



Agricultural Technology and Sustainable Rural Livelihoods among Makueni County Residents, Kenya

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Abstract: *The main aim of this study was to investigate the influence of agricultural technology on the sustainable livelihoods among the rural residents of Makueni County, Kenya. The study sought to determine the adequacy and relevancy of technology on sustainable livelihoods among the rural of Makueni County. Descriptive survey design and mixed method for data collection were applied. The study targeted 362,105 people from two sub-counties from which a sample size of 100 was drawn made up of farmers and 10 agricultural field extension officers. The study used disproportionate stratified random sampling techniques to select the sample size (farmers) and purposive sampling technique to select the extension service providers. From the findings, majority of farmers had experienced change in weather pattern in the past 10 years of their farming. On the cross tabulation to establishing the relationship between the level of education and technology used to acquire information, it was concluded that most of farmers who used internet to get farm information had secondary and college/university education. It was recommended that the county government expand the market via value chain. The County Government ought to collaborate with NGOs for the purpose of supporting sustainable rural agriculture. Rural residents need to be educated on the value of resilient agricultural practices as an alternative to unsustainable livelihoods, while extension service providers needed financial assistance and build their capabilities via training to ensure they deliver effectively to the farmers.*

Key terms: Agricultural technology, resilient practices, sustainable livelihoods, rural farmers

1. Introduction

Sustainable livelihoods (SL) is a logical framework associated with contemporary studies concerning rural livelihood structures, agricultural changes, and community networks crafted from William Cobbett, Karl Marx, Karl Polanyi, Amartya Sen and other scholars in influential and micro-economics (Scoones, 2015). The results of climate variation is linked with the achievement of key past and current development objectives, including: Millennium Development Goals - 2015 (MDGs) and Sustainable Development Goals - 2030 (SDGs) which focuses on poverty alleviation, food security, health care improvement, environmental sustainability, and investment in natural resources (Steiner, 2006). Christian (2015) associated climate spirited agriculture with reduced poverty and hunger amidst climatic changes as improved associated resources for prospect generations. Since the 1980s the potential outcomes associated with climate change and variability have been highlighted, with more emphasis on the significant threats to agrarian production and food security (Challinor, Wheeler, Garforth, Craufurd and Kassam, 2007). The Organization for Economic Co-operation and Development (OECD) reported some certain improvements

in the mid-1980s, with 10% decrease in both nitrogen and pesticide use in many European countries and Japan, which led to rise in water quality.

The impacts of climatic change in West Africa have affected rural livelihoods mounting challenges in the region and other parts of the African continent. As an intervention strategy, most of the West African Nations have submitted the National Adaptation Programmes of Action (NAPAs) to the United Nations Framework Convention on Climate Change in order to strategically plan activities for dealing with climatic change. NAPA's fundamental goal is anchored on raising awareness among policy makers and guiding the allocation of resources for effective adaptation of climate change (Abdulai, Mbène, Harold Roy, Paco, Robert, 2009).

The government of Kenya, together with other development partners, has developed and implemented strategies to address resilient agriculture for sustainable livelihoods. The following are some of the key approaches that the government has adopted: Agriculture-based livelihoods that promote equality and inclusivity, diversifying practices and aligning markets in order to increase productivity of small and medium agricultural producers, enhancing food security

and socioeconomic development at all levels of the society by improving the management of land, water, and natural resources, improving the ability of targeted vulnerable populations, and activating the access and use in information, innovation, and knowledge that drives holistic growth in the agricultural sector (FAO, 2017).

Most of the resident in Makueni practice small-scale farming that depends on rain as their main economic activity, a practice that is challenged by climatic change and environmental degradation. The increasing trend of the county’s population is expected to mount pressure on the resources. Makueni County performs poorly on most of the socio-economic indicators with a score of P.56 on the Human Development Index (HDI), a development measure that brings together indicators of income, life expectancy, and education levels (KNBS, 2010). Other challenges facing the county include severe scarcity of water and recurring droughts that have affected water supply making most of the rivers seasonal or dry. Issues associated with climatic change in the region have been worsened by high deforestation rates that significantly reduce water catchment capacity. An increase in the population and significant changes in climatic conditions will significantly raise water needs leading to a mismatch between the demands and availability of water resources. Sustainable development can be addressed through the application of integrated policy and programs given that population dynamics, the environment, and climatic change share strong connections (Makueni CIPD, 2013).

