



REVIEW ARTICLE

DETERMINANTS OF MARKET OUTLET CHOICE AMONG SMALLHOLDER IRISH POTATO FARMERS IN KINANGOP SUB-COUNTY, KENYA

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ABSTRACT

Irish potato is a major global food crop and a key source of food security and income for rural households. In Kenya, it ranks second after maize and is primarily grown by smallholder farmers. Despite its importance, productivity remains low due to limited access to inputs, credit, extension services, modern technologies, and timely market information. Market outlet choice strongly affects farmer profitability, yet many farmers rely on intermediaries who offer lower returns. This study investigated determinants of market outlet selection among 241 smallholder Irish potato farmers in Kinangop sub-county, Nyandarua County, Kenya. Data were collected using a piloted semi-structured questionnaire through cluster sampling. Descriptive statistics were used to profile farmers, while a multivariate probit model analyzed factors influencing the choice among brokers, local markets, urban markets, and contract arrangements. On average, farmers were 46 years old, had 10 years of education, 14 years of farming experience, and cultivated 0.92 acres of potatoes. Male-headed households formed 61%, and 72% of farmers lacked timely market information. Access to extension services (18%), credit (18%), and farmer groups (26%) was limited, though mobile phone ownership was high (85%). The mean distance to markets was 28 km. Market outlet choice was significantly influenced by age, gender, land size, market distance, access to information, credit, extension, phone ownership, and primary household occupation. Most farmers (92.95%) sold through brokers due to convenience, although this reduced returns. Strengthening cooperatives, improving access to non-profit marketing agencies, enhancing rural infrastructure, and expanding extension services could improve market efficiency, reduce exploitation, and enhance income stability.

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INTRODUCTION

Irish potato (*Solanum tuberosum* L.) is the world's third most important food crop after wheat and rice, playing a significant role in rural welfare and food security (1). Globally, over 1.3 billion people consume Irish potato, with production increasingly concentrated in developing nations, particularly in East Africa and parts of Asia (2,3). This growth is driven by population increases and rising demand for processed products, including chips and crisps (4). In East Africa, Irish potato serves as a staple alongside other crops, particularly in Kenya, Uganda, Tanzania, and Rwanda (5). In Kenya, the crop is ranked second in importance after maize, with production dominated by smallholder farmers (6). Its high yield per unit area and rapid maturity (less than 120 days) make it an important tool for poverty alleviation and livelihood improvement among rural households (7). Despite its potential, productivity remains suboptimal, averaging 10 t/ha, below the ideal 30 t/ha, though higher than Uganda's 7 t/ha (8,9). Contributing factors include limited access to inputs, insufficient financial support, low adoption of advanced technologies, and information asymmetry between farmers and markets, often exacerbated by intermediaries (10,4,14). A critical decision for smallholder Irish potato farmers is the choice of market outlet, which involves evaluating costs and benefits to maximize utility (11,31). In Kinangop sub-county, Irish potato has emerged as a major source of income and employment for farmers (13,4). Despite the crop's economic importance, selecting an appropriate market outlet remains challenging. Many farmers sell through brokers, often receiving lower prices due to limited bargaining power and information asymmetry (14). Irish potato production and

marketing in the region are characterized by seasonality, weak linkages among stakeholders, inadequate storage infrastructure, and lack of coordination among farmers. These challenges often force farmers to sell immediately after harvest, lowering returns (15,16,17). To address these issues, responsive, efficient, and integrated market structures are needed to optimize resource allocation and improve market efficiency (18). Socioeconomic and institutional factors also influence market outlet decisions. Key determinants documented in literature include age, gender, education level, household size, access to information, transaction costs, extension services, and distance to markets (19,20,21,22,23). In Kinangop sub-county, farmers utilize multiple market outlets to maximize returns, but few studies have analyzed the specific factors influencing their decisions. Consequently, a gap exists in understanding determinants of market outlet choice among smallholder Irish potato farmers in the area. This study was therefore designed to examine these determinants using descriptive statistics and a multivariate probit model, focusing on how socioeconomic and institutional factors influence smallholder farmers' decisions on market outlet selection. By identifying these factors, the study aims to provide evidence-based recommendations for improving market participation, enhancing farmers' income, and promoting efficiency in Irish potato value chains.

