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Adoption of Quality Protein Maize Technology in Hai and Babati Districts, Tanzania

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Technology adoption is a crucial driver of economic growth. The paper assesses the acceptance of quality protein maize (QPM) among farmers in the Hai and Babati districts Tanzania. The study used a random sample of 120 smallholder maize farmers in four villages to collect information regarding the adoption of QPM in the study area. The study employed descriptive statistics to analyse the data collected. The results show that only 25% of the sampled farmers have adopted and are still using the technology. This outcome has a low adoption rate. The study recommends that the government ensure farmers use their inputs and outputs efficiently to achieve QPM. In addition, the government should promote and support QPM's promotion and dissemination activities in the country. Moreover, seed agents should ensure a sustainable supply and timely availability of seeds to farmers.

Keywords: Quality protein maize; technology adoption; smallholder farmers; promotion; dissemination.

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1. INTRODUCTION

Many industrialised and developing nations depend heavily on maize (*Zea mays* L.) for human and animal nourishment [1]. According to estimates from the FAO food balance sheets, maize provides at least one-fifth of the continent's daily caloric intake and accounts for 17–60% of the daily protein requirements of people in 12 nations [2].

Maize is Tanzania's most important staple food, with over 80% of the country's people depending on it for food and income [3,4,5]. In Tanzania, maize provides more than 35% of the population's usable protein and 60% of their daily calories [6,7]. Additionally, maize is a component of animal feed used to raise cattle. More than 75% of the country's grain consumption comprises maize, accounting for 31% of the nation's overall food production [8].

Quality protein maize has almost twice as much useable protein as regular maize. Some QPM hybrids have up to 13.5% protein content [9]. The enhanced QPM populations were made available for direct field use as OPVs (open-pollinated varieties) or bred lines for hybridization. Because of this, there are now a lot of subtropical and tropical lowland cultivars and temperate and tropical highland cultivars with better protein quality. Developing nations use QPM maize widely as a staple food. In 18 developing nations, 750,000 hectares of cropland were under cultivation [10] (Gregory & Sewando, 2014).

QPM is more valuable biologically and nutritionally than regular maize, and it may be grown similarly and has a similar kernel phenotype (Prasanna et al., 2001). Compared to regular corn, this kind has twice as much lysine and tryptophan as usual. However, QPM behaves and appears like regular maize. Since it is created using conventional breeding methods, it is not genetically altered and can only be accurately differentiated through scientific tests. The QPM is expected to increase household food security, generate income, and minimise malnutrition problems, especially among children.

In Tanzania, QPM technology was introduced in 2001, whereby three varieties, Lishe H-1, Lishe H-2, and Lishe K-1, were released. Two international organisations, namely National Agricultural Research Systems (NARS) and CIMMYT contributed much to introducing these varieties in Tanzania, specifically the northern part of the country. These varieties were presented to the Variety Release Committee (VRC) for debate before their formal release. The VRC reviewed the data from the advanced yield trials and the farmers' assessments that the original breeder had assembled [11]. Later, the committee was convinced of the varieties' benefits, and they were made public. The Tanzania Official Seed Certification Institute (TOSCI) certifies all new cultivars' seeds annually.

Technology adoption is crucial for economic growth, especially in emerging nations. In addition, researchers must provide evidence that their investments have been competitive with alternatives in research and technology distribution to draw attention to funding for agricultural research (Bjornlunda et al., 2020) [12]. Thus, a study on the uptake of new technology is essential since it will yield significant indicators for evaluating the effects at the farm level, thereby enhancing farming operations [13,14].

There was a need to comprehend QPM's adoption status as well as the elements that influence it, given the significance of QPM, which can be cultivated and consumed by a large number of families as a nutritionally essential staple grain in the human diet like ordinary maize if they are produced and consumed in sufficient quantities [15]. Since the start of the QPM project in 2003, the Tanzania Agricultural Research Institute (TARI) has been carrying out several QPM promotional activities in the Northern Zone of Tanzania, including field demonstrations, field days, the distribution of leaflets and brochures, the development of various recipes, and the production of QPM seeds [16]. However, the adoption of QPM is not well established. Therefore, this paper fills the gap by establishing the adoption of QPM in Tanzania.

2. MATERIALS AND METHODS

The study was conducted in Manyara and Kilimanjaro regions,s where Babati and Hai districts were selected, respectively. The districts were sampled because they were the country's first to receive QPM technology. Furthermore, these districts have favorable weather conditions for maize cultivation, with bimodal rain experiences ranging from 500-1200 mm and 350-2000 mm, respectively. Usually, the short rainy season lasts from late October until

December, whereas the long rainy season occurs from March to June. The soils range from sandy loam to alluvial clay soil and are of volcanic origin.

