Factors Influencing Selection and production of Common Bean Cultivars in medium Potential Agro Ecological Zone of Imenti South Sub-County, Kenya

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ABSTRACT

Varietal selection is a key aspect in common bean productionin Kenya since different varieties are bred for specific agro ecological conditions. In Kenya,many common bean varieties arefound growingunder medium agro ecological zones, however, some farmers have been found to grow some beanvarieties not suited to preferred ecological zones. The current study was thus carried out to assess the factors that affectvarietal selection and production of common beans in medium potential agro ecological zones of Imenti South Sub County, Meru County. The target population was 300 common bean farmers. A sample size of 75 farmers derived from Gaatia, Kathanthatu, Kiambogo and Kiigene villages using Nassiuma Formula. A structured questionnaire was administered to collected data on socioeconomic factors, common bean production systems and agronomic practices.The collected data weresubjected to analysis of variance (ANOVA) using SAS version 9.4 and Significant means separated using least significant difference at p< 0.05. The findingson socio-economic factors revealed that farmers with higher levels of education produced more beans per unit area. Approximately 10.52 % of the 22.37 % of the farmers with tertiary college educationhad a production of 1.4 – 1.9 tonnes/ha. Majority (88.16 %) of the farmers applied DAP planting fertilizer,while none of the farmersapplied rock phosphate. Moreover, the highest percentage (34.9 %) of farmers who applied DAP had attained tertiary level education. Most (18.42 %) middle aged farmers did not apply rhizobium inoculant during planting. The most popular production system was mixed cropping (46.7 %) and the least was intercropping (6.59 %). Mixed cropping was highest in farmers who planted GLP 585 (13.33 %) and least in KAT B1 (10.23 %). Sole cropping was highest in Mwitemania (12.0 %) and least in Rose coco (6.58 %). Crop rotation was highest in Rose coco (5.26 %) and least in GLP 585, Mwitemania and KAT B1 (2.63 %). Intercropping was highest in Rose coco (2.63 %) and least in GLP 585, Mwitemania and KAT B1 varieties at (1.32 %).Bean variety KAT B1 despite being bred for semi-arid agro ecological zones, performedfairly well in medium potential agro ecological zones.Bean variety KAT B1 can be recommended for productionin medium potential agro ecological zonesto enhance common bean production and food security in Kenya.

Keywords*:* Common bean, production systems, agro ecological zones, agronomic practices, KAT B1 and GLP 585

INTRODUCTION

Common bean (Phaseolus vulgaris L.), ranks second in importance as a staple food after maize and its cultivated by much of the population in sub-Saharan Africa (SSA)(CIMMYT, 2003). Owing to its importance, common bean is highly produced in eastern Kenya, with an average production of 1.5 tonnes/ha (BTL, 2015). It has a commercial value that exceeds all other legume crops combined, hence provides a market opportunity with a high demand in national and international markets (Chibarabadaet al., 2017). Nutritionally, bean provides food to people of all income categories, especially the poor as a source of dietary protein. Despite the importance of beans in Kenya, yields have remained low with an average production of 0.315 tonnes/ha in medium agro ecological zone of Meru County, compared to regional average production of 1.5 tonnes/ha (MCIDP, 2017; UGBF, 2018).

The low yields have been attributed to low and poorly distributed rainfall, low and declining soil fertility, high evapotranspiration rates, mismatching of agro-climatic zones, ineffective and unsustainable land use and poor agronomic practices (Kutu, 2012). Annual total production falls short of demand in SSA partly due to a shortage of agricultural lands, high human population pressure, urbanization, and an array of production constraints, including low soil fertility, drought, weeds, insect pests, and diseases (Badu-Apraku and Fakorede, 2017). These challenges have led to farmers seeking alternative means of increasing yield.Most farmers do notuse improved seed, optimal fertilizer rates and recommended crop husbandry practices (Government of Kenya [GoK], 2010).

