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**Factors influencing use of technologies for sustainable food security in Kenya:** **A case of the Kenya Agriculture and Livestock Research Organization in Embu County**

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**Abstract**

The Kenya Vision 2030 recognizes the role of science, technology and innovation in a modern economy, in which new knowledge plays a central role in wealth creation, social welfare and international competitiveness. According to the Food and Agriculture Organization(2018),when the United Nations Sustainable Development Goals were officially adopted, the clock began ticking on an ambitious goal: ending global hunger by 2030. It is essential for a country to embrace food security but it is challenged by factors such as: lack of education and political instability; poor planning and policies; lack of transparency and improper governance; financing; slow paces in embracing technology and other governance issues. Results from various studies on these factors may vary from country to country. Furthermore, it has not been empirically reported on factors influencing use of these technologies for food security. The objective of this study was therefore to establish factors influencing use of technology for sustainable food security in the Kenya Agriculture and Livestock Research Organization (KALRO) in Embu County. The study adopted the diffusion of innovation theory. The conceptual framework was based on the interaction of various factors that influence technologies for food security in the study area. The study was a descriptive survey research that reviewed various streams of empirical literature on sustainable food security with the use of self-administered questionnaires and interview schedules. A sample of 50 respondents from a population of 73 was used in the study. Survey results showed that literacy levels, cultural issues, poor infrastructure, climate change, poor governance and economic conditions are some of the factors influencing use of technology. The study would be vital to agricultural institutions to alleviate research collaborations and for their quest to diversify research by improving these factors which leads to embracing technologies for food security hence mitigating hunger.

**Key words:** Sustainable, food, security, technology, agricultural

**Introduction**

According to the Food and Agriculture Organization (2010),when the United Nations (UN) Sustainable Development Goals (SDGs) were officially adopted, the clock began ticking on an ambitious goal: ending global hunger by 2030. At the time, that target seemed achievable; during the previous 15 years, the number of undernourished people on the planet had been reduced by half, a staggering achievement attributed largely to international investment in agricultural and economic infrastructure.

Furthermore, the Food and Agricultural Organization (FAO) argues that the world got hungrier again; in 2016, the number of people without much to eat increased to 815 million, up from 777 million the previous year. Some of the reasons as to why this happened were; droughts, floods, conflict and displacement which have reduced harvests and affected food output.

According to Tonny Tugee (2019), the agriculture sector in Kenya remains the highest foreign income earner and contributed 31 percent of the Gross domestic Product (GDP) in 2017 and 32 percent in 2016. On poverty alleviation, he states that one way to achieve and maintain sustainable agricultural production and food security is through use of Information Communication Technologies (ICT). A study in the Journal of Development and Agricultural Economics indicates that ICT plays a significant role in a country’s development and the strategic application of ICT to the agricultural & livestock sector offers the best opportunity for economic growth and poverty alleviation.

Tugee also reiterates that for Kenya to realize its ambitions on food security, a deliberate investment in technology, which facilitates access to relevant data, markets and financial services, will be critical. If done right, agriculture & livestock can help meet the United Nations SDG number two of promoting sustainable food security. This in turn can be the engine that fuels rural development, improves resilience to climate change, grows employment opportunities and ultimately grows our economy.

In the year 1989 Kenya Agriculture Research institution (KARI) was formed. In the year 2013 under the Kenya agricultural and livestock research Act NO. 17, several agricultural research and livestock institutes were merged to form the current Kenya Agriculture and Livestock Research Organization (KALRO). This was done so as to promote and establish a suitable legal framework for coordination of agricultural and livestock research in Kenya. Strategic objectives of KALRO include: to generate and promote technologies and innovations for demand driven agricultural and livestock chain research; and to enhance availability of knowledge, information and technologies on agricultural and livestock chain research.

The survey study and sentinel data collected in June and July 2019 by the Kenya Food Security Steering Group indicates that food insecurity has significantly worsened since the May mid-season assessment. 2.6 million Kenyan people were currently experiencing crisis or worse food insecurity, including some households that were in emergency food relief in Turkana, Marsabit, Isiolo, Mandera, Tana River, Garissa, Wajir and Baringo counties. This represented a 60 percent increase of population with food insecurity.

