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Socio-Economic Determinants of Spring Onion Yield among Smallholder Farmers in Bomet County, Kenya

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Abstract: **Spring onion is a short-cycle vegetable that can generate frequent income for smallholder households, yet yields in Bomet County remain below attainable levels. This study examined the association between household socio-economic characteristics and spring onion yield. A descriptive and explanatory cross-sectional design was used. A multistage procedure selected 395 farmers from five sub-counties; 302 questionnaires were returned and 196 complete observations were retained for the regression analysis. The questionnaire had high internal consistency (Cronbach's alpha = 0.86). Descriptive statistics and multiple linear regression were applied. Seasonal yield averaged approximately 2.6-3.4 t ha−1 across the reported sub-counties. The socio-economic model was significant ($R = 0.894$, $R^2 = 0.800$, adjusted $R^2 = 0.791$; $F = 93.414$, $p < 0.001$). Education, household size, primary occupation, farming experience and annual farm income were positively associated with yield, whereas age and gender were not statistically significant after adjustment. The results indicate that management capability, timely family labour, accumulated experience and liquidity matter more than demographic headship characteristics alone. County interventions should therefore combine crop-specific training with simple production calendars, group labour arrangements, seasonal input finance and farmer-group procurement. Because the study is cross-sectional and relies partly on farmer recall, the reported coefficients should be interpreted as adjusted associations rather than causal effects.**

Keywords: **Allium fistulosum; farm income; household labour; smallholder horticulture; socio-economic factors; vegetable productivity.**

1. INTRODUCTION

Horticulture is an important pathway through which small farms diversify diets, generate repeated cash flow and respond to expanding urban and peri-urban food markets. Spring onion (Allium fistulosum L.) is particularly suited to this role because it has a relatively short production cycle, is harvested as a green vegetable and can be marketed in successive batches. Its food and nutritional value, culinary versatility and responsiveness to timely crop management make it a potentially useful enterprise for smallholders (Kim et al., 2023; Luu et al., 2024). At the same time, vegetable production is highly sensitive to delays in land preparation, seed acquisition, fertiliser application, weeding, irrigation and harvesting. The economic value of the crop therefore depends not only on agro-ecological potential, but also on household capability and the ability to mobilise labour and cash at the correct time.

Across sub-Saharan Africa, smallholder productivity reflects a combination of farm scale, household objectives, local institutions and access to technology. Small farms frequently produce for both food and income, but their capacity to intensify is constrained by limited liquidity, fragmented service delivery and uncertain output markets (Giller et al., 2021; Alliance for a Green Revolution in Africa, 2020). Public strategies in Kenya similarly recognise that productivity growth

requires coordinated investment in skills, finance, markets and climate-resilient production rather than isolated input distribution (Government of Kenya, 2019, 2021; Alliance for a Green Revolution in Africa, 2024).

The socio-economic characteristics of the farm household influence how these constraints are managed. Education can strengthen information search, numeracy, record keeping and the interpretation of agronomic recommendations. Household size can expand the labour pool for time-sensitive operations, although the effect depends on the age and availability of household members. Farming experience may improve judgement about planting windows, input timing and market risk. Primary occupation affects the attention given to the farm, while income determines whether seed, fertiliser and hired labour can be purchased before harvest income is realised. Technology-adoption evidence shows that these characteristics interact with credit, extension and market conditions, and that the same technology may generate different outcomes among households with different resources and comparative advantages (Suri, 2011; Ruzzante et al., 2021; Andati et al., 2022; Musafiri et al., 2022).

Kenya's high-value crop sector has grown within a policy environment that promotes commercialisation, yet county-level gaps remain in certified planting material, working capital, extension coverage, irrigation and post-harvest handling. National statistics and horticultural reports document the sector's economic importance, while recent Kenyan studies show that adoption and productivity remain socially differentiated (Agriculture and Food Authority, Horticultural Crops Directorate, 2023; Kenya National Bureau of Statistics, 2024; Kamau et al., 2022; Mogaka et al., 2021). Bomet County has a mixed crop-livestock economy, favourable highland conditions and active rural markets, but many vegetable producers cultivate small plots and transact through informal channels (County Government of Bomet, 2023).

