



**EXTENT AND USE OF NON-CHEMICAL PEST MANAGEMENT ALTERNATIVES
AMONG SMALLHOLDER VEGETABLE FARMERS IN KENYA:
THE CASE OF SIAYA AND MIGORI COUNTIES**

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Acronyms and Abbreviations

BvAT	Biovision Africa Trust
CAP	Chapter
CEJAD	Centre for Environmental Justice and Development
CBO	Community Based Organization
HHPs	Highly Hazardous Pesticides
ICIPE	International Centre of Insect Physiology and Ecology
IPEN	International Pollutants Elimination Network
IPM	Integrated Pest Management
NGOs	Non-Governmental Organizations
KAP	Knowledge, Attitude and Practice
KOAN	Kenya Organic Agriculture Network
OCA	Organic Consumers Alliance
PCPB	Pests Control Product Board

Executive Summary

This report is an assessment of the non-chemical pest management approaches used by smallholder vegetable farmers in the Lake Victoria region. The report also documents the challenges faced by farmers practicing such approaches as well as the general challenges facing adoption of agro-ecology in the region. The study was conducted as a case study in the counties of Siaya and Migori in the Lake Victoria region, south western Kenya. Information used in this report was gathered through literature review, interviews, field visits and photography. The study team visited the Dala Rieko community-based organization and its members in Asembo, Rarieda Sub-County, and while in Migori County, Rural Farmers Research Network (RFRN) and Wachna Farmers community-based organization (CBO) and various farmers were visited.

The study established that there are various non-chemical approaches that are being used by smallholder vegetable farmers in the Lake Victoria region to control pests and diseases. However, adoption and use of such practices is still low among smallholder farmers. In most cases, such approaches are used alongside synthetic pesticides. Some of the non-chemical approaches used by farmers include crop rotation, use of homemade natural pesticides, intercropping, use of wood ash and biopesticides, and use of pest repellent crops such as grass onions.

In addition, farmers in the region experience different challenges in the use of these approaches, which has derailed efforts to accelerate adoption of agro-ecological approaches in the region. The challenges enumerated by farmers included: low payment for organic products, negative attitude and perception by smallholder farmers on agro-ecology, inadequate research on non-chemical pest management approaches, inadequate extension services, limited production levels due to inadequate knowledge, skills and appropriate technologies among farmers, inadequate market and lack of certification schemes for organic products, ineffectiveness of some of the non-chemical ways in controlling pests and diseases, and climate change.

To improve adoption of non-chemical approaches to pest management in Kenya, the study recommends more information sharing on non-chemical pest management approaches and the development of strong policy and regulatory frameworks on agro-ecology. There is also a need to develop and implement extension programs for farmers on non-chemical pest management techniques. Lastly, it is important to develop and test non-chemical pest management approaches, as adoption of such approaches by farmers will depend highly on their effectiveness in managing pests and diseases.

CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.1 Background

Pesticides have for a long time been used by farmers to manage pests and diseases and improve production. The agricultural nature of the Kenyan economy has led to a high and steady increase in the use of pesticides, with the country importing 17,803 tons of pesticides worth 128 million dollars in 2018 alone. A study conducted by Centre for Environment Justice and Development (CEJAD) in 2019 to assess the situation of highly hazardous pesticides (HHPs) in Kenya found 43% of the nationally registered pesticides for use are highly hazardous pesticides; 81% of which are registered for use in food crops. In addition, according to another study by Route to Food (2019), 32% of pesticides registered for use in Kenya are banned in European Countries.

While the basis for adopting pesticides has been to improve crop yields, the majority of chemical pesticides have long term effects to the environment and humans through their persistence in nature and/or in body tissues. As a result, worldwide pest management is facing economic and ecological challenges. One of these challenges has been the inadequate safeguards on proper use of pesticides, which has continued to threaten the health of many farmers and consumers in Kenya. To deal with these challenges, there has been a global recognition to replace synthetic pesticides with alternatives that are safe for humans and the environment. Seen as one of the viable alternatives, agro-ecology received attention in the 1970s in response to the negative environmental, social, and economic concerns resulting from a growing dominant industrial agricultural model. According to Moore, 2016 agro-ecology is an approach that considers natural ecosystems and uses local knowledge to plant a diversity of crops that boost the sustainability of the farming system as a whole. Another alternative that has gained attention in the recent years is the use of biopesticides. The latter is often pest specific; hence, farmers may need to have different bio pesticide products to control multiple pests.

