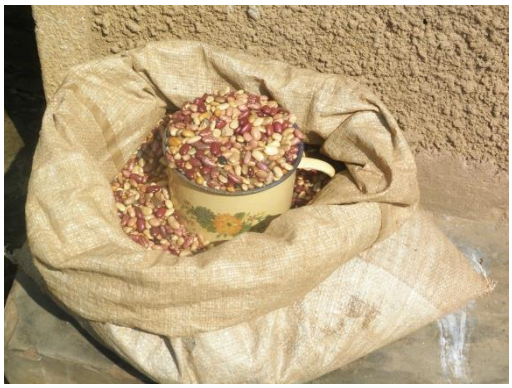
Farmers' practices and value chain of climbing bean production in South Western Uganda



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MSc Internship report (PPS-70424)
The N2Africa project in Kisoro, South Western Uganda
February 2014

Wageningen University

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Supervisor: Esther Ronner
Plant Production Sciences
Wageningen University, Wageningen, the Netherlands
In cooperation with Peter Ebanyat, Makerere University, Kampala, Uganda

Acknowledgements

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Acronyms

CB	=	Climbing beans
FFB	=	Farmer Field Book
Ush	=	Ugandan shillings (2461 Ush = 1 US Dollar)
Season A	=	The growing season from January/February to June
Season B	=	The growing season from August/September to December/January

Summary

From October 2013 till January 2014 we were in the South-West of Uganda for our internship to do research on climbing beans (CB). N2Africa is cooperating with smallholder farmers in Kisoro district to enhance the CB cultivation. The first aim of our research 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 and to map the relationships between these actors. To answer these research questions, interviews and field measurements were conducted, which led to the following findings.

N2Africa demonstrated treatments with fertilizer, manure and inoculants, which non-N2Africa farmers never apply to CB. Furthermore, N2Africa used a higher plant spacing than what is common in Kisoro, and planted the CB in rows, while non-N2Africa farmers broadcast or plant the seed randomly. N2Africa farmers were instructed to weed regularly, which most farmers did up to three times during the season, while non-N2Africa farmers usually only weed once. The majority of the farmers mentioned that stakes are a problem, since they are expensive due to their high demand. Unfortunately, the harvest data are not known yet. Due to a lot of rain in January the harvest was delayed. A cost and benefit analysis was made, which mainly focussed on the inputs for CB production.

To address the second objective, actors in the CB value chain were mapped in Figure 3. Furthermore, a SWOT analysis was made; the strengths of the CB are its high productivity, capacity to increase soil fertility, high market demand, and high nutritional value. Weaknesses are the price of staking material, labour intensive cultivation, CB sensitivity to heavy rains, marketing challenges, and challenges in the dissemination of knowledge. Opportunities include the introduction of different staking methods and materials and improved bean varieties. Furthermore, it is suggested to experiment with lower planting density and planting trees for stakes, and to improve erosion control. Other opportunities, related CB marketing, are improving the bargaining position of farmer groups, contracting supply and demand, niche specialisation and adding value to the product. Current threats are the low availability of staking material, declining soil fertility, pests and diseases, climate change and fragmented farm area.

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1. Introduction

N2Africa is an organisation that is involved in agricultural projects with smallholder farmers as the target group and is focused on enhancing Biological Nitrogen Fixation by growing legume crops. N2Africa is led by Wageningen University and is implemented and conducted in 13 countries in sub-Saharan Africa, including Uganda. The N2Africa project in Uganda is still in the initial phase. During our internship we were involved in the N2Africa project in Kisoro, in the South-Western highlands of Uganda.

General information of the region

Kisoro district is located in the South-West of Uganda and borders Rwanda and Congo. In Kisoro, the population consists of three different ethnic groups: Hutus, Tutsis and Batwa. The Batwa are the original inhabitants of the Kisoro district, the Hutus and Tutsis originate from Rwanda. Although the Batwa once were the only tribe living in Kisoro, nowadays only 5% of the Kisoro population are Batwa. The Batwa used to be hunters, but the area in which they can hunt has decreased tremendously due to the creation of national parks and the expansion of the area used for agriculture. The Batwa are said to be discriminated and not to be trusted by other people in Kisoro, as they are mainly unemployed and are engaged in criminal activities and begging to make a living.

The Hutus are mainly living in Kisoro town and comprise 85% of the Kisoro population; the Tutsis comprise 10% of the population and can be found deep in the villages, where they keep cattle. The Hutus moved to Uganda many years ago, but the Tutsis mainly came after the genocide in Rwanda. The Hutus and Tutsis are still seen as two different groups and can be distinguished easily as they look different, but unlike in Rwanda, the relationships between these ethnic groups are less influenced by the history of these tribes. The local language spoken in Kisoro and part of the Kabale district is Rufumbira, which is very similar to Kirwanda, the language spoken in Rwanda. (Source: conversations with local people).

Kisoro is located at an altitude of around 1800-1900m. The reliable rainfall (1368mm) and its bimodal distribution allows two cropping seasons a year (Kabeere and Wulff, 2008). The long rainy season is from March to May and the short rains are from September to December. The average temperature is 17.2°C with a minimum temperature of 11.3°C and a maximum of 23.2°C (Figure 1).

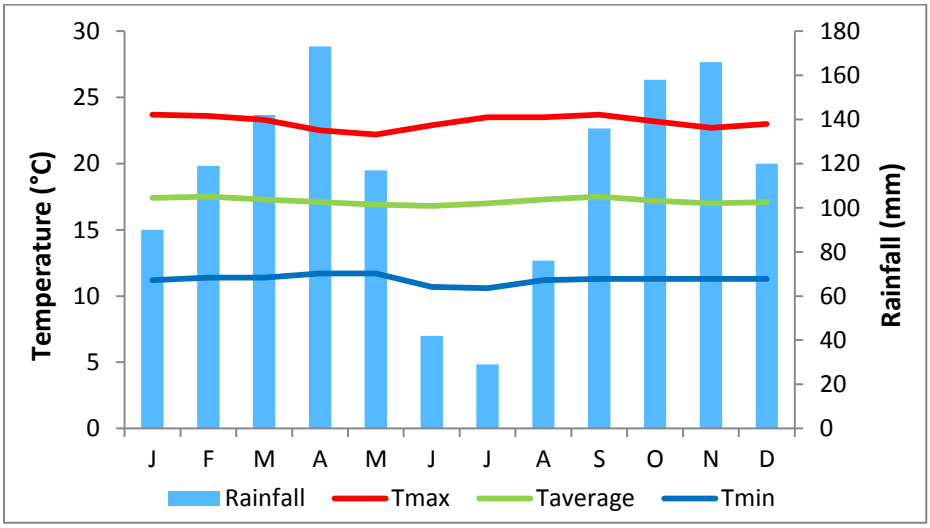

Figure 1: Temperature and rainfall data of Kisoro district. Source: Climate Data (2013)

Agriculture is the main economic activity in Kisoro. Small-scale farmers dominate the agricultural sector with an average farm size of 1.5 hectares. This system is characterised by rain fed agriculture, low inputs of agrochemicals and manual labour is most prevailing. A common practice is to feed crop residues to livestock. There are only a few large scale farmers, and they are mainly involved in growing cash crops with the use of agrochemicals and irrigation.

The Kisoro region has medium to highly productive volcanic soils, where mainly the following crops are grown: Irish potatoes, beans (bush and climbing), cabbages, bananas, maize, sorghum, and sweet potatoes. The agroecological zone in this region is the montane system, which reflects the higher altitudes (Kabeere and Wulff, 2008). Kisoro district is densely populated and agriculture is very intensive, leading to overexploitation of the land. This results in a decline in soil fertility and an increase in the area with soil erosion, especially at the hillsides. Yields are declining due to deterioration of soil fertility (Kabeere and Wulff, 2008).

Bean production in Uganda
Based on Ronner & Giller (2012)

Common beans (*Phaseolus vulgaris* L.) are part of the traditional Ugandan diet and are an important source of proteins. Beans are the most important grain legume in Uganda in terms of cultivated area, since more than 60% (925 000 ha) of the total area under grain legumes is used for the cultivation of beans. Climbing beans are mainly cultivated in high altitude regions and the western region in Uganda is the largest producer of beans (44% of total bean production). The beans can be cultivated twice a year when sown in February/March and August/September.

The average yields of the common bean (both bush and climbing) are 0.5 t/ha are far below the potential yield of 4 t/ha. The yields are affected by altitude, rainfall and soil pH. During the last decade, the area under bean cultivation has increased more than total production, indicating that yield gaps are actually increasing. Bean yields can increase considerably with application of fertilisers. For example, in study in Uganda, an increase of 0.77 t/ha was found when 15 kg N/ha was added and the addition of 15 kg P/ha increased the yield with another 0.15 t/ha (Kaizzi *et al.,* 2012). However, in general phosphorus is usually the most limiting nutrient in common bean production.

Bush beans are a fast growing crop, and can be harvested three months after sowing. Bush beans are cultivated on plots with an average size of 0.3 ha and are usually grown as intercrops (2/3 of the plots planted with beans) with maize, cassava, cotton, bananas and groundnuts. The bean yield is used for different purposes: one third of the harvest is sold, one third is consumed and one third is stored or used for other purposes (UBOS, 2010).

In Kisoro, the two types of cultivated common beans are climbing bean (higher altitudes) and short bean (lower altitudes). In Uganda, climbing beans are grown on 20% of the total area under common bean cultivation, in pure stands as well as intercropped with maize (CIAT, 2008). The advantages of climbing beans over bush beans are a higher production (three times higher than bush beans) and less infestation of diseases. Because climbing beans have a higher production than bush beans, more nutrients are removed from the soil when crop residues are removed from the field. Management of crop residues is therefore important to maintain nutrient balances.

When beans are intercropped with maize or bananas, the maize and banana stems can function as stakes. Other staking materials used are bamboo or eucalyptus. The stakes can be used individually or in tripods, the former used in deeper soils, the latter on hillsides. The advantages of tripods are that they can function as windbreaks and that the stronger stakes can compensate the weaker stakes. The downside of tripods is that they increase crop shading (Klapwijk, 2011).

Problems in bean production
Based on Paut (2013)

Paut (2013) has studied climbing bean production in Kenya. The constraints in bean production in Uganda are assumed to be comparable to these in Kenya. The most important problem in bean production is the lack of affordable staking material. The materials are either scarce or too expensive to make the production of climbing beans profitable. Another constraint is the labour requirement for the production of climbing beans, which is much higher than for bush beans. A constraint mentioned by farmers is the lack of knowledge; they do not know how to grow climbing beans. Furthermore, farmers in Kenya usually do not replace bush beans with climbing beans, but replace other crops such as vegetables, other legumes, potatoes or maize. Farmers with a larger farm area have more space to introduce new crops into their system and therefore tend to adopt climbing beans more than farmers with a smaller farm size. Finally, the farmers perceive a lack of good quality climbing bean seed varieties.

Bean value chain
As beans are an important crop in Ugandan agriculture, it is relevant to gain insights in the bean value chain, to see which factors can be improved in production, marketing and consumption of beans (Kilimo Trust, 2012). The value chain analysis includes both a functional as well as an economic analysis of the different components and interactions in the value chain. Kilimo Trust (2012) defined the following actors involved in the national bean value chain: input suppliers, producers, assemblers/middlemen, processers, traders and consumers. However, this chain can also be shorter, e.g. when producers sell directly to consumers.

The focus of this research is on producers and traders. Kilimo Trust (2012) has identified the main constraints and opportunities for the different actors in the national bean value chain. The most important constraints for the bean producers are unpredictable weather conditions, pests and diseases, limited access to improved seed varieties, high production costs and soil degradation. A high demand, two cropping seasons in a year and availability of supportive organisations are the main opportunities for farmers.

The assemblers/middlemen are the next step in the value chain. The main constraints identified by Kilimo Trust (2012), are the lack of trust in buyers by producers, price fluctuations, poor quality products and the supply of unsorted beans. The opportunities for middlemen are the high demand from Rwanda and governmental support by low trade fees.

2. Aim of the project

This internship has two aims. The first aim is to assess the farmers' practices of cultivating climbing beans in Kisoro and compare these practices between farmers who have had a training of the N2Africa project and farmers who did not.

The second aim of this internship is to identify the different actors in the climbing bean value chain specifically for Kisoro and to map the relationships between these actors. This value chain will be analysed with the SWOT model, to see what role N2Africa can play in improving the value chain.

