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Research Article

Characteristics of Smallscale Tomato Production across Four Counties of Kenya

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ABSTRACT

The use of certified tomato seed materials has potential for improving food security due to their vigour in growth, early maturity and high yields. The production of high quality, healthy seedlings require the correct choice of variety and standardized nursery agronomic procedures. Tomatoes have high economic significance thus optimum seedling development techniques should be disseminated to farmers for adoption. Since the crop exhibits lower rates of adaptation to the rapidly changing agroecology, its seedlings have drastically reduced yields and increased total production costs rendering farmers poor. Thus, there's a need to equip farmers with Climate- smart procedures for sustainable production of clean seed materials for higher yields, income and improved livelihoods. Primary knowledge on the commonly adopted cultivation practices such as preferred varieties, production systems and demand for propagation materials by tomato farmers is very critical in developing climate-resilient tomato seed production models. The aims of this study were, therefore: i) To assess the preference levels of various tomato varieties among smallholder farmers in Elgeyo Marakwet, Kajiado, Garissa and Siaya Counties; and ii) To determine the tomato production systems practised by smallholder farmers in Elgeyo Marakwet, Kajiado, Garissa and Siaya Counties.

A situational analysis on preferred tomato varieties and assessment of demand for seed in target Counties (Elgeyo Marakwet, Garissa, Kajiado and Siaya) was conducted from mid-March to end of April 2020. Data on demographics, land management, Seed Supply/ Seed Import information from key stakeholders and types of tomato variety grown were collected from 367 farmers through an in-depth participatory quantitative method using a combination of approaches, methodologies and tools with in-built validation mechanisms.

This involved individual interviews using structured questionnaires on a sample of direct project beneficiaries in the target areas. The data collection tools, sampling frame, sampling technique and sample sizes were developed by KALRO based on the project Terms of Reference. Quantitative data from structured interviews were analyzed using descriptive statistics (frequencies, means, totals, percentages and measures of dispersion).

From the results, 324 (88.28%) of the respondents were individual farmers while 11.72% were group farmers. Kajiado County reported the highest level of participation in this study with a total of 141 respondents, while only 61 respondents were interviewed in Garissa County making this the least number of participants in the survey. Gender segregation in tomato farming had a total of 258 male and 66 female farmers respectively with Siaya County recorded the highest number of female (27) practising tomato farming. The mean age of respondents stood at 39.41 years with the oldest and the youngest respondents being 86 and 18 years old respectively. 139 respondents had acquired basic education (primary level). However, illiteracy levels stood at 1, 21, 18 and 3 in Elgeyo Marakwet, Garissa, Kajiado and

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Siaya Counties respectively. A range of 1 to 25 acres of land was reported to be under tomato farming, with the largest being 15acres and the smallest being 0.25 acres. A mean of 6.7 years in tomato cultivation was recorded across the 4 Counties which were targeted by the survey. 89.37% of the participants source their seeds from the Agrovets and 5.45% use their seeds (recycled seeds). By the time of this baseline survey, all the 4 Counties had received some form of training and capacity building on tomato production with Kajiado County having the largest count (122) of trained tomato farmers. The number of farmers satisfied with the available tomato seed materials was higher than those unsatisfied across the 4 target Counties. Staking of tomatoes was popular with farmers from Elgeyo Marakwet (64), Siaya (98) and Garissa (59). However, 71% of farmers from Kajiado practised practice non-staking production system. Out of the10 common tomato varieties across the 4 counties, Rio grande is the most preferred tomato variety.

Keywords: Baseline survey; Tomato; Seeds; Variety; preferred; Production System

INTRODUCTION

Tomato (Solanum lycopersicum L.), falls among the high-value crops produced by smallholder farmers of Kenya (FAOSTAT, 2018). It is considered the most demanded vegetable in local markets and constitutes about 20% of vegetables produce from Kenya (HCDA, 2017). It also generates an annual income of 137,000 USD from 410,033 tons (Factfish website, 2018), making the horticulture sub-sector a key segment of the Kenyan economy. It also supports the livelihoods of smallholder farming communities through income generation and employment creation (HCDA, 2017).

