FACTORS INFLUENCING SMALLHOLDER FARMERS' BEAN PRODUCTION AND SUPPLY TO MARKET IN BURUNDI

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ABSTRACT

Common bean (*Phaseolus vulgaris* L) is a major staple food in Burundi; thus increasing its production and marketing has the potential for raising incomes of the farming households. In the country, bean outputs have been declining for decades, yet demand for the crop in East Africa has surged considerably. This study was conducted in Burundi to assess the determinants of quantity produced and marketed by smallholder farmers. A total of 380 farmers obtained through a multistage sampling technique, constituted the study sample. Constraints to production and supply of beans to markets include lack of productive assets, lack of improved varieties and inadequate use of fertilisers. Results with regard to these constraints indicate that a unit increase in the value of productive assets is likely to lead to about 10 percent increase in production of beans; while changing to improved bean varieties may increase production by 22%. In addition, a kilogram increase in fertiliser use is likely to raise bean quantities produced by about 10%. Constraints that affect quantities of beans marketed by farmers include levels of production and losses due to transport problems. Thus, an increase in quantity produced will lead to an almost 30% increase in marketed quantities, while reduction in transport losses will lead to an increase in marketed quantities by about 12%. However, an increase in quantity of beans stored for food will lead a reduction in marketed beans by about 19%, implying that storage of beans may not be targeted at the market but for food security purposes. Efforts that promote collective action among farmers while encouraging increasing the proportion of land under beans are likely to enhance bean production and consequently marketable surplus.

Key Words: Fertilisers, *Phaseolus vulgaris,* market participation, transaction costs

RÉSUMÉ

Le haricot commun (*Phaseolus vulgaris* L) est une nourriture principale au Burundi; ainsi l'augmentation de sa production et son marketing est un potentiel pour accroître les revenus familiaux de ressources agricoles. Dans le pays, la production de haricot a connu une baisse depuis bon nombre de décennies, alors que la demande en cette denrée s'est accrue considérablement en Afrique de l'Est. Cette étude était menée au Burundi pour évaluer les déterminants de quantités produites et marchandes par les petits fermiers. Un échantillon de 380 fermiers obtenus par la technique d'échantilonnage à niveau multiple était considéré. Les contraintes à la production et à la fourniture de haricot sur le marché comprennent le manque de matériel productif, manque de variétiés améliorées et l'utilisation non adéquate des fertilisants. Les résultats en relation avec ces contraintes indiquent que l'accroissement d'une unité de valeur du matériel productif entraîne environ 10% d'augmentation de la production de haricot, alors qu'en utilisant des variétés améliorées la production serait accrue de 22%. En plus, une augmentation d'un kilogramme de fertilisants pourrait accroître les quantités de haricot produites d'environ 10%. Les contraintes qui affectent les quantités de haricot fournies sur le marché par les fermiers incluent les niveaux

de production et pertes dus aux problèmes de transport. Ainsi, l'augmentation en quantité produite induira environ 30% d'accroissement de quantités fournies, alors qu'en réduisant les pertes liées au transport induira une augmentation en quantités marchandes d'environ 12%. Cependant, une augmentation en quantité de haricot sctocké pour consommation induira une réduction de la quantité marchande de haricot d'environ 19%, impliquant que le stockage de haricot ne pourrait être visé au marché mais plutôt pour sécurité alimentaire. Efforts qui favorisent l'action collective entre les agriculteurs tout en contribuant à l'amélioration des champs de haricots pourraient aussi augmenter la production du haricot et par conséquent un surplus de vente.

*Mots Cl*és: Fertilisants, *Phaseolus vulgaris,* market participation, transaction costs

INTRODUCTION

Common beans (*Phaseolus vulgaris* L) is widely grown as a major staple food in Eastern and Southern African region (ECABREN, 2000). Common bean is a crop whose production and marketing could be a potential pathway for improving rural livelihoods. It is recognised as an important source of human dietary protein and calories. However, smallholder farmers encounter multiple constraints such as inadequate capital, pests and diseases, poor access to improved germplasm, poor marketing infrastructure, low labour productivity and unreliable climatic conditions. This has led to low agricultural productivity and low supply of beans in the market by the smallholder farmers. Bean production has declined in Burundi from 250,000 tonnes in 2003 to 202,934 tonnes in 2009 which is not able to meet the growing domestic demand (FAO, 2011). In order to meet this growing demand, adoption of better production technologies focusing on improving production and marketing of beans is necessary.

