

## Management of Biotic Constrains to Tomato Production by Farmers in Bungoma County, Kenya

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### ABSTRACT

A baseline survey on pest and disease management by tomato farmers was conducted in seven farming communities of Chemsis, Chesikaki, Bukonoi, Namtoholo, Chemondi, Kabomi and Kang'anga' in Mt. Elgon sub-county. A total of 93 farmers were selected using the stratified proportionate sampling method and interviewed through structured questionnaires. Data collected included demographic characteristics, tomato varieties, sources of tomato seed materials, major pests and diseases management practices, farm record keeping and communication information transfer. The cultivated tomato varieties were Elgon Kenya F1, Cal J, Safari F1, Stricker F1, Rionix, Kilele F1, Rio Grande (Simlaw), Rio Grande (Seed Co), Terminator, Money Maker, Roma F1, Shanti F1, Pamela F1 (Agrotec), Ranger F1 and Safa F1. Adult farmers (36 to 81 years) dominated tomato farming at 59% while youths (18 to 35 years) represented 41% of the respondents, 96.7% sourced tomato seeds from agrovets, 2.2% recycled their own seeds and 1.1% borrowed seeds from fellow farmers. The use of synthetic agrochemicals in managing pests and diseases stood at 55.9% and 45.8% respectively. About 16.3%, 10.3%, 7.9%, 4.8% and 4.8% of respondents planted tolerant varieties, practiced crop rotation, rouging, use of botanicals and indigenous knowledge to control pests respectively. Rouging, use of tolerant varieties, scouting and crop rotation were reported by 12.5%, 15%, 1.7% and 12.8% of respondents, respectively. However, 8.7% of respondents were not controlling pests and diseases whereas 3.5% relied on indigenous knowledge. About 14% of the respondents relied on other farmers for information. The study therefore recommends awareness creation on correct use of chemicals and use of safer alternatives. Future studies on the level of synthetic chemical residues in tomatoes produced in Bungoma county are necessary.

**Keywords:** *Lycopersicon esculentum*; Biotic constrains; Management; Bungoma county

## INTRODUCTION

Tomato (*Solanum lycopersicum* L.), is a high value crop produced by small holder farmers of Kenya with Bungoma county constituting 2.2% of Kenya's total yield. It is considered to be among the most demanded vegetable in local markets and constitutes about 20% of vegetables produce from Kenya. It also generates an annual income of 137,000 USD from 410,033 tons

making the horticulture sub-sector a key segment of Kenyan economy. Therefore, it supports the livelihoods of smallholder farming communities through income generation and employment creation.

Tomato production is impeded by various factors with biotic challenges such as arthropod pests and diseases constituting the

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most significant setbacks. The most significant tomato insect pests include the thrips, (*Frankliniella occidentalis*), leaf miner (*Tuta absoluta*), African bollworm (*Helicoverpa armigera*), mites (*Tetranychus spp.*), whiteflies (*Bemisia tabaci*) and aphids (*Myzus persicae*) according. The crop is also infected by phytopathogens/diseases such as bacterial wilt (*Ralstonia solanacearum*), powdery mildew (*Oidium neolycopersici*), chlorotic spot disease, leaf curl virus, late blight (*Phytophthora infestans*), early blight (*Alternaria solani*), Fusarium wilt (*Fusarium oxysporum*) and tomato spotted wilt. To manage these pests and pathogens, small holder farmers largely depend on the use of synthetic chemicals. However, consumers and food safety experts are increasingly raising concerns over the negative impact of such chemicals on the environment and human health. High chemical residue levels in farm produce including tomato have posed a major challenge in accessing international markets by farmers. Therefore, the aim of this study was to assess the status of biotic challenges to tomato production and their management by smallholder farmers in Mt. Elgon sub-county of Bungoma county [1-6].

