

Climbing bean (*Phaseolus vulgaris* L.) cultivation and its diffusion in Kapchorwa District, Uganda



JRNM Hüskens

MSc Internship report (PPS-70424)
Plant Production Systems
N2Africa project in Kapchorwa, Eastern Uganda
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Wageningen University



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Summary

From April 2014 till July 2014 I was in Eastern Uganda for my internship within N2Africa on climbing bean (*Phaseolus vulgaris* L.) cultivation and diffusion in Kapchorwa District. N2Africa is cooperating with smallholder farmers in Kapchorwa District to enhance climbing bean cultivation. The first objective was to map the diffusion of climbing bean cultivation and technologies used during cultivation in Kapchorwa District. The second objective was to visit farmers in Kapchesombe and Kirwoko parishes involved in N2Africa demonstrations on climbing bean in 2013, to see if they continued growing climbing bean and what technologies they are – still - using. In addition, we also would like to understand how and why some farmers adapt cultivation practices. The third objective was to assess this year's N2Africa demonstrations with farmers. The farmers were divided into high, medium and low resource endowed groups for both men and women. These farmers were asked to evaluate different staking methods, climbing bean varieties and fertilizer application. The focus of the evaluation was on understanding what aspects of a treatment farmers are more likely to apply on their own field in a next season. Why do they prefer one method over another and do these differences vary between the groups of farmers? Their feedback will be used later to co-develop suitable climbing bean technologies for farmer with limited resources.

For the first objective, I carried out transect walks in Kapchorwa District to explore where climbing beans are cultivated. And, in addition, I looked at the field sizes of climbing bean, staking material and staking methods, and whether or not the beans are intercropped. A number of farmers were interviewed to get additional information on the cost of stakes and when they first planted climbing beans. The results are presented in maps. Information from the survey on the use of N2Africa technologies was used to complement the information from the transect walks. Further analysis of the answers collected for the second and third objective was beyond the scope of this internship. But given the fact that most time and effort in the field was related to the collection of this data, the approach and methodologies of the survey and demonstrations are evaluated and suggestions for improvement are made.

Climbing bean cultivation is most common in the 'upper' belt areas of Kapchorwa District. Pioneer farmers have spread climbing bean cultivation over large distance in the 'upper belt' area and neighboring farmers have started to copy these practices in recent years. No significant differences in climbing bean field densities were observed between the East and West of Kapchorwa District. Climbing bean fields in the West are larger and more often intercropped, especially with banana. The single staking method is common practice with only a few farmers experimenting with new methods as shown in this year's N2Africa demonstrations. 'Local trees' found close to the homesteads are the most important source for staking material. Most of the farmers - who participated in N2Africa demonstrations in 2013 - from Kapchesombe parish continued to grow climbing bean in 2014 while the majority of farmers in Kirwoko parish did not continue. The failed harvest in the previous year and the absence of seeds were the main reasons for these farmers not being able to plant in 2014.

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Chapter 1: Introduction

N2Africa is a large-scale research project that works on putting nitrogen fixation to work for farmers growing leguminous crops in Africa. For my internship – part of the N2Africa Project and Ph.D. work by Esther Ronner – I carried out fieldwork in Kapchorwa District on Mount Elgon in Eastern Uganda, in the months April, May and June 2014. These months coincide with the first rainy season. Most annual crops are planted at the end of March or at the beginning of April.

Traditionally, bush bean varieties of common bean (*Phaseolus vulgaris* L.) are widely adopted in Kapchorwa District. However, bush bean production is constrained by its vulnerability to diseases – e.g. root rot – and the lower temperatures at higher altitudes. The climbing bean varieties of the common bean are better adapted to lower temperatures and have a better disease resistance than the bush bean varieties David (1997). These crop characteristics in combination with the climbing properties give climbing beans a higher yield potential over bush beans. Due to increasing pressure on arable land through population growth, there is a need now to enhance crop yields. For Kapchorwa District climbing bean was identified within the N2Africa project as the best-bet legume (Farrow, 2014) to achieve this (see Figure 1.1)

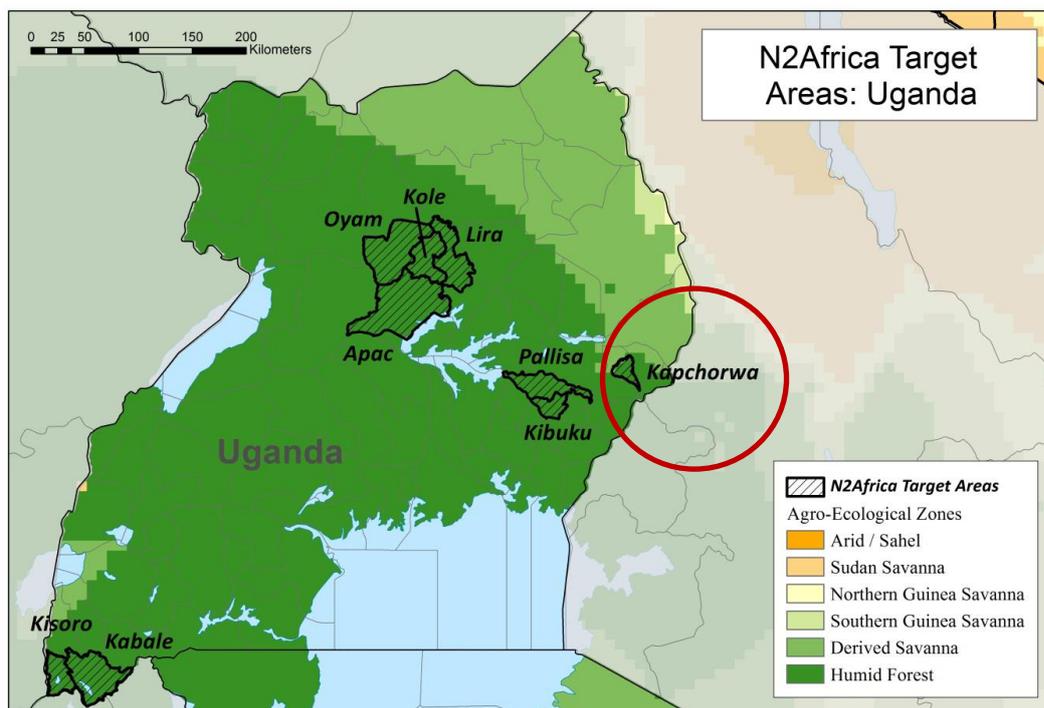


Figure 1.1. Kapchorwa District; one of the N2Africa target areas in Uganda (Farrow, June 2014)

Climbing bean is a relatively new crop for most farmers in Kapchorwa District. The adoption of climbing bean cultivation is assumed to have diffused historically from the west of the district to the east – as it was introduced by farmers from neighbouring Bulambuli District. As a result, there are some differences in challenges in enhancing (climbing) bean yields between farmers in the parishes in

the east and west of the district. Farmers in the western parishes need innovations in cultivation practices to intensify climbing bean production. Farmers in the eastern parishes would benefit from the dissemination of seeds and transfer of knowledge on sound cultivation practices as they have none or very little experience with climbing bean cultivation.

In 2013, the first demonstration fields were set up by the N2Africa Project in two parishes in the east of the district in order to disseminate climbing bean seeds to a small group of sixty farmers and to introduce these farmers to several alternative cultivation methods. In 2014, prior to the growing season climbing bean seeds were made available for both farmers who participated in the N2Africa trials of the previous year and to those who became interested. An adapted version of the demonstration fields was set up in the same two parishes in the east to introduce farmers of the community to different staking methods. In addition, in four parishes to the west, demonstration fields were set up to introduce the most experienced farmers to different climbing bean technologies – i.e. varieties, fertilizer applications, and staking techniques. The treatments in the demonstration fields were tailored to the experience of farmers with growing climbing beans.

Overarching objectives

Appropriate strategies and procedures for a speedy diffusion of legume technologies were already the subjects of research in the mid-1990's (David, 1997). To improve the success of climbing bean technology dissemination campaigns targeted at farmers with few resources a co-development approach is proposed (Research Proposal by Esther Ronner). In this approach farmers, local experts, researchers, and potential other stakeholders are involved to develop suitable climbing bean technologies for farmers with few resources. This co-development approach provides opportunities for farmers to include their opinion and give feedback. Thereby, this co-development approach allows for early recognition of aims and adoption constraints for farmers of different wealth categories – rich, medium and poor in terms of resources. The process of co-development during several seasons should lead to the extension and refinement of a number of best-bet technologies suitable for farmers of different farm types, which can be used to inform on-going dissemination campaigns.

Internship objectives

To develop best-bet technologies that take into account the aims and possibilities of different farm types, the current situation of climbing bean production in Kapchorwa District needs to be understood. Within this internship, I focused on three aspects of the adoption of climbing beans in Kapchorwa District:

- 1. Mapping of diffusion of climbing bean technologies in Kapchorwa District.**

The objective is to trace the history of climbing bean cultivation in Kapchorwa District by carrying out transect walks and conduct short open interviews with farmers along the way. The main focus points are to identify:

- where climbing beans are currently being cultivated.
 - in which year farmers started cultivating climbing beans.
 - where farmers obtained the first seeds from.
 - what staking methods are currently being used by farmers.
 - if differences in practices exist between parishes.
2. **Carry out the *Survey on the use of technologies by N2Africa farmers in Kapchesombe and Kirwoko*¹ parishes - Kapchorwa District.** The objective is to visit at least fifty farmers who participated in N2Africa field trials in 2013 - or who purchased climbing bean seeds through N2Africa in 2014 - for a survey on the adoption of climbing bean technologies. The main issues addressed in the survey are to identify:
- which farmers started to experiment with growing climbing beans on their own fields in the first season of 2014.
 - what are the motives of farmers who did not participate in N2Africa in 2013, to buy climbing bean seeds in 2014.
 - what planting and staking methods are used by farmers.
 - what adaptations have been made to the practices demonstrated in the previous year's field trials, and why these adaptations were made.
3. **Assess together with farmers the performance of the different treatments in the N2Africa demonstration plots.** The objective is to carry out 48 sessions of *pairwise comparisons* of the different treatments in the demonstration fields together with farmers from three wealth categories. The main issues addressed in the *pairwise comparison* are to identify:
- which of the eight treatments in the demonstration fields are ranked highest by groups of male and female farmers from the three wealth categories.
 - what aspects of a treatment appeal to a group of farmers.
 - what climbing bean technologies are most likely applied in their own fields in a next season.

Chapter 2 consists of a literature review on the geography of the study area, the population, common bean production in Uganda, and the history of the diffusion of climbing bean cultivation in East Africa.

Chapter 3 consists of the observations of the *Mapping of diffusion of climbing bean technologies in Kapchorwa District* and analysis of the results.

Chapter 4 consists of an evaluation of the *Survey on the use of technologies by N2Africa farmers* with recommendations on how to improve future surveys. Analysis of the collected answers of the survey was limited to complement the results of Chapter 3. Further analysis was not part of this internship.

Chapter 5 consists of an evaluation of the *pairwise comparison and ranking of treatments in demonstrations* with recommendations on how to improve future

¹ Kirwoko parish is the only part of Kaptanya sub-county that was covered in this study and will be used instead of Kaptanya.

demonstration field assessments with farmers. Analysis of the collected answers of the survey was not part of this internship.

Chapter 6 consists of a synthesis of the previous chapters with recommendations for future studies.

The three objectives were carried out fitfully. Roughly 10% of the time – in the field – was allocated to the collection of data for the first objective (mapping). The second and third objective demanded much more time than anticipated and about 60% and 30% of the time was allocated to these objectives respectively. As a consequence of this time allocation, the number of transect walks carried out was smaller than planned.

Chapter 2: Literature review

2.1 Geography of the study area

Kapchorwa town - within the eponymous Kapchorwa District - is located at 1930 meters above sea level (m.a.s.l.) on the north side of Mount Elgon. The 4321 meter high extinct Miocene volcano is shared between Kenya and Uganda. Its slopes are generally gentle (averaging less than 4°), with characteristic natural terraces cut by sheer cliffs in the north (Sassen et al., 2013). Volcanic soils are dominant on Mt. Elgon with medium to high productivity (Mwebaze, 1999). The climate is determined by dry north-easterly moist south-westerly winds (Sassen et al., 2013). December till March are the driest months of the year, although rainfall occurs throughout the year. The average annual temperature in Kapchorwa District lies between 8 and 23 °C (Farrow, 2014). This large range in average annual temperatures is due to the differences in elevation within the district, with the cooler temperatures found at higher altitudes in the south-east.

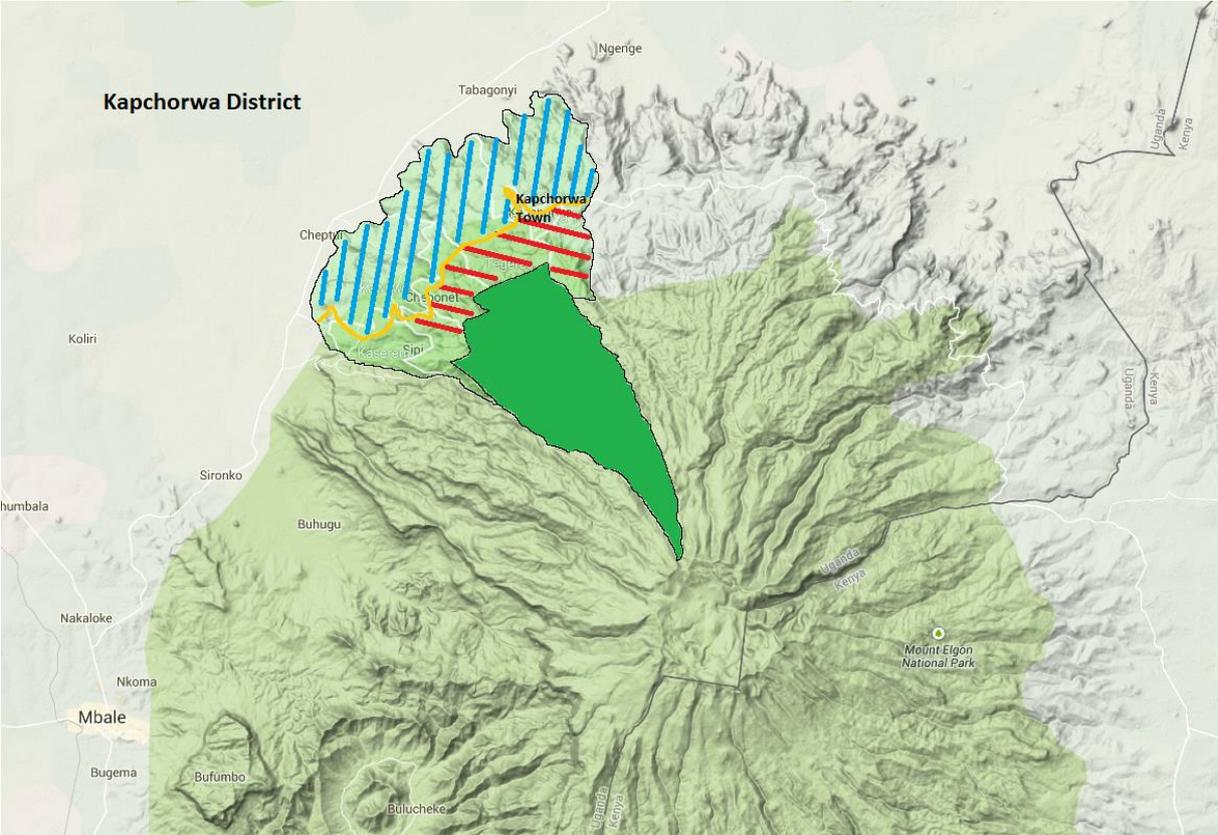


Figure 2.1. Kapchorwa District, Mount Elgon. The dark green area is covered with forest and represents the current size of the national park within Kapchorwa district. The populated area of Kapchorwa district can be divided into an upper and middle/lower part by the tarmac road (orange line). The hatched red area represents the 'upper belt' and the hatched blue area the 'lower belt'.

