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An analysis of the determinants of household level production and marketing of beans in Eastern Congo

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Legumes and especially beans provide some of the most widely grown crops in the East and Central Africa region. The question of whether certain crops, specifically beans, are more beneficial to women than to men in relation to cash crops and other cereals, has been raised from time to time. In the central Africa region and in particular in the Democratic Republic of Congo (DRC), bean production has been promoted in the recent years. Beans contribute to better nutrition and soil fertility improvement in the region. The economic benefits and costs associated with beans production has not received adequate attention at the household level while taking into consideration male and female farm actors. Based on beans, this paper examines the differentiated profitabilities and costs of production for beans at the household level, among male and female farmers in the South Kivu Province of the DRC. The paper uses results obtained from a survey of 160 farmers in 10 villages in the South Kivu Province of DRC. Data was collected on household characteristics, costs, prices and quantities associated with bean production. Regression analysis was used to assess factors that influence the observed bean gross margins and production costs among the households. The results indicate the average age of bean farmers is relatively low and that there is no significant difference between the profits received by men and women farmers in spite of men incurring relatively higher production costs than women farmers. The results also indicate that larger surfaces put under beans do not necessarily lead to higher gross margins. Market access had factors such as physical location of the farmers vis a vis markets influenced to raise the costs incurred in bean production for those farmers located much farther away from major markets. Farmers located in remote areas suffer higher production costs in acquiring inputs, usually at higher costs than those located in optimal locations. Interventions that would enable such farmers to affordably access productive inputs are likely to impact positively on the farmers' economic welfare.

Key words: Bean production and marketing, South Kivu, gender, gross margins.

INTRODUCTION

Despite their immense contribution to society (ILO, 2009), women's productive, domestic and community-related activities seem to be underestimated; consequently they

are misunderstood and are rendered invisible. The division of farming activities between genders varies according to the enterprise, the farming system, the

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technology used, and the wealth of the household. The Control over the benefits of production also varies between gender regarding labor input, use of produce for consumption or for sale, cultural norms regarding their enterprises, the dominance of men as the household heads and, their entitlements to the most important resources like land and credit. This makes estimations of the contribution of women to agriculture more complex (Marinda, 2006).

In addition to working in the home and on the farm, rural women are engaged in a diverse range of off-farm reproductive and community activities. There are few enterprises in which women dominate both the workloads and the control of the benefits. But there are several enterprises in which women and men share both the workloads and the benefits. However, in most cases, men are the key players in crop and livestock production, and control income generated from produce sales. In many countries that produce legumes, beans are one of the major pulses produced both for home consumption and for sale. Though men and women share the workload in bean production, the right to access the benefits is very limited for women (Lemlem et al., 2010).

Gender issues are important when addressing the factors influencing economic development of countries, as any national economy will benefit if the gender roles in communities are equal, and prejudices and inequality suffered by women can only downsize any development efforts, as well as poverty, trade and debt-related issues. In Africa, gender system is much more complex, and while women have some land use and other rights, which come into play with changes in agricultural production with women farming in their own right as heads of household (Boserup, 1970).

In South Kivu, most rural households depend on commercialisation of agricultural products where there is surplus, for livelihood. For the last decade, there has been declines in crop yields which do not favour most households to sell their commodities and thus a major proportion of production is used for home consumption at household level. Many development agencies which operate in Eastern DRC and South Kivu in particular have not paid much attention to legume production as a source of livelihood improvement. Most have focussed on emergency aid rather than long term poverty alleviation, food security and income generation strategies that can move most people from a crisis situation. One of the initiatives targeted at improving economic and nutritional welfare in the South Kivu province is the Consortium for Improved Agricultural Based Livelihoods in Central Africa (CIALCA) operating in Bas-Congo, South Kivu, North Kivu provinces of the DRC and in Rwanda and Burundi since 2005. One of the main focus of the consortium is on legumes because legumes make some of the best crops to introduce to communities in crisis or just getting out of crisis. They grow fast (60-90 days) but also improve soil

