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CHALLENGES AND OPPORTUNITIES IN COMMON BEAN PRODUCTION AND MARKETING IN BOTSWANA: PROSPECTS AND FARMER'S PERSPECTIVES

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ABSTRACT

Common bean (*Phaseolus vulgaris*) is the most consumed legume crop in the world, and one of the most consumed legume crops in Botswana. This study aims to identify constraints and opportunities in common beans production in order to enhance common bean production in the country. A survey was conducted among 287 farmers in two districts of Southern and Chobe with farmers selected by multi-stage sampling technique. The majority of farmers were female (66.1%), a few farmers planted common bean (11.5%). Slightly more than a quarter (27.8%) of farmers were above the age of 65 years. Constraints to production included pests and diseases, damage by animals, lack of labour, drought, and lack of seeds. Seven percent of farmers assumed that common bean was a drought tolerant crop and 33% of farmers said common bean taste better than other pulses. However, only 21% preferred to grow it. More farmers (13.2%) grew common bean in the Southern district than farmers in the Chobe district (7.0%). Farmers who grew common bean bought their seeds from Agro dealers (76%) with an average amount of 6kg of seed purchased at a time at an average price of $1.11 kg^{-1}. Common bean was planted on 7% of the arable land that was planted. Most of the farmers (87%) were not trained in common bean production and received little or no assistance from extension officers resulting in little knowledge by farmers about the production of common beans. Strategies to create awareness are needed to facilitate access and mobilise farmers to adopt common beans to improve their livelihoods. This is particularly encouraged in agro-ecological zones such as Chobe with high yield producing potential. Development of seed systems and release of varieties tested in Botswana agro-ecological zones, would increase the production of common bean to improve food security and nutrition, and reduce import bill in Botswana.

Key words: Common bean, Cropping systems, Marketing, Production, *Phaseolus vulgaris,* Agro-ecology, Multi-stage, Pulses, Drought

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INTRODUCTION

Common bean (*Phaseolus vulgaris*) is considered the most important food legume crop in human diet in the world [1]. It is an annual legume grown mainly for its rich nutrients such as protein, complex carbohydrates, vitamins, dietary fibre and minerals [2, 3]. Common bean has rich health benefits, and besides its high level of protein (about 22%), it is a good source of iron and zinc (both of which are key elements for mental development). Moreover, common bean consumption is believed to reduce colon and breast cancer, and heart diseases [4]. Dry beans can be consumed as cooked or boiled dry grains and the leaves are used as green vegetables [5]. Common bean also serves as a rotation crop with cereal, reducing soil pathogens and supplying nitrogen to the cereal crop [6].

Common bean is grown in subtropical and dry tropical zones, and also does well in warm climates with average temperatures of between 18°C and 24°C [7]. Common bean is considered more sensitive to high temperature than other legume crops [8], whereby daily temperatures greater than 30°C and night temperatures greater than 20°C cause a significant reduction in yield by inhibiting pollen growth [9]. Global production of common bean was estimated at 25 million tonnes in 2014, which was almost double that of chickpeas and dry peas [10], with a value estimated to exceed those of chickpea, lentil, pea, and cowpea combined, revealing the economic potential of common bean [11]. Common bean is an important cash crop and also the main grain legume grown in Eastern and Southern Africa [5]. In both regions approximately 60 percent of common bean production is produced for consumption while 40 percent is marketed at a value of UDS 452 million [12].

In southern Africa a number of beans growing areas suffer from frequent drought stress [9], as in Botswana, which is located in a semi-arid environment with majority of population relying on rainfed agriculture. The crop can be produced in marginal environments prone to drought, as observed in such areas in Ethiopia, Kenya, and Tanzania where large areas of common bean production is undertaken [13]. Common bean is susceptible to prolonged moisture deficit but will provide reliable yield with some supplementary irrigation and also perform well in areas with reliable rainfall and cooler temperatures [14]. The crop is adaptable to various cropping systems across the world, and this makes it attractive to a large number of farmers globally [15].