**Area of study:** Bungoma county sits on the foothills of Mt. Elgon and borders Uganda towards the West. The county stretches over a land area of 2,068.5 km<sup>2</sup>. The county borders Trans-Nzoia county to the North, Kakamega county to the East and Busia county to the South-West. The study area falls within Latitude: 0°50' 59.99" N Longitude: 34°42' 59.99" E. Altitude ranges from 1800-4320 meters above sea level on lower highland agro ecological zone. Influenced by Mt. Elgon, the defining topographical feature. The seven (7) targeted tomato farming communities have different types of soil, which comprise of fertile deep Andosols, Acrisols and Nitisols. They experience average temperature range between 15 and 23°C yearly. The communities also experience bimodal precipitation pattern

**Table 1:** Target population.

Respondent category	Community	Population (N)	Sample (n)	Percent (%)
Tomato farmers	Chemsis	110	11	10
	Bukonoi	200	20	10
	Chemondi	130	13	10
	Kang'ang'a	110	11	10
	Kabomi	100	10	10
	Chesikaki	120	12	10
	Namtoholo	160	16	10
Total		930	93	

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 collected included demographic characteristics of farmers such as gender, age, land tenure system, education levels, farm size under tomato production and duration of tomato production in years. Other data parameters included; tomato varieties, sources of tomato seed materials,

yielding between 950 mm-1,500 mm of rainfall annually. The long rains are spread between March and July while short rains fall between August and October. The county is among the tomato producers in Kenya and is dominated by small scale farmers contributing 2.2% of the total annual tomato yield in Kenya. Approximately 52% of the human resource in the county focuses on agricultural activities accounting for over 60% local household incomes; 19% wage earners and 13% self-employment [7-10].

## MATERIALS AND METHODS

A baseline survey was undertaken in October, 2020 within Bungoma County of Western 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 7 farming communities growing tomato in Mt. Elgon sub-county. Stratified proportionate sampling was used to get respondents from the 7 communities in Mt. Elgon sub-county. 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 a sample size of 10%-30% of the total population is adequate for a study in descriptive research. This research adopted 10% of the target population of 930 giving a sample size of 93 tomato farmers [11-15] (Table 1).

major pests and diseases affecting tomatoes, tomato disease management practices, farm record keeping and communication and information transfer. Digital photos of pests and symptoms of diseases were used to assist the farmers in identification. Pest and disease prevalence were determined orally from farmer narrations and visually through field visits as described by. At least 10 tomato plants at vegetative, flowering and fruiting stages were randomly sampled from each field and scouted for

presence of individual pests, damages caused, disease symptoms and signs [16-21].

**Data collection procedure:** The team of KALRO researchers obtained official permission from the Bungoma county government through the county crop protection office to conduct the survey in the study area. The Sub-county agricultural extension office situated in Chapattis was 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 93 respondents from the 7 tomato farming communities. Social distancing was observed in strict adherence to the Ministry of Health guidelines for the containment of the COVID-19 pandemic.

## RESULTS

**Demographic characteristics of respondents:** The demographic data of this study is summarized in Table 2. The survey

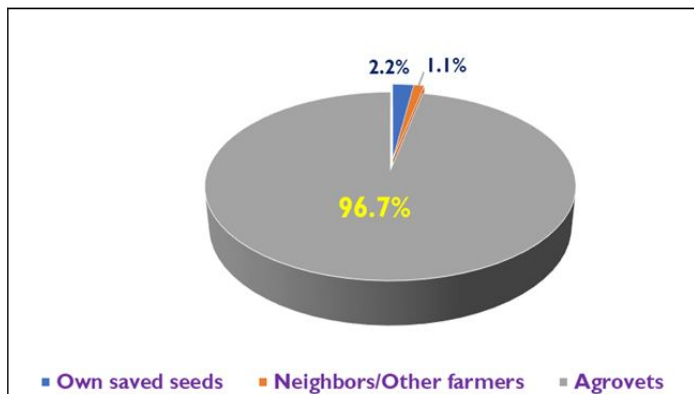
indicated dominance of the male gender in tomato farming in the 7 farming communities. This was consistent with the findings of an earlier study on characteristics and production constraints of smallholder tomato production in Kenya. A majority of tomato farmers interviewed during the study were male (56.2%). Of all the tomato farmers interviewed, 37% were youth between the ages of 18 and 35 years. Additionally, 63% of the tomato farmers aged between 36 and 81 years. The average duration of tomato production per respondent in years across the 7 farming communities was 6.7 years. The land under tomato cultivation ranged from 0.25 to 1.5 acres with most farmers practicing tomato production in 1.25 acres or less.