Over the past 6 years, CEJAD has been working to advocate against use of highly hazardous pesticides and to promote alternatives to synthetic pesticides as a way of protecting the vulnerable populations from the adverse effects of exposure to pesticides, and more so, highly hazardous pesticides. This study precedes a study (supported by Global Green Grants Fund (GGF)) that was conducted by CEJAD and sought to establish the level of Knowledge, Attitude and Practice (KAP) among smallholder farmers on the effects of pesticides use and benefits of organic farming. One of the key findings of this study was that smallholder vegetable farmers were aware of the effects of pesticides use and benefits of agro-ecology. It is against this backdrop that CEJAD conducted this study to document current non-chemical pest control practices used by smallholder farmers to act as a guide for educating and sensitizing vegetable farmers on non-chemical pest control approaches.

1.2 Objectives of the study

The main objective of the study was to document non-chemical alternatives to pest management among smallholder vegetable farmers in the Lake Victoria basin.

Specific objectives include:

- i. Establish the extent and use of non-chemical alternatives among smallholder vegetable farmers in Siaya and Migori Counties

- ii. Identify challenges affecting the adoption of non-chemical pest management practices in the Lake Victoria region.

1.3 Study target

The survey was conducted in Siaya and Migori Counties between 16th and 21st November 2020. In Siaya the survey team visited the Dala Rieko community-based organization and its members in Asembo, Rarieda Sub-County. In Migori County, the team visited various farmers and smallholder farmer organizations. Farmer organizations visited in Migori included Rural Farmers Research Network (RFRN) and Wachna Farmers community-based organization (CBO).

1.4 Study methodology

The study was undertaken by in-house personnel at CEJAD. The information was collected primarily through desktop literature review, key informant interviews and field visits to document non-chemicals pest management approaches that are used by farmers.

1.5 Data analysis and presentation

The study relied on qualitative data. The information collected was organized and presented through narrations. For this purpose, the information was coded and used to grid the findings into themes that fed into the objectives of the study. Responses that were considered irrelevant were discarded.

CHAPTER TWO: LEGAL AND INSTITUTIONAL FRAMEWORKS THAT SUPPORT ECOSYSTEM APPROACHES

This chapter highlights the various policies, regulations and laws that govern non-chemical pest management approaches in Kenya. This section also aims to update the status of legal and policy frameworks presented in the 2019 country situation report.

2.1 National organic agriculture policy framework

Kenya developed a draft National Organic Policy in 2017 to spearhead the implementation of organic farming in the country by promoting a well-coordinated and vibrant organic agriculture sub-sector. This policy addresses various issues afflicting the organic agriculture sub-sector in Kenya, including: research and development; training; extension; inputs; production; marketing and trade; and legal and institutional framework(s). Three years later, this policy has not been passed, meaning that the gains that were envisioned in the policy cannot be realized. There is a need to fast track the development of this policy as it is key to the development of the organic agriculture sub-sector in Kenya.

2.2 Policy frameworks that support the manufacture, import, distribution and use of bio-pesticides

Biopesticides are pesticides that are derived from micro-organisms (such as bacteria, fungi and viruses, etc.), plants (such as neem and pyrethrum, etc.) and natural enemies of pests (parasitoids, predators and pathogens). They also include semiochemicals (e.g. insect sex pheromones), enzymes (proteins) and natural plant regulators and insect growth regulators. In Kenya, biopesticides are governed by the Pest Control Products Act Cap 346. This act provides for importation, exportation, manufacture, distribution and use of biopesticides in Kenya. The act prohibits any person from importing into or selling in Kenya any pest control product, including biopesticides, unless that product has been registered, packaged and labeled according to the provisions of the regulations under the Act. It also prohibits any person from exporting or re-exporting out of Kenya any pest control products, including biopesticides, without complying with the requirement specified in regulations made under the Act.¹

The registration of biopesticides in Kenya is controlled by the Pest Control Products (Registration) (Amendment) Regulations, 2006. All bio pesticide products must be registered by the Pest Control Product Board (PCPB) before they can be used in Kenya. However, the use of biopesticides for research purposes is exempted from registration, but a permit must be obtained from PCPB to that effect. According to the list of registered products by the Pest Control Product Board (PCPB), a total of 71 biopesticides are registered for use in Kenya. A full list of various types of registered biopesticides is publicly available at <https://www.pcpb.go.ke/biopesticides-on-crops/>.

