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Original Paper

Key Determinants of Local Bean Production and Marketing in Mbeya District, Tanzania

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***Abstract*— Common beans are a widely cultivated crop in East and Central Africa. This study aimed to assess the factors affecting local bean production and marketing at the household level. Using a non-experimental research design, the study surveyed 111 farmers from the Isangati division in Mbeya District. Cross-sectional data were collected through expert sampling methods, and regression analysis was employed to examine the influence of socio-economic factors on the production and marketing of local bean varieties. The results indicated that variables such as age, education, occupation, and farm size significantly influenced bean production ($p<0.01$), as did market accessibility and the acceptability of bean varieties ($p<0.01$). The study concluded that proximity to markets, socio-economic conditions, and consumer preferences play a crucial role in shaping bean production and marketing outcomes. As a result, interventions should be tailored to meet both user and consumer preferences.**

Keywords*— Bean production, Bean marketing, Integrated pest and disease management, Intervention sustainability, Local bean varieties.

I. Introduction

The common bean (Phaseolus vulgaris L.) is a staple grain legume grown on over four million hectares across Africa [6, 43, 54]. It provides a vital source of dietary protein for more than 100 million people in both rural and urban regions. Eastern Africa has the highest global bean consumption rates, with an annual per capita intake of 50–60 kg [7,33, 35]. In developing countries, beans are an essential, affordable source of protein, particularly addressing protein deficiencies in rural diets [17, 30, 56]. In Tanzania, beans are not only a crucial protein source but also a significant cash crop for many farmers, with major growing areas in the southern highlands, northern, eastern regions and the Lake Zone [45, 69].

Vazeux-Blumental, Mathieu, Trabac, Palaffre, Lagardère, Carraretto & others[70], El-Mehy, Shehata, El-Deen Mohamed, Saleh & Suliman [25] and Tripp [67] note that common beans are key components of many cropping systems, though their roles can change or be replaced. Legumes are often viewed as insurance crops due to their deep root systems and sensitivity to light competition, but they are also vulnerable to insects and diseases due to their high nitrogen content [23, 61, 65]. Different cropping systems require distinct bean varieties, and farmers often grow multiple varieties for their agronomic and culinary qualities [39]. However, as incomes rise, bean consumption tends to remain stable or decrease [25, 67, 68].

In Tanzania, local bean production is largely managed by smallholders for personal consumption, with around 20% sold as surplus [18]. Tanzania ranks as the sixth-largest global dry bean producer and second in Sub-Saharan Africa after Ethiopia [18]. Despite new agricultural technologies such as improved bean varieties and pesticides, Muthoni-Andriatsitohaina & Chimboza[44) report that farmers are often reluctant to adopt these innovations due to the lack of involvement in their development [60]. Farmer preferences are often overlooked by researchers [49]. Although, 73% of bean growers use pesticides to control pests and diseases, post-harvest losses still account for up to 50% of bean yield loss [31]. With limited information on factors affecting local bean production and marketing compared to high-yielding varieties, this study focused on identifying the key determinants influencing the production and marketing of local beans in the Mbeya District.

II. Materials And Methods

A. Study Location

The present study took place in the Isangati Division of Mbeya district. This location was selected due to its position in the lowland or coffee zone, situated below an altitude of 1900 meters. The coffee zone receives an average annual rainfall between 750 mm and 1200 mm, and the soils in this area are generally low in fertility. Farmers cultivate maize, beans, finger millet, potatoes, and coffee. Additionally, this study area is a key bean-producing region in the district, with beans being a vital subsistence and commercial crop [38]. Most farmers in this division supply beans to both rural and urban markets, which has given them access to improved bean and integrated pest management (IPM) technologies.

B. Research Design

This study adopted a non-experimental design [8,9] due to its efficiency and cost-effectiveness when implemented post-program phase-out, given adequate existing data [9]. Participants with comparable characteristics were selected from both treated and control villages to determine differences in the adoption of IPM technology for common bean cultivation. According to Doss [22] and Baker [8,9] that non-experimental design is essential as it involves participants from both treatment and control groups, allowing for comparisons of outcomes between individuals who received project interventions and those who did not, thereby aiding discussions on causality. Additionally, data was collected using a cross-sectional time dimension at a single point in time [62], a method considered suitable given the study's nature.

