



Socio-economic and Institutional Factors Influencing the Potato (*Solanum tuberosum L.*) Production at Smallholder Farmers Level in the Gicumbi District in Rwanda

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Résumé :

Facteurs socio-économiques et institutionnels influençant la culture de la pomme de terre dans le district de Gicumbi au Rwanda

Le rendement de la pomme de terre est faible au Rwanda. Il se situe autour de 9 tonnes par hectare alors que le rendement potentiel est estimé à 40 tonnes par hectare. Les causes de ce faible rendement sont peu connues. Cette étude analyse les facteurs socio-économiques et institutionnels qui influent la production de la pomme de terre chez les petits agriculteurs dans le District de Gicumbi. Des données primaires et secondaires ont été utilisées. Les données primaires ont été collectées à l'aide d'un questionnaire semi-dirigé auprès de 120 petits agriculteurs. Les données secondaires proviennent des publications et bases de données existantes sur la pomme de terre. L'analyse des données a été faite à l'aide du modèle de régression « *Probit* ». Les résultats montrent que le sexe, l'âge, la taille de la famille, l'expérience du producteur, la possession de vaches et de petit bétail, la superficie totale cultivée et le prix à la ferme sont des facteurs socio-économiques qui influencent positivement la production de la pomme de terre. Le coût de la terre et de la main-d'œuvre influence négativement la production de la pomme de terre. Les facteurs institutionnels qui ont une influence positive sur la production de la pomme de terre sont le crédit pour l'engrais, l'accès aux crédits et aux services de vulgarisation, la formation sur la tenue et l'enregistrement des données de la ferme, l'utilisation d'engrais ainsi que les techniques de plantation et de sarclage. La distance pour aller au marché ainsi que le contrôle naturel des pestes et maladies ont une

influence négative sur la production de la pomme de terre. Les facteurs ayant un impact positif sur la production devraient être renforcés tandis que ceux ayant un impact négatif devraient être revus afin qu'ils influencent positivement la production de la pomme de terre.

Abstract :

The potato (*Solanum tuberosum* L.) yield in Rwanda is low. It is around 9 tons per ha compared to potential yield estimated at 40 tons per ha. The causes of low yield are not fully known. This study analyzed the socio-economic and institutional factors influencing the potato production at smallholder farmers level in Gicumbi district. Primary and secondary data were used. Primary data were collected using a structured questionnaire administered to a sample of 120 smallholder farmers. Secondary data extracted from existing publications and database on potato. The Probit regression was used in data analysis. The results show that gender, age, family size, farming experience, cows and small livestock ownership, total area cultivated and farm gate prices positively influence the crop production. The cost of land and labor do negatively influence the potato production. The institutional factors comprising of fertilizer credits, access to credits and extension services, training on farm records, fertilizer use and planting and weeding techniques positively influence the potato production. The distance to market and natural control of pest and diseases influence negatively the potato production. The factors with positive impact on production should be enhanced while those with negative impact should be addressed so that they could positively impact on potato production.

Keywords : potato production, socio-economic and institutional factors, smallholder farmers, Gicumbi district, Rwanda

Introduction

The agricultural productivity is still low in most of sub-Saharan African countries compared to other developing economies (3). However, the agriculture has historically been the source of livelihoods for the majority of population in Africa. More than 75% of the population practice subsistence and traditional agriculture (17). Similarly, in emerging economies such as China, Brazil and India, agriculture has been the precursor to the acceleration of industrial growth which led to economic growth (3).

The potato (*Solanum tuberosum* L.) is the fourth food crop most cultivated after maize, wheat and rice (1). It is the most important tuber crop ranking first in volume produced among root and tuber crops with an annual production of approximately 381 million tons grown on about 23 million hectares and source of cash income for smallholder farmers (1). Worldwide, there are wide regional disparities in potato production. The world's major regions producing the potato are Asia and Europe which account for more than 80% of world production (1). The production of potato is strongly expanding in the developing world (5). The developing countries are now the world's biggest producers of potato (5). The developing countries' potato production represents today 47.2% of world's total production while their contribution to global output was 10.5 in 1961 (5). The potato is the fastest growing staple food crop. It is viewed as a high potential food security crop as it is able to provide a high yield of high-quality product per unit input with a shorter crop cycle (mostly less than 3 months) compared to major cereal crops (8). It considerably produces more energy and protein than cereals (9). It is a valuable food security and cash crop for millions of farmers in developing world because of its ease of cultivation and nutritive content (5). In the main



production seasons, the average potato production in research based plots and at farmers' level is 29-45 t/h and 22 t/ha respectively (18). The gap between research and farmers' fields might result from poor practices, climate change as well as poor seeds (18).