Agro-ecological circumstances

Within the N2Africa project, the common bean was identified as the best-bet legume for Kapchorwa District (Farrow, 2014). This type of legume suits the agro-ecological circumstances of the area and fits into the dominant farming systems (Farrow, 2014). In Kapchorwa District, common beans already play an important part of the livelihood strategies of the Eastern Lowland Maize Beans Rice Zone and the Mt Elgon Highland Irish Potato and Cereal Zone (Farrow, 2014). For the cultivation of the climbing bean variety the Mt Elgon Highland Irish Potato and Cereal Zone – ‘Upper belt’ in Figure 2.1 - is of particular importance. Other important staple crops in this agro-ecological zone with high and effective amounts of rainfall are Banana (*Musa* spp.), sweet potatoes (*Ipomoea batatas* (L.) Lamk), cassava (*Manihot esculenta* Crantz), and Maize (*Zea mays* L.) (Mwebaze, 1999). Arabica coffee (*Coffea arabica* L.) is an important cash crop (Mwebaze, 1999).

Population

The 2011 mid-year population in Kapchorwa district² was projected to be about 200,000 (FAO, 2014). Population density seems to be highest at the higher altitude levels near the boundaries of the national park (CIESIN, 2009). “Two ethnic groups predominate around Mt Elgon in Uganda: The Bagisu, of Bantu origin, in the south and south-west and the Sabiny, of Nilo-Cushitic origin in the north and north-east. The Sabiny were originally pastoralists dwelling in both the semi-natural forest grasslands and high-altitude moorlands and in the lower northern plains. Since the 1980s, they turned to agriculture for cash, often under the influence of Bagisu or immigrants from the plains” (Sassen et al., 2013). According to Scott (1998) livestock – especially cattle – remain very important for the Sabiny people. The population of Kapchorwa consists largely of Sabiny.

Accessibility

A new murrum road – a form of clayey material used for road surfaces in tropical Africa – opened in 2003 and connected Kapchorwa to Mbale and improved market access of the people living near Kapchorwa town (Sassen et al., 2013). A couple of years later the road was upgraded to tarmac and the road from Kapchorwa town to the Kenyan border awaits further construction. Agricultural products are transported to the major local markets in the west, northwest and to the borders with Kenya (Sassen et al., 2013). During the rainy seasons, the roads are not always easily accessible and this results in increased transport costs (Sassen et al., 2013). Land degradation with occasional landslides is a serious problem on the slopes of Mount Elgon (Cleassens et al., 2013; Sassen et al., 2013).

National park

The Ugandan side of Mt Elgon National Park covers approximately 1120 km² (Sassen et al., 2013). Sassen et al. (2013) studied the drivers of forest cover change for three periods between 1973 and 2009. More than 25% of the forest cover of the Mt Elgon Forest Reserve/National Park was lost in 35 years. In areas

² The population here includes the Kween-district population which was split off from the Kapchorwa-district in 2010.

with a dense population – in combination with profitable coffee production – the forest clearing was greatest during times of weak law enforcement. Alternating periods of weak and strong law enforcement led to a 'back-and-forth' process of clearing and regrowth (Sassen et al., 2013). The forest is a source for staking material in climbing bean cultivation for the people that live close to the National Park. The land outside the National Park on the north-eastern slope is covered with few trees as most land is now used for cultivation or grazing (Sassen et al., 2013).

2.2 Common bean production in Uganda

Bean is a major crop in many parts of Africa, and especially in eastern Africa. It is an important food to people of all income categories and it is especially important to the poor as a source of dietary protein (Wortmann et al., 2004). The importance of bean as a crop is closely associated with human population density. Bean production intensity is greatest in areas of high population density, where farm sizes are small and few significant sources of other dietary protein exist (Wortmann et al., 2004). Common beans - part of the traditional diet in Uganda - provide 15% of the protein sources of Ugandan families, compared with e.g. 3% by groundnut (*Arachis hypogaea* L.) and 1% by cowpea (Kabeere et al., 2008) (Ronner et al., 2012). Common bean is grown primarily by small-scale farmers who have limited resources and usually produce the crop under adverse conditions such as low input use, marginal lands, and intercropping with competitive crops (Wortmann et al., 2004).

From 1980 to 2011 the production quantity of (dry) beans in Uganda increased from 133,000 tons to 915,000 tons (FAO, 2014). Bean production increased rapidly between 2007 and 2008, from 430,000 tons to 911,667 tons (FAO, 2014).

Climbing bean vs bush bean

Currently, climbing beans constitute an estimated 20% of the total land area under bean cultivation (CIAT, 2008). The advantages of climbing bean over bush beans – higher yields per unit area, better resistance to diseases and ease in drying during heavy rainfall due to staggered harvesting – allow for intensified production which can alleviate food security problems, especially in areas of high population density and land shortage.

Climbing beans are better adapted to humid highland areas as these conditions favor the proliferation of fungal diseases – e.g. root rots – to which bush bean varieties have little resistance (Musoni et al., 2014).

Ramaekers et al., (2013) found median yields of 1333 kg/ha for climbing beans in Kenya in the 2009 October rain season, which is higher than reported yields for bush beans in the region with averages ranging from 300 to 800 kg/ha. The potential for climbing bean in scientific reports is reported to be 4 to 5 tons/ha under optimal conditions with the use of fertilizers and pesticides (Ramaekers et al., 2013).

Climbing beans in Uganda are grown in pure stands or intercropped with maize (CIAT, 2008) or other crops. The bean crop's quick maturity and tolerance of shading have encouraged its widespread use in intercropping with maize or banana. Sole crop production is also important. Sorghum, cassava, and sweet potato are also commonly associated with beans. Two crops per year are grown, with sowing times in March to April and September to October (Wortmann et al., 2004).

According to (Wortmann, et al., 2004) "Opportunity exists to extend the significant impact achieved with climbing bean varieties in the highlands of central Africa to other bean production areas".

Historical diffusion of climbing bean cultivation

Climbing beans originate from the medium to high-altitude regions of the Andes and Central America (Voyses, 2000). In 1984, improved climbing bean varieties from CIAT were officially released and promoted in Rwanda (Sperling and Muya-neza, 1995) and gradually spread to other highland areas in neighbouring countries, such as Embu district in Kenya in 1995 (Ramaekers et al., 2013).

In Rwanda, the adoption of climbing bean rose from 5% in 1985 to 42% in 1992, then to 60% in 2005. However, most of the expansion was limited to the cool and humid northern highlands (1,800 -2,300 m.a.s.l.) where adoption reached 95% (Musoni et al., 2014).

In Uganda, climbing beans first reached the highland areas of [Kisoro](#) and [Kabale](#) districts in the southwest on the border with Rwanda. Later, this crop spread to the slopes of Mount Elgon – an area that is known for its high concentrations of bean production (Gray, 1990; Wortmann et al., 1994; Wortmann et al., 2004)). According to (Hoogendijk et al., 1997) Mbale district is a 'traditional' climbing bean area. However, it is not being mentioned when the climbing bean was first cultivated in this area. The first official release of climbing bean took place in 1994 and 1995. In these years the Mt Elgon Conservation and Development Project in Eastern Uganda in collaboration with bean researchers distributed small quantities of three Rwandan climbing bean varieties to bean farmers in the mountains of Mbale District (Hoogendijk et al., 1997).

Little is known about the diffusion of climbing bean cultivation to and within Kapchorwa district. In general, cultivation of climbing bean seems to follow an altitude gradient, with more adopters at the higher altitudes or 'upper belt'. At the lower altitude areas 'middle/lower belt' cultivation of climbing bean is mixed with bush beans as these altitudes are suitable for both varieties (Personal communication Ronner 24-03-2014). Climbing bean appears to have been introduced historically in the western part of Kapchorwa district by people from the Bagisu tribe. The western part of Kapchorwa is the most densely populated area within the district and the need for intensification and innovation to achieve this is largest. Farmers in other parishes with larger Sabinu population appear to learn from these farmers (Personal communication Esther Ronner 07-08-2014).

Constraints in adoption of climbing bean cultivation

“The success of any new agricultural technology is judged ultimately by its adoption and acceptance by farmers and consumers and the positive changes it brings at household, local, national and regional levels.” (David, 1997)

Ramaekers et al., (2013) assessed the diffusion and adoption rates of climbing bean and analysed the determinants of farmers’ decision to adopt climbing bean. Ramaekers et al., (2013) concluded that the awareness and trial by households closely linked with the altitude of the village. “Possible explanations given are the differences in soil and climate conditions as pH and temperature decrease and rainfall increases with increasing altitude. Compared to bush beans, climbing beans are more suitable for these conditions and, therefore, the difference in performance between bush and climbing beans will be explicitly larger at high altitudes” (Ramaekers et al., 2013).

In addition, Ramaekers et al., (2013) found “a substantial proportion of the examined population does not continue growing climbing beans after a trial period of one season”. In the study area around 90% of the households were aware of climbing beans, 39% tried climbing beans for at least one season. The share of the population still growing climbing beans in at least one of the two previous seasons – the so-called adopters – was only 11%.

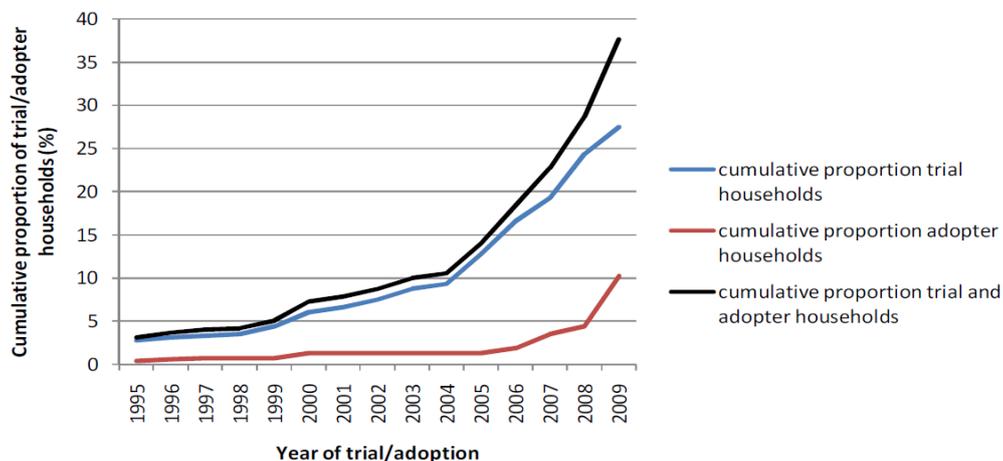


Figure 2.2. Trial and adoption rates of climbing bean in Embu District, Kenya. Percentages of adopter households (red curve), trial households (blue curve) and both adopter and trial households (black curve) per year. The time period shown is from 1995 (starting year of climbing bean promotion) till 2009 (one year before the survey). Figure derived from Ramaekers et al., (2013).

In Figure 2.2 the trial and adoption rate in the Kenyan Highlands is mapped over time. Although promotion of climbing bean started in 1995, more than ten years were required to have at least 10% of the farmers perform a trial and that actual adoption only started to take off after 2006. According to Ramaekers et al., (2013) the adoption of climbing beans cultivation in the Kenyan highlands is/was hampered by some or a combination of the following constraints:

- Unavailability of seeds
- Too labour intensive
- No interest
- Lack of knowledge about how to grow climbing beans
- Lack of staking material
- Lack of space
- Attack by birds
- Sensitivity to drought

Musoni (2014) argues that despite the fact that climbing beans provide the best option for intensification and the production of surplus beans in Rwanda, shortage of staking wood is a major challenge limiting the wider adoption. Poor staking or none causes a yield loss of 50-90%. In studies on alternative techniques that reduce the over-reliance on wood for staking it was concluded that farmers base their choices on the availability, labour implications, durability and cost of the stakes (Musoni, 2014).

It is expected that – some of - the above mentioned constraints that were found in other highland areas in eastern Africa also play an important role in the decision-making of farmers in Kapchorwa district to experiment with and eventually adopt climbing bean cultivation. N2Africa aims to remove a number of constraints by providing seeds and setting up demonstration fields with innovative practices that address the limited availability of staking material.

Chapter 3: Mapping of diffusion of climbing bean technologies in Kapchorwa district.

The aim of this chapter is to map the diffusion of climbing bean technologies in Kapchorwa district.

Objectives:	<ul style="list-style-type: none"> ➔ To create overview maps of: <ul style="list-style-type: none"> • Where climbing bean cultivation currently is practiced in Kapchorwa district. • The climbing bean technologies that are currently used, e.g. staking method and material, plot sizes, intercropping. • The first year farmers started cultivating climbing beans. ➔ Analyze if there are significant difference in practices used between regions in Kapchorwa district.
Means:	Observation of current practices and short open interviews with farmers for additional information.
Activities:	<ul style="list-style-type: none"> ➔ Carry out transect walks with a GPS-tracker for observations in parishes with – or adjacent to – an N2Africa demonstration field. ➔ Carry out short open interviews with farmers when they are at or near their field.
Deliverables:	<ul style="list-style-type: none"> ➔ Maps and reflection on results. ➔ Excel sheets with GPS-locations and observations.

3.1 Purpose

Climbing bean cultivation appears to be spreading in the Kapchorwa region. Based on observations of earlier field visits³ it was assumed that the cultivation of climbing bean is spreading from Sipi to [Chema](#) and [Tegeres](#) sub-counties - west of Kapchorwa - to [Kaptanya](#) sub-county in the east of Kapchorwa (personal communication with Esther Ronner). See Figure 3.1 for an overview of the location of the different sub-counties in the district. The adoption of climbing bean cultivation is assumed to spread from the higher altitude parishes, close to the borders of Mount Elgon National Park, to the parishes in the ‘middle and lower belt’. This is similar to the observations made by Ramaekers et al., (2013) for the Kenyan Highlands.

The main purpose of mapping the diffusion of climbing bean technologies is to get a better understanding of the way climbing bean cultivation technologies spread. This could help to identify regions where climbing bean adoption is low and could benefit from dissemination campaigns.

³ By others within the N2Africa project.