The common bean has a wide ecological adaptation and range of yield maturity phases depending on the genetic basis of the variety grown (Cortes, 2018).Different bean varieties have been grown in medium agroecological zones. The bean varieties bred and are commonly grown in medium agro ecological zones of Kenya include; Rose Coco (GLP 2), Mwitemania (GLP 892), MweziMoja (GLP 1124), and Red Haricot (GLP 585) (Infonet, 2020). However, some of the farmershave grown Katumani bean 1 (KAT B1)in medium agro ecological zones not originally bred for such zones owing to its preference and to increase yield. Katumani bean 1 (KAT B1) can be grown under minimal irrigation throughout the year (KARI, 2008). The variety is bred for moisture stress areas. It has different agronomic practices relative to bean varieties bred for non-moisture stress areas. KAT B1 variety is fast maturing, drought tolerant, it takes approximately two months to mature and produces an average of 1.4 - 1.9 tonnes per ha (Joseph *et al*., 2020). In Kenya, KAT B1 maturity period and yield under medium potential agro ecological zones are not well documented.

Farmers have adopted growing of common bean varieties specific areas they are not bred for as a try and error method an example is KAT B1. There is a disconnect between the bean varieties released by plant breeders for a particular region and what the other regionscan achieve in terms of production and yield. Hence, the most effective method of ensuring adoption of common bean varieties in areas they were bred for, is by involving farmers in varietal selection process. There is limited information on the level and magnitude of bean adoption of popular varieties bred for different ecological zones in Kenya. Thus, the need to conduct baseline survey on common bean varieties grown by farmers, farmer characteristics as well as factors affecting selection of bean varieties and production in medium potential agro ecological zone of Imenti South Sub County of Meru County in Kenya. This study aimed at revealing why farmers chose certain bean varieties and not others, the agronomic practices and common bean production systems used.

MATERIALS AND METHODS

Study Site

The survey was conducted in Nkuene ward, Imenti South Sub County in Meru County.The ward lies at latitude: -0.08613^{o} longitudes: 37.66376^{0}target population consisted of300 common bean farmers in four villages i.e., Gaatia, Kathanthatu, Kiambogo and Kiigene.

The villages were purposely selected as they were within the experimental site. Nkuene ward was selected purposively because it lies in medium agro ecological zone where KAT B1 is currently being grown. The ward is a potential agricultural area and local communities are predominantly farmers practicing agricultural farming and livestock production on small land holding. The main crops grown include coffee, maize, beans, tea, bananas and vegetables.

The altitude of the area is approximately 1200 m above local sea level. It has an annual mean minimum and maximum temperature of 17^{o}C and 24°C, respectively (Jaetzoldet al., 2006) and annual rainfall varing from 950 to 1500 mm. The rainfall is bimodal, falling in two seasons, with the long rains (LR) lasting from March through June and short rains (SR) from October through December. The short rains tend to be more reliable for crop production than the long rains (Kwenaet al., 2017). The soils are Humic Nitisols (Jaetzold& Schmidt, 1983) which are deep, well weathered with moderate to high inherent fertility.

Research Design

Descriptive survey method was adopted to collect information in this studyusing a questionnaire.The questionnaire was used on preliminary and exploratory studies to allow the researcher to gather information, summarize, present and interpret for the purpose of clarification on factors affecting varietal selection and production of common beans in medium agro ecological zone of Meru County.

Sample Size Determination

The sample size was derived according to Nassiuma (2000), whereby a coefficient of variance not exceed 30% is considered adequate for most surveys.

$$n = \frac{NC^2}{C^2+(N-1)e^2} \qquad (1)$$

where;

n = sample size

N = population from which sample is obtained

C = coefficient of variance 20%

e = standard error set at 0.02

$$n = \frac{300\ (0.2^2)}{0.2^2+(300-1)0.02^2} = 75.19 \qquad (2)$$

Therefore, a sample size of 75 farmers was used.

Sampling Procedure

A cluster random sampling technique was employed in choosing the farmers who made up the sample (Table 1). The clusters consisted of the Gaatia, Kathanthatu, Kiambogo, and Kiigene villages in Nkuene ward.

Table 1: Smallholder Common Bean Farmers

Villages	Number of Households	Sample size
Gaatia	71	18
Kathantatu	79	20
Kiambogo	82	20
Kiigene	68	17
Total	300	75

Research Questionnaire

A semi-structured questionnaire was used to collect data from the farmers. The questionnaire was organised into the following main parts: socioeconomic factors (education level); common bean production systems (sole cropping, crop rotation and intercropping); agronomic practices (fertilizer application, rhizobium inoculation and plant spacing).