C. Sample Design

Sample size determination

Before data collection, a sample size of 111 was calculated considering both time and financial constraints. Despite this, the selection of a small sample size was due to its inadequacy in accurately replicating the key characteristics of the accessible population [42]. Therefore, Ortiz and Pradel's [55] estimation formula was used to determine the sample size from the infinite population, ultimately deciding on a sample size of 111 to accurately reflect the key characteristics of the accessible population [42].

Sampling procedure

Before data collection, a sample size of 111 was calculated This study involved two groups of respondents: those with and without IPM technology project intervention. A multi-stage approach was used to select the target area. In the first stage, Mbeya District was purposively chosen, specifically Isangati Division, which had an IPM technology intervention for bean growers. In the second stage, two wards with interventions were selected. In the third stage, one village with an IPM intervention and three villages without it, all within the same agro-ecological zone, were selected to evaluate the technology's scaling in the ward, in line with the FFS goals. The villages of Isuto, Shinzigo, Idiwili, and Iwowo, situated in a coffee zone at 1500–1700 meters above sea level with a savanna climate [14], were included. A purposive technique was also employed to identify households involved in bean cultivation within each village. The village registry served as a reference to select villages for interviews, forming the sampling frame. The survey targeted both female and male household members involved in agricultural activities and bean production.

Sampling Size

The assessment included one village with a FARMESA intervention and three villages without the project. A list of farmers was obtained from village registries for the survey, resulting in 111 participants.

D. Data Collection

Both secondary and primary data were collected for this study. Secondary data sources included field project appraisals, beneficiaries' project reports, district socio-economic profiles, National Bureau of Statistics data, and scholarly electronic information. Primary data were gathered through household surveys, focus group discussions, and key informant interviews.

Types of data collected

The study gathered information on various factors related to the adoption of common bean IPM technology. These factors included changes in production levels, socio-economic characteristics of households, technology-specific characteristics within households, and the availability, accessibility, and utilization of farm inputs.

Data Analysis

The STATA package (version 15) was used for descriptive statistics and quantitative data analysis, focusing mainly on frequencies, percentages, and quantitative estimation. Frequency analysis was employed to verify the consistency of the collected data and identify any outliers. For describing dispersion, the study relied on the standard error and coefficient of variation. The proportion between participants and non-participants of the disseminated IPM technologies was considered homogeneous or heterogeneous based on whether the observed mean and standard deviation were the same or different, respectively [15,27]. Multiple linear regression analysis was conducted, with a test for multi-collinearity. The variance inflation factor (VIF) results indicated no multi-collinearity problem, as the VIF values ranged from 1.28 to 2.86, adhering to the rule of thumb that a VIF less than 5.3 signifies no multi-collinearity issue [29]. The study implicitly specified multiple linear regression as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \varepsilon_i$$

Whereby:

y = number of IPM technologies adopted by a farmer;

x_1 = age of household head; x_2 = sex of household head;

x_3 = marital status; x_4 = education level of household head;

x_5 = Occupation of respondents; x_6 = Household size;

and x_7 = farm for bean.

III. Results And Discussion

A. Socio - Economic Characteristics of Respondents

Findings (Figure 1) showed that 28% of the respondents were aged between 18-32 years, and 41% were aged between 33-47 years. This suggests that respondents in these age categories were more likely to actively participate in bean production compared to those aged 48-62 years and 63-77 years, who constituted 27% and 3% of the respondents, respectively. Farmers' age can influence the likelihood of adopting technologies. According to Rakholia, Tailor, Prajapati, Shah, & Saini [58], the common bean (Phaseolus vulgaris L.) is a staple grain legume grown on over four million hectares across Africa [6, 43, 54]. It provides a vital source of dietary protein for more than 100 million people in both rural and urban regions. Eastern Africa has the highest global bean consumption rates, with an annual per capita intake of 50–60 kg [7, 33, 35]. In developing countries, beans are an essential, affordable source of protein, particularly addressing protein deficiencies in rural diets [17, 30,

56]. In Tanzania, beans are not only a crucial protein source but also a significant cash crop for many farmers, with major growing areas in the southern highlands, northern, eastern regions, and the Lake Zone [45, 69].

