

Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya

Charity Kiambuthi, Alfred Wandera Sanday

Abstract— Tomato production in Kenya significantly contributes to the Country's economy, recorded at 8% total input of the GDP. Tomato farming has, over the years, proved to be easily practiced by most homesteads, most of whom develop small or large kitchen gardens to generate income. In Kirinyaga County, which is in Kenya, tomato production accounts for 14% of the agricultural production in the County. This paper identified the underlying productivity and adoption of modern technologies as; I) to determine the technologies adaptable by farmers, ii) methods used to adopt to increased productivity, and iii) to investigate whether modern technologies influenced productivity increase. Primary data was obtained from tomato farmers in the five sub-counties of Kirinyaga County. Questionnaires were administered to tomato farmers by enumerators using CS Entry software. SPSS was used to analyse the data from the 397 respondents.

This study found that the primary source of income for tomato farmers who were respondents to the study showed that 100% of households depended on tomato farming as the only income-generating product. 98% of respondents had financial challenges, resulting in 98% of tomato farmers indicating that they could not adapt to new technologies due to these limitations. Further, they were challenged by the fact that the new technologies were expensive to practice, and there needed to be more technology training and personnel to consult. Of significance was that new technologies were not affordable, nor were they available to tomato farmers, with the majority totalling 141 indicating that greenhouses were the top technology they could adopt, 114 adopting drip irrigation and plastic mulching adopted by 63 respondents, respectively. Furthermore, 246 respondents were still determining whether the new technologies are sustainable, with only 74 indicating they were sustainable. Similarly, it was revealed that lending loans to farmers (154 respondents) and free training (138 respondents) were the solutions to adopting new and modern technologies. In conclusion, for tomato farmers in Kirinyaga County to remain the top producers of tomatoes in Kenya, they need financial input from the County and national government to boost their farming practices.

Of the tomato farmers who participated in this study, 144 posed low yield due to pest and disease infections, with 102 confirming that lack of agricultural information on pests and diseases significantly contributed to low yield. This study sought to find if introducing modern tomato farming technologies could increase production, and 83% of respondents indicated that they were not introduced to modern technologies. Therefore, factors that influence tomato production are of great essence to tomato farmers. In this study, it was evident that agricultural information on pests and diseases, tomato seed varieties, pre-and

post-harvest, monitoring and evaluation, storage facilities, and marketing were vital in production.

Index Terms— Tomato productivity, Yield increase, Adoption, Modern technologies.

I. INTRODUCTION

The horticulture industry in Kenya contributes to 8% of the country's GDP and 36% of the overall agricultural sector (Sigei et al., 2014). The government of Kenya (2012) posits that horticulture has grown to 15-20% in the last ten years. In production rating, it is the second leading vegetable in Kenya (Sigei et al., 2014), with 95% open-ground production against 5% greenhouse production. Tomato also constitutes 7% of total horticultural produce in Kenya and 14% of the entire vegetable produce (Ochilo et al., 2019). Tomato farmers in Kirinyaga County depend on horticultural farming to improve their livelihoods and increase the County's GDP. Farmers' interaction with new technologies to increase food productivity is an undisputable need in today's society.

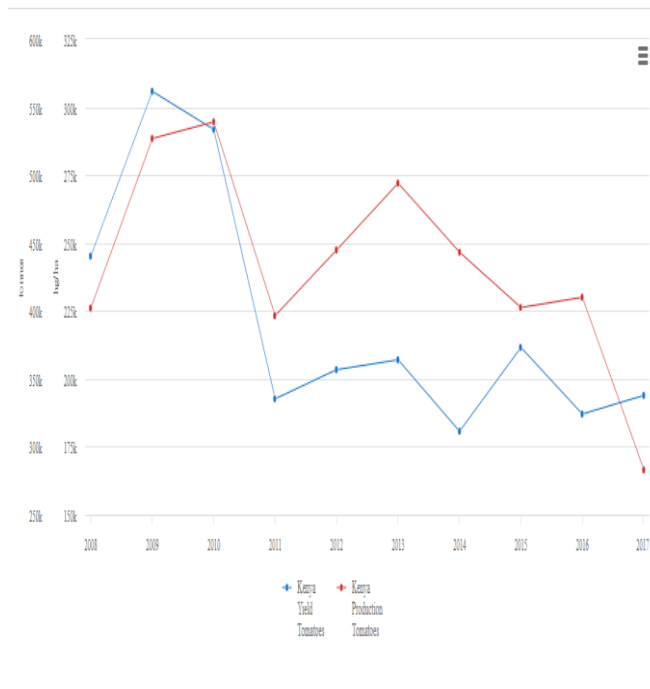
Small-scale farmers need more finances to boost their farming practices, making the yield low (Abteu et al., 2016). Tomato farmers in Kirinyaga County exhibited that introduction to new technologies were not introduced, and when it was, the cost was relatively high for them to adopt. Some technologies introduced to them included greenhouse farming, drip irrigation, and plastic mulching. Loans from either cooperative societies or government facilities were not available to them. Kirinyaga County tomato farmers have experience limitations in that agricultural experts need to dedicate their time and resources to train tomato farmers on how to tackle challenges faced during farming. Unfortunately, like Kirinyaga County, small-scale farmers in developing countries are resource-constrained, limiting their capacity to pursue sustainability (Abteu et al., 2016). Hence, tomato farmers expressed the need to have agricultural information on technology available for adoption to sustain their productivity.

Tomato productivity in Kirinyaga County, which tops Kenya in production, required agricultural information to ensure farmers are economically empowered. It is of great essence to enhance scaling up farming technologies to guarantee enhanced yield.

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Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya



FAOSTAT, 2019

Figure 1.1: Tomato yield and productivity over 10 years

II. METHODOLOGY

2.1 Study sites

The study was conducted in July-August 2020 in the top tomato-production County in Kenya. The study achieved 397 who are tomato farmers. Tomato farmers were selected using the cluster sampling technique, and samples drawn from each cluster were determined by the five sub-counties in Kirinyaga County, which included Kirinyaga East, Kirinyaga West, Kirinyaga Central, Mwea East, and Mwea West. Kirinyaga County is located at the foothills of Mt. Kenya in the central region of Kenya, 125 km north of Kenya’s capital city, Nairobi. Kirinyaga County covers 1,479.09 square kilometres and borders Embu County to the East, Machakos County to the South, Murang’a County to the South West and Nyeri County to the West. Kirinyaga County has a favourable tropical climate for agriculture with a minimum of 12°C to a maximum of 26°C and rainfall of 1,100mm and 1,250mm per annum. Agriculture in Kirinyaga County, as described by County Integrated Development Plan 2013-2017, is the most critical activity in the county, with 87% of the total population deriving their livelihood from the sector and accounting for 72% of household income.