The research questions to be answered through this research were:

1. Who are the different actors in the climbing bean value chain and how do they interact?
2. Which interactions can be improved and what role can N2Africa play in improving the value chain of climbing beans?
3. How do non-N2Africa farmers in South Western Uganda cultivate climbing beans with respect to inputs and agronomic management practices (staking methods, plant spacing and density, number of weeding activities, etc.)?
4. Which climbing bean practices are demonstrated to farmers participating in N2Africa in 2013B, and how do the demonstration plots differ from the non-N2Arica farmers' practices?
5. What are the costs and benefits of climbing bean cultivation for:
    a. N2Africa demonstration plots
    b. Non-N2Africa practices

3. Methodology

Area description

The farmers interviewed during this internship, live in the sub-counties Nyakabande, Mutolere and Busanza in Kisoro district. In addition, farmers in Bubare village, in Kabale district were interviewed (information can be found in Appendix II). Both Nyakabande and Mutolere are located 20min by boda from Kisoro town. Nyakabande is located at the paved road to Kabale, which makes this sub-county easily accessible. Mutolere can only be reached via very bad mud roads and is hard to access, although it is located much closer to Kisoro town than Nyakabande. In both Nyakabande and Mutolere, a lot of volcanic rocks can be found in the soils. In both areas, the farmers use these rocks to build walls around their fields. These villages are located in hilly areas and most of the hillsides are used for agriculture.

Busanza is located at 40min by boda from Kisoro town. It can only be reached via mud roads and is not accessible when it has rained. Busanza is called the food pot of Kisoro district, since many fruits, Irish potatoes and sugarcane are produced. This area has many swamps, small rivers and trees. Unlike Mutolere and Nyakabande, the hillsides are not cultivated. The location of the different areas we have visited during our research, are given in Figure 2.

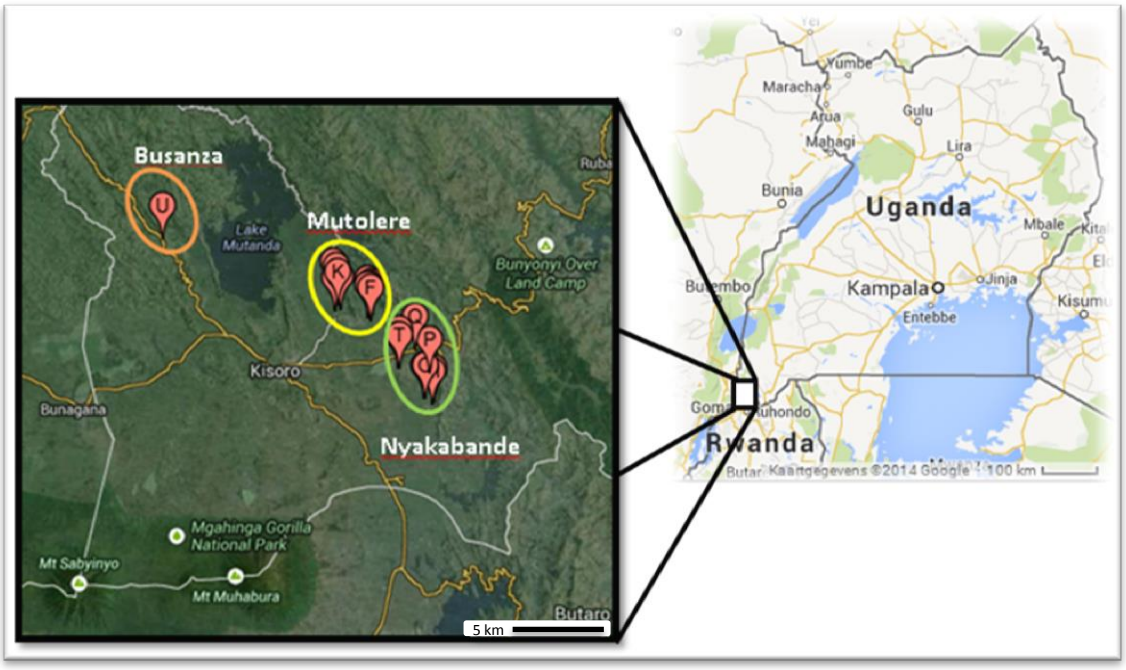

Figure 2: Kisoro district is located in the South-West of Uganda. Farmers in the sub-counties Busanza, Mutolere and Nyakabande were interviewed in this research.

N2Africa demonstration

The local partner of the N2Africa project is the organisation Africa 2000 Network, which works in both Kisoro and Kabale. In season 2013B, 27 farmers in the Kisoro district were involved in the N2Africa project: 18 farmers in Nyakabande and 9 farmers in Busanza. Each farmer had an on-farm trial, consisting of four 16m² demonstration plots. On two of the plots, a local variety was sown, whereas on the other two plots, an improved variety (NABE12C) was sown.

In the N2Africa project, five different input combinations were demonstrated: P fertiliser, inoculants, manure, P fertiliser + inoculants and P fertiliser + manure. Each demonstration trial included four

treatments: one of the five treatments was applied to two different varieties. On the two control plots, the two varieties were grown without inputs. The P fertiliser was applied as TSP at a rate of 15 kg P/ha and the cow manure at a rate of 2 t/ha. The inoculants were mixed with the seeds at a rate recommended by the manufacturer (Makerere University). Besides the seeds and free inputs for the treatment, the farmers received money to buy stakes. The farmers were instructed to weed regularly.

Data collection
During this internship, there were three data collection activities.

First, nine farmers with an N2Africa demonstration plot were selected in the village Nyakabande. The following input combination were applied to these plots: P fertiliser (two farmers), manure (three farmers), manure + inoculants (two farmers), P +inoculants (one farmer) and inoculants (one farmer). With these farmers, a farmer field book (FFB) was filled in during the cropping season. The FFBs contain general farm information, sheets on costs of inputs used and sheets on amounts of labour spent on the cultivation of climbing bean throughout the season. The farm activities can take place either on the field such as ploughing and weeding, or outside the field such as collecting manure, fetching stakes, etc. The farmers were visited regularly throughout the season to update these sheets.

To compare the input and labour requirements between farmers involved in the project and farmers outside the project, nine farmers without an N2Africa demonstration plot were selected (hereafter described as non-N2Africa farmers). The non-N2Africa farmers live in the Mutolere village and were also visited regularly to update the FFB.

Second, observations and measurements of how farmers cultivate climbing beans were done. These data were used to compare practices between N2Africa versus non-N2Africa farmers. The following aspects were measured or observed:

- Staking method
- Number of plants per stake, stake height, stake/plant density, etc.
- Outputs

Third, additional interviews with 14 famers from Kisoro district (6 from Nyakabande, 6 from Mutolere and 2 from Busanza), were conducted. These interviews served to gain more insights in the farmers' practices. The aim of these interviews was to obtain information on:

- How these farmers grow climbing beans
- What problems exist in growing climbing beans
- Where these farmers get their inputs
- Where these farmers sell their beans
- Etc.

These interviews also served to increase our understanding of the value chain of climbing beans. This was the starting point to make contact with the other stakeholders in the chain. We wanted to find out with which stakeholders the farmers interact and what the opportunities and constraints are for expanding the area under climbing bean. We wanted to deepen our understanding of those constraints and specify them by finding answers to the questions: who, what, where, when and how?

The insights gained through answering the first four research questions enabled us to develop recommendations for the N2Africa project on how to strengthen the production and value chain of climbing beans in Kisoro.

4. Results and Discussion

The results are divided in different parts. First, a general description of the farms and farm households is given. After that, the different actors involved in the CB value chain at the levels of inputs, production and outputs are mapped, followed by the farmers' practices of the N2Africa and non-N2Africa farmers. Furthermore, a cost and benefit analysis is made and the result section is concluded with a SWOT analysis of the climbing bean value chain.

4.1. General farm description

The households of the interviewed farmers consist of 6.7 members on average (see Table 1), with 53% of the members between 16 and 60 years old, 42% below 16 years old and 5% above 60 years old. Eleven out of 18 farmers have some livestock; three farmers have a pig, five farmers have goats and three farmers have sheep. Four farmers have one or two cows and one farmer has five cows. Chickens were not counted as livestock.

The fields are usually scattered and farmers have 5.5 fields on average, ranging from three to eleven fields. The total area of farm land ranges between 1 and 3.2 ha, with an average of 1.1 ha; one farmer who has 8 ha is excluded from this average. Due to the high population density, cultivation is intensified. Farmers would like to buy more land, but this is expensive. Some farmers sell land and have different reasons for selling. Some migrate to Kabale or Kampala, others have problems and need money directly. Some farmers sell land because they need to pay school fees for their children. Sometimes, people sell unfertile pieces of land and buy land that is more fertile.

Table 1: General farm information for N2Africa and non-N2Africa farmers.

		Household size (people)	Tropical Livestock Unit	Number of fields	Total farm area (ha)
N2Africa	Average	6.8	0.5	5.6	1.0
	Range	2 - 16	0 – 1.7	3 - 10	0.4 – 2.0
Non-N2Africa	Average	6.7	0.7	5.4	1.2
	Range	3 - 13	0 – 3.5	3 - 11	0.8 – 3.2

All farmers said they hire people to work on their land. Only three N2Africa farmers work on other people's land. A surprising fact is that for both N2Africa and Non-N2Africa farmers most work is done by hired labour and not by themselves. For the N2Africa farmers 57% and for Non-N2Africa 56% of the hours spent on practices related to CB cultivation was done by hired labour. For certain farm activities, such as first and second ploughing and weeding, labour is hired. For example, a farmer needs to plough his land and hires two workers to work with him the whole day. Sowing and placing stakes is mainly done by the farmers themselves. This topic will be elaborated in paragraph 4.3.

Several farmers mentioned that they have other sources of income besides farming, for example trade, working as hired labour, selling clothes or working in town. Usually the women take care of the garden, while the men work off-farm to generate extra income.

Most farmers in Kisoro district have been growing climbing beans their whole life, just like their parents. The way of growing climbing beans has not changed, except for the fact that they grow different varieties. Before the climbing bean was introduced, people were growing bush beans. Now, people prefer to grow climbing beans as the yield is much higher than bush beans. Bush beans are still cultivated, but only when farmers do not have enough stakes. During our field visits some farmers showed us their field with bush beans.

4.2. Value chain analysis

In Figure 3, the different actors involved in the climbing bean value chain at the level of inputs, production and outputs are mapped. The relations between the different actors are represented with arrows and the pictograms indicate which in- or output flows from one actor to another. Although chemical fertilisers and inoculants were applied on the N2Africa fields, these inputs are not included in the value chain map, since they are not used by farmers outside the project.

After mapping the value chain, the different actors involved in the input supply are described, followed by the actors to which the beans are sold. Both in and output actors are described from a farmers' perspective. After that, the interviews with post-production actors are described. This chapter is ended with some general remarks about the CB value chain in Kisoro.

4.2.1. Inputs

Seeds
For planting, all farmers use the seeds from the harvest of a previous season. Other sources of seeds are NGOs (e.g. Africa 2000 Network), governmental organisations (e.g. NAADS or NARO), the local market and neighbours. The governmental organisations introduce new varieties, which they promote by, for example, the radio. One farmer said that NARO gave her a small amount of seeds (1 or 2 kg), which she had to return after harvest. The farmers can keep the remainder of the harvest to expand the area grown with this variety.

When farmers go the market to buy beans for consumption, they occasionally find a good looking, tasteful variety. Sometimes they decide to plant this variety and when the production is good, they start cultivating this variety. The farmers sometimes buy seeds from their neighbours when they see that the beans grow well.

Stakes
A large majority of the farmers buys the stakes from 'the car'. This car is coming from Rubanda (Kabale district, close to Kisoro district) and sells stakes in bundles of 100 stakes. The bundles consist of eucalyptus only or are a mixture of eucalyptus with cinchona, bricot or bamboo. Most bundles are a mixture of eucalyptus and cinchona; mixtures with bamboo and bricot are less common. The car moves around in Kisoro at planting time and stops in the villages (both Nyakabande and Mutolere) to sell stakes. Usually the price of one bundle of stakes is 10,000 Ush (100 Ush/stake), but this price increases to 12,000 when the demand is high (shortly after planting). Some farmers also buy stakes from their neighbours or relatives. These stakes are sometimes cheaper than stakes from the car and for the farmers who buy from neighbours, it saves time for transporting the stakes.

Besides buying stakes, farmers use stakes from previous seasons. After harvest, the stakes are bundled and placed in the storage; this storage can be a building like a house or a shed, but it can also be on the field or under a tree. Most farmers store the stakes outside as they do not have a shed or space in their house. The stakes can be used for 2 to 4 seasons (1 to 2 years), but some farmers reported to use their stakes for 6 seasons (3 years), depending on the staking material, soil characteristics, rainfall and storage place.

