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RELATIVE PERFORMANCE OF STAKING TECHNIQUES ON YIELD OF CLIMBING BEAN IN HIGHLANDS OF BURUNDI

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ABSTRACT

Common bean (*Phaseolus vulgaris* L.) is an important staple grain legume in the Great Lakes Region of Africa. In addition, it is a major source of proteins, energy and micro-nutrients (e.g. Fe and Zn), especially for smallholder farmers. The climbing bean is particularly more productive, an efficient land user and tolerant to environmental stresses compared to bush bean types. This study was conducted to evaluate the performance of three staking techniques, namely (i) sticks, (ii) strings, and (iii) maize intercropped with climbing beans during the cropping seasons 2010B and 2011A on 10 sites of Ngozi, Mwaro and Karusi provinces of Burundi. Staking with sticks led to the most grain yielding among the three staking techniques; however, economic analysis showed that staking with intercropped maize was the most efficient. Use of strings as staking materials can replace the use of sticks without a reduction in production.

Key Words: Great Lakes, maize intercrop

RÉSUMÉ

Le haricot commun (*Phaseolus vulgaris* L.) est une légumineuse tres importante dana la région des Grands Lacs africains. En plus, c'est une source majeur de protéines, énergie et micronutriments (ex Fe et Zn), spécialement pour les petits agriculteurs. Le haricot volubile est particulièrement plus productif, efficient en termes d'utilisation des terres et tolérant aux stress environnementaux par rapport au haricot nain. Cette étude était conduite pour évaluer la performance des techniques de tuteurage, nommément tuteurage avec (i) petits bois (ii) cordes et (iii) maïs intercalé avec le haricot, au cours des saisons culturales 2010B et 2011A, dans dix sites des provinces de Ngozi, Mwaro et Karusi au Burundi. Le tuteurage par le bois a induit un plus grand rendement parmi les trois techniques utilisées. Néamoins, l'analyse économique a montré que le tuteurage par le maïs intercalé avec le haricot est le plus rentable. L'utilisation des cordes, comme matériaux de tuteurage, peut bien remplacer le bois sans toutefois réduire la production du haricot.

Mots Clés: Grands lacs, maïs intercalé

INTRODUCTION

Due to land fragmentation, farmers need to grow climbing bean varieties in order to feed the rapidly growing population. The shortage of staking materials is ranked among the major contraints for climbing bean varieties production despite their high yielding potential. With improved agronomic practices, which include staking options, climbing beans varieties can produce up to 4 metric tonnes per hectare, while bush beans produce between 1 and 2 tonnes per hectare (CIAT, 2005). The long stems of climbing beans enable them to produce more pods as compared to the bush types.

The reduction of tree plantations associated with the high cost of stick staking explains the unavailability of sticks for staking. Indeed, staking a one hectare plot size of climbing beans requires around 25,000 sticks stakes, with a cost estimated

at US$ 350 (Ruraduma *et al.*, 2012). Besides, most farmers in the region lack sufficient knowledge on best staking options. Although staking leads to better yields, lack of appropriate staking materials is a key challenge to adoption of the technology. Wood sticks are preferred by farmers to other alternative uses; these competing needs, therefore, could lead to environmental degradation through deforestation (ISABU, 2006).

To cope with this situation, the use of strings such as banana and sisal fibres has been identified to be a potential alternative. In Burundi, for instance, where banana fibre is sufficiently available, fibres can offer the benefit of reduced utilisation of stakes.

The objective of this study was to identify the most suitable staking option of climbing beans in Burundi, targeting environmental preservation.

METHODOLOGY

This study was conducted onfarm in three provinces of the highlands of Burundi, namely Karusi, Ngozi and Mwaro. Karusi Province is located in the eastern part of Burundi, between latitude 2° 47'16' and 3° 13'78'' south and 29° 25'11'' and longitude 29° 55'95'' east (République du Burundi, 2006). The Province is characterised by highland conditions, with a temperature range of 17-20 °C. Rainfall ranges from 1200-1500 mm per annum; and the province's altitude ranges between 1600 and 1900 metres above sea level (masl).