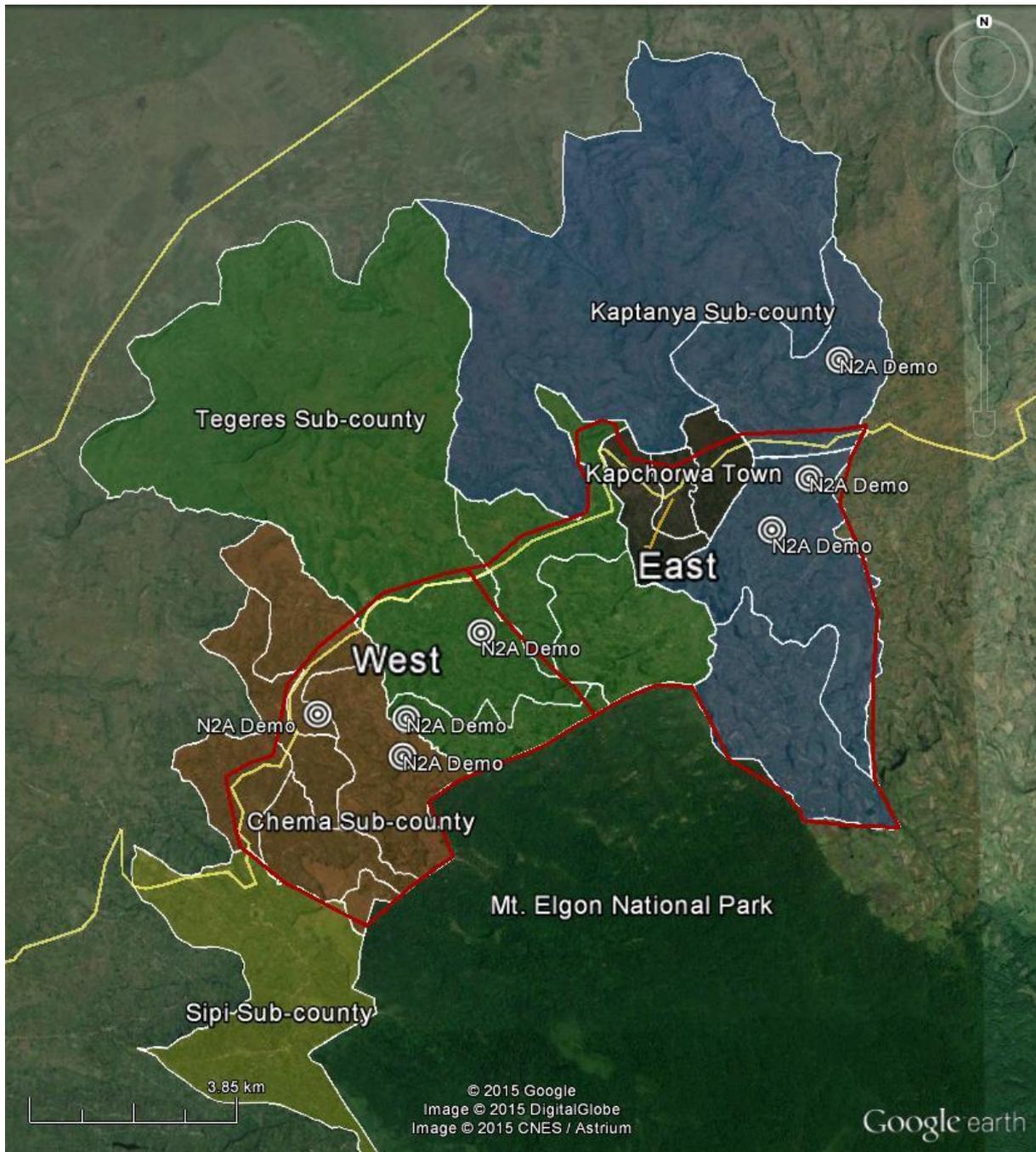


Figure 3.1. Overview map of sub-counties and N2Africa demonstration fields in Kapchorwa district. For comparison of climbing bean cultivation methods within the district, the study area - outlined in red - is divided in a west and east region.

3.2 Approach used

Transect walks were carried out in Kapchorwa District to identify areas with climbing bean cultivation. In order to easily distinguish climbing beans from bush beans, transect walks were carried out after staking took place. Given the vast area, it was decided to follow roads that are at least accessible by cars and motorbikes. Most of these roads follow the contour lines from east to west or are oriented from high to lower areas. Thereby a raster is created that covers a large area in relative short time-frame.

Through conversations with farmers in both the 'upper' and 'lower belt', it became clear that, due to favourable microclimatic conditions, climbing beans are planted several weeks earlier in the 'upper belt'. The adoption of climbing bean cultivation is also more prominent in the 'upper belt', whereas in the 'lower belt' the adoption is still low. Therefore, transect walks were first carried out in the 'upper belt' area of Kapchorwa, in Chema, Tegeres and Kaptanya sub-counties. Including these areas is interesting, as they cover six out of the seven N2Africa demonstration plots (Chapter 5) and demonstrated staking methods might already be observed in the surrounding climbing bean fields. More transect walks in other areas of Kapchorwa district were to be carried out only if time would allow.

See Figure 3.2 for the climbing bean fields – within 50 meters from the road - marked with a GPS. The following observations were made for each plot:

- The estimated size of the field used for climbing beans.
- Are climbing beans grown sole or intercropped? If intercropped, with which type of crops?
- Staking material used.
- Staking method used.

If the owner of the plot was around, the following questions were asked during an informal and open interview:

- How many years ago did you start growing climbing beans?
- Where did you buy or get these seeds from?
- What variety of climbing bean are you growing?
- What type of fertilizers are you using?
- What type of chemicals are you using?
- Did you collect the stakes yourself, or did you buy them? If bought, how many bundles did you buy and at what price?

In order to test if there are differences in the adoption of climbing bean cultivation, and cultivation techniques within the district, the district is divided into two regions. See Figure 3.1 for the division of the district into East and West.

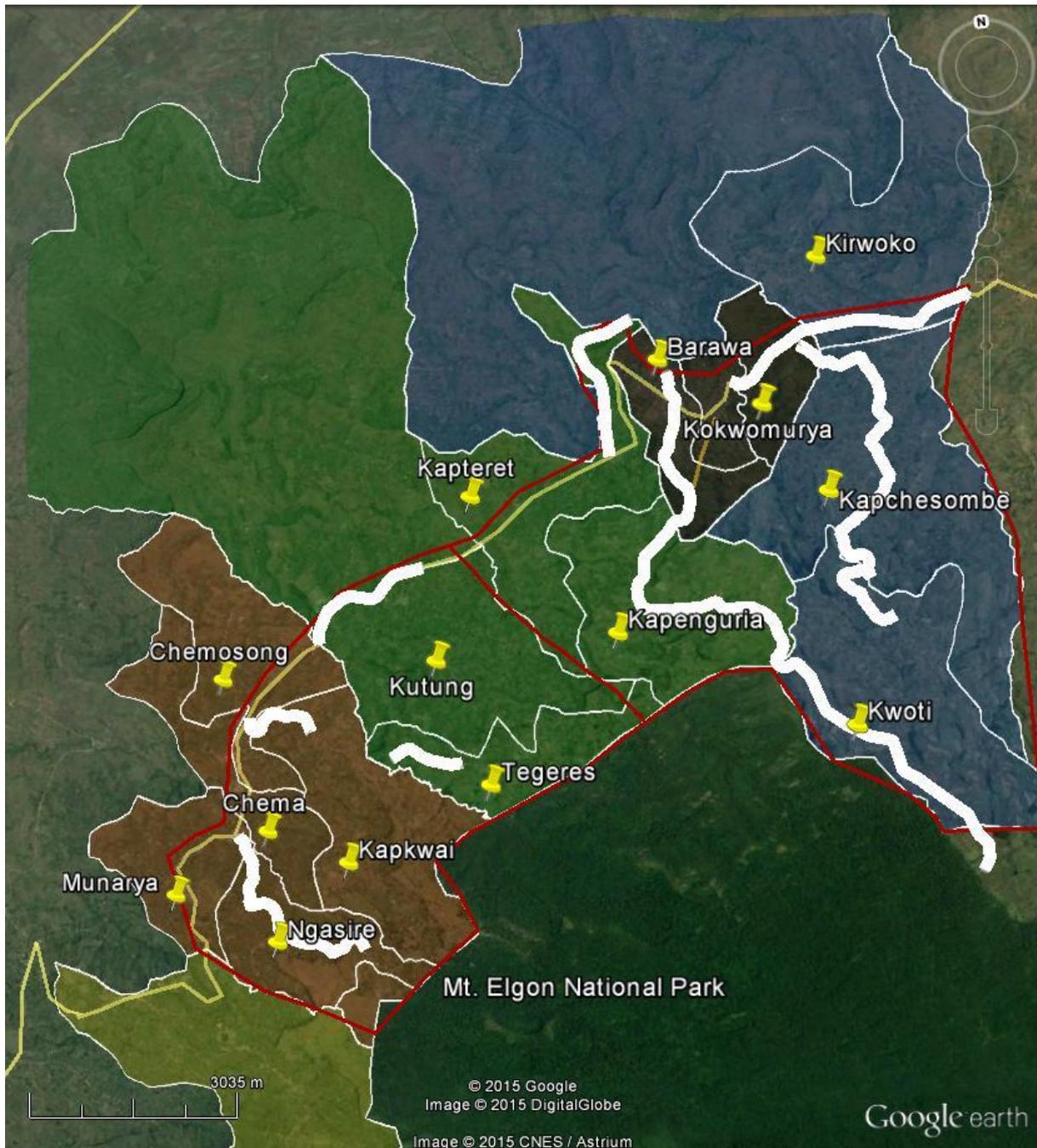


Figure 3.2. Overview map of parishes within the study area – outlined in red - in Kapchorwa district. The area covered by the transect walks is indicated in white.

3.3 Observations

3.3.1 Where in Kapchorwa district are climbing beans cultivated?

In all parishes, where transect walks were carried out, climbing bean fields were observed (see Figure 3.3). The highest densities of climbing bean fields were observed in Ngasire and Kapkwai-Chemosong parishes in Chema sub-county (See Table 3.1). The highest density of climbing bean fields was observed in Ngasire; where on average 15 plots of climbing beans were encountered for every kilometer covered. In two parishes in Tegeres sub-county – Tegeres and Kapenguria - the observed climbing bean density was about half of that observed in Ngasire.

In Barawa parish in Kapchorwa Town, the density was only a third of the density in Ngasire. In the other parishes in Kapchorwa Town and Kaptanya field densities ranged between 2.1 and 3.5 per kilometer. The lowest field density of just 1.5 fields per kilometer was observed in Kapteret parish - Tegeres sub-county. The transect walk carried out in this parish was the only one which covered a part of the 'lower belt' of Kapchorwa District.

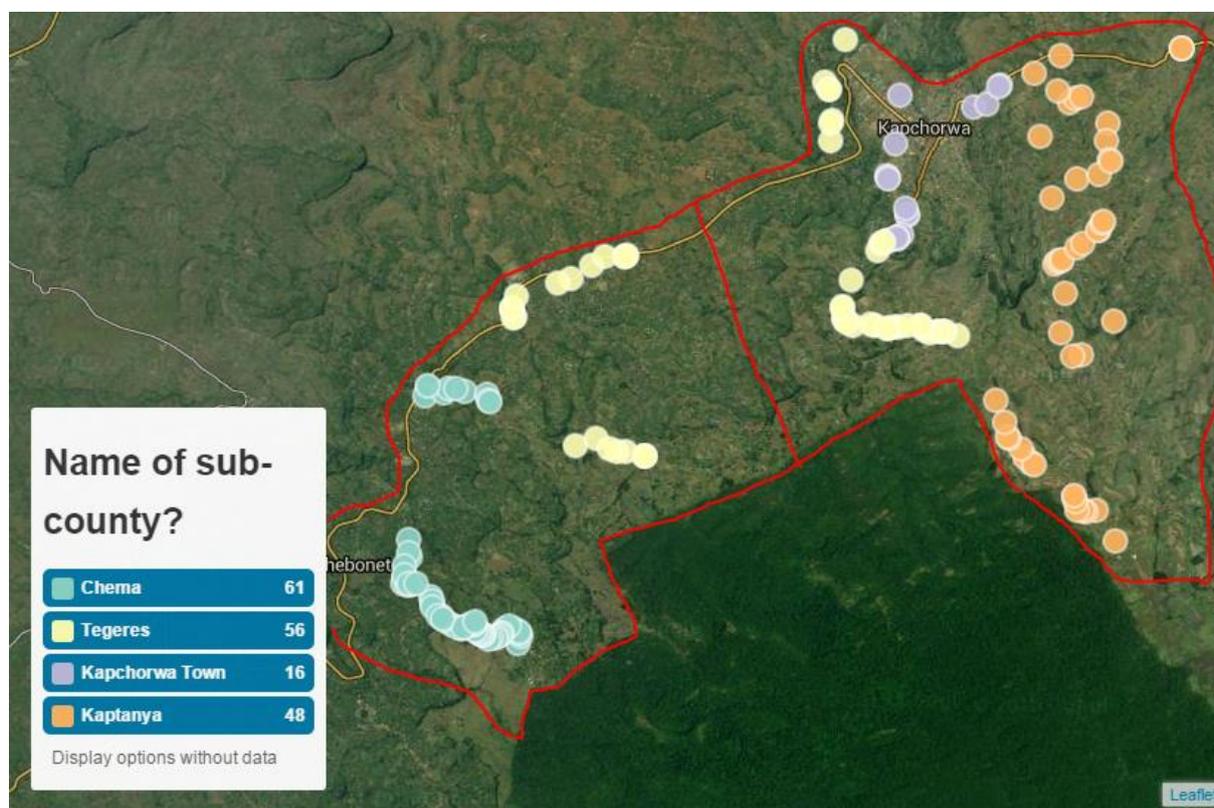


Figure 3.3. Observations of climbing bean cultivation in four sub-counties in Kapchorwa district. Study area is outlined in red.

Table 3.1. Climbing bean field densities observed during transect walks in parishes in Kapchorwa district. CB = Climbing beans. M.a.s.l. = meters above sea level.

	Sub-county	Parish(es)	Length of transect walk in km	Orientation of transect	Altitude range transect in m.a.s.l.	CB fields observed	Fields /km
West	Chema	Ngasire	3.4	High-low	2050-1775	51	15.0
		Kapkwai-Chemosong	1.1	High-low	1980-1870	10	9.1
	Tegeres	Tegeres	1.1	Contour	2070-2020	8	7.3
		Kutung	2.0	Contour	1850-1830	12	6.0
		Kapenguria	3.4	High-low	2235-2010	25	7.4
East	Kapchorwa Town-Kaptanya	Kapteret	4.1	High-low	1850-1690	6	1.5
		Kokwomurya-Kirwoko	3.4	Contour	1935-1880	7	2.1
		Barawa	2.5	High-low	2010-1890	12	4.8
		Kwoti	6.1	High-low	2600-2250	19	3.1
	Kaptanya	Kwoti-Kapchesombe	6.2	High-low	2285-1915	22	3.5

A two-samples t-test was conducted to compare climbing bean plot density between East and West regions in Kapchorwa district. There was no significant difference in the scores for West ($M=9.35$, $SD=3.98$) and East ($M=3.73$, $SD=2.13$); $t(4)=2.59$, $p=0.06$. These results suggest that the density of climbing bean plots in the East of Kapchorwa was not significantly different from the West of Kapchorwa in the first season of 2014.

3.3.2 What cropping systems are used?

Different cropping systems for climbing bean cultivation were observed in Kapchorwa district (see Figure 3.4). In the East, nearly half of the climbing bean plots were grown sole. This practice of cultivation without any form of intercropping was nearly absent in the West of Kapchorwa district. In these two parishes intercropping with – high - shade providing perennial crops like coffee, banana, and trees, is widely used. Also, a combination of perennials and annual/biennial crops is common practice in these parishes.