MATERIALS AND METHODS

The study was conducted in Kinangop sub-county, in Nyandarua County, Kenya. The county lies between longitude 36° 42' and 36° 25' East and a latitude 0° 32' and 0° 50' South, at an altitude of 2667.11m above sea level. Agriculture is the main economic activity in the area and Irish potato is the major crop grown with the potential of increasing production and marketing. The sub-county is the leading in Irish potato production in Nyandarua county (the top Irish potato producer in Kenya). Cross sectional data was collected using a piloted semi-structured questionnaire that was administered in face-to-face interviews to systematically explain the questionnaire to smallholder Irish potato farmers. Ten percent of the sample size (25 farmers) were randomly selected from Kipipiri sub-county to pretest the questionnaire, to facilitate the adjustment of the questionnaire and to check the questionnaire's validity and reliability. A cluster sampling technique was utilized to select 241 smallholder Irish potato farmers in the study area where sampling formula by (32) was utilized.

Multivariate probit Model Specifications: Smallholder Irish potato farmers (f) could select selling Irish potato to either brokers, local, urban or contract market outlets. An individual farmer could select one market outlet (m) to sell Irish potato or select a combination of two or more outlets and therefore, be faced with a problem of multiple choices. Based on the principle that smallholder Irish potato farmers will select one or a combination of the market outlets that will maximize their satisfaction, multivariate probit model was utilized to examine the factors determining the market outlet choice among smallholder farmers in Kinangop sub-county. The model showed the influence of a group of causal variables on market outlet choice while accounting for interactions between latent disturbances and the association between market outlet choices. Multivariate probit model was the best model utilized to measure Irish potato farmers' differences in market outlet selection and determine correlated binary outcomes jointly; given the likelihood of concurrent market outlet selection and correlations between the market outlet selection decisions. The binary equation of the dependent variables is specified in equation 1.

$$A_{fm} = \alpha_m x_{fm} + \varepsilon_{fm} \quad (1)$$

Where; A_{fm} represents unobservable latent variable of the selected market outlet (Brokers, local market, urban market, or contract) by the f^{th} Irish potato farmer ($f = 1, 2, 3, \dots, n$). $\alpha_m = k \cdot 1$ for vector parameters to be determined. ε_{fm} are error terms with a normal distribution, zero mean and a covariance matrix M (equation 4). Matrix M has one value on the main diagonal of the correlated market outlets. Thus, the selection of the utility maximizing market outlet m by Irish potato farmer f is A_{fm} . The decision of smallholder farmer f to sell in market outlet m is $m(A_{fm} = 1)$ or otherwise $m(A_{fm} = 0)$ is given in equation 2.

$$A_{fm} = \begin{cases} 1 & \text{if } A_{fm} = x\beta_{fm} + \varepsilon_{fm} \geq 0 \Leftrightarrow x_{fm} \geq -\varepsilon_{fm} \\ 0 & \text{if } A_{fm} = x\beta_{fm} + \varepsilon_{fm} < 0 \Leftrightarrow x_{fm} < -\varepsilon_{fm} \end{cases} \quad (2)$$

The choice of a market outlet is assumed to be dependent on the choice of another market outlet, and the choice decisions could be affected by a similar set of independent variables, creating a system of econometric equations (Equation 3).