However, the challenges faced by farmers in tomato seeds production include unimproved cultivars, poor plant stand, lack of use of fertilizers and other improved agricultural inputs in the management of the crop, in addition to biotic and abiotic factors (Tumwine et al., 2002; Waiganjo et al., 2006). Food production must increase at a pace that meets increasing population needs (Johnston et al. 2014). Sukprakarn et al. (2005) noted that good seeds were undoubtedly one of the most important materials for farmers. Suitable seeds for optimum yields should be disease free with a potential vigorous growth. (Dhiman et al. 2010). Seeds embody the genetic potential of plants, which determines the upper limits of plant yield and the overall output of other agricultural inputs (Dhiman et al. 2010).

For a healthy plant growth and improved quality and yield per unit area, seedlings should be produced from high-quality seeds, environmental conditions should properly be arranged, production techniques should be well-selected and cultural practices throughout the growth period should properly be implemented. Therefore, seedling quality is a significant factor in healthy and sustainable growth. The success in seedling production starts with the procurement of seedlings with a balanced dry matter distribution throughout plant organs and a well-developed root system (Tüzel et al. 2015). Planting is followed by a rapid growth and development stages.

Since the seedlings with a balanced dry matter distribution throughout plant organs and a well- developed root system can exhibit well-adaptation to their actual growth media, their growth, development and yield parameters will then be positively influenced.In the case where entire development factors are sufficiently and steadily supplied, plants exhibit a normal development throughout the entire life cycle and form proportionate root, stem, leaf, fruit and seed. It is impossible to expect high yields from poorly developed plants (Uzun 1996).

AREA OF STUDY

The baseline survey was carried out in Elgeyo Marakwet, Kajido, Garissa and Siaya Counties of Kenya. Elgeyo Marakwet County comprises of 3 distinct zones, namely the Highlands, the Escarpment, and the Kerio Valley. The Highlands are 3,300 m asl and the Lowlands lie at 900 m asl. As a result, there exist highly steep escarpments which descend the Highlands. The Highlands account for 49% of the County's area with a higher density of human population exceeding that of the Escarpment and the Valley. The Highlands are most conducive for crop production, receiving annual rainfall amounts ranging from 1200 to 2000 mm.

Kajiado County lies on the Southern rangeland of Kenya. It falls between longitudes 360 5' and 370 5' east and latitudes 10 0' and 30 0' south (Anwata, 2013). The County experiences long rains from March-May and short rains from October – December. In the Eastern part of Kajiado County, more rainfall is experienced between March-May. The mean annual rainfall range is from 300 to 800mm (ROK, 2009a).

Siaya County has a landmass of 2,530 km^2 with a water coverage of 1,005 km2. It lies between latitude 0° 26´ S and 0° 18´ N and between longitude 33° 58´ and 34° 33´ (Government of Kenya, 2015). The County's altitude rises from 1,140m on Lake Victoria shores to 1,400m asl on the North. The main type of soil is ferrasols with a fertility range from moderate to low and most soils do not support high yields unless they are supplied with external sources of nutrients. Elevated areas (highlands) receive 800mm – 2,000mm of rainfall annually while low-lying areas receive between 800 – 1,600mm of annual rainfall (Government of Kenya, 2013).

Garissa County is in the North-Eastern part of Kenya and lies between latitude 40 16'N and 00 29'S and Longitude 390 38'E and 400 6'E. The County falls within the Kenyan homogeneous rainfall zones since it exhibits the same temporal characteristics with similar rainfall patterns and magnitude (Ogallo and Anyamba 1983).