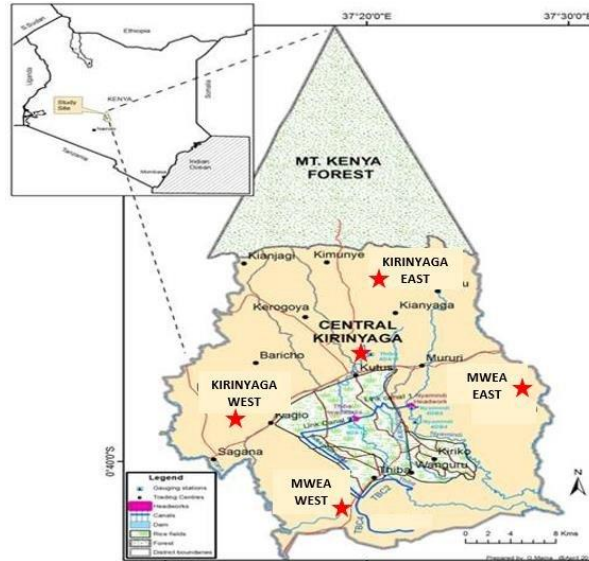
2.2 Data collection

Data were collected using CS Entry software. Farmers were selected using cluster sampling and samples drawn from the clusters. In this case, the clusters were the seven wards in Kirinyaga County. In order to obtain a proper random sample, a systematic random sampling procedure was used to select the sample population from each cluster. The total sample size was 397, divided into five sub-counties: Kirinyaga East, Kirinyaga West, Mwea East, Mwea West, and Kirinyaga Central—sampling intervals of 7, where every seventh farmer was sampled.

2.3 Data Analysis

Descriptive statistics, frequencies, and percentages were calculated. Data was mined from CE Entry software into the Statistical Package for Social Sciences (SPSS). Pie charts and histograms were used to interpret data frequencies and percentages to calculate the descriptive statistics that determined gender, age, education levels, and tomato farmers' land size, production, and adoption experiences and observations.

Map 1: Location of Kirinyaga County with the five sub-counties stated.



Source:https://www.researchgate.net/figure/Kirinyaga-County-map-showing-the-five-sub-counties-stars-visited-during-the-study-Map_fig1_332802943

III. RESULTS

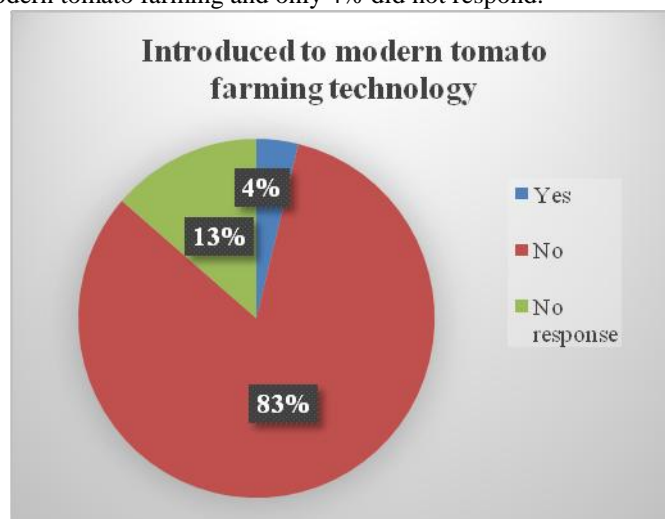
3.1 Modern technologies Adoption

Figure 3.1.1 indicates that tomato farmers depended on their farm production as their main source of income hence the importance of adoption of advanced technologies for yield increase.



3.1.1 Farming as an income

The figure below illustrated that 83% of tomato farmers were not introduced to modern tomato farming technology while only 13% were introduced to new modern tomato farming and only 4% did not respond.

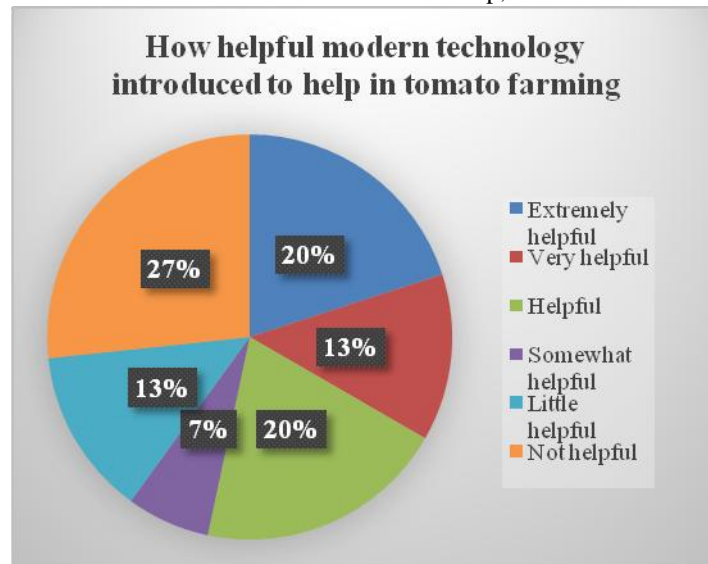


3.1.2 Introduced to modern tomato farming technology

The researcher was interested to know if the modern technology introduced to tomato farmers was helpful, and 27% of respondents indicated that it could have been more helpful. In comparison, 20% showed that it was beneficial and helpful,

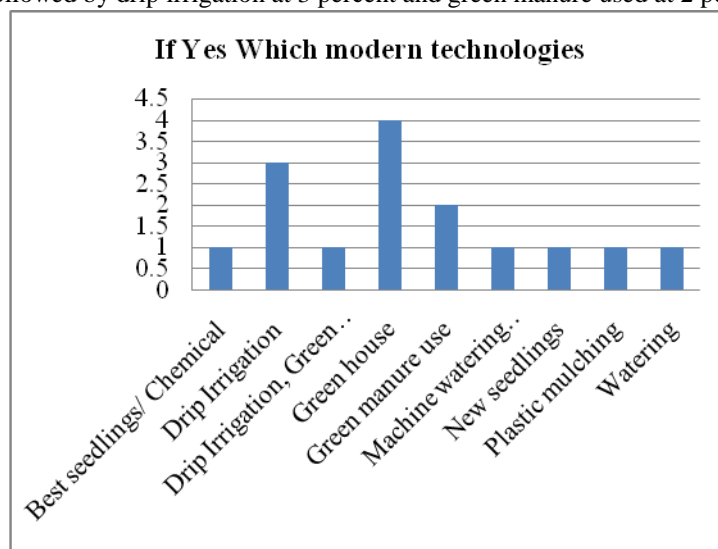
Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya

respectively. However, respondents at 13% indicated that it was of little help, and 7% stated it was somewhat helpful.



3.1.3 How helpful modern technology introduced to you helped in tomato farming

The respondents were asked to specify the modern technologies introduced to them. Greenhouses technologies at 4 percent were the most introduced, followed by drip irrigation at 3 percent and green manure used at 2 percent, respectively.