$$\begin{cases} A_1^* = x_1\alpha_1 + \varepsilon_{f1} & A_1 = 1 \text{ if } A_1^* \text{ is } > 0, A_1^* = 0 \text{ otherwise} \\ A_2^* = x_2\alpha_2 + \varepsilon_{f2} & A_2 = 1 \text{ if } A_2^* \text{ is } > 0, A_2^* = 0 \text{ otherwise} \\ A_3^* = x_3\alpha_3 + \varepsilon_{f3} & A_3 = 1 \text{ if } A_3^* \text{ is } > 0, A_3^* = 0 \text{ otherwise} \\ A_4^* = x_4\alpha_4 + \varepsilon_{f4} & A_4 = 1 \text{ if } A_4^* \text{ is } > 0, A_4^* = 0 \text{ otherwise} \end{cases} \quad (3)$$

where; A_1, A_2, A_3, A_4 are brokers, local, urban and contract market outlets, α_1^* are parameters to be estimated and ε are error terms with a normal distribution, with a variance value of 1 and a 0 mean. If ρ_{fm} signifies the correlation between the market outlets, then symmetric matrix M can be estimated as in equation 4.

$$\begin{pmatrix} \varepsilon_{fm1} \\ \varepsilon_{fm2} \\ \varepsilon_{fm3} \\ \varepsilon_{fm4} \end{pmatrix} Q \left\{ \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \begin{pmatrix} 1 & \rho_{12} & \rho_{13} & \rho_{14} \\ \rho_{21} & 1 & \rho_{23} & \rho_{24} \\ \rho_{31} & \rho_{32} & 1 & \rho_{34} \\ \rho_{41} & \rho_{42} & \rho_{43} & 1 \end{pmatrix} \right\} \quad (4)$$

RESULTS

Preliminary Test

Test for multicollinearity: Before running the Multivariate probit model, an ordinary least squares (OLS) regression was run to check the presence of multicollinearity by use of VIF (variance inflation factor) command. Variance inflation factor measured the degree of multicollinearity in the regression model by estimating an index that estimated the increase in the regression variance of the coefficients estimated.

The calculated VIF value was low (Table1) when compared to the critical value (<5 or <10). The results revealed the absence of multicollinearity among the explanatory variables. Therefore, the variables were fit to be used for analysis.

Test for heteroskedasticity: The Breusch-pagan test was employed to evaluate heteroskedasticity between the dependent and independent variables. Breusch-Pagan/Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of e2

chi2 (1) = 567.63

Prob > chi2 = 0.0000

The computed p value was found to be 0.000 indicating the test was significant, thus rejecting the null hypothesis; there is constant variance. The findings imply that the standard error of the regression results was not randomly distributed across the explanatory variables, hence the presence of heteroskedasticity. Therefore, robust standard errors were used to correct the heteroskedasticity.

Table 1. VIF and 1/ VIF results

Variable	VIF	1/VIF
Experience	2.00	0.4989
Household age	1.85	0.5415
Education years	1.42	0.7040
Land under Irish potato	1.30	0.7690
Credit access	1.30	0.7717
Phone access	1.26	0.7966
Group membership	1.18	0.8458
Market distance	1.18	0.8476
Extension access	1.17	0.8515
Main occupation	1.16	0.8656
Information access	1.15	0.8708
Household size	1.13	0.8825
Household head gender	1.05	0.9569
Mean VIF	1.320	

Source: Field survey, (2023)

Legend: Variance Inflation Factor (VIF) and tolerance (1/VIF) were computed to detect multicollinearity among explanatory variables used in the multivariate probit model. VIF values below 5 and tolerance values above 0.1 indicate no serious multicollinearity among the predictors.

Social economic and institutional characteristics of smallholder Irish potato farmers in Kinangop sub-county: The descriptive statistics of Irish potato farmers showed that the average age of farmers was approximately 46 years, with a mean of 10 years of formal education (Table 2). On average, each household had about three members contributing labor, which helped minimize production costs. Farmers had an average of 14 years of farming experience, suggesting familiarity with production and marketing practices.

The average land size under Irish potato production was approximately 0.92 acres, while the mean distance to the nearest market was 28 kilometers, indicating potential challenges related to transportation and market access. The results further showed that 61.41% of the farming households were male-headed. In terms of access to information, 72.2% of farmers lacked timely or reliable market data. Regarding institutional characteristics, 18.26% of farmers had access to extension services, 85.48% owned mobile phones, and 17.84% accessed credit. Only 26.14% of farmers belonged to farmer groups. Additionally, 76.35% of households reported agriculture as their primary economic activity.

