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Dolichos lablab (*Lablab purpureus*): Smallholder Farmers Knowledge, Attitude and Practices in relation to Food and Nutrition Security in Tanzania

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Abstract

Worldwide, adequate consumption of food is questionable though farmers cultivate various crops. Farmers' understanding of their food products, particularly underutilized crops, is less linked to dietary choices. This study examined the knowledge, attitudes, and practices of 344 Lablab growers in Tanzania about underutilized Lablab. Findings show that Lablab knowledge varied and was low in Babati (39.6%) and Arumeru (27.3%). The ordered probit model revealed knowledge differences being influenced by location (0.142) ($p \leq 0.05$) and advice (0.247) ($p \leq 0.01$). Furthermore, the marginal effect indicated locality (0.055) ($p \leq 0.05$) and guidance (0.096) ($p \leq 0.01$) influenced the likelihood of farmers having high knowledge. Mvomero's favourite attitude on Lablab was lower (20.1%). Practically, Lablab was primarily for business, with black accession being most marketed but least consumed. Smallholder farmers' food products are a direct and basic source of consumption in farmers' households, so increasing their acceptability is critical for addressing food and nutrition insecurity.

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Introduction

Worldwide, adequate consumption of food is related to health and wellbeing (Grosso *et al.*, 2020). Meeting the global nutritious food demands, underutilized Dolichos Lablab legumes are significant veritable rich sources of macro and micronutrients (Baldermann *et al.*, 2016; Ferreira *et al.*, 2020). However, Lablab beans have limited contribution to food even among Lablab growers (Tefera, 2006). The underutilized Lablab beans, or in other common names Hyacinth bean/Egyptian kidney bean/Indian bean, have extremely diverse accessions (Maass *et al.*, 2010; Maass, 2016). The crop can be consumed as a green leaf vegetable, flowers, immature seeds (green pods) and dry seeds/pulses (Sarma *et al.*, 2010; Grotelüschen, 2014; Minde, 2020). Understanding it could mitigate food and nutritional insecurity for smallholder farmers' households (Davari and Kasture, 2018). It is argued that in low-income countries, particularly in sub-Saharan Africa, inadequate intake of nutrients on rich foods is common (Shelef *et al.*, 2017; Snapp *et al.*, 2018). FAO, IFAD, UNICEF (2020) reported that sub-Saharan has notable increases of about 32 million undernourished people whose lives depend on USD 1.90 per day or even less. Inability to access adequate quantities and qualities of dietary diets is associated with climate challenges and poverty (UNICEF, 2018), besides the large population is over-dependent on staple crops (FAO IFAD UNICEF, 2017) which are less nutritious and energy dense (Mabhaudhi *et al.*, 2017). African regions are rich in a diversity of nutritious legumes such as Lablab (Maass *et al.*, 2010; Baldermann *et al.*, 2016). Wisely, synergies solutions focusing on nutritious food intake in relation to consumer-farmers' acceptance of their products can safeguard nutrient deficiencies without leaving anyone behind.

Lablab is well-known drought tolerant in the family, Fabaceae (legume family) and perennial, which assures its availability (Maass *et al.*, 2010; Mabhaudhi *et al.*, 2017). The legume provides a good complement with cereal meals of balanced amino acids such as lysine content of 6 - 7% (Omondi, 2011). Likewise, Lablab accessions present seeds of nutrients content such as protein of 23 to 35% compared to that of soybean (Sarma *et al.*, 2010; Miah *et al.*, 2017) and carbohydrates which range from 54 to 67.23% (Hossain *et al.*, 2016; Mabhaudhi *et al.*, 2017) with a great source of daily energy requirements. Surprisingly, Lablab is a highly underutilized crop (Davari and Kasture, 2018; Singh and Abhilash, 2019). In Tanzania, Lablab cultivation is mainly for business purposes. The study by Nord *et al.* (2020) visualized diverse cultivars of Lablab crops to fetch high market value outside Tanzania.

Despite the economic benefits of Lablab accessions, especially in Northern Tanzania, farmers are less familiarized with Lablab meals (Tefera, 2006). Lablab accessions have been seldom documented as a source of the human diet, which might relate to its underutilization (Siddique, 2016). National and local governments are required to recognize the potentials of underutilized crops (Chivenge *et al.*, 2015; Shelef *et al.*, 2017) in overcoming hunger and all forms of malnutrition (FAO, IFAD, UNICEF, WFP and WHO, 2019). Lablab crop is one of the potential underutilized crops that can contribute to dietary diversification to henceforth reduction in nutritional deficiencies in resource-poor communities (Minde *et al.*, 2020). Nutrition interventions centered on underutilized crops like Lablab in relation to customer(s) preferences are foreseen under the future food and nutrition security.

Therefore, it is worth exploring and understanding consumers' behaviour towards food, particularly underutilized foods, to guarantee their acceptance (Adhikari *et al.*, 2017). A knowledge, attitude and practices (KAP) survey is acknowledged to be the effective and measurable tool that can reveal consumers' preference on various foods (Ahamad and Ariffin 2018; Jin *et al.*, 2019). Thus, KAP survey was used to investigate farmers' understanding, acceptance and behaviour/belief on Lablab accessions in the study sites. Since KAP survey is correlated to each other, it can generate data on knowledge gaps, culture, choices of food and hence is likely anticipated to improve dietary intake. The human innate sense of perception (Román *et al.*, 2017) may excessively contribute towards Lablab diets acceptance. In view of farmers' preferences, collecting information on Lablab accessions in relation to their food systems also could reawake interest on the consumption of the underutilized Lablab beans. Therefore, this study focused on factors which determine knowledge, attitude, and preference, frequency of consumption, and attributes contributed to the acceptance and barriers to Lablab utilization in Tanzania.