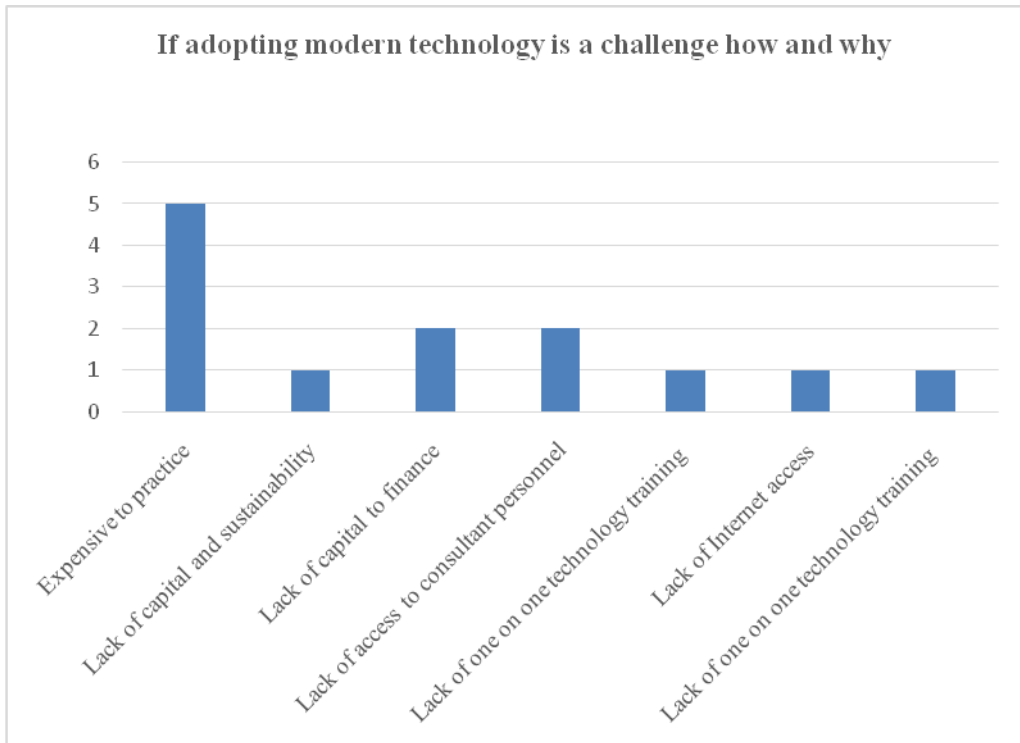
3.1.4 If yes which modern technologies

Figure 3.1.5 indicates that 98% of respondents had financial challenges, with only 2%, suggesting that they had no financial challenges.



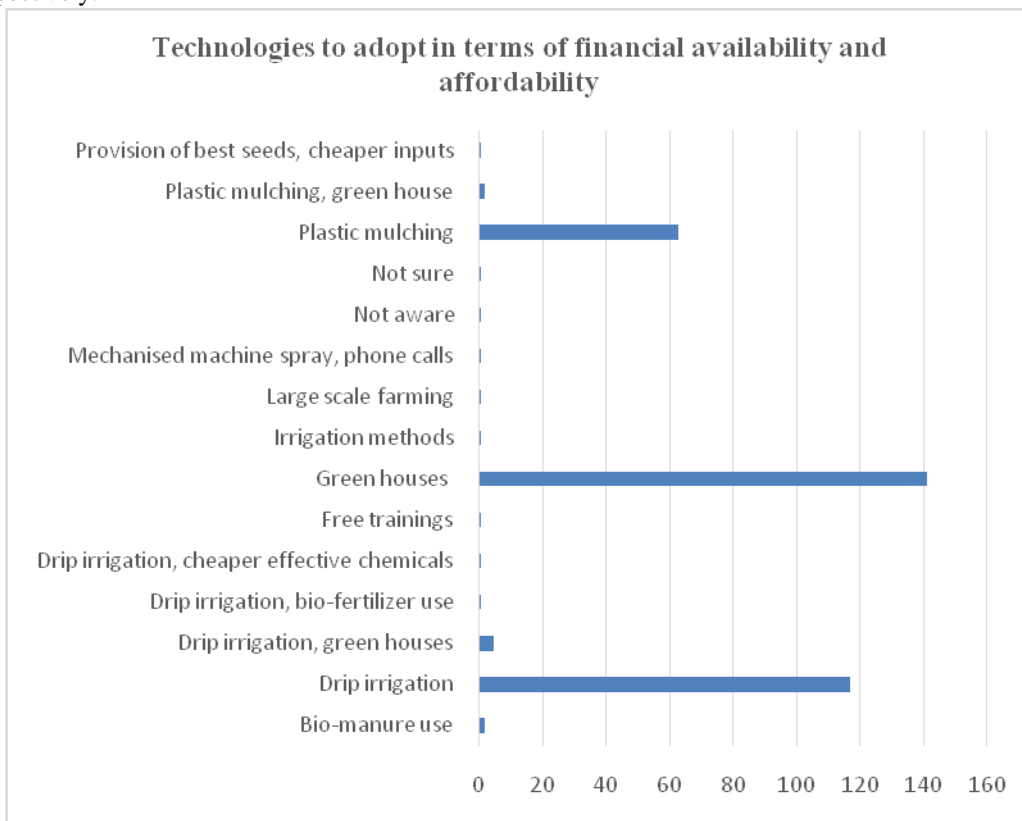
Figure 3.1.5 Financial challenges for not adopting new technologies

Adopting modern technologies was expensive to practice, as shown by five respondents, 2 of each displaying a lack of capital to finance farming and a lack of access to consultant personnel, respectively.



3.1.6 If adopting modern technology is a challenge how? and why?

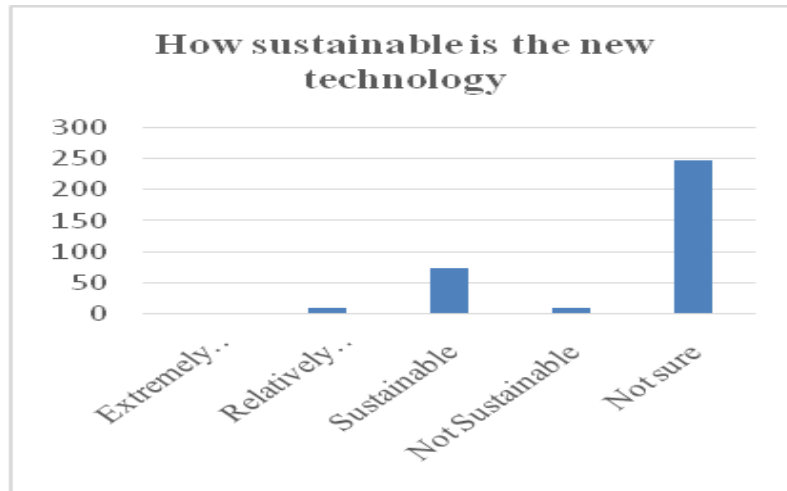
Finances and affordability of technologies adoption were a concern to tomato farmers, hence the question of if they were financed to adopt technologies and, if those technologies were affordable, whether they could practice them 141 respondents believed that they could adopt them. In comparison, drip irrigation followed drip irrigation with 117 respondents and 63 plastic mulching, respectively.