Table 2. Summary of descriptive results

Variable	Obs	Mean	Std. Dev.	Min	Max
Household head age (years)	241	46.0996	12.0401	20	75
Education years	241	9.5934	3.9127	0	16
Household size	241	3.7469	1.7578	1	10
Experience (years)	241	13.9129	10.6413	1	50
Land under Irish potato (acres)	241	.92168	.8231	0.125	5
Market distance (kms)	241	28.0709	16.7682	0.5	60
Gender	241	.6141	.4878	0	1
Information access	241	.2780	.4489	0	1
Extension access	241	.1826	.3872	0	1
Phone access	241	.8548	.3531	0	1
Group member	241	.2614	.4403	0	1
Credit access	241	.1784	.3837	0	1
Main occupation	241	.7635	.4258	0	1

Source: Field survey, (2023)

Legend: Descriptive statistics summarize socio-economic, farm, and institutional characteristics of smallholder Irish potato farmers in Kinangop Sub-county. Binary variables are coded as 1 = Yes, 0 = No. Continuous variables include household head age, education, household size, farming experience, land under Irish potato, and distance to market.

Main market outlets among smallholder Irish potato farmers: The study revealed that the major market outlets used by smallholder Irish potato farmers in Kinangop Sub-county include brokers, local markets, urban markets, and contract markets. The majority (92.95%) of farmers sold their produce to brokers, showing that Irish potato marketing is largely dominated by intermediaries who link producers to markets. Farmers commonly preferred selling to brokers at the farm gate to avoid the high transaction costs and risks associated with transporting and marketing their produce. Immediate cash needs also influenced their choice of the most convenient and accessible market outlets.

Table 3: Market outlet results

Market outlets	Freq.	Percent
Brokers	224	92.95
Local market	11	4.56
Urban market	5	2.07
Contract	4	1.66
Total	241	100

Source: Field survey, (2023)

Legend: This table shows the proportion of farmers selling their Irish potato produce through different market outlets. Brokers dominate the marketing system, highlighting smallholder dependence on intermediaries for farm-gate sales, while local, urban, and contract markets remain minimally utilized.

Determinants of market outlet choice among smallholder Irish potato farmers: The Wald χ^2 (52) = 258.35 with a p-value of 0.000 was statistically significant at the 1% level, indicating that the model coefficients were jointly significant and that the model provided a satisfactory fit. The correlation parameters ρ_1 , ρ_2 , ρ_3 , and ρ_4 corresponded to brokers, local, urban, and contract markets, respectively. Significant negative correlations existed between brokers and contract markets (ρ_{41}), brokers and urban markets (ρ_{31}), and brokers and local markets (ρ_{21}) at the 1% significance level, implying that participation in one outlet reduced the likelihood of selling to the others (Table 4). Specifically, participation in broker markets reduced the probability of selling to local, urban, and contract markets by 63.86%, 41.47%, and 47.16%, respectively. Of the thirteen variables included in the multivariate probit model, nine were statistically significant at the 10%, 5%, or 1% levels. These included age, land under Irish potato production, distance to the market, gender, access to information, extension access, phone access, credit access, and household main occupation. Selling through broker markets was significantly influenced by land under Irish potato production, market distance, and phone access ($p < .01$). Participation in local markets was significantly influenced by land size and gender ($p < .05$), information access and market distance ($p < .01$), and extension and phone access ($p < .10$). Urban market participation was significantly affected by age and market information ($p < .01$) and by phone access ($p < .05$). Participation in contract markets was significantly influenced by age and credit access ($p < .01$), and by market distance, market information, phone access, and household occupation ($p < .05$).