Materials and methods

Study sites, Design and Population

The study was conducted in the four main Lablab growing districts of Arusha (Arumeru), Manyara (Babati), Kilimanjaro (Same) and Morogoro (Mvomero district) regions. The four districts were purposively selected (Fig. 1). Thereafter, four known wards cultivating Lablab were selected from the three districts, namely Arumeru, Babati, Same and two wards in Mvomero.

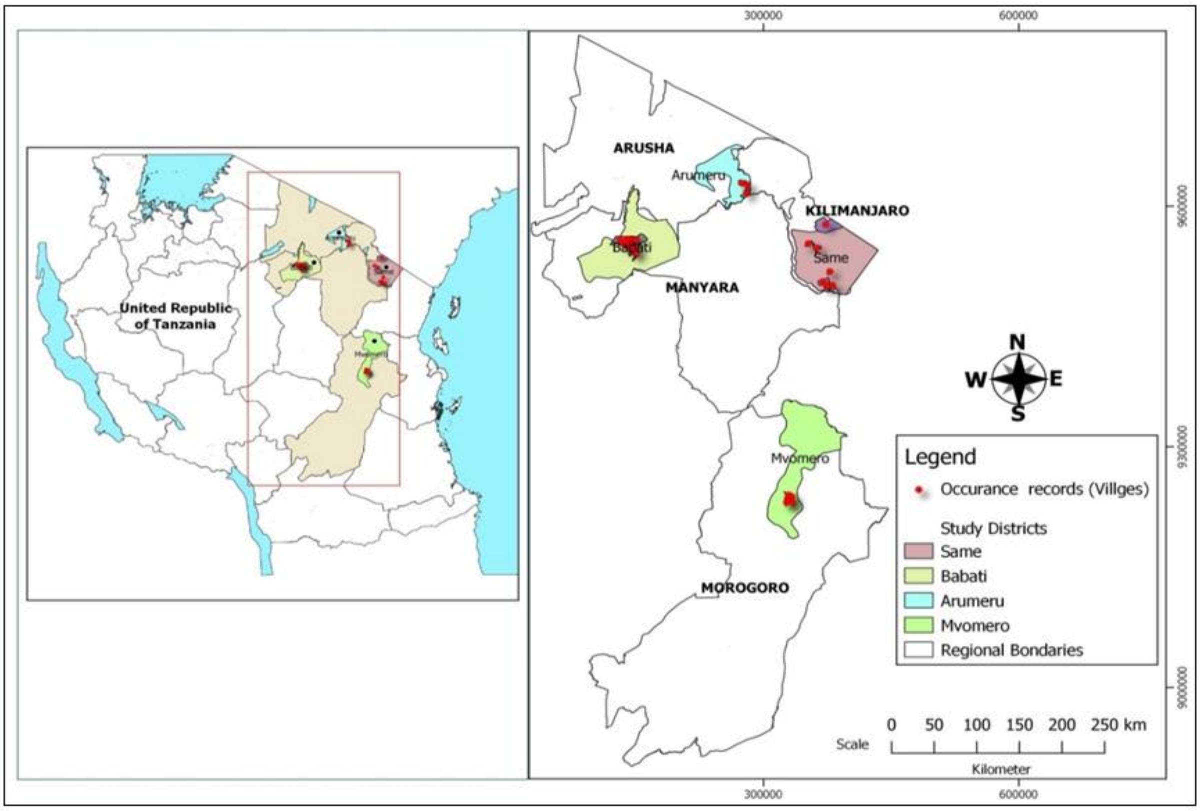

Fig. 1. Study districts showing study sites where Lablab was cultivated on map of Tanzania.

The wards were selected with the assistance of agricultural extension officers, who then identified villages and Lablab growers from their recorded list. From Arumeru nine villages were purposively selected (Meru District Council, 2017), Babati six (Babati District Council, 2020), Same eight (Same District Council, 2018) and five from Mvomero (Mvomero District Council, 2018). Thereafter, a cross-sectional survey was undertaken through face-to-face interviews within farmers' households. Farmers were randomly selected from the identified sites in Fig. 1 to make a total of 86 Lablab growers per district, which in total from the four study areas added to 344 interviewed farmers who were also consumers at the household level.

Data collection

A pre-tested structured questionnaire with open and closed KAP statements were used to interview farmers in the study sites (Macías and Glasauer, 2014; Grotelüschen, 2014). Three trained enumerators were recruited to assist in data collection from the selected households. Field observations were also purposely conducted to collect actual information on cultivation systems, Lablab accessions available and other crops grown, as mentioned during the interviews. Based on Fig. 2 on accession colors, 15 types were collected, three (3) from Arumeru, Babati four (4), Same five (5) and Mvomero had three (3).

Ethical approval

The ethical was approved by the Northern Zone Health Research Ethics Committee (KNCHREC00028). Informed consent was sought from the respondents prior to participating in the study.