3.1.7 Technologies to adopt in terms of financial availability and affordability

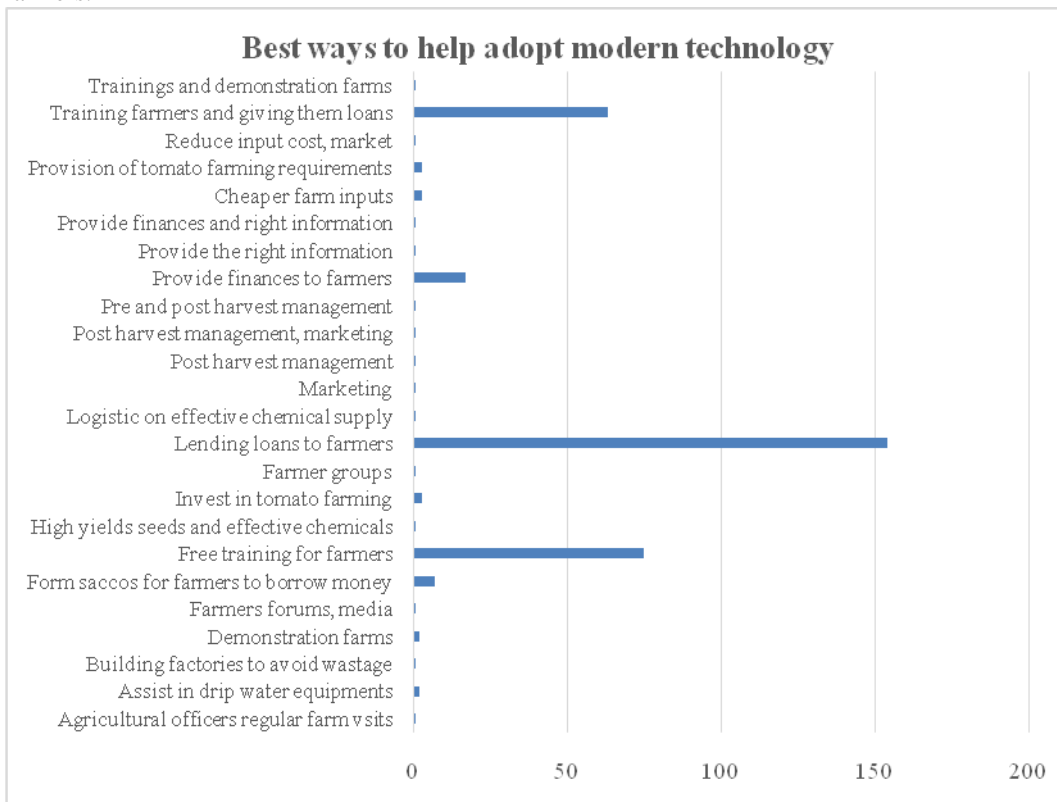
It was clear that a few tomato farmers were positive about the new technology, with a respondent total of 74, while 246 respondents were not sure. These figures indicate that there was uncertainty that could be solved if agricultural information was available so farmers could practice new technologies without any fear of loss.

Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya



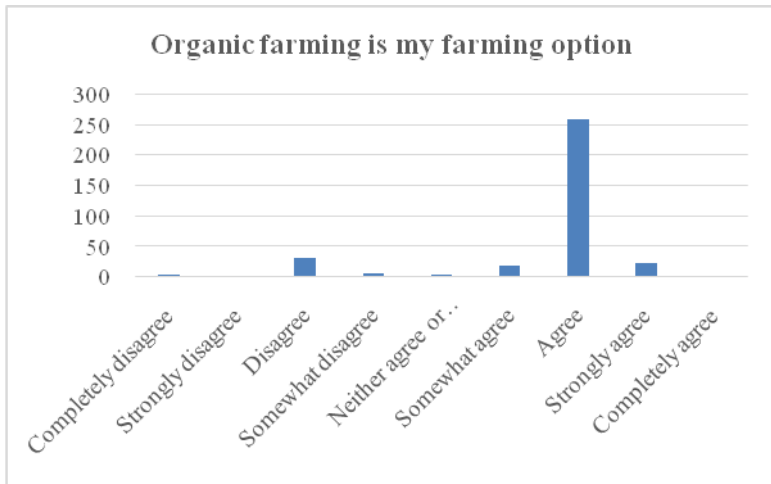
3.1.8 How Sustainable is the new technology

The study resolved to find out the best ways to help farmers adopt modern farming technologies, to which 154 respondents that lending loans to farmers could help farmers afford the technologies being introduced for increased yield. One hundred thirty-eight respondents indicated training as a way to adopt modern farming, with 63 training and 75 free training for tomato farmers.



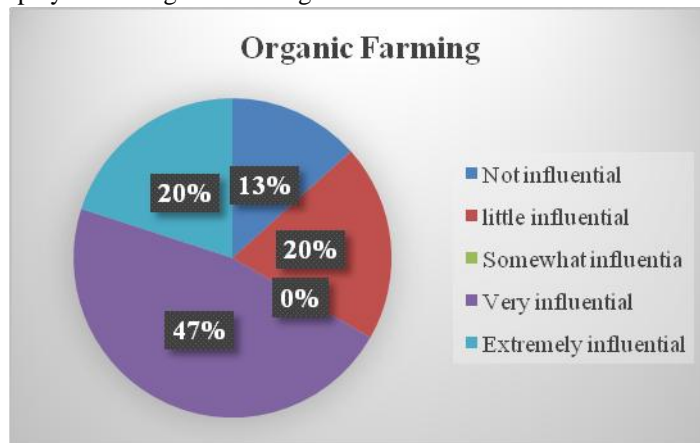
3.1.9 Best ways to help adopt modern technologies

A total of 257 respondents agreed that organic farming was the best, while only 31 respondents did not agree that organic farming is a good option.



