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Disease Constrains to Tomato Production and their Management by Smallholder Farmers of Kajiado County, Kenya - A Baseline Study

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Abstract

In order to determine the disease management practices for tomato farmers in Kajiado County, a baseline survey was undertaken in 4 wards of the county namely; Mashuuru, Kimana, Kuku and Oloboisoit. A total of 148 tomato farmers were identified using the Stratified proportionate sampling method and interviewed through a structured questionnaire. Data parameters included demographic characteristics of respondents, gender, age and education standards, land ownership, farm size under tomato production, years under tomato production, source of tomato seeds, diseases affecting tomato, disease management practices and source of information on tomato disease management. Over 89% of farmers sourced tomato seeds from agrovets. All the respondents recorded multiple responses on disease prevalence as one farmer could experience multiple diseases. For instance, 90% and 31% of farmers in Mashuuru experienced Bacterial wilt and early blight respectively. These two diseases were the most prevalent at incidences of 33.08% and 24.42%, respectively. All the respondents applied single or combination of synthetic chemicals as the only means of managing tomato diseases. The fungicides used were Metalaxyl-M, Propineb+Cymoxanil, Mancozeb, Propineb and Carbendazim. The chief source of information on tomato protection was Agrovet shops. The findings recommend awareness creation of integrated disease management for tomatoes.

Keywords: Tomato; Diseases; Management; Kajiado; Agrochemicals

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Introduction

Farming is the main economic activity in the County with farmers engaged in cultivation of crops and livestock keeping. Crops grown include maize, beans, potatoes and vegetables such as tomatoes, kales and cabbages. The County is among the key tomato producing regions in Kenya dominated by small-scale farmers [1]. Tomato (*Solanum lycopersicum* L.), is among the most valuable crops grown by small scale farmers in Kenya [2]. It is the most locally marketable vegetable and accounts for about 20% of the total vegetable production in Kenya contributing to 137,000 US dollars annually to the Kenyan economy making it a major source of income and employment to small scale farmers [3]. Tomato production is estimated at an average of 410,033 tons per annum. The production of the crop is impeded by a myriad of biotic and abiotic factors, among which fungal, bacterial and viral diseases are among the most important biotic draw backs [4]. Plant diseases of importance affecting tomato production in Kenya include early blight (*Alternaria solani*), bacterial wilt (*Ralstonia solanacearum*), late blight (*Phytophthora infestans*), Fusarium wilt (*Fusarium oxysporum*), powdery mildew (*Oidium neolycopersici*), and tomato spotted wilt, chlorotic spot disease and tomato yellow leaf curl virus.

In an effort to manage tomato diseases, small scale farmers rely heavily on synthetic chemicals. However, concerns have been raised regarding contamination of the produce and pollution of the environment by bactericides and fungicides, health hazards to producers and consumers and the risk of elimination of non-target beneficial organisms from the ecosystems. In export markets, misuse of synthetic chemicals poses problems in market access due to high residue levels [9-11]. This baseline study was therefore conducted to asses farmers' knowledge on tomato diseases and the methods used to manage them.

Materials and Methods

A survey was conducted in June, 2019 in Kajiado County, Kenya. 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 [5]. The County experiences a bimodal type of rainfall with long rains from March – May and short rains from October – December, where more rainfall is experienced between March-May. The mean annual rainfall range is from 300 to 800mm [6]. Four tomato producing wards representing different agro-ecological zones were selected for the study. Mashuuru lies between 3°9´39´´S and 37°47´9´´E with altitude ranging from 934 to 1,260m above sea level (ASL) on lower highland agro ecological zone. Kuku lies between 0°53´52´´S and 37°36´7´´E. Kimana is within the lower midland zone 2 (LM2) located between 2°48´24´´S and 37°31´27´´E under lower midland zone 2 (LM2) with an altitude ranging from 1,354 to 1,508m ASL. Oloboisoit lies between 2°47´36´´S and 37°41´30´´E.

Stratified proportionate sampling was used to get respondents from the 4 tomato producing wards. This was due to the relative composition across the groups. This sampling technique ensures inclusion in the sample of each sub group and limits sampling errors. According to [7] 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 705 giving a sample size of 148 tomato farmers (118 males and 30 females).

