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How do climbing beans fit in farming systems of the eastern highlands of Uganda? Understanding opportunities and constraints at farm level

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ABSTRACT

Climbing beans offer potential for sustainable intensification in the East-African highlands, but their introduction requires a major change in the cropping system compared with the commonly grown bush bean. We explored farm-level opportunities, constraints and trade-offs for climbing bean cultivation in the eastern highlands of Uganda. We established current food self-sufficiency, income, investment costs and labour, and assessed the *ex-ante*, farm-level impact of four climbing bean options on these indicators. Input for this assessment were a detailed characterization of 16 farms of four types, and on-farm, experimental data of adaptation trials of climbing bean. Climbing beans generally improved food self-sufficiency and income, but often required increased financial investment and always demanded more labour than current farm configurations. Opportunities for integration of climbing beans on small farms were limited. Although some of the poorest farmers accrued the largest absolute benefits from climbing beans, their ability to make the necessary investments is questionable. The analysis was translated into a simple-to-use modelling tool to enable participatory analysis of the outcomes with farmers of the four farm types to understand their perspectives and decision-making. The discussions revealed a recent increase in market prices for climbing bean resulting in growing interest in their cultivation in the eastern highlands. A lack of seed and stakes was limiting climbing bean cultivation, and a sufficient amount of climbing bean seed needs to be ensured through strengthening of farmer cooperatives and improved storage.

1. Introduction

Common bean (*Phaseolus vulgaris* L.) is an important staple crop in the East African highlands providing an important source of protein, calories, minerals and vitamins. While bush varieties have been widely grown in the region for centuries, climbing bean varieties were introduced through a targeted breeding programme in Rwanda since the mid-1980s (Franke et al., 2016; Sperling and Muyaneza, 1995). Climbing beans have a better yield potential (up to 4 to 5 tons ha^{-1}), produce more biomass and fix more nitrogen than bush beans (Bliss, 1993; Ramaekers et al., 2013; Wortmann, 2001). Especially in areas of high population pressure and small farm sizes, climbing beans offer great potential for agricultural intensification (Katungi et al., 2018). In southwestern Uganda, just across the border with Rwanda, climbing beans have now largely replaced bush beans. In eastern Uganda, on the slopes of Mount Elgon, cultivation is less widespread (Ronner et al., 2018).

Compared with bush beans, climbing beans require a major change in cropping system: bush beans are mostly grown in intercropping with maize, but climbing beans have a more prolific growth and smother the maize when planted at the same time (unlike at cooler, high elevations in Latin America, where maize and climbing bean intercropping is common (Clark and Francis, 1985; Davis and Garcia, 1983)). Climbing beans are therefore better grown as sole crops, which means that, in land-scarce areas, they are likely to replace existing crops. Climbing beans also need to be staked, requiring additional labour and capital (Musoni et al., 2014; Ruganzu et al., 2014; Sperling and Muyaneza, 1995). Such disadvantages may provide constraints for farmers when climbing beans are first introduced.

At field level and in terms of agronomic criteria, the benefits of climbing bean over bush bean are clear and the potential of climbing beans has been evaluated in on-farm trials (Franke et al., 2016; Ronner et al., 2018). At farm level, considering the potential replacement of existing crops and criteria other than yield (economic benefits, costs, labour), the comparison may lead to different insights (cf. Sperling and Muyaneza, 1995). Moreover, given the heterogeneity of African smallholders (Giller et al., 2011), advantages and disadvantages of climbing bean cultivation are likely to differ between farms, but this

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diversity has not been studied. By capturing farm diversity, typologies help to disaggregate impacts and opportunities for different types of farmers (Descheemaeker et al., 2016; Franke et al., 2014; Tittonell et al., 2010). A farm-level, multiple criteria exploration could therefore offer insight in the opportunities and trade-offs of climbing bean cultivation for a diversity of farmers.

Discussing the outcomes of such explorations with farmers provides quantitative feedback to farmers about their farming system, and enriches researchers' insights in farmers' priorities and constraints (Defoer, 2002; Falconnier et al., 2017). While researchers may focus on advantages in yields or costs and benefits of a particular crop, farmers may have different priorities based on the allocation of resources over multiple crops on their farm and off-farm activities (Collinson, 2001). An *ex-ante* assessment of which farmers are likely to benefit and how priorities at farm level might hinder or foster climbing bean cultivation could inform rural development projects that aim to expand climbing bean cultivation to new areas.

The objective of this study was to identify farm level opportunities, constraints and trade-offs for climbing bean cultivation among smallholder farmers in eastern Uganda with an *ex-ante* impact assessment tool. Based on a detailed farm characterization we established farmers' current situation in terms of the farm-level indicators food self-sufficiency, income, investment costs and labour. We analysed the effects of four different options for the integration of climbing beans on these indicators. The outcomes of this analysis were discussed with farmers, to understand their priorities, constraints and decision making with respect to climbing bean cultivation. We hypothesized that sole cropping of climbing beans with wooden stakes would provide the largest increase in food self-sufficiency and income, but also the largest trade-offs in terms of investment costs and labour, and that this would therefore not be the most preferred option among farmers.