Historical rainfall records from the Kenya meteorological department, for the last three decades show that ‘severe’ and extreme drought conditions have occurred in Makueni County. Previous studies show that, Makueni County of has suffered many severe and extreme drought conditions, the nature and impacts of which have however remained unknown and undocumented. Traditional drought resistant crops have been abandoned and livestock has remained the only viable economic activity. Makueni County is a traditional society whose residents are currently adopting to contemporary agricultural strategies. Among the adopted strategies include: Irrigation farming, adoption of horticulture, cultivation of fruits, chicken farming, and value chain investment. To mitigate the effects of water scarcity, construction of sand dams has been done to retain water. Studies carried out in the County in relation to agricultural technology on sustainable livelihoods have been inadequate to reveal the extent and significance of this association. It is against this background that the researchers intended to carry out empirical study in this county to confirm the phenomenon.

The main objective of this study was to determine the role of agricultural technology on sustainable livelihoods among rural residents of Makueni County

1.2 Conceptual framework

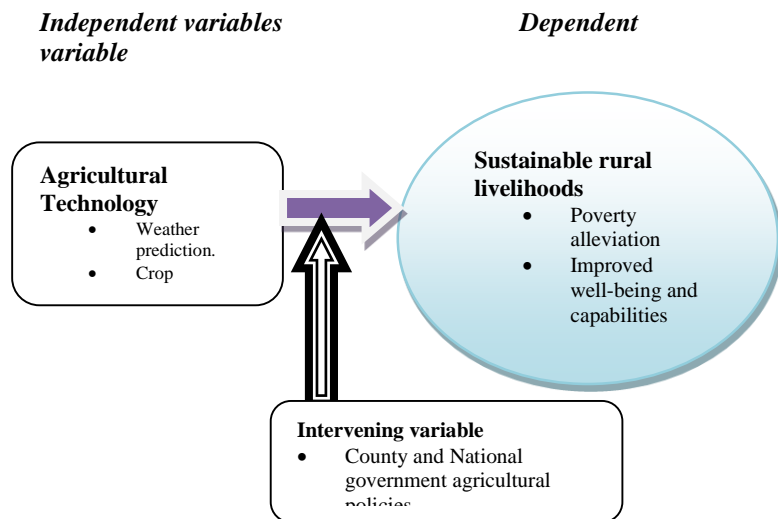


Figure 1. Conceptual Framework

2. Literature review and Studies

2.1 Theoretical Framework

The sustainable livelihoods approach (SLA): The Brundtland Commission Report on Environment and Development, and the 1992 United Nations Conference on Environment and Development introduced this theory and expanded the initial concept that advocated for the achievement of sustainable livelihoods as the main way of eradicating poverty (Krantz, 2001). According to Chamber and Conway 1992, a sustainable rural livelihood is defined as “A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term”.

SL approaches are very important as it gives a way in which key influences on the livelihood of poor people can be conceptualized. This include; the vulnerability, assets accessibility, as well as other factors that affect how resourceful the assets can be to them. The approach is key in the comprehension of the main causes of poverty by paying keen attention on different factors at various levels that determine how poor people access assets either directly or indirectly. The approach makes use of a holistic perspective especially when the analysis of livelihood is done with an aim of identifying the issues that can help in the reduction of poverty either at the local level or at the policy level when a strategic intervention is applied.

Empirical literature has been reviewed thematically from global to local levels identifying the existing gaps. These themes have been identified from the independent variables and their relationship with sustainable rural livelihoods.

2.2 The role of agricultural technology on sustainable livelihoods

The history of technological changes in agriculture can be traced to at least 10,000 years ago when the first cultivators planted wild plants in different environments. The technical performance did not change and remained relatively the same until the nineteenth century (Grigg, 1974). More inventions were fuelled by the rediscovery of Mendel's experiments that led to the invention of scientific plant breeding and artificial fertilizer, which rapidly increased agricultural production. The 2030 Sustainable Development Goal (SDG) aims at reducing by half the number of people living in absolute poverty. The agricultural sector would be required to play a significant role in sustaining the achievement of the SDG as increased agricultural productivity is among the most important determinants of economic growth and poverty reduction.

Actions towards climate adaptation are anchored on strengthening the agricultural sector by reducing susceptibility to climatic changes and adapting technological, behavioral, and manageable strategies. Technological adaptation characterizes the use of technology with the aim of reducing vulnerabilities and strengthening how natural and human systems affect climate change (UNFCCC 2005). These technological adoption measures would include the assessment and adoption of strategies that are aimed at achieving food security and strengthening agro-ecological zones and farming systems (UNFCCC, 2014a). The technologies are classified into three main types including, orgware, software, and hardware.

