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Agroecological farming impact on livelihoods improvement to inform county government on enactment of agroecology policy. Case study of Kiambu County, Central Kenya

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Abstract

The basis for the recognition, adoption and provision of an agroecology legal framework relies on the capacity of the existing agroecological systems to provide enough evidence on their effectiveness. Policymaking in Kenya is moving towards evidence-based policies; hence for agroecology to be recognized, documentation of its current systems is in need. To support the transition to agroecology and influence agroecology policy adoption, a study was carried out in Kiambu, a county in Central Kenya. The purpose of the study was to document the effectiveness of agroecological practices and use the results in agroecology policy advocacy work. From the study objectives, agroecology principles and dimensions, and opinions of the local agroecological promoters, a set of 16 indicators were used to investigate the effectiveness of agroecology under the five key dimensions: Economy, Health and Nutrition, Environment and Climate Change, Society and Culture, and Governance. According to FAO of the United Nations, the five dimensions are the priority areas for agricultural policymakers and are relevant in evaluating sustainable food systems. Different semi-structured questionnaires for farmers, government extension officers, NGOs field officers and county assembly members were designed to collect data. Farmers interviewed were only from Kiambu, while some agroecology promoters were from outside Kiambu.

Through agroecological farmers networks, women and youth empowerment, knowledge dissemination and sharing increased. A good increase to average increase was recorded on farm productivity, wealth creation, food security, nutrition, mitigation of climate change and environmental conservation. Land size and tenure systems were significant determinants of the type of AEP to be adopted. These positive changes were associated with AEP practices such as diversification, local trading, connectivity, local-based innovations, agroforestry, minimum tillage, integrated pest management (friendly biopesticides, mixed cropping), manuring and biogas production. The study results are consistent with many other practical and theoretical case studies that have mentioned or shown the facilitation of agroecology in improving farmers and the larger community's livelihood. The ability of agroecology to provide solutions to the above issues is a direct call for its recognition through promotion, the transition of farms and adoption in agricultural policies and strategies. These results provided a fundamental basis for evidence-based discussions supporting agroecology policy. However, agroecological practices need to be scaled up to enable local to regional applicability and policy contexts.

Acronyms

AEP-Agroecological practices
MASL-Metres above sea level
ICE- Institute for Culture and Ecology
COSDEP-Community Sustainable Development Empowerment Programme
KALRO- Kanya Agricultural and Livestock Research Organization.
FAO-Food and Agriculture Organization of the United Nations
HLPE-High Level Panel of Experts
AFA-Agriculture and Food Authority
MOALFI-Ministry of Agriculture Livestock, Fisheries and Irrigation.
NEMA-Natural Environment Management Authority
PELUM-Participatory Ecological Land Use Management
GOK- Government of Kenya
CBO -Community Based Organisation
NGO -Non-Governmental Organisation
GDP-Gross Domestic Product
ANAK- Alliance of Networks in Agroecology Kenya
ISFAA-Inter-sectoral Forum on Agrobiodiversity and Agroecology
KIPPRA-Kenya Institute for Public Policy Research and Analysis
IPAR -Institute of Policy Analysis and Research
FBO-Faith Based Organization
IPCC- Intergovernmental Panel on Climate Change
TAPE- Tool for Agroecology Performance and Evaluation
AAH-Action Against Hunger
UNSCN-United Nations Standing Committee on Nutrition

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1.1 Introduction

Global agricultural systems need to be re-oriented toward approaches that promote the judicious use of resources while improving food production and nutrition in an environmentally sustainable manner (FAO., 2018; IPBES., 2019). Agroecology has received extensive promotions as an alternative agricultural approach, especially for the resource-poor smallholder farmers (La Via Campesina., 2014; HLPE., 2020), who represent the most significant number among all world farmers. Agroecology has received this recognition because of its systemic approach that is built on local and ecological knowledge and renewable resources and confronts the increased use of agrochemical inputs resulting in environmental, social, economic and health challenges. Within science, agroecology has been a term to describe regenerative agriculture and food systems for almost a century, informing practices to build on complex ecological processes.

Agroecology has evolved through decades with changing scopes and definitions. Its definitions have been broadened, moving beyond the farm to include agri-food supply chains, consumption patterns and waste management. The evolvement led to a more comprehensive definition by Francis et al., (2003) as "the ecology of food systems" and as a scientific discipline, as a set of agroecological practices and as a movement (Wezel et al., 2009). These definitions have been greatly influenced by the continued engagement between different actors in the field of agroecology. Though the early scientific work on agroecology was fundamental to articulating its ecological dimensions, it did not engage the political dimension, which has long been advanced by social movements, communities and farmers' organizations. For example, the definition of agroecology as "the ecology of food systems," which was more comprehensive and holistic, still did not recognize the political dimension. Furthermore, the scientific literature definitions did not adequately acknowledge the deep foundations and precursors of agroecology in traditional and contemporary practices of indigenous people and peasant farmers (Nyeleni., 2015; Anderson et al., 2021).

With the continuous engagement between different stakeholders, agroecology has been gaining favor from an increasing number of farmers, non-governmental organizations (NGOs), some governments, a few researchers and analysts worldwide. Despite the increased recognition, the research establishment has not paid enough attention to agroecological systems. Inadequate evidence and the fragmentations of the limited data which would confirm the effectiveness of agroecological practices, make it remain to some degree an empirical question (D'Annolfo et al., 2017; Mottet et al., 2020). More documented evidence is needed to increase agroecology awareness about its increased agricultural performance through resource-conserving systems. It requires support from local, national and regional authorities to make it more authentic. Based on published performance, country authorities will be motivated to give prioritize greater recognition and inclusion of agroecology in policy and political decision-making. This then calls for more research on the holistic performance of agroecology.

Inclusion of agroecology in various governmental policies and strategies (food and nutrition, agriculture, climate change mitigation measures and natural resource use and conservation) may not be entirely due to agroecology's lack of a visible profile in agriculture, but also the argumentative context within which agroecology is situated and where it is applied. It is worth noting that agroecology is evaluated on its multifunctionality -- diverse productivity, ecological and social benefits -- which makes it complicated to be assessed and provide high-quality performance evidence to compare it with other agricultural systems. It is undeniable that the existing food systems that represent the largest part of the production are not 'feeding the world' despite generating much more food than is necessary. They are also creating many social and ecological problems and do not consider their adaptability to the changing climates and human lifestyles. The continuous drive by farmers using the current agricultural systems to increase yields has not decreased hunger globally (Anderson et al., 2021). In 2020, 811 million people were hungry globally (AAH., 2021), while in Kenya, 2.6 million of the 14.5 million food-insecure people were hungry (ASM., 2020). This is because a large part of agricultural and food systems depends highly on the decisions made by the political class on entitlement and rights on if, when and which people are, or will be able to nourish themselves. This is strongly supported through the formulation of legal frameworks and their implementation methodologies.

Increasing calls such as those from the committee on agriculture from Food and Agriculture Organization for United Nations (FAO) and High-Level Panel of Experts on food security and nutrition (HLPE) for comprehensive measurement and monitoring frameworks for evaluating food systems such as agroecology have made some impact since there have been some efforts on documentation. According to Graeub et al., (2016), about 65% of the extremely poor are employed in the agricultural sector hence it is of paramount importance to provide evidence on the effects of agroecological farming systems on small-scale farmers livelihoods.

Agroecology performance has not been widely sourced and documented. However, it has been said to be a system that improves yield, income and profit, enhances biodiversity, addresses climate mitigation and provides nutrition. Some of the study cases on agroecology practices that have been documented include the following. D'Annolfo et al., (2017) records yield increase by 61% while farm profitability increased by 66% on the cases analyzed using agroecological principles. Panisio et al., (2015) found out that diversification practices used in agroecology can reduce or eliminate any yield gap between organic and conventional agriculture. From the global north of Europe, Jan Van der Ploeg et al., (2019) found out that agroecology creates employment and considerably improves farmer's income as well as the total income generated by the agricultural sector at both regional and national levels. Pretty and Hine., (2000) found out that farmers practicing sustainable rice intensification on rainfed systems in eight Asian countries have seen small cereal increase combined with added production from additional productive systems components, such as fish in rice paddies and vegetables on dykes. These are among the many cases that have shown the capacity of agroecology to provide various benefits to humans and to nature.

1.2 Rationale of the master thesis

A majority of the research done and documented on agroecology has been directed towards promoting the application of agroecological practices while highlighting its potential (Altieri., 1998; Gliessman., 2016; Stassart et al., 2018) and not on the assessment on the efficacy of the applied practices. Inadequate evidence on the effectiveness of agroecology might sabotage farm transitions and recognition by policymakers. Therefore, the main reason behind investigating the effectiveness of the agroecological systems is to support its transition process and provide evidence to the farmers, educators, policy-making bodies, development institutions and other interested parties. Providing relevant information to policymaking within constraints of time, place and in a form that is understood, appreciated and accepted by all the relevant stakeholders has been a challenge. It all requires selecting information that is directly relevant to the defined task or objectives and interpretating it into a consistent and coherent form. Since agroecology is considered as an alternative model of sustainable agriculture, it must meet objectives that are perfectly in line with a sustainable development approach. As a consequence, the objectives set in this research have been inspired by those of sustainable development goals, agroecology principles and policymaking areas of interest.

Although many agroecology principles are present in many Kenyan farming systems, the term agroecology is still new to many local academicians, policymakers and farmers. The document can also be used by farmers with interest in transitioning to agroecology. Since the thesis will assess the effectiveness of agroecological practices, it can create a baseline for future evaluations of agroecological performance in Kiambu and other Kenyan counties. The master thesis document will also be made available to the stakeholders who participated or assisted in sourcing the data. The report can be shared with the neighbouring counties although the production systems might differ slightly.

1.3 Objectives of the study

Goal. The overall goal of this research project is to provide valuable insights on agroecological practices performance that could be used to build more informed policies and legal frameworks that recognize agroecological approaches.

Objectives

1. To identify various agroecological farming practices and investigate how they contribute to livelihood improvements in Kiambu County, Central Kenya.
2. To analyze how the practice of agroecology can inform in the enactment of agroecology policy in Kiambu County, Central Kenya.
3. To investigate agriculture-related policies and strategies in Kenya and how they embrace and promote agroecology and food production.

1.4 Research questions

1. How do the adopted agroecological farming practices contribute to the improvement of farmers livelihood in Kiambu County?
2. In what ways can the effective practice of agroecological farming inform and influence agroecology policy enactment in Kiambu county?
3. Which agriculture-related policies in Kenya embrace and promote agroecology and food production?

2.0 Situational analysis of policymaking in Kenya

The Kenyan policymaking in the past has been left to a group of experts who drafted policies mainly under the influence of country political class, donor interests, international power and vested interests of the private sector. Due to this, the resulting policies in the agriculture sector, which is recognized as the largest contributor to Kenya's Gross Domestic Product (GDP), often do not complement farmers' needs, yet they are designed to regulate their activities (Leippert et al., 2020). Furthermore, this explains the importance of developing agriculture since most poor people live in rural areas where agriculture is the main activity hence its development has significant impacts on poverty reduction. Additionally, according to Alila and Atieno., (2006), a large proportion of the agricultural sector's rural labour force are women. A decline in agriculture has thus far-reaching implications in terms of employment and income stability as well as gender inequality. In general, any policy or strategy affecting the development of the agricultural sector has important implications for the livelihood of farmers and the country's economic growth.

To improve on the effectiveness of policies and legal frameworks, especially those on agriculture whose aims are to increase productivity, income growth, food security, health and improve on resource and distribution, several developments on policing have been done. Among them was the establishment of SRA in 2004, which was started to complement the Economic Recovery Strategy (ERS) in agriculture and emphasizes public-private sectors partnerships to facilitate competition, enhance markets, raise efficiency in the use of resources and improve private sectors profitability (with no stakeholder consultations).

In the District Focus for Rural Development (DFRD), the government emphasized the use of participatory methodologies in programs and projects implementation and research undertakings of local consultancy, universities and policy research institutions, including these in table 1.

Table i. Major agricultural research institutions in Kenya

Name of the main institution	Policy research station

Nairobi university	Institute of Development Studies (IDS)
Egerton university	Tegemeo Institute of Agricultural Policy and Development
PRIs	Institute of Policy Analysis and Research (IPAR) The Kenya Institute of Public Policy Analysis and Research (KIPPRA)

The Alliance of Networks in Agroecology Kenya (ANAK) argues that there are still several weaknesses such as those in the budgetary process, problems of inter-ministerial and governments co-ordination, personality-driven processes, vested interests and confusing paradigms and policy narratives. Power, influence, current employment and economy continue to influence policy formulation and implementation strategies. However, there is some positive shift from some government departments using PRIs as much as they can to inform their policies. It is also important to recognize that the policy formulation environment has fundamentally changed with time. The emerging strengths include the increasing transparency and room for debate, formalized policy formulation process, improved budgetary process and increased capacity for policy analysis. This kind of policy process will be beneficial as budget allocations will have to follow the agreed strategies. For example, with Kenya passing the new 2010 constitution, the agriculture sector mandates are shared by both national and county governments. Although there is still much control of agriculture from the national government, at the county level, county assemblies have been given the mandate to enact legislation and modify those from national governments to ensure that they fit into their respective counties (GOK., 2010). This has created a forum where relevant local stakeholders can voice their opinions during policymaking processes.

Primarily, Kenyan policies and legal frameworks contain government resolutions that tend to influence the whole agricultural sector as the sector's stability relies on the government that allocates the resources. Transfer of some legislation duties is followed by budget allocations at the county level, hence locals can access some services locally. There is also a need to provide more avenues for farmers to express their views during policy formulation and implementation. It can facilitate the making of favorable agricultural policies. Participatory research methodologies development and documentation of sustainable food production system alternatives are among the approaches needed. Then, the studies documented will be forwarded or provided to the local policymakers. This would be advantageous to farmers, policymakers and other stakeholders as the farmers will be aware of the policies and legal frameworks in place. It is essential to highlight that problems with the effectiveness of policies have been due to resource allocation and initiation of policies that have not been established. Therefore, familiarization and understanding of the policies between the implementers and users will also ease the work of extension officers and prevent undue intrusion and implementation of foreign policies.

The Kenyan government is trying to transform agricultural systems to increase productivity, deliver food and nutrition security, reduce social inequality and minimize biodiversity loss through

its development programmes. They include; Vision 2030, Climate Change Act, Kenya Climate-Smart Agriculture Strategy, Big Four Agenda and other socio-economic development strategies. Although some of these key government programs are in various policies and legal frameworks, the policing departments and the relevant stakeholders have not been fully engaged. For example, through the implementation of the Big Four Agenda, Kenya aims to reduce the number of food-insecure people by 50 percent, achieve a 34 percent increase in the average daily income of farmers and reach a 27 percent reduction in malnutrition among children under 5 years of age (GOK., 2018), yet, smallholder producers who are in the majority and tend to sometimes suffer from the hunger have not been engaged.