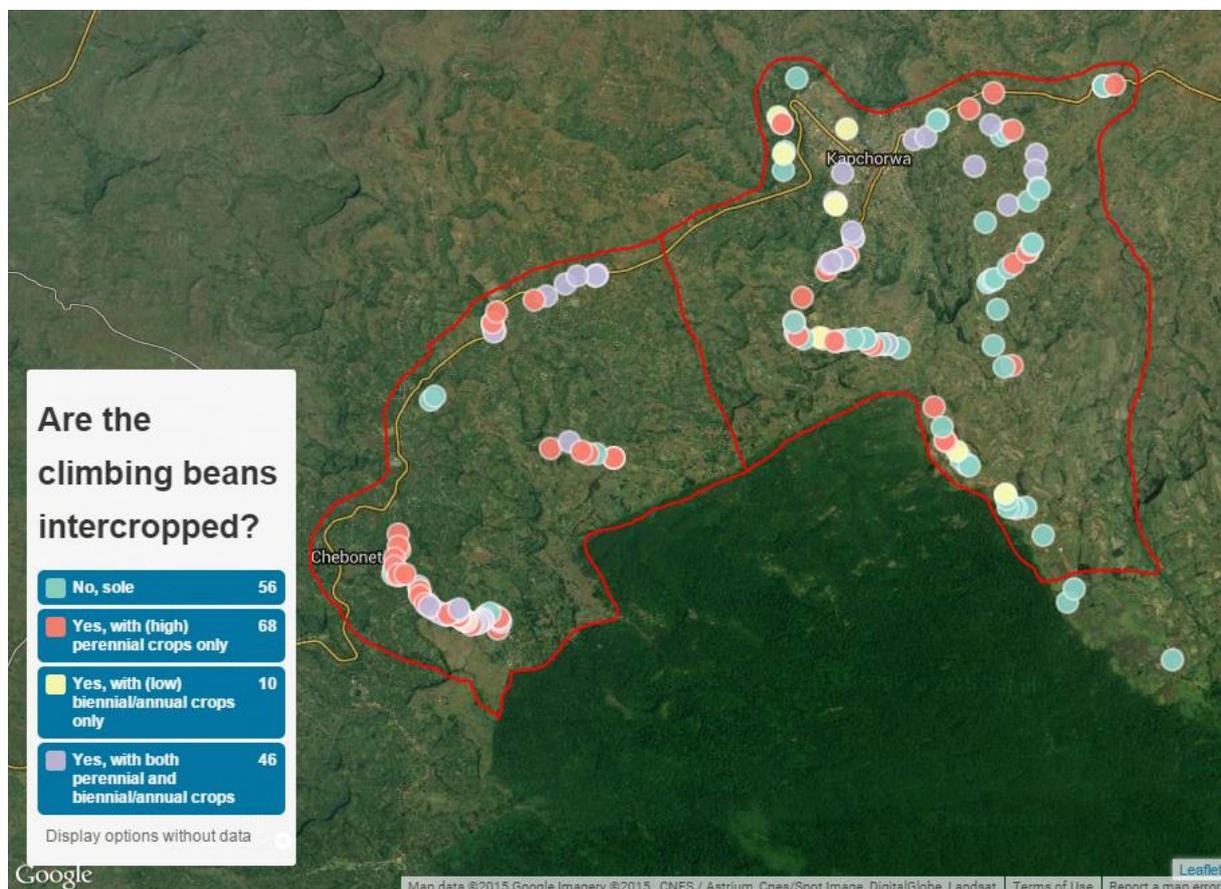


Figure 3.4. Climbing bean cultivation methods used in Kapchorwa district. Study area is outlined in red. Note: observations recorded outside of the transect walks are included in the automated legend count.

Intercropped climbing beans were in 81% of the cases intercropped with banana – an important staple food in this region. In one-third of the fields climbing beans were intercropped with maize – i.e. in the same season. However, in the case of poor staking, this practice was bad for the maize plants as they could be strangled by the beans. Other biennial/annual crops intercropped with climbing beans are Irish potatoes, yam, and cassava. Intercropping with only bienni-

al/annual crops is not a common practice in both West and East Kapchorwa (see Figure 3.5).

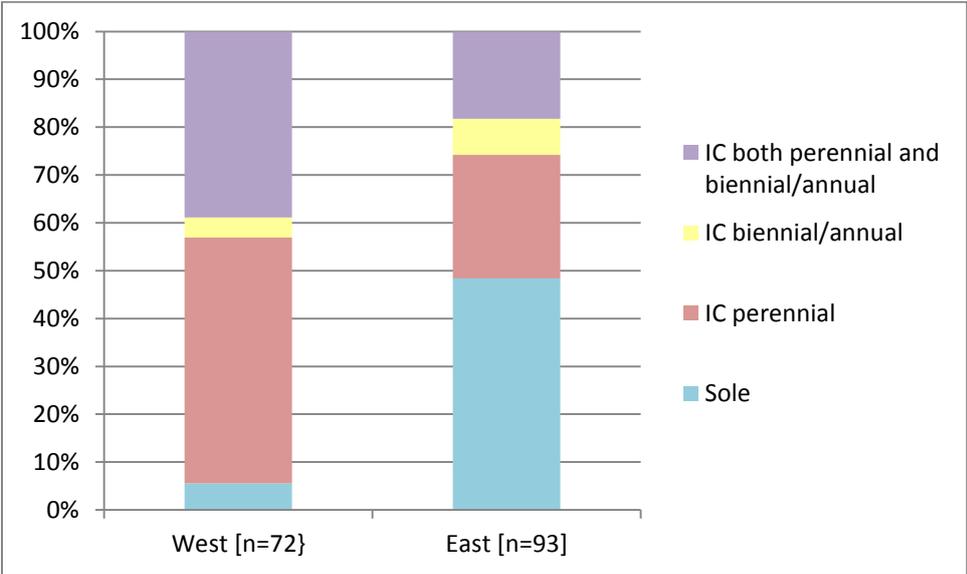


Figure 3.5. Cropping systems used in climbing bean cultivation in West and East Kapchorwa. Only observations from the transect walks within the study area were included here.

A Chi-square test of independence was performed to examine the relations between intercropping in West and East Kapchorwa. The relation between these variables was significant, $\chi^2(3, N=165)=39.33, p=0.00$. These results suggest that there is a clear difference in cropping systems used by farmers in West and East Kapchorwa.

One of the explanations for the observed difference could be due to the influence of the demonstration fields set-up by N2Africa in 2013 and 2014. In order to demonstrate the full potential of climbing beans, sole cropping was used. Although this aspect might have some influence on the use of this practice, it is better to first consider the cropping systems that were already in place. From Google satellite images, one can observe that in the western part of the study area banana and coffee trees form the dominant cropping system. These crops are less common in the parishes east of Kapchorwa Town and intercropping with climbing beans is therefore not a feasible option. Since farmers only recently adopted climbing bean as a new crop (see section 3.3.6.), it had to be incorporated in the existing systems. Which in the case of the western region took place within the banana dominated systems. Whether or not this was at the expense of other intercropped biennial/annual crops is not known.

3.3.3 What staking material is used?

In Ngasire parish, bamboo was widely used by farmers for staking (see Figure 3.6). Also in Kwoti parish bamboo stakes were used by farmers who live near Mount Elgon National Park. Farmers obtain bamboo from the forest and there seems to be a strong relation between the use of this staking material and the distance to the forest. The distance – measured in a straight line - of fields with

bamboo stakes to the forest was between 0.7 and 1.7 km in Ngasire. In Kwoti, the distance was no more than 0.4 km.

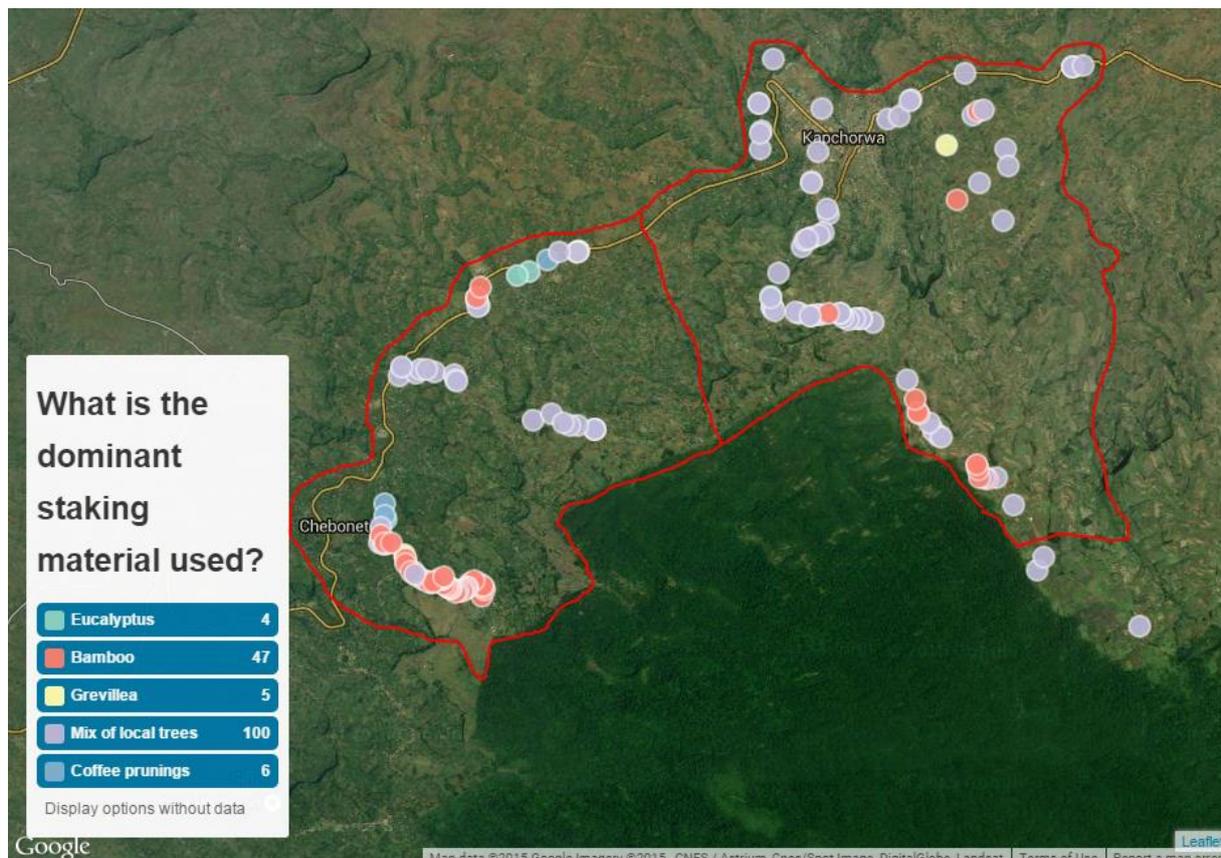


Figure 3.6. Dominant staking material used in climbing bean cultivation in Kapchorwa district. Study area is outlined in red. *Note: observations recorded outside of the transect walks are included in the automated legend count.*

Local trees were the most frequent used staking material. However, the term 'local tree' – often used in the local language - is a bit problematic, because it does not tell whether or not these stakes are obtained from species in the forest. Nor does it distinguish between different types of 'local' species used. Eucalyptus is a non-native species that is planted for timber and is mostly found in the 'upper belt' parishes close to streams. For farmers, the availability of pruning's of Eucalyptus could be a more important source of stakes than the forest. Especially for farmers who live further away from the forest.

The costs of stakes differed from 1,000 to 3,000 Ugandan Shilling⁴ (USh) per bundle. The price depends on where the stakes originate from and how much transport costs are involved. Most farmers collect the stakes themselves, either from their own trees or from the forest.

In Kutung, the price of a bundle of coffee stakes was between 2,500 and 3,000 USh and the price of a bundle of Eucalyptus was 3,000 USh. In Kapchesombe, a bundle of Eucalyptus was around 2,000 USh. In Kapchesombe, a bundle of local

⁴ 3503 USh is equal to 1 Euro (11 August 2014)

trees that originates from the plains costs around 3,000 US\$ which includes 500 US\$ transport costs. A bundle of local trees from Kapchesombe costs around 1,000-3,000 US\$. The latter was the price for a bundle of around 50 stakes. A farmer in Kirwoko parish bought 'local' stakes that originate from Teswo in Kween district at 2,000 US\$ per bundle. A bundle of bamboo stakes can contain up to 100 stakes while a bundle of Eucalyptus might only contain 30 stakes. Only in the last transect walks the amount of stakes in a bundle was added as a question for clarification.

3.3.4 What staking methods are used?

Almost all farmers used the single staking method to grow climbing beans. During the transect walks only one field was observed with another staking method. In Kapchesombe, a young farmer used tripods. This was the first year he grew climbing beans and he said he had learnt this method from someone uphill – direction of Kwoti or Kapenguria parishes. The method was not copied from the nearby N2Africa demonstration field as these were staked at a later moment.

While carrying out the other two objectives of this internship – Use Survey interviews (Chapter 4) and *Pairwise Comparison* (Chapter 5) – I found only two other farmers - both in Kapchesombe parish – who were experimenting with different staking methods:

- Single stakes and banana fibre ropes: This farmer used stakes of various lengths and found that some of them were too short. He used banana fibre ropes to connect the tips of short stakes with the longer ones. This would allow the beans to continue to climb. 2014A was the second season he grew climbing bean and the first season in which he used this method, which he developed himself.
- Tripods and sisal strings: A wealthy farmer got inspired by this year's N2Africa demonstration fields on the different staking methods (Chapter 5). He used long bamboo stakes for making tripods. He also built a construction of poles and barbed wire from which to hang sisal strings. This farmer wants to produce climbing bean on a commercial level.

3.3.5 What are the estimated climbing bean field sizes?

The size of climbing bean fields was estimated using the demonstration plots in Kapchesombe and Kirwoko as a reference (Chapter 5, figure 5.1). One demonstration field consists of eight treatment plots. One treatment plot is 100 m² – 10 by 10 meter. The observations were divided in the following categories: <100 m², 100-200 m², 200-400 m², 400-800 m², and >800 m². For intercropped climbing beans, the total field size was taken into account. However, estimating the field size of a climbing bean in intercropped fields, as banana and coffee trees limit the view.