Enhanced stakeholder understanding and technology ownership can be enhanced using bottom-up participatory approaches such as community-based adaptation. Outcomes of the adoption of these technologies lead to sustainability and reduction of mal-adoption chances. Testing of new technologies encompasses the participation of numerous stakeholders in order to ensure contextual adaptation, validation and effective adoption by the end users. Participatory approach was successful in Bolivia by linking innovation with farmers in the piloting of new varieties of crops. The exercise was characterized by the application of varieties at different altitudes and subsequently adjusting use of seeds and cropping techniques with the aim of achieving sustainability at each context (Bentley & Thiel, 2008). Planting schedules and locations were altered and traditional methods of agriculture including bed raising and irrigation applied in order to maximize yields and achieve sustainability. As a result, the collaboration of the practices with final technology users through flexible and continuous processes and effective technologies could be enhanced.

India occupies the second position globally in regards to farm outputs (Kumari, 2014). The country is also the world's largest sourcing destination for Information Technology (IT), which accounts for about 67% of the US\$124–130 billion market. Although the integration of farm technologies and information communication technology (ICT) are still evolving in India, there is a promise that these technologies will impact agricultural performance and consequently enhance farmers' income levels (IBEF, 2017).

Since 2012, the central Africa government has been involved in a military political crisis that has affected almost all of its territory. As part of its emergency response, FAO promoted a community-based support approach called the "Caisses de résilience" to provide multi-sectorial and integrated support to communities to help them rebuild their economic activities. Areas supported included cereal crops and livestock, market gardening, poultry farming, small livestock farming, fish farming, processing of agricultural products and seed production. The approach is based on three components: technical - improvement of agricultural skills using a variant of "Farmer Field Schools"; financial - support to the endogenous financial system through village associations. (FAO, 2016)

Mukeira, (2014) in the role of government in agribusiness activities in developing rural communities in Kenya: a case study of small scale dairy farmers in Githunguri Sacco limited, reported that the Kenyan government also has another very effective way of promoting agribusiness through the ASK shows that are hosted in various venues across the country to showcase various innovations in the field of agriculture. In response to the current and projected hazards, approximately 92% of the farmers in Makueni county have adopted at least one adaptation strategy; for livestock producers include fodder and feeds conservation, use of simple treatment methods such as de-worming and hoof trimming, and value-adding activities such as cooling and boiling and packaging of milk. Adaptation strategies used by crop farmers include use of early-maturing and drought-tolerant crops, conservation agriculture, seed recycling, home nurseries for seedling production, irrigation, and use of manure. Resource constraints and poor market linkages are major impediments to uptake of adoption of options by farmers, despite current support provided by various government and non-government institutions. Fish farming has also been introduced by Economic stimulus Programme within the county, with now 825 fish ponds with tilapia species.

3. Methodology

This section presents the research methodology that was used in conducting the study. It covers the description of the research design, target population and sample size and the technique that was used in the selection of the sample. It also confers the data collection methods and tools, data analysis techniques, ethical consideration validity and reliability.

3.1 Research Design

This study used descriptive survey design. The relationship between the independent and dependent variable in this study were examined in both the current and past periods. The study applied mixed research methods, which involved both qualitative and quantitative methods. Questionnaire and interview guide as tools for data collection were used to collect data to realize the goal of the study.

3.2 Site description

Makueni County, formerly referred to as Makueni District, is located in the eastern side of Kenya (formerly Eastern Province). The county depends on agriculture as its major economic activity. Hence, the major source of livelihood for most of the population is livestock and agriculture. The main economic activities practiced in the hilly parts of the county include dairy farming and horticulture. Sand harvesting is also an economic activity in the county despite the fact that it was illegalized by both the national and county governments. Temperatures in the county are relatively high during the day and low at night. Severe heat is also experienced in the lower regions of the county between the months of May and October.

3.3 Study and Target Population

Makueni County's population is dominated by young people. Statistics indicated that about seventy percent of the total population was characterized by persons under the age of thirty and forty four percent was children under the age of fifteen years (CIDP, 2013). The target respondents includes farmers from the selected study area and the extension service providers. The selection of the officer was based on their role in implementing the resilience strategies as well as provision of other agricultural resources.

Sample size

According to Mugenda and Mugenda (2003), a sample size of 10-30% of the sample population is considered adequate for a descriptive survey. Out of the six Makueni sub counties, two sub-counties was selected conveniently. The sample size was statistically determined. The projected population for Makueni and Kibwezi west constituencies in 2017, according to KNBS (2013), was 216,657 and 185,484 respectively, with 40,046 of urban population. Agricultural extension officers working in KARI Kiboko and in the County headquarters were interviewed until saturation levels of the study data was attained.