The potato is one of six priority crops targeted by the Crop Intensification Program in Rwanda for increasing its yield and production (12). The Rwandan potato yield is estimated at around 9 tons per ha in 2017 (6) while the potential yield is around 40 tons per ha (13). The production was estimated at 846,184 tons in 2017 (6). The crop is widely cultivated in north-western region of the country mainly composed by Musanze, Burera, Gicumbi and Nyabihu districts which account for 90% of the national production (14). This region has a relatively cool and moist climate which are necessary for potato crop to provide best harvests (14). The potato is becoming an important cash and food crop in Rwanda. It is the most important crop after plantains and one of the main staple crops in terms of growth and yield. It plays a major role in national food security. The annual per capita consumption was estimated at 76 kg in 2000 (7). The increase in urbanization, fast food restaurants and tourism and the eating habits change do lead to the increase in demand for potato chips.

The potato sub sector has still to improve its performance in developing countries including Rwanda for moving from the stagnant and declining yields and production and limited application of science and technology. This requires to know the causes of low productivity and the adoption of good agricultural practices. Different scholars include in the causes of low yield the limited access to services such as extension and credit, limited market information, high transport costs as well as high input costs associated with using commercially supplied inputs such as improved seeds and inorganic fertilizer (2). There are various information gaps surrounding potato production and marketing in developing countries (11). This article analyzes the socio-economic and institutional factors influencing potato production in Gicumbi district in Rwanda.

Materials and methods

This study was conducted in Gicumbi district situated in eastern part of Northern Province of Rwanda. The district has an area of 867 Km² and 397,871 inhabitants (15) implying a population density of around 459 inhabitants per square kilometer which is greater than national population density of 416 inhabitants per square kilometer (15). About 95% of the population are engaged in agriculture which contributes nearly to 85% of the output in the district (15). The arable land in the district is 54,000 ha representing 4.4% of national arable land (15). The land is highly fragmented and the average arable land is 0.49 ha per household (15). Even though the district is a favorable zone for agriculture production, it encounters poverty problems related to high population density as well as the over-cultivation of agriculture land, declining size of arable and pasture land, low use of improved inputs and inadequate soil conservation leading to low and declining productivity. Beans, potato, wheat, maize and banana are major crops in this district (16).

Both primary and secondary data were used in this study. The secondary data were gathered from existing different publications and database on potato and other sources with useful information. The primary data were collected using structured questionnaire administered to a sample of 120 smallholder farmers. The data collected were analyzed using a Probit regression model to estimate the socio economic and institutional factors influencing potato production. The Probit model is a statistical probability unit model with binary dependent variables which takes either value zero or one. The dependent variable in this model is a binary variable which is the likelihood in

participating in potato production. The Probit model assumes that F represents the cumulative distribution function (F) of a standard normal variable (10). The cumulative distribution function (F) is then expressed in equations I and II:

$$H' = - \sum_{i=1}^s p_i \in p_i \quad \text{I}$$

The inverse of equation above (a) gives the linear form of the Probit model (b) used in this study. The explicit form of the model is:

$$\Phi^{-1}(p_{ij}) = Y_i^* = \beta_{1l} X_{1i} + \epsilon \quad \text{II}$$

Where; Y_i^* is the binary variable while X_i is a vector of explanatory variables. The parameter estimates of the Probit model only provide the direction of the effect of the independent variables on the dependent variable (4).

Results and Discussion

Socio-economic characteristics of respondents

The proportion of male headed households was 71.67 %. The proportion of female headed households was 28.33%. This shows that the male headed households are more engaged in potato production than female headed households. The proportion of married respondents was 89.17%; which could imply the stability of respondents and their concentration on potato production. The respondent's age category was 78years for the oldest farmer and 23 years for the youngest farmer while the mean age was 42. This reveals that potato sector in Gicumbi district is dominated by farmers who are still more active and productive. The mean level of schooling is 7 years (completion of primary school). Few farmers completed the university undergraduate studies. This shows that farmers respondents are literate and able to read and get agricultural information like the existing agricultural financial services and new agricultural technologies. The highest working experience in potato farming is 37 years while the less experience is 2 years. The average land area under potato production is 0.62 ha per farmer respondent.

