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Climbing beans in Uganda: A perspective of smallholder farmers on their determinants, associated challenges and implications for research

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In many parts of the world including Uganda climbing beans are mostly grown in highland areas where population density is high and land is limiting. The objective of this study was to contribute to understanding the current status of the factors affecting productivity of climbing beans among smallholder farmers in Uganda. Kisoro and Kabale districts in the South West were selected for the study. Primary data was collected based on 150 households selected randomly in each district in January and June, 2014. In both districts, climbing beans was ranked as a major crop enterprise for income (72.7%). Most of the interviewed households (84 and 92%) in Kisoro and Kabale respectively appreciated that the major advantage of climbing beans was suitability to areas with limited land. The study revealed practices that seem to integrate the different factors and the various components within each factor promoting ecological or interrelatedness in the production system. Lack of staking materials was ranked by the majority (Kisoro 45% and Kabale 59%) as the most important constraint. Common bean diseases (49%) and pests (45%) were highly ranked in Kisoro as compared to Kabale (13 and 22%). Labour scarcity was ranked by the majority of farmers in Kabale (49%) as compared to Kisoro (19%). Given the importance of climbing beans in the two districts, the study recommends their continued and sustainable intensification.

Key words: Common bean, cropping system, ecological, food security, highlands, legume, staking.

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is consumed worldwide as a main source of dietary protein, particularly in most Latin-American and African countries CGIAR (2018). In Eastern and Southern Africa, it is an important component of the production systems and a major source of protein (Katungi et al., 2009). In Uganda, it is an

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important staple food for the majority of farmers and consumers (Sibiko, 2012). In addition, it is an important source of income (Opio et al., 2001; Mwesigwa, 2009). Both bush and climbing beans are grown in Uganda (MAAIF (2004) as cited by Sibiko (2012). However, climbing beans were traditionally grown in the high altitude areas (the south-west highlands and the slopes of Mt. Elgon) (Ronner and Giller, 2013). But they are being promoted to other areas of the country with the introduction of the mid-altitude climbers (MACs) by the Uganda National Legumes Research Program (UNLRP) and other development partners. Currently, climbing beans constitute 20% of the total land area under bean cultivation (Ronner and Giller, 2013). Elsewhere in the world climbing beans are also grown; for example Ramaekers (2012) reported that cultivated climbing beans are found mostly in medium to high altitude (2000 to 2800 masl) regions of the Andes and Central America. In East Africa, other areas include Rwanda, Central Kenya highlands, Western Kenya, Burundi and Eastern DR Congo (Ramaekers et al., 2013; Raphaël, 2013; CGIAR, 2018). All these areas are characterized with high population density and over exploitation of land/land scarcity. Musoni et al. (2014) stated that in Rwanda climbing beans provide the best option for intensification and the production of surplus beans where arable landholdings are diminished.

Climbing beans in the South Western highland areas of Uganda were promoted in the 1990s (CIAT, 2008) as cited by Gabiri (2013). Adoption of the climbing bean technology was to cope with the problem of land degradation and land scarcity to reduce on poverty and food insecurity (Gabiri, 2013). Climbing beans are potentially high yielding, capable of giving two to four times the yield of bush varieties (Musoni et al., 2005; Katungi et al., 2009; Ramaekers et al., 2013). In Uganda, the first improved climbing bean varieties introduced from Rwanda through the East and Central African Bean Research Network (ECABREN) were officially released in 1999. These included NABE7C (Vuninkigi), NABE8C (Ngwinurare), NABE9C (Gisenyi) and NABE10C (Umubano/G2333). A number of development partners participated in dissemination of these improved climbing bean varieties such as International Center for Tropical Agriculture (CIAT) through the Pan African Bean Research Alliance (PABRA) and AFRICARE to the Uganda's southwestern and eastern highlands. In 1999, several germplasm of mid altitude climbers (MAC) were introduced from CIAT-Colombia and subjected to participatory evaluation and this resulted into release of MAC31 as NABE12C in 2003. Unlike the earlier released varieties, the mid altitude climbers were designed by CIAT to be early maturing and more heat tolerant and therefore able to grow and perform well in tropical mid-altitude growing conditions, that is, 500 to 1500 masl (Blair et al., 2007). Between 2012 and 2016, more new improved climbing bean varieties have been released and their dissemination is underway.

Unfortunately, compared to bush beans, for a very long time there have been limited deliberate efforts to document the status of the factors affecting climbing bean production in Uganda. But until recently some studies have been initiated but mainly focusing on farmers participating in the N2Africa project with a few non-N2Africa farmers. For example, Breure and Kool (2014) conducted some studies on climbing beans in Kisoro district and selected nine N2Africa farmers in Nyakabande sub-county and nine farmers without an N2Africa demonstration plot in Mutolere sub-county. To this number, they conducted additional interviews with 14 famers from Kisoro district (6 from Nyakabande, 6 from Mutolere and 2 from Busanza). The aim of their studies was to compare farmers' practices of the N2Africa farmers with the non-N2Africa farmers, in terms of inputs (especially labour, seeds and stakes) and outputs (yields). The second aim was to identify the different actors in the climbing bean value chain specifically for Kisoro. In Kabale district in the sub county of Bubaare, they interviewed: six N2Africa farmers, three Non-N2Africa farmers and an owner of a tree plantation. According to Breure and Kool (2014), N2Africa is a research project that works on putting nitrogen fixation to work for farmers growing leguminous crops in Africa and is led by Wageningen University, but implemented and conducted in 13 countries in sub-Saharan Africa, including Uganda. Similarly, Bharathwaj (2015) also conducted an N2Africa study aimed at having a better understanding of adoption constraints for climbing beans in Kashambya sub-county (Kabale district). N2Africa had provided some farmers with different climbing beans varieties and fertilizers in multiple treatments to increase productivity and 67 farmers were selected. Wytze (2015) conducted another study on a total of 32 households both in Kapchorwa district in the Eastern highlands and Kanungu district in the South-western highlands. The main objectives of his study were to describe and explain the opportunities and constraints for climbing bean cultivation by smallholder farmers in an area with good market access (Chema, eastern highlands) and in an area with poor market access (Mpungu, south-western highlands).