Pest Control Products (Labeling, Advertising and Packaging) Regulations, 1984 provides for labeling, advertising and packaging of biopesticides in Kenya. These regulations prohibit distribution and sale of biopesticides without a label and packaging approved by PCBP. They also provide for how such pesticides should be labeled, including the details that should appear on the packaging material². In regard to imports

¹ Articles 3 and 4 of the Act

² Articles 3 and 13 of the Pest Control Products (Labeling, Advertising and Packaging) Regulations, 1984

and exports of biopesticides in Kenya, the Pest Control Products (Importation and Exportation) Regulations, 1984 prohibit any person from importing or exporting biopesticides into or out of Kenya without a valid license issued by PCPB.

CHAPTER THREE: IMPLEMENTATION OF CROP-SPECIFIC, PEST-SPECIFIC ALTERNATIVES TO HHPs

This section provides information on the various non-chemical practices that smallholder farmers are employing to manage pests and diseases on their farms in the two case study counties of Siaya and Migori. It also highlights the concerns of farmers on the efficacy of some of the non-chemical approaches that they have used/ or are using.

3.1 Implementation of crop specific, pest specific alternatives in Siaya County

3.1.1 Overview of the agricultural sector in Siaya County

Vegetable crop production is the third main contributor to the County's agricultural sector, coming after fruits, tuber crops and cereal crops. For instance, vegetable production contributes approximately Ksh 1,346,538,750, equivalent to about 13.5 million USD, to the economy of Siaya County (Directorate of Agriculture, 2016). It is important to note that this is only with regard to the vegetables that are produced under the small irrigation schemes in the County. Siaya County Integrated Development Plan 2018 – 2022 notes that the average farm size for a small-scale farmer is 1.1 hectares. The farm size is estimated to be 0.8 ha for Gem and Ugunja; 1 ha for Alego Usonga, Bondo and Rarieda; and 2 ha for Ugenya. Mechanized agriculture is still minimal in the County.

3.1.2 Non-chemical approaches used by smallholder vegetable farmers to control pests and diseases

In Siaya County, CEJAD visited Dala Rieko CBO, a farmer organization based in Asembo Bay, Rarieda Sub-County. Members of this organization were also visited to document non-chemical practices that they were employing to manage pests and diseases.

About Dala Rieko

Dala Rieko was started in the year 2008 and is a farmers' membership organization that is advocating for sustainable development, including promotion of sustainable food production. To achieve this, the organization has developed demo farms where they grow various fruits and vegetables to facilitate farmer learning and training. To date, the organization has about 1000 smallholder farmers that they work with. These farmers are organized into what is called "Dala Rieko Villages." The approach of organizing smallholder farmers into villages was motivated by the need to improve adoption of farmer field schools in the County. The villages are centres on food production through organic farming and promotion of solar energy. At the time of this study, the organization had organized farmers into a total of six villages; namely, Mabinju, Wera, Kokise, Ongielo, Nndwara and Mahaya.

In terms of vegetables grown, Dala Rieko and its members mainly grow kales (Sukuma Wiki), amaranth, green peas tomatoes, spinach, Jews Mallow (*known as mrenda in Kiswahili*), African night shades (*locally known as 'osuga'*), bitter herbs (*locally known as 'mitoo'*) and spider plant (*locally known as 'dek'*).



Plate 1: Pictures showing some of the vegetables at Dala Rieko demo farms at Asembo Bay. Photo by Fredrick - CEJAD

The organization also grows fruits and trees such as paw paw, banana, mango, avocado and oranges. On the other hand, the tree species grown by the organization are pine, eucalyptus and gravellier.



Plate 2: Pictures showing some of the fruits and tree species at Dala Rieko demo farms at Asembo Bay. Photo by Fredrick - CEJAD

Some of the sustainable agricultural practices being promoted by the organization include:

- a) **Integrated agriculture:** Dala Rieko encourages farmers to integrate crop farming with other agricultural practices to meet both ecological and economic demands (enhance economic benefit to the farmer). Two integrated farming practices are being promoted by Dala Rieko. On one front is the dairy goat - vegetable farming, and poultry – fruit farming. At the time of visit, 20 members were practicing dairy goat – vegetable farming while 50 members were practicing poultry – fruit farming.