There is little production of common bean in Botswana with some evidence of production in the country as some common bean produce are displayed by farmers at the annual Botswana National Agricultural Shows. Additionally, there are some records of sales of common bean from farmers at the Botswana Agricultural Marketing Board. Common bean is sold at most major retail stores, consumed in hospitals and schools, and also offered as government assistance supplementary feeding scheme for underage children at clinics country wide. Despite its high consumption rate in Botswana, common bean is largely imported from other countries. There is a need to enhance common bean production in the country to reduce import bill and improve food security. The aim is to wean Botswana from being a net importer of common bean, to

self-sufficiency in common bean production and subsequently become an exporter of common bean.

The Ministry of Agricultural Development and Food Security through the Department of Agricultural Research found it vital to develop common bean varieties that are stable and well adapted to Botswana's agricultural environment [16, 17]. The identified common bean varieties come in handy to alleviate malnutrition observed among the under-five children recorded at a national average of 4.6% in the country [18]. The benefits of adopting and consuming improved varieties of common bean could help to substantially reduce malnutrition and improve the livelihoods of people especially in rural poor areas of Botswana. It is also necessary to understand the production levels, and the marketing of common bean, which will help inform research about new varieties if the crop will be acceptable to farmers or consumers. No recent study has extensively assessed the production and marketing of common bean in Botswana. A common bean baseline survey conducted by Manthe *et al*. [19] in Mahalapye, Francistown, and Kanye areas among 144 households revealed lack of popularity of common bean among Batswana farmers. This paper fills that gap by documenting production level, and marketing of common bean in the country. Understanding farmer preferred traits, and prioritisation of the production constraints based on different agro-ecologies are key in increasing the adoption rate of improved varieties among farmers [20]. It has been observed that when different technologies are released, farmers tend to adopt some technologies and fail to recognize or fully adopt the recommended technologies. It is assumed that there are various factors affecting the adoption, production and marketing of common bean in Botswana. Therefore, it is important to identify the prospects of producing common bean in Botswana, with the aim to develop participatory variety selection strategies for the development of well-adapted and acceptable varieties. This research is more of a demand led breeding approach where, social scientists, agronomists and plant breeders work together to develop bean varieties that meet the need of farmers and others within the value chain [9]. Therefore, the purpose of this study was to identify the level of diversity of common bean production, marketing, and constraints as revealed by farmers, their preference of common bean compared with other pulses. The study also assessed the preferred traits and the general perception of common bean production in Botswana.

MATERIALS AND METHODS

Description of the study areas

This study was carried out in 2018 in two selected districts of Botswana viz., Chobe and Southern (Figure 1). These two districts were selected based on their prominent crop production in the country. The two districts have different agro-ecological attributes with the Chobe district experiencing an annual precipitation of around 650 mm, most of which is received during the summer season from November to May. The vegetation type in the Chobe district is Savannah, with tall grasses, bushes and trees, while arable agriculture is the main economic activity of the district. The Southern district has rainfall amount of approximately 500 mm, and the district is also characterized by Savanna vegetation.

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Figure 1: Map of Botswana showing the Chobe and Southern districts

Sampling method

A cross-sectional research design was used for this study in line with Babbie [21]. The design allows for data to be collected from a sample selected at a single point in time. The reason for choosing this design is its suitability for descriptive purpose as well as the determination of the relationship between variables [22]. A proportionate stratified random sampling was used. In each district, the farmers were grouped according to their geographical locations, which translated into administrative villages. At the village level, which in this case are the strata, the respondents were randomly selected such that sample size of each stratum was proportional to the population size of the stratum when viewed against the entire population. This means each stratum had its own sampling fraction. There was a total of 470 farmer households for the survey, of which 187 were from the Southern district, and 100 from the Chobe district. The farming population list from each district was developed with the help of agricultural extension officers.

Data collection

Data collection was done using a semi-structured questionnaire to collect socio-economic characteristics in relation to demographic characteristics, marketing, farmers' perceptions, constraints affecting common bean production, and access to agricultural information. A structured questionnaire, which consisted of both closed and open-ended questions was designed to capture quantitative data. Farmers were asked to rank constraints based on their prevalence and severity. Data on the following variables, (1) household head characteristics (gender, age, education, and main occupation); (2) Farmers' access to information (3) market factors (distance to nearest town) and (4) household endowment (hectares allocated to common bean) were collected.

