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Farmers' Perceptions on Drought, Low Soil Fertility, Coping Strategies and Preferred Traits of Beans (*Phaseolus vulgaris* L.) in Balaka District of Malawi

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ABSTRACT

Background: Bean is an important nutritious food and cash crop. Bean productivity is low mostly due to various abiotic, biotic and socio-economic constraints. The aims of this study were to assess constraints to high bean seed yield productivity, determine farmers' perceptions on drought and low soil fertility, strategies farmers are practicing to adapt to the constraints and preferred bean traits.

Methods: A Participatory rural appraisal approach was applied by administering a questionnaire to 139 household representatives from Bazale, Phalula and Utale areas in 2017.

Result: Farmers (68.4%) cultivated beans under irrigation in winter (dry) season and most of them practiced sole cropping. Constraints to high bean seed yield productivity include drought and low soil fertility (31.7%) and deforestation (81.3%) contributed a lot. Farmers (44.6%) implemented afforestation, 32.4% grew early maturing bean varieties, while 20.9% practiced conservation agriculture. Farmers were not involved in variety development as indicated by 91.4% of the respondents. However, farmers preferred determinate plant type (95.7%), creamy taste (61.2%) and high number of pods per plant (47.4%). These farmers' preferred traits need to be considered in the ongoing bean improvement program(s) to increase adoption rate of improved varieties.

Key words: Beans, Constraints, Farmers' perceptions, Genetic enhancement, Preferred traits.

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is a diploid (2n=2x11=22) species and annual crop that belongs to the legume *Fabaceae* family according to Beebe *et al*. (2013). The bean crop is cultivated in Malawi and many other parts of the world. In Malawi and other developing countries in Africa, common bean is a cash, food and nutritious crop that provide carbohydrates, amino acids, vitamins and is a cheap source of proteins to people as well as livestock (Muthoni *et al*., 2007; Wortman *et al*., 2004). As such, the crop contributes to food and nutrition requirement of the resource poor farming communities.

The crop is cultivated in winter dry season in wetlands at a very small scale and also under rain-fed production in summer at a larger scale. Generally smallholder farmers' seed yields productivity remain less than 600 kg/ha (Amane *et al*., 2016). The current mean bean seed yield productivity is far much less than the potential yield of over 2500 kg/ha under good crop husbandry (Muthoni *et al*., 2007). Low bean seed yield productivity is attributed to poor soil fertility, low soil-P in particular and frequent drought occurrences among other factors. The impacts of these constraints to high seed yield productivity affect most the rural poor communities in areas such as Balaka district of Malawi. Therefore, this household survey was conducted in order to inform policy makers, non-governmental organization and bean crop improvement programs for necessary interventions. Specifically, the objectives were (i) to determine the bean cropping seasons and systems, (ii) constraints to high bean productivity, (iii) farmers' perceptions of low soil fertility and drought, (iv) strategies farmers have adopted to cope with low soil fertility and drought effects, (v) farmers' participation in variety development and (vi) preferred bean traits for further crop improvement.

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MATERIALS AND METHODS

The study was conducted in Balaka district (Longitude °E: 034° 50.00′; Latitude ° S: 15° 20.00′) in the Southern region of Malawi (Fig 1). Altitude of the study areas range from 437 to 626 meters above sea level. Balaka district falls under the low altitude production zone of <1000 meters above the sea level with unimodal type of rainfall and it could be

considered an environment optimum for common bean production as described by Wotman *et al*. (2008). Balaka district receives an average rainfall of less than 971 mm/ year. The soil types are Chromic Luvisols and in some areas are predominantly Eutric Fluvisols (Ngwira *et al*. 2014). Balaka district comprises of Bazale, Mpirisi, Phalula, Rivirivi, Utale and Ulongwe agricultural Extension Planning Areas (EPAs) (Fig 1).

Balaka district was purposely selected because it is a drought prone area and the soils are generally low in fertility. Bazale, Phalula and Utale EPAs were randomly selected among the six EPAs of Balaka district (Fig 1). In the selected EPAs, targeted interviews were conducted in all the households that cultivated or had ever cultivated common beans in the past. The study unit was a household.