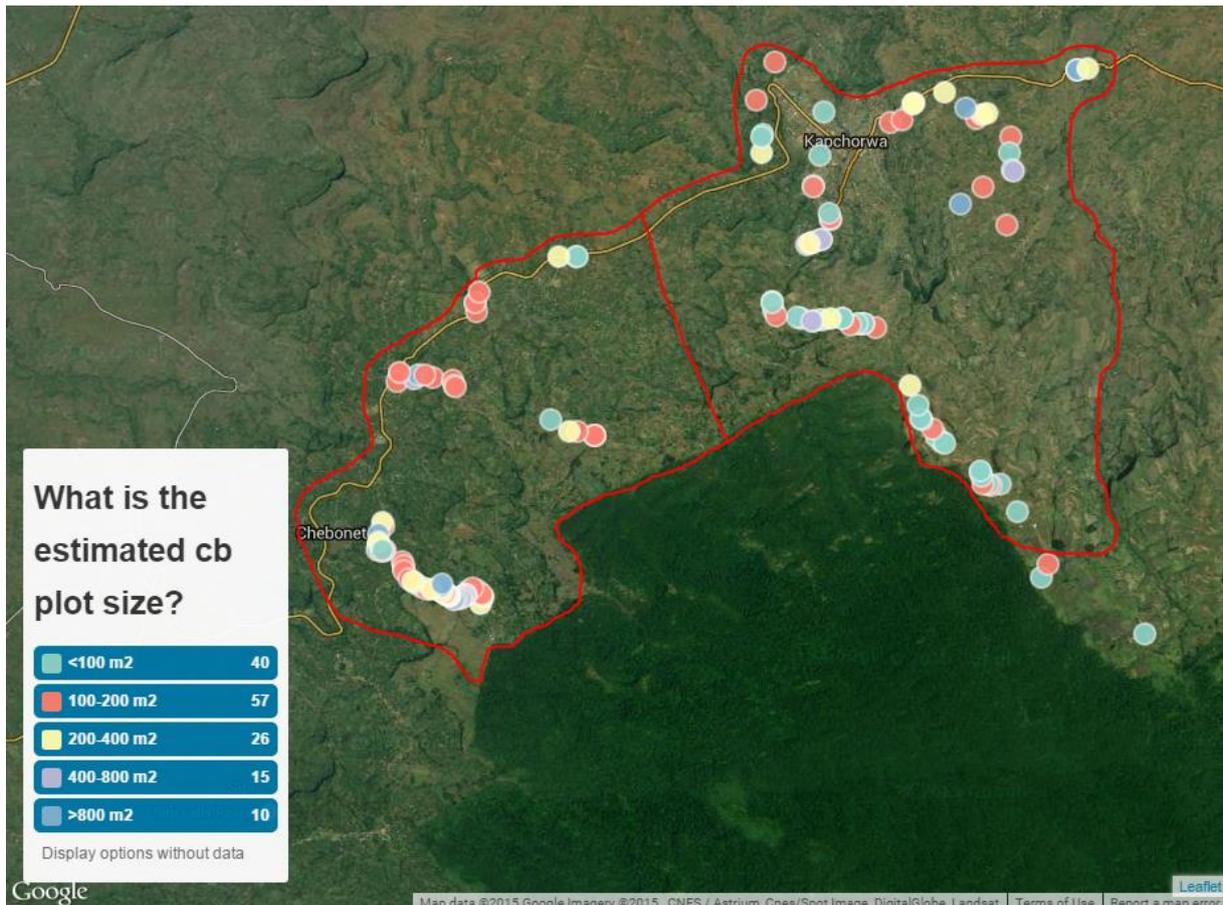


Figure 3.7. Estimated climbing bean plot sizes in Kapchorwa district. Study area is outlined in red. Note: observations recorded outside of the transect walks are included in the automated legend count.

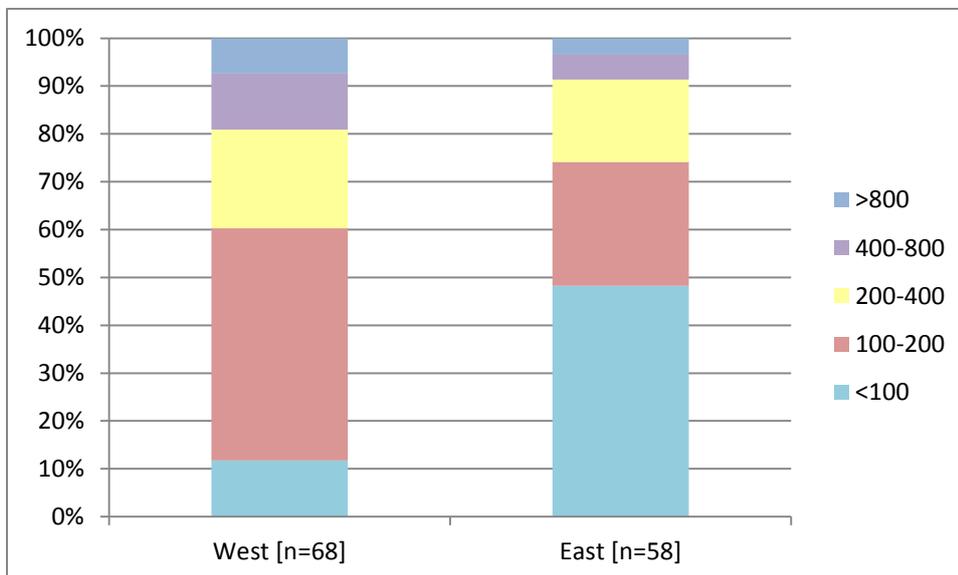


Figure 3.8. Estimated climbing bean plot sizes in West and East Kapchorwa. Only observations from the transect walks within the study area were included here.

The area allocated to climbing bean plots appear to be larger in the West of Kapchorwa district (see Figure 3.7). In the West, only 12% of the observed fields were smaller than 100 m² compared to 48% in the East (see Figure 3.8).

A Chi-square test of independence was performed to examine the relations between plot size in West and East Kapchorwa. The relation between these variables was significant, $\chi^2(4, N=126)=21.43, p=0.00$. These results suggest that there is a clear difference in the size of climbing bean plots used by farmers in West and East Kapchorwa.

3.3.6 In which year did farmers start cultivating climbing beans?

All of the interviewed farmers in the study area started with climbing bean cultivation after 2006. In the eastern region (see Figure 3.9), the first reported year was 2009. Because only a small number of farmers were found near their field during the transect walks, and therefore, very little information on the first year of climbing bean cultivation was obtained. Based on the information from the interviews during the transect walks it is not possible to confirm the hypothesis that climbing bean cultivation is spreading from west to east.

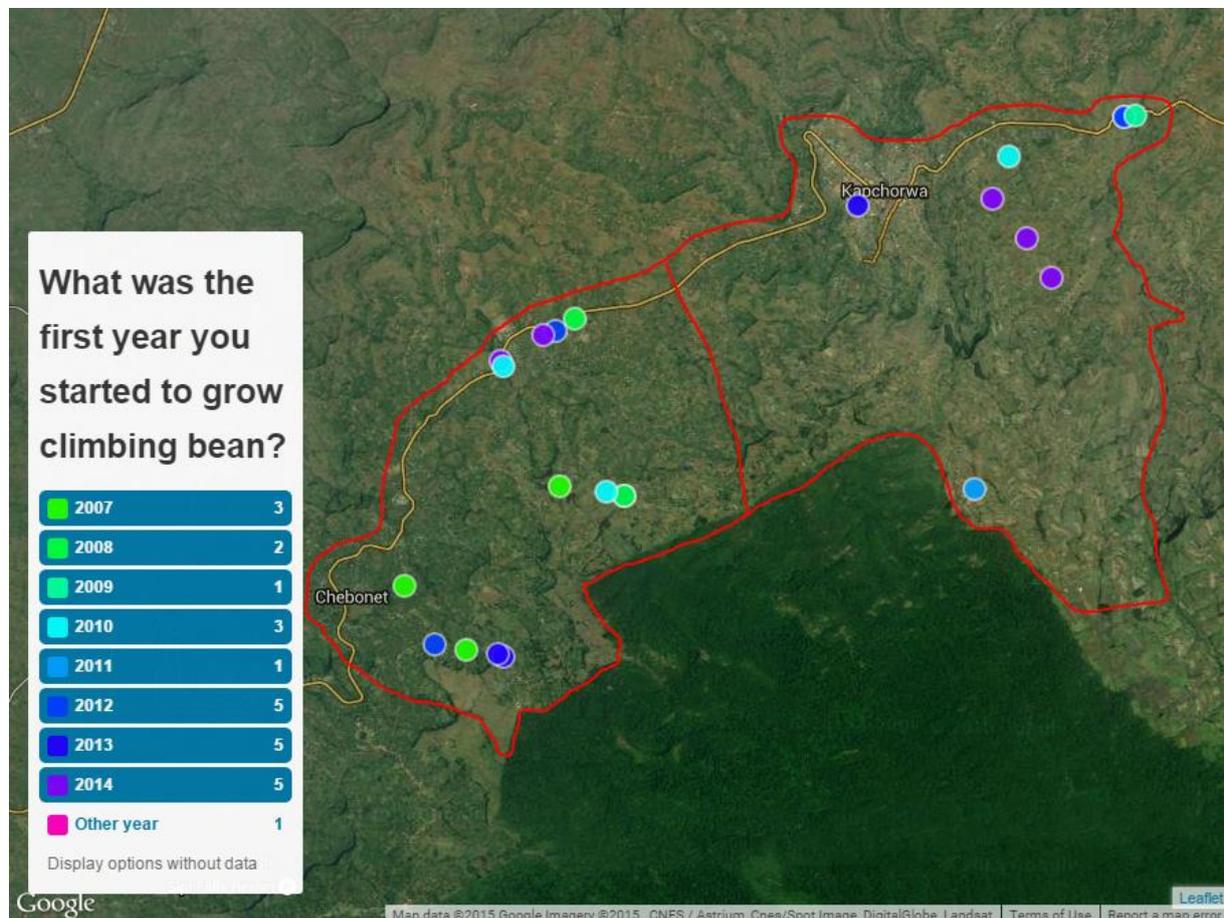


Figure 3.9. First year of climbing bean cultivation in Kapchorwa district. Study area is outlined in red.

In Tegeres, the site supervisor of the N2Africa demonstration field was one of the first to grow climbing bean in his parish. He bought the first seeds of Atawa red and Muzongoto from a market in Kamus in neighbouring Bulambuli district in 2007. He has no interest in growing bush beans anymore because this type of bean gives a low yield and is less resistant to blight. The previous year he sold around 87 kg of climbing bean to other farmers. However, he could not tell if the buyers used these seeds for planting only or for consumption as well. A neigh-

bour started growing climbing bean (Atawa red) since 2008. He bought his first beans from a shop in Kapchorwa town. The previous year he sold around 50 kg to other farmers for planting. Another neighbour started in 2010 and cultivated Atawa and a variety that is called Kangewa (small red beans). Last year he sold 30 kg of Atawa to other farmers for planting. A farmer who started in 2012 obtained seeds from his neighbours, although it is not clear whether he bought them or received them as a gift to try out.

In Ngasire parish, where climbing bean cultivation is common. One family has been growing climbing bean (Atawa variety) since 2007 and is cultivating them on at least four fields. Their son owns two of these fields now and has started in 2013 with the cultivation of climbing bean.

3.3.7 Where did farmers obtained the seeds for the current year from?

In Tegeres parish, farmers used seeds from their own stock for planting this year. In Ngasire, a young farmer used the seeds from his parents stock. In Kuntung parish, farmers who were cultivating climbing bean for a number of years relied on their own stock, farmers who have only started this year bought their seeds from a nearby shop or from neighbours. In Kaptoyoy parish in neighbouring Kween district, the farmers relied on their own stock, except for one farmer who claimed to have planted 100 kg this year. He bought these seeds in a shop in Kapchorwa.

3.3.8 Climbing bean cultivation in neighbouring districts

In [Kween](#) district – east of Kapchorwa - the uptake of climbing bean cultivation appeared to be low (see Figure 3.10). In [Kono](#) parish, between 1900-1820 m.a.s.l., no fields of climbing bean were observed. Along the main road from Kapchorwa to the Kenyan border, only a few fields were observed in [Kaptoyoy](#), around 1880 m.a.s.l. Farmers who live close to the main road in Kaptoyoy started to grow climbing bean since 2013 but said they lack knowledge on how to grow this crop. They bought the first seeds in shops in Kapchorwa town, Tegeres or Sipi. At the border of Kapchorwa and Kween district, at around 1900 m.a.s.l., a farmer had planted several large fields of climbing bean. Around 100 kg of seed was planted according to the owner this season.

In [Kaseko](#) parish, at around 2150 m.a.s.l., a number of fields with climbing bean were found. According to a local informant, the farmers growing these beans are of the Bagisu tribe and have moved to this place recently.

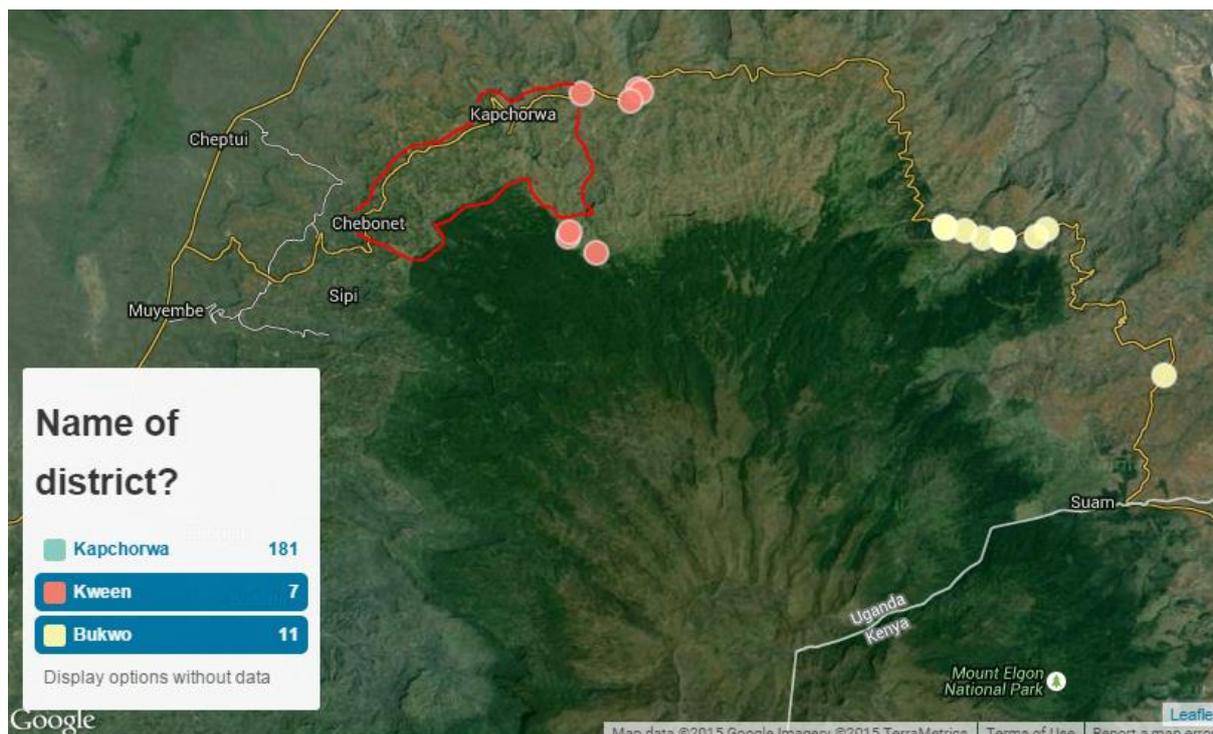


Figure 3.10. Observations of climbing bean cultivation outside the study area in Kapchorwa district. Study area is outlined in red.

In [Bukwo](#) district along the main road to the Kenyan border, only in two places climbing bean fields were observed. One field of climbing bean was observed near Suam at around 1940 m.a.s.l. The lady received the seeds from a neighbour in 2013 and this was the second season she was planting. Her neighbour moved in from Mbale and brought the seeds with him two years ago. Along the road from Kapchorwa to the Kenyan border, in [Chesower](#) sub-county, around ten fields of climbing bean were observed, between 2000 and 2150 m.a.s.l. According to the translator, these farmers used to live in Sipi (Kapchorwa district) and moved or returned here recently. These farmers have continued the practice of growing climbing beans.

Additional note

For details of individual observations, the maps in figures 3.3., 3.4., 3.6., 3.7., 3.9., and 3.10. are accessible via ona.io; user name JanHuskens; password 8Kapchesombe8; Form kapchorwa_observations_final.