fertility. In humid tropics where most nutrients are in the vegetation form war tends to clear all the vegetation and hence the need to introduce nitrogen fixing crops as communities go back to their homes after the war. The war has increased reliance on resource extraction leading to the destruction of traditional livelihoods and alternative sources of protein when communities are forced to flee from their gardens (Hart and Mwinyihali, 2001). These challenges have led to poor food security status and soil and natural resource depletion and degradation that has in turn affected productivity further. Legumes can add substantial amounts of nitrogen from the atmosphere to the soil and still provide food (grains) and animal feed (haulms). Legume-based protein is an important source of protein in South Kivu because many households lost their livestock during the war. In addition legumes have attracted good market values and are being traded locally and regionally.

This paper provides a detailed analysis of the relative costs and profit abilities of bean production in the South Kivu province of the Democratic Republic of Congo. Various studies show that women are increasingly playing a critical role in agriculture (Ezumah and Di Domenico, 1995) and that there is a growing trend towards women headed households in many countries (Enete and Amusa, 2010), a trend that may affect the productivity of the households. This paper investigates factors influencing returns on bean production, as well as factors that influence the costs faced by male and female bean farmers in order to gain more understanding of household production and marketing dynamics among smallholder subsistence oriented farmers. The paper makes a contribution to new research area of knowledge with respect to livelihoods improvement through legume production and sales especially for crops that have a relatively higher women participation in production and marketing. An analysis of costs and profitability is necessary to provide information on the attractiveness of the legumes as a source of incomes. This will ensure that the benefits of legumes in fixing nitrogen to improve soil fertility is assured, and in addition, a good source of protein for better health is assured for the millions of people in Africa, and especially in conflict areas such as South Kivu.

Household production and marketing of beans

The paper is based on the household decision making theory (De Janvry and Sadoulet, 2003). A farmer makes decisions about what to grow, how much to grow, and the number of necessary inputs in response to market prices of inputs and outputs and the available fixed environmental inputs available on their land. The farmer makes two decisions: Production and consumption, both of which are made simultaneously and this decision has an impact on household utility. The decision farmers make

to grow a particular crop is basically to bring more benefits than others and the idea behind the decision is to increase utility. Therefore, the benefits can be represented by the amount of produce consumed and the amount sold. If the amount of produce is not enough for consumption purposes, farmers are likely to buy from the market to maintain their lifestyle.

Economic theory suggests that different factors affect farmers' benefits derived from a crop. Existing literature reveals that the possible factors that may affect the benefits accruing to the farmer include heterogeneity of farmers' resources such as land, resource endowment like education, labor and wealth, a multiplicity of farmers' household needs among which include food, fodder, trade, access to markets, and income motives among others. These factors can be incorporated into a basic household model, iteratively. Economic models for analyzing benefits from an enterprise can be modelled using agricultural household models (Singh et al., 1986).

The analytical framework presented here models farmers' benefits from a legume enterprise (beans) as a function of farmers' utility maximization, constrained by resources endowment. Assuming a well-behaved utility function, and based on Van Dusen (2000) a farmer's utility maximization can be set as:

$$\max U = U(G_f, G_p / \omega_0) \quad (1)$$

Where G_f and G_p refer to consumption of aggregate on-farm produced and aggregate purchased goods, respectively and ω_0 refers to the vector of household level exogeneous factors including inputs endowment and heterogeneity (land and labor), human capital (age, sex, and education), asset endowment (livestock, land holding and wealth) and market access factors (distance or time to market places) and extension, all conditioning utility. However, utility maximization is subject to certain constraints such as land, cash, labor and other inputs that are available at the disposal of the household and the competing requirements for the resources.