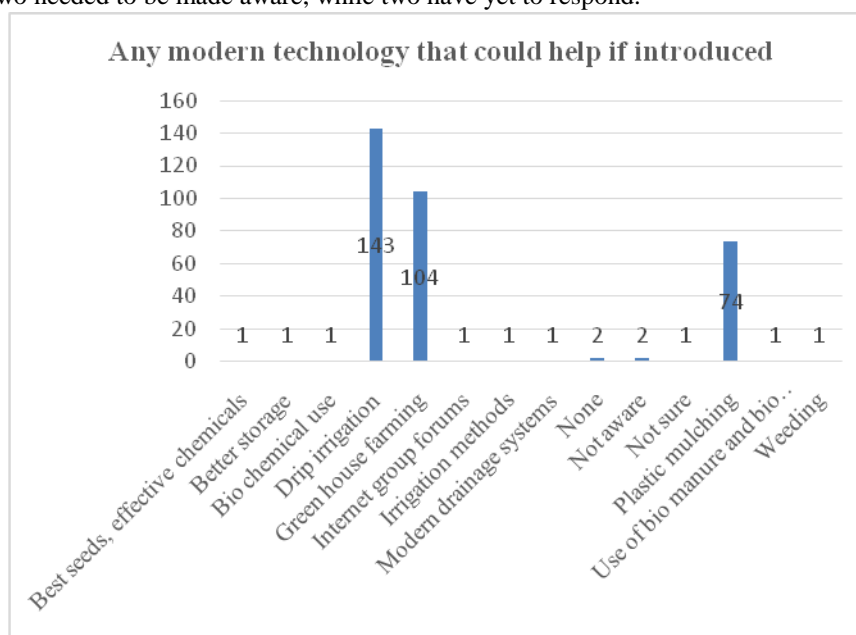
3.1.10 Organic farming is my farming option

Organic farming was identified as an option for most tomato farmers, and a question on how significant tomato productivity increase emerged; 47% indicated that it was very influential. In comparison, 20% stated that it was highly influential, totalling 67% of the respondents who displayed that organic farming is influential.



3.1.11 Organic Farming

Respondents ranging from 143 indicated that Drip irrigation could help them if introduced. In contrast, 104 respondents felt that greenhouse farming was a better option, and 74 respondents felt plastic mulching was their best option. The other option had one respondent each; two needed to be made aware, while two have yet to respond.

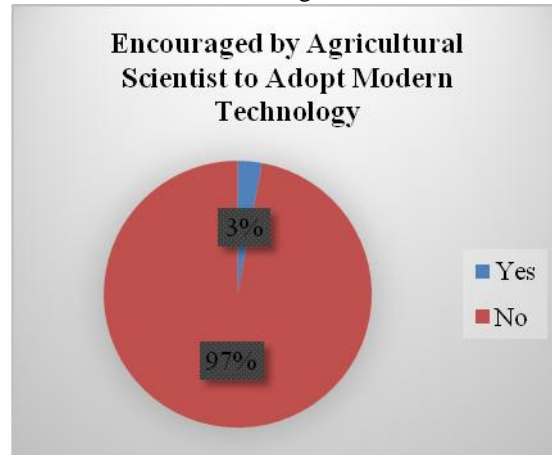


3.1.12 Any modern technology that could help if introduced

The study investigated if there were any agricultural scientists to adopt modern technology. Respondents at 97% showed that no

Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya

scientists visited, and only 3% indicated some scientists availed agricultural information.

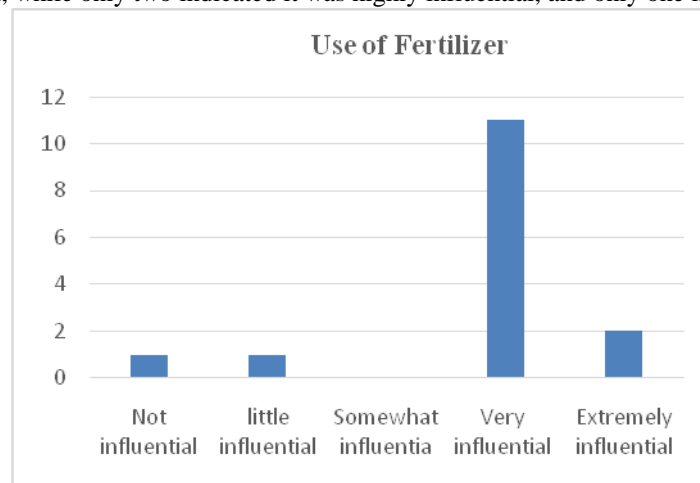


3.1.13 Encouraged by Agricultural Scientist to Adopt Modern Technology

3.2 Influences on Productivity Increase

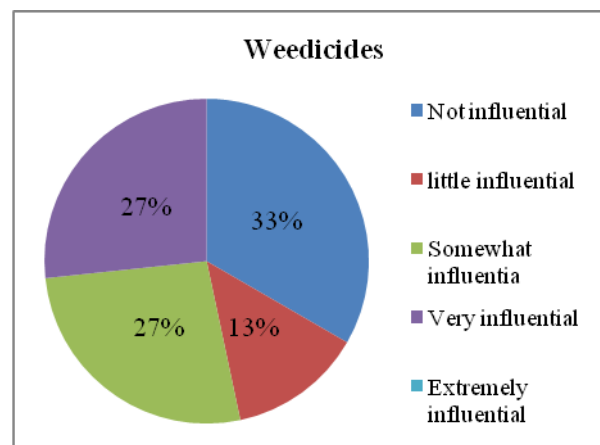
Tomato productivity increase is the goal that all farmers focus on achieving in their farming practices; hence, this study was determined to investigate productivity weaknesses and strengths.

Figure 3.2.1 investigated the influence of the use of fertilizer in tomato production. This was seen as 11 respondents indicated it was very influential, while only two indicated it was highly influential, and only one indicated it was not.



3.2.1 Use of fertilizer

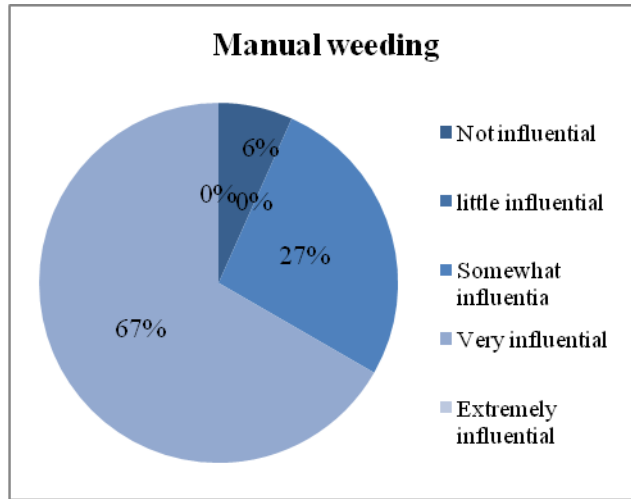
Farmers commonly use weedicides to eliminate weeds. However, tomato farmers indicated that they were not influential at 33%, with 27% each indicating they were very influential and somewhat influential, respectively. However, 13% showed that it had little influence.