In an effort to improve bean production in Burundi, the bean improvement programme by Pan-African Bean Research Alliance (PABRA) in collaboration with Institut des Sciences Agronomiques du Burundi (ISABU) has been developing improved bean varieties. The improved varieties offer resistance to important diseases, are tolerant to low soil fertility, and possess desirable seed and plant characters (Chirwa *et al.,* 2007*)*.

Commercialisation and improved market access are critical for improving rural farm incomes. Smallholder market participation is highly influenced by factors of production as well as transaction costs. Key *et al*. (2000) have alluded that high transaction costs is one of the key reasons for smallholder farmers' failure to participate in markets and supply the right quantity of produce. Abdulai and Birachi, (2009) in a study on smallholder milk farmers in Kenya and Ouma *et al*. (2010) in a study on banana producers in Central Africa (Burundi, the Democratic Republic of Congo (DRC) and Rwanda), find that distance to market place, means of transport, source of information and the geographical location of the household have direct effects on the level of transaction costs that producers face.

The presence of transaction costs often leads to exploitation of farmers by middlemen or brokers demotivating farmers' involvement in bean production and marketing. The potential for bean to contribute to rural population livelihoods is not likely to be achieved if the constraints are not addressed early enough. This study, therefore, analyses the major factors that influence quantity of beans produced and supplied in the market by smallholder farmers in Burundi.

MATERIALS AND METHODS

Study area and sampling procedure. The study was conducted in Northern and Central regions of Burundi and covered six provinces, namely Muyinga, Rutana, Ngozi, Bubanza, Gitega and Makamba in 2010. A multi-stage stratified sampling procedure was used to select sampling units. In the first stage, purposive sampling was used to select two districts and two markets in each province, covering the major bean producing areas. Simple random sampling was used in the second stage to draw a sample of 380 smallholder farmers. The study mainly focused on smallholder farmers in order to capture their production and marketing decisions.

Data collection procedure and analysis. The primary data were collected from the smallholder farmers using structured interview schedules. The interview schedule covered a range of issues including social-economic status of households, cropping and farming characteristics, production estimates and costs, handling costs, farm-gate and market prices, bean production and marketing constraints, and information on the availability and accessibility to bean markets. The model parameters were estimated using STATA software, version 11.

Econometric models. A modified Cobb Douglas production function was used to determine the influence of different factors on the quantities of beans produced by farm households, while a supply function was used to determine factors influencing the quantity the households marketed. A Cobb Douglas function estimates elasticity of production and marginal productivity of critical factors of production. The general form of Cobb-Douglas production function is presented in Equation 1.

$$\varphi_i = \theta \, \lambda_1^{\alpha_1} \lambda_2^{\alpha_2} \lambda_3^{\alpha_3} \lambda_4^{\alpha_4} \cdots \lambda_n^{\alpha_n} \quad \ldots \ldots (1)$$

Where: φ_1 = quantity of output I, λ = vector of variable resource with j = 1, 2, 3 ….n, θ = constant; α_k = coefficients with k= 1, 2…n: which estimate the elasticity of transformation ratio for the inputs λ. Estimation of constant and coefficients for the establishment of elasticities involved transformation of Equation 1 to a logarithmic linear function specified in Equation 2. The Cobb-Douglass production function has some desirable properties, which make it more appropriate for this study. These include the use of α_k to estimate the partial elasticity of bean output with respect to the inputs. In other words, it measures the percentage change in that particular input while holding other inputs constant. The quantities of beans produced could, therefore, be inferred using these coefficients. It is possible to calculate returns to scale, that is the response of φ to a proportionate change in inputs (Gujarati, 2004). This could also be used to explain the factors influencing the volume of beans produced in Equation 2.

