

Research Application Summary

**Factors affecting potato production in rural Kenya. A case of small-scale potato farmers in Molo Sub - County**

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**Abstract**

Potato (*Solanum tuberosum* L.) is among the promising commodities in horticultural production in Kenya. Over the years, potato production in Kenya has intensified. Yields, however, continue to remain low due to a myriad of constraints and factors. This paper was focused on the factors such as farmer's age, gender, education, potato farming experience, membership in farmer group, land ownership, access to credit, quality potato seeds, extension services that affect the production of potato small-scale in Molo Sub-County, Kenya. The study adopted cross-sectional survey design which was used to obtain information to determine the existing phenomena. The target population was 6000 both male and female consisting of small-scale farmers. The estimated sample size was 413 from the target population using Yamane's formula. The study employed purposive sampling to include all the wards; proportionate allocation was used to determine the number of farmers from each ward that would be the respondents in the study. Simple random sampling was used to select the actual respondents from the wards. Data was analysed using descriptive and inferential methods. Multiple linear regressions results revealed that factors such as membership to a farmer group, farmer's education, access to extension services, access to quality potato seeds, access to credit are determinants of potato production, each had p-values [0.024, 0.036, 0.015, 0.000, 0.005], ( $R^2=83.8\%$  F= 135.390 and P-Value= 0.000), which shows a significant positive relationship between these factors and potato production. Therefore, the conclusion is that the farmers should develop their education level, be a member to a farmer group, access extension services, access quality potato seeds, access credit to maximize their potato production. The study recommends that the government should encourage small-scale farmers to seek the extension services, quality potato seeds, credit, join farmer groups and improve their education.

**Keywords:** Access to credit, Access to extension services, Multiple Linear Regression, Potato production, small-scale farmers

**Résumé**

La pomme de terre (*Solanum tuberosum* L.) fait partie des produits prometteurs de la production horticole au Kenya. Au fil des années, la production de pommes de terre au Kenya s'est intensifiée. Cependant, les rendements continuent de rester faibles en raison de diverses contraintes et facteurs. Cette étude s'est concentrée sur les facteurs tels que l'âge, le genre, l'éducation des agriculteurs, l'expérience en matière de culture de pommes de terre, l'appartenance à un groupe d'agriculteurs, la propriété foncière, l'accès au crédit, les semences de pommes de terre de qualité et les services

de vulgarisation qui affectent la production de pommes de terre à petite échelle dans le sous-comté de Molo, au Kenya. L'étude a adopté une conception d'enquête transversale qui a été utilisée pour obtenir des informations afin de déterminer les phénomènes existants. La population cible était de 6000 agriculteurs, hommes et femmes, à petite échelle. La taille de l'échantillon estimée était de 413 personnes, en utilisant la formule de Yamane à partir de la population cible. L'étude a utilisé un échantillonnage délibéré pour inclure tous les quartiers ; une allocation proportionnelle a été utilisée pour déterminer le nombre d'agriculteurs de chaque quartier qui seraient les répondants de l'étude. Un échantillonnage aléatoire simple a été utilisé pour sélectionner les répondants réels parmi les quartiers. Les données ont été analysées à l'aide de méthodes descriptives et inférentielles. Les résultats de la régression linéaire multiple ont révélé que des facteurs tels que l'appartenance à un groupe d'agriculteurs, l'éducation des agriculteurs, l'accès aux services de vulgarisation, l'accès à des semences de pommes de terre de qualité, l'accès au crédit sont des déterminants de la production de pommes de terre, chacun ayant des valeurs de  $p$  [0,024, 0,036, 0,015, 0,000, 0,005], ( $R^2=83,8\%$   $F=135,390$  et Valeur- $P=0,000$ ), ce qui montre une relation positive significative entre ces facteurs et la production de pommes de terre. Par conséquent, la conclusion est que les agriculteurs devraient développer leur niveau d'éducation, être membres d'un groupe d'agriculteurs, avoir accès aux services de vulgarisation, aux semences de pommes de terre de qualité et au crédit pour maximiser leur production de pommes de terre. L'étude recommande que le gouvernement encourage les petits agriculteurs à rechercher des services de vulgarisation, des semences de pommes de terre de qualité, du crédit, à rejoindre des groupes d'agriculteurs et à améliorer leur éducation.