3.2.2 Weedicides

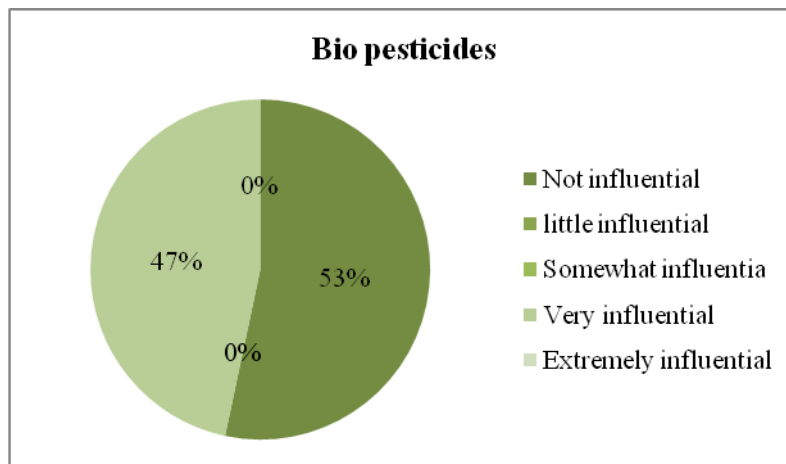
Manual weeding was very influential to tomato farmers as the responded at 67% while 27% indicated it was somewhat

influential.



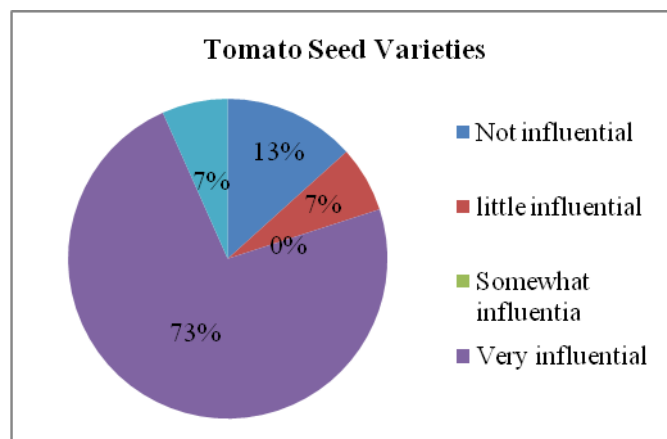
3.2.3 Manual Weeding

In response to the influence experienced through Biopesticide use, Tomato farmers indicated that it was not influential 53%, while 47% indicated it was highly influential. This demonstrated that information on Biopesticides should be disseminated to farmers for adoption.



3.2.4 Use of Bio pesticides

The researcher wished to find out if tomato seed varieties were a source of increase in tomato production, whereby 73% of respondents exhibited that it was very influential and an indication that tomato farmers could adopt new tomato seeds if they had a more practical option.

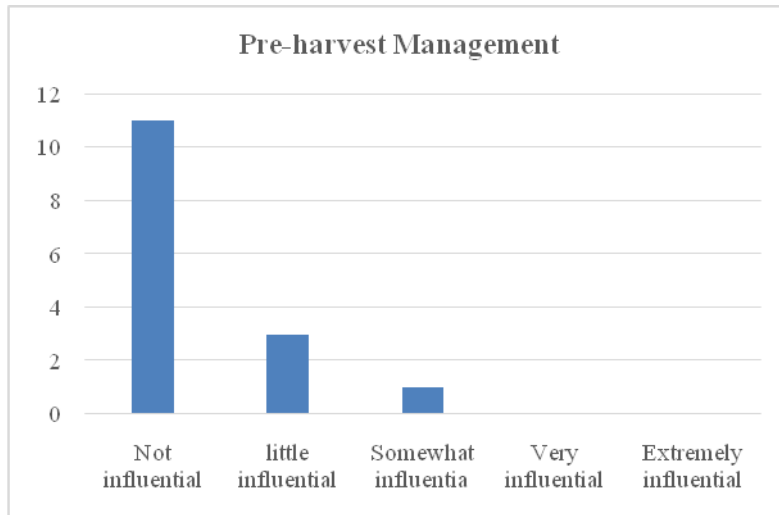


3.2.5 Tomato Seed Varieties

Accessing agricultural information on pre-harvest management is weighty in tomato farming to create awareness of pests and

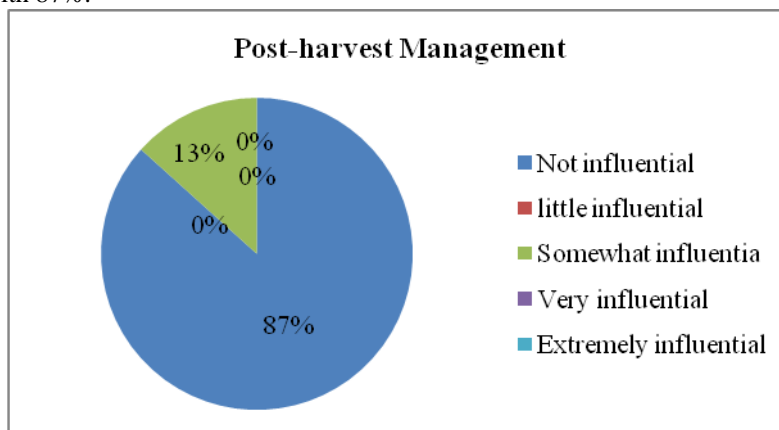
Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya

disease infections that could damage the crop. In that case, available pre-harvest agricultural information could have been more influential to tomato farmers, with 11 respondents supporting the fact. At the same time, there were no respondents based on very influential or highly influential.



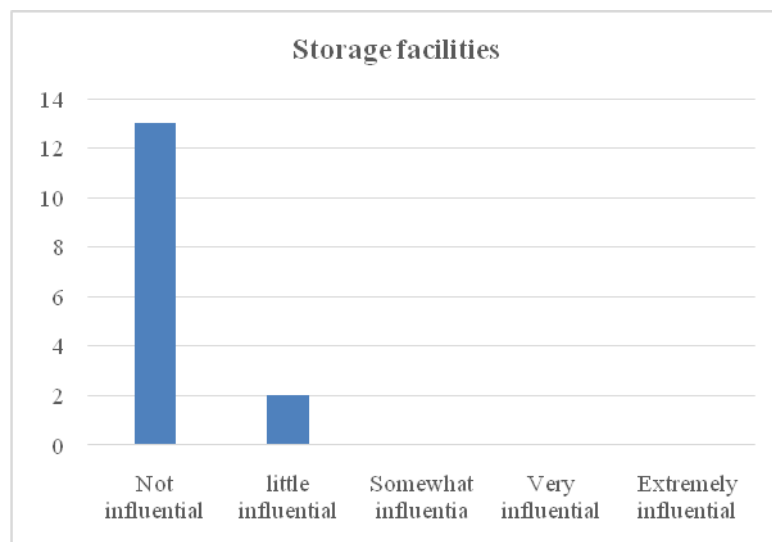
3.2.6 Pre-harvest Management

Agricultural information on post-harvest management is critical in tomato productivity as it determines the output, impacting the farmer's market value. Respondents asked whether agricultural information on post-harvest management was influential and revealed that it was not with 87%.