Plate 3: Pictures showing poultry structure and orange farm at the home of one of the members of Dala Rieko that is practicing integrated poultry and fruit farming. Photo by Fredrick - CEJAD

- b) **Agroforestry:** Smallholder farmers are also encouraged to plant trees and vegetables. About 100 members of Dala Rieko are integrating trees with vegetable crops. The organization produces tree seedlings that are distributed to farmers for planting on their farms.
- c) **Organic farming:** The organization is promoting green ecology by promoting organic farming among its members. This is well at the centre of concept of Dala Rieko Villages where members are organized into farming villagesne way that the organization is doing this is by promoting use of ecosan toilets by their members. This enables them to collect urine and feecal matter that is later used as manure on their small farms. Urine is mixed with water, then used for top dressing upon fermentation, while tithonia is mixed with feecal matter and used as manure. Additionally, the organization promotes the use compost manure, which is prepared from water hyacinth and other farm materials.

Non-chemical Approaches used by Dala Rieko and its members to control pests and diseases

Dala Rieko and its members employ a number of practices to manage pests and diseases. These practices include:

I. Use of natural herbs to spray crops

An herb locally known as “hila hila,” and scientifically known as *Mimosa pudica*, is used to manage a wide variety of pests including aphids and army worms, mainly in kales and spinach. Another herb that is used as a natural pesticide is stinging nettle, locally known as “anyach.” Smallholder vegetable farmers use ‘anyach’ as a repellent. In addition, a solution of tithonia and pepper (‘pili pili’) is used to control aphids and army worms on vegetables. To prepare the latter, a mixture of tithonia, pepper and water is left to ferment for 3 days, after which it is filtered and used as a spray.



Plate 4: A picture showing planted tithonia at Dala Rieko demo farm in Asembo Bay. Photo by Fredrick - CEJAD

II. Use of wood ash

This is one of the oldest practices that has been used to control pests on vegetables, and has for a long time been used as a last resort, especially when a farmer cannot afford to buy chemical pesticides. Wood ash is used to control aphids, caterpillars and army worms on kales.

III. Intercropping

Intercropping can be defined as the cultivation of two or more crops simultaneously on the same farm. It can also mean the growing of two or more crops on the same field, with the planting of the second crop after the first one has completed its development. The rationale behind intercropping is that the different crops planted are unlikely to share the same insect pests and disease-causing pathogens and to conserve

the soil. Intercropping as a pest and disease management practice not only helps in reducing pest populations and diseases, but also attracts beneficial insects³. This is one practice that is being promoted by Dala Rieko among its members. Intercropping is practiced between vegetables as well as cereals and tuber crops.



Plate 5: Pictures showing intercropping between vegetables and maize as well as between varieties of vegetables. Photo by Fredrick - CEJAD

IV. Crop rotation

This is one of the oldest and most effective cultural control strategies. This is a practice where a farmer has planned order of specific crops planted on the same field. A key principle of crop rotation is ensuring that the succeeding crop does not belong to the same family of the previous one. This is one practice that has also been adopted by Dala Rieko and its members.

At one site in Asembo, a farmer pointed out that this practice is, however, affected by limited availability of land, as most farmers lease farms that they cultivated on.

“I mostly lease the farms that I cultivate on and sometimes I can only cultivate on a farm once and move to a different one next time. This can really make it hard for some vegetable farmers like me to practice crop rotation,” a member of Dala Rieko said.