A Focus Group Discussion (FGD) was conducted in May 2017 in Bazale EPA. The FGD had 22 participants; 9 were female and 13 were male. Among the group were the village chief and lead farmers. A check list questionnaire was used to gather information that was subsequently used to develop a study questionnaire that was later on administered to 139 household representatives in all the three selected EPAs (Bazale, Phalula and Utale). The questionnaire focused on bean cropping seasons and systems, farmers' knowledge and perceptions of constraints to high bean productivity, strategies to cope with low soil fertility and drought effects on bean plants, participation in variety development and preferred bean traits. Data were analyzed using Statistical Package for the Social Sciences (SPSS version 16).

RESULTS AND DISCUSSION

Bean cropping season and system

The majority of farmers (68.4%) cultivated beans under irrigation in winter (dry) season and most farmers practiced sole cropping (Table 1). Bean cultivation in winter is mostly done in low lying areas (*Dimbas*) where the water table is high and along the river banks such as the *Rivirivi* river that carries water from upland districts. This is probably so due to unreliable and unpredictable rainfall pattern during the

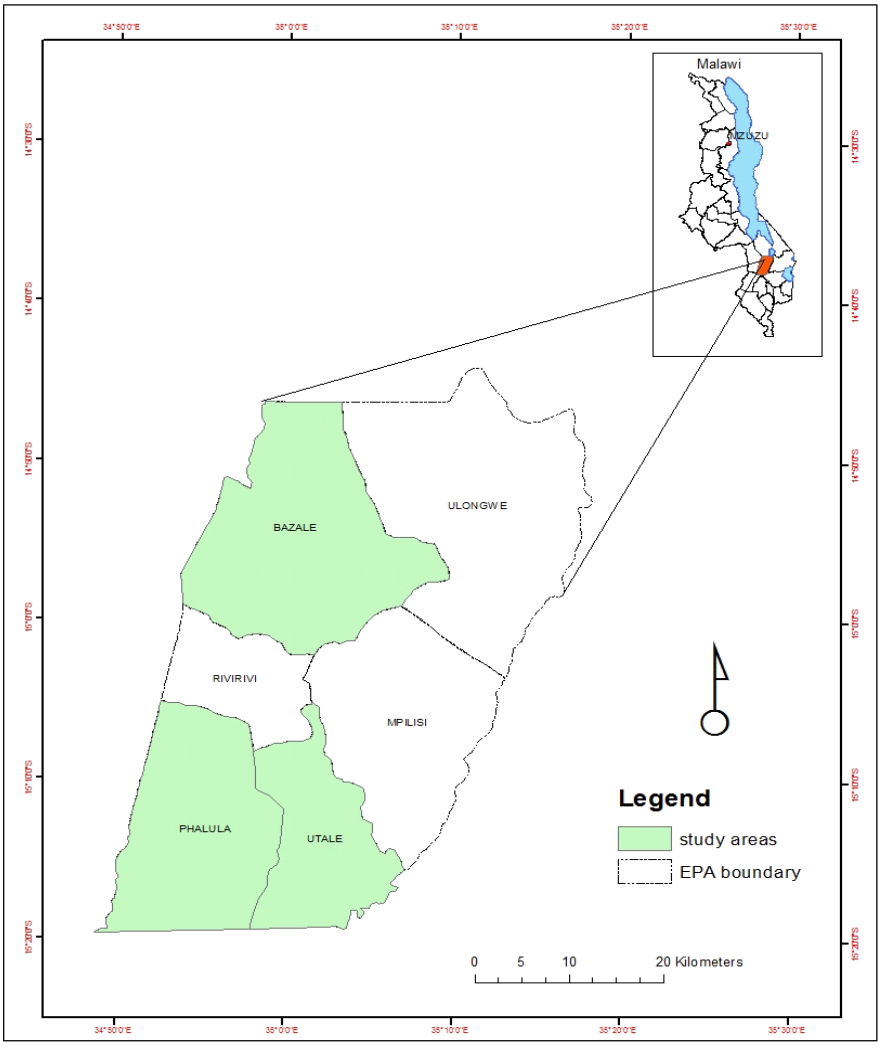

Fig 1: Map of Balaka district in Southern Malawi showing study areas.

rainy season and also because most farmers cultivated other priority food and cash crops on their small pieces of land under rain-fed production in summer. Therefore, Balaka district would benefit from improved bean varieties tolerant to low soil fertility and drought. Similarly, Patel *et al*. (2022) and Amarapalli (2022) identified genotypes adaptable to drought stress in Cluster bean and Green gram varieties respectively.