Pilot Study

The pilot study was carried out in Chogoria ward, TharakaNithi County, which has similar climatic conditions as that of the research area. Eight questionnaires were administered to randomly selected smallholder common bean farmers. According to Bell *et al.*, (2018), a minimum sample size of eight (8) respondents is applicable for a pilot study.

Validity Test

The study used the judgement approach of content validation through conducting an intensive literature review to identify what questions were to be included in the questionnaire. For content validity, the input used the university supervisors, departmental experts and ministry of agriculture extension officers.

Reliability Test

Cronbach alpha coefficient was used to test for the questionnaires reliability. The reliability test determines whether the questionnaire is consistent throughout. The scale reliability was found to be 0.7214. George and Mallery (2003) provided the following rule of thumb: if $\alpha > 0.9$ – excellent, $\alpha > 0.8$ – good, $\alpha > 0.7$ – acceptable, $\alpha = 0.6$ – questionable, $\alpha = 0.5$ – poor and $\alpha < 0.5$ unacceptable. A value greater than 0.7 is accepted indicating that the tool was reliable.

Data Analysis

The data collected was subjected to analysis of variance using SAS version 9.4. Significant means were separated using least significant difference (LSD) at $\alpha = 0.05$.

RESULTS

Relationship between Level of Education and Bean Production

There was a significant association ($p = 0.023$; $X^2 = 13.549$) between level of education and yield of beans produced in medium potential agro ecological zone of Imenti South (Table 2).

The percentage of the bean farmers who had not attended school was 5.26 %, while those who attended tertiary level colleges was 34.21%. The findings of the study also showed that, generally those with higher level of education produced more beans per unit area, with 10.52 % out 22.37 % of the farmers who produced 1.4 – 1.9 tonnes/ha having a tertiary college education level.

Table 2: Relationship between level of education and bean production

Education level	**Bean production in tonnes/ha**			
	0.1 – 0.6 t/ha	0.7 – 1.3 t/ha	1.4 – 1.9 t/ha	Total
Didn't attend school	2 (2.63 %)	2 (2.63 %)	0 (0.00 %)	4 (5.26 %)
Primary	5 (6.58 %)	15 (21.05 %)	6 (7.89 %)	26 (35.53 %)
Secondary	5 (6.58 %)	11(14.48 %)	3 (3.95 %)	19 (25.00 %)
College	1 (1.32 %)	17 (22.37 %)	8 (10.52 %)	26 (34.21 %)
Total	13 (17. 11%)	45 (60.53 %)	17 (22.36 %)	75 (100.00 %)
p value	0.023			
X^2	13.549			

Relationship between Level of Education and Type of Fertilizer Applied in Bean Production

There was a significant relationship ($p = 0.032$; $X^2 = 33.196$) between level of education and type of fertilizer applied in bean production in medium potential agro ecological zone of Imenti South (Table 3). The majority (88.16 %) of farmers applied DAP fertilizer while no farmer applied rock phosphate.
Moreover, for farmers who applied DAP, the highest percentage (34.9 %) had attained tertiary college level education.

Table 3: Relationship between farmer's level of education and the type of fertilizer applied during planting of common bean

Edu Level	Fertilizer Applied During Planting Beans				
	DAP	TSP	Rock phosphate	None	Total
Didn't attend sch	2(2.64 %)	0 (0.00 %)	0 (0.00 %)	2 (2.63 %)	4 (5.26 %)
Primary	21 (26.93 %)	0 (0.00 %)	0 (0.00 %)	4 (5.26 %)	25 (32.19 %)
Secondary	18 (23.69 %)	1 (1.32 %)	0 (0.00 %)	1 (1.32 %)	20 (26.33 %)
College	25 (34.9 %)	0 (0.00 %)	0 (0.00 %)	1 (1.32 %)	26 (36.22 %)
Total	66 (88.16 %)	1 (1.32 %)	0 (0.00 %)	8 (10.53 %)	75(100.00 %)
p value	0.032				
X^2	33.196				

Relationship between Age of Farmers and Adoption of Given Technologies in Bean Production

The majority (76.32 %) of farmers did not use rhizobium inoculant during planting (Table 4). However, there was significant association (p = 0.02; X^2 = 16.089) between age of farmers and adoption of rhizobium inoculum in medium potential agro ecological zone of Imenti South. Generally, older farmers seem to have adopted application of rhizobium inoculant during planting than the younger generation farmers. In contrast, most (18.42 %) of the middle aged farmers did not apply rhizobium inoculant during planting of common beans.