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$$\ln \varphi_c = \ln \theta + \alpha_1 \ln \lambda_1 + \alpha_2 \ln \lambda_2 + \alpha_3 \ln \lambda_3 + \alpha_4 \ln \lambda_4 + \alpha_5 \ln \lambda_5 + \alpha_6 \ln \lambda_6$$
$$+ \beta_1 \phi_1 + \beta_2 \phi_2 \cdots \beta_6 \phi_6 + \varepsilon \quad \ldots \ldots \ldots \ldots \ldots (2)$$

Where: φ_c = total quantity of beans (kg), θ = constant, λ_1 = total farm size allocated to beans (ha), λ_2 = quantity of fertiliser used in bean production (kg - both Calcium Ammonium Nitrate (CAN) and Di-Ammonium Phosphate (DAP); λ_3 = total labour used in bean production (Man days); λ_4 = value of production assets (BIF), λ_5 = age (years), λ_6 = market price (BIF), ϕ_1 = gender of household head (dummy, 0 = male and 1 = female), ϕ_2 = access to credit (dummy: 0 = access and 1 = no access), ϕ_3 = access to extension messages (dummy: 0 = access and 1 = no access), ϕ_4 = association/group membership (dummy: 0 = membership and 1= otherwise), ϕ_5 = production losses (dummy: 1 = high 2 = medium, 3 = low) ϕ_6 = variety of seeds (1 = local, 2 = improved), ε = error term.

A supply function was used to determine the factors influencing the quantity marketed to traders in the local market. Supply function was preferred because beans have other alternative uses such as home consumption and can also be stored for seeds and thus not all produce has to be taken to the market. The supply function was specified as:

$$\pi_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_T D_T + \alpha_s D_s + \varepsilon \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3)$$

Where π_i= quantity marketed, X_1 = quantity of beans produced (kg), X_2 = distance to the market (km), X_3 = quantity consumed at home (kg), X_4 = quantity given as gifts (kg), X_5 = household size (number of persons), D_T = transport losses (dummy: 1 = low, 2 = medium 3 = high), D_s = storage losses (dummy: 1 = low, 2 = medium 3 = high) and ε = random error.

Collinearity diagnostics tests were done using a simple regression matrix of the variables. Variance Inflation Factor (VIF) was used to check for tolerance level of multicollinearity. The average VIF of less than 10, implies that the variables in the model had no serious multicollinearity (Gujarati, 2004). In addition, Durbin Watson test (DW) was employed to test for serial autocorrelation which occurs due to

omission of explanatory variables and mis-specification of the mathematical model.

RESULTS AND DISCUSSION

Generally, smallholder farmers used the larger part of output on household consumption as indicated (Fig. 1). This is a clear indication that many of them produce beans for subsistence rather than for commercialisation purposes. In Ngozi province, the farmers sold larger part of the output to the market making them more market oriented than the farmers in the rest of the provinces. A general observation among bean farmers in Burundi is that a majority preferred producing beans because all parts of the plant could be consumed; the grain is eaten fresh or dried (Fig. 1) and the leaves are also used as vegetables. The least amount of beans was supplied to the market in Gitega. This result is in line with the view that beans are a basic consumption commodity in Burundi and the rest of Sub-Saharan Africa (Mauyo *et al.*, 2007). However, this appears to hold true when production levels are low. In high bean producing areas such as Ngozi and Gitega, bean takes on a commercial orientation as higher proportion of the output is sold. (Fig. 1).

The factors influencing output and marketable surplus of bean in Burundi are presented in Tables 1 and 2, respectively.

The results reveal that land size influences bean production in Burundi with elasticity of 0.323. This implies an elastic response to bean production; thus a unit increase in land would increase production by 32%. This, therefore, means that allocation of more land to bean production would increase its output and amounts marketed. Edriss and Simtowe (2002) working in Malawi on groundnuts production argued that more land should be allocated to crops to increase output. This situation is similar in Burundi such that within the available land constraints, productivity of the bean crop can be increased to raise production towards meeting the food needs and the surplus being marketed. The potential to increase productivity through better varieties and management practices has not been fully utilised in the country.