The objective of the current study therefore was to contribute more to understanding the current status of the factors affecting productivity of climbing beans among smallholder farmers in Uganda.

MATERIALS AND METHODS

The study area and sampling procedure

The study was conducted in Southwestern Uganda region covering Kabale and Kisoro districts in January and June, 2014. The districts were selected purposively as areas where specifically climbing beans are mostly grown in Uganda (Opio et al., 2001). Kabale altitude ranges between 1,219 m (3,999 ft) and 2,347 m (7,700 ft)

above sea level. In terms of geographical co-ordinates, Kabale district is located at latitude: -1° 14' 54.85" S and longitude: 29° 59' 23.75". Kisoro is at an average of 1,980 m (6,500 ft) above sea level at latitude 01°17'S and longitude 29°48'E. This Southwestern region is characterized by a bimodal rainfall pattern, sufficient for two crops per year and intensive farming practices. The households interviewed were selected from five sub-counties in Kisoro district (Kisoro town council, Nyakinama, Nyarushiza, Nyarubuye, and Muramba) and in three sub-counties in Kabale district (Kitumba, Bubare and Kamuganguzi). All the sub-counties in Kisoro were purposively selected mainly because there are major climbing bean production areas. In Kabale, Kitumba sub-county is a major climbing bean producing area. Bubare and Kamuganguzi sub-counties were selected because the national breeding program was conducting participatory variety evaluation and seed dissemination activities. The population of interest was both men and women farmers that are involved in climbing bean production. The sampling unit was the farm household. A total of 150 households were randomly selected and interviewed in each district. The random sampling was based on guidance of the agricultural extension officers and key contact persons or farmers in those sub-counties who knew the different households involved in climbing bean production.

Data collection

Primary data were collected using a standard questionnaire using both open and close ended questions. A systems thinking perceptive was used to view various components of the agro-ecosystems as potential factors affecting climbing bean production. Primary data were collected from households including: (1) demographic variables, mainly gender of the households and household age, (2) human capital variables, mainly education level, (3) physical capital variables, including households' land and non-land assets and income sources, and (4) climbing bean factors of production with the different components of production. Considered also was more detailed information about climbing bean production and consumption, how climbing bean production systems relate to the environment, the benefits of climbing bean production, climbing bean production constraints and copping strategies.

Data processing and analysis

Data was analyzed for a total sample size of 300 respondents. Collected data was cleaned, coded and entered into Microsoft excel and then subjected to analysis using Microsoft excel and the Statistical Package for Social Scientists (SPSS) version 16. Descriptive statistics (means, frequencies, percentages) and qualitative method of data analysis were used to analyze the information gathered during the survey. Chi-square (χ^2) test was used to test for association between the different factors of production, characteristics of cropping systems, and districts from which the farmers come from. Non-parametric statistics especially, Wilcoxcon-matched paired test was also used to compare the characteristics of farmers and cropping systems between the two districts.

RESULTS

Households' socio-economic characteristics (education status, age and source of income)

Results show that the majority of household heads interviewed growing climbing beans have at least attained primary education (Kisoro 95.3%; Kabale 88.7%) (Table 1). Kisoro had high percentage (36.7%) of the household heads that had attained College or University level education as compared to Kabale district (8.7%). In terms of age, the results show that 82.2% of interviewed households from Kisoro were of 21 to 50 years. Whereas in Kabale 67.1% of the households interviewed were also in that same age range.

In the two districts, the majority of the households interviewed (Kisoro 82.7%; Kabale 94.7%) have crop farming as their main source of income. The other alternative sources of income included wages from manual work, business and salary.

Household production and consumption of climbing beans

Overall, most farmers in Kisoro district (77.3%) grow climbing beans as compared to Kabale district (48%) (Table 2). According to the interviewed households, in both districts there is no farmer who does not grow climbing beans. In terms of consumption, results show that climbing bean is an important component of the diet in both districts. In both districts more than 95% of the households eat climbing beans at least once a day (Table 3). However, the proportion of households who eat climbing beans more than once a day, that is, lunch and supper is higher in Kisoro (91.3%) compared to Kabale (68.6%). In both districts in the study area, climbing bean is ranked by the majority of interviewed households as the most important crop enterprise for diet (Table 4). It was highly ranked by more households in Kisoro (94%) compared to Kabale (69%). They mostly eat climbing beans with Irish potatoes and sweet potatoes.

Climbing beans as a source of income

Just like in the case of diet, climbing beans was ranked first by the majority of the households interviewed as a major crop enterprise for income (72.7%, n=109) in both Kisoro and Kabale districts followed by Irish potatoes (Table 5). Only a small proportion (Kisoro 23.2%; Kabale 19.9%) ranked it in the second position. Households explained that climbing bean fresh pods and dry seeds normally fetch high premium prices and have high demand and ready market.

Climbing beans production seasons

This study revealed that most farmers grow climbing beans both in the first and second seasons in both districts. A very strong association (Chi-square = 161, df = 3, $p<0.001$) was noted between the time of planting and the districts (that is, farmers in Kisoro start their season

Table 1. Socio economic characteristics of interviewed households in Kisoro and Kabale districts in South Western Uganda.

Parameter	Frequency of households (Kisoro)	Proportion (%)	Frequency of households (Kabale)	Proportion (%)
Education status	**n=150**		**n =150**	
Illiterate	7	4.7	17	11.3
Primary	55	36.7	94	62.7
Secondary	33	22	26	17.3
Tertially/College	34	22.7	13	8.7
University	21	14	0	0
Major source of income	**n= 150**		**n=150**	
Crop farming	124	82.7	142	94.7
Salary employment	19	12.7	6	4
Causal labour	4	2.7	1	0.7
Business/Trade	3	2	1	0.7
Age	**n=146**		**n=149**	
21-30	31	21.2	20	13.4
31-40	56	38.4	39	26.2
41-50	33	22.6	41	27.5
51-60	22	15.1	40	26.9
61-70	4	2.7	7	4.7
71-80	0	0	2	1.3

Source: Field Survey Data; at the age variable, n is less than 150 because a few individuals were reluctant to disclose their age.