Table 4. Relationship between age of farmer's and adoption of technologies

Age	Usage of Rhizobium Inoculum		
	Yes	No	Total
less than 20 years	0 (0.00 %)	2 (2.63 %)	2 (2.63 %)
21 - 25 years	2 (2.63 %)	9 (11.84 %)	11 (14.47 %)
26 - 30 years	0 (0.00 %)	5 (6.58 %)	5 (6.58 %)
31 - 35 years	1 (1.32 %)	8 (10.53 %)	9 (11.84 %)
36 - 40 years	2 (2.63 %)	11 (14.47 %)	13 (17.11 %)
41 - 45 years	3 (5.26 %)	14 (18.42 %)	17 (23.68 %)
46 - 50 years	8 (10.53 %)	4 (5.26 %)	12 (15.79 %)
More than 50 years	1 (1.32 %)	5 (6.58 %)	6 (7.89 %)
Total	17 (23.68 %)	58 (76.32 %)	75 (100.00 %)
p value	0.02		
X^2	16.089		

Common Bean Production Systems

All the common beans were grown under diverse systems. The most popular production system was mixed cropping (46.7 %) and the least was intercropping (6.59 %) (Table 5). Mixed cropping was highest in farmers who planted GLP 585 (13.33 %) and least in KAT B1 (10.23 %). Sole cropping was highest in Mwitemania (12.0 %) and least in Rose coco (6.58 %). Crop rotation was highest in Rose coco (5.26 %) and least in GLP 585, Mwitemania and KAT B1 (2.63 %). Intercropping was highest in Rose coco (2.63 %) and least in GLP 585, Mwitemania and KAT B1 varieties (1.32 %).

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Table 5: Varieties grown and production systems adopted by farmers

Which production system do you practice?	**Which of the following varieties do you grow?**				**Total**
	Rose coco	GLP 585	Mwitemania	KAT B1	
Mixed cropping	8(11.14 %)	10 (13.33%)	9 (12.0 %)	7 (10.23%)	34 (46.7 %)
Sole cropping	5 (6.58 %)	6 (7.49 %)	9 (12.0 %)	6 (7.49 %)	26 (33.56%)
Crop rotation	4 (5.26 %)	2 (2.63 %)	2 (2.63 %)	2 (2.63 %)	10(12.82 %)
Intercropping	2 (2.63 %)	1 (1.32 %)	1 (1.32 %)	1 (1.32 %)	5 (6.59 %)
Total	19 (25.61%)	19 (24.77%)	21 (27.95%)	16(21.67%)	75 (100%)

Agronomic Practices for Common Bean Production in Medium potential Agroecological Zone of Imenti South Sub County

There was a significant relationship (p = 0.046; X^2 = 11.055) between the spacing of common beans and varieties grown (Table 6). The most popular spacing for GLP 585, Rose coco and Mwitemaniabean varieties was 30 x 15 cm and 45 x 20 cm for KAT B1 (Table 6). There was no farmer who grew rose coco and GLP 585 bean varieties at a spacing of 45 x 20 cm, and no farmer that grew KAT B1 at a spacing of 30 x 15 cm and 40 x 15 cm.

Table 6. Common beans agronomic practices in medium potential agro-ecological zones

Variety	**Spacing used when planting beans**			
	30 x 15 cm	40 x 15 cm	45 x 20 cm	Total
Rose coco	25 (33.53 %)	3 (3.95 %)	0 (0.00 %)	28 (37.48 %)
GLP 585	27 (36.16 %)	6 (7.94 %)	0 (0.00 %)	33 (44.1 %)
Mwitemania	5 (6.58 %)	3 (3.95 %)	1 (1.32 %)	9 (11.84 %)
KAT B1	0 (0.00 %)	0 (0.00 %)	5 (6.58 %)	5 (6.58 %)
Total	57 (76.27 %)	12 (17.11 %)	6 (7.9 %)	75 (100.00 %)
p value	0.046			
X^2	11.055			