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Data analysis

Data collected were analyzed using SAS version 9.4 computer package. Variables were subjected to descriptive statistics (frequencies, percentages, means and standard deviation) to analyze the respondents' socio-economic characteristics and identify challenges facing smallholder common bean producers. Cross tabulation and Chi-square test analyses were conducted.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents from the two districts

Gender, occupation and educational level of farmers from the two districts (demographics)

Majority of arable farmers in both districts were female at 66.1% as shown in table 1. Most of the farmers were in the age bracket of 51 to 65 years. A quarter of farmers were above the productive age of 65 years (27.8%). Only 11% of farmers were below the age of 35 years. The majority of farmers are literate and most of them (50.7%) had formal education up to the primary school level. A very small portion of farmers (4.2%) completed tertiary education and about a quarter of farmers (27.3%) were illiterate. Most of the farmers (55%) had more than 10 years' experience in arable farming. Although a number of the farmers had more farming experience, only a few farmers (25.4%) had experience in common bean production. Almost half of the farmers (47.88%) had opportunity to access credit, and 81% did not belong to any farmers' associations, while 3.6% of farmers used to be members of farmers' associations. Only 15.3% of farmers belonged to farmers' associations (Table 1). These findings are consistent with a survey conducted in Botswana on bambara groundnut, where the majority of fields at 71 % were owned by females [23]. Common bean in Kenya is also known to be grown by small-scale farmers, mainly women [20]. The results from Chobe and the Southern districts show a contrast with the national agricultural phenomenon, where male farmers dominate the farming system at (62.1%), while female participation is 37.9 % [24]. The average age of most farmers in the study was in the range of 51 to 65 years, followed by a relatively higher percentage of those above 65 years old, which is a common trend among Botswana farmers as revealed in the national agriculture sector survey [24]. Even though the majority of farmers (50.7%) were literate, a significant number, 95.8% of farmers did not have tertiary education, and 27.3 % who were illiterate could be a hindrance in obtaining good agricultural practices. A similar pattern was observed among cowpeas farmers in Nigeria where a few farmers who obtained tertiary education were the ones who easily undertook good cowpea practices [25].

Farm characteristics and method of land acquisition

Most of the farmers (73.2%) in the two districts did not grow common beans. Only a small percentage (11.5%) of farmers grew common bean and tepary bean (13.9%), while 1.4% of farmers grew both crops. A higher amount of tepary bean (21.0%) is produced in the Chobe district compared to 10.2% in the Southern district, but more common bean (13.2%) is produced in the Southern district and only 7.0% produced in the Chobe district (Table 2). Maize was the most prominent crop on most farms in the Chobe district (92.0%) and in the Southern district (98.4%). It was followed by

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cowpeas (62.0%), which was predominantly produced in the Southern district (79.7%) compared to 28.0% of farmers who grew cowpeas in the Chobe area. Most of the arable land (81.4%) was in cultivation, followed by virgin land (13.6%). A small portion (4.9%) of land in both districts was fallow.

Most of the farmlands were owned by 98.0% of the respondents with such land (22.6%) acquired through inheritance or as family farm and own farm (68.4%) normally allocated by the land board. However, land acquisition varied amongst the two districts in relation to gender of farmers. In both districts, more women were in possession of landholdings than men. Sixty six percent of women owned land against 32.0% men in the Chobe district, while in the Southern district 58.1% of land ownership was by women and 13.2% of land was owned by men (Table 3). This result also, reveals a higher degree of popularity of the *Phaseolus* species among farmers in both districts, given the fact that these crops, are not provided as seed subsidies by government to farmers compared to maize, sorghum, and cowpeas, in The Integrated Support Programme for Arable Agriculture Development [26].