³ http://www.oisat.org/control_methods/cultural_practices/intercropping.html

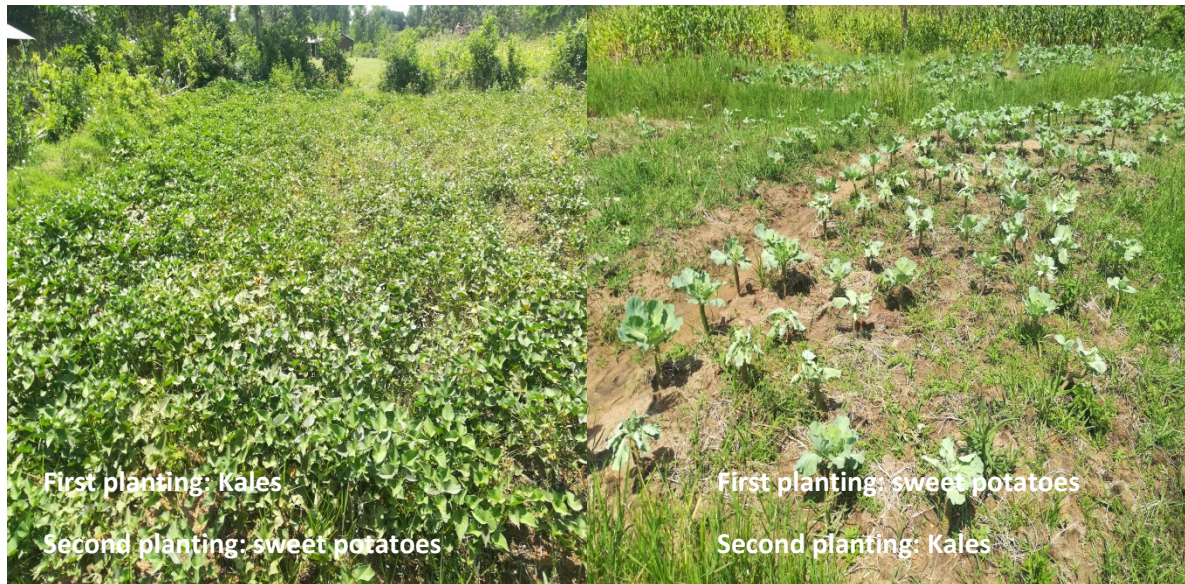


Plate 6: Pictures showing crop rotation between tuber crop (sweet potatoes) and kales at a farm of a Dala Rieko member in Asembo, Siaya County. Photo by Fredrick - CEJAD

3.1.3. Challenges facing the use of non-chemical approaches in Siaya County

Smallholder farmers in Siaya County face a myriad of challenges in their quest to produce safe and sustainable foods through the application of non-chemical pests control approaches. Some of the challenges pointed out by farmers included:

a) Low prices on organic vegetables

The main reason farmers engage in organic farming is the need to produce foods that are safe for consumption. Organic farming is labor intensive and, given the health benefits of its produce, farmers expect to fetch higher prices in the market. Sadly enough, most consumers cannot separate between non-chemically produced vegetables and chemically produced ones; hence, are not willing to pay higher prices. To them, vegetables are just the same, whether organic or not.

“The market is still a challenge for us. Consumers don’t want to pay higher for organic vegetables thus we are compelled to sell at the same price as those produced using chemicals to remain competitive in the market, otherwise we can’t sell,” said a farmer at Wera, Asembo.

Despite the huge benefits that organic agriculture can offer to health and environment, the adoption of the practice has remained very low in the Lake Victoria region. For example, organic farming can play an important role in reducing the chemical burden to the farm; thus, it can help in protecting biodiversity such as beneficial insects, as well as protecting ecosystem services. On the other hand, organic farming protects the farmers by reducing, for example, pesticide self-poisoning cases. In addition, organic farming can improve farmer’s yield over time owing to its huge benefits in the soil compared to conventional farming.

There are steps being taken to improve organic farming in Kenya, particularly by non-governmental organizations such as Kenya Organic Agriculture Network (KOAN), through enhancing the capacity for organic farming, awareness creation and improving the market for organic products. Such initiatives currently remain limited to Nairobi and the central region of Kenya, with the other parts of the country lagging behind. However, the government, both at the national and county level, is not doing enough to promote organic agriculture initiatives in the country.

b) Negative attitude and perception of smallholder farmers towards agro-ecology

The majority of farmers feel that agro-ecological farming practices such as organic farming cannot produce enough produce that can enable them to compete with other farmers that use chemicals to produce food, who they feel can engage in mass production. Others also feel that some of the non-chemical ways are not effective and that they cannot work. Therefore, many smallholder farmers have remained reluctant to join non-chemical food production initiatives that are being fronted by different organizations in Siaya County.

“Majority of farmers here do not believe that these approaches work and that they can produce enough to sell in the market. I think most of them want to see the success of these approaches before they can adopt them. Very few farmers have visited us here but you find that we have people coming all the way from Nairobi to see what we are doing,” said Charles, a member of Dala Rieko.

c) Lack of the non-chemical ways in controlling pests and diseases

“One of the diseases disturbing us is tomatoes blight. This has somehow discouraged some of us from growing tomatoes” A farmer said.

Smallholder farmers noted that they could not find tested non-chemical pest management alternatives in controlling certain pests and diseases. One of the diseases pointed out is tomatoes blight. This has made farmers either revert back to chemical pesticides or stop planting tomatoes. This paves a way to the need to conduct research on the efficient non-chemical approaches that can be used by smallholder farmers to manage pests and diseases that are challenging them.

d) Climate change

Climate change has not only disrupted food availability, reduced access to food and affected food quality, but it has also led to introduction of new pests and diseases. In the wake of climate change, smallholder farmers have to struggle with erratic rain, unpredictable farming seasons and new species of pests and disease which have become resistant or cannot be controlled with some of the non-chemical pest management techniques being applied by farmers. This calls for the need to develop and encourage agro-ecological pest management approaches that will be adaptable to the effects of climate change.