The achievement of national food security was to be a key objective of the agricultural & livestock sector. In recent years, and especially starting from 2008, the country has been facing severe food insecurity problems. Kenya Agricultural Research Institute (2010), noted that the food insecurity problems in Kenya are attributed to several factors, including the frequent droughts in most parts of the country, high costs of domestic food production due to high costs of inputs especially fertilizer, displacement of a large number of farmers in the high potential agricultural areas following the post-election violence which occurred in early 2008, high global food prices and low purchasing power for large proportion of the population due to high level of poverty. Official estimates indicate that over 10 million people in Kenya are food insecure with the majority of them living on food relief. Households are also incurring huge food bills due to the high food prices. Maize being staple food due to the food preferences is in short supply and most households have limited choices of other foodstuffs. This compounded the problem of food insecurity. Kipkoech (2011), indicated that to boost food security and bridge the gap between the envisaged Kenya Vision 2030 and agricultural & livestock projects, technology has to be applied from the farm through to processing, storage and marketing which also requires the implementation of the right policies, finances, insurances, infrastructures and information. The purpose of this study was to assess use of technology for sustainable food security in KALRO Embu County. Specific objectives were to: determine various technologies used for sustainable food security; establish factors influencing use of technology for sustainable food security; suggest technological strategies for sustainable food security. In order to be able to address the above objectives, the study answered the following research questions: which technologies are used for sustainable food security? What factors influence use of technology for sustainable food security? and what strategies exist for sustainable food security?

Literature review denotes literal footprints from other researchers who have carried out research on food security. Specifically is a theoretical framework of behavioral policy and environmental factors, and sustainable options to strengthen food security in Kenya.

The statement of the problem is that results from various studies on factors influencing the adoption of agricultural & livestock technologies vary from country to country and even from household to household. However, these factors have not been empirically reported on contribution to food security.

**Literature review**

According to the World Food Prize Laureate Dr Maria Andrade (2016), Global food security implies that all people throughout the world , including vulnerable groups such as the rural and urban poor, at all times have access to adequate quantities of safe and nutritious food to maintain a healthy and active life. Food security is a right that should be embraced by all countries, irrespective of their level of technical, economic and social development. It is essential to a country but it is challenged by factors such as: lack of education and political instability: inadequate planning and policies; lack of transparency and improper governance, financing; slow paces in technology issues and other governance issues. Improving these factors should contribute to improved food security. It is believed that technology can contribute to the achievement of global food security.

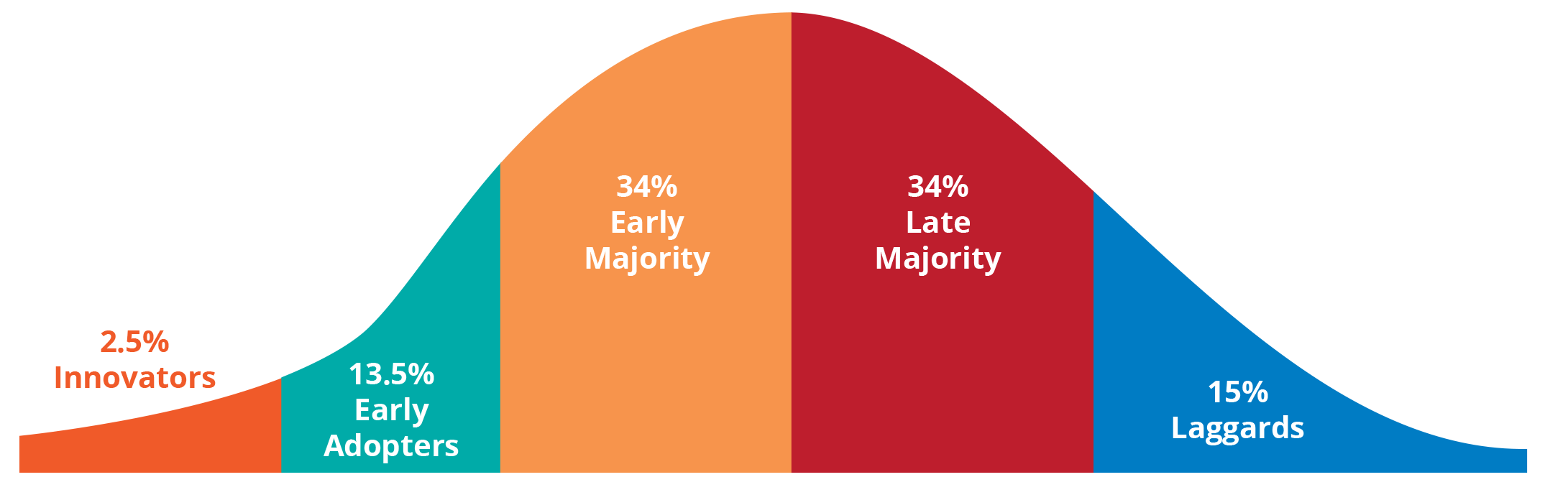
World Food Prize Laureate Dr Maria Andrade defines the term technology as the collection of techniques, skills, methods and processes in producing food. The technology required to be food secure is country-specific. It depends on the physical environment, infrastructure, climate, culture, literacy, economic conditions and governance. Developing countries typically develop food security strategies following paths and processes that are different from those adopted by developed countries. She continues to reiterate that in developing countries, technologies to achieve food security span a wide range of subject areas, including land preparation, soil and water management, seed production, weed management, pest and disease control, farm management, harvesting and post-harvest practices such as storage, processing, packaging, marketing and distribution.