MATERIALS AND METHODS

A baseline survey was undertaken from mid-March to end of April 2020 within Elgeyo Marakwet, Garissa, Kajiado and Siaya Counties of Kenya. It was administered to each respondent via farm visit using the most convenient language or an interpreter as necessary. Additionally, field visits and observations were made to authenticate the information provided since most farmers resided within their farms. The survey targeted tomato farmers in the 4 targeted arid and semi-arid Counties. Stratified proportionate sampling was used to get respondents from the 4 Counties. This was due to the relative composition across the groups. This sampling technique ensures inclusion in the sample of each subgroup and limits sampling errors (Kasomo, 2006). According to Mugenda (2003), a sample size of 10 - 30% of the total population is adequate for a study in descriptive research. This research adopted 20 % of the target population of 1,835 giving a sample size of 367 tomato farmers.

Table 1: Respondent sample size across the 4 Counties of Study.

Respondent category	County	Population(N)	Sample(n)	Percent (%)
Tomato Farmers	E. Marakwet	320	64	20
	Garissa	305	61	20
	Kajiado	705	141	20
	Siaya	505	101	20
	Total	1835	367	

A Global Positioning System (GPS) unit assisted in the establishment of coordinates for the farming communities. A structured questionnaire was adopted for individual interviews during the survey. Data on demographic characteristics which included gender, age and education standards were collected. Other data sets included sources of seedlings, tomato varieties grown, variety preference and tomato production systems.

Instrumentation

All sets of primary data were obtained through a researcher-administered questionnaire during the interview sessions. Questionnaire approach was preferred due to its ability to cover wider areas thus reaching many respondents in shorter times at lower costs (Kothari, 2004).

The questionnaires had both closed and open-ended questions which were designed on a Likert scale of three to five items to allow respondents to give their opinions on particular items of the study.

The validity of the Research Instruments

In complying with Gall, Borg and Gall (1996) recommendations, an instrument's validity is improved through relevant expert judgement. In the case of this survey, content plus construct validities were established in consultation with experienced research scientists from KALRO to evaluate the accuracy and adequacy of instruments. Their advice, comments, suggestions and clarifications all helped to improve the validity of these instruments.

Data Collection Procedure

The team of KALRO researchers obtained official permission from relevant authorities in each of the target counties to survey the study area. The Sub-county agricultural extension offices in all the 4 Counties were consulted to link the research team to the ward extension officers who aided with the mobilization of tomato farmers from the targeted communities. The questionnaires were administered by the research team to the 367 respondents. Social distancing and other Ministry of Health protocols for the containment of Covid-19 were strictly adhered to throughout the study.

RESULTS AND DISCUSSION

Demographic data

The demographic data of this study are summarized in Table 7 below. The survey indicated the dominance of the male gender in tomato farming in the 4 Counties of study. This is consistent with the findings of an earlier study on "characteristics and production constraints of smallholder tomato production in Kenya" (Ochilo et al, 2019). A majority of tomato farmers interviewed during the study were male (70.3%). Of all the tomato farmers who disclosed their age, 41% were youth between the ages of 18 and 35 years. Additionally, 59% of the tomato farmers were aged between 36 and 81 years. The landmass under tomato cultivation ranged from 0.25 to 15 acres with most farmers practising tomato production in 1.25 acres or less.

Further, the study indicated that 88.28% of the farmers who participated in the survey were individual landowners while 11.72% owned land as groups (Figure 1). The study also indicated an 11.7% level of illiteracy since 43 out of the 324 individual tomato farmers interviewed had no formal education.

The table below shows the number of participants across the 4 Counties. The highest and lowest numbers of farmers interviewed in the study were 141 and 61 in Kajiado and Garissa respectively.

Table 2: Number of respondents across the four Counties targeted in the study.