Socio-economic factors influencing potato production

The results in table 1 indicated that gender is influencing the potato production. Male-headed households are more likely to adopt new farming techniques than female headed households. This could be due to many social and economic activities males are more exposed to contrarily to female-headed households which have in general limited access to resources including land and involvement in socio-economic activities because of cultural matters. The age is significantly influencing the potato production. An increase in age of potato producer implies an increase in his/



her experience in the production of the crop. This results in the best performance of the farmer; thus a higher productivity in potato production. The total area cultivated is significantly influencing the potato production. The potato production is more profitable with the increase in farming land allocated to potato production. The experience in farming also influence the potato production. Farming experience does generally lead to better managerial skills being acquired over time and eliminate unnecessary production costs.

Table 1: Socio- economic factors influencing potato production

Participation in potato production	Coef.	Std. Err.	Z	P> z
Gender	4.67	1.83	2.55	0.01*
Age	0.06	0.06	0.96	0.04*
Marital status	0.88	0.66	1.33	0.19
Family size	1.03	0.42	-2.44	0.02*
Education	-0.19	0.19	-1.00	0.32
Farming experience	0.21	0.10	2.17	0.03*
Cost of land	-0.01	0.00	2.02	0.04*
Cost of seeds	-0.31	0.00	0.98	0.33
Cost of fertilizers	-0.08	0.00	0.90	0.37
Cost of pesticides	-0.04	0.00	1.50	0.13
Labor cost	-0.02	0.00	2.09	0.04*
Cows ownership	1.91	1.00	-1.90	0.05*
Farm gate price	0.07	0.05	-1.37	0.03*
Small livestock ownership	0.81	0.36	-2.29	0.02*
Total area cultivated	0.02	0.01	2.10	0.04*
Cons	1.13	4.76	0.24	0.81

Log likelihood = -30.38, Number of Obs =120, LR chi2(36)=52.62, Prob > chi2=0.04 and Pseudo R²=0.46

* Significant at 5 % percent level of significance

Source: Primary data, 2017

The family size is a significant factor influencing potato production. The potato production is a

farming labor intensive activity during peak seasons i.e. planting, weeding, pesticides spraying and post-harvest operations. Consequently, a big family size and availability of cheap labor could enhance the potato production. The cows and small livestock are significantly influencing the potato production. This could show that the number of cows or small livestock owned by the farmers help in getting the organic manure that contribute to the increase of potato productivity. The education level of farmers does not affect the production of potato. This could show that the knowledge received from school is not used in and/or too general to apply to potato production as the average schooling is 7 years corresponding to primary level. This implies that the potato is produced in using mainly indigenous knowledge and some knowledge gained from few ad hoc trainings organized by administration and NGOs. Farmers do not have agricultural knowledge from a specialized modern school teaching the agriculture or particularly the potato production taking into account the use of modern agricultural technologies and inputs.

The cost of labor and land do negatively influence the potato production. An increase in cost of these two items results in a decrease in potato production. These two factors are determinant in potato production as they are the basis for potato production activity. The results could mean that it is impossible to improve the potato without changing this trend in labor and land cost. The increase in potato production profitability should result from the minimization of the cost of inputs engaged in the production process. The cost of fertilizers, seeds and pesticides on the other hand do not influence the potato production. This could show that these inputs are not given high importance in potato production activity; so that they do not impact on potato production. It could also explain the low yield which is still observed (around 9 tons per ha while the potential yield is around 40 tons per ha). The farm gate price positively influences the potato production. As far as there is higher price for their agricultural produce, production costs are compensated and the remaining amount of money (which is actually the profit) after covering all costs of production is higher.

Institutional factors influencing potato production

Among 21 institutional factors or covariates, 14 factors positively contribute to the production of potatoes in Gicumbi District while 8 factors do not (Table 2). The fertilizer credits, access to credits and extension services, training on farm records, fertilizer use and planting and weeding techniques positively influence the potato production. Having access to credits help the farmers to conduct field operations on time because of being able to pay for agricultural services and inputs needed in potato production. The trainings on various agricultural practices and technologies such as planting, fertilizer use, weeding and farm record influence positively the potato production. This implies that participation in agricultural trainings especially training on potato farming practices do help the farmers to increase the potato yield and production. The extension services help to equip the farmers with improved technologies and innovations that improve the production efficiency leading to high yields. The extension activities help farmers to accumulate knowledge on new agricultural technologies which help them to improve the production methods. The knowledge gained from extension agents led the farmers to adopt improved technologies and management practices which have resulted in improvements in potato yield and production.