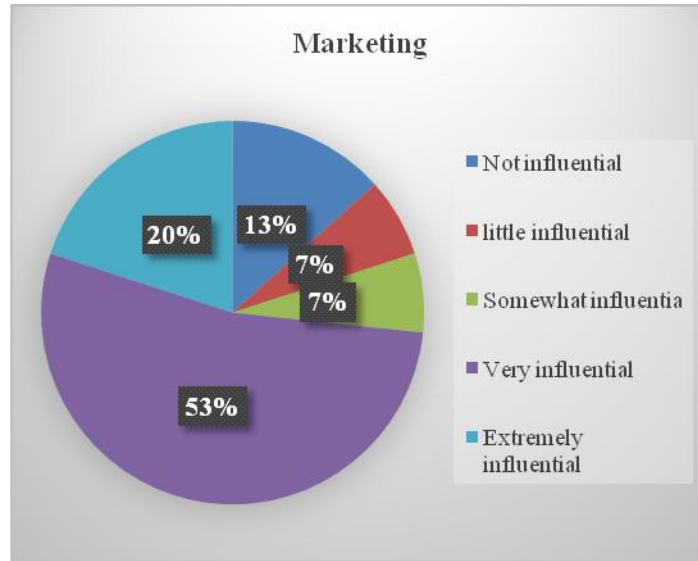
3.2.7 Post-harvest Management

Tomato is a perishable fruit that needs care at storage, transportation to the market, and harvesting. Tomato farmers, therefore, required agricultural information on storage facilities; 13 respondents indicated that the information already available needed to be more influential.



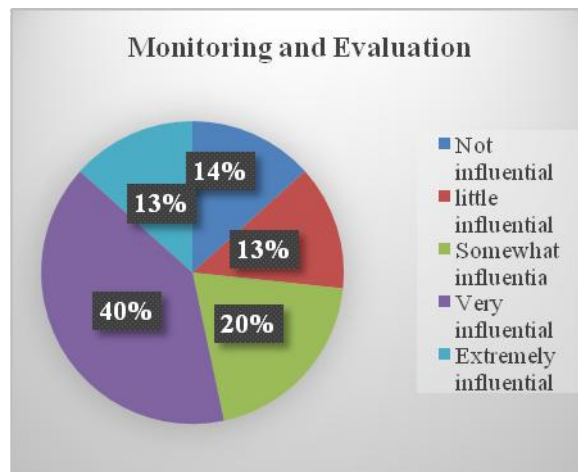
3.2.8 Storage Facilities

Marketing in tomato farming is critical for farmers because it is perishable fruit, hence the need to determine if farmers accessed agricultural information to help market their products. 53% of respondents were optimistic that they had influential agricultural information, and a further 20% indicated that it was highly influential, which gives an excellent percentage for a positive response.



3.2.9 Marketing

Monitoring and evaluation were seen as influential factors, with 40% of respondents showing that it was very influential, 20% somewhat influential, 14% not influential, and 13% each of highly influential and little influence, respectively.



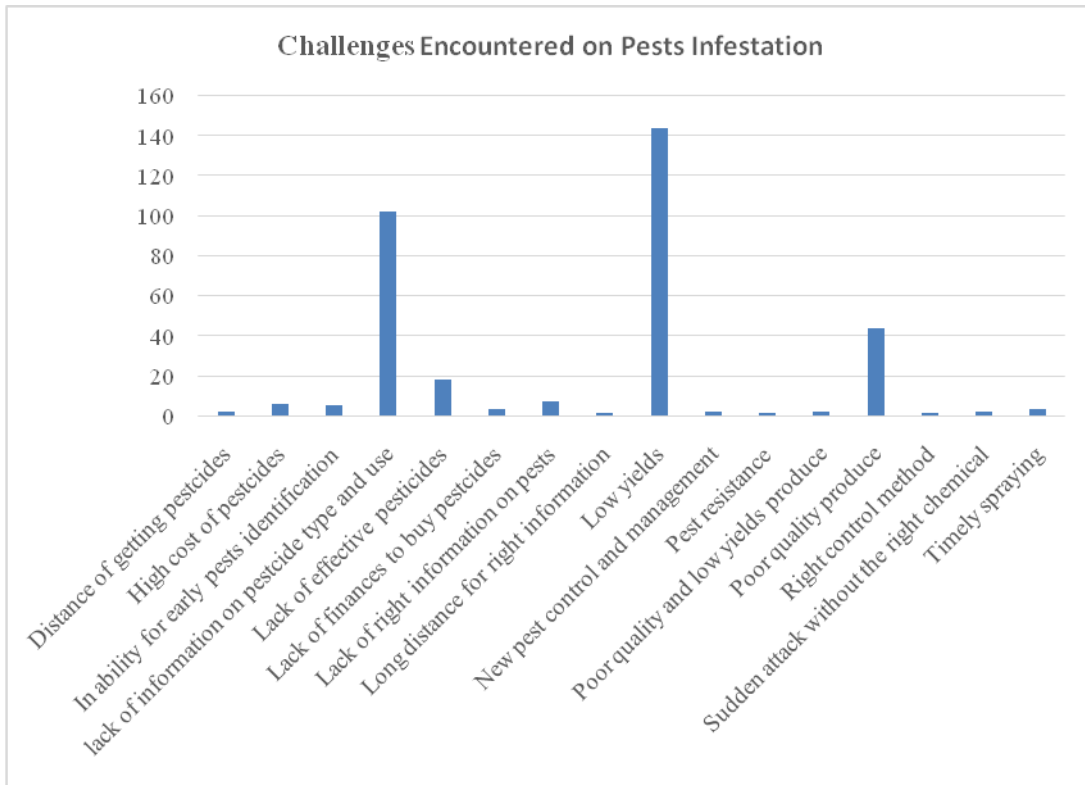
3.2.10 Monitoring and Evaluation

3.3 Productivity Challenges

Tomato productivity had challenges some of which were imperative. This study investigated the major challenges which are represented in the section.

Figure 3.3.1 exhibited that pest infections were low yields with 144 respondents while low yield was caused by low information on pesticides type and use with 201 respondents hence, poor quality produce with 44 respondents and lack of effective pesticides with 18 respondents.

Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya



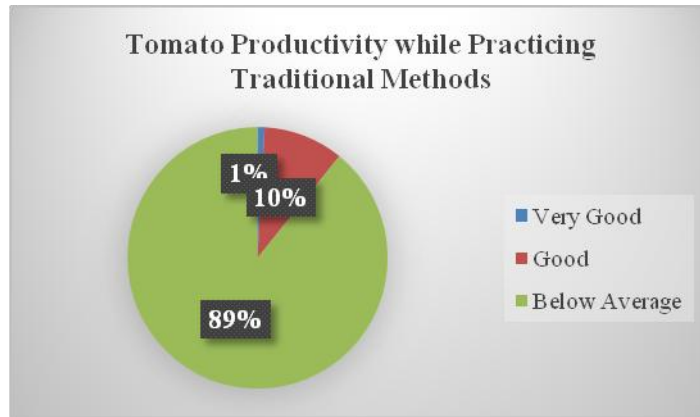
3.3.1 Challenges encountered on pests infestations

Challenges were encountered while practicing traditional tomato farming methods as follows; low yields at 31, poor quality of products up to 24, lack of right information up to 20, insufficient mulch 19 and time and labour consuming 14.