Vision 2030 has a social pillar that seeks to build a just and cohesive society that embraces social equity within a clean and secure environment, while an economic pillar is included to ensure that Kenyans' livelihood prosperity is achieved (GOK., 2008). Agroecology can be part of the programmes as it contributes to the economic dimension by increasing diversity and value addition on farm products while enhancing gender and other social equity. In the development programs initiated by the government, some of the themes include climate change, food security and nutrition, sustainable use and conservation of natural resources, while not forgetting the adherences to the Article 43(c) of the Kenyan constitution which provide the right to be free from hunger and to have adequate food of an acceptable quality (GOK., 2010). Generally, most government's stated interventions are in conjunction with agroecology principles. Farmer's compliance and contribution to government agendas and policy have not been effective as expected due to the lack of government engagements with farmers and other relevant stakeholders.

Although the term 'agroecology' is missing in the existing government's departmental policies and strategies, its elements and principles are present in various departments but with marginal recognition hence they are less effective in operation. For example, in the KCSAS implementation framework of 2018-2027, with the purpose to "promote climate-resilient and low carbon growth sustainable agriculture that ensures food security and contributes to national development goals in line with Vision 2030'' (GOK., 2017), agroecology elements; diversity, efficiency, synergies and resilience are included. The lack of agroecology policy has contributed to its poor recognition and official government support and hindered the realization of its great potential in transforming agricultural practices and natural resource management in the country.

Table ii. Government programs and strategies with agroecology elements.

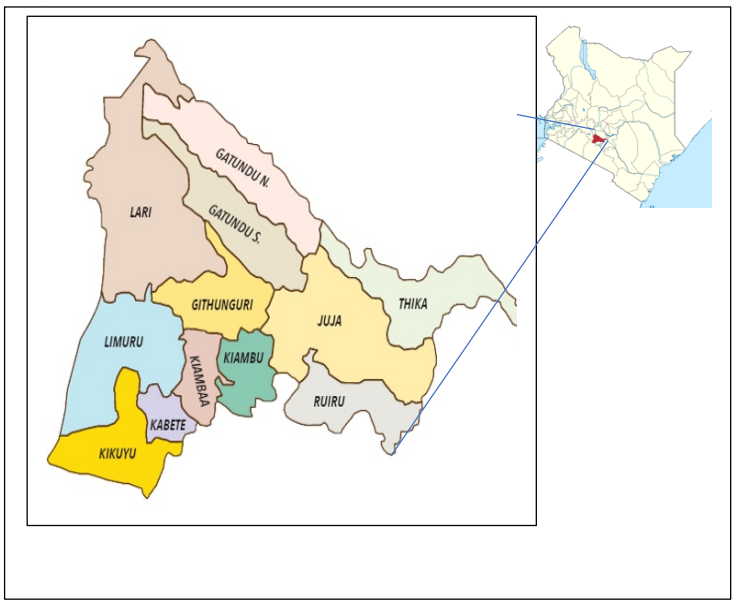
Project/strategy	Year of formation	Elements
Vision 2030	2008	Diversity, efficiency, synergies and resilience
Small-scale Irrigation and Value Addition Project (SIVAP)	2015	Recycling, efficiency, value addition
Climate Change Act	2016	Biodiversity, connectivity, participation
Kenya Climate-Smart Agriculture Strategy (KCSAS)	2017	Resilience, circular economy, soil health
The National Agriculture and Rural Inclusive Project (NAGRIP)	2017	Value addition, participation, connectivity
Big Four Agenda	2018	Nutrition diversity, secure food systems, economic diversification

3.0 Methods

3.1 Study Area-Kiambu county

Kiambu was selected for the case study because it comprises diverse farming systems related to food production such as large vs small scale production, rural vs urban markets, farms vs residential land use and diverse ecological zones. It is close to the ICE office where I was attached. ICE has been organizing forums and leading a committee working on advocacy for an agroecology policy for Kiambu. It is also among the counties with the many agroecological projects that ICE and other closely-related organizations have been working.

Figure 1. **Map of Kiambu county**



Kiambu County is one of the 47 counties in the Republic of Kenya. It is located in the central region and covers a total area of 2,543.5km^2 with 476.3km^2 under forest cover according to the 2009 Kenya Population and Housing Census. Kiambu county borders Nairobi, Kajiado, Machakos, Muranga, Nyandarua, and Nakuru. Currently, the county is divided into 12 sub-counties.

Kiambu county population by 2019 census was 2,417,735 with 1,187,146 males and 1,230,454 females (sex ration of 1:1.04). This was influenced by the county's high population growth rate, which was at 2.81 percent and the influx of people working in the city who prefer to stay in Kiambu and its surroundings which are characterized as less congested and well-developed infrastructure areas.

Kiambu County is divided into broad topographical zones, upper highland, lower highland, upper midland and midland zone. The upper highland zone is found on the Aberdare ranges' extensions that lie at an altitude of 1800-2550masl. It is dominated by highly dissected ranges and it is very wet, steep and important as a water catchment area. The lower highland zone is mostly found in Limuru and some parts of Gatundu, Githunguri and Kabete constituencies. The area is characterized by hills, plateaus, and high-elevation plains. The area lies between 1500-1800 masl and generally a tea and dairy zone though some activities like maize, horticultural crops and sheep farming are also practiced. There are also large plantations of pineapples owned by Del Monte in parts of Thika sub-county. The upper midland zone lies between 1300-1500 masl. The landscape is comprised of volcanic middle-level uplands. The lower midland zone partly covers Thika town Limuru and Kikuyu constituencies. The area lies between 1200-1360 masl, with steep slopes and valleys, which are unsuitable for cultivation. Forests cover large parts of Lari and Gatundu sub-counties.

The county is covered by three broad categories of soils: high-level upland soils, plateau soils and volcanic footbridges soils that cover large parts of the county. These soils are of varying fertility levels, with soils from high-level uplands from volcanic rocks, being very fertile. They are red to dark brown and well-drained with moderate fertility; conducive for livestock keeping and growth of various cash crops and food crops such as tea, coffee, horticultural products, pyrethrum, vegetables, maize, beans, peas and potatoes. These soils are found in the highland areas. Low fertility and shallow soils are mainly found in the middle zone and the eastern part of the county, forming part of the semi-arid areas (low rainfall), severely limiting agricultural development. However, these soils are suitable for ranching and the growth of resistant crops. The soils are sandy or clay and can support drought-resistant crops such as soya beans and sunflower as well as ranching. These soils are primarily in Juja, Thika town, Ruiru, and Kabete constituencies.

Climatic and ecological conditions

The county experiences a bimodal type of rainfall with long rains between mid-March to May and short rains between mid-October to November. The annual rainfall varies with altitude, with higher areas receiving as high as 2000mm and lower areas of Thika town constituency receiving as low as 600mm. Water in the county is from two principal sources, surface and sub-surface. About 90 percent of the county's water resource is comprised of both surface water resources and groundwater potential. The county has several permanent rivers, streams and wetlands such as the famous one from Ondiri in Kikuyu. The average rainfall received by the county is 1200mm. The

mean temperature in the county is 26°C, with temperatures ranging from 7°C in the upper highland areas to 34°c in the lower midland zone. The lowest temperatures are experienced in July and August, whereas January to March is the hottest period.

Economic activities

Cropland makes up 40% of the agriculturally used land in Kiambu county. Majority of the farmers have diversified croplands. In the areas far from Nairobi, more land is in crops than in areas bordering Nairobi and Kiambu which is mostly occupied by other forms of investments. Agriculture in the survey sample is primarily rainfed, with about half of the households cultivating vegetables, cereals and fruits. Most large-scale farms such as Del Monte pineapples use irrigation due to low rainfall conditions while most export flower farms are under greenhouses. The top field crops grown by households include cereals (maize, rice, wheat, millet), vegetables (cabbages, green kale, spring onion, pumpkin, zucchini, cucumber green beans, sponge gourds and garlic), tubers (potatoes, sweet potatoes, arrow roots) and fruits (passion fruits, pineapples, nuts, avocados, macadamia). Multipurpose trees, shrubs and grasses such as napier grass, grivellia, calliandra for animal feed are present. Animals reared include cattle (mostly dairy cows), pigs, sheep, goats and chickens. Raw milk, eggs, meat and milk products are the most important animal source foods produced for direct household use. The same products are sold in addition to fish. Majority of farmers use much of their produce for household consumption hence keep them in their stores while the rest is sold. The mode of marketing is mainly farmgate followed by local marketing.

3.2 Methodology

For this study, an evaluation questionnaire was designed. This was in order to get the information from farmers and other relevant stakeholders such as extension officers, NGOs promoting agroecology and a member of the county assembly. Selected themes were essential alternatives for this case since it was impossible to conduct direct measurements due to covid-19 restrictions, finances (personally-funded research) and the limited time available for research. Themes depended on the data available on the farm, past research, government and NGOs reports. The designed questionnaire was built on five key dimensions (Economy, Health and Nutrition, Environment and Climate Change, Society and Culture, and Governance) that have been said to be relevant to sustainable food and agriculture and to achieve the ecosystem and human well-being (TAPE., 2018). These key dimensions are tandem with four aspects of agroecology: social, economic, environmental and institutional. They are described as priority areas of work for agricultural policymakers. The five dimensions are also strategic to frame the study's results and communicate them to inform policymaking processes (TAPE., 2018).

From the list of the study objectives, a set of indicators that would support the key dimensions were used to investigate the effectiveness of agroecological practices. Indicators play an important role in transforming data and adding value by converting them into relevant information for direct use by decision-makers and the public. As derived from Martin et al., (1996) the term 'indicator' is described as a variable that helps to understand and to interpret a complex system by

synthesizing data, showing the current state, demonstrating the achievement, communicating the current status to users for management decisions and policy development. At various levels of use, indicators describe the overall state of a system and can highlight several factors that affect it. FAO has also recognized some of the indicators used in this case in its 10 elements of agroecology (FAO., 2018).

Table iii. Summary of question formulation

Key dimension	**Indicators/Criteria and their definitions**
Economy	Productivity-overall farm productivity- Total physical biomass/volume of goods produced from a set of resources and inputs (FAO., 2017)
	Income-Profit – is the value of the outputs produced by the farm minus the value of the inputs used (FAO., 2017)
	Added value- Created wealth that helps to sustain an enterprise or a household.
Health and Nutrition	Food security- is the availability of food and individual ability to access it (FAO., 2014).
	Dietary diversity- is nutrient adequacy (coverage of basic needs in terms of macro and micronutrients) and diet variety/balance, which are the two main components of diet quality (UNSCN)
	Exposure to pesticides-
Environment and Climate Change	Climate change- long-term shifts in temperature and weather patterns resulting from natural and human-related activities (UN)
	Agrobiodiversity- is the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries (FAO)
	Soil health- covers the stabilization of soil structure, the maintenance of soil life and biodiversity, retention and release of plants nutrients and maintenance of water-holding capacity, thus making it a key criterion for agricultural productivity and environmental resilience (FAO., 2005).
Society and Culture	Connectivity- (producer-consumer and other stakeholder interaction) i.e on knowledge sharing and trading.
	Women empowerment- facilitation of women with resources, skills and decision-making opportunities with the goal of enhancing the wellbeing of themselves, their families and that of the community.
	Youth empowerment- is the facilitation/enhancement of young people with resources and skills to enhance their wellbeing and that of the community hence constructing meaningful community change.
Governance	Land tenure systems- are the system of rights and institutions (terms and conditions) under which land is held, used and transacted and is one of the principal factors determining how resources are managed and used.

	Farmer's networking and participation in governance forums
	Complementarity of policies and strategies with farmers' work.

This research approach is relevant because it creates a holistic picture of a farm and its related sectors by showing its multidimensional features. Moreover, it is crucial for raising awareness about the need for agroecological projects and initiatives by demonstrating their effectiveness and benefits. Additionally, the study results will highlight how effective agroecological strategies conserve the environment and improve community livelihood. Lastly, it can be used to convince stakeholders such as transitioning farmers and decision-makers to support agroecology recognition and development.

3.3 Collection and evaluation of data

A 6-month internship was spent at the Institute for Culture and Ecology (ICE) in Nairobi, Kenya. It was an opportunity to understand the situation of agroecological farming in Kenya, study the host organization mode of operation and its network with affiliated staff and across other initiatives of agroecological agriculture in Kiambu region.

The research was done in two steps. Firstly, to document the effectiveness of agroecological farming on livelihood improvement and environment management, and secondly, to use the documented results to inform agroecology policy formulation. A case study approach was used to collect the information. Case studies have an advantage over other research methods when a how or a why the question is being asked about an ongoing set of events over which the investigator has little or no control. Its nature also provides room for several sources of information.

As agroecology information on application and knowledge is relatively low in Kenya, few publications and online resources were used for consultation. At the onset of the research, the strategy entailed contacting field staff from ICE and other NGOs for short unformal conversations, traveling to the farms they work with to get personal insights, interviewing them and the farmers. Online research was conducted to get confirming information in addition to the interviews. After gaining a better understanding of the farming situation in Kenya, the study focused on examining the effectiveness of agroecological farming on the community's livelihood. For this part of the research, snowball sampling was used, whereby contacts made referred to other farmers, policy implementers and non-state agroecology promoters, allowed to reach a more comprehensive network and information in addition to those associated with the ICE.

Semi-structured questionnaires were used with face-to-face interviews to gain a deeper understanding of farmer's and other interviewee's experiences with agroecological farming (See appendix I, for interview questionnaires). Semi-structured interviews are a qualitative method that

uses predetermined questions but provides room for spontaneous changes by the interviewer (Qu and Dumay 2011), very efficient in exploring personal opinions and people's experiences on a specific topic. This methodology offers an opportunity for the respondents to answer in their own terms in which relevant themes develop during the interview. In this sense, the interview should resemble a 'flowing conversation'. The method is particularly suitable for small-scale case studies and provides good flexibility to adapt to new information emerging during the interview process (Drever., 1995).

Sample question. "Created wealth," the criteria for this study on the economic dimension, was assessed with the question, 'How do you rate the growth of your household wealth since you started employing agroecology?' Choices included 'No influence at all,' 'Partial increase,' 'Medium,' 'A good increase,' and 'A great increase'.

To get valuable insights, the interviewees were selected by the attribute of being a contact person. So, the chosen interviewees all had knowledge based on their work from farming, policymaking and policy implementation. For example, the policy implementers and non-state agroecology promoters offer consultation services to farmers, teach at agricultural vocational institutions and have access to agricultural data. Another example is the natural resource management department, which works together with farmers. Therefore, the interviews were held based on their personal knowledge, work experience or as representatives for stakeholder groups and field assistants.

The interviews with the farmers were approached a bit differently because the aim was to collect comparable information about each farming practice. Therefore, the interviews were conducted more on preset questions. In some cases, the questions could deviate if a farmer has a unique practice or a particular production activity on the farm. In this case, time spent depended on its connection to the aim of the research though later, the conversation is led back to the original questions.

The agroecological farmers were selected from farmers groups and organizations working with NGOs and community-based organizations (CBOs) promoting agroecology and other practices such as those of ecological or organic farming for more than five years. These groups are formed by farmers with shared goals or interests such as food and farm input production, knowledge exchange, value addition, agroforestry or product marketing. The farmers groups support agroecological practices. Other practices of sustainable agricultural systems that align with agroecology principles were also considered. The sampling approach of the agroecological farmers was based on the following criteria:

- farmers will be from within Kiambu county to control the location effect.
- farmers who are part of such agroecology projects/groups and have been practicing agroecology for not less than 5 years

- farmers with mixed cropping systems and integrated crop-livestock farming systems were prioritized.