Sampling Technique

To get the sample size for the study, disproportionate stratified random sampling technique was used to select the participants in the study. Out of the 100 participants for the two Sub-Counties, the researchers got fifty respondents from each of the two sub-Counties. Purposive sampling technique was used to get the agricultural extension officers in the study area. To get the 100 small scale farmers, the researchers employed Slovine formula of 1960 on surveys.

Slovin (1960) provides this simplified formula to calculate sample sizes for a survey study paying attention to the following assumptions: - 90% confidence level. (e= 0.1 margin of error)

Where, N = Total population, n = sample size; e is the level of precision. 1 is constant.

$$n = \frac{362105}{1 + 362105(0.1)^2}$$

= 99.9 Therefore the sample size was 100 respondents

Table 1 Sampling for rural farmers

Sub county	Total population	Sampling tech	Sample size
Kibwezi west	174,439	Disproportionate stratified simple random sampling and purposive sampling	50
Makueni.	187,666,	Disproportionate stratified simple random sampling and purposive sampling	50
Total	362,105	-	100

Methods and Instruments of Data Collection

Interviews are the most common effective means of obtaining detailed information in a survey. The researcher used structured questionnaire and interview guide to collect primary data. Structured questionnaire with both open-ended and closed ended type questions covering technology, infrastructure, extension service provision and farmers organizations were administered to the farmers. The open ended questions allowed free response from the respondents with help of an assistance since most farmers in the villages couldn't read or speak English.

Data Analysis Procedures

Data analysis is defined as a critical examination of the assembled and grouped data for studying characteristics of the study objectives and determining the patterns relating to the relationships and variables relating to it (Krishna, 2003). To enhance data management, the researcher coded the respondents' responses in preparation for data capturing, and this involve classifying of data thematically. Descriptive statistics was used to analyze qualitative data by use of mean, deviation, percentages and frequencies. ata was finally presented in graphs, tables and charts.

4. Results and Discussion

Table 2
Response Rate

Category	Sample size	No. collected	Return rate
Extension officers	10	10	100%
Farmers	100	96	96%

The findings displayed in Table 2 shows that the response rates of the target group was good and willing to participate as well as provides enough information for the

study. The response rate for farmers was 96%. As discoursed by Mugenda and Mugenda (2003) the percentage of respondents to questionnaires is adequate if it is 50% or more. Therefore 96% was deemed very good for data analysis and reporting of the findings on.

Table 3
Age group

Gender	Frequency	Percent
Below 25 years	6	6.3
25 to 35 years	57	59.4
36 to 45 years	23	24.0
46 to 55 years	10	10.4
Total	96	100.0

Findings in table 3 above display that 57(59%) of the respondents were aged between to 25 to 35 years, 23(24%) were aged between 36 to 45, while 10(10%) were aged between 46 to 55 years and below 25 years of age had a small percent of 6(6%).This implies that majority of those who participates in agriculture in the county are youths aged between 25 to 35 years. Further, it shows that Makueni County has an energetic and versatile labour force who are capable enough to understand the role of agricultural technology on sustainable rural livelihoods among Makueni county residents, Kenya.

Respondents were asked to indicate their education level; in this regard gathered and analyzed data was summarized in figure 2 below.

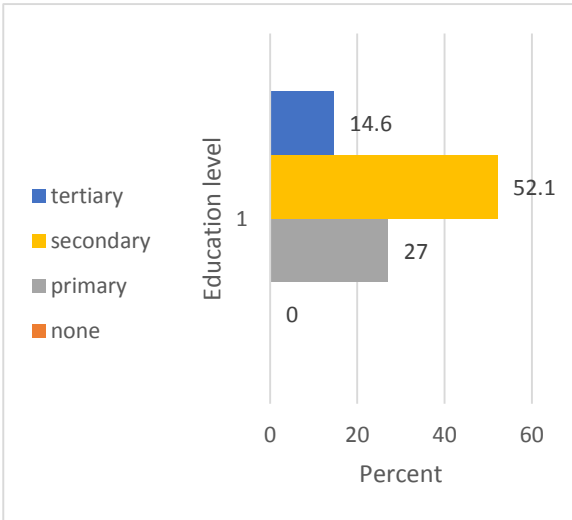


Figure 2: Educational level

As depicted in figure 2 above, most of the farmers 50(52%) had learned up to secondary school, 25(27%) to Primary level while 14(15%) had studied up to tertiary level. This shows that the farmers were well educated to understand and give information pertaining to the role of agricultural technology on sustainable rural livelihoods among Makueni county residents, Kenya.