3.2 Implementation of crop specific, pest specific alternatives in Migori County

3.2.1 Overview of Migori County

Agricultural activities in the County occupy approximately 63% of the total land, with 60% under food crop cultivation and the remaining 40% under cash crop cultivation. Agricultural production is mainly undertaken in Uriri, Awendo, Kuria East, Rongo and parts of Suna East and Kuria West Sub-counties (County Integrated Development Plan 2018-2022). In terms of vegetable production, the County produces kales, cabbages, capsicum and tomatoes.

3.2.2 Non-chemical approaches used by smallholder vegetable farmers to control pests and diseases

The study identified the following non-chemicals approaches for pest management in Migori County:

a) Use of lab-lab to improve soil fertility and destroy striga weed

This is one agro-ecological approach that is being promoted by the Rural Farmers Research Network (RFRN) organization in Migori County. This approach entails planting seven different varieties of lab-lab plant on a farm that had been infested by striga weed. Using a farmer research model, the organization encourages farmers to plant all these varieties and compare the results with the normal practice of using chemical pesticides. The organization has enrolled about 200 farmers into the research project and the approach has proven to be very effective in controlling striga weeds on infested farms.



Plate 7: Photos showing lab-lab planted on a demo farm and maize crop infested by striga weeds in Oyani, Urir Sub-County. Photo by Fredrick - CEJAD

b) Intercropping

Intercropping was observed in several farms visited in Uriri Sub-County. It was noted that most smallholder vegetable farmers plant different types of vegetables on the same piece of land. Intercropping was observed in various vegetable and herb types including, kales, eggplant, spinach, turmeric, onions, African night shade, spider plant, carrots and capsicum, among others.



Plate 8: Photo showing peas and kales on the same piece of farm in Bware village, Uriri, Migori County. Photo by Fredrick - CEJAD

c) Use of solution of Mexican marigold (*Tagetes minuta*) and lantana camara as a pest repellent

These are other natural pesticides that are being promoted by Rural Farmers Research Network among its members as a repellent to various types of pests, including aphids and army worms. According to a key informant at the organization, these two herbs are crushed and mixed together and fermented for 7 days before they can be sprayed on vegetable crops.



Plate 9: Tito, Project Coordinator at RFRN, carrying Mexican marigold plant in Oyani Village, Uriri. Photo by Stanley - CEJAD

“Apart from promoting the use of agro-ecological approaches to pest management such as the use of Mexican marigold in repelling pests, we also encourage our farmers to grow organic vegetables in raised beds as they are critical in retaining soil water,” said Tito, Project Coordinator at Rural Farmers Research Network.

d) Use of grass onion as a pest repellent

This is one approach that is used at the Mercy Compassionate Orphanage’s organic kitchen garden to control aphids and army worms on vegetables such as kales and spinach. This practice was also observed in farms of other small-scale farmers in the region. Grass onion is planted in proximity to kales and spinach. According to respondents, this practice has proven very effective in repelling aphids and army worms and is one of the cheapest and easiest ways of managing these pests.

“I learnt about the use of grass onion to control aphids on Sukuma wiki in one of the forums that I attended in Migori and I decided to try it out on our kitchen garden. Since I started practicing it, I have not seen aphids on the leaves of my vegetables. It is really effective and I encourage other farmers to try it out,” Mercy, Director of Mercy Compassionate Orphanage, said.

e) Use of a solution of tithonia, Mexican marigold and pepper as a natural spray

This is another approach that is used by smallholder farmers to control common pests such as caterpillars, army worms and aphids on vegetables. To prepare this kind of spray, tithonia and Mexican marigold (*Tagetes minuta*) and pepper are crushed and mixed together. Water is then added and the mixture fermented for 3-7 days. A solution of one bar of soap can also be added to the final solution to help the spray stick on the leaves of vegetables. The soap also helps in suffocating the pests.