County	Frequency (Number of Respondents)
Elgeyo Marakwet	64
Garissa	61
Kajiado	141
Siaya	101

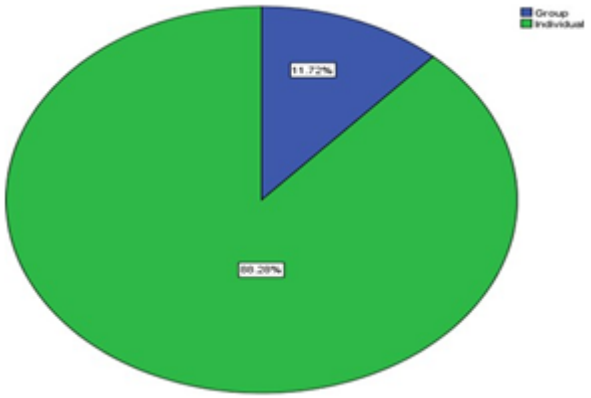
Grand Total	367

Out of the 367 farmers interviewed in the survey, 88.28% (324) were individual farmers while 11.72% (43) were group farmers.

Table 3: Farm ownership across the 4 Counties targeted in the study.

Farm Ownership	Frequency (Number of Respondents)	Percentage (%)
Individual	324	88.3
Group	43	11.7
	367	100

Figure 1: The farm ownership across the 4 Counties is further illustrated in the pie-chart below.

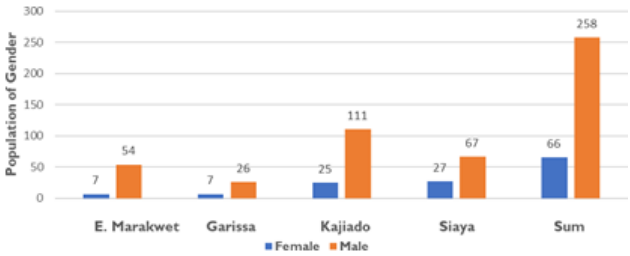


Gender distribution

The graph below illustrates the distribution of male and female farmers across the target Counties. Tomato cultivation is generally domiciled by male farmers in all the study areas. Out of the 324 individual respondents, 258 were male while 66 were female. Siaya county recorded the highest number of female (27) practising tomato farming.

The dominance of the male gender in tomato cultivation may be partly attributed to high investment capital demand by tomato production. In the Kenyan context, higher levels of both human and physical capital are easily accessed by men compared to women (Mwangi et al, 2015). Besides, cultivation of tomato is regarded as risky and most women are risk-averse (Clottey et al, 2009). Lastly, this finding could be attributed to quality differences in land cultivation by both women and men, (including soil quality, land topography, and proximity to roads, sources of water and housing). Poor access to credit facilities, fiscal implications involving the acquisition of farm inputs also limits the production potential of women below the frontier of their male counterparts. (Peterman et al, 2011).

Figure 2: Segregation of respondents by gender through the 4 Counties of study.



Age

The table below illustrates respondent age distribution in which a mean age of 39.41 years was reported with the oldest and the youngest being 86 and 18 years respectively. The insufficient youth involvement in tomato cultivation could be attributed to land scarcity (lack of access to land) in addition to other factors. Land access by the youth is a challenge since most of them are not landowners. Further, the youth lack access to farm inputs, viable agro-produce markets and extension support since most of the government-sponsored incentive programs lock them out.

The social narratives that tend to associate farming with poverty and low self-esteem have equally harmed the involvement of young people in tomato farming.

The result of this is the rural-urban migration of youth who target salaried employment (Bezu and Holden 2014; Chinsinga and Chasukwa 2012; Naamwintome and Bagson 2013).

Table 4: Descriptive statistics on the age of individual respondents interviewed in the study.