Mots-clés : Accès au crédit, Accès aux services de vulgarisation, Régression linéaire multiple, Production de pommes de terre, petits agriculteurs

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## Background

Agriculture sector is the mainstay of Kenya's economy accounting for 33 % of the country's gross domestic product (GDP) (GoK, 2022). In addition, it is estimated that the sector employs more than 40 percent of the total population and 70 percent of the rural population either directly or indirectly (Kashindi, 2021). Similarly, the sector accounts for 65 per cent of the export earnings, and provides the livelihood through offering employment opportunities, income, and food security needs for more than 80 per cent of the Kenyan population and contributes to improving nutrition through production of safe, diverse, and nutrient dense foods to the people (Lokuruka, 2020). Further, the sector contributes to the non-agricultural economy including manufacturing, providing inputs and markets for non-agricultural operations such as construction, transportation, tourism, education, and other social services (Amwata, 2020). Small-scale farmers dominate the agricultural sector with farms ranging from 0.2 to 5 hectares and produces over 70% of total agricultural output (Woodhill *et al.*, 2020).

In particular, the horticulture sub-sector of agriculture forms the bulk of agriculture, and it has grown to be a vital source of income for small scale farmers, government revenue, and foreign exchange earnings (Sang, 2020). Besides, the sub-sector contributes immensely to food security, as well as being a crucial source of raw materials for the manufacturing sector (Dae, 2022). Vegetables in horticultural production accounts for 80 percent of all growers and produces 60 percent of horticultural exports and the main horticultural crops produced include vegetables, fruits, herbs, root crops (Irish and sweet potatoes), spices and cut flowers (Ringo, 2022). Potato (*Solanum tuberosum* L.) a popular and extensively cultivated vegetable is among the promising

commodities in horticultural production in Kenya (Aksoy *et al.*, 2021). In terms of production, Kenya is amongst the leading producers of potato in sub-Saharan Africa with a production of about 2 to 3 million tons (Kangogo *et al.*, 2020). Given its numerous favourable attributes, the potato is a suitable candidate for crop diversification in Kenya.

Potato has wide acceptance, and many households already depend on it as a primary or secondary source of food and nutrition (Muthoni *et al.*, 2017). The crop is eaten by nearly all the households as a source of essential nutrients including carbohydrates, minerals such as potassium, calcium, magnesium and phosphorus, vitamins such as vitamin C, vitamin B6, fiber, and high level of antioxidants that help heart health (Dolnir, 2021). Moreover, the potato is a very productive crop: it produces more food per unit area and time than wheat, rice, or maize, one of the crop's assets is its adaptability – it can be grown in a wide variety of farming systems (Salmensuu, 2021). The crop has a short and highly flexible vegetative cycle and can be ready for harvest within 100 days of planting. It fits well with double-cropping and intercropping systems, is ecologically quite adaptable and can be grown as an off-season crop (Aksoy *et al.*, 2021).

Over the years, potato production in Kenya has intensified and there is an increasing concern in Kenya that potato production can significantly contribute to realizing the nationwide objectives of vision 2030 by generating employment, enhancing food security, improving nutritional security, and raising incomes (Republic of Kenya, 2019). For example, as reported in National root and tuber crops development strategy 2019-2022 report potato contributes to economic development and industrial growth through income of about 50 billion Kenya shillings annually towards the Growth Domestic Product of Kenya, and thus it is acknowledged as one of the pillars that will significantly contribute to achievement of Kenya vision 2030 because of its substantial contribution to food availability and income in the country (Republic of Kenya, 2019). However, potato production has remained low due to a myriad of impediments in the country and the study area. Small-scale farmers face increasing difficulties in their attempt to maintain productivity on intensively potato farms. These difficulties have led to decrease in potato production leading to household food insecurity particularly among small scale farmers in Molo Sub-County who depend on it for both food and income source (Chepkoech, 2022).