The other most important constraint that the household faces is the production technology constraint which is conditionnal on choices of crop enterprises and varieties. It may be assumed that, in deciding whether to plant beans or not, the producer weighs up the expected utility of wealth from the expected benefits represented as

$U^*_A(\pi)$ and the expected utility of wealth from planting alternative crops represented as $U^*_N(\pi)$ and a producer will select an enterprise only if $U^*_A(\pi) > U^*_N(\pi)$ (Abdulai and Binder, 2006). This is under the assumption that farmers are risk neutral and that net farm

returns (π) represent wealth. The parameters of this decision can be represented by the costs and returns associated with the enterprises and can be captured in monetary terms. Utility of bean enterprise can be related to a set of explanatory variables, Z as follow:

$$U(\pi) = \delta Z_1 + \varepsilon_1 \quad (2)$$

Where δ is a vector of parameters and ε is an error term with mean zero and variance σ^2_ε . The error term includes measurement and factors unobserved by the researcher but known to the farmer. Variables in Z include all the variables described previously. Following this logical model, when costs are optimised, an empirical model for both costs and profits in this paper can be presented as follows:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 \quad (3)$$

Where Y = Gross profit on beans; X_1 = Sex; X_2 = Age of farmer; X_3 = market access indicator (Time to market); X_4 = Bean hectares; X_5 = Education level; X_6 = Land ownership; ε = other factors outside the control of the farmer. Similarly, determinants of cost of bean production can be evaluated as follows:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \varepsilon \quad (4)$$

Where: Y = Cost of bean production and marketing; X_1 = Sex; X_2 = market access indicator (location of farmer); X_3 = Marital status; X_4 = Bean hectares; ε = other factors outside the control of the farmer.

Using the empirical models both gross margins and costs of producing and marketing beans were analyzed using ordinary least squares regression to evaluate factors influencing the bean gross profit margins and the observed costs.

The gross profit margin is suitable for this study because when using the net profit margin, the costs incurred by farmers are very high and do not express any efficiency on land use and profitability. Gross profit margin is useful for comparing product lines because it allows farmers to make decisions about whether a product is worthwhile, and to keep track of how items perform over time while net profit margin shows the health of the business overall because it indicates how well the activities are doing at keeping expenses low and sales high.

MATERIALS AND METHODS

The paper is based on a survey conducted in the eastern DRC, South Kivu province, in 2007. Random sampling procedures were employed to get a representative sample of farmers that were included in the survey. Two sites (Lurhala and Kabamba) were randomly selected from among four CIALCA project intervention areas and an equal number of farmers selected from each of them. A sampling frame was prepared from all villages in these two sites and 5 villages were selected (Buganda, Isimbu, Nyalushoze, Bukalye, Karambi in Lurhala; and Kaboneke, Chifinjo, Ceyal, Lukayo, Kahanga in Kabamba). Sixteen farmers were randomly selected for inclusion in the interviews from each of the villages resulting in a total of 160 farmer respondents. The population of the study consisted of farmers who produce beans regardless of whether or not they produce other crops since 93% of the

Table 1. Definition of variables.

Variable	Definition	Measure
Sex	Sex of farmer	
Location	Market access indicator	1=poor access (Lurhala), 2=good access (Kabamba)
Age of farmer	Number of years since birth	Years
Time to market	Market access indicator (Time it takes to reach main market)	Minutes
Education level	Education levels	1=no formal education 2=primary 3=post primary education
Marital status	Marital status	1= single 2=married-monogamous 3=polygamous 4= widow
Land tenure	Type of land ownership	1=purchased or rented, 2 = inherited or by donation
Land size	Size of land under beans	HactaresHectares
Quantity produced	Quantity of beans produced	Kgkg/ha
Selling price	Sale prices of the beans	\$USD/kg
Cost of production	Cost from land preparation to post-harvest activities	\$USD/ha
Gross margins	Margins derived from bean sales	\$USD/ha

1 USD = 500 CF (Congo Francs) on 30th July 2007.

population rely on agriculture as the main livelihood activity. A general classification of the two sites indicated that Kabamba had a generally better market access compared to Lurhala.

Data description

Data was collected on landownership and size, age and sex of farmer household heads, labour and capital and other factors that contribute to output produced such as experience of the farmer, access to market in terms of time to reach market points as well as bean prices. Data was presented using statistics such as frequencies, mean comparisons, and regression analysis. The variables of interest are described in Table 1. Sales prices were computed after converting the local unit measures into US dollars per kilogram. Costs of production were computed as the sum of all cost incurred (land preparation, planting, weeding, harvesting and post-harvest costs) per hectare that were incurred by the farmers. Gross margins were computed as the difference between production costs and the sales value of the beans (sales value = quantity sold*price per kg/unit).