Jack (2011) observed that an indigenous system for generating technical change is necessary if the technology is to match changing local needs. Inadequate community participation, high level of poverty, cultural issues, poor infrastructure and marketing problems may be some of the other challenges faced by farmers while implementing modern agricultural technologies (Habel et al, 2015). Sub-Saharan Africa is the only region where the number of people living poor and food security continue to decline and where people living in poverty has increased in the last decade. These concerns led the African government to pursue different kinds of agricultural & livestock policies and strategies together with adoption of new technologies, to boost agricultural production and therefore reduce poverty and food security (Rosegrant et al, 2014). Technologies such as intensive use of fertilizer, improved variety of seeds, pesticides and irrigation have not been adopted by a significant number of farmers especially in Kenya yet their potential to increase agricultural & livestock productivity exists if we compare the actual farm yields with those of demonstrations (Beddington et al, 2010).

According to International Federation of Organic Agriculture Movements(IFOAM,2012), increasing number of farmers, NGOs, politicians and development experts have realized that instead of the capital and chemical input intensive approach, we should favour an organic agriculture that emphasizes bio-diversity, recycling of nutrients, synergy among crops, animals, soils, and other biological components, as well as regeneration and conservation of resources.

According to Jomo Kenyatta University of Agriculture and Technology (2013), the ever increasing population poses a great challenge to production of adequate food and materials with available land and other natural resources. The situation is exacerbated by occasional adverse weather phenomena such as drought and extreme conditions which damage crops, resulting in low agricultural yields and low product quality. Protected production within green houses (greenhouse horticultural production technology) offers means of increasing productivity through improved water use efficiency, reducing the incidence of pests and enhancing production of a range of horticultural crops. Modern agricultural technologies adoption and implementation faces many challenges. According to Agricultural Society of Kenya (2011), there is limited access to extension services in most parts of the country with the national extension staff to farmer ratio standing at 1:1,500, inadequate research extension farmer linkages to facilitate demand driven research and increased use of improved technologies continue to constrain efforts to increase agricultural productivity as farmers continue to use outdated and ineffective technologies. This situation has hindered most farmers from keeping pace with changing technological advances. Jack (2011) observed that an indigenous system for generating technical change is necessary if the technology is to match changing local needs. Inadequate community participation, high level of poverty, cultural issues, poor infrastructure and marketing problems may also be some of the other challenges faced by farmers while implementing modern agricultural technologies in the study area (Mukisira, 2008).

In order to understand how individuals respond to new technologies in a system, the classification of people in different adopter categories was fundamentally important. The categories of adopters are: innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003). These categories are illustrated in figure 1 below.

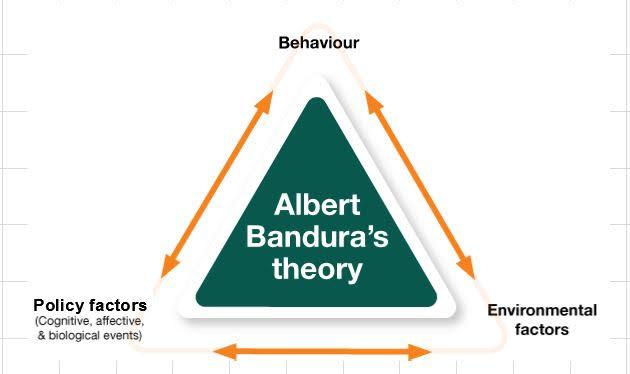


Source: John Hopkins University, 2016

# Figure 1: Diffusion of innovation theory

## Theoretical Framework

This study is based on the diffusion of innovation’ model or theory suggested by Rogers (1962). Diffusion is the process by which an innovation is communicated through certain channels over a period of time among the members of a social system. An innovation is an idea, practice, or object that is perceived to be new by an individual or other unit of adoption while communication is a process in which participants create and share information with one another to reach a mutual understanding (Rogers, 1995). Zhou, (2012) indicated that this model helps agricultural workers to communicate new technologies to farmers. This helps in the promotion of agricultural messages designed and developed by research scientists with limited input from the technology users (farmers). It is now widely recognized that innovation comes from multiple sources, including farmers and how the agendas of different stakeholders are represented affects the ‘appropriateness’ of new technology developed (Suleiman et al, 2006). In order to advance agricultural innovation it calls for building 27 of institutionally sustainable innovation systems, which can be gauged by growing interrelations between the participants in the innovation system, and intensive communication between all stakeholders such as the public sector, the private non-profit sector and the private for profit sector. If an innovation or agricultural technology is adopted by farmers, farm productions are improved and hence food security status improved. The study looked into how implemented agricultural technologies influence food security among households.