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Table 1: Respondent sample size across the 4 wards of study.				
Respondent category	**Ward**	**Population(N)**	**Sample(n)**	**Percent (%)**
Tomato Farmers	Mashuuru	190	38	20
	Kimana	180	36	20
	Kuku	190	38	20
	Oloboisoit	180	36	20
	Total	**705**	**148**	

Disease prevalence in tomato was determined visually as described by NICRA (2012). Twenty tomato plants at vegetative, flowering and fruiting stages were randomly selected from each field and physically checked for presence of disease symptoms. Samples of diseased tomatoes from farmers' fields were also collected, taken to the laboratory for isolation of the pathogens for further confirmation. A Global Positioning System (GPS) unit assisted in the establishment of coordinates for the target wards. A structured questionnaire was adopted for individual interviews during the survey. Data on demographic characteristics which included gender, age and education levels were collected. Other data sets included sources of seedlings, tomato varieties grown, and variety preference and tomato production systems.

Statistical analysis

Data on age, gender, education level, farm sizes, sources of seedlings, varieties of tomatoes grown, incidence of pests and diseases, management practices and source of agricultural information was reviewed, cleaned, summarized, organized in Microsoft Excel, coded and analyzed using Statistical Programs for Social Sciences (SPSS) (IBM Statistics 20). Descriptive statistics were carried out to generate frequencies and percentages of the variables studied.

Results

Demographic characteristics of respondents

The demographic data of this study is summarized in Table 2. The survey indicated dominance of the male gender (80%) in tomato farming in the four (4) wards of study. This was consistent with the findings of an earlier study on characteristics and production constraints of smallholder tomato production in Kenya [12-16]. 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 land mass under tomato cultivation ranged from 0.25 to 15 acres with most farmers practicing tomato production in 1.25 acres or less. Further, the study revealed that 88.28% of the farmers were individual land owners while 11.72% owned land as groups (Table 2). The study also reported a 15.8% level of illiteracy since 23 out of the 148 individual tomato farmers interviewed had no formal education.

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Table 2: Summary of the demographic characteristics of farmers involved in smallholder tomato production in the 4 wards.				
a). Categorical Variables	Number of Farmers	Percentage (%)		
Farmers' Gender (*n*=148)				
Male	118	80		
Female	30	20		
Farmers' Age (*n*=148)				
Youth 35yrs and below	61	41		
Adult >35yrs	87	59		
Farm Ownership (*n*=148)				
Individual	131	88.3		
Group	17	11.7		
Education Level (*n* = 148)				
College/University	12	8.3		
High School	46	30.8		
Primary School	67	45.1		
No Formal Education	23	15.8		
b). Continuous Variable (*n*=148)				
	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

Source of seeds and varieties grown by farmers

The study findings indicated that majority of the tomato farmers (approximately 79%) sourced for tomato seeds from agrovets.

Source of tomato seeds Percent (%) response	**Mashuuru (n=38)**	**Kimana (n=36)**	**Kuku (n=38)**	**Oloboisoit (n=36)**	**Average %**
Own saved seeds	2.2	3.7	6.7	4.8	4.5
Other farmers	1.1	4.7	3.3	6.9	4
Agrovet	96.4	88.48	74.1	86.3	86.3
Seed companies	0.3	3.1	15.6	1.8	5.1

While the practice of tomato seed borrowing among neighboring farmers was notably limited (4%), a slightly higher number of tomato farmers (4.4%) expressed confidence in seed recycling through on-farm conservation of (own seeds) for establishment of new tomato crops.