Table 2. Proportion of farmers that grow climbing beans according to interviewed households in Kisoro and Kabale districts in South Western Uganda

Description	Proportion of interviewed households (%)	
	Kisoro (n=150)	Kabale (n=150)
None	0	0
Few	2	12.7
Average	2	2.7
Many	18.7	36
Most	77.3	48
No response	0	0.6

Source: Field Survey Data.

Table 3. Number of times climbing beans are eaten a day in Kisoro and Kabale districts in South Western Uganda.

No. of times beans are eaten in a day	Proportion (%) of interviewed households	
	Kisoro (n=150)	Kabale (n=150)
0	0.7	4
1	8	27.3
2	81	63.3
3	9	5.3
4	1.3	0

Source: Field Survey Data.

Table 4. Major crops for diet of the interviewed households in Kisoro and Kabale districts in South Western Uganda.

Crop ranking	Percentage of interviewed households ranking the different crops as sources of diet in Kisoro and Kabale districts						
	Climbing beans (*P. vulgaris*)	Irish potatoes (*Solanum tuberosum*)	Maize (*Zea mais*)	Sweet potatoes (*Ipomea batatus*)	Banana (*Musa* spp.)	Bush beans (*P. vulgaris*)	Sorghum (*Sorghum bicolor*)
1st Crop diet	94 (**69**)	6 (**12**)	0 (**0**)	0 (**12**)	0 (**5**)	0 (**1**)	0 (1)
2nd Crop diet	5 (**17**)	44 (**23**)	19 (**2**)	14 (**24**)	11 (**21**)	3 (**1**)	1 (12)
3rd Crop diet	1 (**5**)	18 (**29**)	28 (**5**)	27 (**23**)	9 (**2**)	2 (**10**)	11 (22)

Source: Field Survey Data; Numbers in bold represent Kabale; Only the most important crops are shown in the table; but other crops for the diet such as vegetables; pumpkins and millet were mentioned.

Table 5. Important crops for income for the interviewed households in Kisoro and Kabale districts in South Western Uganda.

Crop ranking	Percentage of interviewed households ranking the different crops as sources of income in Kisoro and Kabale districts							
	Climbing beans	Irish potatoes	Sorghum	Sweet potatoes	Maize	Passion fruits	Banana	Bush beans
1st Crop income	72.7 (**72.7**)	26 (**12.7**)	0 (**10**)	0 (**0.7**)	1.3 (**0**)	0 (**2**)	0 (**0**)	0 (**2**)
2nd Crop income	23.3 (**19.9**)	26.7 (**28.8**)	2.7 (**17.8**)	8.7 (**25.3**)	30.7 (**2.7**)	0.7 (**1.4**)	3.3 (**0.7**)	0.7 (**2.1**)
3rd Crop income	3.5 (**3.5**)	13.8 (**35.7**)	19.3 (**16.1**)	14.5 (**14**)	26.9 (**2.8**)	0 (**0**)	11 (**2.1**)	2.1 (**21**)

Source: Field Survey Data; *Values in bold in the parentheses are for Kabale district.

much earlier in the year as compared to those in Kabale) (Table 6). The same association between time of planting and district was also noted in the second season (Chi-square=42.19, df =2, $p<0.001$). Results from the study further suggest that climbing bean production takes place in the whole year, with some seasons starting earlier in the year. The majority of interviewed households in Kisoro district (76.7%) reported that the best season for growing climbing beans is the first season whereas in Kabale district (91.3%) it is the second season.

Climbing bean varieties grown

NABE 12C (Large sugar bean) was the most popular improved climbing bean variety grown in the two districts (Table 7). A number of landraces (local varieties) were also grown. Eibanga lya Kagame (51%) was the most popular landrace grown in Kabale, whereas in Kisoro they were Umwizirahenda (70%) and Nyiramwigondore (70%). Households gave different reasons for preference of different varieties they were growing. In general, in both districts, the main characteristics considered were food security, climbing bean good attributes for high productivity, tolerance to common bean diseases and insect pests, environmental factors with 70 and 64%, 26 and 53%, 25 and 46%, and 22 and 33% households in Kisoro and Kabale, respectively (Table 8). The survey further revealed that in a period of five years (2009 to 2013) some varieties are no longer grown because of lack of desirable attributes for productivity, susceptibility to biotic factors, poor cooking qualities and are not adaptable to local conditions. Other varieties were also abandoned because of their characteristics for example one variety “Gihurabagabo” in the Kifumbira local dialect which means “can be threshed by men” was abandoned due to the fact that it required a lot of strength to thresh and hence could not be easily threshed by women.

Cropping systems in the climbing beans agro-ecosystem

The major cropping systems reported for climbing beans growing in Kisoro and Kabale districts

Table 6. Production seasons for climbing beans in Kisoro and Kabale districts.

Months for growing climbing beans	Proportion of households (%)	
	Kisoro	Kabale
a) In season one		
January- May	6	0
February- July	88	22
March-August	6	57.3
April- August	0	20.7
Chi-square = 161, df = 3, p<0.001		
b) In season two		
July-December	4	0
August-January	38.7	10
September-February	57.3	90
chi-square =42.19, df =2, p<0.001		
Season with the highest climbing bean yield		
First	76.7	7.3
Second	14.7	91.3
Did not give any response	8.7	1.3

Source: Field Survey Data.

Table 7. Climbing bean varieties grown by farmers in Kisoro and Kabale districts in South Western Uganda.