Further, the study indicated that 59.3% of the farmers practiced community land ownership while only 10.3% owned land as individuals, with a 5.6% level of illiteracy being recorded since 5 out of the 93 respondents had no formal education (Table 2).

**Table 2:** Summary of the demographic characteristics of farmers involved in smallholder tomato production in the 4 Counties.

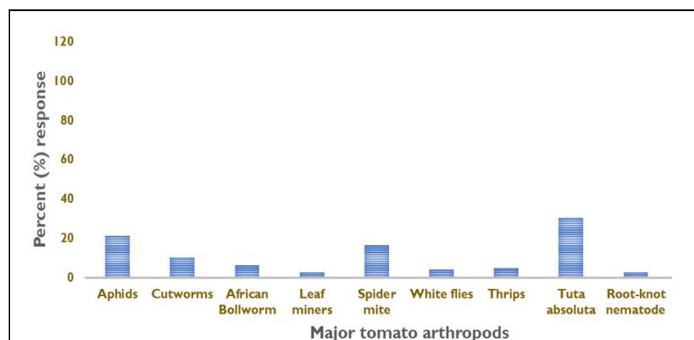
a). Categorical variables	Number of farmers	Percentage (%)		
<b>Farmers' gender (n=93)</b>				
Male	50	56.2		
Female	39	43.8		
<b>Farmers' age (n=93)</b>				
Youth 35 yr's and below	34	37		
Adult >35 yr's	59	63		
<b>Farm ownership (n=93)</b>				
Sole ownership	10	10.3		
Joint ownership	4	4.3		
Family ownership	55	59.3		
Renting/Leasing	24	26.1		
<b>Education level (n=93)</b>				
College/University	16	16.9		
High school	32	34.8		
Primary school	40	42.7		
No formal education	5	5.6		
<b>Continuous variable (n=93)</b>				
	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std deviation</b>
Land size (acres) under tomato	0.25	1.5	1.25	5.60389
Years of tomato farming	1	40	6.7	7.578

**Sources of tomato seed materials:** The study findings indicated that majority of the tomato farmers (96.7%) sourced tomato seeds from agrovets. While the dependence on seed borrowing among neighboring farmers was low (1.1%), a slightly higher number of tomato farmers (2.2%) expressed confidence in seed recycling though replanting their own seeds (Figure 1).

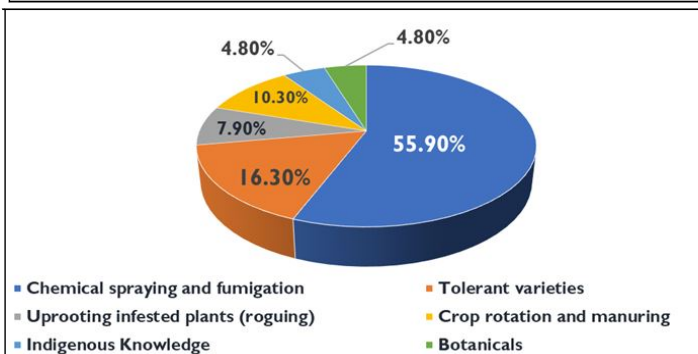


**Figure 1:** Sources of tomato seeds by percent (%) response in Bungoma county.

**Arthropods affecting tomato production and their management:** *Tuta absoluta* was the most prevalent tomato arthropod pest reported by 30.6% of the 93 respondents in the study area. However, aphids, spider mites and cutworms were also significantly prevalent with 21.5%, 16.7% and 10.4% reporting, respectively by the respondents. Other pests reported included; African bollworm, leaf miners, whiteflies, thrips and root-knot nematodes (Figure 2).



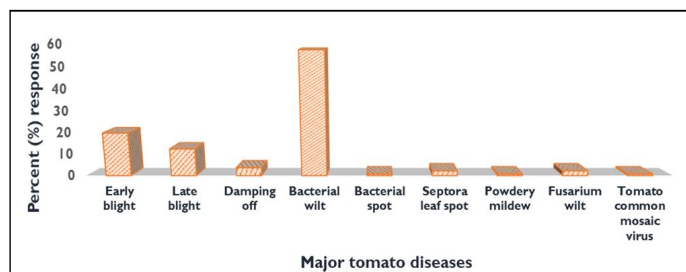
**Figure 2:** Distribution of the major tomato arthropods across Bungoma county.