1.1 Problem statement and knowledge gap

Spring onion yields reported by the surveyed farmers were substantially below the yields attainable under well-managed production. The gap has practical consequences: a short-cycle crop cannot deliver reliable household cash flow when farmers miss planting windows, use suboptimal seed, apply nutrients late or cannot mobilise labour for weeding and harvesting. Earlier work has often treated onions as a broad commodity or examined technology adoption without isolating the household attributes associated with spring onion yield. Crop-specific evidence from Bomet was therefore needed to identify which socio-economic characteristics remained associated with yield after other household factors were considered together.

The study addressed this gap by estimating the relationship between spring onion yield and age, gender, education, household size, primary occupation, farming experience and annual farm income. The objective was to determine the socio-economic factors associated with yield among small-scale farmers in Bomet County. The null hypothesis stated that the socio-economic factors had no statistically significant joint association with spring onion yield.

1.2 Analytical perspective

The analysis was informed by production and resource-allocation perspectives. A household transforms land, labour, capital, seed, knowledge and management into output. Because those inputs are scarce and their timing matters, the household allocates them across competing farm and non-farm activities. Education and experience represent elements of managerial capability; household size represents potential family labour; occupation represents attention allocation; and income represents liquidity. The expected sign of these variables is generally positive, but age and gender are theoretically ambiguous because they may proxy experience, labour constraints, asset control or unequal access to services. Credit and risk research also shows that even knowledgeable farmers may underinvest when cash and insurance constraints bind (Duflo et al., 2011; Karlan et al., 2014).

2. MATERIALS AND METHODS

2.1 Study area and research design

The study was conducted in Bomet County, Kenya, covering Bomet Central, Bomet East, Chepalungu, Sotik and Konoin sub-counties. Bomet lies in Kenya's south-western highlands and has a predominantly agricultural economy. The county experiences bimodal rainfall and temperatures generally suitable for diversified crop production. The 2019 population census reported 875,689 residents in the county (Kenya National Bureau of Statistics, 2019), while the county development plan identifies agriculture, extension, water access and market infrastructure as core development priorities (County Government of Bomet, 2023).

A descriptive and explanatory cross-sectional design was adopted. The descriptive component characterised farmers and production conditions, while the explanatory component estimated adjusted associations between the selected socio-economic variables and yield. A cross-sectional design was appropriate for establishing a county-level empirical baseline, but it does not by itself establish temporal precedence or causality (Creswell and Creswell, 2018).

2.2 Population, sample and sampling procedure

The target population comprised 26,817 small-scale spring onion farmers recorded across the five sub-counties. Slovin's formula with a 5% margin of error produced an intended sample of 395. Bomet County was purposively selected because of its spring onion activity; the five sub-counties formed strata; the sample was allocated proportionately; and individual respondents were selected systematically from farmer lists maintained by the relevant agricultural offices. Table 1 presents the allocation.

Table 1. Target population and proportionate sample allocation

Sub-county	Target population	Proportion (%)	Planned sample
Bomet Central	7,108	26.5	105
Bomet East	4,419	16.5	65
Chepalungu	5,028	18.7	74
Sotik	3,809	14.2	56
Konoin	6,453	24.1	95
Total	26,817	100.0	395

Source: Author's computation from the Bomet County farmer frame (2023).

2.3 Data collection, validity and reliability

Primary data were collected through a structured, researcher-administered questionnaire. The instrument captured respondent characteristics, farming experience, household labour, annual farm income, crop output and area under spring onion. Yield was standardised as tonnes per hectare per season. Subject specialists reviewed the instrument for content validity. A pilot involving 40 farmers was conducted in neighbouring Kericho County. Internal consistency was assessed using Cronbach's alpha, for which the final instrument obtained 0.86. This exceeds commonly used thresholds for acceptable reliability (Tavakol and Dennick, 2011).

Of the 395 questionnaires administered, 302 were returned, a response rate of 76.5%. The econometric analysis used 196 complete cases after screening for missing values on the variables required in the models. Reporting both figures is important: 302 describes survey participation, while 196 is the effective analytical sample for the regression estimates.

2.4 Variables and model specification

The dependent variable was spring onion yield in tonnes per hectare per season. The focal predictors were age of household head, gender of household head, education level, household size, primary occupation, years of farming experience and annual farm income. Categorical variables were coded for regression analysis, while continuous variables retained their observed scales. The multiple linear regression model was specified as:

$$Y_i = \beta_0 + \beta_1 Age_i + \beta_2 Gender_i + \beta_3 Education_i + \beta_4 Household\ size_i + \beta_5 Occupation_i + \beta_6 Experience_i + \beta_7 Income_i + \varepsilon_i$$

Ordinary least squares was used to estimate the partial association of each predictor with yield while holding the remaining variables constant. Model fit was assessed using R, R^2, adjusted R^2, the standard error and the omnibus F-test. Statistical significance was evaluated at the 5% level. The analysis was implemented in SPSS version 26. Standard econometric guidance informed model interpretation (Hair et al., 2019; Wooldridge, 2020).