Name of variety	Type of variety	Seed type	% of households	
			Kabale	Kisoro
NABE12C	Improved	Large sugar bean	83	60
Eibanga lyakagame	Landrace	Small Khaki with light red	51	0
Nshemereirwe	Landrace	Large black	19	0
Nyiramwigondore	Landrace	Medium kidney red	1	70
Umwizirahenda	Landrace	Large red kidney	0	70
Nyirakanada	Landrace	Small yellow	0	22
Umwirasi	Landrace	Light orange medium	0	26
Nyirakyigufa	Landrace	Large white with spots	0	15

Source: Field Survey Data.

include crop rotation, intercropping, integrated livestock, agro-forestry and monocropping (Table 9). They explained that climbing beans are mostly rotated with Irish potatoes, sweet potatoes, peas or sorghum. A few who plant bush beans indicated they may rotate climbing beans with either maize/bush bean intercrop or sorghum/bush bean intercrop. In case of intercropping the major crops are maize, sorghum or bananas. Agro forestry involves short term maturing trees such as C*alliandra*, *Sesbania*, *Leucaena* and *Vernonia* species. Each farming household often uses more than one cropping system when growing climbing beans in both districts. Wilcoxon Matched-Paired test showed that there was no significant difference (p=0.188) in the proportion of the farming households practicing the different cropping systems. Households cited several reasons for practicing each type of cropping system while growing climbing beans include the following: crop improvement, controlling biotic factors, avoiding soil degradation, for food security, environment management, inadequate land, and agronomic practices being easily practiced.

Interviewed households were asked to give further explanations about each reason and they reported that crop improvement is realized from the different cropping systems in different ways. For example, when grown as a sole crop, climbing bean yield potential is higher due to reduced competition for nutrients. Some households explained that when climbing beans are intercropped with

Table 8. Reasons for preference and dropping of climbing bean varieties by interviewed households in Kisoro and Kabale districts in South Western Uganda.

Parameter	Explanation given by farmer(s)	% of households	
		Kabale	Kisoro
a) Reasons for preference			
Food security	Good taste and easy to cook	64	70
Environmental	Drought tolerant, tolerant to low soil fertility, improves soil fertility	33	22
Tolerance to insect pests and diseases	Not easily affected by pests and disease	46	25
Good attributes	High yielding, seed/grain size, seed color, stores for a long time	53	26
b) Reasons for dropping varieties			
Biotic factors	Susceptibility to common bean pests and diseases, rodents (rats)	1	21
Lack of acceptable attributes	Low market demand, late maturing, hard to thresh	0	37
Poor cooking qualities	takes long to cook, not palatable	0	11
Not adaptable to local conditions	Do not grow well in hard conditions	0	6

Source: Field Survey Data.

Table 9. Reasons for practicing various cropping systems in the climbing beans agro-ecosystem.

Cropping system	Percentage of households who gave different reasons for practicing various cropping systems in Kisoro and Kabale								
	Crop improvement	Agronomic practices	Control of biotic factors	Avoid soil degradation	Income	Environment management	Food security	In-adequate land	Ecological processes
Mono-cropping	56.7 (79.3)	8 (39.3)	6 (21.3)	30 (18)	3.3 (2)	2.7 (2)	2.7 (1.3)	0 (0.7)	0 (0)
Crop rotation	24 (34.7)	0 (1.33)	25 (36)	47 (51.3)	2.7 (12.7)	5 (1.3)	23 (15.3)	1 (8)	3 (1.3)
Integrated livestock and cropping systems	8 (15.3)	0 (0)	1.3 (1.3)	41.3 (72.7)	21.3 (35.3)	2.7 (0)	3.3 (0)	4 (0)	0 (0)
Agro Forestry	2 (1.3)	0 (0)	0 (0)	10 (14)	1.3 (0)	40.7 (58)	0 (0)	0 (0)	6.7 (0)
Inter-cropping	5 (7.3)	3 (5.3)	4 (6.7)	5 (12)	11 (2.7)	13 (24)	28 (2)	16 (5.3)	0 (0)

Source: Field Survey Data; Values in parentheses are for Kabale.

others crops such as maize, both crops will have improved yields in that the maize will provide the needed stakes for the climber, while the climbing beans will contribute to increased soil fertility for the maize.

All the different cropping systems were important in avoiding soil degradation also in different ways. Climbing beans and agro-forestry trees (such as *Calliandra, Sesbania*) have the ability to restore and maintain soil fertility. They fix nitrogen in the soil and the large biomass from climbing beans provides manure on decomposing. Agroforestry trees also hold the soil firmly and prevent soil erosion. Other households reasoned that climbing beans was a basis for crop rotation

for other crops, since it improves soil fertility through N-fixation and biomass production that supports the successive crops. For example, cereals were mentioned to perform well after climbing beans, in a rotation. This system allows the soil to retain its fertility for one to two seasons. Whereas integrated livestock and cropping systems provide farm yard manure/mulches which improve on soil fertility.

For the case of environment management in the climbing bean agro ecosystem, they explained that trees, bananas and coffee plants act as wind breakers. In addition, the trees (agroforestry) will provide the staking material needed for the climbers. Whereas practicing crop rotation and intercropping with cereal crops (such as maize and sorghum), the stalks of the cereal crops after harvesting and live plants respectively also provide the stakes. Consequently, in this era of environmental degradation, intercropping (provides live stakes) reduces on both the cost of staking materials and on the need for conventional stakes hence reducing on deforestation.

On the other hand, control of biotic factors resulted from the fact that some cropping systems involving climbing beans may break the life cycle of pests and diseases. According to households, mono cropping of climbing beans eliminates birds and rats due to reduced congestion. Furthermore, climbing beans have the potential to suppress weeds. This is probably the reason why in Kabale fields after harvesting, climbing beans are weed free and are normally followed by field peas, a crop which is never traditionally weeded by farmers.

As for food security, it was explained that some cropping systems involving climbing beans help in diversifying for a balanced diet (get more food), hedge against total crop loss/risk of complete loss of a particular enterprise.