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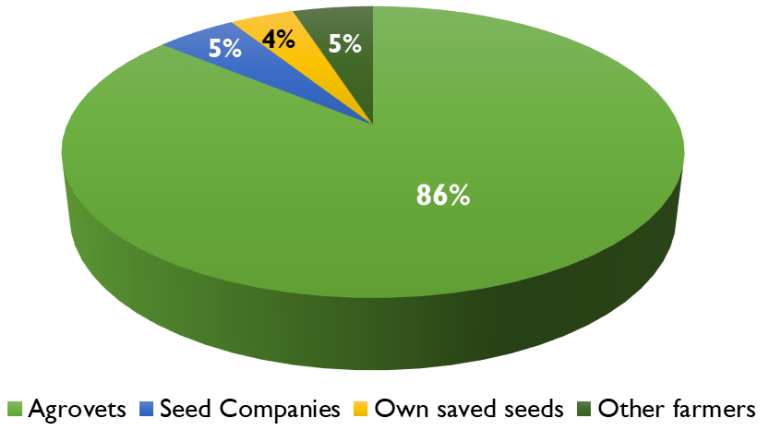
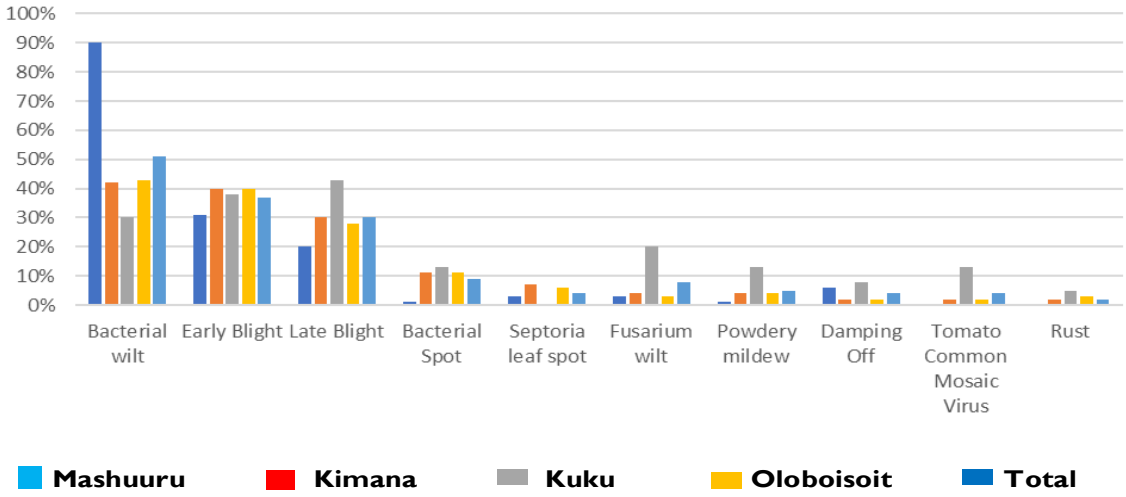
Figure 1: Distribution of tomato seed sources across Kajiado County.



Diseases affecting tomato production

Notably, the participants recorded multiple responses, whereby one farmer could experience multiple diseases. For instance, among the 34 farmers in Mashuuru, 90% had experienced Bacterial wilt, 31% had experienced early blight. From figure 2, bacterial wilt and early blight were the most prevalent tomato diseases at incidence of rates of 33.08% and 24.42%, respectively.

Figure 2: Common diseases of tomato as distributed across the 4 wards.



Disease management practices in tomato production

All the respondents applied synthetic chemicals as the only means of managing diseases in tomatoes. They relied on either single or a combination of chemical formulations. The fungicides used to control diseases included Metalaxyl-M, Propineb+Cymoxanil, Mancozeb, Propineb and Carbendazim. Results of this study found that the highest percentage of farmers (65%) in Kimana combined chemicals followed by 52.5% in Oloboisoit, 22.8% in Mashuuru and 20.5% in Kuku.

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Table 3: Chemicals used by farmers in the control of diseases on tomato.					
Percent (%) use per Ward					
Active ingredient	Group	Mashuuru	Kimana	Kuku	Oloboisoit
Metalaxyl-M	Anilide	7.8	10.6	2.4	14.2
Mancozeb	Dithiocarbamate	4.5	9.8	16.8	3.9
Propineb	Dithiocarbamate	4.7	-	3.6	10.8
Carbendazim	Carbamate	2.2	-	-	-
Chemical combinations					
Metalaxyl-M, Propineb+Cymoxanil		22.8	65	3.4	26
Metalaxyl-M, Cypermethrin		17	5	20.5	52.5
Propineb+Cymoxanil, Cypermethrin		14.5	12	13.5	24.2

Source of Agricultural information on tomato disease management

Farmers relied on different sources for knowledge on chemical management of tomato diseases. About 38.1% and 30.5% of the respondents in Kuku and Mashuuru wards respectively relied on other farmers while 54.5% and 34% of respondents in Kimana and Oloboisoit wards, respectively relied mainly on Agro-vet dealers (Table 4).