Figure 3.3.2 Challenges Encountered in Practicing Traditional Methods

Tomato productivity while farmers practiced traditional methods was low at 89% an indication that tomato farmers needed agricultural information on adoption of modern farming technologies.



3.3.3 Tomato Productivity while Practicing Traditional Methods

The question on if the right agricultural information if disseminated to tomato farmers could improve tomato farming, 99% of the respondents indicated that yes, it could. On the other hand, 1% indicated that they could not.

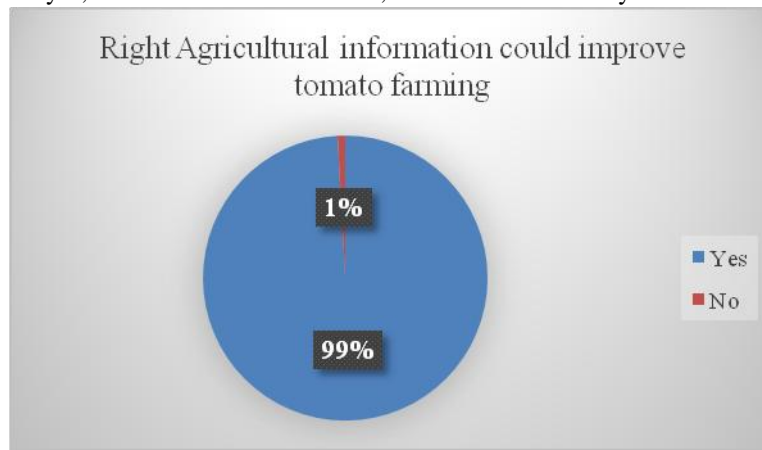


Figure 3.3.4 Right agricultural information

IV. DISCUSSION

Tomato farming is one of the primary sources of income in Kirinyaga County, with the study revealing that 100% of tomato farmers depended entirely on the output as an income in the homesteads. The study explained the significant influencers of tomato farming, which emerged as financial availability, with 98% of tomato farmers identifying it as a significant challenge. Again, most farmers indicated that new technologies are expensive and not affordable, with 141 respondents showing this factor. Drip irrigation was demonstrated as the technology that could influence tomato production. However, the study produced results that could have been more affordable and available for adoption. The options of biopesticide use were declared not influential by farmers, with manual weeding showing to be very influential. At the same time, weedicides were also not influential, with only 33%, while 27% of each showed somewhat or very influence. Agricultural information was identified as of great value to tomato farmers, but 87% indicated that the office disseminated so far could have been more influential at post-harvest, pre-harvest with 11 respondents for the same idea. Storage of tomatoes at the harvest stage is essential because the tomato is very delicate. However, tomato farmers indicated that the agricultural information could have been more influential with 13. In contrast, they indicated at 53%

that 73% of respondents indicated that the information was influential and highly influential to their tomato production. Tomato farmers believed new tomato seed varieties could be very influential if introduced.

Of importance to note was that no agricultural scientists were available to encourage farmers to adapt to modern technologies. However, the use of fertilization to very influential with 11 respondents, while the use of bio-pesticides was not influential at 53% in terms of respondents. The use of bio-pesticide was good for adoption by tomato farmers. This study represented a study of the increase in tomato production and the production of modern technologies which could boost farmers' income. It was evident that significant factors influenced tomato production increase, including organic farming respondents. Of the study, 257 respondents agreeing the practice was of significant influence.

On the other hand, manual weeding was identified as significant to tomato farmers, but this being the usual traditional method, farmers posed that it helped them increase production, with 67% indicating it was highly influential. Factors that emerged as contributors to enable tomato farmers to scale up tomato farming were free training and financial assistance (such as access to loans) Abteu et al., (2016). Tomato farmers also were concerned about the agricultural information on the type of pesticide to use and at what level of their crop life span. Of tomato farmers who participated in this study, 144 posed low yield due to pest and disease infection, with 102 confirming that lack of agricultural

Factors affecting Adoption of Modern Technologies and Production in Tomato Farming: A Study of Tomato Farming in Kirinyaga County, Kenya

information on pests and diseases significantly contributed to low yield. Our study revealed that 246 were still determining whether the new technologies were sustainable, with only 74 confirming that they were sustainable.

V. CONCLUSION

This study noted that of significance is that farmers need to be introduced to new modern tomato farming technologies to help them increase production. A small percentage that indicated they adopted new technologies could have been caused by the findings that modern farming technologies were expensive and not affordable yet unavailable while the difficulty in adopting. Affordability, availability, and adoption all elucidated that tomato farmers needed financial help from the county and national governments to improve their farming technologies to increase yield.

This study found that the primary source of income for tomato farmers who were respondents to the study showed that 100% of households depended on tomato farming as the only income-generating product. In this vein, 98% of respondents had financial challenges, which resulted in 98% of tomato farmers indicating that they could not adapt to new technologies due to this limitation. Further, they were challenged by the fact that the new technologies were expensive to practice, and there needed to be more technology training and personnel to consult. Of significance was that new technologies were not affordable, nor were they available to tomato farmers, with the majority totalling 141, indicating that greenhouses were the top technology they could adopt, with 114 drip irrigation and plastic mulching 63 respondents, respectively. In the same breath, 246 respondents were unsure whether the new technologies were sustainable, with only 74 indicating they were sustainable. Tomato farmers then revealed that lending loans to farmers (154 respondents) and accessible training (138 respondents) were the solutions to adopting new and modern technologies. Organic farming was also seen as a better option by 257 respondents. In conclusion, tomato production could increase if farmers were given free training about marketing, storage facilities, pre- and post-harvest management, pest and disease control, and monitoring and evaluation experts to monitor the implementation progress. For tomato farmers in Kirinyaga County to remain the top producers of tomatoes in Kenya, they need the county and national government's financial support to boost their farming practices.

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She is also the founder of an NGO called Communication for Sustainable Agriculture Africa whose objective is to alleviate poverty, hunger and disease through interpersonal communication. The mission is to engage communities in disseminating agricultural information from Research Centres to farmers for nutritious food farming and utilize the arable land to alleviate poverty and hunger in Africa.

Charity has gained experience in research from International Centre of Insect Physiology and Ecology (icipe) in the department of Technology Transfer Unit (TTU). Further, she has a work experience of over 20 years in various organizations as a PA/Administrative Assistant, Office Manager and Secretary.

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