Farmers with integrated crop-livestock production were prioritized because the system is highly relevant to the assessment of agroecology. Mixed crop-livestock system shows a defining agroecological characteristic (diversity) which in turn, provides increased opportunities for operations such as full nutrient cycling and circular economy approaches, reduced dependence on external inputs, increased natural synergies, multiple outputs maximization and therefore offers multiple sources of production and income. These features are fundamental characteristics of a diversified agroecological farm. Thus, mixed crop-livestock systems appear to be ideally situated in the transition to agroecological systems, which is one of the reasons the study was done.

A total of 48 farmers were interviewed, four farmers were selected from every sub-county and 2 farmers per group. Five field officers, 2 extension officers and a member of the Kiambu county assembly were also interviewed. Sixty percent of the respondents were female, 40 percent male, with a collective average age of 40-49 years (see appendix II for a list of interviewee demographics). Less data was collected from farmers focus group meetings. The majority of the elderly farmers (above 60 years) did not attend. The quantitative information(information in percentage) includes only the farmers outcomes. Results obtained from the non-farmer respondents are few in the first three dimensions; economy, health and nutrition, and society and culture. Most non-farmer results are in the dimensions of environment and climate change and governance in generalized form. Because of less time for interviews due to covid-9 restrictions, non-farmer respondents were mainly interviewed on policies and the farmers connection and networking.

4.0 Results

The data in this chapter is the generalized outcome of interviews with agroecological smallholder farmers from Kiambu, non-state promoters of agroecology, policy implementers and a policy maker.

4.1 Economy

Table iii. Results of economic assessment questions

Criteria	**result**
Productivity	90% of farmers experienced a medium increase in productivity while 65% have experienced a good increase.
Income/profit	74% had a medium increase in income
Created wealth	60% of farmers had a medium increase in household wealth
Circular and solidarity economy	90% sell their extra produce locally- Kenyan markets 10% sell part of their produce internationally indirectly

4.1.1 Productivity

In this study, the terms productivity represents the difference between the production before the use of AEP, during the transition period and after five years of using AEP. Ninety percent of the farmers estimated that their overall farm productivity had improved compared to the past production experience. The majority of the other 10 percent were farmers who do not rear animals. According to 60 percent of farmers interviewed, the productivity per single crop had decreased during the first years of the transition period. However, a moderate increase had been experienced in the consequent years. Most farmers indicated that the diversification of farm initiatives had compensated for the gap arising from a drop in single crop production. Although a majority of farmers do not keep farm production records, 60 percent mentioned that the productivity change is evident. For example, several Githunguri and Limuru sub-counties farmers mentioned how maize, peas, beans and potatoes production had greatly increased within a span of two years. The farmers had divided their land and rotated crops; between maize-peas mixture, cabbage and potatoes-beans mixture and indigenous vegetables.

Farmers with integrated crop-livestock systems had more products; crops, milk, meat, and draft power, besides adding another trophic level to their systems, making it even more complex. Animals are fed on crop residues and weeds with a little negative impact on crop productivity. This serves to turn unusable biomass into animal protein and transforms plant materials into manure. According to farmers practicing crop production only, manure access had decreased since most farmers rearing animals spread the manure on their lands. The farmers with animals also stated that they still do not have enough manure since they rear few animals, and animal waste is used in biogas production before being applied on the farm. The need for animal feed broadens

the crop base to include plant species such as desmodium and napier grass which are helpful in soil and water conservation. Leguminous plants such as sesbania are often planted to provide quality forage besides improving the soil's nitrogen content.

All the farmers interviewed were members of farmers groups that partner with various organizations with agroecological development projects that incorporate traditional knowledge and modern science elements. The development projects have features of resource-conserving and effective production systems, such as polyculture, agroforestry, and integrated crop-livestock systems. Farmers from well-established networks mentioned that the networks have assisted in disseminating knowledge, practices and shared pieces of equipment. Farmers stated that these practices have a particular contribution to their increased farm productivity.

4.1.2 Income /profit

Income is an important part of a farm economy. The ability of a farm to make a profit enhances the sustenance of the farm systems and producer's livelihood. Profit has been a key determinant in developing and implementing agroecological practices and projects. Seventy-four percent of the farmers mentioned that overall farm income had a good increase. Twenty percent of farmers with single enterprises stated that they had not yet experienced a significant change in income. Farmers owning either single enterprise or integrated crop-livestock systems had a low-income percentage because a majority of them mentioned that they produce for household use, sell or share with the extended family living close hence they do not account for it as an income source. According to farmers, the basic income has increased on average due to the diverse enterprises producing various products all around the year. Diversification has also created a favourable environment for farmers as resources from one crop or animal enterprise are used to run the ongoing or next production. The provision of different products has attracted more customers interested in sourcing from a single producer hence providing a dependable market that increases farmers market coverage. The market is reliable because most consumers are local and buy directly from the farm, reducing packaging and transportation costs.

Thirty percent of the farmers noted that farm labour increased which sometimes forced them to seek external workforce. Farmers have more food than before. The finances used to buy food are allocated for hired labour and farm improvement. The point to note here is that most farmers do not consider the manual labour or skills provided by the household members as an input resource.

4.1.3Added value

Added value is interpreted as the created wealth resulting from the farm above the general wealth of the farmer. Sixty percent of the interviewed showed a measurable medium increase in wealth. The wealth generated has been used to improve farm and cater for other needs such as education. Sixty percent of farmers used a large part of their crop and animal production on household needs while the rest is sold. The majority of farmers stated that they had a medium increase in created wealth because of small farm sizes with fewer market products hence the profit earned influences

wealth slowly. Many farmers do not have other income sources hence they rely on the farm income to cater for their family needs. Most farmers claimed to generate enough income to live off the land throughout the year, even if subjected to the regular weak market-based economy. Sixty percent of farmers mentioned that wealth generated from their farms could be evident on farm structures or household improvement. They have educated their children to high schools and universities with farm income and manageable loans from farmers' SACCOs. New investments such as farm equipment and structures, i.e., concrete and plastic water tanks, animal sheds, housing improvements, have been built from farm income savings in farmers SACCOs.

According to farmers, rural outmigration has partly been replaced by rural in-migration, with some people investing in agriculture as a full-time job or an extra job. This has provided rural farmers with an additional income as they are primarily involved in managing the new farms. The employment provided is sometimes bartered with seeds, seedlings or farm products, thus not directly contributing to their wealth. Even if Indirectly, it takes longer to be evident. The labour demand tends to be available when they are needed in their farms hence sometimes unreliable. These results are consistent with the Sidney et al., (2020) study stating that farm employment tends to be available at the same time of the season. Despite these challenges, farmers with small farms have benefited from the increased work which has also triggered a wage increase. Farmers from Gatundu and Githunguri areas mentioned that intercropping of bananas and coffee had reduced their workload due to decreasing weed population. This has given them more time to earn extra income from other farms. Earnings from individual farms and labour services have raised the living standards of some farmers, hence reducing human inequalities.

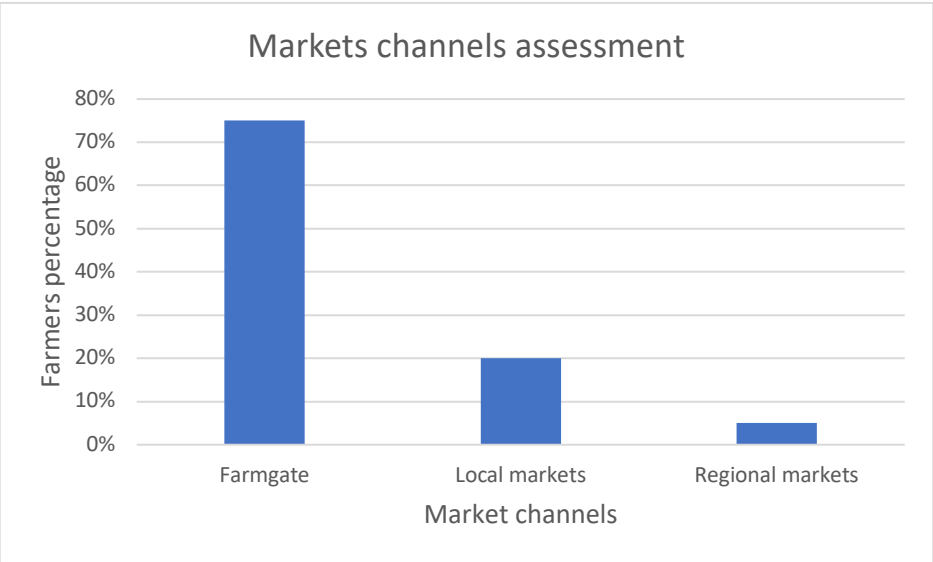
4.1.4 Circular and Solidarity economy

Ninety percent of the respondents produce and sell most of their farm products primarily locally, except for a few horticultural crops such as cauliflower, broccoli, cucumbers, sweet pepper and eggplant. Most of the horticultural crops are sold in the nearby urban markets. Some cash crops like tea, macadamia and coffee (requiring more processing) are sold to the processing companies through their local agents. The existing intermediaries are either those of processing companies or local farmers themselves.

Table iv. Results on farm products utilization question

Farm products utilization	Farmers percentage
Household consumption	60%
Marketing	40%

Figure 2. A graph on markets channels assessment.



As 60 percent generate products for household consumption, the remaining products are available for marketing. Seventy-five percent sell at farmgate, 20 percent at local markets and 5 percent at regional markets. Most of the local buyers are well known by farmers as they are fellow farmers, regular customers or local traders. This has created a good network for the local economy. In Limuru and Githunguri sub-counties, the processing of cash crops like tea and coffee is happening in small scale quantities. However, the farmers are yet to access reliable market avenues. According to the extension officers, the networking of agroecological farmers has improved the flow of information into villages and local areas over time. For example, the establishment and growth of organic shops and markets in big towns like Thika and Nairobi have encouraged agroecological farmers to process and improve packaging on their products. Few farmers manage to supply products to the market traders. Inadequate market information and few product quantities make the intermediaries and traders offer low prices. The farmers noted that they continue to accept the low prices to avoid incurring more costs on the packaging, transport and municipal council taxes.

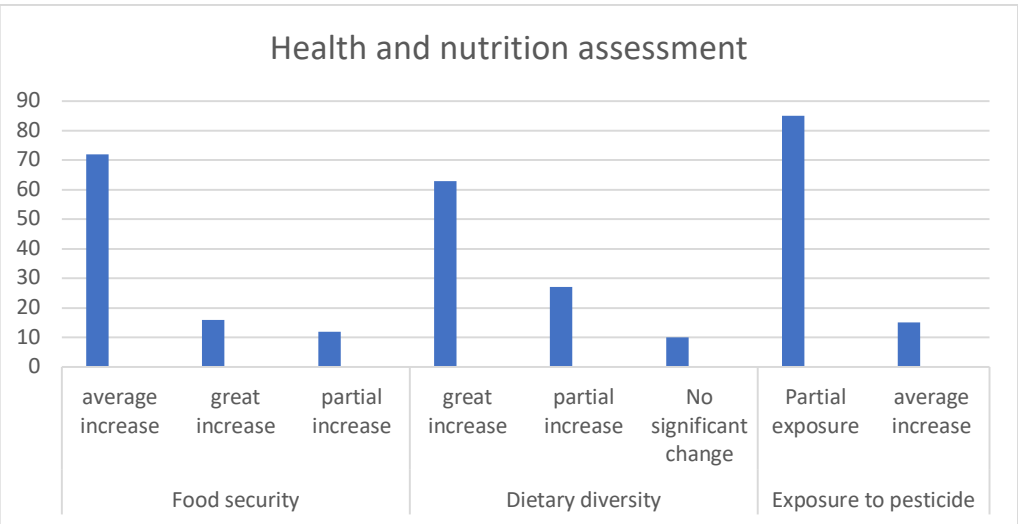
Local consumers and residents of urban areas such as Thika, Githunguri, Limuru, Kiambu and Kikuyu provide accessible markets. Although there are enough and available markets, many customers have not been quite thoughtful or aware of the nature of products in the markets hence tend to value both agroecological and conventional products as being of the same quality. This makes the marketing of ecological products quite difficult if farmers raise farm products prices. Weak networks among the farmers and customers have been part of the setback. Farmers with good connections with customers noted that the customers are conscious of the importance of ecological products and those produced locally. The connection extends beyond product trading to knowledge sharing on food production, processing and consumption. The network between farmers and customers has been of great importance during the covid-19 pandemic. The farmers

were supplying the customers directly or customers would pick products from the farms. This created a good environment of avoiding the common congestion found in most marketplaces, which are usually located in centres, towns or cities. According to the farmers, the majority of customers are ready to buy from local agroecological producers.

4.2 Health and nutrition

4.2.1 Food security and nutrition

Figure 3. A graph on health and nutrition assessment questions



Thirty percent of the farmers sell more than 50 percent of their vegetables and cereals while sixty-five use more than 50 percent of their produce for households. Seventy-two percent responded that their food security had increased on average, 16 percent stated that their food security had partially increased between different years due to varying weather patterns and post-harvest practices. The remaining 12 percent noted that they had not experienced significant change, though diverse nutrition had partially increased. For example, farmers from Lari sub-county have been practicing green vegetable preservation by drying vegetables with a drier that farmers involvement innovations have made. Several producers showed processed products they make when the market price is unfavorable. The farmers practices vegetable drying during surplus season hence they have enough vegetables when out of season as well as they have reduced farm product waste which smallholder farmers face regularly. Farmers in Githunguri are trained on making jam from their farm fruits. Fruits jams and paste are processed from fruits with minor injuries and from the surplus season. The value addition has increased their household food and income by selling value-added products. According to the farmers, the challenge of the surplus season is that most farmers have the same farm products, which lower market prices, increasing possibilities of lost income due to wastage.

Figure 4. Locally made vegetable drier

Majority of farmers mentioned that their food security and nutrition had resulted from the increased number of crops cultivated and species of animals raised, and local marketing of their products which has increased their incomes. The farmers have the tradition of growing seasonal crops that match their two seasons hence there is production between them. The marketing of horticultural and cash crops such as vegetables, tea, coffee and pyrethrum provides them with an extra income that is used to buy food products they do not produce or when they are off-season. Favourable income and networking with farmers from other regions allow customers to access farm products that they do not cultivate due to their climate. A large population from Thika and Ruiru have topography with low fertile soils and less rainfall hence depend on other regions such as Githunguri, Gatundu, Lari and Limuru to get their extra needed food.

4.2.2 Dietary diversity

Sixty-three percent of the interviewed farmers stated that their dietary diversity had an average increase, 27 percent had a partial increase, while 10 percent had not experienced any significant change. The 10 percent mentioned that they have been using diverse farm crops and animals hence a vast dietary source has been available. The changes they have made are adopting new AEP, especially on soil maintenance and post-harvest management practices. For several farmers who explained that their diets had no significant change, the strategies of sourcing their diets have increased. They revealed that this had given them the decision to eat what they want and not only

what is available. They have also been able to substitute what they produce with other food products that satisfy the same dietary needs.