RESULTS AND DISCUSSION

Summary statistics show that the majority of socio-economic characteristics

The sampled respondents comprised 57% women farmers and 43% men. The mean age of the both male and female farmers was 36 years of age. Most of them were married. A large number (68%) did not have any formal education as presented in Table 2.

Access to productive assets (land, labor, credit, inputs and seeds)

The land tenure system can be characterized by a mix of

systems: some farmers used land purchased by themselves, other rented-in land. Other modes include inheritance and donations. A majority of the farmers used land inherited from the families as well as land donated to them (68%) while about 32% used purchased or rented-in land. In this study, land tenure was represented by land either purchased/rented in and land that was inherited or acquired under deonation. These two classifications captured the incentives to invest in the land to improve productivity.

Market access

Accessibility to market can determine whether or not farmers have access to inputs and output markets and whether this has an impact on transaction cost and it is likely to affect crop production and marketing as farmers tend to sell at a lower price due to poor market access. Market access can be measured by time to reach markets. Market access may also be measured by assessing whether a location has been determined to be a good access or poor access location for the farmers involved. Each of the two regions had an equal number of farmers included in the survey. The two regions where the survey was carried could be classified as follows: Kabamba generally was a good market access region while Lurhala was more remote relative to major roads and urban areas (Table 4).

The average time to reach the markets was about 70 min (Table 5). Most of the farmers in the province were more likely to use human back or head to transport products to markets (on foot). The average land under beans per farmer was 0.34 ha, this may be a factor of wealth endowment or show the ability to put up more land under beans. The mean selling price of beans was

Table 2. Respondents' marital status, marriage types and education levels.

Marital status	Percent	Education level	Percent	Gender	Percent
Single	9.4	No formal education	68.1	Male	43.1
Monogamy	66.9	Primary school	22.5	Female	56.9
Polygamy	7.5	Secondary school	9.4		
Widow	16.3	Total	100.0		
Total	100.0				

N=160.

Table 3. Land tenure.

Land tenure	Percent
Purchase/rented	31.9
Heritage/donated	68.1
Total	100.0

N=160.

Table 4. Distribution of sampled farmers by location.

Location indicator	Percentage of sample
Lurhala	50
Kabamba	50
Total	100

about 340 FC (USD 0.68) per kilogram. The costs of production were defined as costs related to household labour use, hired labour and other costs such as the input purchases, land preparation, planting, weeding, harvesting, and post harvest activities. The other costs were the costs of transport and different taxes (both official and informal). The average cost of production per farmer was about 21,000FC (USD 42) while the average gross margin was about 140,000 FC (USD 280).

Factors influencing household level gross margins and production costs

Regression results on the factors influencing bean gross margins are summarized in Table 6. The regression results show that the size of land under bean production was inversely related to the amount of gross margin achieved by the farmers. Farmers with smaller land holdings, most of whom were women, were more likely to achieve higher gross margins from their beans. Due to their relatively poor economic status, women in this study grew beans in land that was not purchased or rented, they did not hire labor and transport equipment and services as their male counterparts did. Thus, they operate relatively smaller plots than men. It would also imply that farmers that had larger land holdings used

more inputs, hired labor and equipments which increased the costs of production and transporting beans to markets, thus reducing their overall returns. Conversely, smaller farmers (women) used very low levels of production inputs resulting in relatively less costs.

The time taken to reach markets also had some minimal and negative influence on the gross profit margins reported. Longer times to markets appeared to reduce the amount of gross profit margins achievable by the farmers as this increased the costs of accessing markets or prevented farmers from accessing more profitable markets, ending up selling at lower prices. The longer distances hampered the purchase and transportation of inputs necessary to achieve higher production due to various reasons including lack of regular, reliable motorized transport system. This also affected farmers' capacity to transport their produce to the market and bring back the required farm inputs. Most often farmers carried their commodities on heads or backs to reach market places. Due to very poor infrastructure, farmers may not afford to pay for transport.