Category	N (sample size)	Minimum	Maximum	Mean	Std Deviation
Age	324	18.00	86.00	39.4198	13.10247

Education Level

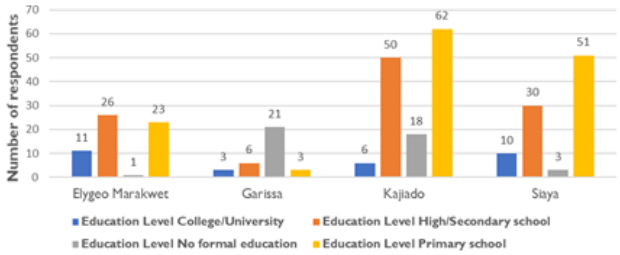
From the table below, a total of 139 respondents had acquired primary school education making it the most popular level of education across the 4 Counties of study. Of all the 4 Counties, the highest number of respondents without formal education was recorded in Garissa County.

Table 5: Distribution of different levels of education across the 4 Counties of study.

County	College/ University	High School	Primary School	No Formal Education
Elgeyo Marakwet	11	26	23	1
Garissa	3	6	3	21
Kajiado	6	50	62	18
Siaya	10	30	51	3

Totals	30	112	139	43

Figure 3: Graphical illustration of how different education levels are distributed across the 4 Counties.



Land and Management Data

The table below indicates that each respondent (individuals and groups) had allocated an average of 1.25 acres of land for tomato production by the time this survey was conducted, with the biggest and the smallest land sizes being 1.5 and 0.25 acres respectively.

During the survey, respondents indicated an average of 6.7 years in tomato production across the 4 Counties of Study.

Table 6: Duration of tomato cultivation and land sizes under tomato cultivation across the 4 Counties of study.

Descriptor	N (Sample size)	Minimum	Maximum	Mean	Std Deviation
Duration of tomato farming (Years)	367	1	40	6.70	7.578
Land size under tomato farming (acres)	367	0.25	1.5	1.25	5.60389

Table 7: Summary of the demographic characteristics of farmers involved in smallholder tomato production in the 4 Counties.

a). Categorical Variables	Number of Farmers	Percentage (%)
Farmers' Gender (n=367)		
Male	258	70.3
Female	109	29.7
Farmers' Age (n=324)		
Youth 35yrs and below	134	41
Adult >35yrs	190	59
Farm Ownership (n=367)		
Individual	324	88.3
Group	43	11.7
Education Level (n = 324)		
College/University	30	8.2
High School	112	30.5
Primary School	139	37.9
No Formal Education	43	11.7

b). Continuous Variable (n = 367)	Minimum	Maximum	Mean	Std Deviation
Farm size (acres)	0.25	1.5	1.25	5.60389
Years of Tomato farming	1	40	60.7	7.578

Seed sources

The table above shows the various sources of seed materials. The study findings indicated that the majority of the tomato farmers (>89%) source for tomato seeds from agro vets (Table 8). While the practice of tomato seed borrowing among neighbouring farmers was notably limited (2.5%), a slightly higher number of tomato farmers (5.4%) expressed confidence in seed recycling through on-farm conservation of (own seeds) for the establishment of new tomato crops.

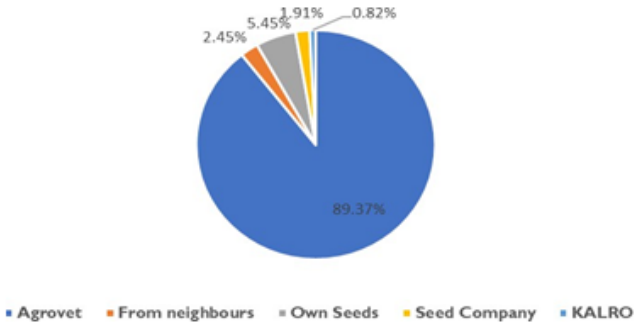
Only 0.8% of the respondents relied on Kenya Agricultural and Livestock Research Organization (KALRO) for the supply of tomato seeds.

Table 8: Distribution of different tomato seed sources among respondents in the target Counties.