Adopting intercropping and integrated crop-livestock systems has provided farmers with diverse food products. The idea of integrated and mixed cropping in farms has increased lately due to the education and training the farmers have received on agroecological practices on various platforms facilitated mainly by NGOs and the government with 62% and 30% respectively. The nature of their mixed production systems that includes both local to exotic varieties increases nutrient diversity. This is highly evident in vegetables, fruits, legumes and animal breeds. Majority of farmers who are regular attendees of the knowledge sharing forums have not been buying vegetables in the past years because they have been farming more than seven varieties of vegetables among other crop varieties. The varieties are of indigenous and exotic origin as they produce both for household and market.

Mixed farming has influenced the diversity of diet sources and introduced new methods of food preparation that ensure that the nutritional value of the food is not reduced or destroyed during storage, preservation and cooking. In one of the farmers meetings, the farmers were trained by a fellow farmer the lost tradition of preparing indigenous vegetable. Agroecological networking groups practices promote also provide safe and healthy food for households.

4.2.3 Exposure to pesticides

Eighty-five percent of the farmers mentioned that direct exposure to pesticides had significantly reduced as they no longer use pesticides in their farms. Application of AEP such as mixed cropping, integrated pest management, organic and ecological non-harmful pesticides have reduced pest and weed infestations. This has reduced the need to spray harmful synthetic pesticides. Most mentioned AEP were mixed cropping, organic manuring, cover cropping and crop rotation. To decrease any spread if infestations occur, the farmers have separated plots with grasses such as napier grass, chili pepper, bananas and pigeon peas. The farmers use recommended protective gear to reduce any chances of chemical exposure if there is need to spray.

Ten percent of the interviewed farmers indicated that neighbours use chemicals hence they might have spread to their farms either through the air or flowing rainwater. Ten percent of the farmers also stated that they might be exposed to harmful chemicals when working in the nearby large farms where chemical use is common and they lack enough and appropriate protective gear, hence increasing possibility of pesticide exposure. Several farmers have built non-living fences and planted live fences around their farms to minimize the risks of chemical spread. Few farmers noted that they might be exposed to pesticides from some of the products they buy such as cooking oils and cereals produced in far counties and countries.

Farmers highlighted that working with various NGOs and government extension agents has encouraged them to reduce chemicals usage. In conjunction with research institutions and government extension officers, NGOs have educated them on preparing friendly farm inputs such as bokashi and other spray liquids. Young farmers from Kiambu have been practicing vermiculture. The worms transform farm waste and animal manure to vermicompost. This has reduced the need for harmful solid inorganic and foliar fertilizers application. The farmers produce worms that are used as an alternative source of animal feeds hence reducing the need for synthetic protein. According to the farmers, this has reduced the need for inorganic inputs and the high cost associated with the inputs that requires farmers to expose themselves to chemicals by working for large farms to get income to buy the pesticides.

Figure 5. Vermicompost production,) locally designed vermicompost production structure b) animal and kitchen waste put on the trays with worms, c) refined vermicompost-drying phase, and d) packaged vermicompost for storage and distribution.

4.3 Environment and climate change

4.3.1 Climate change.

According to interview responses, many farmers use AEP that mitigates climate change. Some farmers who use them are not aware of their consequences on climate change and to the environment. Ecological practices used include cover cropping, intercropping, leguminous cropping, minimum tillage, crop rotation, mulching, organic manure use, integrated crop-livestock systems, agroforestry, use of biopesticides and land terracing. Majority of farmers have trees in their farms either as fruit trees, fences, shade trees and small forests. Although farmers mostly plant tress for various purposes such as economic benefit and farm protection, they are major contributors to terrestrial carbon sink and modify surrounding environmental conditions.

Majority of the farmers interviewed are aware of climate change and they have been acquiring education from local leaders, the internet, social media, NGOs, and other agencies on sustainable systems. Due to their capital capability and ability to develop farming information quickly and widely, the new generation of farmers has introduced new sustainable, innovative practices through technology. Interviewed farmers hope is that these experiences will stimulate others to explore and develop new adaptive mechanisms that will help smallholder farmers guard themselves against the harsh effects of climate change. The available innovative practices are being shared, replicated and scaled up for other farmers.

4.3.2 Agricultural biodiversity

Agricultural biodiversity is described the diversity of crops species and varieties, livestock species and breeds, pollinators and soil microorganisms that makes agricultural and food production possible (Erisman et al., 2016). Ninety-eight percent of the respondents mentioned that farmers practice mixed-crop rotation ranging from three to seven crops, and numbers decline toward the eastern part of Kiambu. Small land sizes and favourable climate encourage the farmers to practice intensified agriculture, meaning the production per unit area is high. This is common on the western side, where there is large-scale production of coffee and tea, whereas smallholder farmers are marginalized with small land pieces of land.

Although many farmers practice crop rotation, some have portions of perennial and permanent crops such as coffee, tea, napier grass, fodder grasses, pineapples, cassava and fruit trees such as avocados, macadamia and mangoes. Cash crops such as tea are integrated with avocado trees while coffee is integrated with bananas, macadamia, grevillea among others. Farmers cultivate grasses such as napier grass and fodder grasses, sweet potatoes and tea across the hilly landscape to provide long-term soil coverage. The crop and animal diversities support important agroecological elements such as recycling, synergies, efficiency and resilience in production which reduces depletion of the local resources.

Ninety percent of farmers rear livestock ranging from dairy cows, dairy goats, sheep, pigs, fish, poultry to insects. Around 70 percent of the farmers had more than two of the named livestock species. Due to the small size of farms, many animals are under zero-grazing with a small open shed (grass space) for sunlight and feeding during the day. Napier grass is the main animal feed in most farms as it sprouts quickly and requires fewer management practices. Cut and carry fodder practice is the most common. Other fodder from the farm biodiversity includes maize stalks and cobs, sweet potato vines and leaves, leguminous shrubs and trees on fences, banana stems and grasses strips planted across the contour to reduce water and soil erosion.

4.3.3 Soil health

Eighty-five percent of the farmers mentioned that the status of their soils has improved with time since they started alternating synthetic fertilizers with agroecological practices. Among the 85 percent, 15 percent stated that their farms' soils have partially improved due to the minor changes to their traditional farming practices. Most of the farmers with significant improvement were those who had stopped using inorganic fertilizers and pesticides among other practices. This does not mean that they have better soils than those practicing traditional farming. Farmers rearing dairy animals and pigs have improved soils resulting from the application of compost made from animal, farm and kitchen waste. Previously, few farmers used to dig a hole and bury all their kitchen waste, but after attending compost-making training and visits to other group members farms, they learned the composting method. By ensuring that the soils are always covered, several farmers had discovered that their soil had become loose and more friable to work with.

Majority of farmers take advantage of the ability of some cropping systems to reuse their own stored nutrients and the tendency of certain crops to enrich the soil with organic matter. All the farmers interviewed have been practicing crop rotation and inter-cropping which ensures equal utilization of soil nutrients hence avoiding singular nutrient depletion as evident in most monocrop fields. Most of the smallholder farmers interviewed use simple tools such as a hoe, *jembe, panga* animal-drawn equipment and simple machines. The use of simple tools prevents the formation of hardpan and soil compaction, which are not good for soil health, soil microorganisms, human working and crop growth. Seventy percent of the farmers practices reduced tillage and mulch their land with crops residues and animal waste such as animal beddings and forage leftovers.

Farmers have designed cropping systems that are productive and reduce water and soil erosion on hillside areas. Several organizations have taken on this challenge with initiatives that emphasize the management of soil resources, utilization of local resources, and inputs produced on the farm. NGOs and local government have been sponsoring agricultural initiatives and training programs that support the control of erosions and restore the fertility of degraded fields. Drainage techniques, contour farming, grass barriers, and organic fertilization methods such as leguminous cover crops practice are some of the trained practices. Farmers have planted permanent soil cover plants such

as tea, grasses and sweet potatoes. The presence of hedges and grass strips such as napier and other grasses have helped to reduce soil and water erosion.

Several farmers have made terraces and dug drainage ditches on the farms lower sides to collect the excess water and eroded soil. State agents such as those from natural resource management bodies and non-state promoters of agroecology have persuaded producers from farming at the edge of the water sources as well as water sources. Ecological practices such as planting trees and grass near the water banks have helped in filtering solid particles from getting into water bodies. These have reduced the flow of solid particles and chemical residues such as soil and crop leftover particles, nitrogen and phosphorous to the waters, reducing severe water quality problems in water bodies.

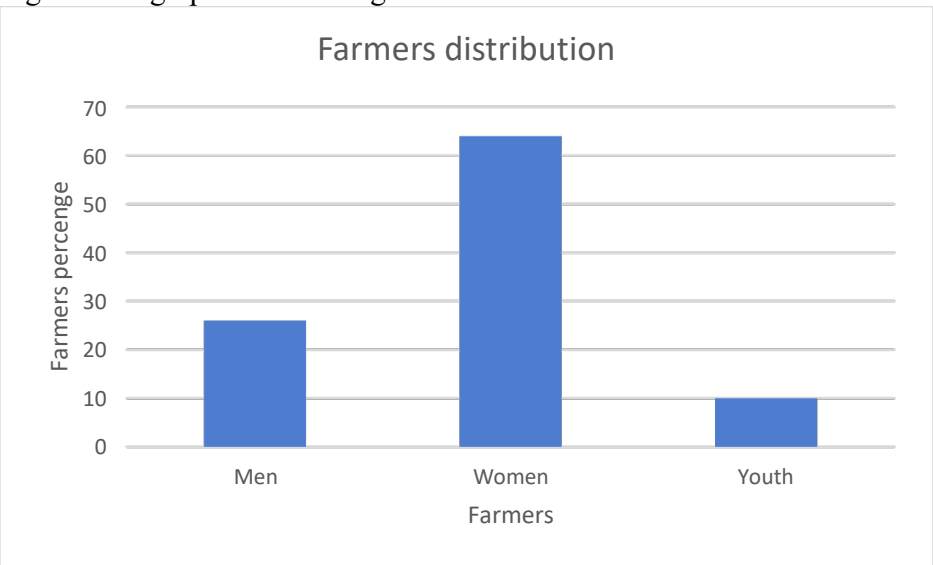
Few farmers in Kiambu use worms to make organic fertilizers from animal waste while others preserve it for later use. Several farmers stated that preserved manure had been more effective in nutrient release and labour required for distribution than the immediate application. During the preservation, animal waste is put under the shade of farm trees and partially covered with polythene to provide a cool environment for decomposers. Few farmers have invested in biogas production, producing watery manure that is less labourious to spread. Few animals, knowledge on biogas production and cost of installation are some of the factors limiting the adoption of this fundamental eco-friendly technology.

4.4 Society and culture/ human and social values

Table vii. Results of society and culture assessment questions

Farmers	**percentage**	
Women	64%	85% married
		10% widows
		5 % single
Men	26%	
Youth	10%	

Figure 6. A graph on farmers gender distribution



4.4.1 Women empowerment

Seventy percent of the interviewed farmers were women, of whom 12 percent were widows while 5% were singles. A large number of participants in training and demonstrations were women. Eighty-five percent of the women interviewed own the land together with their spouses or it is family land. More involvement of women in farm decision-making has played a role in empowering women over the control and the use of farm income. Majority of women highlighted their contribution to farm management has been happening and not just to work on what had to be decided by their spouses. Through their contribution, the number of annual crops planted for household use have increased, supporting household food security as they do not have to wait for market crops income to buy food. Dominant cash crops such as tea and coffee have reduced and have been substituted with various species of crops for household food and market, increasing dietary diversity at household, local and county level.

Few women interviewees stated that they prefer to take excess produce to the local markets as they can get reasonable prices in comparison to the farmgate prices. In contrast, the majority prefer selling from farmgate to save transport cost, time and municipal council revenues. The diversity of crops and animals in the farms has provided women with more opportunities for decision-making to farm operations since they are mostly engaged in daily management and access to agroecological knowledge. Secondly, women have gained a share of the responsibilities unlike in the past where some farms were only producing and selling to intermediaries at farmgate without knowing the existing market price. According to the extension agents, through the training provided to producer groups by NGOs and government agents, women have been able to access market information and decide as a group the price they can charge on their ecological products though it has not been a complete success.

Women have benefited from farmers groups as government and NGOs promoting ecological practices provide education and knowledge on farming, farm equipment, seeds and guidance on access to credits destined for farm use or agribusiness. The several engagements of women in farmers groups and leadership have reduced the total workload that existed before. Adoption new ecological practices such as inter-cropping and mulching has reduced farm's workload. Several farmers explained how intercropping of coffee and banana weakens the weeds due to crop shadow and indirect sun heat making the soil friable for easy weeding.

4.4.2 Youth

Ten percent of the interviewed farmers were youths, with the age of between18 to 35 years. The number of youths engaged in ecological farming is higher than the percent presented by these results. The interviews were conducted through farmers group links thus many youths were not reached as their parents who own the land were interviewed. Secondly, youths have not received enough motivation to join farmers groups, with one reason being that farmers groups have been recognized to be of a parents' affair for a long time.

Majority of youths who engage in farming have other employment attachments. This has mainly been attributed to the lack of enough land for investments since most of the land belongs to the nuclear or extended family, which discourages long-term personal investment. The common notion of referring to agriculture as the poor man's enterprise still exists in some youth minds despite the emerging positive wave of youth engagement in agriculture. Most youths have spent most of their late teenage life in boarding schools and universities, hence the opportunity to visit the farm is on holidays.

Youth engagement in ecological farming has significantly affected the general production in farms. Youth from Lari constituency have been producing vermicompost. They are also producing animal protein from worms hence substituting the external inputs for their family farms. They have been receiving several visitors -lecturers, extension officers, NGO agents and the media who are interested in learning more about this expertise. Under the same kind of project, they work with other youth groups from the nearby villages. These projects provide enough compost for their family farms and sells the rest. They have earned resources to enlarge the project. This is just a case among many youth initiatives that are bringing youth into ecological agriculture.

4.4.3 Connectivity

Farmers in Kiambu connect through various platforms that exist at different community levels. From the bottom side, the farmers are organized in various groups and engage during community functions. The groups serve several purposes such as agroecological training groups, marketing groups, farm machines and equipment groups. The most common areas where farmers engage are during farmers training, communal social functioning, farm demonstration and exchange visits.

An example is a women's group that buys water tanks for its members. Although most of the producers interviewed were smallholders, some of the processing and marketing groups composed of both small-scale and large-scale producers. All respondents unanimously noted that the groups with both small-scale and large-scale producers have enabled farmers from Kiambu to address and act under one voice, making them relevant at the county and national level debates.