DISCUSSION

Relationship between Level of Education and Bean Production

The findings of this study revealed that there is a strong association between bean production and education, as well as education and yield per unit area. Education positively influences the decisionsmade by farmers including what theypractice, howtheypractice, and when to practice. This therefore informed the mindsetof the farmers on the best way to increase crop production. Education is a key factor in improving agricultural productivity since formal education is expected to open up the mind of the farmer to knowledge and enhance adoption of improved technologies.The findings of this study agreewith those of Oluwasusi (2014) that attainment of some form of formal education, usually exposes farmers to the knowledge of being innovative and having technical information on best ways of increasing yield in crops. However, it contradicts with those of Monica *et al*. (2018) that most small-scale legume farmers in Tanzania relied on their own experience and knowledge as majority lacked formal education which led to poor yield. During the study, it was observed that farmers with higher education produced higher yield compared to those without education since they were able to grow beans with correct type and timely fertilizer application and better management practices.

Relationship between Level of Education and Type of Fertilizer Applied in Bean Production

In the study, Education influenced application of fertiliser and type applied.The level of education is very crucial in knowing the type, amount, method and time of fertilizer application.It is widely acknowledged that inappropriate fertilizer management is the main reason for fertilizer over-application (Pan & Zhang 2018). This is so because negative environmental consequences have been attributed to over-application of fertilizer leading to global warming, soil acidification and water eutrophication (Ha *et al*., 2015). Most of the farmers who attained tertiary level college education applied diammonium phosphate (DAP) fertilizer during sowing. However, these findings contradict with Kirkpatrick *et al.* (2014) who reported that the highly-educated older Florida residents lacked knowledge about the rationale for local fertilizer use regulations. None of the farmers applied triphosphate (TSP) and rock phosphate fertilizer during planting except those withsecondary education that applied TSP fertilizer. Lack of use of TSP and rock phosphate by farmers could be attributed to the unavailability of thesefertilizers in the local markets. In the study area, farmers had insufficient knowledge about the effects of fertilizer over-application. Studies by Chen *et al*. (2013) showed that only 20 % of farmers in chinaknew that fertilizer over-application resulted in water eutrophication and agricultural system degradation. Most farmers held the view that more fertilizer use resulted to higher yields. However, studies by Chen *et al.* (2013) showed that only 20 % of farmersthat applied more fertilizer led to higher crop yields. On the other hand, a reduction in fertilizer application results in a definite yield loss (Jin*et al*., 2015). This clearly show thatfarmer education is instrumental in enlightening farmers on the importance of using fertilizers in crop production.

Relationship between Age of Farmers and Adoption of Selected Technologies in Bean Production

The age of farmers influenced usage of rhizobium inoculant during planting of common beans. Farmers with less than 20 years did not apply rhizobium inoculant while those between 46 – 50 years were majority in application of rhizobium inoculant at planting. This showedthat the adoption of rhizobium inoculant technology was mostly embraced by older farmers compared to young farmers. This finding disagree with those of Zamasiyaet al. (2014) that most soybean farmers were within productive age (43 - 50 years) and most of the middle aged farmers who grew common beans for a couple of years were not conversant with usage of rhizobium inoculant. In the study, youths were reluctant in adopting the use of rhizobium inoculanttechnology compared to older farmers. This could be attributed to their short farming experienceand lack of knowledge on its benefits. The results also show a low adoption of technology among the youths in common bean production. There is a need to encourage youth involvement in the adoption of technologies that enhance common bean yields.The findings of this studywere consistent with those of Ndushaet *al*. (2020) who reported a low involvement of youths in inoculation during soybean production in Congo. In the study area, youths were not interested in performing various agriculture related activities hence they were less involved in the adoption of new technologies in the sector.

Common Bean Production Systems

In the study area, different crop production systems were used by farmers. These systems adopted depended on farmer's knowledge on technology adoption. In the current study, farmers practiced mixed cropping, sole cropping, intercropping and crop rotation. The use of different crop production systems by the farmers in the study area was attributed to farmer's education and training on the benefits of using different production systems to increase productivity. Mixed cropping was the most preferred and intercropping the least preferred. This could be because of the small land sizes that farmers hold in medium potential agro ecological zone due to increased land subdivision. Mixed cropping minimizes space as compared to intercropping, since intercropping require planting in rows. GLP 585 was grown by majority of the farmers since it is well adapted in the region and also high yielding. It is also a variety that is preferred by many consumers when cooked. Mutunga *et al*. (2017) and Nyang'auet al. (2021) showed that most farmers in Kitui and Kisii counties respectively have adopted various adaptation measures to reduce the adverse effects of new crop varieties with adoption of mixed cropping in order to increase yield. These adverse effects are reduced by cover cropping, which lower moisture loss from the soil.