In Tanzania, local bean production is largely managed by smallholders for personal consumption, with around 20% sold as surplus [18]. Tanzania ranks as the sixth-largest global dry bean producer and second in Sub-Saharan Africa after Ethiopia [18]. Despite new agricultural technologies such as improved bean varieties and pesticides, Muthoni-Andriatsitohaina and Chimboza[44] report that farmers are often reluctant to adopt these innovations due to the lack of involvement in their development [60]. Farmer preferences are often overlooked by researchers [49]. Although 73% of bean growers use pesticides to control pests and diseases, post-harvest losses still account for up to 50% of bean yield loss [31]. With limited information on factors affecting local bean production and marketing compared to high-yielding varieties, this study focused on identifying the key determinants influencing the production and marketing of local beans in the Mbeya District.

Ikenda, Owusu, Oberhauser, Masinde and Bain [31] and Abdulai & Huffman [1] report that older farmers are more likely to adopt technology due to their accumulated knowledge, capital, and experience. Conversely, younger farmers, who exhibit lower risk aversion and are at an earlier stage of their life cycle, are more inclined to adopt new technologies with long-term benefits [36, 63]. However, Tiamiyu, Akintola and Rahji [66] found that age did not significantly impact the adoption of improved technology.

Regarding farming experience, observations revealed that 46% of the respondents had 16-30.5 years of farming experience, while 30% had 0.5-15 years of experience. This indicates that the respondents with 16-30.5 years of experience had more farming experience compared to those with 0.5-15 years. Shorter farming experience is essential for building longer experience over time [28, 52, 66]. However [4, 19] found that farming experience does not significantly affect the adoption of improved technologies. Among the respondents interviewed (Table 1), 63% were female and 40% were male, indicating that women were more engaged in common bean production compared to men. This suggests that men often view common bean farming as a woman's job, despite having greater access to information about new technologies [5, 51, 71]. Conversely, these findings contradict [13] who observed that young men benefit more economically from bean production than young women.

Furthermore, findings (Figure 1) showed that the majority (81%) of farmers engaged in bean production were married, while 17% were widowed, and 1.5% were separated. Examining marital status is important because it influences agricultural production in various ethnic groups. Marriage is highly valued and likely holds true for most Tanzanians. Jari [32] associates married households with stability in both the household and farming activities. On the other hand, marriage is also considered a leading factor limiting women's access to and control over resources, particularly in rural areas where the majority reside [40].

As a result, findings (Figure 1) showed that 49.5% of respondents' households had a family size of 1-4 members, while 40.5% had a family size of 5-8 members, including parents and children. This suggests that having a large family does not necessarily guarantee a sufficient labor force for bean farming. Bamire and Manyong [10] assert that family labor available in the household is not always used for farm operations. Consequently, bean farmers who can afford to hire labor will tend to maximize their returns on investment in bean farms.

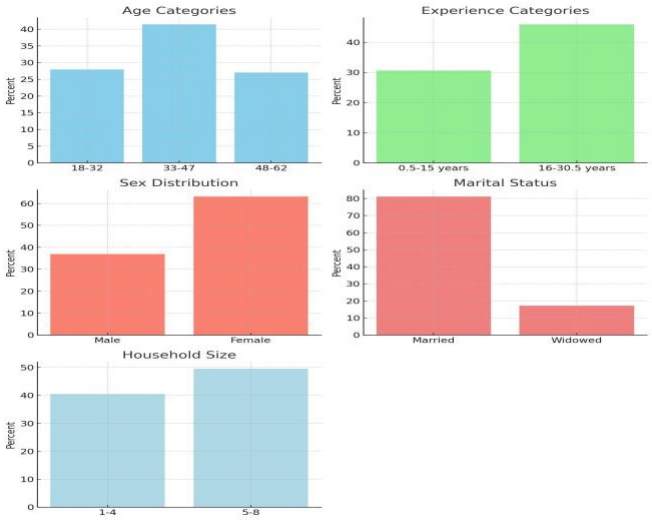

Fig. 1. Socio-economic characteristics of respondents

Level of education attained by respondents

Results (Figure 2) showed that the majority (77%) of respondents had attained primary education, while 20% had no formal education. A smaller proportion (1.8%) had completed form four education or college education. This suggests that primary school leavers constitute a large proportion of beneficiaries, implying that the majority of participants could learn new skills. These findings align with Edwards and Mancini [24] and Marisennayya and Bojago [34], who noted that education enhances skills acquisition. However, those with higher education levels tend to migrate to urban areas for other economic activities or employment [69].