Knowledge of constraints to high bean productivity

About 31.7% of the respondents indicated drought under rain-fed production and low soil fertility as the major constraints to common bean high seed yield productivity, 30.2 % indicated pests and diseases, 20.9% indicated high cost of seed and other farm inputs, while 17.2% indicated inadequate extension services (Fig 2). The findings agree with Katungi *et al*. (2017) that common bean productivity is prone to insect infestation, disease and climate related production constraints in many countries of southern Africa. Development and farmer adoption of improved bean varieties that are tolerant to drought and low soil fertility among other desirable traits would increase bean productivity in areas such as Balaka district.

Perceptions of the causes, intensity and history of low soil fertility and drought

The major cause for low soil fertility and drought was deforestation (81.3%) due to careless cutting down of trees, followed by soil erosion (16.5%) and lastly mono-cropping (2.2%). Efforts were also made to assess farmers' perceptions on impacts of low soil fertility and drought on bean productivity. Low soil fertility and droughts were perceived by the farmers to have high impact on bean productivity (74.8%) and this was confirmed by agricultural extension workers who indicated that common bean seed yield production was very low. About 25.2% of the farmers indicated that the impacts were moderate. The majority of respondents (60.4%) indicated that low soil fertility and drought were experienced in the past 10 years, 20.9% indicated the past 11 to 20 years, while 18.7% indicated more than the past 20 years. To ascertain the soil fertility status in the study area, there is need for soil testing using nutrient index approach (Ojobor *et al*., 2021). The results agree with Resilience Policy Team (2015) and Jarawura (2014) who reported that drought and floods have increased in frequency, intensity and magnitude over the past ten to twenty years. Jarawura (2014) further explained that frequency and severity of drought in most areas was on the rise and that there was an emergence of near permanent drought conditions. Bwambale (2015) explained that farmers now experience drastic and severe weather patterns characterized by drought longer than ever before. It was indicated that of late, climate change effects have been worsening in Balaka district.

Knowledge of indicators and strategies to cope with low soil fertility and drought effects on bean plants

The farmers indicated stunted plant growth (46.8%), followed by yellowing or purple color on the leaves (44.6%), leaf senescence (5%) and lastly death of plants (3.6%) as

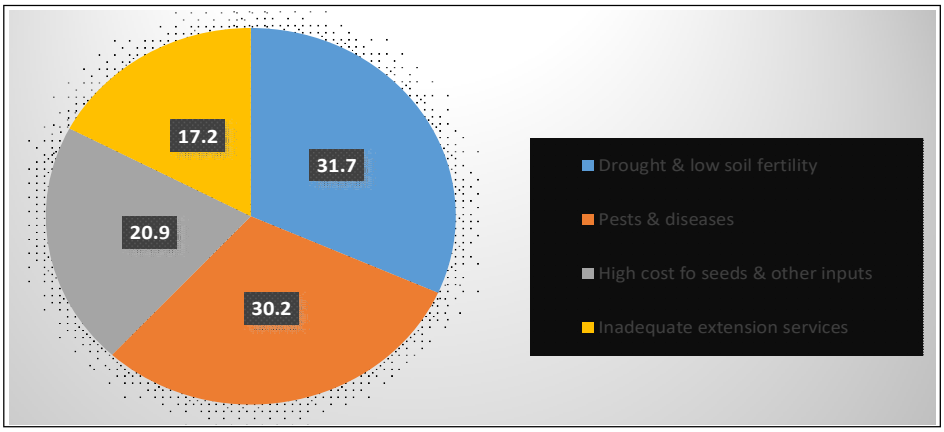

Fig 2: Distribution (%) of major constraints to common bean production in Balaka district (n=139).

Table 1: Distribution of farmers based on cropping systems and seasons.