Access to market and information

The majority of farmers (76%) bought common bean seeds from Agro dealers. Other sources of seeds (14.6%) was common bean grain from the government, normally given at clinics for children under the age of 5 years as food ration. The rest of the seeds came from other farmers (5.1%), hawkers (2.3%) and from own seed beds at 1.4%. The average price of common bean seed was $1.09 per kg, while Chobe district had a relatively higher price ($1.16 per kg) and $1.01 per kg in the Southern district. Farmers normally bought an average of 6kg of seed per time. In Chobe farmers bought an average of 10.27kg of seed per time, while farmers in the Southern district bought an average of 1.6kg of common bean seed per time (Table 4). Most of the farmers (87.1%) had no training in common bean production and the 12.9% of trained farmers received it through demonstrations, extension visits and through Rural Training Centres. More farmers (86.4%) had access to extension offices since their farms were located within the periphery of less than 20km. The visits by extension officers were not frequent as expected, but 37.0% of farmers revealed that they were visited sometimes, while 27.0% of farmers were visited regularly. About 27.8% of farmers were rarely visited by Extension officers and only 6.1% said they were never visited (Table 5).

Limited availability of seeds is one of the main hindrances to high crop productivity of common beans in Botswana, and thus, farmers tackle seed shortage through an informal seed system, which offers a wide range of crops sold in small quantities [27]. Similar findings were observed in a bean baselines survey where, when seeds were available, farmers would be willing to grow common bean in Botswana [28]. Main crops grown in Botswana include maize, sorghum, cowpeas, millet, sunflower, and groundnut. The national survey for these crops showed the largest proportion of arable land (66438 ha) was allotted to maize, followed by sorghum (41675 ha), and cowpeas (32862 ha) [24]. Among the two districts surveyed, it was observed that maize was the most preferred at 96.0% as in the national survey, but now followed by cowpeas (62.0%), watermelon (60.0%) and sorghum (42%).

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Farmers' perception, production and preference of common beans

Farmers' perception of common bean was assessed based on nine attributes listed in (Table 6). The majority of respondents did not know much about common bean as their lack of knowledge ranged between 80–90%, for pests and diseases, drought tolerance, soil nutrition improvement, yield, income returns, and fertilizer application rates. However, on the assessment of the nutritive value attributes, 23.0 % of respondents thought it is more nutritious than other grain legumes, and 30.0% suggested that it tastes better than other grain legumes (Table 6).

Production of common bean and its preference in this study was measured by the number of hectares planted with common bean compared with other pulses (Table 7). A greater percentage (75.0%) of arable land in hectares was used to grow cowpeas, followed by tepary bean (8.0%), common bean (7.0%), and bambara groundnut at 2.0%. The remaining 8% of the arable land area was covered by other pulses. However, in terms of preference most respondents prefered cowpeas, albeit at reduced percentage of (37.0%), then common bean (21.0%) and 13.0% tepary bean. A small portion of farmers (11.0%) prefered bambara groundnut and 18.0% of farmers prefered other pulses (figure 1).