All farmers mentioned that stakes are a problem. The demand is high and the availability is low, leading to expensive stakes. Growing trees is an option for some farmers, although land is limited and cutting stakes from trees is very labour intensive, since the stakes need to be cut and split. Also, one end of the stakes needs to be sharpened so that they can be placed in the soil easily, which is labour intensive work.

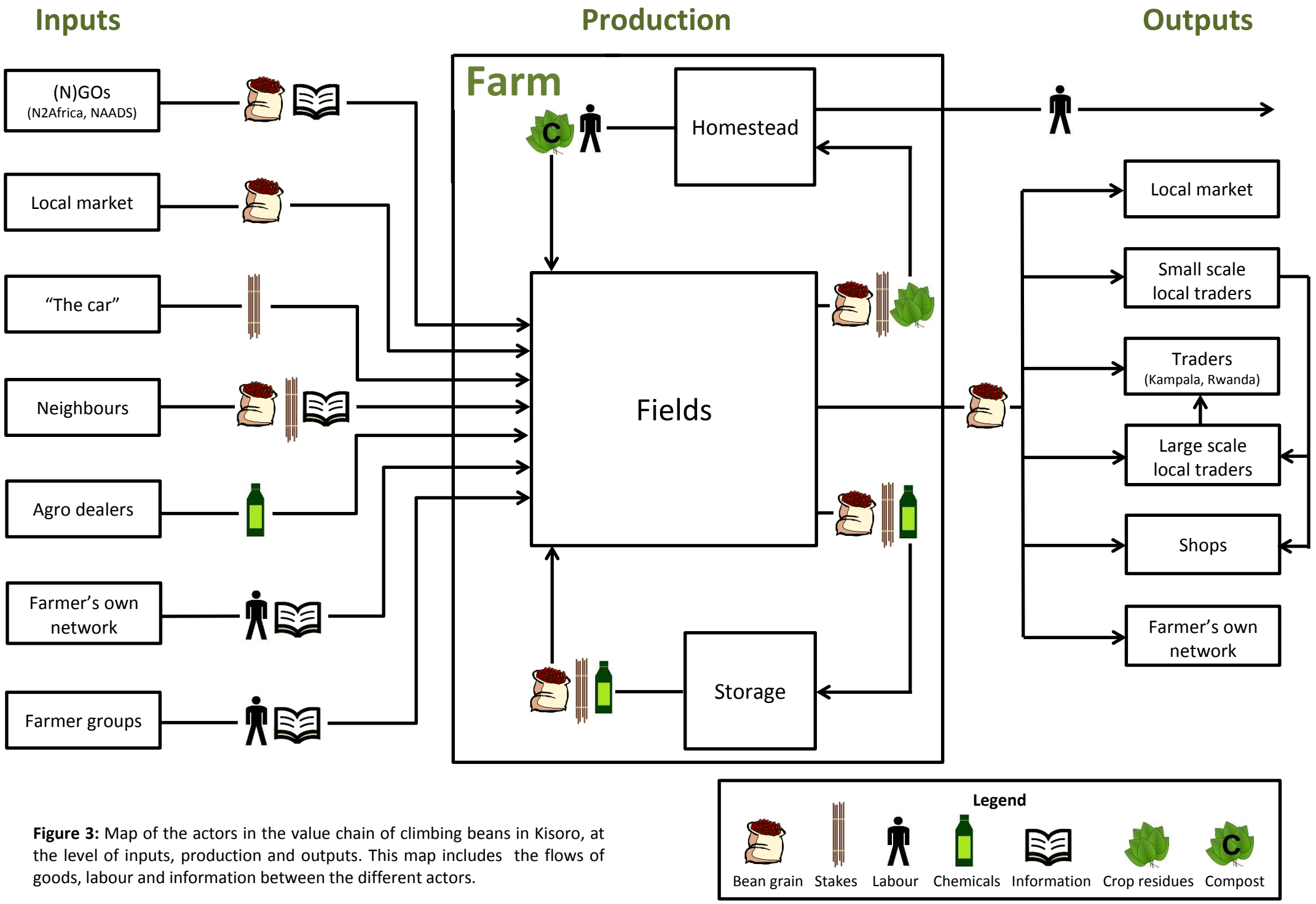

Figure 3: Map of the actors in the value chain of climbing beans in Kisoro, at the level of inputs, production and outputs. This map includes the flows of goods, labour and information between the different actors.

Labour
For 12 out of 18 farmers, the main source of labour for the CB cultivation is not the own household (farmer, partner and children), but hired labour. Seven farmers (3 N2Africa, 4 non-N2Africa) hire more than 75% of the labour input and six farmers (3 N2Africa, 3 non-N2Africa) hire less than 50% of the labour input. One non-N2Africa farmer has enough financial means to hire all the labour needed for CB cultivation, others hire labour only when they do not have enough time to work themselves. The farmers who hire labour, find the workers within their own network; one farmer mentioned that she always hires relatives. Some farmers work together with people from their farmer group and work on field of other group members. Labour is always manual; animal traction is not used.

Manure
Manure was applied on the CB fields of five N2Africa farmers, however, this is not a common practice in Kisoro as people have few animals and rather apply the manure to other crops (e.g. Irish potatoes). The manure was bought for 500Ush/kg at a local market in Kabale, since in Kisoro cattle manure is not available. Eight of nine non-N2Africa farmers used compost on the CB field during this growing season. The home waste of farm households is usually composted and applied to crops. Some farmers compost home waste together with crop residues and/or manure. Others incorporate the crop residues into the soil at the first ploughing and do not compost it off-field.

Biochemicals
The prices of chemicals range between 2000 and 4000 Ush for a bottle of Malathion, Dithene, Chlorine or Rocket, which can be used for one or two seasons, depending on the amount of bean plants or grains that need to be treated. Ambush costs 15,000 Ush for a bottle that can be used for four years. Most farmers think the prices of the chemicals are not expensive. The chemicals are bought in Kisoro town (agro shops or the big market) or in local shops in the villages.

Information
Farmers obtain information from different sources. Information on alternative cultivation methods and new beans varieties are usually obtained from governmental organisations or NGOs, which work with local organisations or inform farmers via the radio. Farmers can go to organised trainings, but the organisations also go into the village or spread information by going to the local markets.

Information of bean prices on the market usually spread through 'village talk'. Some farmers ask neighbours what the price is or call somebody they know from their own network or farmer group. Besides information on market prices, farmers obtain information about prices and locations of inputs, production and outputs from their neighbours, own network or farmer group. Information inputs are usually free. Sometimes farmers even receive money when they go to meetings organised by NGOs, otherwise they are not willing to attend.

4.2.2. Outputs

The amount of harvest sold, kept for planting next season and used for home consumption depends on the yield, which depends on farm size and other factors such as rainfall, pests and diseases, soil fertility, etc. The amount of beans kept for planting next season and for consumption is usually the same each season. For the farmers interviewed, on average 50-100 kg is used for home consumption and 50-100 kg is kept for planting. The remainder, varying between 100-500 kg, is sold.

Farmers can sell their beans to a variety of buyers, which offer different prices. These prices depend on different factors, such as the supply. For example, one trader said that when the harvest is good, she buys beans for 2000 Ush/kg, but if the harvest is bad, she buys beans for 2500 Ush/kg. Besides

this, the bean price depends on the time in the season, the quality of the mixture and the buyer which the beans are sold to. The different buyers pay prices ranging between 1000 and 2500 Ush/kg.

Some buyers (e.g. traders or hotels) buy quantities of at least 20 kg at once, while other buyers (e.g. people on the market or neighbours) buy quantities of less than 10 kg. If a farmer wants to sell large quantities, it saves a lot of time to sell to a trader, since going to the market is very time consuming. However, the price a trader is willing to pay might be much lower than the price in the market and the time spent on sitting at the market also has a price. The decision to which person to sell, is made based on the time and money they have. This means that the farmers usually do not know in advance to whom they are going to sell and that they might sell to different person(s) as the season before. Also the price that a farmer gets can differ a lot between different seasons.

The time between harvest and selling depends on the financial situation of the farmer; when money is needed, farmers sell (a part of) their beans directly after harvest for a relatively low price (1000-1400 Ush/kg). If financially possible, farmers sell one or two months after harvest when the price is high (starting from 1500 Ush/kg, up to 3000 Ush/kg, depending on the variety sold).

Some farmers indicated that they usually sell their beans at the big market in Kisoro or a small market in their village. The disadvantages they mention for selling in markets, is the tax they need to pay, which is 3000 Ush for one sack (100 kg) of beans on the big market and 500 Ush (irrespective of the quantity sold) at the small market in Kisoro.

Other disadvantages are the distance the farmers need to walk to the market (between 15 and 40 minutes) and the time they lose by sitting in the market all day. Most farmers obtain information about the bean price on the market from neighbours or people in their network and sell when the prices are high. This is usually one or two months after harvest. Some farmers bring a sack of beans to the market and sell it in one day, these farmers usually transport the beans by boda. The majority of the farmers bring smaller amounts (20-50 kg) to the market, which they transport on their head.

The price of beans at the market depends on the quality of the beans and the time in the season. All farmers grow different varieties in one field and do not sort the beans after harvest. Sugar beans are the only variety that is never grown and sold as a mixture. The price of the mixture depends on the size and sweetness of the beans. Smaller beans are cheaper than large beans, but the sweetness of the bean is the most important price determinant. The price of mixed varieties varies between 1500-2500 Ush/kg when the demand is high, whereas the price of sugar beans varies between 2300-2800 Ush/kg on the market. When the women go to the market to sell their beans, they agree on a minimum price with the other women and base the price of their beans on the quality of the mixture.

The farmers in the Mutolere area mentioned that sometimes a local trader on boda visits the village after harvest. These traders buy quantities of at least 20kg and sell to shops, hotels, boarding schools or governmental institutions. The farmers like to sell to these traders as it saves time and usually the prices are good. These traders do not announce in advance that they are coming and do not work with contracts, although one farmer mentioned that she has a phone number of a trader, who she calls when she wants to sell her beans.

A few farmers in Nyakabande indicated that somebody visits them around harvest time, who is announcing that within a short time period, a car will be in the area. The person gives information on the price that farmers will get and when the car will arrive. If the farmers are satisfied with this price, they sell their beans to this car, otherwise they will try to find another place to sell their harvest. These cars are coming from Kampala or Rwanda and do not work with contracts. Farmers like to sell to these cars, because they can sell their harvest at once, which saves a lot of time.

Some farmers (both in Mutolere and Nyakabande) mentioned that they try to sell their beans to hotels or shops. They usually inquire which price they get and decide whether to sell at the market or to the shop or hotel. Other people that buy the beans, are neighbours (who buy for both consumption and planting), family members living in big cities like Kampala and individuals who come to the farmers' homestead to buy beans for home consumption.

4.2.3. Post-production actors

Besides interviewing farmers, other actors of the CB value chain were interviewed as well. These actors include shops, traders, women on the market and a restaurant.

Shops
Four different shop owners in Kisoro were interviewed about the climbing beans they sold. In all shops, other products besides climbing beans are sold (e.g. vegetables, cooking materials, etc.) The shops buy the beans at the big market in Kisoro or from a trader and add 300-500 Ush/kg. The prices of the mixtures in the shops range between 2500 and 3500 Ush/kg. Two shops do not know and care about the varieties they buy and sell, the other two shops sell sugar beans separately from a mixture of big, sweet, red beans. One shop sells sugar beans for the same price as the red beans (3500 Ush/kg), the other shop sells sugar beans for 2700 Ush/kg and red beans for 2500 Ush/kg.

One shop owner does not treat the beans, because she buys 110kg, which is sold within three weeks. Another shop owner uses Malathion against bruchid beetles, because it takes three months before all his beans (500kg) are sold. This man buys from small scale local traders without contracts and said that he would like to buy beans from farmers directly for a cheaper price. He is open to get in touch with farmers, but he does not want to go to the village to find them, since he is retired and does not have the energy. If the farmers can deliver the beans at his shop, he is willing to pay a good price.

Traders
One small and one large scale local trader from Kisoro and three large scale local traders from Nyakabande were interviewed about the buying and selling of beans. The small scale local trader buys small quantities of beans and sells them locally, whereas large local traders buy large quantities and sell them outside Kisoro district. All traders have other jobs besides selling beans. Two traders are farmers, the other three traders also process and sell sorghum.

Besides selling to individual customers, schools, orphanages, etc., all four large scale local traders sell beans to traders from Kampala, Kabale or Rwanda. These traders buy the climbing beans for 1000 Ush/kg and add 20, 50 or 200 Ush/kg on the price. The local traders buy between 3000 and 5000kg from small scale local traders or from farmers directly. Usually the farmers bring the beans to the traders, but three traders also go into the villages to collect the beans. Only one large scale local trader has contracts with the farmers and the traders from Kampala.