**Figure 3:** Distribution of major arthropod control methods in Bungoma county.

To combat the challenge of arthropod pest infestation, the respondents reported different management practices for these pests. A majority of them (55.9%) applied synthetic insecticides and fumigants as a control measure. The use of ecofriendly pest control options such as tolerant varieties, crop rotation, rouging, botanicals and indigenous knowledge were reported by 16.3%, 10.3%, 7.9%, 4.8% and 4.8% of respondents, respectively (Figure 3).

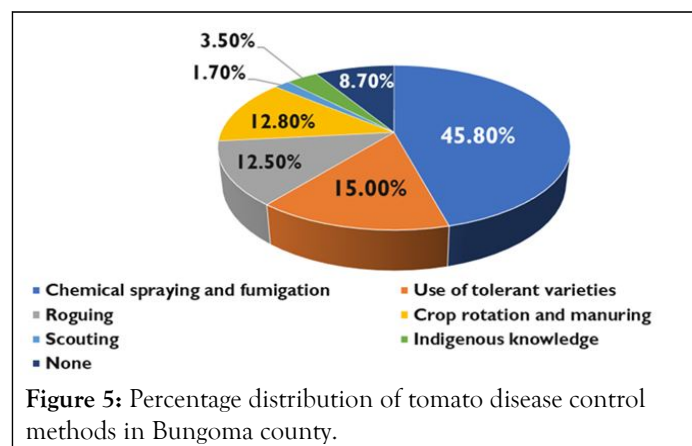
Diseases affecting tomato production and their management: Bacterial wilt of tomato was reported by 57.4% of the 93 respondents as the most prevalent disease. However, early and late blight diseases were also significantly prevalent among 19.9% and 12.5% respondents, respectively. Other tomato diseases reported were; dumping off, septoria leaf spot, fusarium wilt, bacterial spot, powdery mildew and tomato common Mosaic Virus (Figure 4).



**Figure 4:** Distribution of the major tomato diseases in Bungoma county.

**Disease management practices in tomato production:** Most of the respondents (45.8%) reported using synthetic insecticides and fumigants as the main disease management option. Less hazardous control options such as rouging, tolerant varieties, scouting and crop rotation were reported by 12.5%, 15%, 1.7% and 12.8% of respondents, respectively (Figure 5).

A significant number of respondents (8.7%) were not applying any of the available disease control methods in the management of their tomato fields. A total of 3.5% respondents were still applying indigenous knowledge to control diseases.



**Figure 5:** Percentage distribution of tomato disease control methods in Bungoma county.

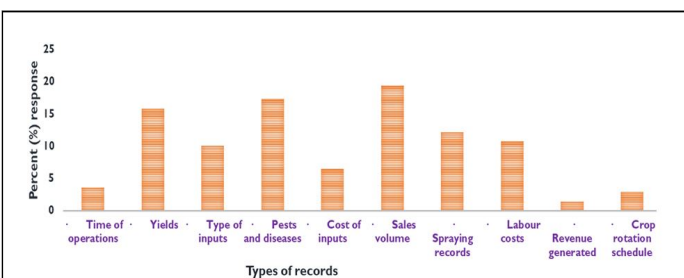
**Types of records kept by tomato farmers in Bungoma county:**

From the baseline survey conducted in Bungoma county, a total of 40 out of 93 respondents (43.5%) admitted keeping farm records. Out of the 40 respondents keeping farm records,

17.3% had specific records on pest and disease management. This was slightly lower than the cumulative percentage of respondents keeping agribusiness records of labor costs, yields and sales volume (46%) (Table 3 and Figure 6).