Chapter 4: Evaluation of the *Survey on the use of technologies by N2Africa farmers*

The aim of this chapter is to evaluate the approach and practicalities of conducting the *survey on the use of technologies by N2Africa farmers* in the field. Data analysis is limited to two aspects: the adoption of climbing bean cultivation by farmers, and cropping systems used for climbing bean cultivation in the study area. In the synthesis (Chapter 6), the results of this survey are compared with the outcomes of Chapter 3. Further analyses of the collected data during this part of the fieldwork were beyond the scope of this internship.

Objectives:	<ul style="list-style-type: none"> ➔ Evaluate the approach and practicalities of conducting the <i>survey on the use of technologies by N2Africa farmers</i>. ➔ Create overview maps of: <ul style="list-style-type: none"> • The first year farmers started cultivating climbing beans in Kaptanya sub-county. • Cropping systems used for the cultivation of climbing beans in Kaptanya sub-county.
Means:	<i>Survey on the use of technologies by N2Africa farmers.</i>
Activities:	<ul style="list-style-type: none"> ➔ Carry out at least 50 structured interviews with farmers in Kaptanya sub-county who: <ul style="list-style-type: none"> • participated in N2Africa on-farm demonstrations in 2013. • bought seeds through N2Africa in 2014.
Deliverables:	<ul style="list-style-type: none"> ➔ Excel sheet with survey results. ➔ Evaluation of the <i>Survey on the use of technologies by N2Africa farmers</i>. ➔ Maps and reflection on results.

4.1 Purpose of the survey

In the second season of 2013, sixty farmers in Kapchesombe and Kirwoko parishes - Kaptanya sub-county, East Kapchorwa District (see Figure 4.1.) - participated in N2Africa on-farm demonstrations. Each participating farmer provided a plot of 100 m² that was divided into four treatments. A new climbing bean variety, NABE 12C, and a local climbing bean variety from Kabale were grown both with and without any inputs. The treatments with inputs were fertilized with Triple Super Phosphate (TSP) and manure, and Rhizobium inoculant was applied.

We wanted to learn which of the demonstrated practices farmers were still applying in the first season of 2014, and, therefore, a survey on the use of technologies by N2Africa farmers was conducted. The project facilitated the sale of seeds of an improved variety (NABE 12C) as well as TSP fertilizers through local N2Africa distributors, so farmers had the opportunity to buy these inputs. The seeds were also available for farmers who did not participate in last year's demonstrations. The *survey on the use of technologies by N2Africa farmers* was also conducted among a number of farmers who bought seeds this season and did not participate before, to see if the practices used by these farmers differ from those who participated in the demonstrations of the previous season.

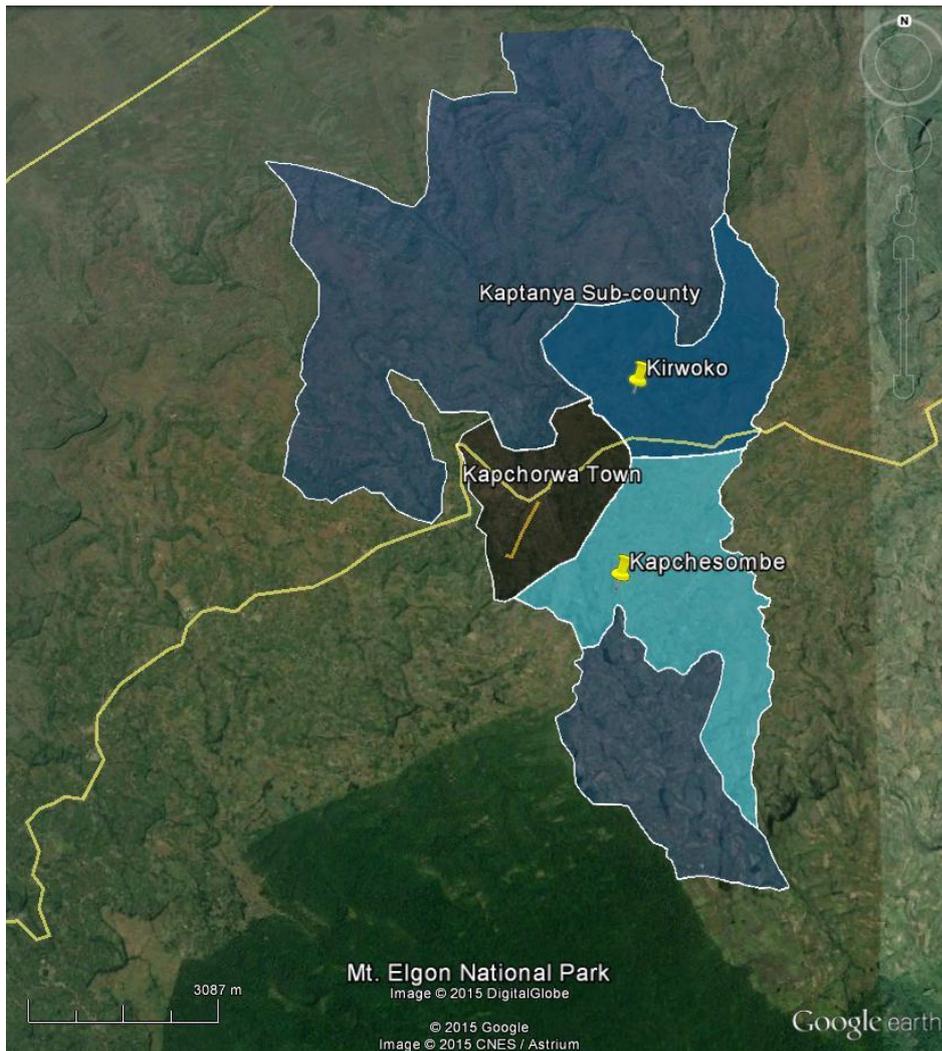


Figure 4.1. Overview map of Kaptanya sub-county in East Kapchorwa District.

Most farmers were visited after they had done the staking so it was possible to check what method for staking they were using and if the 2014 demonstration fields (Chapter 5) were already influencing farming practices or not. In general farmers were not trying any of the new staking methods from the 2014 demonstration fields. They wanted to see the results first before applying it to their own fields. In total 57 farmers were visited for the use survey, of which 42 participated in demonstrations last year and 15 did not participate but bought seeds this year (see Table 4.1).

Table 4.1: Amount of farmers interviewed who participated in 2013 demonstrations and/ or bought seeds through N2Africa.

	Participated in the demonstrations of 2013B	
	Yes	No
Kapchesombe	21	11
Kirwoko	21	4

4.2 Evaluation of the survey

4.2.1 Tracing farmers

The fields used in 2013 for the on-farm demonstrations could be traced easily with the GPS-coordinates from the N2Africa Field Books and a GPS-tracker. Most of these fields were close to the homestead of the owner. It proved to be more difficult to trace the farmers whose fields were not close to their homestead. The same was the case for farmers who bought seeds through an N2Africa seed distributor, as only a name and the name of the village were available. With the help of local people, most farmers could be traced eventually.

In the table below an overview is provided of some of the challenges encountered during the tracing of the farmers, with suggestions to overcome these challenges.

Challenges or limitations	Suggestions for improvement
Initially, it was not clear if the GPS-location in the Field Books was of the fields or the homestead.	In case the field is not in the proximity of the homestead, GPS-locations of the field and the homestead should be noted in the Field Book.
It was not always clear if the partners of farmers who bought seeds through the N2Africa distributor, participated in the demonstrations in the previous year.	Record the names of the partner in the Field Book and on the list of seed buyers as well. Two names make it easier to find the right farm.
Unexpected visits were in general not a problem, however for the farmers who live in more remote areas with no other farmers to interview nearby, it would be nice to check in advance if they are at home.	The N2Africa seed distributor should keep track of the phone numbers of the farmers who buy seeds. Phone numbers of those interviewed for this survey are now available as well.

4.2.2 Cooperation of farmers

Farmers were friendly and it was no problem to make some time for an interview. The purpose of the interview was explained at the beginning of the interview and it was also explained that the collected data would remain confidential. When I was using the GPS-tracker, I explained what it does and that it is used to find this farm again in the future.

In Kapchesombe, there were some questions about the demo of last year. Some participants did not understand the agreements that were made last year very well. They could get money for appreciation if the plot was managed well. Initially, I did not understand what was agreed upon in the previous year, so I told them I would write down their complaints and forward. Many of the farmers thought they were supposed to get 30,000 US\$ for the stakes. At least one person seemed to be quite angry about it because he thought that people were still supposed to get money.

4.2.3 Questions in the survey

The questionnaire (Appendix B: Survey on farmers' use of N2Africa technologies) worked well. Farmers did not have any problems with answering very personal questions, e.g. if they were struggling to find food in certain months. Many farmers did not remember the varieties that were planted or fertilizers that were used in the demonstration fields because they were insufficiently involved at the time of planting.

For the first interviews, I copied the part with general questions on household characteristics, farm size, the number of livestock, etc. from the Field Books of the previous year. However, there were many differences between the answers that were given and the field books. In some cases there was a rather large age difference, the family size did not match or it turned out that they did not have pigs and that they never had them. So I decided to ask all questions again.

Challenges or limitations	Suggestions for improvement
In Part D of the survey, the question on <i>suggestions for improvements of the demonstration field</i> was not understood well in general.	I changed this question to: <i>What advice would you give to other farmers if they want to get a good yield?</i> This question was understood better.
Language	An additional note that I made was the language that was used for the interview. This makes it easy if the person needs to be contacted in the future, e.g. by phone, and if a translator is required.

4.2.4 General suggestions for improvement

In this section, I make some general recommendations that could help to improve data collection through surveys.

Challenges or limitations	Suggestions for improvement
We know very little about the farmers who buy seeds through N2Africa. In case, a lot of farmers buys seeds it is nearly impossible to visit all of them for interviews like the <i>survey on the use of technologies by N2Africa farmers</i> .	If new seeds are going to be distributed again through a person in the community, this would be a good opportunity to get some more information from the buyers, e.g. if this is the first time to grow climbing bean or not, since when they are growing climbing bean, what other varieties are they going to plant, etc. It would require some proper instruction of the seed distributor and their family members. Questions could also be translated into local language. Multiple choice questions could be used to avoid having difficulties with reading the answers.
The answers from the survey need to be converted from paper to Excel. This is a time-consuming task.	Use a tablet with an XLSForm to enter data immediately when carrying out an interview. This is most suitable for the parts with general questions (Appendix B: Survey on farmers' use of N2Africa technologies Part A and B). It could be useful to

send data every couple of days to a data-base. This would speed up the work and it would be easy for supervisors to keep track of the progress. If the device has a camera it would be easy to link relevant pictures to a questionnaire. Disadvantages could be that it breaks down, it could get stolen, or you can run out of power.

There were a lot of farmers who did not remember what inputs were used in the demonstration of the previous year. Often this was because they were not involved in the planting.

I would suggest to give leaflets to farmers that explain what was done and why, what inputs were used (with pictures), phone numbers of people that they can call if they have questions, e.g. the extension officers from the Sabinu Agro Commodity Cooperative (SACCO). Farmers can have a look at it again later, e.g. just before planting in the next season. If these farmers are visited by people from another organisation it is easier for them to understand the purpose of this N2Africa project, just by reading the leaflet.

4.3 Observations

4.3.1 What cropping systems are used?

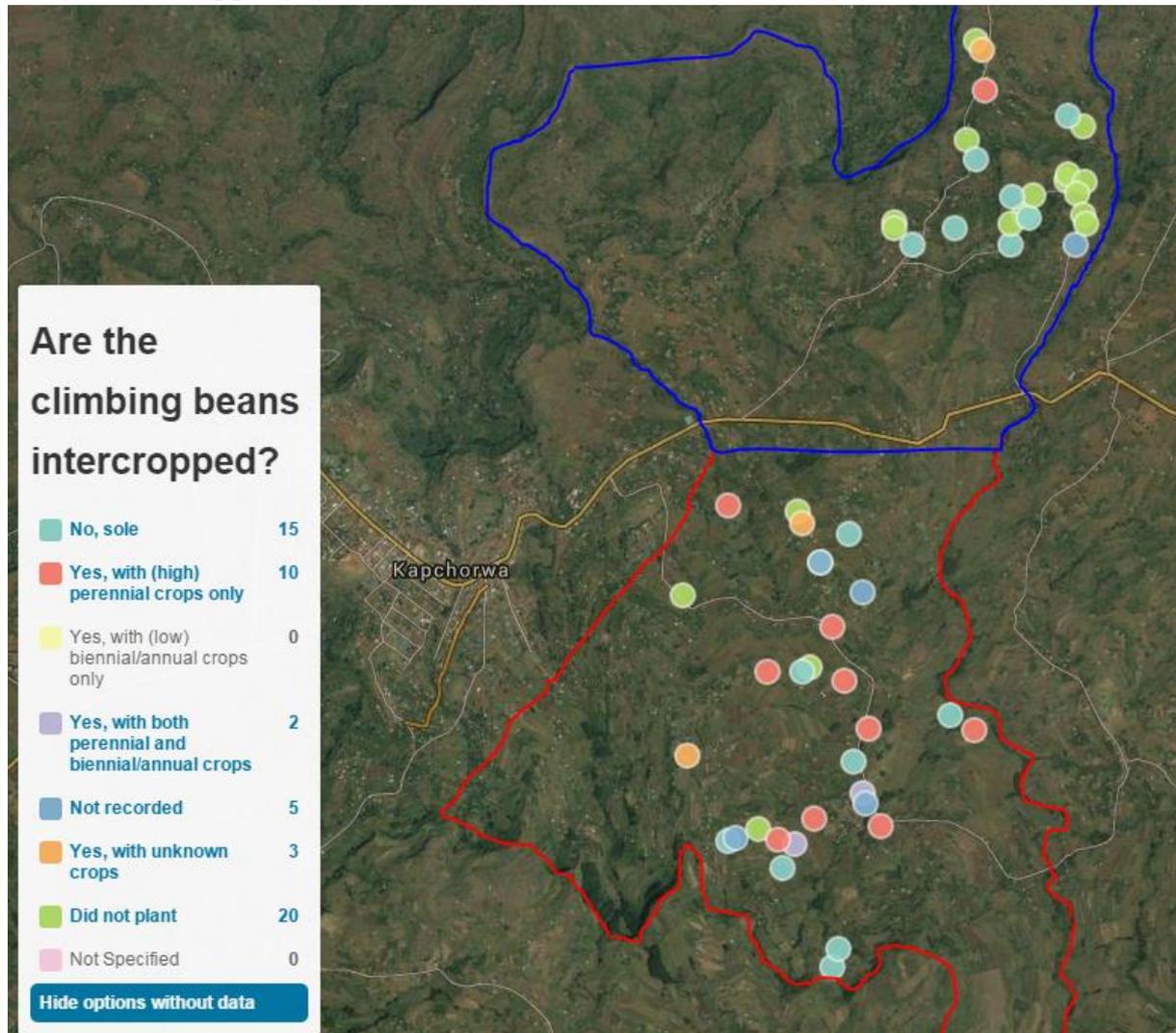


Figure 4.2. Climbing bean cultivation methods used in Kaptanya sub-county. Kapchesombe parish is outlined in red; Kirwoko parish is outlined in blue. Note: 2 observations are not included as exact GPS-locations are incomplete.