The traders buy mixtures of many different bean varieties, all for 1000 Ush/kg. These beans can be either small or big, sweet or unsweet, good or bad quality after cooking, etc. Most traders mention sweetness as the most important quality of the beans, followed by size and cooking characteristics (cooking time and suitability of making a good soup). Sugar beans are never sold in a mixture, because the price is much higher than for other varieties. One trader buys sugar beans for 2500 Ush/kg and sells for 3000 Ush/kg, another traders buys for 2000 Ush/kg and sells for 2020 Ush/kg.

The local traders do not have problems with storage and none of them treats the beans against bruchid beetles. The local traders try to sell the beans as quickly as possible (sometimes within one week after buying) and therefore do not spend money on preserving the beans.

Restaurant
The owner of a restaurant in Kisoro was interviewed. Every week, she buys 5kg of beans on the big market in Kisoro, regardless of what price they have. She goes to the big market, because then she can choose between different mixtures. She prefers to buy sugar beans or Mwizarahenda, since the customers like sweet beans.

4.2.4. General remarks

This chapter contains some general remarks on the CB value chain in Kisoro.

Variety preferences
Two traders, one shop and one restaurant mentioned that Mwizarahenda is a good quality variety. Mwizarahenda is grown by three out of nine N2Africa farmers, two out of nine non-N2Africa farmers and one out of two farmers from Busanza. The traders, shop owner, restaurant and farmers like Mwizarahenda, because it is big, sweet and produces well. In addition, one farmer says that the rats do not like Mwizarahenda. Africea is another good quality variety; one shop owner and one trader like to buy and sell this variety. The trader says that this is a variety which is introduced recently.

One shop owner does not like to sell Mwigondore; the customers don't like this variety, because it is not sweet. Mwigondore is grown by one N2Africa farmer and one non-N2Africa farmer. The N2Africa farmer says that the rats like Mwigondore, therefore she grows this variety mixed with Mwizarahenda. Although the shop owner says that Mwigondore is not sweet, the N2Africa farmer states that she likes this variety, because of the sweetness.

Trust
During the interviews we conducted and the conversations we had with neighbours, our translator, friends and other people we met in Kisoro and Kabale, we got an impression of how the Rufumbira culture works. One of the things we noticed, is the large distrust within the Rufumbira community. Some farmers were very suspicious when we visited them for the first time and were afraid that we would steal information, money or their harvest. For example, the question 'Do you know how other people store their beans?' was answered with 'No, you do not show your harvest to others, because they might steal it'. Another farmer said she had to defend herself after our visit, because the people in her village thought we either paid her a lot of money, which she would have to share within her community, or thought that we were going to steal information from them.

Furthermore, the people in this community have a very money-focused mentality, both towards outsiders (either Ugandan or foreign), but also towards people from the own community. We have heard several stories of local people inviting white or rich Rufumbira people in the expectancy that they would get money. A farmer who organises meetings for farmers told us that people participate in activities or projects if they receive money, free inputs or other goods and do not attend a second meeting if they do not receive anything after the first meeting. According to another farmer, people should be paid when attending a meeting. We got the impression that the farmers underestimate the value of information and are not eager to invest time in a project without short term benefits.

We noticed that several farmers involved in the N2Africa project did not feel responsible for the N2Africa plots in their gardens and expected the project to do weeding and provide chemicals for spraying the beans. Although expecting project workers to do the work and cover all the costs for cultivation is one of consequences of the 'What do I get' mentality, raising the right expectations by clear communication could have partly prevented the initial reluctance to invest time and money in the N2Africa project. As it can be hard and takes time to win the trust of the Rufumbira people, good communication about the purpose of meetings is necessary to motivate them to invest time and be involved in a project.

4.3. Farmers' practices

In this chapter, the farmers' practices for CB cultivation in Kisoro for the N2Africa farmers and non-N2Africa farmers will be described, such as the cultivation activities, seed varieties and stake materials used, etc. Finally, some major challenges related to the farmer practices will be explained, including pest and diseases, soil fertility and climate.

4.3.1. Cultivation

All interviewed farmers plough two times before planting the beans. With the first ploughing they incorporate the crop residues into the soil. With the second ploughing, most farmers make beds to improve the water run-off. The majority of the farmers apply home compost to the field before the first ploughing, whereas a few farmers apply compost between first and second ploughing. N2Africa demonstrated manure application, which is not a common practice in Kisoro, since most farmers have few animals and rather apply the manure on Irish potatoes than CB.

After second ploughing, the field is ready for sowing. A few farmers broadcast the seeds randomly, while others plant beans by making holes in the soil with one hand and placing seeds with the other hand. A farmer said that broadcasting is mainly done when the soil contains many stones, as making holes in such a soil is hard. Another farmer said that she broadcasts the seeds when time is limited. All farmers plant one seed per hole and for local beans they use a plant spacing of 10 x 10cm (ranging from 4 x 4 to 15 x 15cm) on average. For more information on plant spacing see Appendix I. Several farmers say that this high sowing density reduces the number of weeds. If this statement is true, less weeding is required compared to the N2Africa practice. Three farmers mentioned that for sugar beans, the plant spacing should be larger than for local beans. The reason for using different spacing is that sugar beans have bigger leaves and grow taller than local beans. As a consequence, sugar beans need more space to produce well. However, some farmers use the same spacing for all types of beans. Often different varieties are grown mixed, but the sugar beans are always grown separately, because of their high value.

Two or three weeks after sowing the stakes are placed for about 30cm into the soil. All interviewed farmers use the single stake method, while we observed that some other farmers in the region also use tripods. Before placing the stakes, the ends are sharpened so the stakes can be pushed into the soil easily. Thick stakes can be split or halved. Several farmers mentioned that fetching and preparing stakes is time consuming. The stake density is on average 2.9 stakes per m², ranging between 1.3 and 6 stakes per m² (see Table 2). One field has only 1.3 stakes per m^2, this can be explained by the way beds are made. The distance between beds is as big as the bed width, whereas for most farmers the bed width is twice as big as the distance between beds. Furthermore, the variation of stake length is high as it ranges from 0.90 m to 3.06 m, with an average of 1.94 m. One farmer said she uses her tallest stakes for her sugar beans, because they grow taller than local beans. Several farmers indicated that for a good yield, the stake length should be at least 1.80 to 2.10m.

Table 2: Results of field measurements done on the N2Africa fields and fields outside the N2Africa project.

		Stake length (m)	Stake density (stakes/m2)	Nr of plants per stake	Plant density (plants/m2)
Non-N2Africa farmers	Average	2.03	2.4	8.0	19
	Range	0.90 – 2.80	1.9 - 3.3	3 - 18	11.5 - 24.6
N2Africa farmers (project fields)	Average	1.99	3.1	2.4	7
	Range	1.10 – 3.06	1.3 - 5.5	1 - 6	4.9 - 12.0
N2Africa farmers (own fields)	Average	1.74	3.1	6.5	20
	Range	1.07 – 2.64	1.4 - 5.7	1 - 24	11.8 - 52.0

When most bean plants have developed flowers, the majority of the non-N2Africa farmers start weeding. While the majority of the non-N2Africa farmers weed only once a season, the N2Africa farmers weeded the demonstration plots up to three times, because the project workers told them to weed regularly. However, on their own climbing bean fields, they only weed once a season. According to most farmers, weeding one time a season is sufficient, because the weeds are suppressed due to soil cover by the beans, which is a result of the high planting density.

Some farmers pick the young green leaves, which they eat as a vegetable, but not all bean varieties produce tasty leaves. Furthermore, it is common to harvest some green pods every now and then. A few weeks before the harvest, the beans plants turn brown and the beans are left to dry on the plants. Farmers said that this season the harvest is delayed, because there is more rain than usual; it takes more time for the beans to dry. Around four to five months after sowing, the dry beans can be harvested. Some farmers pick the pods by hands, while others uproot the whole plant, then remove the plants from the stake and beat the plants with a stick to separate the grains from the pods. One farmer who prefers to pick the pods, said that this method is less tiresome than uprooting the plants with the stakes, but it requires more labour. The advantage of picking beans, is that the crop residues remain on the field and do not have to be carried to the house, which can very labour intensive work if the field is far from the house.

Sometimes pods are picked while they are not dry enough yet, then the farmers place the pods on a mat and dry them in the sun for one day. After that, the pods are beaten with a stick to separate the grains. Beating one sack of pods can be done in less than 20 min. One farmer said that the pods of sugar beans are harder to break than local beans, so then she needs to beat harder.

The bean grains are dried for one or two days on a mat in the sun. To test if the beans are completely dry, farmers listen to the sound the beans make when shaking them. Beans which are not used for direct consumption, are always treated against bruchid beetles with preservative chemicals. The beans are put in sacks and stored in a room in the house. Only one N2Africa farmer does not store the beans in his house, as he has a store. We visited the store and it is very similar to other houses, with a concrete floor and a corrugated roof. This farmer is probably richer than other farmers, since he usually has a harvest of five to seven sacks, which is far above the average. When the beans are stored, first stones and wood are placed on the floor, and then the sack with beans is placed on top. The farmers say that the stones protect the wood against ants. If the beans would be stored on the ground, the cold coming from the floor would cause the beans to decay.

4.3.2. Cultivation calendar

Table 3 shows the farmer practices during the season for both the N2Africa farmers and the non-N2Africa farmers. The N2Africa farmers did not apply any compost, while this was done by most non-N2Africa farmers. The N2Africa fields received fertilizer and manure treatments and N2Africa farmers were told not to apply anything else. The N2Africa farmers were instructed to prepare their land, before the team of N2Africa came to sow the beans and apply treatments with fertilizer, manure and inoculants. The N2Africa team came in the beginning and middle of September and visited all the N2Africa plots. Two non-N2Africa farmers sowed their CB at bit earlier, at the end of August. This might explain the reason why a few non-N2Africa farmers harvested earlier.

Furthermore, both N2Africa farmers and non-N2Africa farmers fetched and placed stakes in September and October. A difference between the N2Africa farmers and the non-N2Africa farmers is the frequency of weeding. N2Africa instructed farmers to weed regularly, while the common practice is to weed only once or twice. Spraying insecticide is not so common as it is only done by one N2Africa farmer and three non-N2Africa farmers.

Table 3: Cultivation calendar throughout season B in 2013/2014 comparing the timing of the farmers' practices between N2Africa farmers and Non-N2Africa farmers.

N2Africa farmers	Number of farmers	July End	Aug Early	Aug Mid	Aug Late	Sep Early	Sep Mid	Sep Late	Oct Early	Oct Mid	Oct Late	Nov Early	Nov Mid	Nov Late	Dec Early	Dec Mid	Dec Late	Jan Early	Jan Mid	Jan Late	Feb Early	Feb Mid
Applying compost	0																					
First ploughing	9		9																			
Second ploughing	9			2		7																
Sowing + treatment	9					7	2															
Fetching stakes	9*						3	2	1													
Placing stakes	9						3	2	3		1											
First weeding	9							2	6		1											
Second weeding	8									1		6					1					
Third weeding	6														2	3	1					
Spraying insecticide	3**								1		1		1		1							
Harvesting	9																		?	?	?	?

Non-N2Africa farmers	Number of farmers	July End	Aug Early	Aug Mid	Aug Late	Sep Early	Sep Mid	Sep Late	Oct Early	Oct Mid	Oct Late	Nov Early	Nov Mid	Nov Late	Dec Early	Dec Mid	Dec Late	Jan Early	Jan Mid	Jan Late	Feb Early	Feb Mid
Applying compost	8***	2	2	1	1																	
First ploughing	9		3	3	2	1																
Second ploughing	9				2	6	1															
Sowing	9				2	5		2														
Fetching stakes	9****					?	?	1	3													
Placing stakes	9					1	1	3	3	1												
First weeding	9									1	2	2	2			2						
Second weeding	3														1	2						
Third weeding	0																					
Spraying insecticide	1									1												
Harvesting	9																2	1	?	?	?	?

* For three farmers it is unknown when they fetched stakes

** Two farmers sprayed once in Oct, while one farmer sprayed twice in Nov and Dec

*** For two farmers the timing of applying compost is unknown

**** For five farmers the timing of fetching stakes is unknown

4.3.3. Seeds

Farmers grow many different bean varieties, with various colours: pink, white, red, yellow, black, purple, green, and black and white. The beans have different characteristics; cooking time, size, taste, swelling characteristics during cooking and some varieties make a better soup than others. Furthermore, some bean varieties are more susceptible to rain than others. Table 4 gives an impression of some common varieties grown by farmers in Kisoro district. All farmers like to cultivate bean varieties that are high yielding. Some farmers find it important that the beans taste sweetly.