The distance to walk to reach the markets for selling and buying inputs influence negatively the potato production. This means that the further away the farmer is located to the market, the farmer's willingness to produce for the market reduces due to lack of market information



and higher associated transaction costs. The control of pests and diseases negatively influence the potato productivity as well as the natural method used by farmers. This can be explained by the existence of ecologically sound technologies and practices that include the Integrated Pest Management which is a crop protection method combining natural and artificial strategies in pest and disease control recommended to farmers for fighting against pests and diseases in crops.

Table 2: Institutional factors affecting potato production

A cooperative membership	Coef.	Std. Err.	Z	P> z
Distance to main road	0.05	0.03	1.57	0.12
Distance to markets	-0.01	0.02	-0.59	0.05*
Distance to water source	0.02	0.01	1.49	0.14
Fertilizer credits	2.88	1.18	2.44	0.02*
Improved seeds credits	-0.29	1.24	-0.23	0.82
Access to improved varieties	2.07	1.56	1.32	0.19
Access to credits	0.31	0.08	3.44	0.00*
Access to extension services	0.00	0.00	2.11	0.04*
Adoption of agronomic practice	-0.97	0.84	-1.16	0.25
Physical control of pest and diseases	-0.49	1.32	-0.38	0.71
Natural control of pests and diseases	-1.12	0.58	-1.91	0.06
Training on farm management	0.36	0.78	0.47	0.64
Training on diseases management	0.30	0.99	0.30	0.76
Training on farm records	1.33	0.57	2.32	0.02*
Training on fertilizer use	1.12	1.11	-1.01	0.01*
Training on use of improved seeds	-0.20	1.67	-0.12	0.91
Training on planting techniques	0.19	0.97	-0.20	0.02*
Training on weeding techniques	2.08	2.28	-0.91	0.00*
Training on harvesting techniques	-0.72	1.41	-0.51	0.61
Training on breeding	0.02	0.61	0.03	0.98
Training on irrigation system	0.15	1.66	0.09	0.93
_cons	-2.04	2.01	-1.02	0.31

Log likelihood = -53.46, Number of Obs=120, LR chi2(20)=45.43, Prob > chi2=0.00 and Pseudo R2=0.2982

* Significant at 5 % percent level of significance



Source: Primary data, 2017

Conclusion

The production of potato is increasing in Rwanda. However, the potato yield in Rwanda is still low. The yield was around 9 tons per ha in 2017 while the potential yield is around 40 tons per ha. This study aimed at analyzing the socio-economic and institutional factors influencing the potato production at smallholder farmer's level in Gicumbi district. Both primary and secondary data were used. A structured questionnaire was used to collect primary data from a sample of 120 smallholder farmers. Secondary data were retrieved from existing publications and database on potato crop. Data were analyzed using the Probit regression.

The socio economic factors that positively influence the potato production comprise of gender, age, family size, farming experience, cows' ownership, small livestock ownership, total area cultivated and farm gate prices. The cost of land and labor do negatively influence the potato production. The institutional factors which positively influence the potato production consist of fertilizer credits, access to credits and extension services, training on farm records, fertilizer use and planting and weeding techniques. Distance to market and natural control of pest and diseases negatively influence the potato production. The socio-economic and institutional factors that do positively influence the potato production should be reinforced for increasing their impacts on production. A particular focus should be put on the reinforcement of the provision of extension services given the high impact the agricultural knowledge gained could have on potato production. In this line, training and information dissemination on new technologies needed in potato production for increasing the yield should be the focus of extensionists.

On the other hand, socio-economic and institutional factors that negatively influence the potato production should be addressed so that they could positively impact on potato production. Marketing infrastructure should be improved especially by constructing more feeder roads. Farmers should be helped in acquiring new methods of crop protection (Integrated Pest Management) increasing productivity. A particular price policy for farming land and labor should be put in place. Factors influencing the potato crop production should be assessed in other Rwandan production areas in order to propose the improvements which could be done for increasing the yield and production of potato in the country.

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