Occupation status of respondents

engaged in crop farming to earn their livelihood. This indicates that the agricultural sector remains the primary employer for the majority of respondents in the study area. Most Tanzanians (about 65% of the population) live and earn a living in rural areas, with agriculture as the cornerstone of their livelihood [26,48]. This suggests that improving farm incomes for the rural population is crucial for reducing rural poverty in Tanzania [69].

Fig. 2. Other socio-economic characteristics of respondents

Sources of income for the household

Present results (Figure 2) showed that the majority (99%) of respondents depend on farm employment rather than off-farm employment. This suggests that most respondents rely solely on farm activities, with fewer people engaging in off-farm activities as a complementary source of income. This is likely due to a lack of off-farm employment opportunities in the study area. Similarly, Davis, Nkonya, Kato, Mekonnen, Odendo, Miiro and Nkuba [21] observed less diverse activities in rural households in African countries compared to other continents. On the other hand, Danso-Abbeam [20] and Barbieri & Mahoney [11] found that off-farm activities were driven by complex motives that were both economic and intrinsic in nature, which enhanced the adoption of improved varieties.

B. Adoption of Imroved Bean Varieties

Farmers' yield depends significantly on the rate of variety adoption. Study findings (Figure 3) showed that farmers have their own variety preference criteria, which are often overlooked by research and extension personnel. The majority of respondents preferred local varieties due to their palatability, local market demand, and compatibility with the area's agroclimatic conditions. Other factors considered included maturity time and yield advantage when cultivated similarly to improved varieties. During focus group discussions (FGD), a sample of bean growers reported improved market price and disease resistance as additional benefits. These results align with observations by Sanga and Mahonge [60], who noted that despite the availability of high-yielding and disease-resistant improved varieties, there is limited adoption.

Understanding farmers' technology preference criteria is crucial in the technology generation and dissemination process. Often, a mismatch between the preference criteria of technology promoters and end users (farmers) hinders the adoption of new technologies. Farmers have identified bean deliciousness and short cooking time as the most preferred attributes by bean consumers, which guide their selection of local bean varieties. This highlights the need for participatory research that considers farmers' technology preference criteria, needs, and priorities [49, 59].

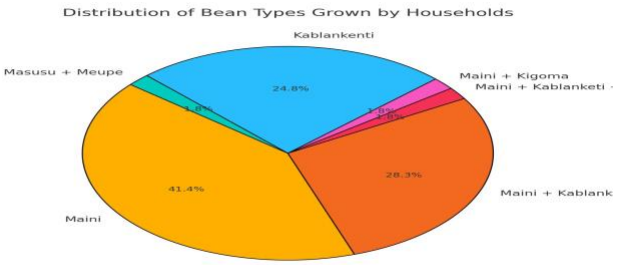

Fig. 3. Distribution of Local bean type grown by households in the study area

Farmers in the study area showed a high interest in cultivating traditional common bean varieties due to local consumption demand, high market prices (marketability), and the better suitability of these seeds to the area's agro-ecology. Farmers' lack of interest in improved varieties was attributed to these varieties not being preferred by the farmers and the unavailability of improved seeds in the study area. The absence of a push supply strategy and the lack of distribution of improved seeds indicate their unavailability. Therefore, efforts by the government and other organizations are needed to address farmers' needs, particularly by introducing improved seeds based on farmers' preferences.

C. Analysis Factors Influencing Production and marketing of Local bean

Local bean production is influenced by independent variables such as age, sex, marital status, education level, occupation, household size, and land for bean cultivation. Observations (Figure 4) showed that age is inversely correlated with local bean production and is statistically significant at the $p<0.01$ level. The results indicate that production decreases with the age of participants, suggesting that older participants benefit less from interventions than younger farmers. This could be because younger farmers are more proactive in seeking various bean varieties due to their previous interest and experience in the crop, and they may also have better access to information about different varieties. These findings are consistent with observations by Rabe et al. (2023), Edwards and Mancini [24] and Bamire, Fabiyi & Mayong [10] that age affects an individual's mental attitude towards new ideas and influences adoption in various ways. However, the findings contradict Tiamiyu, Akintola & Rahji [66], who observed that a farmer's age did not significantly influence the adoption of improved technology.