In the study area, intercropping was the least practiced activity by the farmers growing in Mwitemania bean variety. This could be because it decreases the yield in relation to cost benefit ratio compared to when grown as a sole crop due to competition for growth resources. Intercropping allows for efficient use of resources such as soil moisture, solar radiation and soil nutrients (Nassaryet al., 2020b). It also reduces insect pest and disease problems (Lopes et al., 2016). Intercropping also gives higher and stable yields in many crop combinations with minimal production inputs like fertilizers hence it is economical in crop production (Aberaet al., 2017). In the study area, sole cropping was a common practice. It gave higher yield possibly due to reduced competition for available resources compared to intercropping. The low yields in intercropped beans was attributed to shading by taller plants which reduced the photosynthetic space of the beans.

Crop rotation was the least (9.1 %) practiced in KAT B1 farmers. This could be because KAT B1 being a fairly new crop variety introduced in 2006in the region (Ojwang*et al*., 2009), its level of adoption had not gained momentum hence the number of farmers growing the crop were few compared to other common bean varieties that have been grown for many years since the 70s (Johnson *et al*., 2018).Crop rotation ensures that the crop make use of the available nutrients in the soil as well as reducing the incidences of insect pests and diseases which attack specific crop species. Accordingto EU, (2009) crop rotation is among the recommended measures to increase yield. Failure to rotate crops encourages low yield, pest attack and decrease in soil nutrients.In study area, every farmer used different farming system that they thoughtcould enhance bean production. However, every production system that was practiced by the farmers gave varying yield results.

Agronomic Practices for Common Bean Production

In the study area,spacing was found to be very vital in production of common beans. Finding by Samangoet al. (2018) reported spacing of 40 cm between rows and 10 cm between plants to boost bean production in Ethiopia. Majority of farmers in the study area grew GLP 585, rose coco and M witemaniabean varieties using the recommended spacing of 30 x 15 cm.The bean variety KAT B1bred for semi-arid agro ecologicalzones was grownusing a spacing of 45 x 20 cm that is recommended for semi-arid agro ecological zones. The wider spacing could have contributed to low yield realized in the study area compared with other common bean varieties grown in medium potential agro ecological zone. Studies byMasa *et al.* (2017) found productivity of common bean to be low due to use of inappropriate inter and intra row spacing for varieties of different seed sizes and growth habits. Hence, theneed to establish an appropriate spacing for bean variety KAT B1 for medium potential agro ecological zones that can be adopted by farmers, due to differences in biotic and abiotic factors in the medium potential and semi-arid agro ecological zones.

The choice of plant population is an important agronomic practice that increases yield with an increase in plant density (Parr *et al.*, 2011). Wider spacing lowers plant densities, reduces the rate of competition for available resources however, total yields per unit area is low. Therefore, realistic crop spacing need to reflect on the agro ecological zones, asit allows for root exploration that mimic production conditions critical when considering plant yield (Smith *et al*., 2019).In this study area, farmersuseddifferent spacing for bean variety KAT B1. In addition, some of the farmers werealso not conversant with agronomic practices such as fertilizer application, weeding, use of rhizobium inoculant, manure application, control of pest and diseases, line planting, intercropping and crop rotation for KAT B1because it was a recentlyintroducedin the region. Hence, the need to establish the factors influencing selection and production of common bean varieties by farmers in medium potential agro ecological zones of Imenti South Sub County.

CONCLUSION

The results of this study revealed that education is paramount in production of common bean since it helps the farmers in adoption of new technologies while using various common bean production systems and appropriate agronomic practices. There is opportunity to increaseKAT B1 productivity throughimproved agronomic practices for the medium potential agro ecological zone. Therefore, KAT B1 being a drought tolerant bean variety that was bred for semi-arid zones, also performs well in medium potential agro ecology hence this study recommends farmers to grow drought tolerant KAT B1 variety in medium potential agro ecological zone of Imenti south, Meru County for sustainable production.

ETHICALCONSIDERATIONS

Ethical approval was obtained for this research. There is no conflict of interest in this research.

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