Small-scale farmers being resource poor are not able to invest in quality seeds, access credit and extension services which are important in potato production (Wamuyu *et al.*, 2021). Solution lies in analysing factors that are possibly having an influence on potato production. To scale up the steering of increment in potato production, there is need to have a deeper considerate and analysing of the prevailing factors such as farmer's age, gender, education, potato farming experience, membership in farmer group, land ownership, access to credit, quality potato seeds, extension services and their influence on potato production. This will show how well the prevailing factors fits into the complex pattern of potato production change in the farming system therefore led to improvement in potato production.

Studies have shown that factors for instance farmer's age, gender, education, potato farming experience, membership in farmer group, land ownership their relationship to the decision to crop production, access to credit, quality seeds and extension services have an influence on crop production (Ofosu *et al.*, 2020). According to Maertens *et al.* (2021) extension services are effective in predicting agricultural problems outbreaks, thus permitting time for development and application of proper mitigation measures. They are essential in supporting farmers to deal with existing and new challenges in agricultural production besides enhancing information exchange,

knowledge, skills among farmers as well as stakeholders (Norton *et al.*, 2020). Age for instance is a key latent characteristic in making decisions on adoption practices, production and predisposes a farmer to better farming techniques through learning and better management skills (Thinda *et al.*, 2020). According to Abdi (2020) gender has been known to influence agricultural production through issues and concerns that surround access and control of resources for production. Women especially in the developing countries reside in rural areas and are greatly involved in the agricultural production (Ball, 2020).

According to Sapbamrer *et al.* (2021) farming experience have an influence on crop production. In this they explained that by gaining farming experience farmers can increase proficiency in the processes of farm production due to skills and knowledge gained and, therefore, increased productivity. Abdul-Rahaman and Abdulai (2020) found that membership in a farmer group is likely to increase producers' income earning capabilities due to skills and joint learning among them as opposed to individual farmers who do not belong to a farmer group. Bestowing to Alban Singirankabo and Willem Ertsen (2020), the nature of land ownership has an important contribution to how a farmer utilizes and makes investments on land and intensification of agricultural production in his/her land. Education would help farmers get exposed to more knowledge and skills on changing innovations and ideas meant for improving potato production, proper use of chemical fertilizers and pesticides, adoption of improved potato varieties leading to increase potato production (Ullah *et al.*, 2020).

While in reviewing different literature with regard of the study area, the author found that different studies conducted in the study area were on factors influencing potato production but focused on technical efficiency, fertilizer use, soil nutrients respectively. However, nothing research was found concerning influence of access to credit, quality potato seeds and extension services, farmer's age, gender, education level, potato farming experience, membership in farmer group and land ownership on potato production. Knowing this will highlight the extent to which these factors account for disparities in potato yields. Therefore, this study specifically aims to investigate the influence of factors such as access to credit, quality potato seeds and extension services, farmer's age, gender, education level, potato farming experience, membership in farmer group and land ownership on potato production among small scale farmers in Molo Sub County, Kenya.

## **Methodological approach**

**Study location.** The study was conducted in Molo Sub-County Kenya, explicitly in Mariashoni, Elburgon, Turi and Molo wards. Molo Sub-County is in the Rift Valley along the Mau Forest, which runs along the Mau escarpment and the main cash crops are potatoes, barley, maize, and pyrethrum (Kenya National Bureau of Statistics [KNBS], 2019).

**Research design.** The study employed a cross-section research design whereby data were collected at one point in time. This design was most suitable because it enabled the researcher to describe, analyse, and interpret conditions that exist in variables under study without manipulating the environment of the study

**Validity and reliability.** Content validity was used where the researcher shared the research instrument with experts to assess its appropriateness in content. Split half method was employed to test the reliability of the instrument.

**Sampling procedures and sample size.** The target populations for this study were small-scale potato farmers. The four wards were purposively selected namely Mariashoni, Elburgon, Turi and Molo owing to their importance in potato production. The sample size for the smallholder potato farmers was determined using the formula recommended by Yamanne's *et al.* (2020) for small populations less than 10,000 was used to determine the sample size as follows:

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

n = the desired sample size (for target populations less than 10,000).