3.2.3. Challenges facing the use of non-chemical approaches in Migori County

The challenges facing the application of agro-ecological pest management and adoption of these approaches among smallholder vegetable farmers include:

- a) Lack of policy and regulation on agro-ecology:** Farmers in Uriri noted that agro-ecological initiatives have not gained much attention among smallholder farmers because there is no regulatory framework that guides agro-ecology in Kenya. This, they noted, has affected, for example, the prices of organic vegetables in the market. Organic products are not recognized by consumers, and as such fetch the same prices as chemically produced vegetables. They feel that they are not getting value for their efforts in contributing to safe and sustainable food production, which would otherwise be recognized if Kenya had a law that provided for things like certification schemes.
- b) Inadequate research on agro-ecology:** The farmers and stakeholders pointed out that there is inadequate research on agro-ecological approaches to pest management. Farmers thus do not have full confidence in some of these approaches, which, they pointed out, are not effective against some pests and diseases. This has resulted in continued reliance on chemical pesticides for pest management by many farmers who are making efforts to integrate agro-ecology in their food production system.
- c) Inadequate knowledge and training on agro-ecology:** There is low awareness among the farmers on 1) existing agro-ecological approaches to pest management and 2) other agro-ecological techniques for managing pests and diseases. Although there are attempts by different sector players such as community based organizations and non-governmental organizations to promote agro-ecology in the region, such programs are still limited and have not reached a lot of farmers. For this reason, most farmers are reluctant to adopt agro-ecological approaches in the region because of “fear of the unknown.” This points to the need for more awareness creation and training programs on agro-ecological approaches to pest management in the region.
- d) Inadequate extension services for agro-ecology:** Smallholder farmers expressed concerns with the limited access to extension services for farmers practicing agro-ecology. Furthermore, agro-ecology extension services have not been mainstreamed in the public extension services system at the national or county level.
- e) Limited production levels due to inadequate knowledge, skills and appropriate technologies among farmers:** The government has prioritized conventional agriculture and, as such, little attention is paid to agro-ecology for skill and knowledge development as well as technological

transfer. Besides, agro-ecology is labor intensive; hence, many farmers find it difficult to practice large scale non-chemical farming.

- f) **Inadequate market infrastructure and labeling requirements:** Farmers do not have a guarantee system for marketing and trading of agro-ecological products. This means that consumers cannot identify vegetables that have been produced using non-chemical means in the market; hence, farmers are not able to get value for such products.

3.3 National initiatives in agro-ecology implementation

The following agro-ecological initiatives are being implemented at the national level:

3.3.1 Implementation of Integrated Pest Management initiatives

There are two main IPM technologies/initiatives that are being implemented in Kenya to manage pests and diseases in crops: biopesticides and Push - Pull technology.

Use of Biopesticides

The use of bio-pesticides as an alternative approach to the use of chemical pesticides has gained recognition among various farmers in Kenya. To date, a total of 71 bio-pesticides have been registered for use in crops in Kenya.

Push- Pull technology

Developed by ICIPE, in collaboration with Rothamsted Research, United Kingdom, and partners in eastern Africa, Push - Pull technology involves intercropping cereals with a pest repellent plant, such as desmodium, which drives away or deters stemborers from the target food crop. Concurrently, an attractant trap plant such as Napier grass (*Pennisetumpurpueum*) is planted around the border of this intercrop to attract and trap pests. This technology has been adopted by farmers in Bondo, Butere, Rongo, Homa Bay, Busia and Kisumu.

3.3.2 Organic agriculture initiatives in Kenya

Organic farming is one agro-ecological initiative that has gained a lot of momentum in Kenya over the years. This is because a lot of attention has been paid to organic farming by various farmers, especially in the central region of Kenya. Some cities such as Nairobi have also witnessed a tremendous growth in the number of outlets for organic products. There are over 43,000 certified organic farmers in Kenya.

3.4 Organizations that support and initiate agro ecological implementations

The following institutions/organizations play an active role in the promotion of agro-ecology in Kenya:

Table 1. Organizations/institutions promoting agro-ecology in Kenya

Institution /organization	Role
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<p>Kenya Organic Agriculture Network (KOAN)</p>	<p>KOAN is the national coordinating body for organic agricultural activities in Kenya, and has a membership of producers, exporters and traders of organic products, non-governmental organizations, and like-minded individuals that promote organic agriculture in Kenya. KOAN promotes organic agriculture through supporting and mainstreaming organic agriculture in government programs and policies, creating a market for organic products, certifying and developing standards for organic products, capacity building for farmers, and developing extension and information programs, as well as ensuring quality control.</p>
<p>Organic Consumers Alliance (OCA)</p>	<p>Organic Consumer Alliance (OCA) is a limited company that advocates for a world free from toxins and environmental pollutants that cause harm to the soil, plants, animals, human beings and the entire ecosystem. OCA supports agro-ecology in Kenya by ensuring education and awareness on the benefits of organic agriculture by serving as a “Clearing House” for all health & safety matters related to the needs and concerns of organic consumers, providing a platform for organic consumers to exchange information/ideas and share experiences, and conducting capacity building, as well as policy advocacy.</p>
<p>Biovision Africa Trust (BvAT)</p>	<p>Biovision Africa Trust, a non-for-profit organization, was established in the year 2009 by Biovision Foundation of Switzerland and is supported by the International Centre of Insect Physiology and Ecology (ICIPE), with the main aim of alleviating poverty and improving the livelihood of smallholder farmers in Kenya and other African countries. BvAT supports agro-ecology through supporting information dissemination and technological exchange about human, animal, plant and environment health.</p>
<p>Community Based Organizations (CBOs) and Non-Governmental Organizations (NGOs)</p>	<p>These organizations play a key role on awareness creation and training in agro-ecology.</p>

