Contribution of Agricultural Extension to Insect Farming for Food and Nutritional Security among Smallholder Farmers in the Kenyan Lake Victoria Basin

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Abstract
The study intended to investigate the contribution of agricultural extension on edible insect farming for food and feed nutritional security among smallholder farmers of Siaya County in Kenya. There was no explicit study on the contribution of agricultural extension on insect farming as evidenced by the existing literature. Specifically, the study aimed at determining the influence of agricultural extension on the production of insects as food and feeds among smallholder farmers in the study area. In so doing, the study probed relevant questions to establish the role of agricultural extension in the promotion of insects for food. The study adopted a descriptive survey design since it allows for collection of large amounts of data from the target population. Both primary and secondary data was collected from the respondents which included small holder farmers, extension service providers and stakeholders in the insect food farming and value addition sectors. A sample size of 210 respondents from a population of 443 were interviewed using questionnaires. The data collected was analysed quantitatively using standard statistical packages to extract various pieces of information namely household characteristics, insect food and feed technology within households, status of food and nutritional security, status of livelihoods and challenges to improvement of food and feed nutritional security and general livelihoods. The general outcome of the analysis indicated that extension service provision had influence on the production of insects among small holder farmers. The study generated crucial knowledge to various stakeholders and players in the agricultural sector, key among them being Governments and Non-Governmental agencies promoting new technologies to enhance food and nutritional security.

Keywords: contribution of agricultural extension, insect farming for food and feeds, small holder farmer, value addition, adoption, nutrition security
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1.0. Introduction

The agricultural sector plays a significant role in the global economy. The bulk of the world's poor—roughly 75%—live in rural regions and rely heavily on agriculture for their livelihoods. Around 500 million smallholder farmers worldwide depend on agriculture as a key means for alleviating poverty and promoting sustainable development (Matthew et al., 2019). Insects for feed and food can play a significant role in both ensuring food security and living more sustainably. By 2030, they can assist in achieving the Sustainable Development Goals (SDG) (DESA, 2016). This specifically relates to SDGs 2, to achieve food security, eliminate hunger, improve nutrition an promotes sustainable agriculture, SDG 12, which aim to create sustainable consumption and production patterns; SDG 13, to stop and reverse land degradation, manage forests, combat desertification, halt biodiversity loss and take prompt action to address climate change and its implications. SDG 15, to ensure the sustainable management and use of terrestrial ecosystems. The implication of these SDGs is for all involved stakeholders to use all available means to ensure food and national security. However, within the Kenya Lake Victoria Basin, the focus has always been on large scale farming and few stakeholders believe that with small-holder farmers, it is possible to achieve food and nutritional security. This is after the Kenya Lake Victoria Basin continues to suffer from increasing poverty and also inadequate food and nutritional supply (Manyara, 2018).

According to Folaranmi (2012), a significant number of people lack access to healthy food because they are living below the international poverty line, which causes undernourishment, particularly protein-energy malnutrition (PEM), throughout Latin America, Asia, and Africa (Hengeveld et al., 2018). In addition, trends foresee a continuous rise in population to 9 billion by 2050, which would raise the demand for food and feed from existing agro-ecosystems and put even more strain on the environment. There are predicted shortages of nutrients, non-renewable energy sources, water, forest, fishery, and biodiversity resources (FAO, 2017). Genetic selection, intensive agricultural practices, and most recently, the creation of genetically modified organisms (GMOs) have all improved food production systems (Belluco et al. 2013). Despite these improvements, alternative food sources—particularly protein sources are still required for a secure future food system. In several low-income African and Asian countries, edible insects already have high market values that are occasionally comparable to or even higher than those of traditional livestock. Therefore, insects are a commodity with a market (McGill, 2016). Utilizing insects for food and nutrition is consistent with the sustainable diet context for food and nutritional security (Kelemu et al. 2015; Van Huis et al. 2013). Eaten insect species range from ants to beetle larvae consumed by tribes as part of their subsistence meals in Africa and Australia to the popular fried locusts and beetles consumed in Thailand. Despite the fact that some small insects are a major source of food and nutritional security, very little, if any, has been done towards farming them. Stakeholders in the Kenya Lake Victoria Basin, in a bid to achieve food and nutritional security, only focus on large scale farming, which then leaves out the small-holder farmers to also play a role in achieving the SDGs associated with food and nutritional security.