Data analysis

Data were cleaned, coded, entered in Statistical Package for Social Sciences (SPSS) version 21. Descriptive analysis was employed to compute mean, frequencies, standard deviation and percentages to establish the variations among farmers. Whereas, likelihood of farmers' knowledge about the crop was determined by an ordered probit model through STATA version number 14.0. Furthermore, marginal effect (ME) was used to describe how the knowledge level (outcome) changes when specific independent (explanatory) variable changes (Tam ´as, 2005). The independent variables included age (in years), level of education (in years), location (districts), sex (male or female), advice (number of counseling sources with regard to Lablab farming), production (in kilogram), income (total kilograms of Lablab beans sold), farm size (hectares), farming experience (years in Lablab crop farming), and household size (total number of household members). Statements portraying attitude and practices based on five options (Likert scale) (Macías and Glasauer 2014) were all added accordingly with respect to neutral responses (Thiessen and Blasius, 2001) to get a total score which was then compared across the districts using one-way ANOVA at five percent (5%) confidence level.

Results

Socio-demographic characteristics of the farmers

Findings on the socio-demographic characteristics provided in Fig. 3(a) showed that both males and females participated in farming activities with the exception of the same district where gender difference was noticeable between males (68.6%) and females (31.4%).

Table 1. Factors determining farmers' level of knowledge of Lablab crop from an ordered probit model**.**

Variable	Coefficient	Standard Error	Marginal effects on different knowledge levels					
			Low knowledge		Medium knowledge		High knowledge	
	Coef.	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
Age	-0.014*	0.067	0.004*	0.002	0.001	0.001	-0.006*	0.003
Education	-0.105***	0.025	0.037***	0.008	0.008**	0.003	-0.041***	0.010
Location	0.142*	0.063	-0.044*	0.020	-0.011	0.006	0.055*	0.025
Sex	-0.103	0.129	0.032	0.040	0.008	0.010	-0.040	0.051
Advice	0.247**	0.095	-0.077**	0.296	-0.019*	0.009	0.096**	0.037
Production	0.001	0.000	-0.000	0.000	-0.000	0.000	0.000	0.000
Income	-0.020	0.039	0.006	0.012	0.002	0.003	-0.008	0.015
Farm size	-0.014	0.016	0.004	0.005	0.001	0.001	-0.005	0.006
Farming experience	-0.004	0.005	0.001	0.000	0.000	0.000	-0.002	0.002
Household size	0.043	0.032	-0.013	-0.010	-0.003	0.003	0.017	0.013
/cut1	-1.457	0.550						
/cut2	-0.537	0.546						
Log likehood	-354.529							
Number of obs	344							
LR chi2 (10)	32.00							
Prob> chi2	0.004							
Pseudo R2	0.0432							

Statistically significant level: ***P ≤ 0.001; **P ≤ 0.01; *P ≤ 0.05; Marginal effects (dy/dx) of the variables determining farmers' level of knowledge after ordered probit regression analysis.

The age range between 31 - 40 years had more farmers in Arumeru, Babati and Same where between 41 to 50 years were from Mvomero. More than 50% of the respondents across study sites had primary education. The results in Figure 3(b) also showed that the majority of farmers' households had about 6 to 13 individuals; more than 50% owned land and were capable of cultivating two to five hectares. Furthermore, the results indicate that farmers had 13 to 49 years of experience in farming, where most of them grew black Lablab across the study areas.

Among the study sites, Arumeru had over 80% of farmers cultivating this type.

Table 2. Farmers' attitude on Lablab crop (n=344).

Statements	District (%)												
	Arumeru			Babati			Same			Mvomero			F-test
	D	N	A	D	N	A	D	N	A	D	N	A	
Lablab farming is a beneficial activity	0.0	1.2	98.9	0.0	9.4	90.6	0.0	1.0	98.9	20.8	11.5	67.7	56.480^{***}
Lablab farming add nutrients to the soil	8.1	3.5	88.4	2.0	4.2	93.8	1.0	19.8	79.2	4.2	5.2	90.6	16.563^{***}
I prefer to cultivate Lablab as cash a crop	3.5	4.7	91.9	2.1	14.6	83.3	8.4	25.0	66.6	68.8	17.7	13.6	115.423^{***}
I often feed my cattle with Lablab remains after harvest	20.9	14	65.2	18.8	25.0	56.3	16.7	58.3	25.0	91.7	2.1	6.3	54.923^{***}
Lablab are consumed by human	40.7	7.0	52.3	29.2	28.1	42.7	14.6	9.4	76.0	3.1	3.1	93.7	54.923^{***}
Some Lablab accessions take short time in cooking	25.6	27.0	47.5	25.0	35.2	41.0	32.2	37.5	30.2	79.2	1.0	19.8	46.598^{***}
We usual consume Lablab	67.4	11.6	20.9	33.7	14.6	51.7	36.0	23.0	41.0	7.3	3.1	89.6	4.060^{**}
I prefer to eat all types of Lablab accessions	38.4	46.5	15.1	24.7	29.1	46.3	3.5	31.4	65.1	11.6	10.5	77.9	3.452^{*}
Lablab is a nutritious food	13.5	33.5	53.0	20.9	35.4	43.7	10.4	46.3	43.3	22.9	17.7	59.4	25.771^{***}
Lablab local dishes are known in my village	12.8	5.8	81.4	7.3	23.3	69.4	11.5	16.3	72.3	4.7	7.0	88.3	35.434^{***}
Lablab farming is economically profitable	7.3	3.1	89.6	0.0	9.4	90.6	3.5	4.7	91.9	64.4	11.1	24.5	55.470^{***}

Statements portraying farmers' attitude were statistical significant ($P \leq 0.001$; $P \leq 0.01$; $P \leq 0.05$) on various aspects of the crop.