A cross-sectional study design was applied in a non-experimental fashion. Statistical Packages for Social Science (SPSS) software Version 20 was used to compile, code, and analyze the obtained data. Comparative mean analysis and descriptive statistics were used, focusing on frequency distribution.

3. RESULTS AND DISCUSSION

3.1 Work-related Qualities of the Head of Household

Among the factors influencing the use of technology are occupational characteristics such as farm size, off-farm activities, and animal ownership. Findings show that households' average farms were 1.0 hectares (3.68 acres) planted in maize (Table 1). Regarding total farm size, adopters had more acreage than non-adopters; however, the difference was insignificant. The average amount of land used to grow maize by adopters and non-adopters was 0.8ha and 0.6ha, respectively. Maize, beans and sunflower are the most important crops grown. Maize ranked first among the crops planted for adopters and non-adopters, then beans for Babati and sunflower for Hai district.

Off-farm activities are additional income sources that may encourage or discourage investment in new technologies. This study's main off-farm activities were casual labour, salary employment, carpentry, and petty business. There was a significant difference ($p<0.01$) in the number of adopters and non-adopters involved in farm activities. The results showed adopters are less involved in off-farm activities than non-adopters of QPM technology (Table 2). Casual labour was the type of work mainly reported to be done by adopters (55.6%), and there was a significant difference ($P<0.05$) between adopters and non-adopters. This indicates that the availability of labour in local markets would affect technology adoption. When there is a local labour market, farmers can hire labour as needed. Members of farmers' households may also sell labour to obtain cash as necessary.

According to Farkas [17], an institution is a system of behavioural norms that controls and shapes how people interact, partly by assisting individuals in developing expectations of what others will do. Thus, extension services, research, seed/input provisional services (input stockists), and loan facilities are some of these institutions' support systems. As they are created to lessen risk and uncertainty in human exchange, institutions are seen as methods for structuring human relationships in the face of uncertainty. Institutions aid people in developing expectations of others' behaviour [18].

Findings from Table 3 show that 54% of the adopters and 27% of the sampled non-adopters of QPM accessed agricultural extension services. These findings are similar to [19], who observed that adoption was higher for farmers having contact with extension agents working on agro-forestry technologies than for farmers who have never experienced any extension contacts.

Around 26.7% of adopters and 54.4% of non-adopters claimed to have used local credit facilities. (Table 3). This demonstrates how existing credit facilities offer credits for other uses. Some of the biggest problems with the credit facilities offered are that they are hard to get, take too long to pay back, and need to give more information. Savings and Credit Cooperative Societies (SACCOs) and Village Community Banks are two credit sources in the research region (VICOBA), Bangladesh Rural Advancement Committee (BRAC), Cooperative union and Vision Fund.

3.2 Knowledge about QPM Technology

Farmers are only able to adopt a technology they are familiar with. It implies that farmers must be aware of new technology in their surroundings before accumulating knowledge and experience can begin. Targeting farmers' ability to gather information is only possible with knowledge of the technology. As a result, the first step in any adoption process should be to educate farmers. In other words, before using innovations, farmers must be aware of them. According to the study's findings, the respondents had a high level of knowledge about the QPM technology (Table 4).

The level of knowledge about QPM technology among non-adopters from the Hai district was 70.8%, while that of Babati was 52.1% (Table 4). The results showed that Hai District knew more about QPM technology than Babati District did. The slightly higher awareness rate in Hai District may be because SARI has worked harder to promote and spread QPM technology there than in Babati District, for example, by giving QPM Field demonstrations on farmers' fields.

Table 1. Farm qualities

Farm characteristics	Adopters		Non-adopters	
	Mean	SD	Mean	SD
Land owned	1	0.8	0.9	0.9
Area under maize	0.6	0.4	0.6	0.4

Table 2. Activities outside of agriculture

Item	Adopters	Non-adopters	χ^2 statistic
Involved in activities outside of agriculture	19 (36.7%)	51 (56.7%)	3.71*
activities outside of agriculture (Casual labour)	10 (55.6%)	15 (30.6%)	4.38**

**=Significant at 10% level, **=Significant at 5% level*

Table 3. Distribution of sampled farmers' characteristics

Characteristics	Adopters %	Non-adopters %
Membership in farmers organization /group	70.0	33.3
Farmers access to extension	54.0	27
Participation in on farm demonstration trials	90.0	33.3
Attendance to farmers field days	63.7	3.3
Farmers access to credit	26.7	54.4

Table 4. Knowledge about QPM

Knowledge about QPM	Adopters (n=30)		Non-adopters (n=90)		Total
	Response		Response		
	Babati	Hai	Babati	Hai	
Yes	14 (46.6)	16 (53.4)	24 (52.1)	31 (70.4)	85 (70.1)
No	0	0	22 (47.9)	13 (29.6)	35 (29.9)
Total	14	16	46	44	120

3.3 Source of QPM Technology Information

According to respondents, there are two primary sources of information about the technology: researchers (37.7%) and farmers' field days (28.2%). The TARI-Selian Center was mentioned as the centre of agricultural research for the technology in these regions. Other sources included extension officers and farmers themselves.