Source of Seed	Freq. (Number of Respondents)	Percentage (%)
Agrovets	328	89.4
Neighbours	9	2.5
Own Seeds	20	5.4
Seed Company	7	1.9

KALRO	3	0.8
Totals	367	100

Figure 4: Percentage preference to different sources of tomato seeds by farmers across the 4 target Counties.

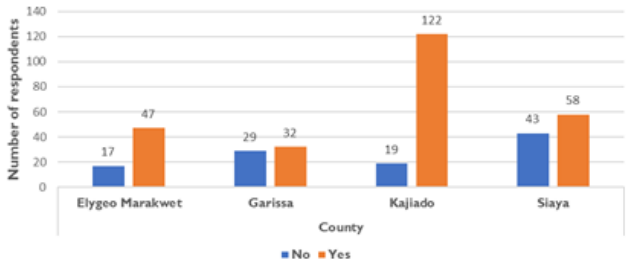


Training on tomato seed systems

The graph below revealed that few farmers had received any form of training on tomato seeds systems. For instance, only 5 farmers from Elgeyo Marakwet had received training by the time of this survey.

Kajiado County is the leading producer of tomato in Kenya (12%) (AFA, 2019; Mabele and Ndonga, 2019) indicated the highest number of farmers with skills on tomato seed systems (Figure 5). This could be an attribute of increased access to agricultural information through both electronic and print media, enhanced participation of tomato farmers in government and NGO- sponsored workshops, field days and exhibitions. Furthermore, the exchange of emerging agricultural information between farmers and extension staff could also increase the skilled farmer population. The scramble for a potential client base in tomato producing areas by various seed companies could also enhance information access.

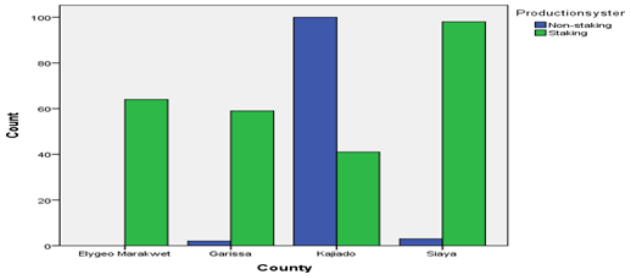
Figure 5: Graphical illustration of farmers with skills on tomato seed systems across the 4 Counties of interest.



Seed Satisfaction

Among the 61 farmers from Garissa who participated in the study, 49% (29) were not satisfied with the seeds they planted. Lack of satisfaction could be attributed to consistently poor yields, high susceptibility of varieties to biotic and abiotic constraints (such as pests, diseases, water stress, heat stress etc) and lack of knowledge on tomato variety suitability.

Figure 6: Illustration of farmer-satisfaction with various tomato variety seeds.



Production system

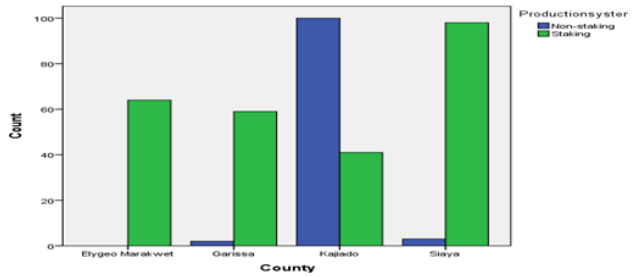
There are two main tomato production systems, which include staking and non-staking. The preferred tomato production systems in the 4 Counties were distributed across the respondent population as indicated in table 9 and figure 7 respectively. Elgeyo Marakwet tomato farmers expressed an overwhelming interest in staking as a system of production with Siaya and Garissa also indicate significant popularity of the same production system. However, 71% of tomato farmers from Kajiado County practised non-staking production system by the time of this study.