KAP assessment

Farmers' level of knowledge

Results in Figure 4a indicates that in the same, 40% of farmers had a high knowledge level on Lablab while Babati had a 30% knowledge level (low) (Figure 4a). Making comparison between knowledge level in relation to sex and location, results showed that male respondents from Babati and females from Arumeru had higher knowledge on the crop (Fig. 4b). Notably, lower knowledge level was observed in Mvomero from both sexes. The differences in knowledge across the study areas necessitated looking at factors that had an influence on farmers' understanding. On the same, farmers' knowledge was determined across ten independent variables. An ordered probit model indicated that four independent variables: age, education, location, and advice (consultations), had a statistically significant effect on Lablab growers' knowledge (Table 1). However, two factors: age (-0.014) ($P \leq 0.05$) and education (-0.105) ($p \leq 0.001$) had negative influence on farmers' knowledge while two factors: location (0.142) ($p \leq 0.05$) and advice

(0.247) ($p \leq 0.01$) had a positive impact (Table 1). This explains that age and education by chance negatively contributed to farmers' knowledge. Furthermore, the marginal effect (ME) was employed to measure the changes on the dependent variable when specific an independent variable changes while other covariates (regressors) were held constant.

The findings of ME on a high level of knowledge among farmers was statistical significant positively influenced by location (0.055) ($P \leq 0.05$) and advice (0.096) ($P \leq 0.01$) with the exception of age (-0.006) ($P \leq 0.05$) and education (0.041) ($P \leq 0.001$) as noted to have a negative effect. Moreover, results revealed that farmers' low knowledge level was positively influenced with age (0.004) ($P \leq 0.05$) and education (0.037) ($P \leq 0.001$), whereas location (-0.044) ($P \leq 0.05$) and advice (-0.077) ($P \leq 0.01$) had a negative effect. Findings likely indicate that farmers' formal education had a positive influence (0.008) ($p \leq 0.05$) on farmers with a moderate level of knowledge but negatively on advice (-0.019) ($p \leq 0.05$) (Table 1).

Table 3. Attributes that contributed to the acceptance of cooked black Lablab accessions (n=344).

Variable	District %				
	Arumeru	Babati	Same	Mvomero	F-test
Colour					66.307***
Unacceptable	55.8	20.8	3.1	1.0	
Neutral	23.3	36.5	14.6	5.2	
Acceptable	20.9	42.7	82.3	93.7	
Smell					82.108***
Unacceptable	52.3	62.5	9.4	1.0	
Neutral	17.4	26.0	42.7	24.0	
Acceptable	30.2	10.4	47.9	75.0	
Texture					53.740***
Unacceptable	66.2	34.4	9.4	0.0	
Neutral	32.6	38.5	39.6	5.2	
Acceptable	1.2	27.1	51.1	94.8	
Taste					153.503***
Unacceptable	45.4	85.4	33.3	0.0	
Neutral	53.5	11.5	37.5	16.7	
Acceptable	1.2	3.1	29.2	83.4	

Farmers' acceptance of cooked black Lablab beans was influenced by food attributes, which was statistically significant ($P \leq 0.001$) across all study sites.

Farmers' attitudes

The results in Table 2 indicate that all statements tested had a significant contribution to Lablab grower's attitude. In general, across the study areas, farmers had a high favourite attitude level by 80.2% in Arumeru, 66.3% Babati and 58.4% in Same on Lablab crop. However, farmers from Mvomero had less favorite's attitude by 20.1% towards the crop (Figure 5a). Mvomero farmers devalue Lablab production since it is less economically viable for their households (Table 2).

Farmers' practices

Preference of Lablab food consumption across the study areas was of great diversity. In Mvomero, more than half of the respondents (69.8%) were observed often taking Lablab meals (Figure 5b).

In Arumeru (9.3%) and Babati (4.2%), however, very few people presumed to eat Lablab diets on a regular basis. Nonetheless, other farmers from Arumeru (43%), Babati (53.1%), and Same (43.8%) ate them on occasion (Figure 5b). The observed eating scenario demanded that food attributes on the most common black accessions (Figure 3b) in the study areas be investigated.

The findings showed that in Arumeru (52.3%) and Babati (62.5%), respondents were uncomfortable with black Lablab beans smell during cooking (Table 3). Likewise, its taste was perceived not palatable among farmers from Babati (85.4%). In general, the food attributes shown in Table 3 have a statistically significant ($P \leq 0.001$) influence on farmers' acceptance of black bean diets, underscoring the Lablab crop's contribution to food and nutrition security.

Barriers on lablab crop consumption

Findings in Figure 6 shows that intake of Lablab foods was hindered by less exposure to various dishes and tedious meal preparation, particularly on black Lablab accessions. Likely, it was observed that harvested beans had insect damages which caused farmers to sell them immediately after harvesting.

Fig. 2. Lablab accessions collected from the study sites based on their color differences; note that the black colored beans were found in all study sites.