Respondents were asked to indicate the farming type they practice. Responses were summarized and presented in figure 3 below.

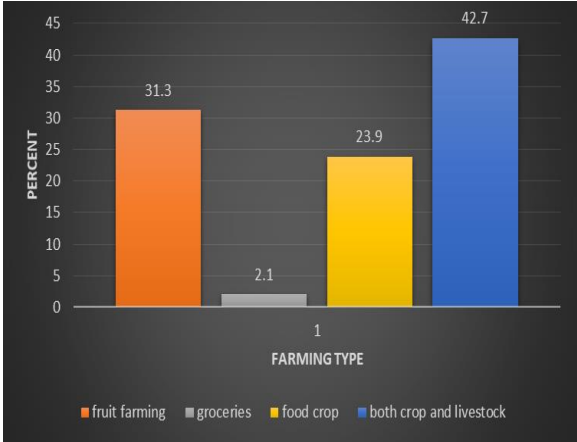


Figure 3. Farming type

Findings depicted in figure 3 above shows that 42(43%) of the respondents practiced both crop and livestock farming, 30(31%) practiced fruit farming, 23(24%) practiced food crop, while 2(2%) groceries. This implies that most of the respondents did farming, therefore they were deemed fit to understand and give information pertaining the study. Further, it implied that most of Makueni residents practiced mixed farming. Mixed farming is an agricultural farming system where the farmer cultivates crops and raise animals simultaneously on the same piece of land. Different crops with different maturity periods are grown at the same time. There is continuous cropping throughout the season.

Table 4
Crop faming practiced

Crop farming practiced	Frequency	Percent
Rain fed	42	44.7
Irrigation	7	7.4
Both rain fed and irrigation	45	47.9
Total	94	100.0

Further, respondents were asked to indicate the type of crop farming they practiced. Responses are summarized and presented in table 4 above.

Table 4 shows that 45(48%) practiced both rain fed and irrigation, 42(45%) practiced rain fed and the rest 7(7%) practiced irrigation farming. From these results, the biggest population of farmers in Makueni County depends on both irrigation and rain fed type of crop farming, meaning the rains were not fully dependable for farming. The findings were consistent with those of Timothy Williams, the Director for Africa of the International Water management Institute in Accra, Ghana through the suggestion that the

continent's use of water resources was low as only 5.2% of the farmlands were irrigated. The director also believed that good water resource management could be established from building sustainable agriculture (AEC, 2016).

The researchers sought to understand the farmers' coping level when there is inadequate rainfalls for their crops and animals and gathered data was summarized and presented in figure 4.

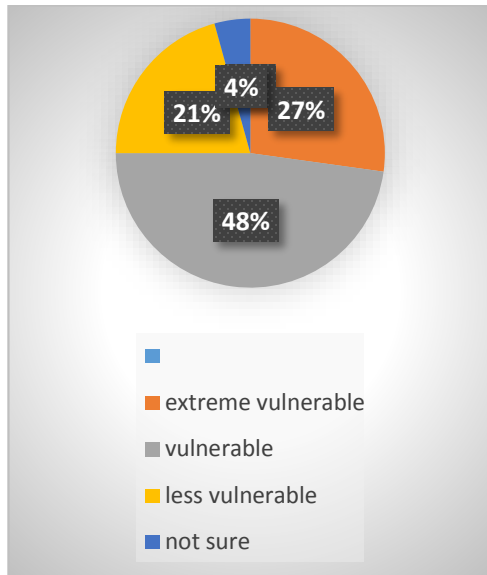


Figure 4. Coping level when there is little rain

Figure 4 above shows that 46(48%) of the respondents were vulnerable when rainfalls are not adequate for their food crops and animals, 26(27%) are extremely vulnerable, 20(21%) are less vulnerable while the remaining 4(4%) were not sure. These findings imply that the respondents could hardly cope with inadequate rainfalls. This is because large population of the farmers depends only on the rain for their agriculture and subsistence farming is practiced as farmers engage in agriculture for the sole purpose of feeding himself and the family. Farming is characterized by small land ownership and farm tools. The general perception regarding subsistence farming is that farmers are poor and do not apply farm inputs such as fertilizers and improved seeds hence low productivity. In addition, other important resources such as irrigation and electricity are unavailable.