Ngozi Province is located in the northern part of Burundi, within 2° 39'' 19'' and 3° 5'00'' latitude south and 29° 25'11'' and 29° 37'57'' longitude east (République du Burundi, 2006). It is also characterised by highland conditions, with the altitude ranging from 1800 to 1900 masl. The temperature ranges between 17-20 °C and rainfall between 1200 -1500 mm per annum.

Mwaro Province is located in the central western part of Burundi within 3° 18'' and 3° 50' latitude south and 29° 35' and 29° 51' longitude east (République du Burundi, 2006). Its altitude ranges from 1500 to 2200 masl; temperature 16-19 °C; and annual rainfall between 1300 - 2000 mm.

The field experiment was conducted during the second cropping season of 2010 (2010B) and the first season of 2011 (2011A). Treatments included bean staking using sticks, fibre strings or maize (*Zea mays* L.) stems intercropped with the beans. These treatment were evaluated using three improved climbing bean varieties (AND10, VCB 81012 and G13607), recommended for middle and highlands conditions (Ntukamazina, 2008).

On top of other agronomic practices, sole bean plots were fertilised with a pre-planting dose of diammonium phosphate (DAP) at a rate of 100 kg ha^{-1} and organic manure made from cattle (10 t ha^{-1}). Intercropped maize climbing bean plots received 20 t ha^{-1} of organic manure in addition to 100 kg ha^{-1} of DAP. All these fertilisers were applied as a single dose just before planting. The treatments were laid out in a randomised complete block design (RCBD) with six farmers as replications. Experimental plots were of 30 m^2 size.

Data were collected on grain bean yield and subjected to an analysis of variance to assess the effect of each staking technique on the three climbing bean varieties This statistical analysis was fitted using GenStat 12th Edition. Mean separation, in cases where there were significant differences among treatments, was done using Student-Newman and Keuls test (Gomez and Gomez, 1993).

For economic analysis, for each treatment, the total factor cost (TFC) was determined by multiplying its price by the total number of units used. The total value product also known as total revenue product (TRP) was calculated by multiplying the total physical product (yield) by its price. For each treatment factor, the profit was estimated by substracting the total factor from the total revenue product, i.e Profit = TRP – TFC (Hill, 2006). The profit values obtained from the three treatments were compared and the treatment with the highest profit value was considered as the most economically effiscient.

RESULTS

There were highly significant differences among the three staking techniques ($P<0.001$). Staking with sticks was the most grain yielding technique among the three studied (Fig. 1). Furthermore, the multiple comparisons of means using the

