Original Research Article

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

Abstract

Adoption of technology is an important factor in economic development. The objective of the paper was to assess the adoption of QPM in Hai and Babati districts, Tanzania. Primary data was collected from a random sample of 120 smallholder maize farmers in four villages. Data collected were analysed using descriptive and quantitative methods. Study findings revealed that the rate of adoption of QPM technology was 25%. Differences exist between adopters and non-adopters. The study therefore recommended government to ensure efficiency input output linkage for QPM production. The government should promote and support promotion and dissemination activities of QPM in the country. Seed sources (Public, private and CBOs) at all levels should be sustainable to ensure timely availability.

Keywords: QPM, non-adopters, promotion, dissemination

INTRODUCTION

Many industrialized and developing nations around the world depend heavily on maize (Zea mays L.) for human and animal nourishment (FEW NET, 2018). 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 to 60% of the daily protein requirements of people in 12 nations (Galani *et al.,* 2022).

Over 80% of Tanzania's population depends on maize for both food and financial income, making it the most significant staple food in the country (URT, 2017; Barreiro-Hurle, 2012). For the people of Tanzania, maize provides 33% of their daily calories and 33% of their usable protein (URT, 2007). Additionally, maize is a component of animal feed used in the raising of cattle. More than 75% of the country's grain consumption is made up of maize, which accounts for 31% of the nation's overall food production (FAO, 2017).

Compared to regular maize, quality protein maize has almost twice as much useable protein. Some QPM hybrids have up to 13.5% protein content (Shawa *et al.,* 2020). The enhanced QPM populations were made available for direct field use as OPVs (open pollinated varieties) or as bred lines for hybridization. Numerous cultivars (both OPVs and hybrids) with enhanced protein quality have therefore been made available for subtropical and tropical lowland cultivation as well as temperate and tropical highland environments. In poor nations where maize is a staple food, QPM is widely used. In 18 developing nations, there were 750,000 hectares of cropland under cultivation (Asea *et al.,* 2014; Gregory and Sewando, 2013).

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). In comparison to regular maize, this kind has twice as much Lysine and Tryptophan as usual. 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. In general, the QPM is anticipated to contribute to household food security, revenue generation, as well as minimizing malnutrition problems, especially among children.

In Tanzania, the National Agricultural Research Systems (NARS) in collaboration with CIMMYT and SG 2000 released three varieties of QPM in 2001, two hybrids Lishe H-1 and H-2, and one Open Pollinated Variety called Lishe K-1. These varieties were officially released after their advanced yield trials data and farmers' assessment data compiled by originating Breeder and tabled for Variety Release Committee (VRC) for discussion before the varieties were released (Twumasi-Afriyie, 2016). Later on the committee was satisfied by the merits of the varieties and were released. Tanzania Official Seed Certification Institute (TOSCI) conducts continuous seed certification every year for the released varieties. So far TOSCI has no laboratory facilities for testing QPM protein contents standards. These laboratories are in CIMMYT Mexico and Ethiopia. In Tanzania this exercise is done by the researcher to assure its standard by the use of Light Table Test in the process of variety release.

Technology adoption is crucial for economic growth, especially in emerging nations. Researchers must provide evidence that their investments in research and technology distribution have been competitive relative to alternatives in order to draw greater funding for agricultural research (Bjornlunda *et al.,* 2020; Mukasa, 2016). A research on the adoption of new technology is crucial since it will produce crucial indicators for assessing the impact at the farm level and thereby enhancing farming operations (Lugamara *et al.,* 2021; Wordofa1 *et al.,* 2021).

There was a need to comprehend QPM's adoption status as well as the elements that influence it given the significance of QPM in the human diet as a nutritional staple grain that can be grown and consumed by many families like regular maize. Since the start of the QPM project in 2003, Tanzania Agricultural Research Institute (TARI) has been carrying out a number of 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 (Misaki *et al.,* 2016). However, the adoption of QPM is not well established. Therefore, this paper established the rate of adoption of QPM in Tanzania.

Materials and Methods

The district of Babati and Hai hosted the study. One of the five districts in the Manyara area is Babati, and one of the six (6) districts in the Kilimanjaro region is Hai. These districts are situated in Tanzania's northern region. Rainfall in Babati and Hai districts is bimodal, with annual ranges of 500–1200 mm and 350–2000 mm, respectively. Between 950 and 2,450 meters are above sea level. The soils range from sandy loam to clay alluvial soils and are of volcanic origin. The short rainy season typically lasts from the end of October to December, whereas the long rainy season occurs from March to June.