Agroecology practices that encourage peer-to-peer learning have revived extensive participation from farmers. Farmer-to-farmer and field school training forums have been in the front line to disseminate farming information. The existing farmers and communal networks have enabled the successes of these platforms. This is common especially when the information to be shared is of indigenous origin. Training and demonstrations on the production of indigenous varieties, their preservation and consumption have benefited many farmers. The existing relationships have drawn the attention of the governmental departments, NGOs and other private institutions. The involvement of outsiders (non-farmers such as processors) has brought extra and new knowledge for free or at a low fee that farmers can afford. For example, Participatory Ecological Land Use Management (PELUM) association of Kenya is a network of civil society organizations that support agroecological farming training and agroecology policy advocacy. PELUM and ICE have been working on a draft of agroecology policy for Kiambu county. They also involve other stakeholders such as the ministry of agriculture organization and grassroots organizations that work directly with communities. PELUM's training is extended to field assistants and field officers of the member organizations. These trainings go beyond Kiambu county and this has facilitated Kiambu farmers connections with other counties. These connections do not only provide knowledge, but there is exchange of seeds and products happens.

Figure 7. Engaging with farmers at a demonstration site.

Many organizations present prefer working with groups, which has aided ecological farmers groups. Farmers have benefited from free training through class lessons, workshops and field demonstrations. Field demonstrations are held in one of the group members farms. In most cases, one farmer provides his land for demonstration. It is mostly done by the leading farmers. This does not mean that a single farm is used for demonstration since the trials are done rotationally. The

most centrally located and easily accessible fields are mostly preferred. All members have a vote and all groups' decisions are reached collectively. In one of the farmers farms in Lari sub-county, 8 demonstration nursery beds contained 12 varieties of vegetables that were to be shared among groups members or sold. The income sale of the seedlings is used to hire trainers or buy more seed or group equipment. Farm demonstrations have attracted non-ecological farmers to agroecological farming after attending demonstrations. These connections bring more knowledge and make the groups stronger and this is important in collecting evidence for agroecology advocacy work.

4.4.4 Water management

Table viii. Agricultural practices used in farms

Agriculture practices	**Percentage**
Rainfed practice only	80%
Irrigation practices only	Non
Both rainfed and irrigation	20%

Eighty percent of farmers interviewed depend on rainfall for their farm production while 20% rely on rainfall, but in case of shortage, they have water for irrigation. Seventy-five percent of these farmers have tap water while the rest use water from rivers, water tanks (rainwater) and wells. Majority of farmers have plastic tanks or brick tanks while others have constructed water reservoirs to trap the rainwater. Farmers trap rainwater from roofs of the farm buildings to water tanks and water trenches that are directed to a reservoir. The rain and well water are used for house chores, animals and irrigation during the dry season. They reduce water bills and save clean water that would have gone back to the natural water systems. Fifty percent of the farmers stated that water management within Kiambu has partially improved, while 30 % mentioned that the water quality in some parts of Kiambu is being polluted by large-scale flower farms, residential apartments and industrial waste dumping.

Several farmers have built improved animal structures to ensure that animal wastes are collected at the same facility for biogas production. The by-product from biogas production is spread on the farm. According to farmers, this utilizes the wastewater and makes the manure distribution less labourious. This is not in all farms, since the zero-grazing sheds are surrounded by permeable floors that allow water seepage. Majority of farmers pointed out that at field and agroecosystem levels, measures to improve water management have improved.

Farmers from Lari sub-county explained that the availability of fodder and forage in their fields and natural resources department had reduced natural forests grazing. Application of AEP such as agroforestry, mixed cropping and intercropping have provided fodder. Coffee farmers mentioned that intercropping of coffee and bananas increased animals' fodder from bananas stems, leaves and unwanted suckers. Farmers with hilly farms noted that planting grass strips and cover crops on the

hilly areas of the farm have increased animal fodder, decreasing the need to graze animals and use of synthetic feeds that have undigestible contaminant residues that might end up in rivers.

4.5 Governance

4.5.1 Land tenure systems

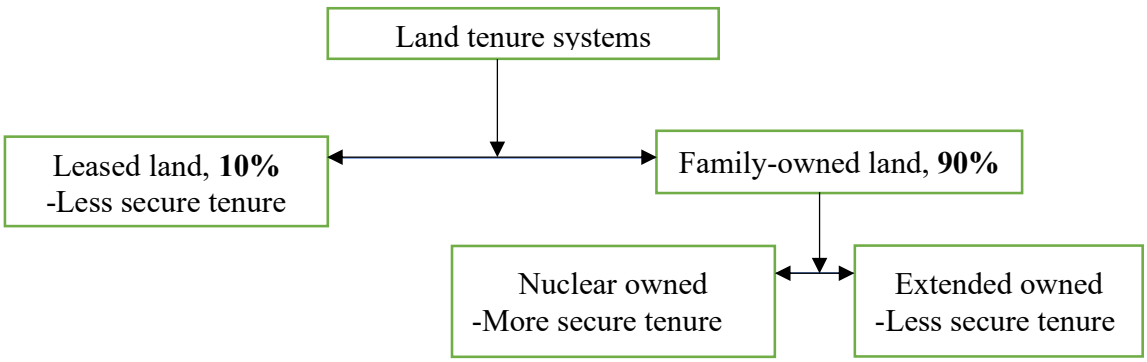


Figure 7. Results of secure land tenure system assessment

Ninety percent of the farmers own the land they use for farming with few having extra land on rent. Land ownership explained from interviews was under two forms. The first type of land ownership is in which land belongs to the nuclear family. It is acquired through buying, inheritance or owned by the extended family where the farmer (mostly male) is given a land to cultivate. Farmers with nuclear family-owned farms expressed more security. They can develop the farm without outside consultation, unlike in extended ownership where some farm development has to be discussed with the extended family due to lack of defined boundaries in some cases.

The second type of land ownership is land under lease. Leasing land for farming is done per year or several years and the owner can retain the land at the end of the agreed time or rent it again. Farmers mentioned socioeconomic and cultural, land tenure system and other factors as key in adopting short-term to long-term AEP. According to farmers, it is a considerable risk to do a long-term or substantial investment on leased land since the owner can repossess the land at any time. Investing in practices such as agroforestry, farm structure construction and perennial crop production requires authorization from the owner.

In both nuclear and extended family land ownership systems, the male gender tends to have more authority over land use. The male's family owns the majority of farms hence the male has more influence on land use. Even in the cases where a nuclear family has acquired the land, the male gender tends to have more influence as an element of tradition that recognizes the male as the head of the family is still at large. In some cases, female and youth farmers mentioned that there is family consultation. However, the male gender gives the final consent, which might affect the adoption of AEP as women are the most engaged in farm work and agroecological training. With

time, family consultation has been the base of farm development on decision-making, especially with the rising training and education offered to women in most farmers groups. The ability of the female gender to share more ideas on farming resulting from training and education has increased its influence on land use decision-making.

4.5.2 Participation in networks

All the farmers interviewed belonged to farmers networks with the same interests. Most farmers belong to more than one group. According to all interviewees, this has increased their connections with more extensive networks. The collective participation impact has gone beyond their local villages. Agroecology promoters noted that networking of organic, agroecological, ecological, traditional farmers and other eco-friendly oriented farmers has improved farmers livelihood and policy making arena. Majority of the farmers stated that agroecological farming is in the front row in promoting existing and newly formed farmers networks. From these collective foundations, farmers learn, discuss and forward their collective interests to the local and national government through their elected leaders or extension service providers such as agricultural extension agents and agroecology promoters. Non-state promoters of agroecology mentioned that through the local organisations and joint committees such as the agroecology policy steering committee, can consolidate farmers interests and create awareness. The committee has been identifying the ongoing policies that might affect farmers and engaged the relevant stakeholders involved in the policy-making process.

Through the farmers networks in Kiambu, they have been able to elect a local government leader who has been supporting agroecological farming. This has made other elected leaders attentive to farmers networks interests. For example, a member of parliament from one of the Kiambu constituencies who has been eyeing a more prominent seat, provides certified seed sources for indigenous vegetables and support farmers with technical and information services. Another elected leader, a member of the agroecology policy steering committee, has been inviting officials from the ministry of agriculture in the ongoing agroecology advocacy work. Through farmers networks, the media collects and transmit the work of the farmers through social media platforms. Although this method has not been quite productive, respondents have reported positive impacts.

4.5.3 Policy and strategies complementarity.

Seventy-five percent of the farmers stated that their farming enterprises are not directly affected by the existing departmental policies and national strategies. All non-farmers interviewees unanimously mentioned that the current policies do not consider most of the existing eco-friendly farming systems hence no funds are allocated to these enterprises during budgeting. Sixty-five percent of the producers expressed dissatisfaction with the bit of assistance provided. The little support provided has been on agricultural education that is often inadequate due to the wide farmers-extension service providers ratio. Farmers cited that despite being the majority producers of the food consumed in Kenya, they have been ignored and marginalized during policy

engagements. The government has only come back to reality during the latest covid-19 pandemic due to the smallholders' essential role in food provision. Several groups leaders and leading farmers noted that during media and research interviews, they are often asked what the government can do for them and a few requests have been responded to as a result of these platforms.

Policymakers have been working under the influence of present government agendas, politicians and foreign influence that have no link with the producers expected to adopt or follow policy regulations. The policy implementers who have links with the producers are provided with policies and expected to oversee their implementation. The disconnections along the policymaking, implementation and adoption organization create many loopholes that make farmers reluctant to implement them as they are informed what to do without their participation. For example, in 2019, the GOK through the cabinet secretary in the Ministry of Agriculture, Livestock, Fisheries and Irrigation (MALFI), Agriculture and Food Authority (AFA) and county governments drafted a bill with a clause to illegalize animal manure use in crop production. Despite knowing that many food producers in Kenya practice integrated crop-livestock farming and use manure to enrich their soils, this had been discussed and written. Although this information could not have reached farmers, its impact would have been detrimental to their farming systems which is their source of daily livelihood. There were also proposals to regulate procedures and conditions for licensing collection centers, dealers, processors, warehouses, imports and exporters. While the regulations did not compel farmers to become part of the growers' association, they would limit dealers to buy from licensed growers. This is just one bill among many legal legislations and strategies from governmental departments designed without farmers involvement. Luckily this bill came out to the public before its approval in parliament. Due to criticization of its several clauses by local leaders, farmers unions and NGOs, the bill was rejected.

5.0 DISCUSSION

5.1 Economy

Overall, the results from the study showed that management of complexity of the increased diversity in crops, livestock and value-addition is possible. Diversification has been recognized as an efficient system of enhancing overall farm food production (IPES-Food., 2016). Although some studies have documented higher productivity in terms of harvestable products per unit area in monocropping than in multiple cultures, diversity in mixed cropping has shown a higher overall output. Several experiments conducted on the comparison between monocultures and AEP on intercropping and polycultures have shown better outputs in terms of total biomass produced (Malezieux et al., 2009, Kintl et al., 2018) while other studies have found positive relationships between farm diversification practices and yield (Ponisio et al., 2015, Dainese et al., 2019). Though most farmers do not keep farm production records, they all mentioned that the productivity change is evident. For example, farmers from Githunguri and Limuru sub-counties mentioned how mixed cropping of maize, peas, beans and potatoes production had greatly increased within a period of two years after dividing their land and crop rotating between maize-peas mixture,

cabbage and potatoes-beans mixture and indigenous vegetables. Farms diversification and integration have reduced producer's vulnerability should a single crop, livestock or other farm enterprise fail. Crop rotation and multiple cropping systems developed by smallholders enhance the production efficiency due to synergetic relationships between the crop mixtures.

The progressive outcomes on food production are even more significant as farm complexity increases. The increased productivity increases household food and provides more products for exchange and sale. The sale of the diversified farm products has increased the farmers income. Farmers meet their needs with a combination of self-consumption and a limited share of cash income generating produce. Other global cases have shown the capacity of agroecological diversification to increase income among other benefits (Stratton et al., 2021). D'Annolfo et al., (2017) show in their review that adopting agroecological practices increased yield in 61 % of the 74 studies and farm profitability increased in 66% of the 73 cases studied, whereas a decrease was found only in 20% and 23% respectively. The farmers have received more customers because they provide various products at a single market, hence becoming reliable sources. Another study from Guatemala found that agroecology-based farmers had higher levels of food availability than semi-conventional ones during both dry and rainy seasons. The former produces 27% more plant varieties during the dry season and 62% more during the rainy season than conventional farmers (Calderon et al., 2018).

The yield difference can be explained by a combination of factors including cropping, which is nearly continuous (3-6 crops per year). One of the primary mechanisms of maintaining intensity is through seedbeds, where seeds are germinated before the older crops are harvested. Secondly, the loss declines due to weeds, insects and diseases control and more efficient use of the available resources: water, light and nutrient. Thirdly, the application of organic manures plus a leguminous plant combination maintains a good soil fertility level despite the continual harvest of crops. Reducing dependence on external inputs has substantially contributed to building farm resilience and a stable production over time. Stability in production over time is an important indicator of farm resilience. Lastly, much care is given to the farm system because many farmers are full-time growers. Such careful husbandry can facilitate high yield. In general, adopting AEP such as an integrated crop-livestock system reduces high farm income variability and volatility and has shown to increase farm income steadily.

The agroecological diversity yielding increased income comes with extra tasks associated with production and postharvest practices such as processing, packaging and storage. Most agroecological farmers have low access to education, skills, knowledge and equipment for new practices. The use of simple sustainable technologies stimulated by learning and research institutions, government and NGOs and based on local participation has enhanced smallholdings productivity. Additionally, the study results showed that increased yields sometimes led to low market prices and thus, farm processing and value addition with good storage could be used to address these risks. Although findings from this study show that farmers have been receiving

processing education, they mentioned that more could be achieved if AEP adoption is promoted. These include value addition knowledge, processing equipment, appropriate transportation and market storage conditions. Overall, this will control low prices, deterioration risks and health risks associated with deteriorating food. A circular economy through value addition, co-creation and knowledge exchange and localized marketing anchored in agroecology can reduce the continuous pollution caused by food waste.

Agroecological produce is locally commercialized, but this does not mean they do not sell outside Kiambu. Majority of smallholder farmers are those with the capacity to produce quite a few products and in medium quantities. This aligns with the case by Calderón et al., (2018) in Guatemala which found that smallholders agroecological products are commercialized at the municipal level. Farm or communal processing and the sale of products at municipal levels are essential because waste materials can be recycled at farms. When processing happens far outside the production area, waste ends up in other areas such as urban areas, where it has become an environmental challenge due to poor disposal. Underdeveloped roads, poor transportation and storage equipment have facilitated the increased urban garbage resulting from the deterioration of perishable food products. Nairobi, a neighbouring county, is a metropolitan city experiencing solid waste management challenges resulting from poor waste disposal. Although there exists a link between market traders and farmers on the transportation of the food waste, the systems are still not functioning effectively due to the cost and contents of the waste that are highly mixed with other forms of toxic and undegradable wastes.

Diversified farming system, which is an agroecological principle, provides income from its resilient localized food system through employment. Garibaldi and Pérez-Méndez., (2019) analysis found that countries with higher crop diversity supported more agricultural employment. Higher crop diversity may require a more diverse set of inputs, equipment, skills, and services depending on the product use and farm scale. Moreover, crops may have different processing and marketing channels where some would need group processing while others need individual processing. Landscapes with higher crop diversity also provide more resources for other rural economic activities such as beekeeping and tourism (Frimpong et al., 2016) hence providing more income sources. All these diverse sources of products, employment and income offer more evidence on how agroecology can improve the livelihood of communities and other food-systems stakeholders if supported.