The land tenure was distributed between purchase and heritage land and some land rented and donated (Table 3). Related to form of land holdings, farmers who used inherited or donated land were more likely to receive higher gross margins relative to those who rented or purchased land that they used. The paper classified land ownership into purchase/rent and heritage/donation to reflect the influence on the gross margins based on the two major classes of ownership. Both male and female farmers were not willing to invest long time in land that they do not have full usage rights thus leading to lower returns. Such farmers are less likely to apply soil fertility enhancements such as fertilizers, manure and/or soil amendments that would be beneficial beyond one season of renting. Temporary tenure systems, common in DRC are not favourable for increasing land productivity. Those who used purchased land were also more likely to receive lower returns due to having purchased less productive parcels which require more inputs and management for maximum production. In addition, DRC land tenure policies and rules are not clear, making the purchasers of land not sure how much they should invest in it.

"Under the formal law, the state owns all the DRC's natural resources (land, water, forests, and minerals);

Table 5. Summary statistics for factors influencing costs and margins of beans.

Variable	N	Mean	Std. deviation
Age of farmer	160	36.3 years	31.1 years
Time to market	57	69.5 min	39.6 min
Bean area in ha	72	0.34 ha	0.63 ha
Selling price	111	342.3 (CF)	56.50 (CF)
Total cost of bean production per hectare	144	21230.5 (CF)	31625.80 (CF)
Gross margin on beans per hectare	53	141769.0 (CF)	175261.30 (CF)

1 USD = 500 CF (Congo Francs) on 30th July 2007.

Table 6. Regression results for factors influencing gross margins achieved in bean production.

Variable	Standardized coefficients	t-value	Sig.
	Beta		
(Constant)		-0.542-0.749	0.465
Bean area in ha	-.560	-3.124***	0.007
Education level	0.174	0.874	0.098
Time to market	-0.325	-1.757	0.098
Form	0.576	2.925***	0.708
Age of farmer	-0.072	-.381	0.708
Gender	0.109	0.571	0.486
-0.129		-0.714	0.486
Age of farmer	0.564	.896	0.008
Land tenure		3.047***	0.008

$R^2=56.7\%$ (adjusted 43%), $F=4.2^{**}$; ***, **, significant at 1 and 5%, respectively; $N=160$.

Table 7. Regression results for determinants of cost of producing beans in south Kivu.

Variable	Standardized Coefficients	t	Sig.
	Beta		
(Constant)		1.250	0.216
Age of farmer	-0.278	-2.876***	0.005
Sex of farmer (1=male, 2=female)	-0.313	-3.187***	0.002
Location of farmer (1=kabamba, 2=lurhala)	0.474	5.198***	0.000
Market access (1=Kabamba=good access, 2=Lurhala=poor access)			
Bean area in ha	0.435	4.912***	0.000
Marital status	0.089	.918	0.362

$R^2=56\%$ (adjusted 53%); $F=16.3$; ***, **, significant at 1 and 5%, respectively; $N=160$.

people can obtain various types of use and exploitation rights under an evolving set of laws and regulations. In practice, customary law endures, and natural resource rights are subject to parallel, incomplete, and often contradictory systems of formal and customary law. Land rights are often ambiguous, usually undocumented, and tenuous. Agricultural land is subject to seizure and land-grabbing. Formal and customary institutions are often ill-equipped to resolve land disputes" (USAID, 2011). Thus, farmers in DRC are not willing to risk investing in land that they cannot be assured of in the long run. It is no wonder then that our results in the survey areas show

that there was very minimal use of inputs irrespective of land tenure. Table 7 presents summary results of factors that contribute to the observed bean production and marketing costs. Model statistics indicate that these factors explain over 50% of the observed variation in costs of production and marketing for beans. The overall influence of the variables is significant at the 1% level of significance.

Land size under bean production also influenced amount of costs faced by the bean farmers as expected. This is expected since a large portion of costs faced by smallholder farmers are direct costs related to managing

Table 8. Gross margins between men and women.