Discussion

Socio-demographic characteristics

Public awareness of underutilized legumes is important to show their contribution to food and nutrition security. The study found that the Lablab crop is commonly farmed by both female and male adults in Tanzania, despite it being one of the underutilized legumes (Figure 3a). The findings, however, revealed that male and female participation in Lablab cultivation differed significantly. For example, there were more men who cultivated Lablab in the same (68.6%) than women (31.4 percent) (Fig. 3a). Lablab was a cash crop in same, (Same District Council, 2018) which might explain the difference. Men are regarded as the family's main cash earners in many Sub-Saharan African communities. Therefore agriculture on cash and agricultural export is male-dominated (Fischer and Qaim 2012). Typically, farmers in Tanzania's northern zone valued the crop as a source of income (Nord *et al.*, 2020). The crop was also widely used as a cover crop and green manure by smallholder farmers in Tanzania (Owenya *et al.*, 2011). This explains why the crop isn't used as much for human consumption. It is critical to include underutilized crops like Lablab in formal education in an attempt to eliminate the knowledge gap that exists among growers interviewed. Despite the fact that the farmers interviewed had only an elementary education, the results in Figure 3a showed that more than half of the respondents were unaware of the underutilized crops. Their basic education unlikely helped them on how to optimize the nutritional value of underutilized and/or neglected crops (UNC) like Lablab (Molina *et al.*, 2020). Farmers, in general, are said to be lacking in food/nutrition knowledge, even when it comes to their own crops (Bundala *et al.*, 2019). Studies that combine nutrition and agriculture, particularly the UNC, in addressing food and nutrition insecurity, could be a key topic in the fight against malnutrition in all forms (Kasolo *et al.*, 2019; FAO, IFAD, UNICEF 2020). Nonetheless, beyond staple crops, the topic requires the attention of researchers and policymakers. This consideration is of necessity as the UNC, like Lablab, are highly nutritious, combat climate change, add nutrients to the soil and make great profit margins (Mabhaudhi *et al.*, 2017; Kasolo *et al.*, 2019; Molina *et al.*, 2020).

In this study, the economic worth of the underutilized Lablab crop was found, and over 70% of farmers were observed to own land and be able to grow more than two hectares, with the majority having 13 to 49 years of experience in Lablab cultivation. The black color Lablab seeds were the most widely grown (Fig. 3b). Over 90% of the black accessions were grown in Arumeru (Figure 3b) and were largely marketed in Kenya (Grotelüschen, 2014). Due to this demand, farmers in the northern zone of Tanzania were motivated to regrow the crop for business (Ngailo *et al.*, 2003; Nord *et al.*, 2020).

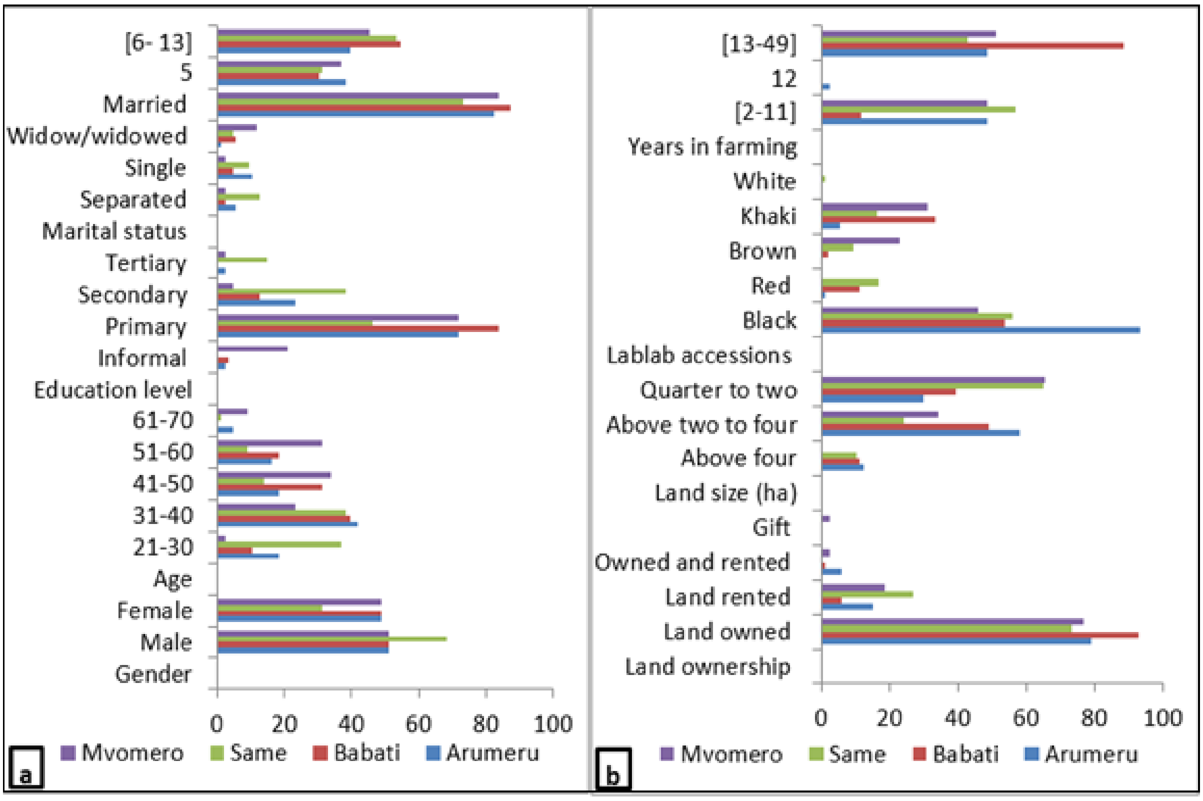

Fig. 3. Socio-demographic characteristics of respondents per study area (%): (a) respondents' gender, age (in years) level of education (in years) and marital status; (b) participants' household size (number of individuals), land ownership status, land area under crop production (hectares), Lablab accessions available based on colour and years in Lablab farming.