5.2. Food security, health, and nutrition

Kenyan statistics show that 14.5 million Kenyans are food insecure. Those in need of emergency food assistance increased from an estimated 1.1 million in February to 1.6 million in May and 2.6 million by July 2019 (ASM., 2020). Kenyan president declared drought a national disaster in 2017 and again in September 2021. Although hunger is claimed and addressed through evidence of improvised national production statistics, the absence of hunger due to high yields at a national scale does not translate to safe and nutritious food availability at an individual level. National-level

data on crop production, used as a measure of national food security, does not adequately measure smallholder food security (Jones et al., 2013). With the situation of food sector continuing to present significant challenges to Kenyans, there is a need to re-think how to approach food system and farming as the base for food systems in the country.

According to FAO (2018), rural smallholders experience higher food insecurity and malnutrition rates than urban households. Uncountable cases show that agroecology has established itself in social, scientific and political debate to ensure food security, maintain healthy ecosystems and support livelihoods. Despite all these potentials, agroecology has not been engaged seriously in government's policies, legal legislation and strategies. Its systems vary from region to region but are built on the key elements that promote and ensure healthy nutrition. The complexity of factors that determine household food security makes it difficult to isolate the degree to which agroecological practices contribute to smallholder food security. However, significant relationships between smallholder household food security and agroecological practices have been found from this study, among others.

Agrobiodiversity within individual farms has increased the availability and accessibility of various foods. Farm diversity promotes food security and nutrition, providing additional food sources and nutrients at different times of the year. The weather and climate patterns variation explain the diverse crops and animal species raised. Unlike in many rural areas in Kenya where maize is often grown as a staple food crop without extensive diversification, in Kiambu, diversification is common because it is close to urban areas which have metropolitan populations. Diversification is also an indigenous practice in Kiambu. This comment is consistent with Altieri., (2014) who states that peasant farmers of traditional agriculture grow a wide variety of cultivars to reduce total loss in case of catastrophic loss hence reducing food insecurities. 'Maizification', a common characteristic of Kenyan rural household diets was found to contribute to the increased incidence of hidden hunger in countries like Malawi (Kasanga et al., 2020). Waha et al., (2018) mention agricultural diversification as an important strategy for achieving food security in Africa.

In pursuit of increasing food production by modernization of small farms, narrowing of the local food varieties has been experienced due to the prioritization of a few selected crops. Some of the prioritized crops are those with export and industrial value resulting in continuous food insecurity and malnutrition cases. As a result, there is a growing concern to embrace forms of food production that are locally diversified, affordable, sustainable and healthy to humans and the ecosystem. These characteristics align with agroecology principles. Traditionally and lately, farmers have been escaping food insecurity and malnutrition by practicing mixed farming where indigenous varieties dominate. This study results show that farm diversification has a higher potential to promote dietary diversity and nutrition. Several farmers mentioned that they intentionally maintain production systems with high spatial and temporal diversity to ensure diverse diets throughout the year.

Agroecology biodiversification encompasses both industrial and household food crops and animals (Altieri., 1999) hence has the potential to promote diverse diets in small farming communities. Farming several species and varieties of crops and trees is a peasant strategy of stabilizing diverse yields over a long time while using limited resources. Walingo and Ekesa., (2013) found a strong positive relationship between dietary diversity of preschool children and crop and livestock diversification while Ambikapathi et al., (2019) found a significant positive relationship between women's dietary diversity and practice of mixed crop-livestock systems. Kasanga et al., (2020) report that the existence of few researches on agroecology diversity improving household food outcomes is not enough yet, while Madsen et al., (2020) question the degree to which changes in yield translate directly into improved food security and nutrition due to the influence brought by other factors. Pellegrini and Tasciotti., (2014) and Bezner-Kerr et al., (2019) research findings showed that household food security and dietary diversity increased significantly over 2 years after adopting AEP. Given that interviewed farmers utilize a significant portion of their diet from their fields, which is a characteristic of many smallholder farmers globally, farming approaches provided by agroecology seem to be among the promising solutions for improving household dietary diversity. This evidence reinforces the need for strategies that alternate the global trend of declining agrobiodiversity. However, it must be stated that positive correlations do not prove cause and effect.

Vegetables, tubers, pulses, cereals and tree plants make for overall higher cultivated plant diversity in agroecological fields. Kiambu farmers control a few indigenous seeds such as pulses, local vegetables, tubers and trees but show dependence on corporations to provide most market vegetables and grains. Agroecological farmers in Kenya experience challenges because no strategies or legislation exist that recognize their nature of production, unlike in neighbouring countries -- Uganda and Tanzania -- where local varieties are protected through laws and legislation. Kenya does not have legislation that protects local varieties nor promotes their breeding, hence increasing their vulnerability, especially after catastrophes such as drought.

Lack of promotion and protection of local seeds production to boost farmers seedbanks have increased input costs at the beginning of every season. Agroecology promotes a bottom-up approach to food security whereby it recognizes and appreciates indigenous knowledge, smallholder farms and communities as the drivers to food security. However, it is important to create awareness about the benefits of the indigenous species, especially to local farmers and give those with traditional experience a chance to share their knowledge. This could promote farmer-to-farmer learning which is affordable and available. Although various local organizations create awareness about the importance of local varieties by engaging with farmers, the results have been limited. The challenge of the farmer-to-farmer knowledge sharing is that often farmers are busy and will only listen to external service provider who can assist with funds or other benefits for the suggested intervention or change. Government money accompanies the stipulated policies or

strategies hence lack of agroecology policy hinders access to governments funds and other supportive initiatives for the agroecological farmers. Therefore, the existing legislations and strategies should be revised while the incoming strategies targeting food insecurity mitigations should involve and address relevant barriers such as those hindering recognition of promising practices such as those in agroecology.

Though diet diversity should be a concern for everyone, women have found themselves responsible for household diets in most African family setups. This shows the important role women play in the provision of a diet. The ability of agroecological practices to increase women's role in decision-making has facilitated the increase of crops that would be of importance to the family diet. Practices such as intercropping have given women more opportunities to add crops destined for household use rather than for the market hence providing more local sources of food diet. Although most farmers did not mention this directly, it came out during the conversations and transect walks.

Although Kiambu has demonstrated food sufficiency in the study results, some areas in Thika east sub-county are faced with erratic climate patterns, depleted soil nutrients and a growing number of food-insecure people. As in many parts of Africa, Kiambu farmers practice rain-fed agriculture and according to Perez et al., (2019) and Devereux et al., (2019) studies, food insecurity tends to be severe in the middle of the short period after farmers have seeded. Agroecological diversity that includes both short and long season crops could help to improve household food security by including crops that mature at different times in the cropping season. In this context, smallholder farmers intercrop early maturing crops such as beans and peas in their diversification, which they rely on before the main harvesting season.

5.3 ENVIRONMENT AND CLIMATE CHANGE

It is estimated that the global food system may contribute up to 35% of GHGs emissions (Vermeulen et al., 2012), thus food systems should be a critical focus for GHGs mitigation and adaptation strategies. Contrarily, food systems are also vulnerable to climate changes and a damaged environment. The vulnerability to climate change may be increased by other factors such as socio-economic factors, including poverty and being environmentally marginalized. Availability of resources, access to and control over resources, geographical location and ability to adapt to change among individuals and communities influence the degree of vulnerability to climate change (Ribot., 2014). Viability of food systems is a matter of survival for humans whose lives depend on food production chains both directly and indirectly. In sub-Saharan Africa, smallholder farmers face multiple challenges in sustaining a viable food system and are highly vulnerable to new climatic threats (Souza et al., 2015). Taking crop production in Africa as an example, climate change will result in yield reductions in most cereal grains, but with some regional differences (Lobell et al., 2008). There is a need to adapt agricultural systems to mitigate climate change and reduce food system vulnerability.

Diversification has proven to be a feature behind many positive aspects of sustainability associated with agroecology: synergy, efficiency and resilience (Calderon et al., 2018). Diversification is essential for environmental management and climate change mitigation. Resilience is built from synergies and efficiencies resulting from diversification. Farm resilience helps farmers establish stable farms records that are essential for farm economic stability and credit applications. Through ecological synergies and efficiencies, soil fertility is improved hence increased yields Frimpong et al., (2016) and biodiversity (Altieri., 2018, Kasanga et al., 2020). Agroecological farms keep high levels of plant diversity during the dry season, even under water-shortage conditions. This is possible thanks to a multilayered setting including crops, herbs, shrubs, and trees; diversification of the uses are provided by different plants and innovative rainwater storage systems. Multiple cropping, intercropping and agroforestry systems build farms resilience through genetic diversity which can withstand climate-related risks.

Farms diversity provides alternative habitats to predators, parasites and food sources such as pollen and nectar. The abundance of predators and parasites prevents the build-up of pests. Plants diversity attracts various pollinators such as birds, bats and insects hence the continuity of cross-pollinated plant species. Bees pollinate plants in natural ecosystems as well as agricultural systems. The presence of pollinators such as bees which has been affected by conventional agriculture, plays a vital role in food production - facilitating pollen transfer in sexually reproducing plants. Cross-pollination is important because it prevents inbreeding which is a risk with the changing climatic change. Increased agrobiodiversity increases the number of other species. For example, some plant pollen is only suitable for specific pollinators. Seventy-five percent of all plant-derived food depend on insects for pollination. Fruits and berries such as tomatoes, coffee, cacao and most fruits and berries need pollination for food production while potatoes, carrots, onions and beetroots need pollination for seed production. Pollinators increase both the quality and quantity of food and seeds.

Loss of pollinators due to the destruction of their habitats, food sources and use of broad-spectrum pesticides endangers a large part of an ecosystem. Crops grown simultaneously enhance the abundance of predators and parasites, preventing pest's build-up, thus minimizing the need to use expensive pesticides. Pesticides are considered highly hazardous if they present particularly high levels of immediate effect on humans or the environment (FAO., 2016). By increasing agrobiodiversity, habitat for wild pollinators, food sources - especially from indigenous plants and applying agroecological practices for plant and animal protection - may improve the resiliency of an ecosystem. In general, agroecological farmers reduce the use of synthetic fertilizers and pesticides. Both practices cause harmful effects on soil health, water contamination, biodiversity, pollinators, the human environment, and other ecosystem services (IPES-Food., 2016).

Many farmers practice AEP that mitigates climate change either knowingly or unknowingly. Most farmers take advantage of the ability of some cropping systems to reuse their own stored nutrients and the tendency of certain crops to enrich the soil with organic matter. Leguminous trees, shrubs and crops such as *Gliricidia, Calliandra, Canavalia, Cajanus, Desmodium, beans and peas* are used for nitrogen fixation, biomass production, green manure, forage production, and sediment

capture. Broad-leafed characteristic helps in soil coverage and reduce raindrop impact on soil which is usually splashing soil particles on open grounds. Multiple cropping like that of cereals and legumes moderate nutrient competition. Practices such as agroforestry reduce plant competition and loss of nutrients. Trees and woody plants with deeper roots utilize soil nutrients that shallow or annual crops cannot utilize. The mixing of plants with different roots depths helps to restore the soil structure which is important for nutrient accommodation, soil reactions, nutrient circulation and soil microorganism functions. Leaves and small branches from shade trees provide mulch and add more organic matter to the soil after decomposition. The presence of different plant species in each season favours the utilization of soil nutrients and determines the level of soil microorganisms that are essential in the life of a soil.

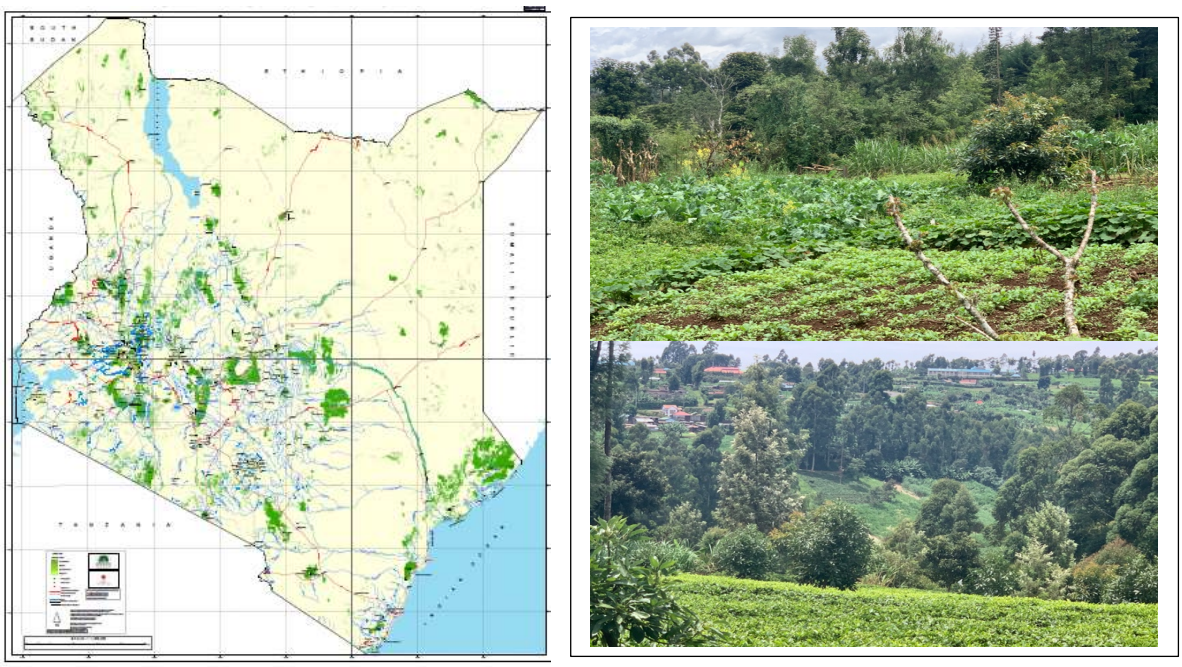
Several layers from plants diversity provide mulch which helps to prevent nutrient leaching, protect and provide habitats and food for soil microorganisms and reduce water loss through evaporation. The use of crops residue prevents the hardening of the soil by reducing exposure to direct sunshine and heat. The crops residues reduce the flow of rainwater during the onset of the rainy season by reducing the pounding of rain that loosens soil particles, allowing low percolation of water, as well as reducing soil erosion. The use of organic fertilizers and optimal plant and animal residues use promote environmental conservation. Recycling lowers external farm dependency. Such land management practices are essential for soil health improvement. After decomposition, mulch increases soil mass and nutrients. Good soil health enhances biodiversity development which is fundamental in environmental maintenance and climate change mitigation.

Agrobiodiversity provides a wide range of animal feed, reducing synthetic feed use, natural forest degradation and wild habitat interference. This protects, conserves and enhances natural resources and ecosystem services such as water flow and natural water purification. Integrated crop-livestock systems promote recycling of organic materials by using manure as fertilizer, crop residues and by-products as livestock feed and for soil cover. Monogastric animals such as pigs, chicken and rabbits, which are easy enterprises to start and manage in terms of capital and management required, have provided high quality manure. The majority of the animals have exotic origins but have been bred with local breeds for many years to increase their capacity to adapt to the local and changing weather and climate. Breeding has been common in dairy cows, dairy goats and pigs. Farmers from this study provide a roof over animal housing to reduce increasing greenhouse gas emissions (nitrous oxide and methane) and control manure quality. The use of good quality manure supports soil health mechanisms such as those of living organisms that help in decomposition. The nutrients in manure fertilizers may be lower but their biological capacity to cause natural conditions for soil processes brings balance to an ecosystem, unlike synthetic products that even kill non-target pests. Organic matter in manure enhances infiltration rates, improves water holding capacity, increases cation-exchange capacity and increases soil carbon (Ndambi et al., 2019).