The varieties cultivated these days are different from the varieties 20 years ago, as several varieties disappeared or are not so common anymore. Several farmers said that the main reason for replacing the old varieties with new ones is because the varieties currently used have higher yields and taste sweeter than old varieties.

Farmers save seed after the harvest for planting in the next season. However, farmers are told that seeds cannot be planted directly after harvest, but have to be stored for several months before they can be used for planting. Besides using seed from their own harvest, farmers sometimes try new varieties by buying some seeds from neighbours or from the market. At the market local varieties are sold, but also exotic varieties from Rwanda or Congo.

Table 4: CB varieties commonly grown in Kisoro district.

Local name	Colour	Characteristics
Gikoti	Black and white	
Gisubizo	Pink	Doesn't fear rain, sweet
Kanyamaza	Red	Hard
Mushali		Sweet
Mwigondori	Red	Not sweet
Mwiras	Pink	
Mwizarahenda	Red/pink	Sweet, hard
Nyiragicoat	White and black	Sweet
Nyiramucala	Black	
Nyiramwirasi	Creamy white	
Nyragasarayi	Red	Hard
Omwiza Aligula	Red	Hard
Sugar beans	Mainly white, with black, purple or green	Sweet, soft, expands more during cooking than red beans

4.3.4. Stakes

Most of the interviewed N2Africa farmers buy stakes from the car, neighbours or relatives. Two N2Africa farmers buy eucalyptus stakes in their villages (Bubaga and Garambe). The Non-N2Africa farmers mainly use eucalyptus and cinchona, while a few Non-N2Africa farmers also use bamboo, elephant grass and 'imishishi'. One farmer mentioned that she knows farmers who use 'bricot' (black water). It is hard wood which lasts long, but it is not easy to get.

Most of the Non-N2Africa farmers grow trees or bushes for staking material. The trees and bushes are either grown on the edges of the field or on hill tops. If needed, farmers buy additional stakes from the car. Only one N2Africa farmer grows a few eucalyptus trees, but they do not produce enough stakes for all his fields. It takes 1.5 year before the first stakes can be cut from a eucalyptus

tree and every year three to four stakes can be cut. One N2Africa farmer is planning to grow trees like calliandra, eucalyptus and cinchona in the future. The reason why many N2Africa farmers do not grow trees is still unclear, for the total farm area that farmers own is more or less the same (Table 1). However, the smallest and the largest farm of the non-N2Africa farmers are bigger compared with the N2Africa farmers. The fact that the farmers live in two different subcounties might play a role. Several N2Africa farmers said that due to shortage of land, they do not grow trees. Also, one N2Africa farmer said she does not grow trees as she usually hires the same piece of land for two to four seasons only.

Farmers indicated that cinchona, bamboo and eucalyptus stakes last for three to six seasons. The trees are often multipurpose, for example the bamboo stakes are also used to support banana trees and for creating ceilings in the house. People like to use bamboo in their houses, because it shines and has a light colour, while cinchona becomes black after a while.

After harvest the stakes are collected, bound together in bundles and placed upside down, so the part that was in the soil, can dry. The bundles are usually stored either next to the house, under a tree or next to a fence or hedge. If the fields are far from the home, the farmer leaves the stakes uncovered in bundles in the garden.

When the stakes are removed from the soil, the rotten part is removed. This means that the stakes are becoming shorter over time and are too short for growing CB after a few seasons. Besides this, every season a part of the stakes breaks. When the stakes cannot be used for CB cultivation anymore, they are used as firewood.

4.3.5. Pests and diseases

Most farmers mentioned that they have problems with rats in their bean fields. The rats eat or cut the roots of the bean plants, causing the plant to die. One farmer said she only has problems with rats in Season B (Aug to Jan), as rats only come when it rains a lot. Rats prefer certain bean varieties, for example, one farmer said that the rats like her red beans, but not her sugar beans. The rats eat the soft green pods of the red beans and do not like the harder pods of the white beans. For this reason, she grows white and red beans mixed in Season B, while in Season A (Jan to Jun), she grows them separately.

Other farmers also indicated that they grow different varieties mixed to reduce the amounts of rats coming. Other common measures which are said to help against rats are spraying with Ambush (insecticide), Dithane (fungicide) and Malathion (insecticide), placing traps, weeding and removing bushes around the field, so that the rats lose their hiding place. Some farmers mentioned that they are financially constrained to buy chemicals.

Other challenges in climbing bean cultivation are birds and moles. The birds like to eat the bean flowers; this prevents the formation of pods, which can cause severe yield losses. Some farmers say that birds like the flowers of all varieties, while according to other farmers, birds only like certain varieties. For example, birds eat the flowers of grey and sugar beans, while they do not like red bean flowers.

To scare the birds, farmers have developed different methods: they use scarecrows or place sticks with black, shiny tapes which are moved by the wind. However, the birds get used to these objects after a while. Sometimes the children are asked to chase the birds by throwing stones. Spraying against birds is less common; one farmer sprays Malathion against birds, and another sprays Rocket

(fungicide and insecticide). A few farmers mentioned that they have moles in their gardens. Moles can damage the roots of the bean plant severely, causing it to wilt and die. Moles are caught in traps, which are usually placed by experts.

Some farmers mentioned that the leaves of the beans turn yellow when it rains too much. It starts with older leaves of a few plants and eventually all plants in the field will be yellow. A few farmers use Dithane to prevent the whole field turning yellow, indicating that the plants are probably affected by fungi after heavy rains.

Besides the pests and diseases treatments in the field, farmers also do post-harvest treatments. All interviewed farmers use agrochemicals for the preservation of beans after harvest. Malathion is commonly used and one farmer also uses chlorine (fungicide and insecticide). If the beans are not treated well after harvest, bruchid beetles will make small holes in the beans (Figure 4). If the beans have small holes, they cannot be used for planting as they fail to germinate. The beans can still be consumed, but the holes will decrease the value.

Figure 4: Beans attacked by bruchid beetles

4.3.6. Climate

Farmers said that due to climate change, it is raining more often (almost daily) than e.g. 20 years ago. The rains are less predictable, but are also less intensive than before. According to several farmers, Season A is more suitable to grow climbing beans than Season B, as there is less rainfall.

Most farmers mentioned that in this season (Season B, 2013) there is more rain than usual, which affects the yield negatively. Heavy rainfall or hail can be extremely harmful when the bean seedlings just emerged and can cause great yield losses. Besides this, rain causes weeds to grow faster.

Most farmers say that bush beans are more susceptible to rain than CB, as they can be covered with mud after a heavy rain shower. They argue that CB do not drown, as they are much taller than bush beans. Furthermore, a few farmers mentioned that sugar beans are more susceptible to rain than the local varieties. Some CB varieties, like Gisubizo, are well adapted to grow under wet conditions.

4.3.7. Soil fertility

Several farmers mentioned that they see a decline in soil fertility over the years, while some farmers say the soil fertility is the same as before. Before, farmers left some fields fallow to regain soil fertility, but now farmers consider this impossible, as land is scarce.

Only a few farmers use chemical fertilizers like NPK and DAP, which is usually only applied to the Irish potatoes, and never to CB. As the crops are rotated, other crops can also benefit indirectly from the fertilizer. Compost is applied to the fields close by home; it is made from home waste and crop residues. Some farmers have animals and therefore they can apply manure on the fields. However, according to the farmers the amount of compost and manure is not sufficient to maintain soil fertility on all fields.

4.4. Cost and benefit analysis

In this chapter, the input costs for cultivating 100m² of land with climbing beans for the N2Africa demonstration fields and the non-N2Africa farmers are calculated. The given values in Table 5 are averages of the nine N2Africa and nine non-N2Africa farmers. The amounts and costs of the inputs are not specified for each of the five treatments applied to the N2Africa demonstration fields. For inputs which are not paid for, the opportunity costs are used. This chapter also contains detailed information on the labour inputs for each activity in CB production.

Seeds
The input costs for seed are calculated by multiplying the amount of planted beans with the price of one kg. After counting two mixtures of beans, we have calculated that one kg contains around 2900 medium to large sized beans. The N2Africa farmers received 160 seeds of a local variety (2700 Ush/kg) and 160 beans of NABE 12C (3000 Ush/kg), bringing the costs to 313 Ush per farmer. For the non-N2Africa farmers, a price of 1500 Ush/kg is assumed, which is based on the information given by the farmers. As Table 5 shows, the costs for seeds are almost six times higher for the non-N2Africa farmers than for the N2Africa, due to a much higher planting density.

Stakes
Six of the nine non-N2Africa farmers produce their own stakes, so the opportunity costs are used to compare this input with the N2Africa farmers. These costs are calculated by multiplying the amount of stakes used with the price of a stake when bought from the car (100 Ush/stake). Table 5 shows that the input costs for stakes are higher for the N2Africa farmers (32,488 Ush/100m²) than for the non-N2Africa farmers (24,322 Ush/100m²). This difference is caused by the fact that the N2Africa farmers have a higher stake density than the non-N2Africa farmers.

Labour
The N2Africa farmers spend more labour on each cultivation activity than the non-N2Africa farmers (Table 6). These differences can be attributed to the field size of the N2Africa fields, which is 72m² on average (average field size of the non-N2Africa farmers is 955m²). Collecting labour data for small field sizes can easily lead to inaccurate numbers and is biased by small scale inefficiencies. For three of the non-N2Africa farmers, the field size is expected to be larger (for another non-N2Africa farmer smaller) than the estimation based on field measurements, since the seed, stake and manure inputs seem to be too much for the area. This means that the labour inputs of the non-N2Africa farmers are probably less than shown in Table 6.

Due to the inaccurate labour data of the N2Africa fields, it is hard to compare this data with the non-N2Africa farmers. However, what the results do show, is that both the N2Africa and the non-N2Africa farmers use the same amount of hired labour (57% and 56% respectively; Table not given).

The input costs of labour are calculated by multiplying the total amount of hours spent on cultivating a field of 100m², by the costs of one hour of hired labour. The N2Africa farmers paid 1281 Ush/h for hired labour, the non-N2Africa farmers 670 Ush/h. The costs of hired labour for the N2Africa farmers are also influenced by the small field sizes, since the labour data are inaccurate. Also, upscaling usually leads to more efficient use of inputs, which means that the higher amount of labour spend by the N2Africa farmers can partly be explained by inefficiencies in small-scale farming.

The labour costs for cultivating 100m² of climbing beans are calculated to be 77,046 Ush for the N2Africa farmers and 21,078 Ush for the non-N2Africa farmers (Table 5). Note: the labour data for the harvest and post-harvest activities are not included.

Table 5: Input amounts and costs of climbing bean cultivation in Kisoro (Aug '13 - Jan '14) for a field of 100m². When opportunity costs are calculated, only the average value is given. Costs are in Ush.

Per area of 100m²		Seeds		Stakes		Labour		Fertiliser		Manure*		Inoculants		Biochem.	Total	BEP**
		Kg	Costs	Amt	Costs	Hours	Costs	Kg	Costs	Kg	Costs	Packet	Costs	Costs	Costs	Kg
N2Africa	Average	0.16	**465**	313	**32,488**	**60**	**77,046**	**0.09**	**353**	**9**	**4,513**	**0.14**	**274**	**1,982**	**117,121**	**78**
	MIN	0.11	326	125	10,286	31	-	0	0	0	0	0	0	0	-	-
	MAX	0.24	688	547	54,749	100	-	0.36	1420	22	11,209	0.45	907	5,495	-	-
Non-N2Africa	Average	1.79	**2,685**	228	**24,322**	**31**	**21,078**	**0**	**0**	**77**	**0**	**0**	**0**	**30**	**48,114**	**32**
	MIN	0.26	-	160	-	11	-	0	0	0	0	0	0	0	-	-
	MAX	3.65	-	333	-	52	-	0	0	267	0	0	0	267	-	-

*On the N2Africa plots, manure was applied; the non-N2Africa farmers use compost.
**BEP = break-even point

Table 6: Labour inputs of the climbing bean cultivation in Kisoro (Aug '13 – Jan '14) for a field of 100m². 'Own' and 'Hired' indicate whether the activity is done by people from the own household (children below 16y are counted as 0.5 adult) or by hired labour. Own and Hired labour are both in hours, the costs are the money spend on hired labour and are expressed in Ush.