In Kirwoko parish 16 – out of 21 – farmers who participated in the N2Africa on-farm demonstrations in the second season of 2013 did not plant climbing beans in the first season of 2014 (see Figure 4.2). In 2013, the demonstration fields were planted late and most of the fields were affected by drought. As a result only very few farmers obtained enough seeds to replant in the next season. Although seeds were available through a local N2Africa distributor, not everyone was aware of that.

In Kapchesombe parish, five – out of 21 – who participated in the N2Africa on-farm demonstrations in the second season of 2013 did not plant climbing beans in the first season of 2014. In Kapchesombe, the demonstration fields were less affected by drought. Reasons for not planting varied. Some farmers did not have

enough time or land to plant, or they were planning on planting again in the second season – e.g. with maize stalks as stakes.

Fifteen – out of 27 – farmers in Kapchesombe parish who were cultivating climbing bean in the first season of 2014 used sole cropping for the cultivation of climbing bean (see Figure 4.2.). Nine were only intercropping with perennial crops like banana and coffee, and two farmers were intercropping climbing bean with both perennial, biennial (cassava) and annual crops like maize, Irish potatoes, and pumpkin. One farmer was experimenting with both intercropping with perennials and sole cropping to see what method works best for her own farm. Eight – out nine - farmers in Kirwoko parish used sole cropping for the cultivation of climbing bean in the first season of 2014.

4.3.2 In which year did farmers start cultivating climbing beans?

Farmers in Kapchesombe parish appear to have started earlier with the cultivation of climbing bean than in Kirwoko parish (see Figure 4.3.). In Kapchesombe parish, the first farmers started around 2004 and 2005. A couple of years later in 2010 and 2011, more farmers started to cultivate climbing beans. 38 farmers - from both parishes - had only started after 2012 when the N2Africa demonstrations took place. Thirteen farmers in Kapchesombe parish had cultivated climbing bean before the N2Africa demonstration and seed sale. Six of these farmers started with a variety called Atawa red. Muzongoto and Kabale are other varieties grown before. In Kirwoko parish, 2011 was the first recorded year a farmer started growing climbing beans.

In Kapchesombe parish eleven – out of 27 - farmers relied on the harvest of last year for replanting. Eight of these farmers replanted the NABE 12 variety from the N2Africa demonstration. Twelve farmers got their seeds from multiple sources (storage, bought through N2Africa, or bought elsewhere) or were using more than one variety this year. Fifteen farmers – including two participants of the previous year’s demonstration - bought their seeds through N2Africa for the first season of 2014.

Climbing bean seems to be adopted by farmers as a crop in Kapchesombe and farmers know where to get seeds from. A number of farmers in Kapchesombe mentioned that they bought climbing bean seeds at a shop in Kapchesombe. That indicates that shop owners in Kapchesombe know that there is a demand for these beans. In Kirwoko, the farmers who did not buy their seeds through N2Africa bought their seeds in Kapchorwa town. This could indicate that these beans were not yet available at the local shops. The community mobilizer in Kirwoko did not inform all of the participants of last year’s demonstration about the seeds that were made available through N2Africa. Farmers, who never had any seeds in stock, were not informed about seeds available through N2Africa. Those who could not buy seeds at a local shop might not have been very motivated to look for new seeds elsewhere. This could explain why the farmers in Kirwoko parish - of whom many of the climbing beans were affected by drought in the

second season of 2013 - did not cultivate climbing bean in the first season of 2014 again.

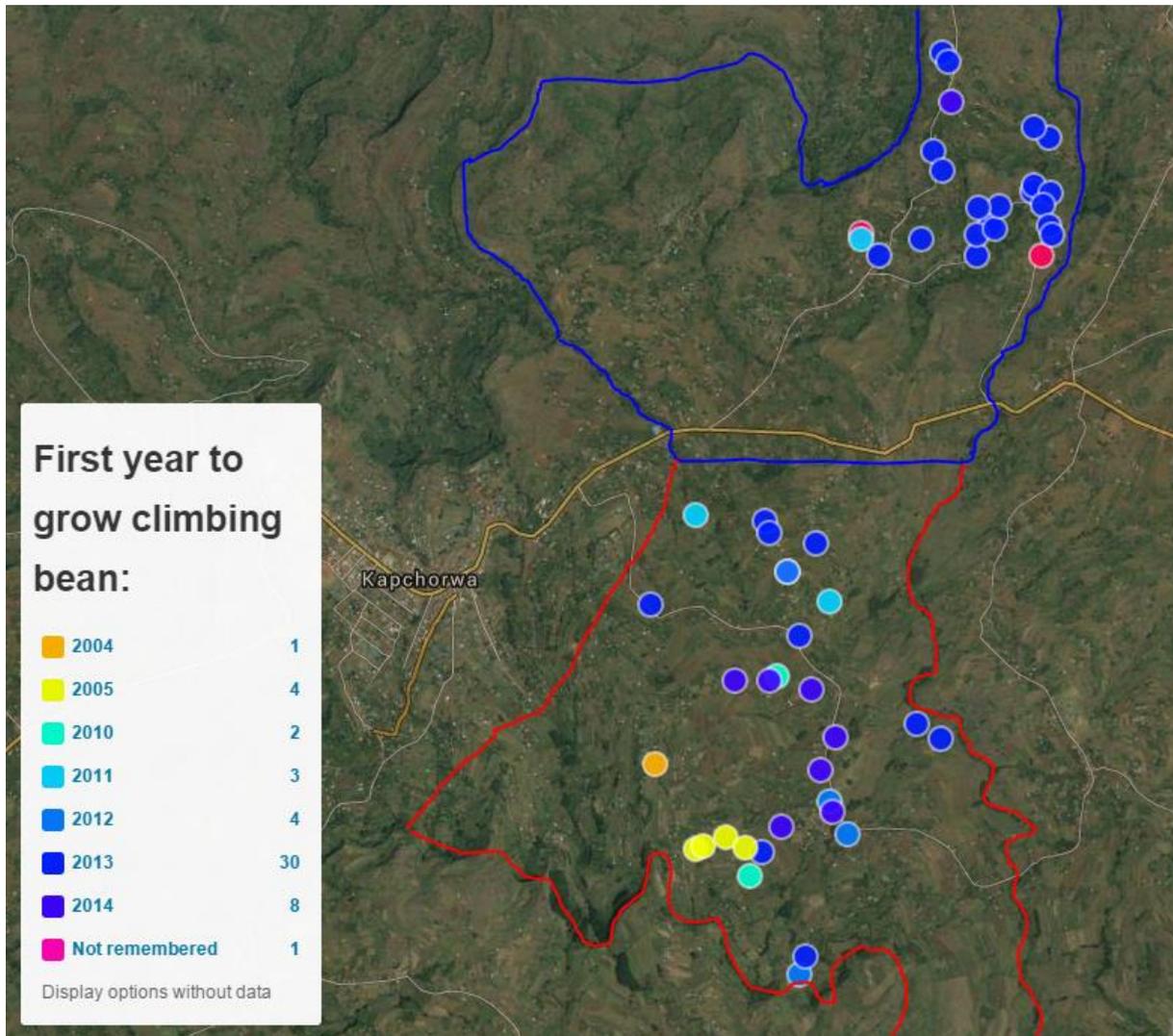


Figure 4.3. First year of climbing bean cultivation in Kaptanya sub-county. Kapchesombe parish is outlined in red; Kirwoko parish is outlined in blue. *Note: 4 observations are not included as exact GPS-locations are incomplete or first year was not recorded.*

Additional note

For details of individual observations, the maps in figures 4.2. and 4.3. are accessible via ona.io; user name JanHuskens; password 8Kapchesombe8; Form kaptanya_first_year_cb_and_ic.

Chapter 5: Evaluation of the *Pairwise comparison and ranking of treatments in the demonstrations.*

The aim of this chapter is to evaluate the approach and practicalities of the *pairwise comparison and ranking of treatments in the demonstrations* in the field. Analyses of the collected data during this part of the fieldwork were beyond the scope of this internship.

Objective:	Assess together with farmers the performance of the different treatments in the N2Africa demonstration plots.
Means:	Demonstration plots are assessed by using a <i>pairwise comparison and ranking of treatments in demonstrations.</i>
Activities:	At each of the four selected locations: <ul style="list-style-type: none">• Assess together with six groups of farmers from different wealth categories – rich, medium, and poor - and gender the current (season A 2014) N2Africa demonstration fields.• Carry out two <i>pairwise comparisons</i> sessions – at staking and at flowering – of 30-60 minutes for each of the four selected location.
Deliverables:	A digital version of the collected data of 48 <i>pairwise comparison</i> sessions in Excel.

5.1 Purpose of the *pairwise comparison and ranking of treatments in demonstrations*

Demonstrations of climbing bean with different staking methods, stake lengths, plant densities, varieties and inputs were set up in Kapchorwa District by the staff of the N2Africa project. A total of seven demonstrations were set up, divided over six parishes and along an altitude gradient on the slopes of Mt. Elgon (see Figure 3.1.). Three demonstrations with different staking methods, stake lengths and plant densities were set up in Kapchesombe and Kirwoko parishes (see Figure 5.1.). Four demonstrations with different staking methods, climbing bean varieties, and inputs were set up in Chemosong, Kapkwai, Kutung and Tegeres parishes (see Figure 5.2.).

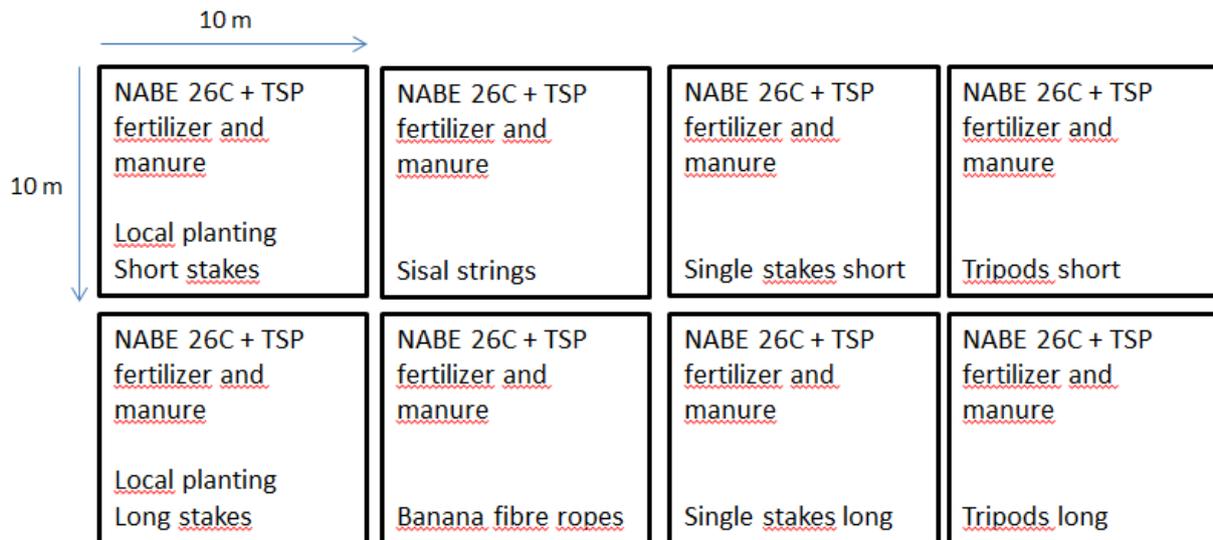


Figure 5.1 Outline of demonstration fields in Kapchesombe upper, Kapchesombe middle and Kaptanya (Kirwoko parish). Climbing bean variety used: NABE 26C.

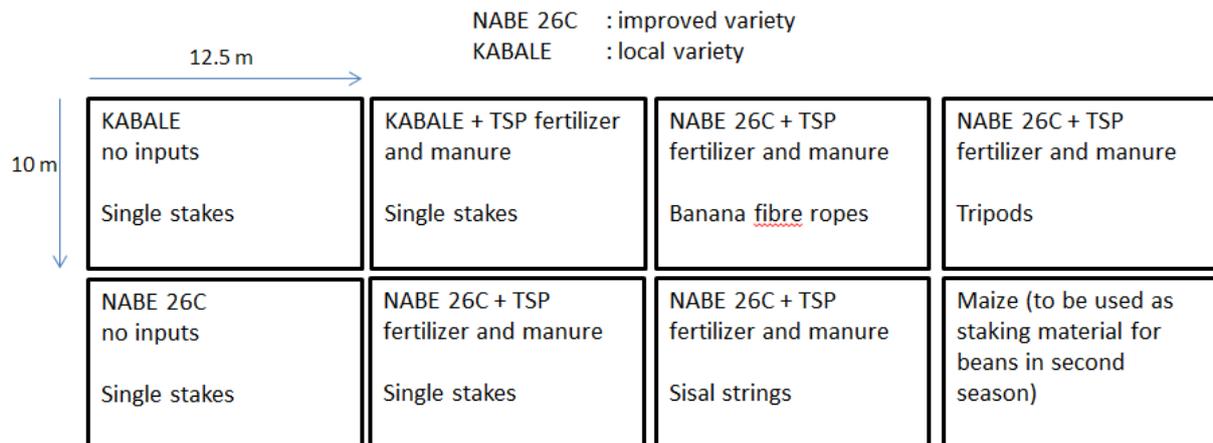


Figure 5.2. Outline of demonstration fields in Chema middle (Chemosong parish), Chema upper (Kapkwai parish), Tegeres middle (Kutung parish), and Tegeres upper (Tegeres parish). Climbing bean variety used: NABE 26C and KABALE.

In each of the four parishes - Kapchesombe, Kirwoko, Chemosong and Kapkwai - six groups of farmers were invited to give their opinions on the different treatments in the demonstration fields. The groups, consisting of six to eight farmers, were selected before in participatory wealth ranking meetings with people who know the community well⁵. The farmers were divided in high, medium and low resource endowed groups for both men and women.

Farmers in Kirwoko and Kapchesombe were asked to compare and rank eight treatments with different staking methods, stake length and planting densities. In Chemosong and Kapkwai, the farmers were asked to compare and rank seven treatments with different staking methods, bean varieties and fertilizer applica-

⁵ The participatory wealth ranking meetings in Kapchesombe, Kirwoko and Kapkwai were carried out by Esther Ronner, and the one in Chemosong was carried out by Jan Hüskens.

tion. The ranking of treatments was done through a *pairwise comparison* of the treatments. The focus of the *pairwise comparison* was on understanding why farmers prefer one method over another and what aspects of a treatment they are more likely to apply on their own field in a next season, and if there were differences in preference between the groups of farmers.

In total the treatments in the demonstrations were compared four times: at planting, staking, flowering, and at harvesting. The amount of labour that is needed to work on crop management differs per treatment. Therefore, the treatments were compared at the moments that the most important crop management tasks take place. The treatments were also compared at the time of flowering and pod development when plant biomass is highest and differences between treatments become visible. Within the time frame of this internship, only the *pairwise comparisons* at the time of staking and flowering were carried out.

5.2 Evaluation

5.2.1 Contact with community mobilizers

Community mobilizers were contacted about one to two weeks before the *pairwise comparisons*. They were asked to select a day that was most suitable for farmers in their parish. I called the mobilizers every couple of days to see how the mobilization was going, and I would also call in the morning of the evaluation to inquire when the first group would be ready. Unfortunately, evaluations were often postponed by the mobilizers for various reasons. It was good to check with the mobilizers if the evaluations really could take place. If this was not the case there was enough time to focus on other work, e.g. the survey on the use of technologies by N2Africa farmers (Chapter 4). It would also prevent making any unnecessary trips to for example Kapkwai. However, staying in touch with the mobilizers was not always possible and sometimes resulted in waiting for no one to come. For communication with the mobilizers by phone, I would use the translator, as this was necessary to make sure that there was mutual understanding.