N = the population size.

e = the level of precision or statistical significance set.

$$n = \frac{6000}{1 + 6000(0.05)^2}$$

Therefore, given that the population of small-scale farmers was 375. Adding 10% for non-respondents (i.e., 38), the desired sample size for this study was 413 small scale potato farmers. Proportionate random sampling was used in determining the number of respondents for the four wards and simple random sampling was be used in obtaining the actual respondents from the wards.

**Table 1. Proportion of sample size per ward**

| Ward       | Number of potato farmers | Proportion (%) | Sample size |
|------------|--------------------------|----------------|-------------|
| Elburgon   | 1000                     | 17             | 70          |
| Mariashoni | 2500                     | 42             | 173         |
| Molo       | 500                      | 8              | 33          |
| Turi       | 2,000                    | 33             | 137         |
| Total      | 6,000                    | 100            | 413         |

**Data collection.** To collect primary data, a questionnaire with closed ended questions was prepared. The questionnaire was then pre-tested and amended based on the feedback received during pre-test. The enumerators, who have contact with the local languages were selected and trained on data collection procedures and techniques to simplify the complexity of data collection. The questionnaire was distributed to the small-scale potato farmers in all the wards. All the questionnaires were filled and were used for analysis.

### Data analysis

Data were then entered in Statistical Package for Social Sciences (SPSS) data management software version 22 and analysed. Both descriptive and inferential methods of data analysis were employed to analyse. Descriptive statistical analysis such as percentages were used in the process of examining variables in the study. Simple linear regression analysis was used to test whether there was a significant influence by factors such as access to credit, quality potato seeds and extension services, age, gender, education level, potato farming experience, membership in farmer group and land ownership on potato production among small scale farmers in Molo Sub County, Kenya at  $\alpha = 0.05$  level of significant.

## Results and Discussion

The study indicated female dominance in potato production in Molo Sub-County. Majority of the small-scale potato farmers were female (63%). Majority of the small-scale farmers were middle aged (56%). On farmer's education over 90 % had at least basic education with averagely (40%) having completed secondary education. Majority of respondents (50 %) had spent up to five years in farming potato. 70% of the small-scale farmers were members of farmer groups which represent a majority. About on average (42%) of the farmers used land that was rented for potato production. Majority of farmers (82%) had access to extension services while low percentage 29 % and 35 % of farmers had access to quality potato seeds and credit, respectively.

**Table 2. Descriptive Statistics**

| Variable                       | Percentage |
|--------------------------------|------------|
| Farmer's gender                |            |
| Male                           | 37         |
| Female                         | 63         |
| Farmer's age                   |            |
| Youth                          | 18         |
| Middle aged                    | 56         |
| Elderly                        | 26         |
| Farmer's education             |            |
| No formal education            | 6          |
| Primary                        | 36         |
| Secondary                      | 40         |
| Post-secondary education       | 18         |
| Farming experience (Years)     |            |
| 0-5 years                      | 50         |
| 6-10 years                     | 26         |
| 11-15 years                    | 10         |
| over 16 years                  | 14         |
| Membership in Farmer Group     |            |
| Yes                            | 70         |
| No                             | 30         |
| Land Ownership                 |            |
| Self-owned                     | 38         |
| Family                         | 20         |
| Rented                         | 42         |
| Access to extension services   |            |
| Yes                            | 82         |
| No                             | 18         |
| Access to quality potato seeds |            |
| Yes                            | 29         |
| No                             | 71         |
| Access to credit               |            |
| Yes                            | 35         |
| No                             | 65         |

**Regression Analysis.** The coefficient of multiple determinants denoted by  $R^2$ , is a measure of proportion of the variation of the regress and explained by the corresponding explanatory variables. The value of  $R^2$  lies between zero and unity  $0 \leq R^2 \leq 1$ . A value of unity implies that 100% of the variations of Y have been explained by the explanatory variables. The study also used multiple linear regression analysis to assess the influence of independent variables on potato production in Molo Sub-County among small-scale farmers.