Productive assets are also important in the production of various crops as indicated by the elasticity of production assets (Table 1). The assets included hoes, wheelbarrows, machetes, ploughs and tractors. Hence, farmers with relatively more assets realised higher bean outputs compared to those with fewer assets. Most bean farmers in the study area relied mostly on human labour to produce beans. Thus an increase in the usage of farm assets increases the efficiency of farming operations hence increasing outputs. Allocation of more land to bean production with adequate investment in productive assets would improve production which is evidenced by a strong positive relationship between productive assets and the level of bean production (Table 1).
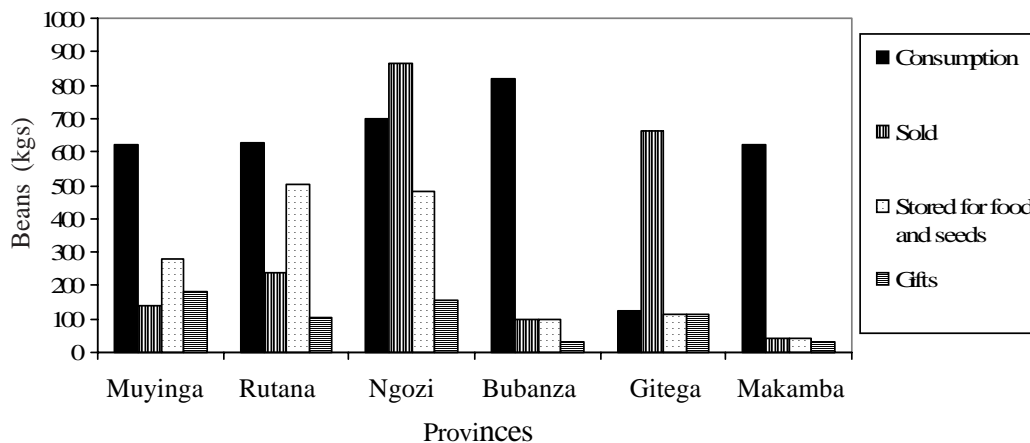

Figure 1. Utilisation of beans across the provinces in Burundi.

TABLE 1. Determinants of quantity of beans produced by smallholder farmers

Variable	Unit	S.E	Coefficient	t-value
Constant	-	1.999	2.037	1.019
Age	Years	0.005	-0.072	-1.446
Gender	Dummy	0.140	0.008	0.161
Land size	Ha	0.060	0.323	6.508*
Production assets	BIF	0.095	0.098	1.942**
Variety of seeds	Dummy	0.381	0.221	1.725**
Fertilisers	Kgs	0.107	0.088	1.782**
Labour	Mandays	0.110	0.060	1.230
Market Price	BIF	0.254	0.009	0.180
Group Membership	Dummy	0.176	0.156	3.141*
Extension	Dummy	0.162	-0.024	-0.490
Credit	Dummy	0.212	0.043	0.863
Production losses	Dummy	0.093	0.087	1.783**

Dependent variable: Total output (kgs), Production losses (1 = High, 2 = Medium, 3 = Low); Variety (1 = Local, 2 = Improved), S.E = standard error, *significant at 1%, **significant at 10%, $F_{C (0.05, 13,379)}$ = 6.534, R^2 = 42.0%, DW =1.472, VIF = 1.174

TABLE 2. Factors influencing quantity of beans supplied to the market

Variable	Unit	SE	Coefficient	t-value
Constant	-	119.993	-42.594	-0.355
Storage Losses	Dummy	14.029	-0.026	-0.532
Transportation losses	Dummy	40.922	0.127	2.624**
Distance to the market	Kilometers	12.479	0.013	0.271
Bean price	BIF	0.068	-0.092	-1.925*
Household size	Persons	3.838	-0.038	-0.787
Quantity produced	kgs	0.020	0.281	5.474**
Quantity consumed	kgs	0.128	0.001	0.018
Quantity retained for seeds	kgs	0.106	-0.054	-1.117
Quantity stored for food	kgs	0.040	-0.189	-3.635**

Storage and transportation losses (1 = low, 2 = medium, and 3 = high), *,** significant at 1 and 10%, respectively