Further, the researchers sought to determine the new methods used in response to climate change in past three years. Findings indicated that 33(43%) of those who changed had switched to crop diversification, 18(23%) had changed to crop rotation, another 18(23%) had changed to irrigation while the rest 8(10%) had changed to animal rearing. This implies that majority of those who changed adopted crop diversification. This improved their food security through growing several variety of crops in same field. Luvandwa

(2012) confirms that actors and stakeholders within the agricultural sector should undertake a shift of their technologies and practices in order to adapt to the eminent climate change impacts (DFID, 2005; World Bank, 2006) and better cope with the current climatic variability (Cooper, Stern & Gathage ,2013). High economic situations compounded by high inflation rates in businesses including banks have significantly affected changes in prices and uncertainties in farm products. In addition, banks are not sure of farmers' returns given that the government delays payments from agricultural purchases.

The researchers also sought to determine the source of information from which they got the new farming methods and responses were summarized in figure 5 below.

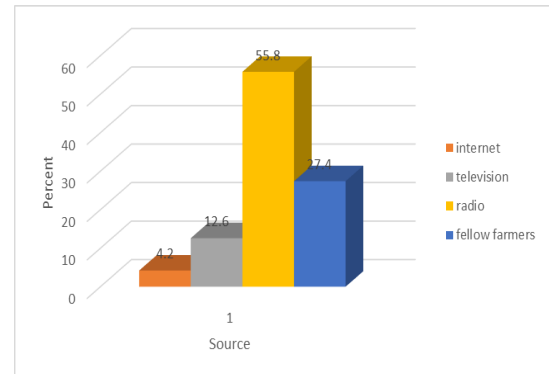


Figure 5. Source of information

Findings presented in figure 5 above show that majority, 53(56%) of the farmers got the information from radio and 26(27%) from fellow farmers. This shows that the leading source of information in informing farmers about the farming methods was radio. Further implies that rural farmers are also able to use technology in farming; something which reduces farming expense in different ways. The above results concur with those of Timmer, (1988) that the technological advances has reduced poverty levels through; enhancing producer income and wages directly, lowering food prices, and creating novel livelihood opportunities in the agricultural sector creating a basis for economic diversification.

Respondents were asked to indicate the organizations which supports delivery of the information. Responses are summarized and presented in figure 6 shown below.

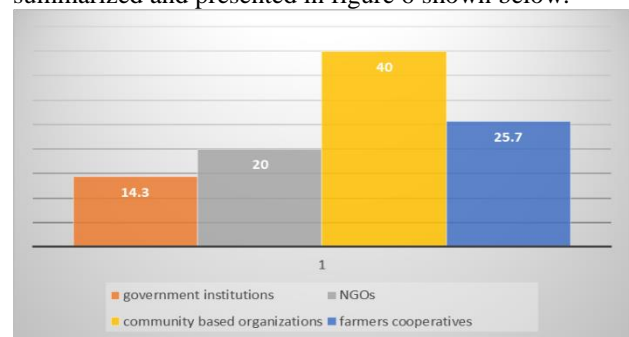


Figure 6. Organizational supporting delivery of info

As revealed in figure 6 above, almost half (40%) of the respondents indicated that community based organizations supports delivery of the information, 25% indicated farmers organization, 20% indicated NGOs while 14% indicated government institutions. This implies that community based organizations were the institution which supported information delivery. This concurs with Atieno, and Kanyinga, (2008) who stated that due to the weakening of the public extension service, a number of extension agents like the community based organizations, private sector, NGOs and consultancy groups have tried to fill the gap.

Respondents were asked if they have ever attended any training or seminar in the past twelve months and gathered data was analyzed and presented in table 6.

Table 6

Training/seminar attended in the past twelve months.

Responses	Frequency	Percent
Yes	50	58.8
No	35	41.2
Total	85	100.0

Findings in table 6 above show that 50(59%) of the respondents had attended training or seminar in the past twelve months while 35(41%) had not. This implies that majority of the respondents had attended farming training in the past twelve months. In addition, those who had attended training in the past twelve months were asked to state the areas which they were trained in. Findings showed that 56% of the respondents had attended training on new and improved method of farming, 35% on pest control and 8% on marketing. This implies that most of the farmers were keen to practice improved farming methods in order to help them cope with the changing climate.

Respondents were asked to state the approach they use to reach livestock and crop farmers and gathered data in this regard was analyzed and presented in figure 7.