Table 5.1. Attendance of farmers for the *pairwise comparisons*.

Location	Timing of <i>pairwise comparisons</i>	Dates	Female			Male		
			High	Medium	Low	High	Medium	Low
Chemo-song	Staking	05-05	3	3	3	4	2	3
	Flowering	12-06	5	4	6	3	3	4
Kapkwai	Staking	21-05; 01-06	3	5	2	3	5	6
	Flowering	16-06; 22-06	2	4	3	3	6	2
Kirwoko	Staking	08-05; 11-05; 14-05	4	4	4	4	3	3
	Flowering	15-06; 27-06	3	3	4	3	4	3
Kapche-sombe	Staking	27-05; 31-05	3	6	3	2	3	5
	Flowering	28-06	2	2	3	2	3	2

For the mobilization of the farmers, I asked the community mobilizers to get at least half of the people that were selected for each group. In most cases around three farmers per group showed up (Table 5.1). The right people were mobilized, with the exception of the evaluation at staking in Kirwoko.

For Kirwoko there were only five to six people selected for one group and the mobilizer had some problems in reaching many of the selected people, therefore he invited others (probably from the same church group) to join. It turned out that more people that were not on the list were there than people that were on the list. Because of this mistake, which was not noted at the time of the pairwise comparisons in Kirwoko, I had to check if the additional people that were selected by the mobilizer for a certain wealth category really suited to that group. Therefore, I visited the people who participated in the participatory wealth ranking in Kirwoko to ask for their opinions. Most of the additional farmers that were invited would fit within the group that the community mobilizer had allocated them to. There were some mismatches, especially when farmers fit in between low and medium, or medium and high resources endowed. It was decided that there was no need to do the pairwise comparisons again. For the next pairwise comparisons, the community mobilizers were instructed again not to bring other farmers, but only the ones that were selected during the participatory wealth ranking meetings.

4.2.2 Demonstration fields at the time of the pairwise comparisons

The demonstration fields were set-up by an N2Africa technician in cooperation with local extension officers and local farmers. Maintenance of the fields was the responsibility of the plot owner and the community mobilizer. When the pairwise comparisons were carried out at the time of staking all the treatments were ready, except for the banana fibre and sisal string treatments. These two treatments were delayed, because of issues with acquiring the timber to attach the strings to. In Chemosong, Kapkwai and Kirwoko the frames were ready, but the ropes were not installed yet. The banana fibres were supposed to be prepared by the owner of the demonstration plot, but they were not really motivated to do this. The N2Africa technician had to put some pressure on them to make sure that these treatments were ready, especially because the climbing beans were looking for support already. In order to make sure that the farmers would understand the concept of these treatments I installed some ropes prior to the pairwise comparisons or together with the first group.

The banana fibre and sisal string treatments in Chemosong were fully installed right after the pairwise comparisons. Here the work was done properly and these treatments continued to grow well. In Kapkwai, Kirwoko and Kapchesombe the beans were not able to grow well. The horizontal line, to which the other ropes were attached, was not tied very strong. As the weight of the beans increased during the growing season the lines started to hang lower. As a result, the beans in these two treatments were not able to climb up to the intended height. In Kapkwai, the farmers said that they were not convinced by this method because these treatments did not look well. In Kapchesombe and Kirwoko farmers said that the methods could work if they were installed properly, so their opinion seemed to be less influenced by the appearance of the demo.

The beans in Kapchesombe were affected and some leaves turned yellow with brown spots. A possible explanation could be a fungal disease - anthracnose – or the high uptake of iron and manganese up to toxic levels (Giller, Amijee, et al., 1992), but further examination of the affected plants is required. The climbing beans of other farmers in adjacent fields did not have the same problem as they were cultivating other varieties than NABE 26C. The farmers participating in the pairwise comparisons noticed that the beans were affected, but it did not seem to have any influence on the way the treatments were assessed.

5.2.3 The pairwise comparisons

The major challenge with the pairwise comparisons was the length of the interview (Appendix C). While it was expected that the pairwise comparisons would take about 20 to 30 minutes per group, it took between 30 to 45 minutes for Chema (Chemosong and Kapkwai) and 40 to 60 minutes for Kapchesombe and Kirwoko. The pairwise comparisons in Chema were shorter as there were fewer treatments to compare and, therefore, fewer questions. The time required for the pairwise comparisons of one group depended on the level of English of the farmers, the size of the group, and how many things they mentioned for each treatment. In some of the locations, the community mobilizers invited the farmers to come at the same time, which meant that some of the farmers had to wait for three hours and were getting a bit impatient.

The community mobilizers were asked to let the farmers come in shifts, so that they would not have to wait very long. In Kapchesombe, this worked very well, in Kapkwai it worked for the pairwise comparisons at flowering. However in Chemosong and Kirwoko most of the groups arrived at the same time. To make sure farmers did not have to wait for too long in these situations, the community mobilizer helped me with translation and the translator that I brought would interview another group at the same time.

5.2.4 General suggestions for improvement

In this section, I will make some general recommendations that could help to improve data collection through the use of *pairwise comparisons and ranking of treatments*.

Challenges or limitations	Suggestions for improvement
Some community mobilizers gave low priority to their tasks within the N2Africa project. In addition, there is very little exchange of information and good practices between community mobilizers.	Invite all community mobilizers for a meeting prior to the evaluations. Preferably with someone that is perceived as a leader and understands the aim of the internship and the project (e.g. the chairman of the Sabiny Agro Commodity Cooperative, the local partner of N2Africa in Kapchorwa). This would be useful to explain to the mobilizers what is expected of them and what can be expected from the student. Agreements can be made on the money that is going to be paid for the mobilisation of farmers. Besides that, the mobilizers will

	have the opportunity to exchange experiences with each other.
Community mobilizer is not available.	The community mobilizers need to appoint a backup mobilizer for their community in case they are not available.
Demonstration fields are not ready for the pairwise comparisons.	An advice that was given by farmers was that if you want to grow climbing beans you should have the stakes ready before you plant the beans. This is also true for the demonstration fields, for which the stakes and ropes should be ready in time. For the upcoming season, this will not be much of an issue because materials can be reused. If the banana fibre is going to be used again, these should also be prepared in advance, so there is enough time to prepare them properly.
The pairwise comparisons are lengthy and could, therefore, in most locations not be completed within one afternoon. In Kirwoko/Kapchesombe, the first matrix consists out of ten comparisons and the second one of nine comparisons. The Kapchesombe/Kirwoko evaluation was too long.	The evaluations could be shortened by making sure that there are not more than four treatments compared with one another. This would result in six questions for the matrix comparisons. In Chema, there were two matrix comparisons of this length. This was convenient for the groups of farmers.

Chapter 6: Synthesis

Through the *survey on the use of technologies by N2Africa farmer* (Chapter 4), it became clear that farmers started with climbing bean cultivation in the East in Kapchesombe parish in 2004-2005. This is before any of the years found during the transect walks (Chapter 3). After 2012, the number of farmers cultivating climbing beans in Kapchesombe parish started to grow. Analysis of data collected during the transect walks (Chapter 3) led to the conclusion that the density of climbing bean plots – in 2014 - in the East are not significantly different from the density in the West of Kapchorwa district. The N2Africa on-farm demonstrations and the seed sale, must have contributed to this growth in the East of the district.

Transect walks are useful to get an overview of where climbing bean cultivation currently takes place in different areas of the district, but sufficient follow up interviews are required to get a better understanding of the historical diffusion and to identify the pioneers of climbing bean cultivation. Insufficient data on the first year farmers started to cultivate climbing bean in the other parts of Kapchorwa's 'upper belt' has been collected. This was insufficient to fully reconstruct the diffusion of climbing bean cultivation in the past decade. It is, therefore, not possible to conclude that climbing bean cultivation has gradually diffused from West to East in recent years. Instead it is more likely that climbing bean cultivation by pioneer farmers makes large 'jumps' of several kilometers, with the practice slowly copied by neighbouring farmers to eventually become a common crop. The dissemination of climbing bean cultivation techniques and seeds by N2Africa, most likely have speed up this process in the East of Kapchorwa. However, from the advantages and disadvantages given by farmers for each of the different treatments in the – 2014 – N2Africa demonstration fields (Chapter 5), one could easily sense that farmers in the West of Kapchorwa district based their answer more on experience than farmers from the East. They were in general able to name more advantages and disadvantages, and they were more critical towards the appearance of the climbing beans in the demonstration plots.

More differences between West and East were observed. The area allocated to climbing bean in Kapchorwa district is in two-third of the cases smaller than 200 m² per field. Larger fields of climbing bean were more common in the West of Kapchorwa, albeit being more often intercropped. In the West of Kapchorwa district farmers tend to intercrop climbing bean with other crops, especially with perennials such as banana. In the East of Kapchorwa district banana cultivation is not common and climbing bean is often not intercropped here. I assume that the previous year's N2Africa demonstrations in Kaptanya sub-county had little influence on the decision of farmers on whether or not to intercrop climbing beans with banana, because the possibilities for most farmers to use this practice are limited.

Single staking is used by almost all farmers who grew climbing bean in the first season of 2014. And the – 2014 - N2Africa demonstration fields had so far very

little effect on this practice. Adoption of these new techniques could well be a process of several years.

6.1 Recommendations for future studies

In the CIAT Bean Atlas (Wortmann, Kirkby, et al., 2004) – Table 3 - it is being indicated that climbing bean at Mt. Elgon in Uganda is traditionally grown and well established. However, from personal observation I can say that this is not true for all the areas on Mt Elgon – especially those east of Kapchorwa town. In neighbouring Kween and Bukwo districts climbing bean cultivation is still pretty much at the pioneer stage as very few climbing bean fields could be observed here. Therefore, these areas are interesting for studying the diffusion of climbing bean cultivation without the influence of a dissemination campaign.

The transect walks provide a brief snapshot of the practices currently taking place in Kapchorwa district. However, there are some limitations to the use of this approach to understand the diffusion of climbing bean technologies. During a transect walk a couple of climbing bean technologies can easily be observed, such as staking method and whether or not the beans are intercropped. Other relevant information – variety planted and where farmers obtained their seed from - can only be obtained if the farmer is around for a short interview. And even then one might come up with new questions along the way, or after the field work has been carried out. In order to get more information we could resort to the use of mobile technologies. If sufficient phone numbers are collected by the project or a specialised company like TTC Mobile, it would be easy to get in touch with farmers more often. By sending questions via text messages one can easily obtain information from thousands of farmers in an area of choice. In this way it would be fairly easy to map for instance the diffusion of climbing bean cultivation adoption over time. This approach could be used to cover all districts on Mount Elgon.

Other advantages of using mobile technologies are:

- The ability to contact farmers – e.g. the farmers who were interviewed for the *survey on the use of technologies by N2Africa farmers* - on a regular basis. This is especially useful if one wants to know very specific type of information, e.g. the type of staking method or material used, without having to visit all farmers again. This would not only help to observe changes in practices over time, but it also allows for evaluating the effectiveness of demonstration fields.
- Farmers can be informed about the availability of new seeds sold through N2Africa distributors or the location of a new demonstration field. In this way one can assure that farmers in a wider area are informed. This would also tackle the problem of a large share of farmers in Kirwoko parish being unaware of N2Africa seeds being sold prior to the 2014A season.

Lucinda Pouw (12-05-2015) from TTC Mobile estimated the costs for a text survey of 10 questions at 5 USD per participant. Mobile technologies should be used in cooperation with local extension officers for verification.

References

- CIAT. 2008. Highlights CIAT in Africa. The impact of improved bush bean varieties in Uganda. CIAT, Kampala.
- CIESIN. 2009. Population density, 2000 - Uganda.
- Cleassens, L., M.G. Kitutu, J. Poesen and J.A. Deckers. 2013. Landslide Hazard Assessment on the Ugandan Footslopes of Mount Elgon: The Worst is Yet to Come. *Landslide Science and Practice* 1: 527-531.
- David. 1997. Dissemination and Adoption of New Technology: A Review of Experiences in Bean Research in Eastern and Central Africa, 1992-1996. *Network on Bean Research in Africa*, Kampala, Uganda. p. 37.
- FAO. 2014. CountrySTAT Uganda. Population. FAO, Rome.
- FAO. 2014. CountrySTAT Uganda Production quantity of Primary Crops by Year, Product (Tons). FAO, Rome.
- Farrow. 2014. N2Africa Uganda characterisation and stratification p. 48.
- Giller, K.E., F. Amijee, S.J. Brodrick, S.P. McGrath, C. Mushi, O.T. Edje, et al. 1992. Toxic concentrations of iron and manganese in leaves of *Phaseolus vulgaris* L. growing on freely-drained soils of pH 6.5 in Northern Tanzania. *Communications in Soil Science and Plant Analysis* 23: 1663-1669.
- Gray. 1990. Bean (*P. vulgaris*) distribution in africa - first approximation. . CIAT, Cali, Colombia.
- Hoogendijk and David. 1997. Bean production systems in Mbale District, Uganda with emphasis on varietal diversity and the adoption of new climbing varieties. CIAT.
- Kabeere, F. and E. Wulff. 2008. Seed Sector Country Profile: Uganda. Volume I: Overview of seed supply systems and seed health issues. Danish Seed Health Centre for Developing Countries, Copenhagen.
- Musoni, A., J. Kayumba, L. Butare, F. Mukamuhirwa, E. Murwanashyaka, D. Mukankubana, et al. 2014. Innovations to Overcome Staking Challenges to Growing Climbing Beans by Smallholders in Rwanda. 129-136.
- Mwebaze, S.M.N. 1999. Country Pasture/Forage Resources Profiles. In: J. M. Suttie and S. G. Reynolds, editors, FAO, Rome.
- Ramaekers, L., A. Michenl, P. Mbogo, J. Vanderleyden and M. Maertens. 2013. Adoption of climbing beans in the central highlands of Kenya: An empirical analysis of farmers' adoption decisions. *African Journal of Agricultural Research* 8: 1-19.
- Ronner, E. and K.E. Giller. 2012. Background information on agronomy, farming systems and ongoing projects on grain legumes in Uganda. Wageningen UR, Wageningen. p. 34.
- Sassen, M., D. Sheil, K.E. Giller and C.J.F. ter Braak. 2013. Complex contexts and dynamic drivers: Understanding four decades of forest loss and recovery in an East African protected area. *Biological Conservation* 159: 257-268.
- Scott, P. 1998. From Conflict to Collaboration: People and Forests at Mount Elgon, Uganda IUCN, Gland, Switzerland and Cambridge, UK.
- Voyses. 2000. Mejoramiento genetico del frijol (*Phaseolus vulgaris* L.): legado de variedades de America Latina 1930-1999.
- Wortmann, C.S. and D.J. Allen. 1994. African bean production environments: their definition, characteristics and constraints. CIAT, Kampala, Uganda.
- Wortmann, C.S., R.A. Kirkby, C.A. Eledu and D.J. Allen. 2004. Atlas of Common Bean (*Phaseolus vulgaris* L.) Production in Africa. Pan-Africa Bean Research Alliance, Cali, Colombia. p. 129.