The fact that one third of the world's population eats insects, a practice that it is not only related to poverty, has resulted into interests within Europe and North America to come up with related industries (Dossey, Morales-Ramos, & Rojas, 2016). Edible insects can be obtained in three ways, namely, wild harvesting, semi-domestication (habitat manipulation to increase population), and farming, which ranges from single small cage to large factory (Yen, 2015). Commercialization is increasing harvesting pressures in the wild since wild-harvested insects continue to be the primary source of insects in the Asia Pacific and African areas. A low-tech, time-efficient approach for producing a very nutritious food that is currently consumed locally in many African and Asian nations is raising insects in the household on a small- to medium-scale. Insects can be reared on land that is unusable for other activities and in side streams or waste that provide sufficient nutrients. Insect farming uses very little water, because of both low water needs for feed production and many insect species do not need to drink water because the moisture in their feed provides enough. This means that farming insects should not only be easy but also highly beneficial. However, edible insect farming in the Kenya Lake Victoria Basin is still very low across the globe. This begs the question as to how agricultural extensions can be involved in promoting edible insect farming in the Kenya Lake Victoria Basin. There should be front runners towards taking up this opportunity in an extensive form so as to not only achieve the SDGs but also ensure that standards of living for small-scale farmers are uplifted.

The dissemination of new information and technology to farmers and other end users is greatly aided through advisory services, community outreach, and extension programs. Governments and international development organizations have committed significant resources to the establishment of agricultural extension systems worldwide. The national governments and international development organizations have funded and executed a wide range of extension models and initiatives during the past 6 decades (Devaux et al., 2018). These programs' makeup has varied from country to country. These programs are still developing (Jayne et al., 2019). Many of these projects have been effective and had a significant influence on improving rural populations' livelihoods and agricultural output. The mopane worm has an animal trade value of more than $85 million alone in Southern Africa. The caterpillars' habitat encompasses around 384,000 km2 of forest in Angola, Botswana, Mozambique, Namibia, South Africa, Zambia, and Zimbabwe, where the mopane woodlands are endemic (Ndlovu et al., 2021). In Southern Africa, an estimated 9.5 billion mopane caterpillars are harvested each year. While Raheem et al. (2019) recorded 23 edible species from the Bas-Congo, a western province of the Democratic Republic of Congo, Ebenebe et al. (2020) discovered 38 distinct species of caterpillar across the Democratic Republic of the Congo, Zambia, and Zimbabwe. There are, evidences, albeit, few fthat support the feasibility of rearing edible insects for food and nutritional security.

The nature of farming is evolving on a global scale. Agriculture is evolving from a production-driven industry to one that is market-driven. To keep the growers informed about the technologies available for increasing productivity and income from farming, effective use of other extension methods, including group/mass contact methods, need-based training programs, demonstrations of proven technologies with active participation from farmers, and more are required. It is therefore important to review the application of various innovative extension approaches for purposes of generating knowledge on its influence on edible insect farming for food and feed nutritional security among small holder farmers. The large fresh water body in the Kenya Lake Victoria Basin has made the stakeholders believe that it is only through large scale farming involving irrigations that can be used to achieve SDGs on food and nutritional security. Nonetheless, with available evidence on small-scale edible insect farming, it would be imperative to find out whether it is feasible in the Kenya Victoria basin. In other words, there is a need to investigate how agricultural extension system can contribute towards promoting small-scale edible insect farming.

Notably, the Lake Victoria Basin of Kenya is located along the Kenyan Equator between the latitudes of 0°20´N-3°S and longitudes 31°39´E–34°53´W with an average elevation of 1134 meters above sea level. Lake Victoria basin is the areas neighbouring the lake in the Kenyan side. The basin experiences mean annual evaporation rates of 1100mm-2400 mm, making the water balance of the lake to be primarily characterized by precipitation and evaporation. The area has witnessed reasonable degree of depletion of resources from within the lake and the its surrounding environs, which is against the spirit of sustainability as provided for by the UN in the SDG's. Seeking alternative sources of protein is deemed appropriate through use of insect farming technology which will go a long way in reducing the pressure on the lake and its resources. It is on this basis that the proposed study seeks to investigate the contribution of agricultural extension on edible insect farming for food and feed nutritional security among smallholder farmers within the Kenya Lake Victoria Basin as a way of not only achieving SDGs but also uplifting the living standards of small-scale farmers who have been, for a long time, ignored to concentrate on large scale farming.