For in-adequate land, households explained that some systems such as intercropping allow to fully or profitably utilize the land.

Furthermore, cropping systems were important for ecological practices in the sense that different enterprises benefit from each other. For example the trees provide stakes for the beans and are also a source of fuel (fire wood) and charcoal. The tree leaves improve soil fertility and are also used as feed for animals which in turn provide manure to the soil. The climbing bean husks are also very good animal feeds as well as used for mulching in other crops. Re-use or recycling of waste as compost or mulch is assumed to reduce on external input use and improves environmental quality.

Benefits derived from planting climbing beans

According to households interviewed in Kisoro and Kabale, the major benefits from climbing beans production were economic benefits and food security (98.7 and 96.7%) and (94.7 and 92%), respectively (Table 10). They explained that economic benefits result from the fact that climbing bean pods and dry seeds fetch premium prices and have high demand and ready market. This income enables households to meet their basic needs such as payment of school fees, meeting medical bills, buying clothes and improving the general household standard of living.

For food security, they reported that climbing bean is a main source of diet/staple food, is tasty and source of protein and other nutrients especially to young children. The compatibility of climbing beans in the different cropping systems also helps in diversifying for a balanced diet (get more food) and hedge against total crop loss/risk of complete loss of a particular enterprise primarily grown by women farmers and who are involved in food preparations. Social benefits were also reported as being cultural pride, used as a gift to friends, served as a special dish on parties, also exchanged in order to get other food stuffs and that one gains popularity because it improves ones livelihood.

Other households reported that climbing bean production was a source of improving soil fertility and was environmentally friendly. This is because the large biomass decomposes giving manure, provides soil cover and the climbing beans husks are used for mulching. Institutional interaction is also realized since households have a chance to interact with agricultural research institutions such as National Agricultural Research Organisation (NARO) who provide information on improved production technologies in order to improve production and productivity. In addition, National Agricultural Advisory Services (NAADS) provides extension services and advisory roles as well as planting materials. Other development partners such as CIAT, CARE and AFRICARE were also mentioned. Ecological benefits were also reported such as the wooden old staking materials being used for firewood. The byproducts after threshing and cleaning beans are used for mulch/compost, fuel, animal feeds though others may throw them away or burn.

Major constraints in climbing bean production and coping mechanisms

Lack of staking materials was ranked by the majority (45 and 59%) of interviewed households in Kisoro and Kabale, respectively as the most important constraint in climbing bean production (Table 11). They explained that stakes are scarce and are expensive. Common bean diseases (49%) and pests (45%) were significantly ranked as major constraints in Kisoro as compared to Kabale (13 and 22%). Labour scarcity was also another important constraint. According to the results, it was a more important problem in Kabale than in Kisoro. On the other hand, social constraints included theft of stakes in the store and fires set to burn stakes by jealous people.

Table 10. Benefits from climbing bean production as mentioned by households in Kisoro and Kabale in South Western Uganda.

District	Percentage (%) of households ranking benefits from climbing bean production						
	Economic	Food security	Socially acceptable	Improves soil fertility	Environmentally friendly	Ecological	Institutional interaction
Kisoro	98.7	94.7	18.7	13.3	4	2	0
Kabale	96.7	92	13.3	20	`14	4	8

Source: Field Survey Data.

Table 11. Constraints in producing climbing beans in Kisoro and Kabale districts in South Western Uganda.

Constraints	Percentage of households ranking the different constraints	
	Kisoro	Kabale
Diseases	49	13
Pests	45	22
Lack of staking material	45	59
Social factors	39	31
Weather	24	18
In put expensive	21	11
Lack of labour	19	49
Land shortages	19	20
Poor methods of farming	19	17
Lack of funds	7	2
Lack of market	6	5
No problem	5	4
Soil degradation	4	12
Weeds	5.3	0.7
Birds	2	17
Rodent	2	17
Natural hazards	0.7	3.3
Termite	0	2.7

Source: Field Survey Data.

Weather related constraint was heavy rain which leads to rotting of stakes and strong winds that cause stakes to lodge.

In order to overcome these constraints interviewed households reported several coping mechanisms. They included the following: (i) recycling of stakes, where the same stakes are stored properly and can be used for more than two to three seasons, (ii) using strong and mature

Table 12. Merits and demerits of growing climbing beans as perceived by households in Kisoro and Kabale districts, south western Uganda

Parameter	Proportion of households (%)	
	Kisoro	Kabale
a) Merits of growing climbing beans		
Suitable for areas with limited land	84	92
Food security	49.3	28
Possess good marketable attributes	48.7	48
Improve the environment	12.7	46.7
Adaptable to local conditions	4.7	6
b) Demerits of growing climbing beans		
Agronomic characteristics	47	21
Production is expensive	34.7	2
Work load	28	59.3
Susceptible to bird damage and rats	6.7	19.3

stakes and also re-staking of dislodged staking materials due to heavy rain fall or strong wind, (iii) practicing the different cropping systems (agro forestry, intercropping, integrated livestock cropping system), (iv) clearing bushes around the gardens and pruning some plants to control rats from invading the climbing bean garden, (v) use of climbing bean husks for mulching and controlling soil erosion, and (vi) using resistant varieties.

Furthermore, social capital was reported as an important strategy for overcoming labour scarcity. It was explained in terms of farmers forming groups. Others use family labor supplemented with hired labor while others either endure and carry out the activity on their own or involve children. To reduce on drudgery and work load, they also reported that climbing beans may be threshed in the garden and bean husks are not carried home and bicycles are used to reduce the load of carrying stakes on the head. For others, stakes are cut early and allowed to dry for a light weight to be carried to the field.

In the case of lack of seed of any particular climbing bean variety, interviewed households mentioned that they exchange with friends/neighbours. They may also borrow stakes from neighbourss and return them after use. A fear is the social conflict which may arise after failure to return the stakes.