2.5 Diagnostic tests and ethical safeguards

Multicollinearity was assessed using tolerance and variance inflation factors (VIF). Rather than relying on a single mechanical cutoff, the values were interpreted alongside the conceptual distinctiveness of the predictors, consistent with the caution of O'Brien (2007). Linearity, residual normality and homoscedasticity were reviewed using the diagnostic

outputs available in SPSS. The study obtained university authorisation, national research clearance and permission from the Bomet County Department of Agriculture. Respondents were informed about the study, confidentiality and voluntary participation before providing consent.

3. RESULTS

3.1 Respondent profile

The respondents were predominantly middle-aged smallholders with substantial farming experience. The mean age of household heads was 49 years, mean household size was 5.3 members, and mean farming experience was 16.8 years. Mean annual farm income was KSh 91,240. Men constituted 65.9% of respondents and women 34.1%. Most respondents had primary (53.0%) or secondary (42.4%) education; only 4.6% reported college education. Nearly two-thirds (63.2%) identified farming as their full-time occupation.

Table 2. Selected socio-economic characteristics of respondents

Characteristic	Category/statistic	Value
Age of household head	Mean; range	49 years; 23-84
Household size	Mean; range	5.3 members; 3-11
Farming experience	Mean; range	16.8 years; 3-30
Annual farm income	Mean; range	KSh 91,240; 8,000-176,000
Gender	Male / Female	65.9% / 34.1%
Education	Primary / Secondary / College	53.0% / 42.4% / 4.6%
Primary occupation	Full-time farming / Other	63.2% / 36.8%

Source: Survey data (2025). Continuous-variable regression sample n = 196; categorical profile based on returned questionnaires where complete.

3.2 Spring onion yield context

Mean seasonal yields in the reported sub-county table ranged from 2.6 t ha−1 in Chepalungu to 3.4 t ha−1 in Sotik. Bomet Central averaged 3.2 t ha−1 and Bomet East 2.9 t ha−1. The thesis table did not report a separate Konoin mean, so none has been imputed here. The observed range confirms a material productivity gap when compared with well-managed production systems and helps explain the economic importance of household capability, input timing and crop management. FAOSTAT (2024) provides the wider production-data context, although spring onion is often aggregated with related Allium crops.

Table 3. Reported spring onion yield by sub-county

Sub-county	Mean ± SD (t ha−1 season−1)
Bomet Central	3.2 ± 0.4
Bomet East	2.9 ± 0.6
Chepalungu	2.6 ± 0.5
Sotik	3.4 ± 0.7
Konoin	Not reported in the source table

Source: Survey data (2025). The source thesis table did not provide a Konoin mean.

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3.3 Multicollinearity diagnostics

Tolerance values ranged from 0.535 to 0.739 and VIF values from 1.354 to 1.871. These values do not indicate problematic linear dependence among the focal predictors. Education, household size, occupation, experience and income could therefore be interpreted as related but empirically distinguishable dimensions of household capability and resource availability.

Table 4. Multicollinearity statistics for the socio-economic model

Predictor	Tolerance	VIF
Age of household head	0.739	1.354
Gender of household head	0.677	1.477
Education level	0.733	1.364
Household size	0.631	1.585
Primary occupation	0.731	1.367
Farming experience	0.535	1.871
Annual farm income	0.631	1.584

Source: Survey data (2025).

3.4 Model fit and joint significance

The socio-economic model had a strong fit ($R = 0.894$). The R^2 of 0.800 and adjusted R^2 of 0.791 indicate that the included terms accounted for a large proportion of observed yield variation in the complete-case sample. The omnibus F-statistic was 93.414 ($p < 0.001$), leading to rejection of the null hypothesis that the socio-economic terms were jointly unrelated to yield.

Table 5. Model summary and analysis of variance

Statistic	Value
Multiple R	0.894
R^2	0.800
Adjusted R^2	0.791
Standard error of estimate	1.083
Observations	196
Omnibus F	93.414
Model p-value	<0.001

Source: Survey data (2025).