Age had both positive and negative significant effects on participation in urban and contract markets ($p < .01$). A one-year increase in age increased the probability of selling through urban markets by 0.065 but decreased the probability of contract market participation by 0.20. Land under Irish potato production significantly ($p < .01$) and negatively influenced the likelihood of selling through brokers, with an additional acre reducing the probability of selling through brokers by 0.20. Market distance significantly ($p < .01$) increased participation in brokers' markets but significantly reduced participation in local ($p < .01$) and contract markets ($p < .10$). A one-kilometer increase in distance increased the probability of selling to brokers by 2.93% but reduced the probability of selling to local and contract markets by 5.56% and 10.41%, respectively. Gender significantly ($p < .05$) and negatively influenced participation in local markets, with male-headed households being 105.32% less likely to sell through local markets. Information access had a negative and significant effect on participation in brokers ($p < .01$) and contracts ($p < .05$), but a positive

and significant effect on participation in urban and local markets ($p < .01$). Access to extension services significantly ($p < .05$) reduced participation in local markets by 48.25%. Access to credit significantly ($p < .01$) increased participation in contract markets by 247.94%. Phone access had mixed effects, significantly increasing participation in brokers' markets ($p < .05$) but reducing participation in local ($p < .10$), urban ($p < .05$), and contract markets ($p < .05$). Agricultural occupation significantly ($p < .01$) increased participation in contract markets by 544.51%.

Legend: The multivariate probit model estimates the influence of socio-economic, farm, and institutional factors on farmers' choice of market outlets. Coefficients indicate the direction and strength of effects, with significance levels denoted as: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Correlation parameters (ρ) represent the interdependence of choices among market outlets, with negative values indicating substitutive relationships. The study examined factors influencing market outlet choice among smallholder Irish potato farmers in Kinangop Sub-county, Kenya. The analysis revealed that access to extension services, credit, mobile phones, and the main occupation of the household significantly affected farmers' marketing decisions across brokers, local, urban, and contract markets. Access to extension services had a negative and significant ($p < 0.05$) effect on the likelihood of choosing local markets, reducing the probability by 48.25%. Access to credit had a positive and significant ($p < 0.01$) effect on participation in contract markets, increasing the likelihood by 247.94%. Mobile phone access significantly increased participation in broker markets by 93.18% ($p < 0.05$) but significantly reduced participation in local (122.48%, $p < 0.10$), urban (73.76%, $p < 0.05$), and contract markets (176.02%, $p < 0.05$). The main occupation of the household also had a significant influence, with households whose primary occupation was agriculture being 544.51% more likely ($p < 0.01$) to participate in contract markets.

DISCUSSION

The socio-economic and institutional characteristics of farmers in Kinangop play a central role in shaping their market outlet decisions. The sampled farmers were relatively mature (mean age 46 years) and experienced (14 years), suggesting adequate capacity for informed production and marketing choices. Household labor availability was also moderate, potentially supporting reduced production costs. Despite these strengths, several structural constraints particularly long distances to markets and limited access to timely market information continue to impede efficient market participation by increasing transaction costs and restricting informed decision-making. Institutional limitations were particularly pronounced. Access to extension services, credit, and farmer groups remained low, constraining farmers' ability to acquire new technologies, negotiate prices, and leverage collective action. While mobile phone ownership was high, the parallel lack of reliable market information suggests that digital tools are not yet fully integrated into local agricultural marketing systems. These findings mirror observations by (26), who noted that limited access to support services hinders smallholder commercialization.

Market Outlet Patterns: The dominance of brokers in the marketing system highlights persistent entry barriers into alternative, potentially more remunerative markets. Although brokers reduce farmers' transaction costs through farm-gate purchasing and immediate cash payments, their informational advantage often results in pricing inefficiencies and reduced farmer margins. This is consistent with (24), who found that potato farmers in Kenya face restricted market access due to high coordination and transportation costs. Significant negative correlations between brokers and all other outlets indicate that participation in one market type substantially reduces the likelihood of choosing another. This substitutive pattern reflects a marketing environment where farmers tend to specialize in one outlet rather than adopt diversified market strategies.