**Figure 2: Theoretical Framework**

**Materials and methods**

A survey research design was utilized in the research as this allowed for observations about the phenomenon under study without manipulating the variables. The study focused on Kenya Agriculture and Livestock Organization (KALRO) in Embu County which undertakes research on farming activities. The population under the study comprised 73 staff. The sample size was arrived at using Gay (2003) which indicates that when the target population is less than 1000, a minimum sample size of 20% was adequate for educational research.

Therefore, a sample size of 50 (69%) was taken which is within the threshold of this study and was able to provide information which was deemed relevant to the study.

Based on the nature of the study and population size, the research used purposive sampling technique. The study was conducted using a questionnaire tool for primary data collection. The necessary changes were made to improve the content validity of the instruments. Pilot study was conducted at Embu University, Department of Agriculture among 10 respondents of homogeneous characteristics with the target population. The test-retest method was used in order to test reliability. Internal consistency techniques were used and Cronbach's Coefficient Alpha of 0.845 established the reliability of the research instruments.

The data was coded, tabulated and analyzed using a statistical package for social sciences. The study findings were presented using percentages, tables and charts as well as interpretations and discussions which were made in order to address the research objectives.

**Results and discussions**

The respondents were requested to rate the following statements onfactors influencing use of technology for sustainable food security: Climate change, Institutions, Governance systems, Infrastructure, Economic conditions and Literacy level. For Climate change; 46% of the respondents rated it as very high, 30% high, 4% average, 4% low and 16% very low. For Institutions; 16% of the respondents rated it as very high, 36% high, 16% average, 26% low and 6% very low. For Governance systems; 10% of the respondents rated it as very high, 40% high, 30% average, 16% low and 4% very low. For poor infrastructure; 16% of the respondents rated it as very high, 36% high, 20% average, 24% low and 4% very low. For Economic and social conditions; 20% of the respondents rated it as very high, 40% high, 16% average, 16% low and 8% very low. And for literacy level; 26% of the respondents rated it as very high, 8% high, 40% average, 10% low and 16% very low. These results are presented in table 1.

## Table 1 Factors influencing use of technology for sustainable food security

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Very High** | | | **High** | | **Average** | | **Low** |  | **Very Low** | |  |
|  | 5 |  | 4 |  | 3 |  | 2 |  |  | 1 |  |
|  | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  | **F. Mean** |
| **Factors** | **F** | **%** | **F** | **%** | **F** | **%** | **F** | **%** | **F** | **%** |  |
| **Climate change** | 23 | 46 | 15 | 30 | 2 | 4 | 2 | 4 | 8 | 16 | **4** |
| **Institutions** | 8 | 16 | 18 | 36 | 8 | 16 | 13 | 26 | 3 | 6 | **3.8** |
| **Governance systems** | 5 | 10 | 20 | 40 | 15 | 30 | 8 | 16 | 2 | 4 | **3.8** |
| **Poor infrastructure** | 8 | 16 | 18 | 36 | 10 | 20 | 12 | 24 | 2 | 4 | **4** |
| **Economic and social conditions** | 10 | 20 | 20 | 40 | 8 | 16 | 8 | 16 | 4 | 8 | **4** |
| **Literacy level** | 13 | 26 | 4 | 8 | 20 | 40 | 5 | 10 | 8 | 16 | **3.8** |

**Key: Frequency (F) & Percentage (%)**

**Conclusion and Recommendations**

The findings of the study show that there are factors that influence use of technology for sustainable food security. This agrees with Mukisira (2008) who argues that inadequate community participation, literacy levels, high level of poverty, cultural issues, poor infrastructure, climate change, governance systems and marketing challenges may be some of the challenges faced by farmers while implementing modern agricultural technologies for sustainable food security.

Based on the findings, food security is a right that should be embraced by all countries, irrespective of their level of technical, economic and social development. It is essential to a country but it is challenged by factors such as: literacy and political instability: inadequate planning and policies; lack of transparency and improper governance, financing; slow paces in technology issues and other governance issues. Improving these factors should contribute to improved food intake and thus mitigate hunger. There is need for the government to alleviate these factors through the following strategies: Allocate more funds in local research instead of depending on borrowed results from international organizations to increase farming technologies; Train young professionals in agriculture & livestock sectors; Educate the population on the importance of using better GMO products especially food to improve on food security; Improve resource allocation in order to enhance food security; Promote institutional partnerships; Develop farm policies; Promote value addition for farm produce to improve income; Enhance infrastructure to broaden areas of research in the field of laboratories; Increase agriculture & livestock research funding for continuous development and upgrading for the national and county governments; Increase inter-institutional collaboration and participation in research at local and international levels; and increase training for farmers on good farm practices

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