Table 4: Available sources of agricultural information on tomato disease control.				
Percent (%) per ward				
Source	**Mashuuru**	**Kimana**	**Kuku**	**Oloboisoit**
Agricultural extension officer	3.4	6.6	-	4.2
Agrovet-shops	44.1	54.5	20.6	34
Trainings by specialists	5.9	-	6.5	4.8
Other farmers	30.5	20.5	38.1	26
Mass media	5.3	3.4	10.7	23.4
Own experience	10.8	15	24.1	7.6

Discussion

Dominance of the male gender and insufficient youth engagement in tomato cultivation across the four Wards is absolutely evident. This can be attributed to the ability of men to meet high investment capital and labour output required for the crop enterprise. Related findings have been reported in Tanzania by and in Kirinyaga County. Adult respondents aged above 35 years accounted for 59% while the youth aged below 35 years accounted for 41%. This finding demonstrated the engagement of more adults in the tomato production enterprise to meet their immediate household needs probably as family heads or bread winners.

Most of the respondents had attained primary (basic) education with a significant number (15.8%) having no formal education. This links most of the primary school leavers to tomato production probably due to their inability to further their education [8]. Education plays a role in enhancing one's intelligence and could therefore enable tomato farmers manage crop production in a better way. Educated farmers may be more flexible to take-up improved crop production technologies and increase yields. The study further revealed that the respondents

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had farm size ranging from 0.25 to 1.5 ha. This tallies with the rest of African tomato production which is characterized by small land sizes. Baseline studies conducted on the economic value of smallholder dry land tomato production in Adamawa State of Nigeria also revealed that over 63.8% of respondents produced tomato in less than 2.0 hectares of land. The reduced land acreage under tomato production could lower yields since land is a critical factor of production.

The high prevalence of tomato bacterial wilt disease caused by *Ralstonia solanacearum* disease across the 4 wards indicated that its management was a challenge to the respondents. These findings concur with earlier research results which reported the pathogen's prolonged persistence in the soil and high virulence as its characteristics.. The survey also revealed that synthetic agrochemical groups such as organophosphates, neonicotinoids, pyrethroids, carbamates and dithiocarbamates were used by respondents to fight the common diseases. However, they are enlisted among those with harmful effects to beneficial living organisms including natural enemies of insect pests.

The adoption of chemical disease control method as the sole approach by respondents signified limited access to information on integrated plant disease management since most of them depended on agrovet dealers who may be unable to provide accurate professional advice to farmers. Such results collaborate with previous findings which pointed out distributors as the key source of information that determined the agrochemicals used by farmers, with 72.5% reliance. Wide variations were however noted in the quantities of respective agrochemicals used by the respondents. These could be linked to efficacy levels of these chemicals, their mode of action and scope of disease infection.

Majority of the respondents in Kuku ward depended on fellow farmers for information pertaining to tomato disease control. These results also revealed shortage of adequate agricultural extension services across the four wards. However, these findings differ from those reported by [9] in Mwea West sub-County, Kenya who found that majority of the farmers (40.4%) sourced information on tomato production from the agricultural extension officers.

Conclusion and Recommendations

Despite being very instrumental in the fight against food insecurity in Kenya, women still play second fiddle to their male counterparts in terms of resource allocation. The adequate allocation of agricultural resources such as land and skills to women could significantly enhance their participation in tomato farming [10]. 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 labor provision and employment creation through agribusiness. This is achievable through the rebranding of 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 favor ownership by the youth [11-16].

Promotion of competitiveness along the tomato value chain remains key to improvement of

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smallholder livelihoods through 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.

The findings demonstrated that tomato farmers in the study area have in depth knowledge of tomato production. However, pests and diseases were the major limitations to tomato production in the region. There are still major gaps in knowledge concerning the use of chemicals on tomato production and awareness on safer alternatives to synthetic chemicals such as use of bio-pesticides. Therefore, the study recommends for increased awareness on the judicious use of chemicals, frequency of application and risks associated with synthetic chemicals in tomato production. Future studies on the level of synthetic chemical residues in tomatoes produced in various regions and their health impact on the farmers should be conducted.

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