Analysis of variance was used to assess whether the model was fit for the collected data. According to the research findings as illustrated in table 3, the p-value was shown to be 0.000, which is less than 0.05. That means at least one regression parameter is different from null and at least one of the predictor variables is determinant for potato production. This is a prove that the model used was reliable in determining how the independent variable [gender of the farmer, age of the farmer, farmer's education, potato farming experience, land ownership, membership to a farmer group, access to extension services, access to quality potato seeds, access to credit] influence potato production in Molo Sub-County, Kenya. Further, the F-calculated (80.920) and this indicates that the model was fit for looking into the influence of these factors on potato production

**Table 3. ANOVA<sup>a</sup>**

| Model |            | Sum of Squares | df  | Mean Square | F      | Sig.  |
|-------|------------|----------------|-----|-------------|--------|-------|
| 1     | Regression | 457.514        | 9   | 50.835      | 80.920 | .000b |
|       | Residual   | 88.578         | 141 | .628        |        |       |
|       | Total      | 546.093150     |     |             |        |       |

a. Dependent Variable: yields per ha

b. Predictors: (Constant), gender of the farmer, age of the farmer, farmer's education, potato farming experience, land ownership, membership to a farmer group, access to extension services, access to quality potato seeds, access to credit

**Table 4. Model Summary**

| Model | R     | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig.F Change |
|-------|-------|----------|-------------------|----------------------------|-----------------|----------|-----|-----|--------------|
| 1     | .915a | .838     | .827              | .79260                     | .838            | 80.920   | 9   | 141 | .000         |

a. Predictors: (Constant), gender of the farmer, age of the farmer, farmer's education, potato farming experience, land ownership, membership to a farmer group, farmer's education, access to extension services, access to quality potato seeds, access to credit

According to the findings, the R-squared for the relationship between gender of the farmer, age of the farmer, farmer's education, potato farming experience, land ownership, membership to a farmer group, access to extension services, access to quality potato seeds, access to credit and potato production in Kenya was 0.838 as shown in table 4. This implies that independent variables studied explain 83.8 % of variation in potato production in Molo Sub-County.

**Table 5. Coefficients<sup>a</sup>**

| Model | Unstandardized Coefficients    | Standardized Coefficients |            |       |        |      |
|-------|--------------------------------|---------------------------|------------|-------|--------|------|
|       |                                | B                         | Std. Error | Beta  | t      | Sig. |
| 1     | (Constant)                     | .695                      | .453       |       | 1.533  | .128 |
|       | Gender of the farmer           | -.089                     | .130       | -.023 | -.681  | .497 |
|       | Age of the farmer              | .005                      | .061       | .003  | .076   | .940 |
|       | Farmer's education             | .066                      | .069       | .036  | .965   | .036 |
|       | Potato farming experience      | -.066                     | .067       | -.038 | -.987  | .325 |
|       | Land ownership                 | -.019                     | .073       | -.009 | -.256  | .798 |
|       | Membership to a farmer group   | .150                      | .142       | .038  | 1.053  | .024 |
|       | Access to extension services   | .073                      | .073       | .036  | 1.009  | .015 |
|       | Access to quality potato seeds | .828                      | .075       | .721  | 11.100 | .000 |
|       | Access to credit               | .251                      | .087       | .188  | 2.873  | .005 |

a. Dependent Variable: yields per ha

The fitted regression model is given:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \alpha$$

Where  $\beta_0$  is the regression intercept;  $\beta_1$ - $\beta_9$  are the regression coefficients while Y is the dependent variable (potato production [Yields in ha])  $X_1$  is the age of the farmer,  $X_2$  is the farmer's education,  $X_3$  is the potato farming experience,  $X_4$  is the land ownership,  $X_5$  is the membership to a farmer group,  $X_6$  is the gender of the farmer,  $X_7$  is the access to extension services,  $X_8$  is the access to quality potato seeds,  $X_9$  is the access to credit.