CHAPTER FOUR: SYNTHESIS

The following conclusions can be drawn from the analysis of the findings of the study:

Legal framework: Kenya still lacks a legal framework on agro-ecology. However, manufacture, imports, exports, distribution and use of biopesticides in Kenya is governed by the Pest Control Products Act Cap 346.

Non-chemical pest management practices: There are several non-chemical pest management approaches that have been employed by smallholder farmers in the Lake Victoria region (Migori and Siaya Counties) to manage pests and diseases. However, adoption and use of such practices is still low among smallholder farmers. In most cases, such approaches are used alongside chemical pesticides. Some of the non-chemical approaches used by farmers include crop rotation, use of homemade natural pesticides, intercropping, use of wood ash and bio-pesticides and use of pest repellent crops such as grass onions. A lot of research and field testing of some of the approaches used by farmers is highly encouraged to determine the efficacy of these methods. This will help in improving adoption of such approaches by farmers.

Challenges: The study uncovered various challenges that farmers are facing insofar as the use of agro-ecology is concerned. The challenges enumerated by farmers included:

- I. **Lack of policy and regulation on agro-ecology:** Farmers expressed concern that agro-ecological initiatives have not gained much attention among smallholder farmers because there is no regulatory framework that guides such initiatives. This has had huge implications on pricing, certification and access to market.
- II. **Lack of knowledge of smallholder farmers & limited promotion on agro-ecology:** The majority of farmers feel that agro-ecological farming practices such as organic farming cannot produce enough produce that can enable them to compete with other farmers that use chemicals to produce food, who they feel can engage in mass production. Others also feel that some of the non-chemical ways are not effective and that they cannot work.
- III. **Inadequate research on agro-ecology:** Formal research in the agricultural sector in Kenya is carried out under the national agricultural research system, while the informal research is carried out by farmers. However, little emphasis has been given to agro-ecology in the national agricultural research system.
- IV. **Inadequate extension services for agro-ecology:** There is limited access to extension services for farmers practicing agro-ecology. Furthermore, agro-ecology extension services have not been mainstreamed in the public extension services system at the national or county level.
- V. **Limited production levels due to inadequate knowledge, skills and appropriate technologies among farmers:** The government has prioritized conventional agriculture and, as such, little attention is paid to agro-ecology for skill and knowledge development as well as technological transfer. Besides, agro-ecology is labor intensive; hence, many farmers find it difficult to practice large scale non-chemical farming.
- VI. **Inadequate market infrastructure and labeling requirements:** Farmers do not have a guarantee system for marketing and trading of agro ecological products. This means that consumers cannot

identify vegetables that have been produced using non-chemical means in the market; hence, farmers are not able to get value for such products.

- VII. **Lack of non-chemical alternatives for managing some pests and diseases:** Smallholder farmers noted that there are no non-chemical alternatives for managing certain pests and diseases. This has discouraged some farmers from using such approaches.
- VIII. **Climate change:** Climate change has not only disrupted food availability, reduced access to food and affected food quality, but it has also led to introduction of new pests and diseases.

Recommendations and project ideas emerging from the challenges

To improve adoption of non-chemical approaches to pest management in Kenya, the study made the following recommendations:

- i. Information sharing through awareness creation programs will be vital in sensitizing the farmers on the importance of non-chemical approaches to pest management. This will also play a key role in changing the mindset of farmers on such approaches.
- ii. A strong policy and regulatory framework on agro-ecology is needed. While there are attempts by various institutions to promote agro-ecological practices among smallholder farmers, this is happening without any legal backing. A legal framework will help spearhead agro-ecology in the country.
- iii. There is a need to develop and implement extension programs for farmers on non-chemical pest management techniques.
- iv. It is also important to develop and test non-chemical pest management approaches. Adoption of non-chemical pest management practices among smallholder vegetable farmers will highly depend on their effectiveness in managing pests and diseases.

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