Per area of 100m²	N2Africa			Non-N2Africa			N2Africa	Non-N2Africa
Activity	Own	Hired	Costs	Own	Hired	Costs	Own+Hired	Own+Hired
1st ploughing	4.2	5.1	5723	3.1	4.2	2500	9.3	7.2
2nd ploughing	3.5	5.6	6462	1.6	4.9	3215	9.2	6.6
Fertiliser application*	0.0	6.1	7854	3.3	0.3	199	6.1	3.6
Sowing	0.0	6.7	8570	2.6	1.4	985	6.7	4.0
Fetching + placing stakes	6.2	3.5	5570	2.6	1.6	1068	9.6	4.2
1st weeding	3.7	4.4	5455	1.7	2.6	2007	8.1	4.3
2nd weeding	2.8	2.3	3236	1.0	0.0	26	5.1	1.1
3rd weeding	4.0	0.3	593	0.0	0.0	0.0	4.3	0.0
Biochemicals	0.6	0.0	0	0.0	0.0	74	0.6	0.0
Other	1.2	0.0	0	0.5	0.0	53	1.2	0.5
Total	**25.0**	**33.9**	**43,463**	**16.3**	**15.1**	**10,126**	**60.1**	**31.4**
Costs hired labour (Ush/hour)			**1281**			**670**		

*Fertiliser is either chemical fertiliser or manure for the N2Africa farmers and compost for the non-N2Africa farmers.

Chemical fertiliser
In Kisoro, chemical fertilisers are only used for Irish potatoes and it is not common to apply it to climbing beans. As a result, the amounts and costs of P fertiliser for the non-N2Africa are zero. For the N2Africa demonstration fields of three farmers, P fertiliser is applied as TSP at a rate of 15 kg P/ha on two plots. The average costs for this input are 353 Ush/100m².

TSP has a price of 4000 Ush/kg and the costs for applying P fertiliser at a rate of 15 kg/ha (57.7 kg TSP) are 230,769 Ush per hectare. In Uganda, a yield increase of 0.15 t/ha was observed when 15 kg P/ha was applied (Kaizzi *et al.,* 2012). If the application of TSP is profitable, depends on the price of the beans, which should be at least 1539 Ush/kg to cover the costs of the chemical fertilisers.

Manure
In this growing season, manure was applied on the fields of five N2Africa farmers at a rate of 5.1 kg per plot. The average amount of manure applied to 100m² by the N2Africa farmers, is 9 kg (Table 5). The non-N2Africa farmers do not use manure, but applied 77 kg of compost for fertilising 100m² of beans. The amounts of crop residues that are incorporated into the soil during first ploughing are unknown. The data on compost can be found under manure in Table 5.

An important difference between using home compost and manure for fertilising, is the costs: farmers need to buy manure (4,513 Ush/100m²), whereas compost is a free source of fertiliser. However, the amount of organic waste that can be produced by a household is limited; this needs to be taken into account when input costs are calculated for larger areas of CB cultivation.

Inoculants
None of the non-N2Africa farmers had ever heard of inoculants. At the demonstration fields of four of the N2Africa farmers, inoculated seeds were planted at two plots. The average costs of inoculants for N2Africa farmers are 274 Ush/100m².

Biochemicals
Four N2Africa and one non-N2Africa farmer have used biochemicals during the season: Rocket, Dithane and rat poison (N2Africa) and Ambush (non-N2Africa). The average amounts of money spend on biochemicals are 1,982 Ush/100m² (N2Africa) and 30 Ush/100m² (non-N2Africa). It is not clear why the N2Africa farmers spend more money on biochemicals; perhaps they felt obligated to maintain the project field very well. This is also seen in the weeding practices: some N2Africa farmers weeded the project field three times, although they weed their own bean fields only once in a season.

Total input costs
When the total costs of the inputs are calculated, N2Africa farmers spend 117,121 Ush on the cultivation of 100m², compared to 48,114 Ush for the non-N2Africa farmers. The fact that, according to these calculations, N2Africa farmers spend much more money on cultivating CB than non-N2Africa farmers, has different reasons. The main difference in costs is caused by the labour inputs; N2Africa farmers almost spend four times as much time on 100m² than the non-N2Africa farmers. This difference in labour inputs is probably caused by inaccurate labour data for small field sizes and cost and time inefficiency of small scale farming. Besides this, the stake density is higher for the N2Africa demonstration fields than for the non-N2Africa fields. Also, the treatments (fertiliser, animal manure, inoculants) of the N2Africa fields bring extra costs, which non-N2Africa farmers do not have.

Outputs & Break-even point
Unfortunately the harvest data are missing. The costs cannot be compared to the benefits of climbing bean cultivation, but the break-even point can be calculated. Assuming that the beans can be sold for 1500 Ush/kg, CB production should be at least 78 kg/100m² for the N2Africa farmers and 32 kg/100m² for the non-N2Africca farmers to cover the production costs.

4.5. SWOT analysis of production

In this chapter, the results of the SWOT analysis of the climbing bean value chain in Kisoro is presented. The aim of the SWOT analysis is *"to generate strategic alternatives for the current situation by identifying Strengths, Weaknesses, Opportunities and Threats"* (Kilimo Trust, 2012). The focus of this SWOT analysis is on the level of input supply, production and marketing from a farmers' perspective. The SWOT analysis is summarized in Table 7.

4.5.1. Strengths

Productivity
CB yields are up to five times higher than short beans. CB can be grown two or sometimes even three times in a year, which is beneficial for farmers who need money regularly (e.g. sweet potatoes can be harvested only once a year). Also, CB can be harvested as fresh beans or dry beans, providing the option to harvest multiple times throughout the season in case money or food is needed. In addition, some farmers reported to eat the young leaves of the bean plants, which are seen as a tasteful ingredient.

Soil fertility
CB can be cultivated for many years on the same field without requiring nitrogen fertilisation and has the ability to improve the nitrogen balance. In general, farmers say that they do not have problems with build-up of pests and diseases in the soil when CB is cultivated year after year (unlike Irish potatoes). One farmer has grown CB for 9 years on the same piece of land without applying any manure. His yields are very good and he does not see a decrease in the yield.

Nutrition
Beans have a high nutritional value and are an important and affordable source of proteins for most Ugandan people.

Demand
The demand for beans is high, both local and (inter)national: trucks from Rwanda and Kampala come to Kisoro to collect the beans. In many Ugandan households, beans are consumed several times a week. CB are sweeter than bush beans and therefore have a higher demand and revenues.

The beans can be sold to different actors. The bean prices on the markets in Kisoro town are usually good, ranging between 1500-2500 Ush/kg, depending on time in the season and the quality of the mixture. Sugar beans are sold for 2300-2800 Ush/kg on the market. Another advantage of selling beans on the big market in Kisoro, is the large amount of buyers; some farmers said that they can easily sell one sack of beans (±100kg) in one day.

Shop keepers are willing to pay a good price for high quality beans. These prices are sometimes even higher than on the market; one shop keeper buys sweet beans for 3000 Ush/kg. Because of the high demand, traders buy any quantity the farmers wants to sell, which saves a lot of time otherwise spend on transporting and selling the beans. Although the traders have a preference for big and sweet beans, they usually buy any kind of mixture.

4.5.2. Weaknesses

Staking material
In contrast to other crops, CB cultivation requires staking material, which is very expensive (e.g. for an area of 100m², N2Africa farmers spent 32,488Ush on stakes, compared to 47,913Ush for labour). The staking materials commonly used (eucalyptus and cinchona) can be used for 2- 4 (in some cases 6) seasons only and have to be replaced regularly. The stakes are often shorter than farmers desire, because tall stakes are scarce. Although six out of nine farmers from Mutolere cut stakes from their own trees, most farmers in Nyakabande do not have enough land to grow trees for staking material.

Labour
In general, farmers mention that growing CB is more labour intensive than cultivating other crops, because of fetching and placing stakes. The high costs of stakes and labour strongly reduce the profitability of this crop; some farmers mentioned that cultivation CB is not profitable, others said it is and a few farmers do not know whether it is profitable.

Climate
Heavy rains in the first two to three weeks after planting (before the plants start climbing), can cause large yield losses. The plants do not recover completely after the heavy rains and produce poorly.

Marketing challenges
Some farmers mentioned that selling beans on the market costs a lot of time, as they spend one day on walking and sitting on the market, while they sell small quantities (20-50kg). When the farmers want to sell larger quantities, they have to transport the beans by boda, which costs money. Also, for selling produce on the market, a tax needs to be paid. This is 3000 Ush for one sack (±100kg) of beans on the big market in Kisoro and 500 Ush at the small market (irrespective of quantity sold).

The disadvantage of selling the beans to shops or hotels, is that the owners do not buy large quantities, as they do not like to store a lot of food (space is limited and the beans decay when stored too long). The traders usually give around 1000 Ush for a kilo of beans, which is very low compared to the price on the market.

Dissemination of knowledge
Most farmers cultivate CB in the same way as their parents and have never experimented with different staking methods, different stake and plant densities, manure application, etcetera, growing different varieties being the only exception. Within the Kisoro community there is a lot of distrust and suspicion and as a result, farmers hardly share information with others. Besides, farmers participate in projects or go to trainings if they receive money or free inputs and often lose interest when they don't. It seems that these farmers do not value knowledge. As a result, the way of cultivating CB in this region has hardly changed in the past 30 years and dissemination of new technologies can be challenging.

4.5.3. Opportunities

A. Opportunities for farmers

Planting trees
To reduce the costs of stakes, the farmers could plant trees; especially nitrogen fixing trees such as Calliandra, Grevellia, Sesbania, Arnas, etc. are suitable to obtain staking material, since they increase soil fertility on the long term. Some farmers mentioned that they do not have enough land to grow trees and the trees cannot be grown alongside the edges of the fields or next to the house, because

of the root system of the trees. The roots destroy their houses or compete with their crops for light, water and nutrients. More research has to be done to find fast-growing tree species that are most suitable for this area.

Planning cultivation
When cultivation activities are planned, the costs of CB production could be reduced. Especially the costs of stakes could be reduced by buying them while the demand and therefore price is low (one month before planting). Farmers know in advance when they need the stakes, but usually buy after the beans have been planted. In addition, the farmers from Busanza mentioned that they sow their bean fields at the same date as the beans in the adjacent fields are sown. The beans in these fields will flower at the same time, reducing the amount of flowers eaten by the birds in each field.

Erosion control
One of the problems with heavy rains is waterlogging and erosion, leading to a loss of soil fertility and yields. These problems mainly occur in the hilly areas, but are underestimated by the farmers. Erosion can be controlled with measures such as placing stone walls, planting grass strips, planting trees and no grazing of animals in the gardens. A few farmers already take measures to prevent erosion and education could increase the group of farmers that are aware of the consequences of soil erosion and could teach them what measures they can take to conserve soil fertility.

Farmer groups
There are large differences in the price farmers get for their beans, depending on time in the season and bargaining position. Directly after harvest, the prices are low, but increase one or two months after harvest. Some farmers need money and sell directly after harvest for a relatively low price (1000-1400 Ush/kg). Collecting yields with a farmer group improves the bargaining position and could increase the price farmers get (up to 2500 Ush/kg). These groups could also provide a small interest-free loan to farmers who need money to bridge the time between harvesting and selling, so the beans can be sold collectively one or two months after harvest for a higher price.

The existing farmer groups could be used to improve bargaining power. When this idea was discussed on the farmer field day, the farmers liked this opportunity to increase their revenues. They noted that one of the problems of collective selling is to find a market for selling bigger quantities. Although traders buy large quantities, they usually offer a low price (100 Ush/kg). N2Africa could do market research to find out which buyers are interested in buying large quantities (schools, national traders, companies, etc.) and what the opportunities are to link farmer groups to these buyers. Also, solutions have to be found for problems such as transport and preservation of the beans.

Contracting supply and demand
None of the farmers has a contract with shops or traders, which gives freedom to sell the beans to the highest bidder, but is also less secure than when supplying under a contract. Kilimo Trust (2012) found that 93% of the Ugandan bean traders do not work with contracts, but acknowledge the advantages of it (e.g. constant supply and regulation of supplier's behaviour). Kilimo Trust (2012) states that the average price for suppliers is 1700 Ush/kg under contract, compared to 1625 Ush/kg without a contract. One of the reasons that traders do not like to engage in contracts is the poor (wet and unsorted) quality of supplied beans.

A few shop owners would like to buy beans from farmers directly instead of buying from the market or traders, as this usually has financial benefits. Existing farmer groups could be the starting point of establishing contract-based relations between suppliers and traders or shops. Linking the farmers or farmer groups to traders could be facilitated by local organisations such as Africa 2000 Network, but could also be initiated by farmers through networking. Contracting supply could improve the revenues of farmers, shops and traders and the supply of beans could be regulated to some extent.

B. R&D opportunities

Staking materials and methods
Exploring different staking materials (e.g. PVC), different staking methods (e.g. strings) and methods to treat stakes against rotting could help to lower the input costs of the staking material for CB cultivation. In addition, storing the stakes inside or covered can increase the durability of the stakes. Furthermore, farmers from Kabale stated that using tripods instead of single stakes could reduce costs, because weaker stakes are compensated by stronger stakes. Also, planting in tripods reduces labour requirements for harvesting, because the plants of three stakes can be uprooted at once. The labour and input costs of different staking methods and materials could be either higher or lower than for the current practices, so trials are needed to determine the most cost efficient staking method and material.

