript. Respondent names are not included in the analytical file.

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