Cropping season[a]	Cropping system		
	Intercropping	Sole cropping	Total
Rainy	17	17	34
Dry	27	68	95
Both rainy and dry	4	6	10
Total	48	91	139

[a]Dry season is May, June, July, August, September and October; Rainy season is November, December, January, February, March and April; Note, [χ^2 (1, *N*= 139)= 5.3, p= 0.71].

indicators of either low soil fertility or drought on bean plants under rain-fed production. The ability of farmers to mention the indicators of low soil fertility and drought on bean plant suggest how critical are the effects of low soil fertility and drought under rain-fed common bean production. The findings are consistent with what was reported by Emam *et al*. (2011) and Bwambale (2015) regarding effects of drought stress and low soil fertility on common bean crop in the field.

Regarding farmers' approaches towards coping with drought and low soil fertility impacts on bean production, 92.1% of the farmers were aware of the methods that are advocated. Only 7.9% were not aware of what to do to cope with drought and low soil fertility. Farmers also indicated afforestation (46.7%), cultivation of improved bean varieties (32.4%) and the practice of conservation agriculture (20.9%) as methods that are practiced to cope up with drought and low soil fertility. The findings agree with Johnson *et al*. (2018) that farmers in Kenya preferred improved drought tolerant bean varieties as coping mechanism to drought. The results on conservation agriculture are consistent with Mango *et al*. (2017) who reported that the practice is common in Balaka district. According to Resilience Policy Team (2015), the Agriculture Sector Wide Approach Support Program (ASWAP) supported among others, conservation agriculture and crops diversification in Balaka district as coping strategies to abiotic stress on crop productivity.

Participation in variety development

The smallholder farmers are not involved in variety development process as indicated by 91.4% of the respondents and 8.6% indicated that farmers were involved only in participatory variety selection. However, there is inadequate documentation on farmers' participation in bean variety development process. As indicated by Buruchara *et al*. (2011) the Pan-Africa Bean Research Alliance (PABRA) variety development model encourages partnerships between and among various stakeholders in bean value chain and this is the demand led plant breeding approach. Farmers' participation in the breeding process enable the breeders to utilize the indigenous knowledge of the farmers about the crop, expose breeding populations to a broader range of micro-environments (Asfaw *et al*., 2007). Resilience Policy Team (2015) also recommended enhanced participatory agricultural research and technology development as sustainable means of adapting to climate change impacts on crop productivity in Malawi.

Preferred bean seed yield, seed quality and plant morphological related traits

Yield related traits desired by farmers that should be considered in bean improvement include many pods per plant (47.4%), many seeds per pod (31.7%) and large seed size (20.9%). Farmers were also asked about bean quality related traits that were preferred for household food as well as for sale. Good (creamy) taste (61.2%) was the most recommended quality related trait for bean improvement, followed by short cooking time (25.2%) and lastly red mottled bean grain color (13.6%). Respondents indicated that bean varieties with good taste are flavored and creamy such as the red kidney beans. The most preferred plant morphological trait for bean improvement was the determinate growth habit (95.7%) and only 4.3% preferred indeterminate bean cultivars. Determinate bean plant type was also one of the preferred morphological trait in the study by Asfaw *et al*. (2007). Short cooking time characteristic agree with Saimon *et al*. (2016), while good taste and red mottled color were also preferred traits by farmers according to Sheikh *et al*. (2017) and Neupane *et al*. (2005). According to Johnson *et al*. (2018) and Fekadu (2013) farmers gave higher priority to quality related traits than yield when choosing bean varieties especially for marketing. Improving bean varieties that are adapted in Balaka district for the preferred traits would probably increase adoption rate of the varieties that may be released. However, the nutrition aspect of the improved varieties should also be considered as observed by Muthoni *et al*. (2007) and Wortman *et al*. (2004) that apart from being a source of income, the bean crop is also of food and nutritional importance to many people especially in Africa.

CONCLUSION

The majority of farmers cultivated beans under irrigation in winter (dry) season and most practice sole cropping. Deforestation was the major cause of drought and soil erosion contributed to low soil fertility, consequently farmers implemented afforestation, practiced conservation agriculture, cultivated diversified crops and grew early maturing varieties as adaptation strategies. The smallholder farmers are not involved in variety development process. However, farmers preferred high number of pods per plant, large seed size, determinate plant type, good (creamy) taste, short cooking time, red mottled common bean grain color and short cooking time for further genetic improvement. Bean improvement programs should target disease resistance, tolerance to drought and low fertility to increase adoption rate of improved varieties and bean seed yield productivity.

Conflict of interest

All authors declared that there is no conflict of interest.

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