Planting density
One non-N2Africa farmer mentioned that she increased the spacing distance between two seeds from ¾ foot (23cm) to one foot (30cm), whereas other farmers say to space 10cm. This spacing density of one foot was also reported by a farmer from Kabale. They both claimed that the yields are higher than when planted with a smaller spacing distance, while it requires less seeds and less labour inputs for weeding. Different planting densities could increase net production (i.e. the yield minus the seeds used to obtain this yield) and could reduce labour requirements. Future research trials could be used to model CB yields as a function of plant density to find the planting density with the highest climbing bean yields.

Plant breeding
A lot of the farmers mentioned the negative effect of heavy rains on CB yields, although some varieties are less affected than others. Most farmers indicated that they would like to grow a variety which is less affected by rain and also produces well. Plant breeding of improved varieties that can grow well with heavy rains could improve yields considerably.

Niche specialisation
Farmers, shop keepers, traders and a restaurant owner mentioned that they like large beans with a very sweet taste, such as Mwizarahenda or sugar beans. Since sugar beans are always sold separately from other beans, this variety has its own market and price. Other bean characteristics that consumers like, are the ability to make a good soup and the size after cooking (some varieties shrink, whereas other expand). As different consumers desire different characteristics, there are a lot of opportunities for niche specialisation.

In order to specialise, information is needed on what characteristics consumers prefer. This requires market research and meetings with multiple stakeholders (e.g. plant breeders, farmers, traders) to regulate the production and marketing of certain bean varieties.

Adding value
None of the interviewed farmers indicated that they process their beans. Processing the beans to (e.g.) bean flower, adds value to the product and can increase the income of farmers. Farmer groups have more money than individual farmers and are able to do investments for buying the materials needed to process the beans. The processed product could be sold locally or to traders from elsewhere. Market research is needed to specify which processed bean products are demanded by consumers and what is already available. After that, the right varieties and production and processing techniques can be determined. When this research is completed, organisations such as Africa 2000 Network could be the starting point to bring farmers together and to organise training on how to grow and process the beans.

4.5.4. Threats

Staking material availability
The availability of locally produced staking material is very low. On average, the stakes can be used for about 2 to 4 seasons and as a consequence, have to be replaced regularly. Many trees in the surrounding of Kisoro are cut for multiple uses, causing erosion and a loss of soil fertility on the hillsides. As a result, farmers will become more dependent on stakes from other regions in the future. Staking material is expected to become more expensive, as farmers are increasing the area under CB cultivation. This will make the cultivation of CB more costly.

Soil fertility
The population density in Kisoro is high, which has led to unaffordable land prices for most people, intensification of cultivation and decreasing soil fertility. Most farmers see their yields declining and need to apply manure or compost to compensate for the loss of soil fertility. Most households cannot produce enough compost to fertilise all the fields and manure is hardly available, as most farmers do not have a lot of animals; buying manure from elsewhere (e.g. Kabale) is very costly.

Pests and diseases
During the growing season, all farmers face problems with moles, rats and birds, which cause considerable yield losses. Trapping moles is usually done by experts and is expensive (1000 Ush/mole). Farmers have to buy traps or poison to kill the rats and birds are usually chased by making scarecrows or throwing stones, both requiring labour. Post-harvest, the beans are mainly destroyed by bruchid beetles, which can only be prevented by treating the beans with chemicals.

Climate change
A few years ago, the rains were very predictable according to most farmers. In the last years, rainfall has become more irregular: in some seasons it rains too much, in others it is too dry. In both ways, yields are negatively affected and it is hard for the farmers to anticipate on the amount of rainfall during the season. In addition, with a lot of rain throughout the season, more weeding is needed and fungal diseases spread easily.

Fragmented farm area
Most farmers have a lot of small fields, which are scattered in and around the village they live in. Farmers lose a lot of time by walking from one field to another. Manure or compost is not applied to fields far from the house, which can cause soil fertility problems on the long term.

Table 7: Summary of the SWOT analysis of the climbing bean value chain

Strengths	Weaknesses	Opportunities	Threats
Productivity	Staking material is expensive	Different staking methods and materials	Low availability of staking material
Increases soil fertility	Labour intensive cultivation	Different planting density	Declining soil fertility
High demand	Sensitive to heavy rains	Planning cultivation	Pests and diseases
High nutritional value	Marketing challenges	Planting trees	Climate change
	Challenges in dissemination of knowledge	Plant breeding to increase tolerance to rain	Fragmented farm area
		Erosion control to conserve soil fertility	
		Increase bargaining position by farmer groups	
		Contracting supply and demand	
		Niche specialisation	
		Adding value to the product	

5. Conclusions and Recommendations

5.1. Value chain

Research Question 1: Who are the different actors in the climbing bean value chain and how do they interact?

Research Question 2: Which interactions can be improved and what role can N2Africa play in improving the value chain of climbing beans?

The different actors in the climbing bean value chain at the level of inputs, production and outputs are given in Figure 3. In general, farmers obtain their inputs from different sources and sell their beans to a variety of buyers. The interactions between the different actors are highly informal, as most of the interviewed farmers, traders, etc. work without contracts or oral agreements.

Due to the informal relations between the actors, the CB market (prices, quality, demand) is not very transparent. Regulating the flow of beans within the value chain could benefit many actors, as farm incomes can be secured and quality standards can be developed. The existing farmer groups could be the starting point for regulating the bean flows. The N2Africa project and its local partner could provide trainings for farmers, focussed on networking, investments, quality standards, etc. and facilitate meetings between farmers/farmer groups and other actors (traders, shops, restaurants).

Many farmers indicated that they would like to grow a variety that produces well and is less vulnerable to heavy rains than the varieties they grow now. Plant breeding can play an important role in improving and stabilising yields. Further research is needed to assess the different varieties that are currently used, their performances and what varieties have the desired characteristics. This information can be used by plant breeders to create new bean varieties. The N2Africa project could conduct the research, function as a bridge between farmers and plant breeders and facilitate the implementation of new varieties.

Niche specialisation and processing beans are two areas which have a lot of potential to increase the revenues from CB cultivation. The N2Africa project could play a role in doing market research, to see what bean characteristics are preferred by consumers and which varieties meet these requirements. In addition, the N2Africa project could provide trainings for farmer groups on how to process beans, varieties that are suitable for processing, marketing strategies, investment costs etc.

5.2. Farmers' practices

Research Question 3: How do non-N2Africa farmers in South Western Uganda cultivate climbing beans with respect to inputs and agronomic management practices?

Farmers in Kisoro have been cultivating climbing beans for several decades. They plough the fields twice to prepare the land for sowing. The common practice is not to apply fertilizers, manure or inoculants to the CB, but only home compost. Non-N2Africa farmers have to some extent access to fertilizers and manure as they use it for crops such as Irish potatoes. Sowing is done either by broadcasting or by planting seeds randomly with one seed per hole, both methods have a high sowing density. Farmers usually use seeds of a previous harvest for planting, although sometimes they buy new seeds from the market or from neighbours. Stakes are either bought from a car coming from the direction of Kabale or grown by the farmers themselves. The non-N2Africa farmers in Mutolere grow trees for stakes, while most of the N2Africa farmers in Nyakabande have to buy all their stakes, this is probably caused by the fact that these farmers are from different subcounties.

For staking material mainly eucalyptus and cinchona are used. After the harvest, stakes are stored outside in bundles, uncovered and upside down, because they can be used on average for three to four seasons. Both the N2Africa and non-N2Africa farmers mentioned that stakes are a problem as they are expensive.

Furthermore, the common practice is to weed only once. Some farmers harvest the young green leaves and some of the green pods during the season for home consumption. For harvesting there are two methods: the first method is picking the pods from the plants by hand and when the pods are dried on a mat, the grains can be separated from the pods by beating the pods with a stick. The other method is to uproot the whole plant and remove it from the stake. The grains are separated from the plants by beating the dried plants on a mat. Farmers face challenges with birds, rats and moles, they use different measures including traps, poison and removing bushes. However, farmers could learn from each other by sharing their knowledge, giving each other ideas how to deal with these pests. Farmers sell their beans to either neighbours, traders, shops or on the market. The beans are not processed by the farmers, but sold as a bulk product.

Research Question 4: Which climbing bean practices are demonstrated to farmers participating in N2Africa in 2013 and how do the demonstration plots differ from the non-N2Arica farmers' practices?

N2Africa demonstrated five different treatments with P fertilizer, inoculants, manure and combinations of P fertiliser + inoculants and P fertiliser + manure. N2Africa planted two CB varieties, a NABE12C and a local variety, this was planted in rows with a fixed plant spacing and with one seed per hole. Although N2Africa demonstrated the tripod staking method, this method was not adopted by the N2Africa farmers as they are still all using the single stake method. Furthermore, the N2Africa farmers were instructed to weed regularly, which the farmers did. Most farmers weeded up to three times, which is more often than what the non-N2Africa farmers do.

It is recommended to do further research on which sowing density is suitable for CB in Kisoro district. The plant spacing N2Africa used, is probably too big, because several fields had gaps where no beans were growing. However, the sowing density of most non-N2Africa farmers is much higher, and can probably be reduced without having a lower yield. The non-N2Africa farmers say that a high sowing density reduces the amount of weeds. Using a high sowing density may be beneficial in terms of labour, because less weeding is required. It would be interesting to make a cost-benefit analysis for different sowing densities, taking into account the required labour for weeding and the costs for seeds. Better conclusions can be made about the difference between N2Africa methods and the common practices when the harvest data become available.

Although farmers did not mention having problems with erosion, signs of erosion are clearly visible on the hillsides. In order to maintain soil fertility, it might be wise to investigate the possibilities for erosion control, such as grass strips, stone walls, etc. In addition, it would be interesting to explore the possibility of agroforestry, to gain more insight which tree species are suitable for stakes and socially and economically feasible for this area. Another suggestion we would like to make, is to do research on planning in CB cultivation, because when farmers plan properly, the CB production costs might be reduced.

5.3. Costs and benefits

Research Question 5: What are the costs and benefits of climbing bean cultivation for N2Africa demonstration plots and non-N2Africa practices?

Due to the small size of the N2Africa plots, the costs of labour and other inputs are biased. However, the data of the non-N2Africa farmers give a good representation of the costs for cultivating climbing bean for the common practice, which are 48,114 Ush/100m². If these costs are compared with the revenues from the yield, the profitability can be determined. Assuming that the beans can be sold at a price of 1500 Ush/kg, the break-even point is 32 kg beans/100m². In future demonstrations (in Kisoro), it is recommended to use the agronomy trial or expand plot sizes of the N2Africa fields to a size of at least 400m² (20x20m) to obtain reliable data on labour and other inputs. Also the costs and benefits of different practices can be compared more accurately.

The non-N2Africa farmers have lower costs for stakes and organic manure than the N2Africa farmers, due to the on-farm production of both and lower stake density. Future studies could find out why the farmers in Mutolere are more self-sufficient than the farmers in Nyakabande, as the total farm area is only slightly larger for the non-N2Africa farmers (Table 1). Self-sufficiency has its limits, as larger areas under climbing bean cultivation require more stakes and more organic manure than the farms and farm households can produce. In further research, it is recommended to make calculations on how many trees farmers should plant to provide stakes for a certain area of CB (for both common and N2Africa practices) and what the costs and benefits are for on-farm production of stakes. These results will help the farmers to make decisions for solving the problem of scarce and expensive stakes.

Unfortunately the harvest data are missing, so the outputs cannot be compared between the N2Africa and non-N2Africa farmers and the outputs cannot be compared with the different inputs.

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7. Appendixes

Appendix I. Comparing seed and plant densities

Table 1. Two seed densities are calculated (in light green) and two plant densities are given (in dark green), based on field measurements.

	Source	Field size (m2) Measured in field	Seed used (cups) Told by farmers	Seed density (seeds/ m2) [1] Seeds/ field size	Distance between seeds (cm) Told by farmers	Seed density (seeds/ m2) [2] Seed distance	Plants density FIELD [3] (plant/m2) Measured in field	Plant density BED [3] (plant/m2) Measured in field
Non-N2Africa farmers	Average	955	10	53	9	347	18.7	30.2
	MIN	143	4	8	4	44	11.5	11.5
	MAX	4275	25	110	15	625	24.7	44.4
N2Africa farmers (project fields)	Average	72	N.A.	N.A.	15 *	44	7.2	8.6
	MIN	46	N.A.	N.A.	15 *	44	4.9	5.4
	MAX	96	N.A.	N.A.	15 *	44	12.1	12.5
N2Africa farmers (own fields)	Average	N.A.	N.A.	N.A.	12 **	108	20.2	27.8
	MIN	N.A.	N.A.	N.A.	6 **	44	11.8	12.5
	MAX	N.A.	N.A.	N.A.	15 **	278	52.1	72.9

Explanatory notes:

N.A = Not available

[1] The seed density is calculated by dividing number of seeds used divided by the field size, assuming that there are 3300 seeds per cup, which is based on counting three cups of beans.