Accessing credit for production of climbing beans from local savings or friends is another important strategy. Others sell climbing bean produce to local markets to get money (capital). Funds are then used to buy seed from the market and/or renting or buying land to expand on climbing bean area of production.

There are special or important strategic interventions that are implemented in order to avoid loss and have continued climbing bean production. Some of the measures implemented include: harvesting and carrying of climbing beans home, while still on their stakes to save the stakes from theft and wild fires, some periodically monitor to ensure security of both beans and stakes or employ people to guard against thieves and scare off birds. To enable longer use of the acquired stakes, they reported storing the stakes on raised beds or under a shade or piling them upside down to expose the part of the stake that had been fixed in the soil to the sun to avoid rotting.

In addition, promoting local practices was also mentioned such as using ropes/strings as staking materials; others said they use stalks of sorghum and maize as staking materials, laying mole rat traps, using scare crows to control birds from pecking young pods and flowers which lowers the production, applying ash in the climbing bean fields to control termites from damaging stakes. For lack of markets, households end up selling in local markets and in case of unfavorable prices they store beans until prices are favorable.

Merits and demerits of growing climbing beans

After analyzing the opportunities and constraints in climbing bean production, households indicated that climbing bean production has several advantages compared to bush beans. In both locations of Kisoro and Kabale, climbing beans were mentioned by the households to be suitable for areas with land shortage (84% , 92%), good for food security (49.3%, 28%), possess good market attributes (48.7%, 48%) and are also adaptable to local conditions (4.7%, 6%) respectively (Table 12). They explained that since climbing beans grow vertically it allows one to maximize the limited space. In terms of food security, farming households explained that climbing beans allow for peace meal harvesting (keep eating pods which developed early as pod loading continues) and are high yielding.

On the other hand, agronomic characteristics of climbing bean was reported a demerit over the bush beans because it requires staking (yield potential is only attained after staking, easily blown by wind after staking because they grow upright). In addition, they are late maturing. The demerits as in order of importance in Kisoro included climbing bean agronomic characteristics 47%, climbing bean production being expensive (34.7%) and work load 28%. While in Kabale, work load (59.3%), the agronomic characteristics 21%, susceptibility to bird and rats damage 19.3%.

In addition, climbing bean production costs are high as explained by households that it requires stakes which are scarce and expensive, as well application of pesticides is very expensive (the crop has too much vegetation). Susceptibility to birds and rat damage was another demerit for climbing beans. They are more liked by birds as well as more affected by rats. Birds affect both flowers and tender bean pods.

Production of climbing beans involves some demanding and cumbersome activities. And if there is no cautious cutting of trees and planting of quick maturing agroforestry trees to provide the needed stakes, it may lead to environmental degradation due to deforestation.

DISCUSSION

First and foremost this study strongly revealed that climbing beans is an important crop in both districts as food and source of income more than the bush beans. In Kisoro, bush beans have not been adopted, whereas in Kabale, climbing beans is a relatively new crop but with potential to replace bush beans because of its several advantages. For food, households mostly eat climbing beans with Irish potatoes and sweet potatoes and this implies climbing beans play a big role in providing proteins in these areas. Climbing bean growth habit leads to staggered harvesting of leaves, pods, and grain, thus providing diversified nutrition and improved household food security throughout the growing season (Sperling et al., 1992 as cited by Musoni et al. (2005)). In terms of income, previous researchers have stated that common bean is considered as an important source of household income in the domestic, regional and international markets (Kimani et al., 2005). In Rwanda, climbing beans are important in raising on-farm productivity and contributing significantly to the gross domestic product (GDP) and replacing the bush type (Musoni et al., 2005). Beebe et al. (2013) stated that beans are becoming increasingly commercial with the trends of urbanization and market globalization.

The observed literacy level among interviewed in Kisoro and Kabale is important because education is assumed to increase the farmers' ability to obtain and use information relevant to the production of crops including climbing beans (Gichangi et al., 2012).

According to Barrett et al. (2001) and Deininger and Okidi (2001) as cited by Walusimbi and Konya (2004), education is a key factor which increases households' opportunities for off farm salary employment, and may increase households' ability to start other various non-farm activities. Similarly, from this study, much as the majority of the households in the two districts depend on crop farming as their main source of income, they also had other alternative sources of income including wages from manual work, business and salary. Related research among maize farmers in Kenya reported that farmers who depend entirely on farming are disadvantaged in terms of farming capital; hence they became less allocatively efficient compared to those who also engage in non-farming activities (Mulwa et al. 2009 cited by Sibiko, 2012).

It was evident from the survey that the interviewed households were generally of active working age, 21 to 50 years. Household demographic composition greatly influences the amount of labor available because in general the very young and very old are not available to work on or off the farm (Puhalla, 2009). Similarly Raemekers et al. (2013) stated that age as a demographic factor is an indicator of labour, that is, household members older than 15 years are (potentially) able to work on the farm (labour endowment). As climbing bean production requires more labour, it is expected that higher labour endowments facilitate the adoption (CIAT, 2004 as cited by Raemekers et al., 2013). This is in addition to the expected experience in production and marketing that is expected of older farmers (Gichangi et al., 2012; Walusimbi and Konya, 2004).

Farmers are able to grow climbing beans both in the first and second seasons in both districts. However, the majority of households in Kisoro reported that the best season for growing climbing beans is the first season whereas those from Kabale indicated it was the second season. There is evidence to support the findings that despite the fact that Kabale and Kisoro districts are both mountainous regions in South Western Uganda, they have differences in climatic conditions.

Wortmann and Eledu (1999) cited by Raussen et al. (2002) stated that much as Uganda's southwest exhibits a good number of common features: bimodal rainfall, hilly terrain, etc., there exists differences in agricultural systems and land-use practices due to local climate, soil and terrain interacted with farmers' traditions, preferences and markets. This probably explains the reported differences in the best seasons for growing climbing beans.