3.4 Rate of Adoption

This study calculates the adoption rate as the percentage of sample farmers who grow QPM. QPM has been in use in the examined region since 2001. About 25% of the surveyed farmers cultivated QPM in the study area, while 75% did not (Table 6). QPM adopters have grown the Lishe K1 QPM cultivar. Additionally, there were no appreciable differences in adoption rates between the surveyed districts. Nevertheless, compared to the Babati district, the Hai district had a slightly higher adoption rate (13.3%). It is likely due to QPM technology distribution operations that were carried out in the Hai district.

Table 7 summarizes the major reason for not adopting QPM technology as given by the sampled non adopters. The major reason for low adoption as mentioned by respondents included non availability of QPM seeds as indicated by 45.6 % and25.7% of the respondents were not aware. These findings concur with those of Gregory and Sewando (2014), who revealed that the main reason for not adopting the technology was the problem of the seed source. Other reasons mentioned by the sampled farmers were the need to be more knowledgeable about the technology, QPM nutritional value, the high price of seeds, and land scarcity.

Table 5. Source of QPM technology information

Source of QPM information	Adopters (n=30)	Non-adopters	Total
	Frequency (%)	Frequency (%)	
Researchers	10 (11.8)	22 (25.9)	32 (37.7)
Farmers field days	13 (15.3)	11 (12.9)	24 (28.2)
Other farmer	4 (4.7)	14 (16.5)	18 (20.2)
Extension agents	3 (3.5)	3 (3.5)	6 (7.0)
Village leaders	-	2 (2.4)	2 (2.4)
Farmers group	-	3 (3.5)	3 (3.5)
Total	30 (35.3)	55 (64.7)	85 (100)

Table 6. Adoption rate of QPM technology

District	Adopters (n=30)	Non adopters (n=90)	Total
Babati	14 (11.7%)	46 (38.3%)	60 (50%)
Hai	16 (13.3%)	44 (36.7%)	60 (50%)
Overall	30 (25.0%)	90 (75.0%	120 (100%)

Note: Values in the parentheses indicate percentage

Table 7. Major reasons for not adopting (n=90)

Reason	Frequency	Percentage	Rank
No trustworthy QPM seed source	41	45.6	1
Little knowledge	23	25.7	2
Insignificant knowledge of QPM nutritional value	11	12.2	3
High price of QPM seeds	6	6.6	4
Scarcity of land for QPM	1	1.1	5

Table 8. Area covered by QPM

District	Typical area in acreage			
	2004/05	2005/06	2006/07	2007/08
Babati	0.43	0.40	0.28	0.20
Hai	0.62	0.63	0.63	0.55

Source: Hai and District Agricultural and Livestock Department
Data from 2008/09 to 2021/22 were not available

3.5 Adoption Trend of QPM Technology

The study examined the patterns of land use in the districts that were sampled. Based on Gregory's (2010) study, adopters in Babati allocated an average of 2.2 acres, while Hai allocated 1.8 acres for growing ordinary maize. However, it is only 15%, and 34% of the total area is grown with QPM, respectively [20].

The trend reveals that during the 2007–2008 growing season, the average amount of QPM-cultivated land decreased from 0.43 acres in 2004–2005 to 0.20 acres in 2007–2008 and from 0.62 acres to 0.55 acres for Babati and Hai, respectively. It signifies a decrease in QPM-cultivated areas of 53.5% and 11.3%, respectively. (Table 8). The primary clarifications for this pattern were the unavailability of QPM seeds, the average yield potential for adopters, and little knowledge for non-adopters.

4. CONCLUSIONS AND RECOMMENDATIONS

The QPM technology was not widely used. It is due mainly to the paucity of QPM seeds, the need for more financial facilities for maize/QPM production, and the lack of knowledge of QPM technology, manufacturing, and marketing. Hence, it is advised that efforts be made to maintain QPM seed sources (public, private, and

community-based organizations) at all levels, particularly at village levels, to ensure timely availability and increase the success of the QPM adoption. Researchers and extension officers can raise awareness of QPM through promotion and dissemination initiatives (such as field days and on-farm demonstrations) and by campaigning at all levels for partnerships and support. In order to raise QPM's output potential, the government must enhance breeders' variety of development efforts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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