This is in line with the study by Forsythe (2019), who argues that Lablab crop is primarily a source of farmers' income rather than for human diet. Consumers' choices may be hampered by factors such as a lack of food knowledge, which limits their meal options (Molina *et al.*, 2020). This has a detrimental impact on consumers since it limits their access to healthful foods, including those produced from underutilized crops. Well-informed food knowledge, as well as suitable cooking methods for diverse underutilized crops, may enhance consumer choice and, as a result, dietary intake. Farmers are the direct consumers; having greater information about the nutritional content of their crops can help them make better decisions and develop a healthier eating pattern.

Farmers' knowledge

Determination of person understanding at a particular product is most important to know how well informed (Ahamad and Ariffin 2018) is. Understanding farmers' awareness is significant, according to Grotelüschen (2014), when bringing underutilized, novel, or developed crops into their food systems. From the results, farmers' knowledge on Lablab crop, the most ancient cultivated crop varied as low, medium and high level (Fig. 4a). Gender-wise, in Arumeru, females and in Babati males were well informed about the crop (Figure 4b). In general, the results show that farmers' knowledge was affected by location (0.142) ($P \leq 0.05$) and advice (0.247) ($p \leq 0.01$) (Table 1). This means that farmers' chances of understanding Lablab crops are influenced by their location and the number of advice they receive. This was also explained by Nord *et al.* (2020) and Forsythe (2019), who pointed out that farmers in the northern zones were more exposed to Lablab crops due to their marketability outside Tanzania. Similarly, respondents with high knowledge were found in Same (36.6%) and Arumeru (27.3%) (Fig. 4a), and their understanding was influenced by their location (0.055) ($P \leq 0.05$) and guidance (0.096) ($P \leq 0.01$) received from various outlets (Table 1). In addition, the results showed farmers with a high understanding of Lablab crops were not influenced by age or formal education. Farmers' formal education had a negative (-0.041) ($P \leq 0.001$) effect on their knowledge about the crop (Table 1). It was expected that the formal education they had could promote their understanding (Figure 3a). Wider perception of education is to reflect changes and also inspire someone's interest in various development aspects of living (Kasolo *et al.*, 2019).

Furthermore, other parameters, including productivity, income, farm size, farming experience, and household size, showed no statistically significant impact on farmers' knowledge levels (Table 1). Although productivity and household size had a favourable impact on farmers' knowledge, income, farm size, and agricultural experience had the opposite effect. According to the findings of the study, the location was an important factor in determining farmers' understanding of the Lablab crop (Table 1).

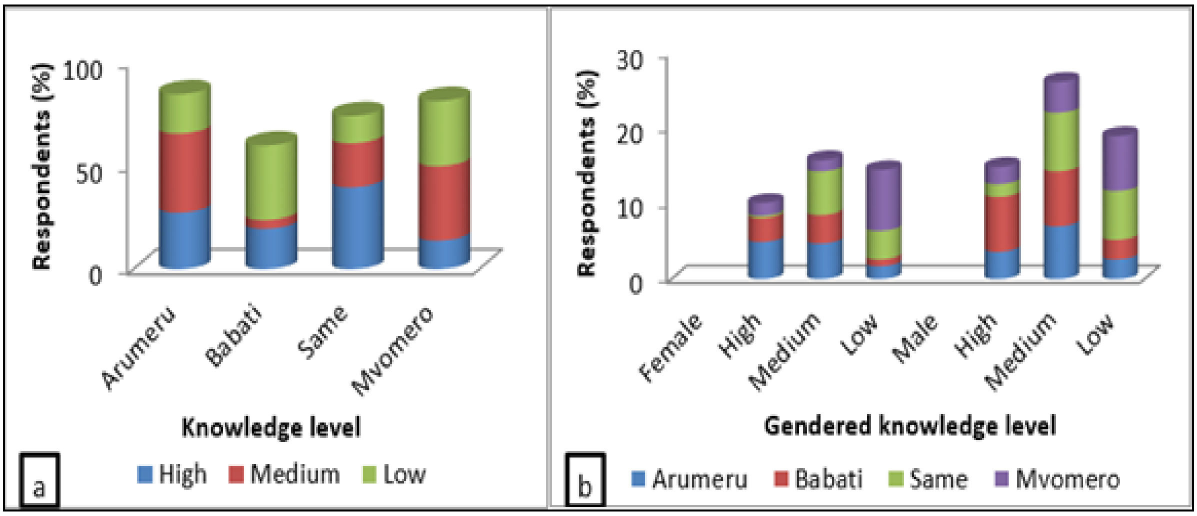

Fig. 4. Farmers' knowledge level across the study sites (4a) and farmers' knowledge level based on location and gender (4b).

Regarding farmers with low knowledge, the findings indicate that, despite being growers, they only knew a few facts about the Lablab crop. Likely, farmers with ordinary knowledge showed the same scenario. Farmers with low knowledge levels were negatively influenced by location (-0.044) ($P \leq 0.05$) and advice (-0.077) ($P \leq 0.001$) (Table 1). This implies that their surroundings inversely influenced their understanding of the Lablab crop. According to the farmers who were interviewed, no training on underutilized crops was provided. They only possessed indigenous or shared local information from parents or relatives, fellow farmers, or neighbors who were less familiar with Lablab food facts and business models. According to a similar assessment by Forsythe (2019), Lablab producers mainly get their information from internal sharing with other farmers or inheritance from parents/grandparents. The same report adds that a lack of comprehensive extension services is directly linked to a lack of crop awareness.