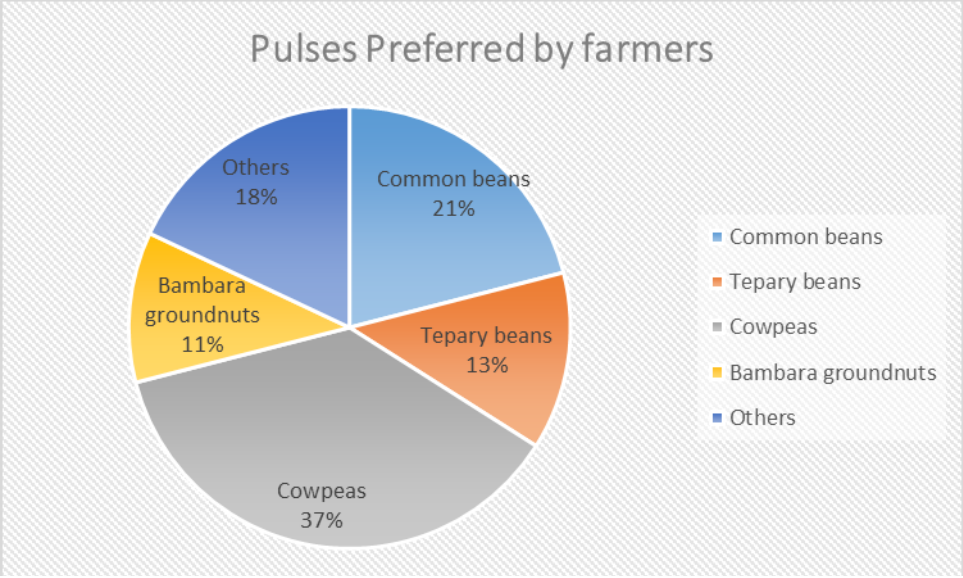

Figure 1: Respondents' preferences for common bean compared to other pulses in the two districts of Chobe and Southern

Responses from both districts showed that the majority (84.2%) generally lacked knowledge on common bean production. However, quite a significant number were of the view that it has a good taste (30.1%) and a higher nutritive value compared to other pulses (Table 6). Recently, stable and well-adapted common bean for the Botswana environment were identified [16]. Attributes of successful pulses include ease of adaptation and higher consumer demand, which indicate a higher likelihood of common bean production and adoption in Botswana [29]. A survey conducted in Kenya

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revealed that some preferred traits in common bean include those of good tastes, drought tolerance, and a higher yield potential [20].

Even though among the pulses a large proportion of hectares was used to grow cowpeas, and only 7.0% for common bean, the majority of farmers still preferred cowpeas. However, to confirm preference and acceptance of developed common bean varieties, farmers are supposed to be involved in a participatory variety selection [30]. This gives farmers an opportunity to reveal their preferred traits in a given crop. Already, a number of farmers grow tepary bean, which is a closely related grain legume species to common bean at 13.9% (Table 2), the crop is grown under a number of landraces, and is well adapted to the persistent drought conditions of Botswana, which provides an opportunity to evaluate and select higher yielding cultivars to be introduced to the farming community [31]. Tepary bean is largely used in the common bean improvement as a useful source of genetic variation, and common bean x tepary bean interspecific lines are available [32].

Constraints to common bean production in the two districts of Chobe and Southern

Farmers are affected by various challenges in common bean production, but the most prominent are pests and diseases (47.1%), followed by damage of crops from domestic and wild animals (44.6%) (Figure 2). Thirty two percent of farmers highlighted that drought is a limiting factor to common bean production, and 31.2% indicated they were limited by the shortage of labour since common bean production is labour intensive. Unavailability of seed also has been a limiting factor to common bean production. These challenges hinder farmers to grow common bean or other pulses in their cropping systems.