From table 5, covariates like membership to a farmer group, farmer's education, access to extension services, access to quality potato seeds, access to credit, each has p-value 0.024, 0.036, 0.015, 0.000, 0.005 respectively which are less than level of significance 0.05. Thus, membership to a farmer group, farmer's education, access to extension services, access to quality potato seeds, access to credit are statistically significant factors of potato production. In contrast, gender of the farmer, age of the farmer, potato farming experience and ownership of land have no significant effect on potato production since their p-value were greater than level of significance 5%.

More specifically, the results show that holding [gender of the farmer, age of the farmer, farmer's education, potato farming experience, land ownership, membership to a farmer group, access to extension services, access to quality potato seeds, access to credit] constant, the potato production in Molo Sub- County, Kenya will be 0.695. Membership to a farmer group coefficient  $\beta_5 = 0.150$ , implies that small-scale potato farmer belonging to a farmer group will lead to 0.150 increase in potato yields tons per ha. Farmer's education coefficient  $\beta_2 = 0.066$  implies that when education level of potato producer is increased by one step, then potato production is increased by 0.066 tons per ha keeping all other variables as constant. Access to extension services slope  $\beta_7 = 0.073$  indicates that when the farmer access extension services then potato production is increased by

0.073 tons per ha keeping all other variables as constant, Coefficient on access to quality potato seeds  $\beta_8 = 0.828$  shows that when a farmer access quality seeds then potato production is increased by 0.828 tons per ha if all other variables are fixed. Lastly access to credit  $\beta_9 = 0.251$ , point out that when a farmer access credit, then potato production is increased by 0.251 tons per ha if taking all other variables as a constant.

These results are consistent with those of Devaux (2020) who stated that belonging to farmer group have the potential to enhance information sharing, networking, exchange of new ideas and increased access to production and marketing information among potato producers due to collective action. Bartova and Fandel (2020) noted that farmers belonging to a group can participate in multiple networks and hence are likely to be most empowered and are more inclined to seek greater decision-making roles to improve crop production. Francis *et al.* (2020) supports the results by stating that as a farmer gain farming experience they can increase proficiency in the processes of farm production due to skills and knowledge gained and, therefore, increased productivity. Hassan *et al.* (2021) conforms to the results by stating that Education keeps farmers well-informed with changing innovations and ideas meant for improving potato production because most educated farmers stand high chances of making better decisions as well as quickly implementing new technologies and innovations in farming.

Extension services act as fundamental in supporting farmers to deal with existing and new challenges in agricultural production moreover enhancing information exchange, knowledge, skills among farmers as well as stakeholders. Seeds are the principal input of agriculture the access and use of quality seeds of adaptable crop varieties are of vital importance to improve agricultural productivity, ensure food security and improve farmers' livelihoods (Pinedo *et al.*, 2021), use of native seeds or the so-called local, 'personal seeds', with an ancestral dynamic such as the exchange of seeds increases the risk of using seed tubers with poor physical, physiological and genetic qualities and the spreading of seed- and soil-borne diseases. The findings that access to credit influence potato production are consistent with similar findings from a study by Agbodji and Johnson (2021) on agricultural credit and its impact on the productivity of certain cereals in Togo. The results show that when small-scale farmers are provided with credit, they result to maximizing their output that would enable them to acquire modern agricultural inputs. Access to credit in agricultural production is an important component of development strategies among farmers (Gershon *et al.*, 2020). However, unequal access to credit is one of the major constraints to agricultural development and aggravates the effects of poverty in rural areas (Julien *et al.*, 2021) while on the other hand improving poor households' access to credit is a common factor of rural strategies designed to induce agricultural production growth.

## Conclusion

The objective of this paper was to expose the influence of gender of the farmer, age of the farmer, farmer's education, potato farming experience, land ownership, membership to a farmer group, access to extension services, access to quality potato seeds, access to credit on small-scale potato production in Molo Sub- County, Kenya. The result from multiple linear regression revealed that membership to a farmer group, farmer's education, access to extension services, access to quality potato seeds, access to credit were statistically significant factors of potato production. In general, to maximize the potato production the farmers must develop their education level by training, access quality potato seeds, access extension services, access credit and join a farmer group. The

agricultural expertise must consider the factors identified and help small-scale farmers to improve their potato production.

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