Farmers' attitudes

The results showed that attitudinal comments conveying feelings on the Lablab crop were statistically significant at P ≤ 0.001, P ≤ 0.01 and P ≤ 0.05 (Table 2). Table 1 suggests that the observed variances across the study areas are related to farmer knowledge levels. A study by Bundala *et al.* (2019) showed knowledge is an important predictor of farmers' acceptability preference rather than production and ownership. Their findings appear to be relatively comparable to the current study, which is that Lablab crop ownership and production were primarily for non-dietary consumption rather than for food acceptance. This was confirmed in Arumeru (80.2%), Babati (66.3%), and Same (58.4%) farmers, who reported a strong preference (Figure 5a) for the crop as a source of income but consumed it less (Figure 5b). Surprisingly, only 20.1 percent of farmers in Mvomero preferred the crop (Figure 5a), despite the fact that more than 60% of people eat Lablab foods (Figure 5b). This anomaly prompted more explanations from these farmers, who indicated that the low cost of Lablab accessions played a role in the crop's lower preference. Farmers claimed the grain had no commercial worth, according to the explanation in Table 2. This meant that farming produce could only be profitable if they were used to generate income rather than food. This is consistent with Grosso *et al.*, (2020) statement that crops that directly serve as food in the household are less profitable for farmers, which may stymie efforts to achieve food and nutrition security in a direct approach. People are more tied to the monetary value of their products, resulting in less money being spent on food, particularly healthy diets. This study suggests modeling behavior studies on underutilized crops, particularly among immediate consumers who are smallholder farmers and, in most cases, are nutritionally insecure.

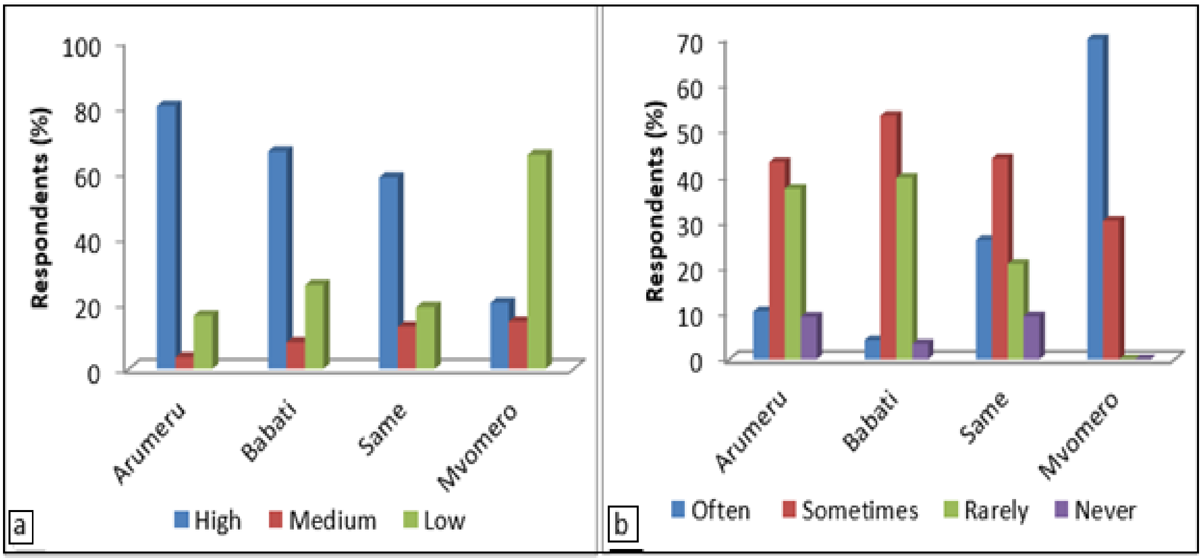

Fig. 5. Farmers' attitudes on Lablab crop across areas (5a) and frequency of eating Lablab foods at their households (5b).

Farmers' practices

Lablab foods were eaten less in all of the research areas, according to the findings (Fig. 5b). They are challenging the importance of underutilized and indigenous crops in ending food and nutrition security (Shelef *et al.*, 2017). Recognition of underutilized Lablab beans is beneficial to human health and domestication of their bean varieties will enrich food systems (Kasolo *et al.*, 2019). However, the findings of the study highlighted that there is still a gap in Lablab crop contribution to agrifood potentials when compared to agribusiness, which needs to be taken into account in the future when it comes to ending food and nutrition insecurity. Take the example of a traditional Arumeru cuisine *Loshoro* prepares with Lablab beans, which also a special delicacy is served at various events such as wedding ceremonies, albeit it is becoming less common. *Makande* was another traditional cuisine found throughout the study areas, but it was typically cooked with common beans, despite the fact that farmers grow Lablab beans. *Kivuge/Chibote* was a traditional Mvomero dish made with Lablab beans with cassava/yams or unripe bananas that were mashed after cooking. Farmers in Mvomero often observed taking this food (Fig. 5b). Green beans were also consumed in Mvomero and non-black accessions were cultivated at a higher rate than black accessions in Mvomero, which may explain the high consumption in this area (Fig. 3b). Respondents in Arumeru, Babati, and Same, on the other hand, who did not eat Lablab meals or ate fewer of them, were identified in the survey (Fig. 5b). The reason for this is that the results of food attributes suggest that poor acceptability of Lablab foods is linked to accession type. Take black accessions, for example, whose food qualities were statistically significant at $P \leq 0.001$ and influenced farmers' acceptance. Nonetheless, with appropriate preparation and cooking, the beans are delicious (Raja *et al.*, 2014). Soaking black beans overnight, washing and sometimes dehulling them, then rinsing and cooking them makes black beans palatable. Table 3 shows that these processes were time-consuming and unfriendly to farmers, resulting in lower acceptance of black accessions.