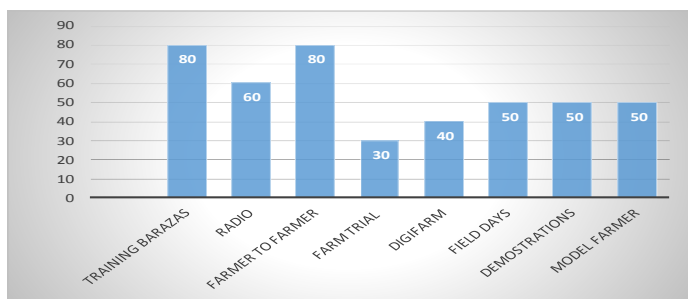


Figure 7. Approaches used to reach farmers

Figure 7 above displays that the most used approaches in reaching farmers are training Barraza (80%), farmer to farmer (80%), and radios (60%). This implied that the most popular approaches in reaching farmers was Training Barraza's, farmer to farmer approach and use of radios. An interview with extension officer R1 from one of the research

station (KKR1) agreed with this findings about the approaches used to reach farmers.

"We use Radios, internet, mobile phones, bulk message, books, pamphlets, field days, agricultural shows, and farmer field schools, administration meetings, demonstrations, model farmers, farm trials, Barazas and the dig farms to reach our farmers." (Respondent R1, 21st August 2018)

Moreover, the researcher sought to investigate the challenges faced by the extension service providers in implementing their roles to farmers. The analyzed and summarized data revealed that majority (80%) faces poor logistic support. Due to inadequate funds, the service providers faces challenges in acquiring airtime in order to communicate to farmers and also materials stationary to demonstrate to farmers. Further, they faced challenges in acquiring funds for fueling their motor bikes as well as fare for public transport. Other challenges were government structure and Competition from other providers more so private firms. Rolling (1990) confirms that the collaboration strategy between extension officers and farmers should be supported and encouraged. If both would work together harmoniously, they could spur economic development and bring about change in the food sector of a community. Hence every effort should be done to eliminate any communication gap that might hinder this collaboration. Another respondent R2 from one of the County agricultural Centre (CMR2) narrated about some of the challenges they face.

"We face different challenges when providing services. Most of them are logistic related. For example, transport, we have to use public means ,money is required for buying airtime in order to communicate to farmers, hiring motorbikes .Most of these issues are as a results of governmental hierarchical structure, which most of the times leads to delay in decision making. Moreover, we face challenges of lack of corporation from the farmers" (Respondent R2, 21st August 2018)

Extension service providers were asked to provide suggestions on the area they wish the community needs to participate in developing a rural sustainable livelihood and their response were as follows; farmers to save own seeds, farmers to use animal manure because it's cheaper to acquire among rural livelihoods, buy fertilizer by themselves to reduce dependency on the government and farmers to join famers' organizations. This was because through groups farmers could easily access loans, it's easy and cheaper for service providers to reach groups that individual farmer, easy for famers to acquire own farm machineries as a group. Further, farmers should participate in proper timing of planting season as well as proper food storage.

Respondents were asked whether they partnered with other service providers like NGOs/other institutions. Their response was that they did partner with other provider for instance. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), which is an NGO mainly focusing on Finger Millet in Kiboko, International Maize and Wheat Improvement Centre (CIMMYT), which is an NGO based in Kiboko Focusing of Maize and wheat. The University of Nairobi also was mentioned as one of the partners in research. UNDP (2011) confirms that solely, the state is unable of implementing strategies associated with adaptation of climate change. Most importantly, the process is characterized by implementing construction of engineering structures that require funding from the national government through making budgetary provisions or participation of beneficiaries in such interventions. Most of the interventions can be carried out by an individual or community level or by civil organizations.

5. Conclusion and Recommendations

The agricultural sector has remained unstable owing to the complex and interrelated factors associated with climate change, public policy, and markets, factors that are beyond the control of farmers who rely on agricultural produce. Farmers must therefore counter the challenges by adopting new farming strategies that incorporate technology and innovations. After carrying out this research, the researchers concluded that for rural residents to achieve sustainable livelihoods, modern farming technology must be adopted to maximize production, control pests and use of improved breeds. Research institutes, via technology, should be able to manage disasters by predicting and managing crisis and assessing how their performance would affect the agricultural sector. Monitoring risks should be fixed with well-timed alerts to aid farmers in making accurate decisions both at the institutional and community levels. These steps would aid in the prevention and preparedness and hence alleviate the impacts that such shocks lead to humanitarian crisis and human suffering and other associated costs. The following recommendations were drawn for all the stakeholder involved in implementing the agricultural resilience strategies.

The county government to collaborate with stakeholders to improve communication, research on animal production and crop farming in the study area for sustainable livelihoods.

Extension service providers to offer financial support and capacity building via training to ensure they deliver effectively to the farmers.