[2] This seed density is calculated by assuming that between and within the rows there is the same seed distance as told by the farmer.

[3] The difference between plant density FIELD and plant density BED can be explained; some farmers grow beans on beds and the space between beds varies enormously. Plant density FIELD includes the space between the beds, while plant density BED excludes this. Some non-N2Africa farmers do not grow beans in clearly visible beds, but intercrop beans with several other crops.

* These numbers are based on the seed distance N2Africa used according to the farmers.

** These numbers are probably not correct, because we think that several of the farmers gave the seed distance of their N2Africa plot instead of the seed distance of their own plot.

Appendix II. Kabale report

Besides the N2Africa project in Kisoro district, N2Africa also operates in the Kabale district, which is located eastern of Kisoro (See Figure 1). In the Kabale subcounty Bubaare, several people were interviewed: six N2Africa farmers, three Non-N2Africa farmers and an owner of a tree plantation. The interviews took place in the first week of December 2013. In addition, field measurements were conducted. In this report the most interesting results will be highlighted.

In Kabale district, farmers have less experience with growing climbing beans (CB) than in Kisoro. On average, farmers have been growing CB beans for 10 years, while in Kisoro CB are grown for several decades. One lady named Reste Twino, a farmer who is not involved in the N2Africa project, was one of the first people who grew CB in Kabale. She grew up in Kisoro and moved to Kabale 29 years ago, where she started to grow CB. Although her neighbours were first suspicious and thought it was not possible, they became interested in CB after a while and started asking her for seed. Over the last 29 years she saw the production of CB increasing, as farmers replaced bush beans with CB.

Besides climbing beans, farmers grow bush beans, cabbages, sorghum, sweet potatoes, Irish potatoes, peas, maize, avocados, apples and eggplants. The soil seems to be less fertile, as there are no volcanic soils as in Kisoro. Some farmers said that they use manure or compost on their CB fields, but none of them uses fertilizer. Furthermore, the rainfall distribution is different from Kisoro, and farmers said that this season (season B, 2013) the rain was average or above average. However, according to another farmer there was not enough rain around sowing, while enough rain is critical for germination.

N2Africa demonstration

N2Africa conducted the same farm trails as in Kisoro, which includes sowing CB in rows with a fixed seed distance of 15 cm, with one seed per hole and treatments with manure, fertilizer and inoculants or a combination of those.

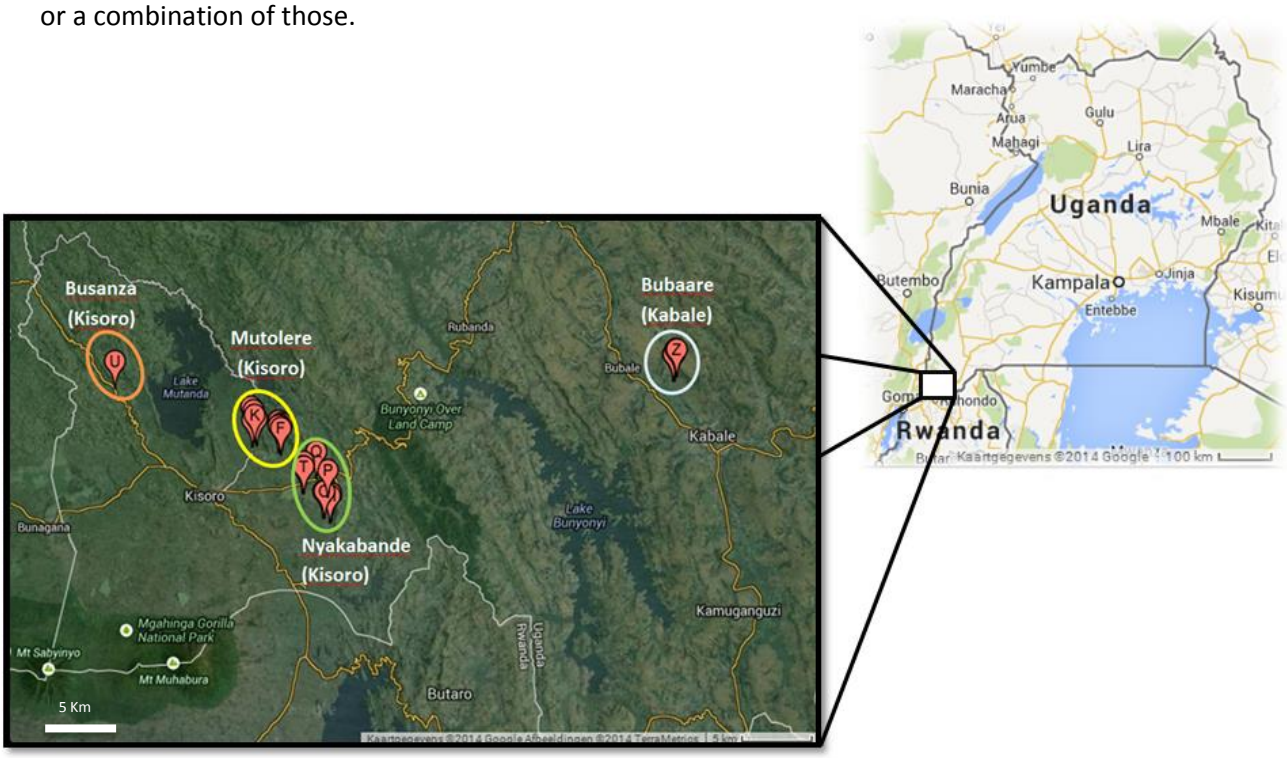

Figure 1. Map of the research area in Kisoro and Kabale district in South-Western Uganda.

Labour comparison

In Kabale the majority of the farmers use the single stake method for growing CB. Farmer Reste Twino, who was mentioned before, tried a different staking method. She placed a line of banana fibres between two trees, which the beans could use to climb on. However, the line broke, because the plants became too heavy and now shes uses the single stake method. N2Africa demonstrated the tripod staking method to some farmers, while others were instructed to use the single stake method. In order to gain understanding about the feasibility of the tripod staking method in terms of labour requirement, farmers were asked to compare the labour inputs for both the N2Africa methods and their own practices (Table 1).

Table 1. Comparing the labour requirement for different cultivation activities for N2Africa methods and common practices, this data is based on six interviews with N2Africa farmers in Kabale.

N2Africa practices versus own practice		
	Tripods vs own	**Single stakes vs own**
Planting	2 : 1	2 : 1
Placing stakes	2 : 1	1 : 1
Weeding	1 : 2	1 : 1
Harvesting	1 : 2	N.A.

Farmers estimated that planting according to the N2Africa methods takes twice as much time compared with their own methods. The reason is that N2Africa uses a fixed plant spacing in rows and measuring the seed distance takes time, whereas the common practice is to broadcast or plant the seed randomly. With the common practice, the sowing density is higher than for the N2Africa method, so more seed is needed. Furthermore, farmers in Kabale usually place two to three seeds per hole, whereas on the N2Africa plots one seed per hole was placed, which is the common practice in Kisoro district.

Placing stakes takes twice as much time when making tripods compared to placing single stakes. Three stakes are bound together with fibres from the bark of the stakes to form a tripod, while single stakes only need to be pushed into the soil. Farmers who use tripods, said that weeding is easier and takes only half of the time needed when using single stakes. The farmers were interviewed in December, before the harvest. They expected that harvesting will be easier with the tripods as tripods can be pulled out at once. Beans grown with single stakes tend to grow like a big bush, where neighbouring plants are completely intertwined with each other. When harvesting those beans, it is hard to separate the bean plants from the stakes. Beans grown with tripods form bushes per tripod and entangle only the plants which are growing on the same tripod.

Field measurements

An interesting difference between Kabale and Kisoro is the length of the stakes. On average, farmers in Kabale use much shorter stakes than in Kisoro, while the stake density is higher (Table 2). The number of plants per stake is for both Kisoro and Kabale lower on the N2Africa plot than on their own fields, which can be explained by the low sowing density demonstrated by N2Africa. This difference in plant spacing between N2Africa and the common practice was also affirmed by the farmers.

Table 2. Field measurements from Kabale and Kisoro on the N2Africa plots and farmers' own plots.

		Stake length (cm)	Stake density (stakes/m2)	Nr of plants per stake
Kisoro N2Africa	Average	199	3.1	2.4
	Range	110 - 306	1.3 - 5.5	1 - 6
Kisoro own fields	Average	174	3.1	6.5
	Range	107 - 264	1.4 - 5.7	1 - 24
Kabale N2Africa	Average	146	4.3	2.5
	Range	100 - 194	3 - 6	1 - 4
Kabale own fields	Average	141	4.5	5.5
	Range	90 - 200	3.8 - 5.3	4 - 8

Stakes

For staking material eucalyptus, Calliandra and blackwater (local name: 'bricot') are used, which are either bought from neighbours who have a plantation or are grown by the farmers themselves. Trees are mostly grown on top of the hills, where the soil is less fertile due to water erosion. The erosion makes these soils unsuitable for crops, but trees can tolerate the low soil fertility. The plantations sell stakes in bundles of 10 to 15 stakes for 5000 Ush and some of the stakes can be split into two or four stakes.

Some farmers buy trees from a plantation, which they have to split themselves. The price of a tree varies between 3000 and 6000 Ush, depending on the size. One farmer bought small trees for 3000 Ush per tree and obtained 10 stakes per tree, however his stakes were very short (on average 124 cm). Another farmer said that a big tree can be split into 50 stakes.

Like in Kisoro, preparing stakes is considered to be labour intensive. Splitting trees to make stakes is very time consuming, one farmer said it took him a week to prepare all the stakes needed for his field, which was not much bigger than 50 m2.

Furthermore, an owner of a tree plantation was interviewed. As it is common in this region, people have more than one job, so he grows trees besides growing crops for home consumption. He said that the demand for wood has increased over the years. Besides using wood for stakes, it is also used for charcoal, construction or firewood. Usually, the branches of the tree are used for stakes or firewood, while the main stem is used for charcoal or construction poles. The tree species he grows are eucalyptus and Blackwater.

Blackwater is more expensive than eucalyptus because of its hard wood and it makes better charcoal. However, eucalyptus grows faster than Blackwater, and regenerates when the stem or branches are cut. Every two years a eucalyptus tree can be cut again, while for Blackwater new seedlings need to be planted. His buyers are mainly neighbours from town. He sells the stakes directly to the farmers and the selling takes place at the plantation. The stakes are sold either in bundles (3000 Ush per bundle with 20 stakes bundle) or as trees (for 10.000 to 20.000 Ush depending on the size).

Stakes are stored after harvest, because they can be used for several seasons. Calliandra can be used for one to two seasons and eucalyptus for three to four seasons. Most farmers leave the stakes

uncovered in a bundle on the field or near the house. Only one farmer said that she stores the stakes inside the house to prevent rotting.

Harvest and Marketing

We got the impression that in Kabale a larger part of the harvest is used for home consumption and less is sold, compared to Kisoro. This is probably because the harvests are much smaller than in Kisoro due to the smaller fields. Three out of six N2Africa farmers do not sell beans at all, while others only sell a little amount. Another interesting fact, what two farmers mentioned, is that besides selling the dry beans, they also sell fresh green beans, which is when the pods are still green and the beans are not mature. Sometimes, farmers need to have 'quick cash', and then they decide to sell some of the green beans, which of course reduces the harvest of the dry beans. However, if they sell too much fresh beans they might end up buying dry beans again for planting in the next season. Dry beans are sold for 1300 to 2000 Ush per kg on small local markets or to neighbours.

Pests and diseases

As in Kisoro, farmers in Kabale also have problems with birds, rats and moles. Some measures they do are the same as in Kisoro, such as removing the bushes and weeding, placing traps or using poison. However, some of the measures are quite different. For example one farmer, Reste Twino, had problems with birds eating the bean flowers. She found several solutions: the first one is to put paraffin on the leaves, because birds do not like the smell and will leave. Another one is to put mashed banana with poison on top of the stake and the bird who eats it will die, which will scare other birds. Another method is from the North of Uganda where they fill a polythene bag with intestines, which is placed in the field. When this starts to rot, the birds will go away as they do not like the smell.