1.1. Statement of the Problem

Information on innovative agricultural extension to support the promotion of edible insect farming and its subsequent value chains is inadequate even with the acknowledgement of the contribution of agricultural extension which has been critical in developing and promoting agricultural technology interventions over the years. Of the many studies carried out on agricultural extension, the main concern has been the academic structure of the extension education, (Azadi et al., 2019) and the organizational structure of the extension agencies (Nogueira, 2019). Some of the studies have also covered private extension services (Riaz, 2014; Mengal et al., 2012; Siddiqui and Mirani, 2012). There is however no explicit study has been undertaken to find out the extent of accessibility to extension services on edible insects by farmers find the extension services useful in the farming of insects as food or feed. While the actual impact of extension services is determined by the level of use of knowledge and technology resulting from farmers' perceptions of the usefulness of the services, no study has yet been conducted to establish such usage and its determinants. therefore aims to provide empirical evidence on the contribution of agricultural extension on insect framing for food and feeds.

1.2. Study Objective

The main objective of this study was to assess the contribution of agricultural extension on edible insect farming for food and feed nutritional security among smallholder farmers in the area of study. In particular the study set to determine the contribution of agricultural extension on the production of insects as food and feeds among small-scale farmers in the Kenyan Lake Victoria Basin.

2.0. Methodology

This area highlights techniques and methods used in undertaking the study and analyzing the data.

2.1 Research Design

Research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure (C. R Kothari 2014). The study adopted a descriptive survey design. Descriptive survey is an observational research design that focuses on determining the status of a defined population, phenomenon, situation or condition being studied (Kothari 2002). The design helps to gather a large amount of data from a given population in order to determine its status with respect to one or more variables (Mugenda & Mugenda, 2003). The design was appropriate for this study since the study sought to assess status of edible insect farming among a large number of small holder farmers, extension services and different actors in the edible insect food and feed value chains and the challenges bedeviling the sector in Siaya county of Kenya.

2.2 Population of the study and the sampling procedure

Sampling refers to selection of a section of individuals from a population so as to estimate the features of the entire population (Singh & Masuku, 2014). As observed, the importance of sampling are; makes data collection process faster and lowers the cost. Sampling is broadly used to gather data about a particular population.

Calculating sample size

$$n = \frac{N}{1 + N(e)^2}$$

Considering the total identified population of N farmers, the study considered the above formular to determine the sample size proportion to use; where n refers to the sample size and N is the population size and e is the level of precision. A 95% confidence level and P = .5 are assumed for equation (Singh & Masuku, 2014).

Substituting the formulae elements with projected total population to attain the sample size, the study obtained the following results; where N was 443.

2.3. Instrumentation

According to Gay (2009), validity refers to the extent to which research instruments measure what it is designed to measure. It implies how best the measuring instrument used in the research fulfills the purpose of the study. There are different types of validity available for researchers to use; criterion validity, construct validity, content validity and statistical conclusion validity. This study used content validity which is the extent to which a measuring instrument provide adequate coverage of topic of study by ensuring all respondent understand the items in questionnaire thus avoiding errors and misunderstanding of results (Kathara, 2014). Specifically to validate the data, cobo collect validation instruments were used in the study when digitizing the data collection form; this ensured that where an integer, float, string, date were so validly collected.

Reliability can be defined as consistency of one's measurements or the degree to which an instrument measures the same way each time; if the measurement is used under the same condition with same subject (Trochim, 2006). A measure is considered reliable if the person's scores on the same test given twice is similar. Reliability of research instruments were run using SPSS and revealed a level of 75% which is within the recommended level.

2.4. Data collection

A total of 210 farmers were interviewed in this study using semi-structured questionnaires with open and closed ended questions. Areas where insect farming is propagated were identified with the help of partners and stakeholders in the insect farming research domain. The survey questionnaire was divided into four main sections namely; personal profile of the farming house hold head and size, access to insect farming advisory and information services, awareness and compliance to insect farming technology adoption and requirement stewardship and awareness on value addition cycle management.

2.5. Data analysis

For all the 3 objectives, answers provided were coded and analyzed using IBM SPSS Version 26 statistics, frequency counts and percentages to describe the personal and demographic profiles of the respondents and summarizes responses to questions regarding their awareness of the insect farming technology. For all the questions, percentages was calculated using the total number of respondents who responded to the questions. Cross tabulations was used to determine the relationship between categorical variables. These included perception on the benefits, farmers' participation in the insect farming and their level of exposure to the insect farming information and advisory.