References

Achim Steiner (2006) *Achieving MDG 7 is an important precondition for achieving all the Advice. Fortieth session. Bonn, 4–15 June 2014. FCCC/SBSTA/2014/L.14.*

African Development Bank (2010) “*Agricultural Sector Strategy: 2010–2014*”, Tunis, Tunisia Agriculture and Food Economics springer open journal. *Among the youth*. The standard media group 7th August 2018 4: 18 pm news.

Borzaga, C. &Galera, G. (2014). *The Potential of the Social Economy for Local Development in Africa: An Exploratory Report* European Union.

Brenkert A.L, Malone, E.L (2005) *Modeling Vulnerability and Resilience to Climate Change: A Case Study of India and Indian States*. Climatic Change 72: 57. Source: <https://doi.org/10.1007/s1058-005-593> retrieved 30. 5 .2018.

Bryan, E., Ringler, C., Okoba, B., Koo, J., Herrero, M and Silvestri, S. (2011). *Agricultural Management for Climate Change Adaptation, Greenhouse Gas Mitigation, and Agricultural Productivity: Insights from Cambridge, UK: Cambridge University Press. Build resilience and food and nutrition security*. Source: www.fao.org/3/a-au195e.pdf. Accessed on: 10th June, 2018.

Development

Centre.<https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8211.pdf> Accessed July 31, 2018. 10:45am.

Develtere, P., I. Pollet, &Wanyama, F. (2008). *Cooperating Out of Poverty: The Renaissance of the African Cooperative Movement*. Geneva: International Labour Organization (ILO).

DFID (Department for international Development), 2005. DFID’s Draft Strategy for Research on Division for Policy and Socio-Economic Analysis. *Experienced in Makueni County, Kenya* Research on Humanities and Social Sciences www.iiste.org ISSN (Paper) 2224-5766 ISSN (Online) 2225-0484 (Online) Vol.6, No.16 *Extension in Southern Africa*, Journal of Agriculture, accessed 12th September 2018 Agricultural.

F.A.O (2016) <http://www.fao.org/3/a-bl864e.pdf>.

FAO (2011) *Global Information and Early Warning System on Food & Agriculture*.

Gajigo, O. and Lukoma, A. (2011) *Infrastructure and Agricultural Productivity in Africa*, AfDB. Geneva: International Labour Organization (ILO).

GoK (2014), *Ending Drought Emergencies: Common Programme Framework for Climate-*

- GoK (2015). *Kenya County Climate Risk Profile Series*. Climate Risk Profile.
- GoT (2014) Tanzania Agriculture Climate Resilience Plan, 2014–2019, Dar es Salaam. Government Press.
- Grigg, D.B. (1974) *Agricultural Systems of the World: An Evolutionary Approach*.
- Gweyi O, Evans L, Cecillia M., John W, Joseph P (2017) *Agricultural Extension Approaches Influencing Uptake of Improved Sorghum Technologies in Embu County, Kenya*.
- IBEF, (2017) *Infrastructure: Appraisal of Public-Private Partnerships*." FAO, Rome Institute Entwicklungspolitik; 54) ISBN 978-3-88985-489-6.
- Kagina .C. (2017) *The National Road Infrastructure Development Programme*.
- Munyua, H. and Stilwell, C. (2010). A mixed qualitative and quantitative participatory methodology. A study of the agricultural knowledge and information system (AKIS)
- Mutua. L. Omuterema .S and Gweyi. J. (2016) *Evaluation of the Nature of Drought in Makueni county*
- Rostow, W.W. (1960). *The Stages of Economic Growth: A Non-Communist Manifesto*, Cambridge University Press, Cambridge, UK. Russian Journal of Agricultural and Socio-Economic Science. Sacco Limited. Usui- Kenya.
- Schlenker, W, & Lobell, D. (2010). *Robust negative impacts of climate change on African agriculture*. *Environmental Research Letters* 5. 014010.
- Timmer, C.P. (1988). *The agricultural transformation*. In: H. Chenery and T. Srinivasan (eds),
- Tyler.S. and Moench, M. (2012) *A framework for urban climate resilience*. *Clim. Dev.* 2012, 4, 311–326.
- UNDPSLP(1996) *Technology Strategy for Sustainable Livelihood*. Malawi Industrial Research and Technology.
- UNFCCC (2014a) *Issues related to agriculture. Subsidiary Body for Science*.
- World Bank (2015) *Climate-smart agriculture in Kenya. CSA Country Profiles for Africa, Asia, and Latin America and the Caribbean Series*. Washington D.C.: The World Bank Group.
- Zauszniewski, J., Bekhet, A., Suresky, M. (2010). Resilience in family members of persons with serious mental illness. *Nursing Clinics of North America*, 45, 613-62.