The small-scale farmers in Burundi mostly plant indigenous or local seeds accessed mainly through the informal seed systems and less of improved seeds. Smallholder farmers in Burundi plant their own saved bean seed, however, the degree of reliance on own stocks varies significantly across and within regions and is influenced by season, household characteristics such as wealth status and the level of production relative to household usage (David and Sperling, 1999). Improved bean seeds have high yields as one of their major traits, which smallholder producers would benefit from by planting them. Access to improved varieties is still a challenge to a number of smallholder producers leading to low production levels. The low production may not meet both consumption and provide a surplus for the market. The coefficient of value of new seed variety was highly significant (Table 1) indicating the importance of high yielding seed varieties in bean production. Farmers using improved seeds often realise higher bean outputs than those using indigenous seeds (Chirwa *et al*., 2007) and thus are more likely to increase outputs (Table 1). Improved varieties have a higher potential to recover from adverse effects of drought, pest and diseases and have a longer life cycle (Chirwa *et al*., 2007) Therefore,

promotion of improved varieties would provide a sustainable solution to malnutrition and mineral deficiency in the diets of the populations.

A 1% increase in use of fertilisers resulted in 8.8% increase in bean production (Table 1). The fertilisers commonly used were di-ammonium phosphate (DAP) at planting and calcium ammonium nitrate (CAN) at top dressing. This implies that *ceteris paribus*, the marginal physical product (MPP) is positive (MPP = 0.088), showing that the amount of fertilisers used had a positive influence on the quantity of beans produced. Thus, besides varieties production of beans can be greatly enhanced by practices such as fertiliser application.

Group membership significantly (P<0.01) influenced the output of bean producers (Table 1). There was a considerable difference in the quantity of beans produced by farmers in groups and the individual farm households. Group members were able to easily access credit, extension services and collective purchase of inputs (Owuor *et al.*, 2004)). Although 16% of farmers belonged to groups (Table 1), the role of collective action in mitigating the challenges facing farmers is still critical. Thus being a member of a group was likely to lead to a 16% increase in bean production. Farmer groups have also become entry-points for the Non-Government Organisation (NGOs) and other organisations promoting agricultural development to reach many targeted farmers and reduce cost of operations. Owuor *et al.* (2004) found that farmer groups were effective, especially in pooling external inputs, lobbying for favorable policies and disseminating market information in Kenya. Thus, farmers that are members to a group are likely to produce more and consequently sell more due to skills and joint learning among them as opposed to non-group membership. Bean producing farmers in Burundi have been encouraged through seminars by CIAT-PABRA, ISABU and other development organisations to work collectively to access technologies, skills and input and output markets.

Production losses from pests and diseases, poor weather conditions and lack of seed germination influenced bean production (Table 1). Producers prioritised these losses as key constraints to achieving high outputs; thus farmers who realised less production losses had relatively higher output from beans. The elasticity of 0.087 also suggests that efforts to reduce pests and diseases and the effect of weather exposure can lead to higher output (P<0.1). This means that anticipated losses are likely to negatively affect the level of production. Other factors such as extension service provision, age of household head, labour, credit and market price did not significantly affect the quantity of beans produced.

Table 2 indicates the likelihood estimates of determinants of quantity supplied to the market by small-scale farmers. The variables significantly influencing the quantity supplied in the market included transportation losses, bean price, quantity produced and quantity stored for food. While the influence of the price and quantity stored was negative, transportation losses and quantity produced had a positive effect. The results reveal a negative relationship between quantity of beans sold by the farmers and the selling prices (P<0.01), which implies that farmers will face lower prices as they increase supply of beans to the market; this is common during harvest periods. This is in line with economic theory; the market price of a commodity significantly influences the farmers' decision to supply to the market for a normal good and thus increased production and market supply is expected to lead to lower prices in the market.

The transportation losses were a major impediment to bean marketing (Table 2). The coefficient of transport losses was significant (P<0.1) and most farmers were unable to transport the desired quantity to the market due to high transport losses. The mode of transport, predominantly bicycle (32%) and human head (33%), led to higher transport losses such as spillage and theft. The results also indicated that even though these losses were not very high each time they occurred, the frequency of occurrence was much higher than other kinds of losses such as diseases. The high frequency of transport losses is what contributed to their significance in bean marketing.