S/N	Men	Women
1	Lease, purchase, gift, inherit land	Gift, inherit land mostly
2	Hire labor, purchase inputs, rent equipments	Own and /or family labor, no purchase of inputs or equipments
3	Hire transport equipments	Women transport produce on their heads or backs

the land (labor) and input application. In this regard, Kabamba was expected to incur more production costs since it has relatively larger acreage under beans than Lurhala.

Results of the age of the farmer indicate that younger farmers are more likely to face higher costs of producing and marketing beans than older farmers. This can be attributed to experience where experienced farmers are likely to benefit from lower costs due to social capital and wide knowledge of sources of resources associated with experience in farming.

With regard to the sex of the farmer, results show that male farmers are more likely to experience higher costs in producing beans relative to female farmers (Table 8). Though they may have an advantage in accessing resources such as credit or services more easily compared to the female farmers. They are also likely to have better collaterals and/or alternative sources of resources to support farming activities compared to their female counterparts. They gain knowledge and skills from training organized by NGOs, orientation from the private sector, field visits and knowledge sharing plus other informal sources. Women usually have almost no access to farm inputs yet according to the Huger Project (Weisfeld-Adams, 2008), if women were able to access the same inputs as men they are likely to increase their yields by 22% which would be more beneficial for them and thus increase the household food security.

Market access was measured by the location of the farmers where certain locations are considered to have good or poor market access. Being located in Lurhala was more likely to lead to higher costs relative to being located in Kabamba. Kabamba is characterized as having fair access to market (located next to the main road and market centre) while Lurhala has poor market access (located more than 5 km away from the main road and market centre). Lurhala is situated much further away from the main road and main markets for beans. Thus Lurhala is likely to incur more costs to keep up production as well as in accessing both input and output markets. Longer distances are exacerbated by intractable roads that are not motorable and /or farmers are not being able to afford transportation fees. Thus the poor access to markets led to higher costs of production for some of the regions.

All these may attract higher costs compared to women who rely on informal sources alone for acquiring knowledge and skills that may not have access to the resources. This may explain why female farmers incur

lower cost than their male counterparts. In addition, female farmers are more likely to perform some production activities on their own rather than hiring labor due to shortage of resources. For example, while men may hire a wheelbarrow or a bicycle for transport, women rely solely on putting the loads on their heads and /or backs to and from the market will thus appear to incur lower costs. But this is simply because they do not pay themselves for labor and time spent in food production and marketing.

Implications for technology interventions and uptake

Interventions that would enable such farmers to affordably access productive inputs are likely to impact positively on the farmers' economic welfare. This is necessary for self empowerment and self sustenance in food and incomes that beans can significantly contribute to in the farming communities.

Due to inefficiency in landuse affecting both profitability and costs, there is need of extension knowledge to increase efficiency of landuse by adopting ISFM technologies. There is need of interventions that would enable farmers to affordably access productive inputs that are likely to impact positively on the farmer's livelihood.

Male farmers access more land to put under beans confirming the gender differentials. Women's production "makes more profit" for various reasons including family labor whose cost is not computed in the production cost. They manage small units which ratyies then more efficient compared to men's bigger beans areas.

In SSA increase in commodity traded is from increased acreage not improved production per unit area. SSA agriculture is known for low use of inputs in general and for bean production in particular.

Rural infrastructure is a challenge and from other studies in the region. Farmers and scholars have listed road infrastructure as one of the major facing small scale agriculture. It confirms studies that show the social cost of infrastructure which is paid by women who end up transporting most of the farm produce to the market. (Blackben and Bhanu, 1999; Birachi and Wanjiku, 2010) show that over 50% of the commodity transport in the region is on human body. Weisfeld-Adams (2008) estimates that they contribute two third of the total rural transport.

Development agents in the region need to lobby for

improved infrastructure in the MDHs and CAADP goals are to be met in DRC. As well as ensuring security which also hinders farmers from investing when not sure if they will harvest. There is also need for relief agents to rethink their intervention strategies and more than from emergency, response to more sustainable long term assistance since relative peace is preventing.

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