In Tanzania, most consumers of Lablab beans are Asian people (Pengelly and Maass, 2001) despite the crop being grown by the smallholder farmers and available in diverse genotypes (Nord *et al.*, 2020).

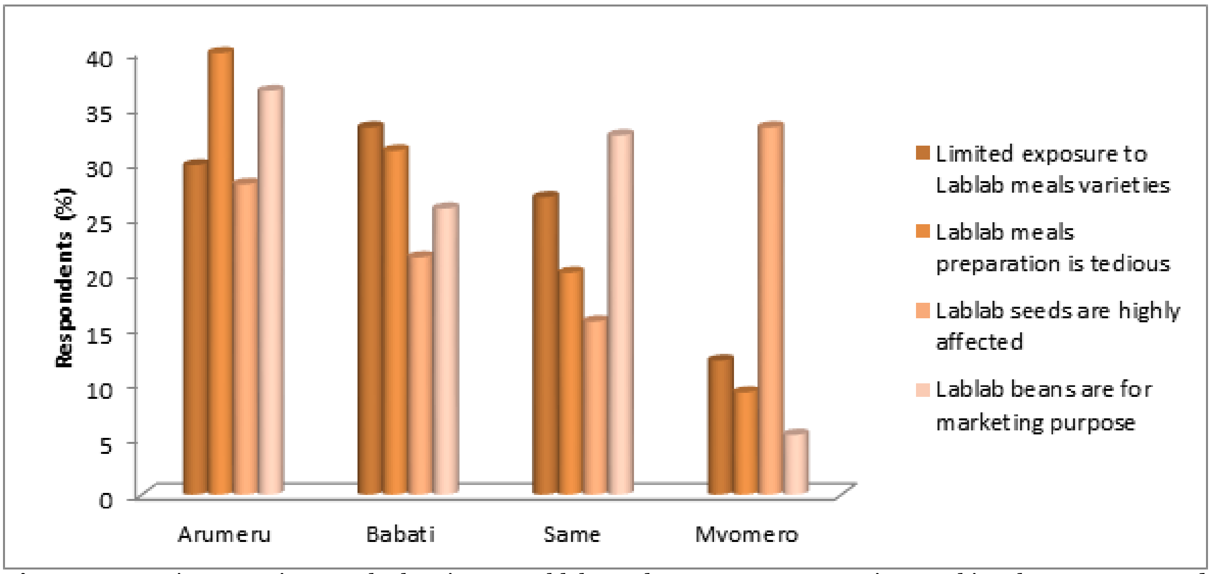

Fig. 6. Farmers' perspectives on the barriers to Lablab meal awareness, preparation, cooking, bean storage, and marketability value across the study sites.

As a roadmap for achieving food and nutrition security, researchers, particularly nutritionists and policymakers, should examine strategies to incorporate the black beans most grown into dietary systems.

Barriers to lablab beans consumption

Intake of Lablab foods is hampered by a lack of exposure to a variety of dishes, as well as the time-consuming preparation and cooking by boiling, particularly for the black accessions. Similar results were also observed by Grotelüschen (2014) on black Lablab accessions from Kenya. The low sensory appeal of the underutilized bean foods is linked to a lack of nutritional information, a scarcity of bean product varieties, as well as poor processing, which all limit their consumption. In addition, black accessions require a long and tedious detoxification process in order to be safe for human consumption. According to the study, farmers were also unfamiliar with Lablab food cooked with green leaves/flowers or green beans. Despite the aforementioned, Lablab foods are well prepared and consumed in Asian countries (Grotelüschen, 2014; Tyagi *et al.*, 2018). Another factor was that, in comparison to common beans, the Lablab accessions were severely damaged by insects during storage. As a result, farmers chose the quick option of selling the beans immediately after harvest, leaving little/no for consumption or seeds for the following season (Forsythe, 2019).

Conclusion

The finding of this study provides information on what farmers knew, feel and did with Lablab crop. Farmers were familiar and had prior experience in growing the Lablab crop, which was primarily grown for household income. Even when the price of the crop declined, it was less consumed. Underutilization of Lablab beans has been attributed to a lack of knowledge about nutritional potentials, a lack of exposure to Lablab food varieties, and a lack of promotion of the beans in agrifood systems, such as for agribusiness and agronomy potential. The study suggests that nutrition education, together with customer acceptance choices, could lead to favorable underutilized Lablab meal preferences on accessions varieties. Adding value to the dominant black accessions would also increase their consumption and income since value-added food products are convenient and usually meet customers' needs. The study recommends for more research to be conducted on the eating habits of underutilized Lablab bean varieties in relation to customer acceptability in contributing to food and nutrition security challenges, particularly in low-income countries.

Author Contributions

Data were collected and analyzed by J. J. M., who wrote the first draft of the manuscript; A. O. M. and P. B. V. supervised the research activities, internally reviewed the manuscript and final revised draft of the manuscript.

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Conflict of interest statement

The authors of this article declared nothing.

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