A 1% increase in quantity stored for food results in a 19% reduction in marketed surplus. The quantity stored for food is significant meaning families that store less quantity of beans

for food are able to supply more to the market. As previously discussed (Fig. 1), most farm household across the provinces produce beans for subsistence with less surplus for sale.

Quantity of beans produced greatly influenced the quantity marketed and the smallholder farmers who realised higher output, supplied larger proportion of their beans to the market (Table 2). The results show that farmers, who increased their output by 1 unit, would be able to increase the quantity of marketable supply by 28%. Farmers with higher bean output have the potential for commercialisation that could increase their incomes thereby enabling them purchase more inputs to increase output (Katungi *et al.*, 2010). Higher incomes from beans can only be realised by intensifying production through adopting new agricultural technologies appropriate and affordable to the resource poor farmers.

CONCLUSION

The study reveals that production losses, land size allocated to bean production, production assets, group membership and type of seed variety planted significantly influence output; while cost of transport, quantity consumed at home, quantity stored for food, market price and storage losses influence marketable supply. To enhance production of beans, the farmers should within their existing land holdings, expand proportion of land under bean production and actively participate in farmer group's activities for easier access to markets.

ACKNOWLEDGEMENT

REFERENCES

Abdulai, A. and Birachi, E.A. 2009. Choice of coordination mechanism in the Kenyan fresh milk supply chain. *Review of Agricultural Economics* 31(1):103-121.

Chirwa, R.M., Aggarwal, Vas, D., Phiri, M.A. and Mwenda, R.A. 2007. Experiences in implementing the Bean Seed Strategy in Malawi. *Journal of Sustainable Agriculture* 29(27):43-69.

David, S and Sperling, L. 1999. Improving technology delivery mechanisms: Lessons from bean seed systems research in Eastern and Central Africa. *Agriculture and Human Values* 16:381-388.

ECABREN. 2000. Eastern and Central Africa Bean Research Network. Towards the Development of Market - Driven Research Framework. ECABREN.

Edriss, A.K and Simtowe, F. 2002.Technical Efficiency in Groundnut Production in Malawi: An Application of a Frontier Production Function. *UNISWA Research Journal of Agriculture, Science and Technology* 6(1):45-50.

Katungi, E., Farrow, A., Mutuoki, T., Gebeyehu, S., Karanja, D., Alemayehu, F., Sperling, L., Beebe, S., Rubyogo, J.C. and Buruchara, R. 2010. Improving common bean productivity: An Analysis Of Socio-Economic Factors In Ethiopia And Eastern Kenya. A baseline Research Report, November. www.icrisat.org/what-wedo/impi/projects/tl2-publications/research-reports/rr-common-bean-esa.pdf. Accessed on 21 August 2011.

FAO. 2010. Food Agriculture Organisation Statistics available at www.fao.org

Gujarati, D.N. 2004. Basic Econometrics. Fourth Edition, McGraw-Hill Publishers, New York, USA.

Key, N., Sadoulet, E. and de Janvry, A. 2000. Transactions Costs and Agricultural Household Supply Response. *American Journal of Agricultural Economics* 82:245-59.

Mauyo, L.W., Okalebo, J.R., Kirkby, R.A., Buruchara, R., Ugen, M. and Musebe, R.O. 2007. Legal and institutional constraints to Kenya-Uganda cross-border bean marketing. *African Journal of Agricultural Research* 2(11):578-582.

Ouma, E., Jagwe, J., Obare, G.A. and Abele, S. 2010. Determinants of smallholder farmers'

participation in banana markets in Central Africa: the role of transaction costs. *Agricultural Economics* 41:111-122.

Owuor, G., Wangia, S.M., Onyuma, S., Mshenga, P. and Gamba, P. 2004. Self-Help Groups, A social Capital for Agricultural Productivity. The case of smallholder maize farmers in Ukwala Division, Siaya District, Kenya. *Egerton Journal of Humanities* 6(3):159-176.