Determinants of Market Outlet Choice: The results reveal substantial heterogeneity in outlet choice across demographic, economic, and institutional variables. Age exhibited mixed effects. Older farmers were more likely to sell through urban markets, possibly reflecting accumulated experience and established networks, but were less inclined to engage in contract markets, which may be perceived as riskier or more demanding. Similar age-related trends have been documented by (22,20). Land size significantly reduced reliance on brokers. Larger producers generally generate higher output volumes, incentivizing them to seek outlets offering better prices and stable returns (23,21). Distance to market strongly influenced market participation. Longer distances increased reliance on brokers—who purchase at the farm gate—while discouraging participation in local and contract markets (19,33). Gender effects indicated that male-headed households were less likely to sell through local markets, perhaps reflecting men's broader market networks and greater mobility (25).

Market information access played a pivotal role in shifting participation toward urban and local markets while reducing dependency on brokers and contract outlets. Access to information enhances farmers' ability to compare prices and evaluate market alternatives (26). Credit access significantly increased participation in contract markets, reflecting the capital-intensive nature of meeting contractual requirements such as quality and quantity standards (27). Mobile phone access increased the likelihood of selling through brokers but reduced participation in other outlets (28,29). Main household occupation emerged as a strong determinant of contract participation. Farmers whose primary livelihood was agriculture were significantly more likely to engage in contract farming, which offers income stability and predictable market arrangements (30). Extension access reduced participation in local markets, suggesting that extension exposure enhances farmers' market orientation, awareness of alternative marketing channels, and capacity to meet higher-value market requirements (31). Overall, the findings demonstrate that market outlet choice among smallholder potato farmers is shaped by a combination of demographic characteristics, resource endowments, infrastructure, and institutional support systems. Improving access to extension services, credit, and reliable market information coupled with investments in rural roads and strengthened farmer organizations could significantly enhance farmers' ability to participate in more profitable markets. Such interventions can reduce dependence on brokers, promote equitable market participation, and ultimately improve household incomes and resilience.

CONCLUSION

The study aimed to determine factors influencing market outlet choice decisions among smallholder Irish potato farmers in Kinangop Sub-County, Kenya. Results showed that most farmers sold their produce at the farm gate to brokers due to convenience and to avoid high transaction costs and marketing risks. A multivariate probit model was employed to analyze the determinants of outlet choice. The findings revealed that the decision to sell to brokers was positively influenced by land under Irish potato cultivation and market distance, while access to phones and market information negatively influenced selling to brokers. Similarly, land size, distance to market, gender, extension service, and phone access negatively affected selling to local markets, whereas access to information had a positive effect. For urban markets, age and access to information positively influenced farmers' participation, while phone access had a negative effect. Contract market participation was negatively influenced by occupation, access to credit, age, market distance, information, and phone access. Overall, land size, market distance, access to information, and phone access were the most important determinants of outlet choice. Farmers with better access to market information preferred high-value markets to maximize returns, while increased land size, distance, and phone access tended to push farmers toward brokers. The study recommends that smallholder farmers form strong marketing groups or cooperatives to enhance collective marketing, improve bargaining power, and reduce exploitation by brokers. The government should establish non-profit public marketing agencies in the area to link farmers with appropriate markets, reduce information asymmetry, and lower transaction costs. Additionally, continuous training and extension services should be provided to strengthen farmers' marketing capacity, especially in rural regions, thereby promoting more efficient and profitable Irish potato marketing systems in Kinangop Sub-County.

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GLOSSARY OF ABBREVIATIONS

A _{fm}	Latent variable representing the selected market outlet by the f-th farmer
BIF	Brokers' Influence Factor (contextual; optional if used in analysis)
Co.	County
CT	Conventional Tillage
km	Kilometer
L	Liter
M	Covariance matrix of error terms in multivariate probit model
MC	Maize-Cowpea intercrop (as used in cropping patterns)
MT	Minimum Tillage
NP	Non-profit Marketing Agency
n	Sample size / number of farmers
OLS	Ordinary Least Squares (OLS)
RCBD	Randomized Complete Block Design
RSE	Robust Standard Error
SPSS	Statistical Package for the Social Sciences
t/ha	Tonnes per Hectare
TRL	Technology Readiness Level
VIF	Variance Inflation Factor
Wald χ^2	Wald chi-square test statistic for model significance
ρ	Correlation coefficient between market outlet choices
ε_{fm}	Error term in multivariate probit model

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