The findings that NABE12C (Large sugar bean) was the only improved climbing bean variety grown presents serious research implications for the Uganda bean research and development program. This indicates that there is still need to continue developing and disseminating more improved climbing bean varieties

with related acceptable attributes. Sperling and Muyaneza (1995) in their studies in Rwanda also found majority of farmers growing one improved variety, Umubano (G2333). They stated that such genetic narrowness can compromise production stability and that if yield of improved climbing cultivars are to remain high, research should put emphasis on releasing many and diverse cultivars. Based on households explanations, the major reason for wide adoption of this variety that was released in 2003 is due to its high yield, good seed colour, large seed size, fast cooking, swelling ability on cooking, good taste, and attractive large fresh pods; all these attributes have made it highly marketable. Given the fact that NABE12C fresh pods and dry seeds have high demand and ready market, households are able to get income from this variety. On the other hand, the earlier (1999) released climbing bean varieties (NABE 7C, NABE8C, NABE9C, NABE10C) were high yielding and aimed at addressing the problem of bean root rot disease. Unfortunately, they were not adopted in these districts mainly because their seed type (mainly seed size) and culinary characteristics were not liked by farmers. According to Rausen et al. (2002), all the four climbing bean varieties were rated with moderate to low success rates in Kisoro and Kabale respectively. NABE7C (Vuninkingi) and NABE10C (Umubano) associated problems were low marketability due to small seeds and attack by birds; NABE8C (Ngwinurare) and NABE9C (Gisenyi) were susceptibility to vermin and birds. Surprisingly, NABE10C was adopted in Mbale, Sironko and Kapchorwa. Today, it is very clear that farmers do not only consider yield and resistance to biotic/abiotic factors if they are to adopt any new bean variety, but the seed type and culinary characteristics seem to be even more important than they were thought before. Musoni et al. (2005) stated that improved varieties that lack the desirable culinary (short cooking time, taste, broth colour, and flatulence) and market attributes (seed colour and size, shape and mass) are the least accepted and adopted by farmers and consumers. The assumption to the high rate of dropping different varieties could be because of the fact that households have not integrated the different practices into a whole-farm strategy that involves managing the crop profitably with respect to the environment, in ways that suit local soils, climatic and economic conditions. According to literature in order to enhance farm productivity, farmers need to have access and use bean production practices that combine seed of improved varieties as well as integrated soil fertility management and integrated pest and disease management (IPDM) technologies (Abanga et al., 2012). Other land races are also no longer grown because of lack of desirable attributes for productivity, susceptibility to biotic factors, poor cooking qualities and are not adaptable to local conditions. Similarly, Kimani et al. (2005) stated that urban market forces have caused farmers to specialize in a few varieties and many have been abandoned, although on average, farmers still grow four varieties in different proportions.

Households reported that the important cropping systems for climbing beans growing in Kisoro and Kabale districts include crop rotation with Irish potatoes, sweet potatoes, peas; intercropping with maize, sorghum or bananas, integrated livestock, agro-forestry (C*alliandra*, *Sesbania*, *Leucaena* and *Vernonia* spp.) and mono-cropping. Similarly, studies by Hüskens (2015) on climbing bean diffusion in Kapchorwa district indicated mainly intercropping with perennial crops like coffee, bananas, trees and annual/biennial crops like maize, Irish potatoes, yam, and cassava. Monocropping is also practiced. Other findings by Raphaël (2013) also reveal that in relation to the cropping systems, climbing beans are mainly cultivated in rotation with cereals (92%) in western Kenya. Musoni et al. (2005) reported that multiple cropping systems are the most common practice in Rwanda, where climbing beans are grown along with other crops. When climbing beans are grown in association with other crops, the other crop provides support for the climbing beans. Interviewed households knew the reasons as to why they were practicing each type of cropping system while growing climbing beans. The major reasons included controlling biotic factors, avoiding soil degradation, for food security, environment management, for improved crop production, inadequate land, and improvement of plant vigour and agronomic practices being easily practiced. Gabiri (2013) stated that growing climbing beans has an added advantage of soil and water conservation as an integrated watershed management practice to reduce on watershed degradation apart from being a food security crop. Raemekers et al. (2013) reported that the wealthy biomass of climbing beans can be used as fodder for animals or may provide soil cover, control weeds, and contribute to soil organic matter. According to KARI (2008) as cited by Raphaël (2013), climbing beans can produce up to 17 to 25 tons of leaves per hectare. Since it has elevated nitrogen fixation potential and with a high biomass production, climbing bean plays an important role in improvement of soil fertility. For inadequate land, households explained that some system such as intercropping allow to fully or profitably utilize the land. Studies conducted by Niringiye et al. (2005) revealed that the climbing bean/maize intercrop resulted into yield and economic advantages over pure stands of the component species during 1996 long and 1997 short rain seasons. However, according to their findings in order to maximize yields in a bean intercrop plant population should not exceed 25,000 maize and 67,000 bean planted ha^{-1} in seasons with ample rainfall. Lower plant densities, such as mixtures of 50% of the sole crop density of each species (that is, 22,222 maize and 55,556 bean plants ha^{-1}) may be used in seasons/areas with rainfall deficient. In addition, crop rotation also keeps the land busy and avoids animals trampling and compacting the soil.

Consequently, as reported by Ramaekers et al. (2011), climbing beans production has a potential for ecological integrity that creates a healthy agro-ecosystem. Musoni et al. (2005) stated that in Rwanda monoculture is practiced especially at higher altitudes (2000 to 2300 masl). In monoculture, climbing beans are planted with the support of wood or bamboo stakes or maize stalks, wires or strings (mostly in Africa) (Raemekers et al., 2013; Raphaël, 2013). Whereas in Andean region, trellising is a widespread system; it is an alternative that reduces the need for stakes, but requires an investment in wires and string for tying up bean vines (Sañudo et al. (1999) as cited by Ramaekers (2011).