The development of urban centers, urban immigration and white-collar jobs have made farm management practices such as farm produce preservation, seed breeding, saving and multiplication to be regarded as typical areas of work for elderly women, younger mothers and low-income families. Many farming families lost indigenous crops that would help them cope with climate change and maintain healthy and diverse ecosystems. Traditionally, farmers diversified their crop production to cope with weather changes. As a result of sequential loss in farms, families are relocating to rural areas to farm. Some of the new farmers are aware of climate change and have been acquiring education on sustainable farming widely. Their capital capability has enabled them to introduce new sustainable and innovative technology. There is hope that the experiences will stimulate others to explore and develop adaptive mechanisms that will guard small farms against the harsh effects of climate change. Farmers are consciously taking control of their situations in collaboration with development agencies and the government to enhance future sustainable livelihoods,

Deforestation and forest degradation contribute about 12% of the world's greenhouse gas emissions. Natural and human factors have induced forests and trees vulnerability. Human causes include high people numbers, poverty, individual and corporate plunder and policy that allow these to happen. The expense at which modernization and population growth cause affect forest ecosystem is questionable and has remained divisive. Other causes attributed to forests degradation include inadequate long-term funding, inefficient technical capacity, ignorance of the grassroots-level contribution and breakdown of long-lasting traditional conservation practices that forged collective action in environmental resource conservation (Kasanga et al., 2019).

The rapid decline of forests and terrestrial areas in Kenya is a major environmental challenge leading to desertification, droughts, erratic rainfall, increasing temperatures, season shifts and soil and water erosions (GOK., 2019). In 2015, the Kenyan forest cover was estimated to be at 7.2 % based on the national projection according to Global Forest Resources Assessment Report (FAO 2015 IN GOK 2019). According to NEMA., (2017), water systems are under threat from pollution and encroachment emanating from human-related activities such as settlements near forests, charcoal burning and agriculture into forests. Forests and trees are very important resources in that they act as ecological habitats for vast species diversity, water sources, fuels for domestic use, medicinal herbs, and soil cover. It is unfortunate that Kiambu and other regions in Kenya experience much rain twice a year but also experiences droughts.



a. b.

Figure 8. a) National forest mapping of Kenya 2020, b) Trees distribution in different farms.

IPBES estimates that nature-based solutions could contribute about 37% of the climate change mitigation needed by 2030 to keep global temperature increase to less than 2 °C while generating jobs and biodiversity co-benefits. The IPCC (2019) special report on Climate Change and Land affirmed that planting forests and protecting existing forests is key to all pathways for limiting global warming to 1.5 °C. The Kenyan government has a forest restoration plan of 10% forest cover (GOK., 2019). Although the government has tried to mitigate temperature rise with tree planting, it has not succeeded. Promoting agricultural practices such as agroecology that uphold forestry environments through agroforestry can be part of the nature-based solution proposed. This is well stipulated in its legal framework on agriculture (farm forestry rules of 2009). Agroecology advocates for fast-growing trees, adaptive and that have an income. This increases biodiversity and carbon sinks hence reducing GHGs emissions. This study results showed that farmers had planted more trees in their farms and reduced forest grazing.

Although several agroecological elements are mentioned in various environmental and agricultural policies and legal frameworks, their potential cannot be fully discovered because the allocated resources do not reach farmers who implement them. The results of this research point to the need for an agroecology legal framework that includes practices safeguarding trees and forests. For example, the use of biogas which remains unrecognized can reduce gases emitted from practices such as charcoal burning. Furthermore, investing in reforestation and afforestation creates jobs and generates economic benefits and could provide livelihoods at a time when millions of jobs have been lost, thus contributing solutions to some of the post covid-19 economic challenges.

5.4 Society and culture

This study results have shown that majority of smallholder farmers sell their produce at farmgate and local markets. These market channels are attributed to social connections. Social connections have also facilitated access to education, farming skills, farm inputs, market prices information and new customers. Local trade promotes local products and culture such as indigenous food and values. The existing communal connection has improved farmers livelihood on the socio-economic aspect. Human and social values such as trust created by farmers networks have strengthened community development.

A stable socio-economic society can be built by re-introducing solid bonds based on what links them. Agroecology has shown greater efforts in confronting the challenge of social disintegration by emphasizing on local and indigenous knowledge, farmer experimentation, strengthening farmers' autonomy and local markets (Dumont et al., 2016). It substitutes and helps redesign industrial systems with efficient-ecological resources and practices and ensures that farm systems and products connect producers and the customer. According to Kasanga et al., (2020) the connectivity in a community can also achieve greater natural resource management through collective actions, which has been evident in Kiambu through agroecology networks. Kiambu local government and several NGOs have been engaging in tree planting events through local networks formed under agroecology initiatives. It is economical for the government since interested partners like NGOs and other private entities support and invest in such projects. Through agroecology initiatives such as tree planting has been extended to farms through agroforestry.

Mostly, societies welcome and support developments when collective values such as culturally important food, gender, farming systems and local resource use are recognized or incorporated into a society dynamic. Lack of family cooperation in pooling agricultural resources such as farm inputs within a household was identified as a constraint to higher productivity (Malapit et al., 2015). For example, unequal access to and control of resources and often lack capital and credit facilities to invest in agriculture keep youth away from farm discussions.

Food system transformation may occur when farm decision-making practice motivates active family members. Participation could be a motivation to support the farm enterprises as everyone's opinion is heeded. Bezner et al.,'s (2019) study mentioned that households that discussed farming with their spouses were associated with increased food security and dietary diversity of more than 2.4 times to those families that do not engage. Although this is not a common practice in most African-based families, somehow it makes the issue of agricultural systems transformation remain to be a challenge. The connection between family members to community level is an important principle in the transformation of food systems at farm, local and territory levels. Gliesmann., (2016) describes agroecology as a food system based on participation, localness, fairness and justice. Through agroecology, the principle of co-creation and knowledge-sharing promotes networking on food culture and farming systems. Education on gender equality, local resource

management and innovations is shared, especially for the youth. In most cases, both bottom-up and top-down approaches are used in agroecological knowledge-sharing platforms.

Gender and age cause women and youth in food systems to face persistent obstacles. They remain economically and politically marginalized and vulnerable, while their contributions in agriculture and other related fields often remain unrecognized. Women's unequal role within households and communities including higher workloads, lower decision-making and control over agricultural resources, significantly impact household food security and nutrition (Frimpong et al., 2016; Bezner et al., 2019). Despite their poorer access to productive assets caused by gender partiality, FAO approximates that women contribute 43 percent of all agricultural labor in low and middle-income countries with productivity levels of 20 to 30 percent lower than male farmers. This study shows that women can develop higher levels of autonomy by building knowledge, creating and discovering new market opportunities and enhancing their leadership skills through networks and collective actions. Women's rising role in farm management has allowed them to access credits. Access to credit has enabled women to invest in farming and own assets in the community. Women's power to influence decisions in their family farms and farmers groups has led to the women's leadership at other community levels. These cases highlight the importance of gender impartiality and knowledge sharing attention which agroecology advocates for. This is consistent with Loos et al., (2014), who mention that individual empowerment is crucial in decision-making process that can influence food security hence improved livelihood.

For a long time, the challenge in engaging youth in agriculture has been their negative attitude towards agriculture-related activities. They categorize it as an analogue form of employment for uneducated village people. Inadequate employment opportunities for the youth due to limited investment in skilled labour and technology, especially on value addition have discouraged them. FAO., (2016) states unemployment and underemployment as among the root causes of distress causing out-migration from rural areas. The youth are useful in that they have potential to regenerate agriculture using modern skills and technologies. This study records a gradual return of youths to farming both in rural and peri-urban areas.

Agroecological supported practices have attracted youths in Kiambu since they embrace modern knowledge, education and skilled labour which provide hope for a source of decent jobs to the unemployed youths in rural areas. Although they have been making recommendable investments and innovations in farming, the rate of access and control access of local and novel productive resources is still limited. For example, in this study, several youths expressed lack of access to land has hindered the expansion of projects that can provide education, skilled labour employment and create networks among the youths. Approaches to agriculture that encompass traditional and modern knowledge and skilled labour, such as agroecology, have and can continue to provide promising solutions such as sources of 'decent' jobs if recognized and supported. Agroecology principles encourage practices that avail rural employment and self-employment while offering other aspirations to the youth. These opportunities might be more attractive to youth as they are

skillful, dynamic and active. These results highlight the need for an institutional aspect of agroecology that advocates for enabling environments for co-creation and knowledge exchange, networking, extension and advisory services from both bottom-up and top-down approaches.

Advocating for the significance of enhancing human and social values and specifically prioritizing to address gender inequalities by creating more opportunities for women and youth is part of an agroecological transition. Opening spaces for women and youth from household to community level to empower them can be essential for the food system transformation, thus improving livelihood.

5.5 GOVERNANCE

Land tenure system

Farmers with title deeds felt secure to adopt short-term and long-term AEP while farmers with insecure land terms often go for short-term practices. Credit access is often available to persons with collateral such as a land certificate or a business. A farmer using a title deed as collateral has a higher probability of getting credit while a farmer with leased land will require other forms of guarantees to access credit. The land owned through inheritance is sometimes not enough security as the land may not be under the farmer's name. Majority of interviewed farmers had a land certificate which is unusual in other parts of the country. This is consistent with Okoth-Ogendo's (1999) finding that central highlands, including Kiambu have the majority of households with land title deeds compared to other regions because the land titling process started in central Kenya before spreading to other parts of the country. Secondly, the cost of acquiring a land certificate is considered high and not affordable to low-income households. Kiambu county has profitable cash crops such as tea, coffee and pyrethrum and modern industries, hence moderate wealth. This might have given them a higher capacity to acquire title deeds. Although title deed is highly associated with credit access, factors such as enterprise capital and credit institutions availability affect credit accessibility. Production of high-value crops such as horticultural crops and integrated crop-livestock would encourage lenders. Provision of credit accessible means of and interest control by the government could facilitate the growth of smallholder's farms. Agroecology promotes networking hence farmers can approach credit institutions as a group, and this could improve individual farmers as well as the group.

Farmers experiencing land insecurities prioritize short-term practices with short-term turnover such as those yielding per year (Kasanga et al., 2020). A farmer with a secure land tenure has more advantages to decide on the type of production to practice hence more chances for household crop use which might increase food sovereignty. With the inability to have secure land entitlements, farmers prioritize growing market-oriented crops to earn an income to pay the land rent at the end of the year. Land insecurities have reduced the motivation to grow crops of choice, especially those intended for household use hence threatening food sovereignty, dietary diversity and nutrition among other aspects of agroecology

Adopting AEP partly depends on the land tenure systems and land size. Farmers have an average of 2.5 acres with approximately 2 acres in cultivation. The average land cultivated by smallholder farms in the 2006/2007 crop year was 2.75 acres (Okoth-Ogendo., 1999). The slight difference is because Kiambu has big towns and acts as a residential area for Nairobian workers hence the size of farming land decreases. This then calls for efficiency in using the little parcels of the land available for agriculture to ensure optimal use of the resources. AEP such as mixed farming and integrated crop-livestock system which are already in place and have shown their capacity to improve livelihood might be part of the extensive solution.

Participation in local networking

Networks can be as simple as a family network to complex ones such as producers' groups, church-based organizations, gender-based organizations and political organizations. Farming networks improve smallholder farming enterprises by aiding in crucial processes such as access to productive resources such as farm inputs, markets, access information and labour. Ndambi et al., (2019) concluded that the most effective extension services in disseminating good manure management practices were those with networks demonstrations that allowed farmers to see what fellow farmers were doing. Through their networks, farmers connect with outside members like extension officers, NGOs, and the government. Local networking promotes conservation and protection of natural resources and agroecosystems through collective action such as planting indigenous trees in communal areas such as forests. Although the role and effects of local networks are apparent, increased erosion of networks has been happening. The erosion of networks has been attributed to the dominant top-down advisory approach that characterizes state-led agricultural initiatives. Insecure land entitlement, weak social capital and lack of political weakens the power of local networks. This extends to overcoming the challenges in the food system such as climate change, depletion of natural resources and environmental degradation.

Agroecology emphasizes both formal and informal networks. It is an alternative approach based on a holistic strategy to improve smallholder agriculture by advocating for farmer-farmer, farmer-consumer networks and participatory methods (Gliessman., 2016; Altieri., 2018). This approach can help in formulating and implementing agricultural initiatives. The new synergies resulting from the networks also help to curb the advancing food system and livelihood challenges. Agroecology focuses on building more just and social systems in which small-scale food producers and communities can thrive (Nyeleni., 2015). These agricultural initiatives have to engage local farmers knowledge as they have been key contributors despite being left out in state-led intervention planning stages. A systemic engagement approach that recognizes all stakeholders including local farmers, is necessary (Namanji et al., 2016). The inclusion of agroecology policy in legal legislation can boost the creation of resilient links. Convincing unions are beneficial to farmers and will promote government initiatives and respect the Kenyan constitution chapter on right to freedom of expression, as well as right to food and safe environment

4.6 Stakeholder engagement

Considering that the agroecology legislation will have short-term and long-term results interventions that will influence many sectors, it is important to have a high-quality process of developing the legal framework. According to Freeman et al., (2018) in a co-management paper, stakeholder commitment among groups with mutual interests poses engagement of all relevant stakeholders as one of the solutions to deal with mismanagement or avoiding crises. In policymaking, a complex understanding calls for effective institutional interactions among participants responsible for the process. Social, political and economic institutions must work together in designing and achieving effective policies. The policy process can be reasonable if all sectors representatives are involved, including civil servants within the social, economic and political spheres (Dunn., 2012).

The difficulties involving diverse stakeholders may lead to lower economic and social performances at the initial steps. Therefore, there is a need to intensify the debate around how to move from a singular idea (group) to a shared vision (groups, community) at a territory level. This model can help smallholder farmers when discussing access to financial processes, extension services and marketplaces during the initial stages of collecting agroecology policy references. On a higher level such as one addressing agroecology as "ecology of food systems" by Francis et al., (2003) it calls for a transdisciplinary approach and, in this case, sociology, economics, environmental sciences, political science and health may contribute to the discussions. Stakeholder engagement corresponds to the complex dynamics within a family in which all its diverse components are combined to keep them moving on as a family. The Freeman theory states that to create sufficient conditions that allow effective stakeholder engagement, relevant stakeholders have to moderate the differences in their power in terms of knowledge, understanding, preconceptions and priorities. The imbalances in power may cause conflicts (Adams et al., 2003), opening up a need to investigate which empowerment actions can encourage these sectors representatives to full participation.