Cross-sectional study design was applied in a non-experimental fashion. Descriptive analysis and the investigation were used to analysed data collected from farmers who grow maize in the sampled districts. The data collected was summarized, coded, and analyzed by using Statistical Packages for Social Science (SPSS) software. Both descriptive statistics including mainly frequency distribution and comparison of means were carried out.

Results and Discussion

Work-related characteristics of household head

Occupational characteristics (farm size, off farm activities and livestock owned) are among the variables which affect the uptake of technology. The mean farm size for the sampled households was 1.0 ha (3.68 acres) of which 51% was under maize cultivation. Adopters possessed more land than non adopters in terms of total farm size although the difference was not significant. The average area of land allocated by adopters and non-adopters for maize production was 0.5ha and 0.3ha respectively. Maize, beans, pigeon peas and sunflower are the most important crops grown. Maize was the first-ranked crop grown, for both adopters and non adopters followed by pigeon peas for Babati and beans for Hai district. Sunflower was the third important crop grown in both Districts.

Off farm activities are sources of additional income which may encourage or discourage investment in new technologies. In this study the main off farm activities were casual labour, salary employment, carpentry and petty business. There was significant different ($p<0.01$) in number of adopters and non adopters involved in of farm activities. The results showed that adopters are less involved in off-farm activities than non-adopters of QPM technology. Casual labour was the type of work mostly reported to be done by adopters (55.6%) and there was 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 local labour market, farmers can hire labour as needed. Members of farmers household may also sell labour to obtain cash as necessary.

According to Lin and Nugent (1999) an institution is a set of behavioral rules that govern and shape the interactions of human beings, in part by helping them to form expectations of what other people will do. Such institutions supporting systems include extension services, research, seed/input provisional services (inputs stockists) and credit facilities. Institutions are considered as mechanisms used to structure human interactions in the face of uncertainty, and as they are formed to reduce uncertainty and risk in human exchange. Institutions help human beings to form expectations of what other people will do (Kirsten *et al*., 2009).

Extension is known to catalyze awareness, organization, information exchange and technology adoption among farmers. Extension service is crucial in uptake and adoption of improved technologies. The number of extension workers per unit of population influences extension delivery. In the study area, about 54% and 27% of the QPM adopters and non adopters had access to agricultural extension services respectively (Table 1). This indicates that most of the sampled household heads did not receive extension visits. This is probably due to lack of appropriate means of transport and wider coverage per extension worker as it has been reported by the respondents that there was only one extension worker per division in the surveyed area. The study by Baidu – Forson (1999) observed that adoption was higher for farmers having contact with extension agents working on agro-forestry technologies than farmers who have never experience any extension contacts.

Table 1 Respondents' distribution on farm characteristics

Characteristics	Response category	Adopters (n=30)	Non-adopters (n=90)
		%	%
Membership in farmers organization/group	Yes	70.0	33.3
	No	30.0	66.7
Farmers access to extension	Yes	54.0	27
	No	46.0	73
Participation in on farm demonstration trials	Yes	90.0	33.3
	No	10.0	66.7
Attendance to farmers field days	Yes	63.7	3.3
	No	33.3	96.7
Farmers access to credit	Yes	26.7	54.4
	No	73.3	43.3

About 26.7% of adopters and 54.4% non adopters reported to access credit facilities in their area (Table 1). In the study area there was none formal credit facility for maize production. This demonstrates that credit facilities that exist provide credits for other activities. The major problems that were reported about credit facilities that were available are, long processes in obtaining credits, short repayment period and lack of information. Credit sources in the study area are SACCOs, VICOBA, BRAC Cooperative union and World Vision.

Being a member of farmers group put a farmer in a privileged position in relation to other farmers. Group members have better access to technical information and receive preferential treatment from extension workers and other development agents. In the study area, these groups are organized by researchers and other development agencies in various agricultural aspects. Examples of these are Kware Lishe group, coffee cooperative society and Mkombozi of Hai and organic farming, Dairy goat groups and sunflower production group of Babati. About 70% of adopters and 33% of non-adopters had membership in farmer organizations/groups (Table 1).