3.0. RESULTS AND DISCUSSIONS

3.1. General Information

The study established that the distribution of the respondents according to the gender ensured that gender rule compliance and general principles of social inclusivity was considered in the research where males constituted 69% and females were 31% of the total respondents. The study revealed that majority of the respondents were less than 36 years of age with 47.1% while those aged between 36 years to 60 years 41.9% and only 11% of the respondents were aged above 60 years. From the findings, the majority of the respondents had secondary education with 54.3%, 27.1% had primary level of education with only 18.6% of the farmers with post-secondary education. On the employment status, 11.9% of the respondents were employed while 88.1% were relying on farming. The study also established that majority of the respondents (87.1%) were married, 10.5% were widowed while only 2.4% of the respondents were single. On the number of dependent, it was established that 45.7% of the families had between 0 and four dependents, 51.4% had between five and nine dependents and 2.9% had more than nine dependents.

This study established that 92.9 % of the respondents indicated that they had less than six acres while 4.8% had between 6 to 10 acres of land with only 2.4% of the respondents with more than 10 acres. It was also well known that most of the small holder farmers with 81.0% had monthly income of less than Ksh. 50,000 while only 19.0% had an estimated monthly income above Ksh. 50,000. Most of the respondents from the region were confirmed to be Christians with 85.2% with only 14.8% non-Christians.

3.2 Access to Extension Information

On the role agricultural extension in promoting insect farming in the Kenyan Lake Victoria Basin, the study findings revealed that 50% of the respondents jointly disagreed that there is adequate information on insect farming coming from extension workers with only 44.7% supporting that there is adequate information on insect farming coming from extension workers. It is also known that 49.5% of the small holder farmers differed with the claim that there have been significant efforts in promoting insects as food and feed in the region with only 39.6% supporting that there have been significant efforts in promoting insects as food and feed to determine the contribution of agricultural extension on the production of insects as food and feeds among small-scale farmers in the Kenyan Lake Victoria Basin.

This study also established that 54.8% of small holder farmers disagreed that information on insect faming extension officers comes from the researchers with only 42.9% supporting the statement. On whether the information on insect farming comes from colleague farmers, 49% of the respondents disagreed with the statement whereas 43.3% supported the claim. It was also established that more than 54.3% of the respondents disagreed that the information on insect farming comes from the NGO's with only 41% collectively agreed that the information on insect farming comes NGO.

Farmers were also asked whether extension services on insect farming had made them to consistently practice insect farming among them in the Kenyan Lake Victoria Basin, 54.8% of the respondents cumulatively disagreed and strongly disagreed with only 39.2% of farmers jointly agreed and strongly agreed that extension services on insect farming had made them to consistently practice insect farming among small holder farmers in the region.

On the level of competency or the capacity building to handle mechanization of the insect farms/designs, rearing methods, value addition, pest and disease management, breeding technologies, marketing, consumption and other forms of utilization, credit acquisition and management and finally climate change and its effects. The results established that 62.4% of the respondents did not either agree or strongly agree with the level of competence/capacity building to handle the mechanization of the insect farms/designs with only 37.6% of the small holder farmers accepting that they can handle the mechanization of insect farms. On rearing methods, 61.9% collectively disagreed with only 35.7% supporting that they were competent on insects rearing methods.

To whether they can handle the management of pest and diseases, 61.9% of the famers submitted that they are unable to manage pests and diseases with only 35.7% of the farmers agreeing that they could properly manage pests and diseases. With the breeding technologies 60.9% of the farmers disagreed that they could competently handle breeding technologies with only 25.7% accepting that they can competently handle the breeding technologies.

Farmers were asked to state whether they had capacity to handle marketing, consumption and other forms of utilization, 53.8% failed to agree whereas only 35.2% of the farmers admitted that they could competently handle marketing, consumption and other forms of utilization.

On the credit acquisition and management, 61.4% of the farmers disagreed that they were not aware of handling credit acquisition and management with only 30.5% admitting that they can handle credit acquisition and management with ease. Finally, on the level of competence/capacity building, 74.3 % did also not either agreed or strongly agreed with the level of competence/capacity building to handle climate change and its effects with only 25.7% accepting that they could easily manage the effects of climate change.

4.0. RECOMMENDATIONS

This study was done to assess the contribution of agricultural extension on edible insect farming for food and feed nutritional security among smallholder farmers in the Kenyan Lake Victoria Basin. It is suggested that similar study should be replicated in other regions with the aim of determining the contributions of agricultural extension on edible insect farming for food and feed nutritional security among smallholder farmers. Further research is recommended to determine the effect of other factors on edible insect farming for food and feed nutritional security not considered in this study.

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