3.5 Adjusted associations with spring onion yield

Education, household size, primary occupation, farming experience and annual farm income were positively associated with yield at the 5% level. Age and gender were not significant after adjustment. Table 6 reports standardised coefficients because several unstandardised entries in the thesis output contained transcription inconsistencies. Standardised estimates provide a common scale for comparing the relative strength of the reported associations.

Table 6. Standardised estimates for the socio-economic model

Predictor	Standardised β	t	p-value	Decision
Age of household head	0.033	0.871	0.385	Not significant
Gender of household head	0.043	1.069	0.286	Not significant
Education level	0.270	7.054	<0.001	Significant
Household size	0.280	6.811	<0.001	Significant
Primary occupation	0.072	2.089	0.038	Significant
Farming experience	0.332	7.414	<0.001	Significant
Annual farm income	0.312	7.580	<0.001	Significant

Source: Survey data (2025). For primary occupation, t and p were recomputed from the reported coefficient and standard error to resolve an internal transcription inconsistency. Significance threshold: $p < 0.05$.

4. DISCUSSION

4.1 Education and managerial capability

Education had a positive and statistically significant association with yield. This is consistent with the interpretation that education strengthens the farmer's capacity to interpret recommendations, compare input options, keep records and coordinate operations. The result does not imply that formal schooling substitutes for practical extension; rather, it suggests that advisory material should be designed for different literacy and numeracy levels. Crop calendars, pictorial fertiliser guidance, demonstration plots and farmer-to-farmer learning can convert information into timely action. The broader technology-adoption literature similarly finds that adoption depends on information-processing ability and the fit between a technology and household resources (Ruzzante et al., 2021; Meti et al., 2025; Kihoro et al., 2025).

The spring onion enterprise amplifies the value of management because small delays can affect the whole production cycle. Plant population, nursery quality, transplanting, top-dressing, irrigation and harvest scheduling are interdependent. Horticultural evidence from Kenya indicates that quality preservation and market value depend on combining farm management with post-harvest practices rather than treating production and marketing as separate stages (Kilelu et al., 2024; Owino et al., 2024).

4.2 Household size, labour and timeliness

Household size was positively associated with yield, indicating that family labour may complement purchased inputs in this setting. Spring onion requires repeated weeding, watering, harvesting, cleaning, sorting and bunching. Where family members are available, a larger household can reduce delays in those labour-intensive tasks. This interpretation should remain cautious because household size is only a proxy: the age, health, competing obligations and actual participation of members were not separately measured. Nevertheless, the finding supports labour calendars, reciprocal labour days and group-based work arrangements during peak operations.

The result is compatible with the view that small farms pursue multiple objectives and rely on flexible household labour when cash for hired work is scarce (Giller et al., 2021). It also helps explain why training alone may not raise yield when the household cannot implement recommendations on time. County extension packages should therefore translate recommendations into a seasonal work plan and help farmer groups identify operations where joint labour is feasible.

4.3 Occupation, farming experience and accumulated knowledge

Farmers whose primary occupation was farming recorded a positive adjusted association with yield. Greater on-farm attention may improve scouting, irrigation response, weeding and harvest timing. The finding should not be interpreted as evidence that non-farm employment is undesirable. Non-farm income may relax liquidity constraints, but it can also compete for time. The relevant policy issue is therefore coordination: part-time farmers need clear calendars, reliable hired-labour arrangements and advisory messages that permit advance planning.

Farming experience showed the largest standardised association among the socio-economic variables. Experience may embody practical knowledge of rainfall variability, soil behaviour, local pests, buyer preferences and the consequences of mistimed operations. Yet experience can also reinforce outdated practices if new information is unavailable. Effective extension should therefore use experienced farmers as peer demonstrators while exposing them to improved seed, nutrient management and record-based comparison. Kenyan adoption studies show that experience operates alongside extension, entrepreneurship and institutional access rather than independently of them (Andati et al., 2022; Mogaka et al., 2021; Musafiri et al., 2022).

4.4 Income, liquidity and timely input use

Annual farm income was strongly and positively associated with yield. Spring onion requires expenditure before returns are realised: seed, fertiliser, crop protection, irrigation materials and hired labour must be secured at specific stages. Higher-income households are better positioned to avoid delay or under-application. Experimental and quasi-experimental evidence demonstrates that relaxing liquidity and timing constraints can increase input use and productivity, although effects vary with risk and local conditions (Duflo et al., 2011; Karlan et al., 2014; Ahmed, 2022).