2. Methodology

2.1. Study area and climbing bean dissemination

The study was conducted in Kapchorwa District (Fig. 1), located on the northern side of Mt. Elgon between 34.30° and 34.55° East and 1.18° and 1.50° North at an elevation of 1500 to 2200 m above sea level (masl). The district can be divided in an “upper” and “lower belt”, with the tarmac road situated around 1900 masl as a rough divide. Annual rainfall in the district averages 1600 mm and falls over two seasons: a long season from March to July (Season A) and a shorter season from September to December (Season B). Nitisols are the dominant soil type.

A climbing bean dissemination campaign started in 2013 in two sub-counties of Kapchorwa (Kapchesombe and Kaptanya) where climbing beans were new to many farmers. Improved varieties of climbing beans were planted with manure, phosphorus fertilizer and best management practices (row planting, plant and staking density, weeding) in small demonstrations on farmers' fields. In 2014, the campaign extended to two other sub-counties, Tegeres and Chema. Here, climbing bean cultivation was more common, but with local varieties and largely without mineral fertilizer or manure. The dissemination approach now changed to parish-level demonstrations on visible locations, in combination with numerous farmers trying out technologies in so-called adaptation trials (Ronner et al., 2018).

2.2. Rapid and detailed farm characterization

The study was conducted in Chema sub-county in the first rainy season of 2014 (Season 2014A), just before the extension of the dissemination campaign to this sub-county. A rapid farm characterization survey was conducted in which 75 households were interviewed with questions on household size and composition, education, land and livestock ownership, production orientation, labour hired, sources of income, valuable goods owned, type of housing, food security and crops cultivated. Stratified random sampling was applied, whereby in each of the four parishes in the sub-county at least one village was selected (five villages in total). Households within the village ($n = 15$) were randomly selected. Four farm types were developed manually, based on distinguishing criteria that were also found to be important in earlier typology studies in East Africa (Franke et al., 2014; Tittonell et al., 2010; Tittonell et al., 2005), such as landholding, livestock ownership, type of housing, valuable assets, production orientation and most important sources of income. We focused on easy-to-measure, structural characteristics to allow development or extension agents to rapidly identify these farm types for the scaling of technologies. Resource persons (extension officer, chairman of cooperative, well informed farmers) confirmed that the typology represented farmer diversity (including the poorest and wealthiest) in the community.

A detailed farm characterization was carried out among a sub-selection of 16 households. Stratification was applied to farm type (four farmers per type were randomly selected), and to climbing bean cultivation: per farm type two farmers were selected who cultivated a relatively large area of climbing beans (sole cropping or climbing beans contributing > 30% in intercropping), and two farmers who cultivated no or a small area of climbing bean (intercropping with < 30% climbing bean).

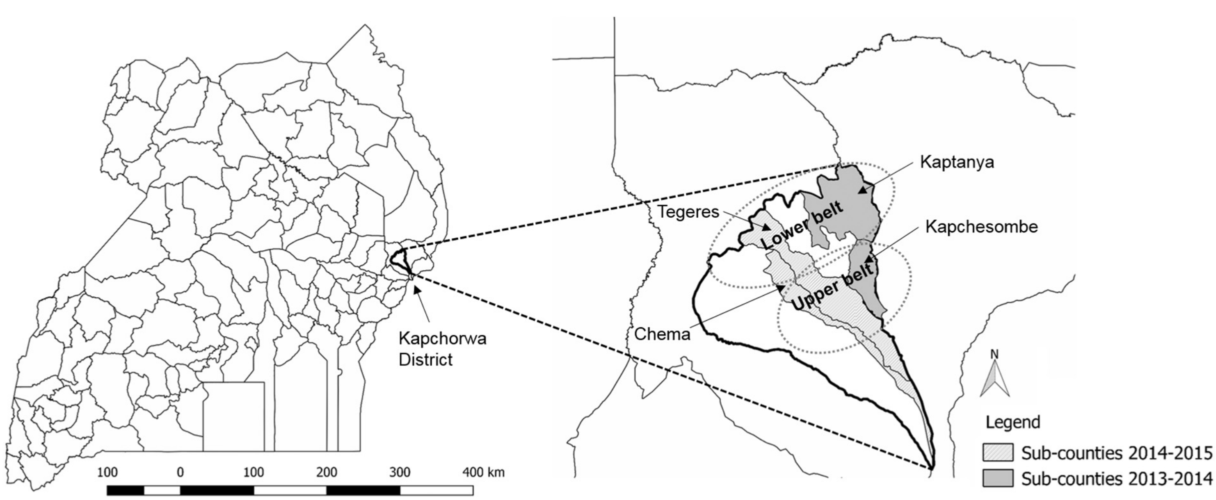

Fig. 1. Kapchorwa District with sub-counties included in the climbing bean dissemination campaign. Grey circles indicate the divide between the lower and upper belt within the district.