Inclusive planning encourages working with multiple disciplines to share knowledge and methods, essential in enriching the policy development process (Namanji et al., 2016). According to Scuotto et al., (2017), it appears that the role of knowledge and information sharing is crucial for achieving the awareness and innovation necessary to create a successful engagement among the stakeholders effectively. The information needs to be shared and understood by the relevant stakeholders for an easy engagement process. The policy development can start by examining the characteristics and the outcomes of current policies and legal frameworks that had included or excluded important stakeholders during the strategizing processes. Through an agroecology forum, outcomes evaluation of the current policies initiative has started in Kiambu, but more initiatives are needed to produce quality results.

Dawkins (2014) recognizes the engagement of all relevant stakeholders, including those referred to as low-power stakeholders as important in the attainment of common interests and goals. Majority of smallholder farmers are underprivileged, hence tend to be involved in marginal issues and have little impact on policies that later affect them. There is a need to understand how to lower barriers behind the low participation of some stakeholders. The empowerment of smallholder representatives, NGOs, public and private institutions, and research institutions is crucial to success in policymaking. Through empowerment, farmers can acquire resources such as credits, knowledge and skills to influence events. Empowered low-power stakeholders can engage with other participants, reducing misunderstanding. Empowered participants can also develop themselves independently on other issues without always depending on other stakeholders.

6.0 Conclusion

Agroecology continues to be recognized as a source of regenerative solutions to the detrimental results of climate change and the practices of industrial agriculture and conventional food systems. The recognition ranges from small-scale to large-scale producers, communities, local and international NGOs, researchers, governments and intergovernmental bodies. Despite its vast glory and numerous positive outcomes, its documentation and recognition in legal frameworks are less impressive. Several countries in Europe and South America have considered alternatives by adopting an agroecology policy. This research investigates the effectiveness of agroecology from agroecological farmers and other relevant stakeholders, to lay a foundation for the documentation of agroecology performance. The purpose of the study was to understand how it has improved smallholders' livelihood and documents the results that could inform agroecology policy work.

Agroecology approaches embrace a transdisciplinary focus that provides transformative pathways in developing sustainable food systems through its major aspects: socio-economic, environmental and political. This means it advocates for an inclusive engagement of all relevant stakeholders in its processes. Thus, a platform under which many social movements and small-scale farmers organizations around the world defend their collective rights and advocate for a diversity of locally adapted agriculture and food systems practiced by small scale food producers in different territories (adapted from Anderson et al., 2015; Nyeleni., 2015). The study used five key dimensions: economy, health and nutrition, society and culture, environment and climate change and governance to frame the study results. They are described as the priority areas for agricultural policymakers by FAO.

The study results are consistent with many past research and study cases that have shown the various capacities through which agroecology can facilitate the transformation of current insecure food systems to sustainable food systems that contribute to the development of smallholder livelihoods and the larger community. The study provides fundamental basis for evidence-based debates around legal frameworks to support a sustainable food system.

The results address farm productivity, wealth creation, food security and sovereignty, nutrition, food health-related challenges, climate change, environmental degradation, women and youth empowerment. However, the full benefits of agroecological transition have yet to be fully experienced. The ability of agroecology to provide solutions to all the above issues is a direct call for its recognition through promotion, farms transition, AEP adoption and inclusion agroecology agricultural policies and strategies. Decisions on budget allocating money and other services through the government's policies and other legal frameworks.

Due to the lack of an agroecology policy, this strategy has not received funds from either county or national governments. The best-funded forms of agricultural investment in Kenya use fertilizer, pesticides and hybrid seeds, despite the weighty evidence of their unfavorable impacts on the ecosystem. In general, there is lack of recognition of the value of scaling up agroecological practices based on agroecological principles to enable local to regional applicability and policy contexts.

The study also identifies past scenarios where some policies were non-compliant with the expectations of the makers because of only partial involvement of relevant stakeholders. This then calls for conducive working space for all relevant sectors. Interactive processes at all stages of policy and legal framework development are needed to ensure a coherent legal document to all sectors affected. Agroecology policy has to have short-term and long-term projected outcomes hence quality time should be invested in its writing. This is to provide an opportunity for meaningful participation where all sectors involved can share their views freely. Sharing provides room for education from diverse knowledge sources as the stakeholders are knowledgeable and have different experiences and relevant points of view.

To conclude, this study highlights the important role that governments and interested institutions can play in improving the livelihood of farmers, communities in general and safeguarding the environment through agroecology without waiting for disasters to act responsibly.

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Appendix I

Farmers questionnaire

Questionnaire No: _____

Date: _____

Section A (Demographic data)

1. Farmers code: _____
2. Which is your Subcounty? (Farm locality)
3. Your occupation?
4. What is your age bracket if you do not mind?
   a) Under 30 c) 30-39
   b) 40-49 d) 50-59 e) Over 60
5. Gender
   - ◊ Male
   - ◊ Female
   - ◊ Others(specify)
6. Current marital status
   - ◊ Single
   - ◊ Married
   - ◊ Separated/Divorced
   - ◊ Widowed/widower
   - ◊ Others(specify)
7. What is your highest level of education attained?
   - ◊ No formal schooling
   - ◊ Completed primary school
   - ◊ Completed certificate level

- ◊ Completed tertiary qualification (certificate/diploma, degree)
- ◊ Completed post-graduate qualifications
- ◊ Others (specify)

8. What is the total size of your farm and what size /proportion is under production _____ (Acres and percentage)?
9. In which community groups are you a member? What do they deal with?
12 How many members does your household have and how many participate in the management of your farm or production system?

Section B (Agroecological farming practices)

1. What type of enterprise(s) do you run in your farm?
   - ◊ Crops production
   - ◊ Livestock production
   - ◊ Fish farming
   - ◊ Poultry farming
   - ◊ Inputs production
   - ◊ Crops, livestock and input production
   - ◊ Others (specify)

2. What agricultural practices do you practice?

Agriculture practice	**Tick**	**Number of acres.**
Rainfed only		
Irrigation only		
Rainfed and irrigation		
Others (specify)		

3. Do you practice any form of agroecology YES/NO

Agroecology is farming that "centers on food production that makes the best use of nature's good and services while not damaging these resources. Agroecological farmers seeks to improve food yields and diversification for balanced nutrition, strengthen fair markets for their produce, enhance healthy ecosystems, builds on ancestral knowledge and customs and supported by farmers-centered applied research and policies. (Agroecology fund).

If yes which agroecological farming practices have you adopted on your farm?

4. What agricultural outputs and services does your farm produce or provide?

Crops	animals	fruits	trees	Others

5. What is the main intended destination of your agricultural productions?
   - ◊ For household consumption only
   - ◊ Mostly household and less for sale only
   - ◊ Equally for sale and household consumption
   - ◊ Mostly for sale and less for household consumption
   - ◊ For sale only
   - ◊ Others (specify)
6. How or where do you sell your products and services and who are the consumers of your products?
   - ◊ Farmgate (Traders or consumers)
   - ◊ Local market
   - ◊ Regional market
   - ◊ Supermarkets, shops
   - ◊ Institutions (schools, hospitals, offices)
   - ◊ Others (specify)
7. From where or who do you get your farming information in case of need?
   a) Farmers groups
   b) Government agents
   c) Internet explorer
   d) Other private entities
   e) Others (specify)
   f) Community leaders
   g) NGOs
   h) Churches /religious community
   i) Media stations
8. Do local and national governments provide any support to encourage practice of agroecology?
   - ◊ Yes……... If yes, what kind of support?
   - ◊ No
   - ◊ I do not know
9. Have you observed changes in the number of agroecological farms around your ward?
   - ◊ Yes
   - ◊ No.
   - ◊ I do not know.

   If yes explain the changes and what is your remark to the trends happening.

Section C (performance evaluation)

10. Which changes/improvements in your farm production have you experienced after adopting agroecological practices?
    1= No influence at all
    2= Partial increase

3= Medium increase
4= A good increase
5= A great increase

Based on your farm observations and records, please mark/tick the appropriate box to indicate…

How do the adopted practices and principles influence the performance criteria in your farm		1	2	3	4	5
Main dimension	**Criteria for measuring the farm performance**					
Economy	Productivity- Improved volume of production over time relative to the amount/number of inputs used.					
	Income/profit (Value of agricultural production- value of all cost used in production of the goods and services in the farm)					
	Added value (total income received in relation to general wealth of the farmer "created wealth")					
	Circular economy (marketing of products and services is largely localized)					
Health and nutrition	Dietary diversity (Provides different varieties of healthy and nutrient based balanced food for individuals)					
	Food security (Availability of seasonal, sufficient and accessible food)					
	Exposure to pesticides (means through which the farmer come into contact with pesticides such as preparation, application, cleaning spraying equipment, buying sprayed food products e.t.c)					
Society and culture	Youth empowerment and migration/emigration (more youths are engaged and develop interest due opportunities created (trainings, education, jobs) by agroecology principles)					
	Women empowerment (More women are favored, engaged and develop interested after agroecology principles knowledge adoption)					
	Connectivity (producer-consumer interaction) i.e on knowledge sharing and trading.					
	Indigenous identity and awareness Promotion of local varieties, traditional foods and culture preservation)					
Environment and climate change	Water use efficiency (saving and recycling)					
	Climate change mitigation (cropping system, land use practices)					
	Agricultural biodiversity (Diversity of crop species and varieties, livestock, and breeds, pollinators soil microorganisms e.t.c)					
	Soil health-improved by adding manure or compost or, minimum tillage, organic fertilization cover cropping practice,					

	reduced use of inorganic fertilizers and pesticides (regulates agricultural output and ecosystem functioning)					
Governance	Secure land tenure (helps the farmers to define the model of farming of their wish)					
	Participation of producers in networks, organizations, forums engaging with governance.					
	Policy and strategies complementarity with farmers need (Gives the farmers a stake or representation in the formulation of policies)					

Section C (policies and strategies)

11. What government policies/laws/regulations are in place or in process that affect or might affect your practice of agroecology either positively or negatively?
12. What are the main strengths and weaknesses of the current agricultural strategy/policy with regard to supporting practice of agroecology? What gaps are there and need to be addressed?
13. What is the level of your general satisfaction so far after applying agroecology for 5 or more years ?

1.Unsatisfied 2.Partially Satisfied 3. Satisfied
4. More than Satisfied 5 Very Satisfied

Policy Implementers questionnaire

Questionnaire No:
Date:

Name of the interviewee: _____
Subcounty: _____
Type of operator? _____

1. What is your role(s) in food production chains?
2. Who do you engage with during your operations?
3. What are the main strengths and weaknesses (what worked well and does not work) of the current agricultural strategy/policy from your perspective?
4. What have been the main changes in farming systems and policy environment in agriculture sector? What changes can be included in the agricultural policy?
5. Have you ever heard of the term "**agroecology"** and if yes, what can you say about it?
   - ◊ Yes
   - ◊ No
   - ◊ I do not know.

Agroecology is farming that "centers on food production that makes the best use of nature's good and services while not damaging these resources. Agroecological farmers seeks to improve food yields and diversification for balanced nutrition, strengthen fair markets for their produce, enhance healthy ecosystems, builds on ancestral knowledge and customs and supported by farmers-centered applied research and policies. (Agroecology fund).

6. Having read this statement, is **agroecology** a production system you would recommend to farmers and policymakers?
   Why?
7. How does your role promote, or can it promote agroecology awareness and performance?
8. What is the percentage of farmers are practicing agroecology practices in your work area?
   a) 1-20 b) 20-40 c) 40-60
   d) 60-80 e) 80-100
9. From your experience, what are the barriers to the recognition and adoption of agroecology within your area or Kiambu county in general?
10. How does the current agriculture policy framework promote or support practice of agroecology in Kiambu County?
11. What policies/laws/strategies are already in place that target the agroecological production of agricultural and food related products?
12. Have you ever been involved in any agriculture or agroecology policy making engagement?
    Yes …… which policy?
    No

If yes, how do you think other stakeholders' participation can be engaged in policy formulation process?

13. What initiatives can both levels of government undertake to promote agroecology?
14. How can enactment and implementation of the agroecology policy be strengthened?
15. Are you satisfied with the current agroecology practice and its general performance?
    1.Unsatisfied 2.Partially Satisfied 3. Satisfied
    4. More than Satisfied 5 Very Satisfied

Give a reason for your response

Policy makers and legislator's questionnaire

Questionnaire No: ____
Date_____

Name of the interviewee. _____
Type of the operator. _____
Government level/Private organization_____

1. What is your major role and how does it relate with food production systems/agriculture?
2. What main changes have occurred in the current farming systems and policy environment for agriculture?
3. Have you ever heard of the term "**agroecology"** and if yes, what can you say about it?
   ◊ Yes
   ◊ No
   ◊ I do not know.

Agroecology is farming that "centers on food production that makes the best use of nature's good and services while not damaging these resources. Agroecological farmers seeks to improve food yields and diversification for balanced nutrition, strengthen fair markets for their produce, enhance healthy ecosystems, builds on ancestral knowledge and customs and supported by farmers-centered applied research and policies. (Agroecology fund).

4. Having read this statement, is **agroecology** a production system you would recommend to farmers and your county for policy enactment?
   Why?

5. How do you think Kiambu county would benefit if agroecology is adopted? Please explain?
6. How do you think your role can influence the enactment of agroecology policy and adoption of agroecology in Kiambu?
7. From your experience, what would be the key barriers to adoption of agroecology within value chains in Kiambu county. How can these barriers be overcome?
8. Currently are there initiatives in your county government or private organization you know of that promote or can promote agroecology?
   a. Yes (What initiatives are they)
   b. No (what initiatives do you think are needed?
   c. I do not know
9. What policies/laws/ regulations/strategies are already in place or in process that might work to promote agroecology?
10. What needs to be changed or added to the present agricultural policy to make it support agroecology practice? Or, what policy domains are missing and need to be included?
11. Describe the procedure of developing an agroecology policy at county level
12. How can multi-stakeholder participation in agroecology policy formulation process be strengthened?
13. Are there other governments departmental polices/strategies apart from those on agriculture that can support agroecology due to its wide scope?
    ◊ Yes
    ◊ No

If yes explain.

Non-state agroecology promoters' questionnaire

Questionnaire No: _____
Date: _____

Name of the interviewee: _____
Subcounty/County: _____
Type of operator? _____

1. What is your role in food production chains?
2. Who do you involve/engage with during your operations?

3. How does your role promote agroecology practice awareness, adoption and performance?
4. Would you recommend agroecology practice to farmers and to your county for policy enactment?
5. How do you think Kiambu county would benefit if agroecology is adopted by many farmers? Please explain?
6. From your experience, what are the key barriers to the recognition and adoption of agroecology within your area or Kiambu county in general? How can these barriers be overcome?
7. Does the current agriculture policy framework promote or support practice of agroecology in Kiambu County?
    a) Yes
    b) No
    c) I do not know

If yes, how does it promote agroecology?

8. Currently, what initiatives are you undertaking in your organization to promote agroecology practice?
9. What more initiatives do you think are missing in the promotion of agroecology practice and its policy enactment?
10. How do you think your role can influence enactment of agroecology policy and recognition of agroecology in Kiambu?
11. Are you satisfied with the current agroecology practice and its general performance?

    1.Unsatisfied 2.Partially Satisfied 3. Satisfied

    4. More than Satisfied 5 Very Satisfied

Give a reason for your response

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