The seeds of False Mopane could serve as good sources of Additionally, findings showed that education is statistically significant and inversely related to local bean production at the $p<0.01$ level. Higher education levels tend to keep participants away from agricultural activities, suggesting that the more educated rural inhabitants are, the less likely they are to engage in agricultural activities. This trend is likely due to rural-urban migration in search of higher-paying jobs. However, education can make a farmer more receptive to advice from extension agencies and better able to handle technical recommendations requiring a certain level of literacy [2, 41].

Moreover, results showed that occupation is statistically significant and directly related to bean production at the p<0.01 level. This indicates that interventions favor rural inhabitants practicing bean farming, likely improving their yields through nitrogen fixation [31, 45, 47. Occupation was a key determinant of local bean production in the study area. Furthermore, observations showed that the possession of land was statistically significant and directly related to bean production at the p<0.01 level. This suggests that the outcome of interventions influences farmers to allocate land specifically for bean cultivation [3, 17, 18, 50].

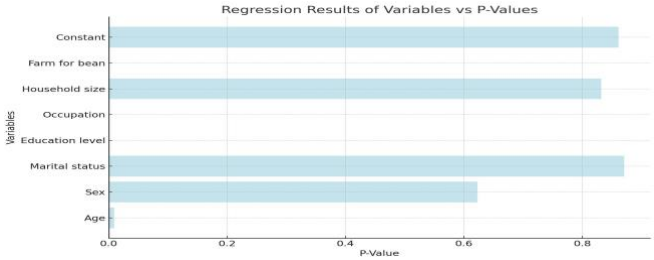

Fig. 4. Regression of socio-economic factors influencing Local bean production

D. Factors Influencing Local Bean Marketing

Research results (Figure 5) showed that bean variety acceptability is statistically significant and directly related to bean marketing at p<0.01 level. This suggests that bean types motivate farmers to engage in agricultural innovation due to attractive outcomes. The increased yield of beans could probably be attributed to an increase in income, consumption, and seeds (study to support or contrast). Also, findings showed that market accessibility for beans is statistically significant and directly related to local bean marketing at the p<0.01 level. This suggests that an increase of 1 unit in bean market acceptability led to an increase in bean production by 69.8%. The result suggests that markets for beans determine farmers' decisions to adopt bean varieties accepted by the market. Findings agree with observations made by Chikuta, Sichoongwe & Nakanga [18], Nanyonjo, Aseete, Ugen, Mugagga, Katabalwa, & Kabanyoro [46], Belaynch, Lemma & Ameda [12] and Ochieng, Niyuhire, Ruraduma, Birachi & Ouma [53] that proximity to markets through traders enhances bean production.

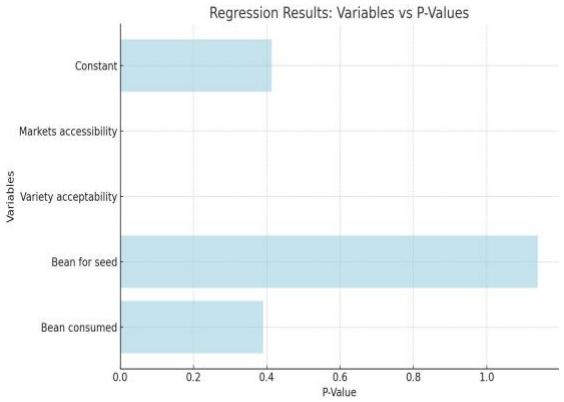

Fig. 5. Regression of factors influencing local bean marketing

IV. Conclusions

Based on the study findings, it was observed that the package of practice, which includes improved bean varieties, was not adopted by common bean growers in the study area. however, factors such as age, education level, occupation, and the size of the bean farm significantly influenced local bean production. additionally, the acceptability of bean varieties and market accessibility played a significant role in local bean marketing. consequently, the study concluded that the adoption of new technologies in bean production and marketing is dependent on consumer acceptance of bean varieties and proximity to markets. therefore, it is recommended that interventions for improved common bean production be validated with users and promptly marketed if they meet farmers' needs and consumer preferences.

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