Most farmers in the 4 Counties indicated a high preference to the non-staking production system (Table 9) and this could be an attribute of low labour requirements, variety suitability and lifespan. Staking is an agronomic procedure which is labour intensive but with numerous benefits such as encouraging aeration, maintaining the cleanliness of fruits, supporting weak tomato stems under heavy fruit clusters and enhancing the ease of routine operations like scouting and spraying of agrochemicals.

Table 9: Distribution of two tomato production systems across the 4 Counties of study.

County	Tomato Production System		Total
	Staking	Non-staking	
Elgeyo Marakwet	0	64	64
Garissa	2	59	61
Kajiado	100	41	141
Siaya	3	98	101
Totals	105	262	367

Figure 7: Tomato production systems as distributed across the 4 Counties.



Preferred Tomato Variety

The three most commonly cultivated tomato varieties across the 4 Counties of study and corresponding percentages of tomato farmers engaged in their production were reported to be Riogrande (33.5%), Onyx (12.5%) and M 82 (12.0%) (Table 10). Their varied preference to specific tomato varieties could have been influenced by consumer feedbacks in the local markets, technical advice from extension staff, promotion of seeds by agribusiness companies.

The cost of seeds, production system (staking vs non-staking), yield performance of various varieties in different agro-ecological zones, imitation of neighbouring tomato farmers and limited availability of tomato seeds in local agro vets could also be crucial in influencing such decision. (Table 8).

Table 10: Farmer preferences to different tomato varieties across the 4 Counties of study.

Variety	E. Marakwet	Garissa	Kajiado	Siaya	Total	Percentage
Riogrande	31	41	34	17	123	33.5
Onyx F1	37	0	8	1	46	12.5
M 82	0	44	0	0	44	12.0
Cal JVF	2	0	19	22	43	11.7
Rambo F1	0	3	1	39	43	11.7
New Fortune Marker F1	0	0	1	35	36	9.8
Anna F1	3	0	7	0	10	2.7
Royal Oxyl	3	1	0	2	6	1.6
Prostar F1	0	0	0	3	3	0.8
Strike F1	0	0	2	0	2	0.5

CONCLUSION

The dominance of the male gender and insufficient youth engagement in tomato cultivation across the country is evident. Annexed to this, is the production of tomato in farm sizes not exceeding

1.25 acres by most of the farmers. There exists a very high dependency on agro vets as the main sources of tomato seed materials by farmers. In terms of tomato variety preference, most of the tomato growers overwhelmingly opt for determinate varieties (Rio grande and Onyx) suitable for both fresh market and processing. The main determinant of this preference is the non-stacking system of production which is very popular with a majority of tomato growers.

Furthermore, most tomato farmers still lack skills and knowledge on standard tomato cultivation practices. The major gaps in skills fall under clean seedling production, field management of the crop, post-harvest handling and marketing of tomatoes.

Despite being very instrumental in the fight against food insecurity in Kenya, women still pray second fiddle to their male counterparts in terms of resource allocation. The adequate allocation of agricultural resources such as land, inputs and skills to women could significantly enhance their participation in tomato farming.

It is therefore critical for the national and devolved levels of government to boost both human and physical capital of Kenyan women through formulation and legislation of relevant policies. Such policies should enhance rights to ownership of land by women, unbiased access to relevant agricultural technical support and advancement of professional skills of women beyond the basic education level.

Encouraging youth involvement in tomato farming is equally important due to their potential for labour provision and employment creation through agribusiness. This is achievable through the rebranding of the agricultural sector as an unexploited resource for sustainable income generation and improvement of livelihoods. The major impediments to youth involvement in farming are access to farmland and lack of financial capital. Workable strategies that could partially or completely solve these challenges include but not limited to; sound credit facilities suitable for the dynamics of agriculture and review of land policies to favour ownership by the youth.

Promotion of competitiveness along the tomato value chain remains key to the improvement of smallholder livelihoods through a transformation from subsistence to business-oriented production. As such, public-private partnerships in the agriculture sector should be explored by the government to enhance farmer-access to validated technologies such as clean seedling production.

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