The implication is not simply to provide general-purpose credit. A short-cycle vegetable requires seasonal products with small transaction costs, rapid approval and repayment aligned to harvest windows. Farmer groups can aggregate seed and fertiliser orders, reduce transport costs and create a platform for bundled technical advice. National and county strategies already identify finance and farmer organisation as part of horticultural transformation; the present results indicate that such support should be designed around the crop calendar (Government of Kenya, 2019; County Government of Bomet, 2023; Agriculture and Food Authority, Horticultural Crops Directorate, 2023).

4.5 Why age and gender were not significant

Age and gender were not statistically significant after education, household size, occupation, experience and income were included. This does not mean that gender inequality or generational barriers are absent. Rather, the model suggests that demographic headship variables alone did not explain additional yield variation once more direct measures of capability and resources were considered. Gender can affect control of land, cash, labour and extension access even when its coefficient in a yield equation is not significant. Similarly, age may contain offsetting effects: accumulated experience can increase yield while physical demands or reluctance to experiment may reduce it.

Programs should therefore avoid using age or gender as crude proxies for productivity potential. Inclusion remains essential, but targeting should focus on the constraints actually faced by women, men and younger farmers: control over income, access to finance, time burden, information channels and participation in groups. Broader Kenyan evidence shows that institutional and biophysical conditions can mediate demographic effects on adoption (Kamau et al., 2022; Musafiri et al., 2022).

4.6 Integrated interpretation

Taken together, the results describe a capability-liquidity-timeliness mechanism. Education and experience support decision quality; household size and occupation affect whether operations are performed on time; and income determines whether inputs can be acquired when needed. These dimensions are complementary. A farmer may understand the recommended practice but lack cash; have cash but lack labour; or have labour but lack crop-specific guidance. Integrated packages are therefore more plausible than single interventions. This interpretation aligns with evidence that technology and value-chain outcomes improve when information, finance, seed and service delivery are coordinated (Quarshie et al., 2021; Manyise and Dentoni, 2021; Wageningen Centre for Development Innovation, 2020). Similar coordination challenges are evident in Kenyan horticultural systems where water governance and service institutions shape production options (Ngutu et al., 2018; Wossen et al., 2017).

5. CONCLUSIONS AND RECOMMENDATIONS

The study concludes that socio-economic conditions are closely associated with spring onion yield among small-scale farmers in Bomet County. Education, household size, primary occupation, experience and annual farm income were positive predictors, while age and gender were not significant after adjustment. The results identify practical levers rather than fixed demographic categories: knowledge, labour organisation, managerial attention, accumulated experience and liquidity.

The County Department of Agriculture and partner organisations should develop modular spring onion training that uses demonstrations, pictorial guides and simple records. Training should be linked to seasonal work calendars covering nursery preparation, transplanting, fertiliser timing, weeding, irrigation, harvest and post-harvest handling. Farmer groups should organise reciprocal labour or paid labour pools for peak operations and undertake collective procurement of certified seed and fertiliser. Financial institutions and development programmes should pilot small seasonal input products with repayment aligned to the short production cycle. Extension officers should deliberately include women, youth and part-time farmers while targeting the specific constraints they face rather than assuming that demographic status determines productivity.

5.1 Limitations and further research

The study used a cross-sectional design and partly self-reported production data. Recall and measurement error may therefore affect yield and income estimates. Complete-case regression reduced the analytical sample from 302 returned questionnaires to 196 observations, which may introduce selection if missingness was systematic. The model estimates adjusted associations, not causal effects. Future research should combine plot measurement, production diaries and repeated seasonal observations; test interaction effects between socio-economic, technological and institutional factors; and evaluate bundled interventions through experimental or quasi-experimental designs. Digital data collection may improve timeliness, but its design must account for uneven access and literacy (Aker, 2010; Fafchamps and Minten, 2012; Fabregas et al., 2019; Baumüller, 2018; World Bank, 2019; Mwikamba et al., 2024; Steinke et al., 2021).

DECLARATIONS

Ethics approval and consent to participate: University research authorisation was obtained, followed by research clearance through the National Commission for Science, Technology and Innovation and permission from the Bomet County Department of Agriculture. Participants received study information and provided informed consent before the questionnaire was administered.

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Data availability: The anonymised data may be made available by the corresponding author on reasonable request, subject to the consent conditions and institutional approvals governing the study.

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