Adoption of QPM technology

It is not possible for farmers to adopt a technology they do not know. This means, before any accumulation of knowledge and experiences start, farmers must be aware of a new technology in their environment. Without awareness, the process of accumulation of information by target farmers is not possible Awareness is therefore the initial stage in any adoption process. Farmers had to know about new innovation before adopting it. From the results of the study, there was high degree of awareness of the QPM technology among the respondents.

Table 2: Awareness of QPM

Awareness of QPM	Adopters (n=30)		Nonadopters (n=90)		Total
	Number of respondent (%)		Number of respondent (%)		
	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

The level of awareness of QPM technology was 70.8% (Table 2). The results showed that Hai District was more aware of the QPM technology than Babati District. The slightly higher percentage of awareness in Hai District could be due to the fact that most of the QPM technology promotion and dissemination activities conducted by SARI such as, QPM Field demonstrations at Farmers' fields and at NANE NANE Agricultural Exhibition grounds which s located nearer to Hai compare to Babati district.

Source of QPM technology information

The major information sources about QPM as reported by respondents were researchers (37.7%) and farmers' field day (28.2%) respectively. These were organized by SARI for the purpose of promoting and disseminating QPM technology in these areas. Table 2 shows that 70.1% of the respondents had information about QPM. However, only 35.3% of these have adopted the technology while 64.7% have not (Table 3).

Table 3: Source of QPM technology information

Source of QPM information	Adopters (n=30)	Non-adopters (n=55)	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)

Note: The number of non adopters who are not aware of QPM=35

Rate of adoption

In this paper the rate of adoption is measured in terms of the proportion of the sample farmers growing QPM. In the surveyed area QPM was introduced since 2001. About 25% of the surveyed farmers cultivated QPM in the study area (Table 4) while 75% were not. The QPM adopters cultivated Lishe K1 QPM variety. Moreover, there were no significant variations in adoption rates across the surveyed districts. Hai district had slightly higher adoption rate (13.3%)

as compared to Babati district (11.7%). This is attributed probably by QPM technology dissemination activities conducted in Hai district.

Table 4: 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%)

Table 5 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% and25.7% of the respondents were not aware.

Table 5: Major reasons for not adopting (n=90)

Reason	Frequency	Percent
No reliable QPM seed source	41	45.6
Not aware	23	25.7
Average yield potential	8	8.8
Lack of QPM nutritional benefits knowledge	11	12.2
QPM seeds are expensive	6	6.6
Shortage of land	1	1.1
Total	**90**	**100.0**

Adoption trend of QPM technology

The study analysed the trend of adoption in terms of land cultivated in the sampled districts. The average land allocated by adopters for maize was 2.2 acres and 1.8acres for Babati and Hai districts respectively. The average area cultivated QPM was 15% and 34% of the total maize cultivated land for Babati and Hai district respectively. Other maize varieties cultivated by sampled adopters are *Kilima* and *Staha* (OPVs) and H 511 SC 627 DK 8071 and PAN 67 (Hybrids).

Table 6: Area under QPM

Cropping season	Average area (acre)			
	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

The results shows that in 2007/08 cropping season, the mean QPM cultivated land decreased from 0.43 acre in 2004/05 to 0.20 acre in 2007/08 and from 0.62 acre to 0.55 acre for Babati and Hai respectively which was about 53.5% and 11.3% decrease of QPM cultivated area respectively (Table 6). The main reasons given for this trend were; unavailability of QPM seeds, average yield potential for adopters and unawareness for non adopters. Farmers' future plans to increase the area under QPM varieties, was reported by 30% of the sample households. The reasons given were; QPM matures early, it tastes well and if QPM seed made available.

Conclusions and Recommendations

The adoption of the QPM technology was low. This is probably due the mentioned challenges such as unavailability of QPM seeds, lack of credit facilities for maize/QPM production, information about QPM technology, its production and marketing. Thus, it is recommended that to make the QPM adoption more successful, efforts to sustain QPM seed sources (public, private and CBOs) at all levels especially at village levels to ensure timely availability is crucial. Promotion and dissemination activities (such as on farm demonstrations and field days) of QPM by researchers and extension officers to create more awareness to diverse groups including advocacy at all levels for support and partnerships. Therefore, the government has to improve the variety development for QPM by breeders in order to increase its production potentials. This will sustainable productivity, improved farmers' livelihood, ensured food security, increased rural income and ultimately poverty reduction in the country.

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