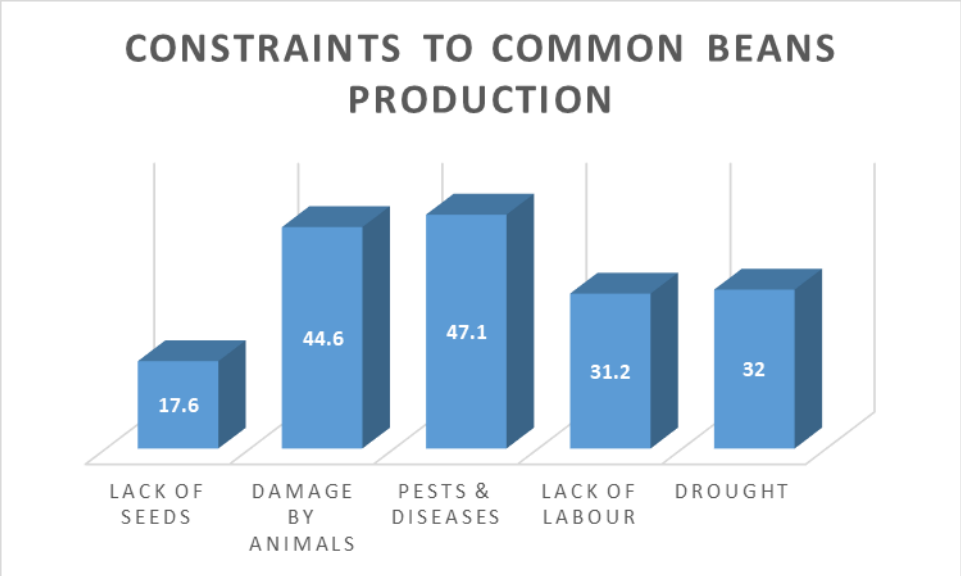

Figure 2: Percentage of farmers affected by different production constraints

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Constraints to common bean production in both districts of great concern are pests and diseases (47.1%), damage by animals (44.6 %), drought (32%) and lack of labour (31.2%) as perceived by farmers. However, preliminary studies conducted on common bean for pests and disease on experimental research plots (Sebele Agricultural Research Station), showed a few incidence of pests such as aphids on the crop (unpublished data). Drought was also reported as a major constraint among common bean farmers in the semi-arid environment of Kenya [20]. Higher crop damage reported is consistent with observations by Mbaiwa, [33], who stated that the main causes of human and wildlife conflict (HWC), include crop damage from wild animals such as elephants, kudus and hippos. Those, HWC are concentrated in the northern part of the country including the Chobe districts. However, several incidents where farmers' crops are lost due to protected wildlife in the Chobe area are well documented [34]. Low productivity in pulses is generally attributed to various production and socio-economic constraints such as persistent drought, lack of improved varieties, and challenges within the seed systems [35].

CONCLUSION

In addition to cowpea as the main legume crop in Botswana, there is evidence of beans (common bean and tepary bean) production though at a relatively low rate. Common bean production is a new technology not yet fully explored and understood by farmers, which makes a significant number of farmers not involved in its production. Therefore, breeding objectives for developing common bean suitable for Botswana, should consider developing biotic and abiotic tolerant varieties, which are high yielding, but with high consumer preference. Consequently, the introduction of common bean to the farming community should target the development of improved common bean varieties that are suitable to farmer's needs. When farmers participate in variety selection of common bean during breeding to incorporate attributes preferred by them, it will lead to a wider ownership of the technology developed. The low level of production of common bean is mainly due to lack of knowledge or information by farmers on its production and also due to inadequate access to quality seed. The Ministry of Agricultural Development and Food Security should find strategies to create awareness, facilitate access, and mobilise farmers to adopt common bean to improve their livelihoods. This is encouraged especially in agro-ecological zones with high yield producing potential such as Chobe. The production of good quality seeds could be explored through the Youth Development Fund (YDF), Non-governmental Organisations (NGOs) and cluster farmers, as the initiative will create employment and provide good quality seeds to diversify the agriculture sector, and thus improve food security in Botswana. The government should also disseminate information on common bean production to the farming community, and sensitize farmers on the opportunities embedded on its production.

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Table 1: Household personal and demographic variables

Characteristics	Chobe (%) n = 100	Southern (%) n =187	Total (%) n = 287	T-stat
Sex				
Male	31	35.52	33.92	
Female	69	64.48	66.08	
Age				
<35	7	13.37	11.15	
36 - 50	35	23.53	27.53	
51 - 65	43	28.34	33.45	
>65	15	34.76	27.84	Pv=0.018
Average	54.3(7.1)	48.9(12.2)		-1.89 ***
Education				
No formal education	25.25	28.34	27.27	
Primary	53.54	48.2	50.7	
Secondary	18.18	17.65	17.83	
Tertiary	3.03	4.81	4.2	Pv=0.345
Ave	7.5(4.65)	13.4(9.2)		-1.02
Years in farming				
<5	21	16.67	18.18	
5 - 10	19	29.57	25.87	
>10	90	52.69	55.24	
		1.08	0.7	Pv=0.55
Average	17.0(7.75)	11.75(6.87)		-0.63
Experience in common bean production	11.69	32.18	9.76	
<3 years	18.18	4.59	2.09	Pv=0.83
>4 years	2.43(0.71)	4.55(1.23)		0.24
Average				
Access to credit				
Has access	18.48	64.07	47.88	
No access	81.52	35.93	52.11	
Farmers association				
Yes				
No	15.79	15.05	15.3	
Used to	80	81.72	81.14	
Average	4.21	3.23	3.56	