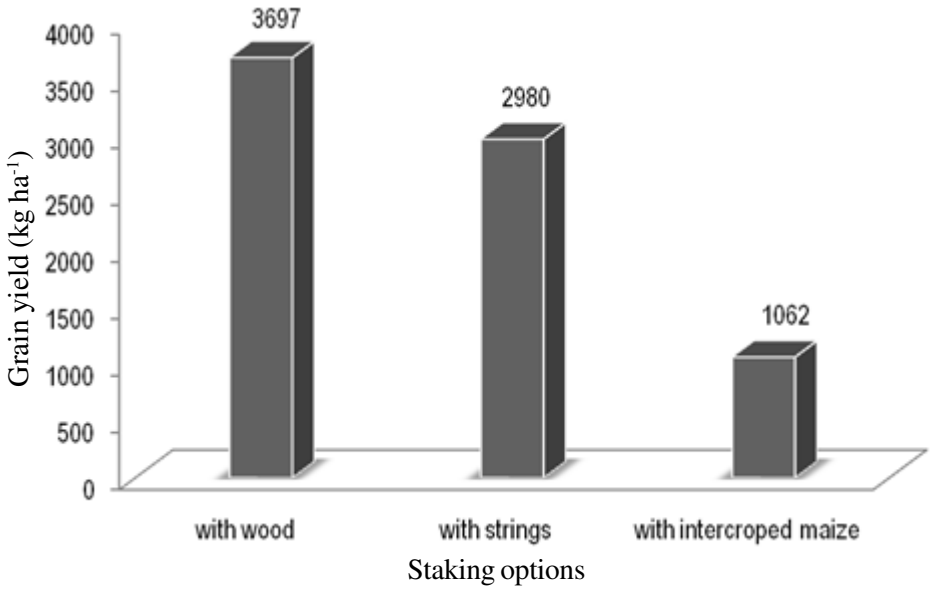

Figure 1. Effect of staking on climbing in the highlands of Burundi.

TABLE 1. Two-way grain yield means for staking types and bean varieties in the highlands of Burundi

Staking type	Grain yield (kg ha^{-1}) per site			
	Mwaro	Ngozi	Karusi	Average
Sticks	3,661	3,983	3,748	3,697a
Strings	2,691	3,064	3,185	2,980b
Maize stems	968	989	1,192	1,062c

Student-Newman-Keuls test showed that the staking technique with sticks is the most yielding, followed by staking with strings (Table 1).

In terms of economic assessment, intercropping maize stems in climbing bean had the highest gross margins, and thus was the most profitable (Table 2). Maize added value to both incomes of the associated communities. The economic profits were in the order of 1,998 US$ for intercropping maize with climbing beans; 1,086 US$ for strings and 244 US$ for sticks.

DISCUSSION

Results from this study show that climbing bean yields are influenced by the staking techniques. Staking with sticks is the most optimal technique, followed by staking with string technique (Fig. 1, Table 1). These two staking techniques could provide alternative solutions to decreasing bean yield among smallholders. In Burundi and in Eastern Africa in general, there is need to use crop production management strategies, including adoption of improved agronomic practices, to cope with gradually declining yields of bean resulting from high population pressure, and decline in arable land area caused by land fragmentation (Bekunda *et al*., 2008). In addition, there are limited opportunities for crop rotation, leading to a reduction in soil fertility and an increase inincidence of diseases.

Even though results from this study, evidently show that the climbing bean cultivars staked with sticks produced significantly higher yields (3697 kg ha^{-1}), the adoption of this technology by smallholder farmers is constrained by limited

TABLE 2. Estimated gross margins based on staking techniques used in a study in climbing beans in Burundi

Item	US$	Quantity			Total Cost = Quantity x unit cost		
		Staking with sticks	Staking with fibre strings	Staking with maize stems	Staking with sticks	Staking with fibre strings	Staking with maize stems
Labor soil preparation	1	100	100	100	100	100	100
Organic manure	33.33	10	10	20	333	333	667
Inorganic fertiliser DAP	0.47	100	100	230	47	47	107
Inorganic fertiliser KCl	0.4	50	50	50	20	20	20
Inorganic fertiliser urea	0.4	0	0	40	0	0	16
Seeds	0.8	70	70	70	56	56	56
Sowing	1	50	50	40	50	50	40
Stakes	0.05	30,000	0	0	1,520	0	0
Supporting sticks	0.08	0	3,000	0	0	245	0
Labour staking	1	50	20	0	50	20	0
Widding	1	25	20	25	25	20	25
Harvesting	1	20	10	20	20	10	20
Total production cost (TPC)					2,221	901	1,051
Yields =Sales quantity (Q)					3,697	2,980	4,574*
Price (P)					0.67	0.67	0.67
Revenue (PxQ)					2,465	1,987	30,494
Gross margin (revenue-TPC)					244	1,086	1998

The sales quantity (4,574 kg) obtained under staking with intercropped maize is obtained by adding bean yield (1,062 kg) to the maize yield (3,512 kg) on the same plot

access to sticks for staking. In this case, adoption of the fibre string staking, a technique whose average yield was 2980 kg ha^{-1}, is more applicable to the smallholder situation.

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