**Table 3:** Distribution of records kept by tomato farmers in Bungoma county.

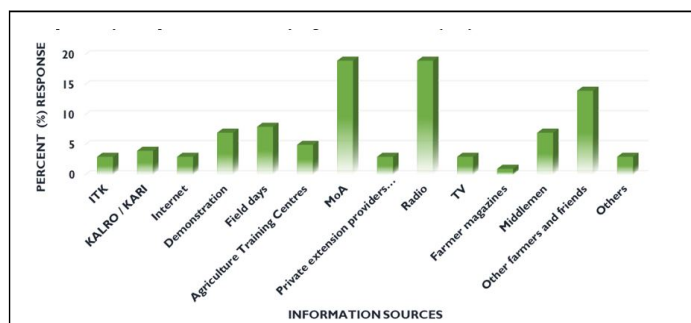
	Percent (%) response
Farmers keeping records	43.5
Types of records kept	Percent (%) response
Time of operations	3.6
Yields	15.8
Type of inputs	10.1
Pests and diseases	17.3
Cost of inputs	6.5
Sales volume	19.4
Spraying records	12.2
Labour costs	10.8
Revenue generated	1.4
Crop rotation schedule	2.9



**Figure 6:** Percentage of respondents keeping farm records in Bungoma county.

**Source of agricultural information on tomato disease management:**

Farmers relied on different sources for knowledge on the management of tomato pests and diseases. About 14% of the respondents relied on other farmers and friends for information while a total of 38% depended on both Radio and the Ministry of Agriculture. However, the numbers of tomato farmers sourcing information from KALRO and agricultural training centers were relatively low at 4% and 5%, respectively compared to those relying on middlemen (7%) (Figure 7).



**Figure 7:** Preference to various information sources by respondents Bungoma county.

**DISCUSSION**

*Tuta absoluta* was the most dominant pest affecting tomato production across the study area. This could have been contributed by the favorable ecological conditions coupled with wider host range and their ability to migrate and colonize new habitats. In addition, the pest has been reported to be resistant to commonly used synthetic systemic chemicals making it difficult to effectively manage them. Further, the presence of viral disease vectors such as aphids and whiteflies indicated the possibility of tomato plants being infected with viral diseases such as Tomato Common Mosaic Virus, Tomato Chlorotic Spot Virus (TCSV) and Tomato Spotted Wilt Virus (TSWV).

These findings are in agreement with a study by in Kirinyaga county, Kenya and Infonet-Biovision who reported thrips and whiteflies as key pests affecting tomato production. The high incidence of bacterial wilt disease across Bungoma county implied that the disease was widespread and challenging to control. These results collaborate with earlier research that have reported the long-term persistence of the disease in the soil and wide spread in many infected tomato fields. The high prevalence of tomato bacterial wilt disease and *Tuta absoluta* pest across the study area indicated that its management was a challenge to the respondents. These findings are in similar to earlier research results which reported the pathogen's prolonged persistence in the soil and high virulence as its characteristics.

Chemical methods of pest control were dominant across the study area. A number of factors could be attributed to such a trend. First, most of the synthetic pesticides have been reported to have a 'knockdown effect' as opposed to botanicals thereby offering quick solutions to all pest related challenges. The ease in accessing a wide range of synthetic pesticides through agro-dealers and the ability of such pesticides to retain high efficacy levels compared to organic pest control products could also be an attribute to their preference. For instance, all respondents reported that they cheaply accessed very strong pesticides some of which are not in the Kenyan market from the neighboring Uganda. The practice of record keeping was not popular among tomato farmers in the study area. This pointed to the need for capacity building of tomato farmers on the significance of keeping records.

## CONCLUSION

The findings from this study revealed that tomato growers in the study area exhibit some level of technical knowledge of tomato production. Lack of awareness on the use of ecofriendly pest control options cannot be underestimated. This calls for capacity building of tomato farmers in the study area on other pest management options and how they can be applied to improve crop health. However, the challenges of insect pests and diseases stood out as the key threats to tomato production. Besides, knowledge gaps still exist especially in the safe use of chemical management options and the availability of ecofriendly alternatives to synthetic chemicals which include bio-pesticides. Hence, this study recommends the dissemination of ecofriendly crop health management technologies and innovations to smallholder tomato farmers. Future studies could be undertaken on chemical residue levels in tomatoes produced in the study area and the impact of using such chemicals on the health of various tomato value chain actors especially producers and consumers.

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