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Table 2: **Farm characteristics in Chobe and Southern districts**

Characteristics	Chobe (%) n = 100	Southern (%) n =187	Total (%) n = 287
Beans grown			
Common beans	7	13.9	11.5
Tepary beans	21	10.2	13.9
Both	0	2.1	1.4
None	72	73.8	73.2
Other crops grown			
Maize	92	98.4	96
Sorghum	48	39.1	42
Cowpeas	28	79.7	62
Millet	4.1	0.6	2
Watermelon	28	77.4	60
History of Land			
Virgin land	21.2	9.6	13.6
Fallow	6.1	4.3	4.9
Cultivated before	72.7	86.1	81.4

Table 3: Method of land acquisition Chobe and Southern districts

Type	Chobe (%) n = 100			Southern (%) n = 187			Total (%) n = 287
Land ownership (by gender)	Male	Female	Total	Male	Female	Total	
Own farm	23	52	75	4.5	44.4	64.9	68.4
Family farm	9	14	23	8.7	13.7	22.4	22.6
Leased farm	0	1	1	2.7	10.4	13.1	8.9
Backyard	0	1	1	0	0	0	0.3

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Table 4: Access to market by respondents in Chobe and Southern districts

	Chobe (%) n = 100	Southern (%) n = 187	Total (%) n = 287
Source of bean seed			
Agro dealers	74.5	77.6	76.5
Hawkers	0	3.5	2.3
Other farmers	3	6.2	5.1
Own seed bed	0	2.1	1.4
Government	22.4	10.5	14.6
Average Price of seed/kg ($)	1.16	1.01	1.09
Quantity of seed bought per time (kg)	10.27	1.6	6

Table 5: Access to information for training in both Chobe and Southern districts

	Chobe (%) n = 100	Southern (%) n = 187	Total (%) n = 287
Training in beans production			
Trained	22.5	7.7	12.9
Not trained	77.5	92.3	87.1
Distance to extension office			
<20 km			
>20km	90	84.4	86.4
	10	15.6	13.6
Visits by extension officers			
Regularly	35.8	25.5	29.1
Sometimes	44.2	33.1	37
Rarely	13.7	35.3	27.8
Never	6.3	6	6.1

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Table 6: Attributes preference in common bean

Farmers perception	Chobe (%) n =100	Southern (%) n =187	Total (%) n = 287
Nutritive value			
Less	1	8	5.6
More	22.2	23.5	23
Same with others	0	1.1	0.7
Don't know	76.8	67.4	70.7
Pests and diseases			
Less	4	12.3	9.4
More	18.2	2.7	8.1
Same with others	0	1.6	1
Don't know	77.8	83.4	81.4
Drought tolerance			
Less	8.1	8	8
More	13.1	3.7	7
Same with others	0	2.1	1.4
Don't know	78	86.1	83.3
Soil nutrition improvement	2	4.8	3.8
Less	12.1	2.1	5.6
More	3	3.2	3.1
Same with others	82.8	89.8	87.4
Don't know			
Knowledge about beans	8.1	7	7.4
Less	9.1	5.3	6.6
More	0	2.7	1.8
Same with others	82.8	85	84.2
Don't know			
Fertilizer application	11.1	2.1	5.2
Less	4	2.7	3.2
More	0	2.1	1.4
Same with others	84.9	93.1	
Don't know			90.2
Yield			
Less	4	7.5	6.3
More	12.1	7	8.8
Same with others	0	0.5	0.3
Don't know	83.4	83	83.1
Taste			
Less	3	7	5.6
More	30.3	30	30.1
Same with others	0	4.8	3.1

Don't know	66.7	58.3	61.2
Income/returns			
Less	3	1.1	1.
More	16.2	5.4	9.2
Same with others	0	5.9	3.8
Don't know	80.8	87.7	85.3

Table 7: Hectares of common bean planted by respondents compared to other pulses

Type of pulses	Area planted (ha)	Percentage
Common bean	46.75	7.3
Tepary bean	50.5	7.8
Cowpeas	482.4	74.9
Bambara groundnuts	13.25	2.1
Others	51.5	8
Total	644,4	100

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