From this study, it was still pointed out that lack of staking materials was the most important constraint in climbing bean production in Kisoro and Kabale. Previous studies by Wytze (2015) also reported stakes as being the most not easily available inputs for climbing bean cultivation in Chema in Kapchorwa district in Uganda. Similarly, Musoni et al. (2014) stated that shortage of staking wood is a major challenge limiting the wider adoption of climbing beans in Rwanda. Another related study by Raphaël (2013) stated that staking material is the most important climbing bean production constraint according to farmers in Western Kenya. In the Nyanza region of Kenya, Gichangi et al. (2012) also reported lack of stakes as well as sufficient knowledge on the best staking methods. Poor staking or none causes a yield loss of 50 to 90% (Musoni et al., 2014). This therefore calls for a more collective regional effort to address this challenge in order to identify alternative farmer-acceptable and environmentally friendly staking options. There is need to demonstrate some of the recent staking innovations reported by Musoni et al. (2014) in the climbing bean production systems in Kabale and Kisoro districts. Related to staking was labour scarcity arising from a number of cumbersome activities (such as carrying stakes to the field, sharpening, and staking) that are often involved. Labour shortage is the main reason that makes farmers stop growing climbing beans (94%) (Raphaël, 2013). However, it is assumed that with an increasing adoption of the crop and an increasing cultivation experience, farmers would be used to climbing beans, therefore become more efficient and the production would be less time-consuming (Raphaël, 2013). Other important constraints that needed to be addressed by research were the diseases and pest problems that seemed to be more important in Kisoro district. Unfortunately, the current study did not attempt to understand the specific type of diseases and insect pests which were of major importance. Social constraints including theft of stakes heaped after harvest for storage in the garden or at home and fires set to burn stakes by jealous people were observed. Others were weather related constraints mainly heavy rain which leads to rotting of stakes and strong winds that cause stakes to lodge. The study further revealed that farming households had devised different coping mechanisms. One of the most interesting coping mechanisms noted was recycling of stakes, where the same stakes are stored properly and can be used for more than two to three seasons. This was also reported in Rwanda that 88% of the farmers obtain stakes from their own farms having learned to grow fast maturing trees and as well recycle stakes efficiently (Sperling and Muyaneza, 1995). Social capital was another interesting strategy that was reported and is in terms of farmers forming groups. Social capital is important since it allows interaction among individuals of a given community and it empowers the individuals to achieve their goals. When they come together in a group for a collective action they share knowledge on better ways of producing and accessing good services, as well reduce on the work load as they would be working collectively. The family labour is believed to comprise of women, it becomes difficult to carry out timely activities at peak periods and men generally have a lot of leisure (gatherings for local brew). Even where men cooperate, some activities like planting, weeding, harvesting, threshing and winnowing are exclusively for women. Hence, with farmer groups, households pool resources together so as to promote climbing bean and sustain climbing bean productivity. Farmers who belong to farmer associations benefit from better access to inputs and information on improved production practices. In addition, new users learn from the other members in the social network, hence, generating significant technology spillovers and improving their allocative efficiency (Sibiko, 2012).

Overall, interviewed households in Kisoro and Kabale districts confirmed that farmers appreciate and are aware of the advantages of climbing beans over bush type. Some of their advantages compared to bush beans include suitability for areas with limited land, good for food security, possess good market attributes, and adaptable to local conditions. In terms of food security, among other attributes as previously discussed, it allows for peace meal harvesting (keep eating pods which developed early as pod loading continues). Earlier researchers reported that climbing beans maximize use of limited space (both horizontally and vertically), and the yield potential is reported to be of two to four times higher than the bush beans, and more tolerant to heavy rains and wet soils (Katungi et al., 2009; Ramaekers et al., 2013). Nevertheless, according to farming households, some of the major disadvantages of climbing beans seemed to be related to their agronomic characteristics which require them to be staked. Similarly, Gabiri (2013) stated that among the short comings of climbing beans, they require stakes for their potential growth and stakes availability is a challenge. Susceptibility to birds and rat damage was another demerit for climbing beans. They are more liked by birds as well as more affected by rats. Increased labour requirements for staking and bird scaring are some of the disadvantages of climbing beans

as perceived by farmers in the central high lands of Kenya (Ramaekers et al., 2013). However, the merits of climbing beans as explained could outweigh the problems. For example, the staggered development of climbing beans which allows utilization in different forms and at different times as previously discussed, attributes more than compensate, for the longer time climbing beans tend to take to attain full maturity. Supposing households got strong mature stakes, these could be recycled for some seasons, as well as giving special care for their maintenance, in addition to the high yields attained cost of production would reduce. Costs considered such as for cutting trees, splitting, sharpening, transportation from the forests and staking activities and frequent replacement of stakes due to breakages as a result of either heavy pod load and/or due to wind/heavy rain effect. In addition, the cumbersome activities (work load), are likely to reduce.

CONCLUSION AND RECOMMENDATIONS

This study highlighted the importance of climbing beans in Kisoro and Kabale districts. Climbing bean productivity in these districts is significantly influenced by the fact that it is a major crop for food, nearly eaten at all meals and also for income. Results further indicated that climbing beans play an important role in the cropping systems and has a sound ecological integrity for improved productivity. However, climbing bean production in the two districts is hampered by several constraints which to a larger extent are similar. For the good marketable attributes of climbing, households seemed to particularly imply the variety NABE12C which has those unique qualities and these have made it to be so far the best climbing bean variety for both home consumption and the market in the study area and in Uganda at large. This therefore suggests the need for more research efforts to develop and release more climbing bean varieties with superior or NABE 12C related attributes. Information generated from this study is therefore particularly useful to scientists and other development partners on the needed interventions in order to intensify climbing bean production in the districts and other parts of the country. This study therefore concludes that there is need for climbing beans agro ecosystem intensification so as to improve genetic diversity in climbing beans in the two districts for increased potential yield so as to minimize the risks of food insecurity as well as increase surplus for sale.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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