



Kenya Context Assessment Report

A desk-top review of the context of agroecological principles of Kiambu and Makueni counties

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The main objective of this context assessment is to provide a comprehensive geographical description of the Agroecological Living Landscapes (ALLs) in Makueni and Kiambu counties in Kenya. The report covers the economic, environmental, social, and political aspects of the two ALLs and assesses the extent to which agroecological principles have been implemented or practiced within these areas. The study broadly focuses on the two selected ALLs, but also incorporates some specific information from the two ALL host centers: the Drylands Natural Resources Center (DNRC) in Makueni County and the Community Sustainable Agriculture and Healthy Environment Program (CSHEP) in Kiambu County. The information in the document is primarily sourced from secondary literature and outputs generated from various Work Packages aimed at characterizing, identifying, and assessing the existing practices and experiences within the two ALLs.

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The CGIAR Initiative Transformational Agroecology across Food, Land, and Water Systems develops and scales agroecological innovations with small-scale farmers and other food system actors in seven low- and middle-income countries. It is one of 32 initiatives of CGIAR, a global research partnership for a food-secure future, dedicated to transforming food, land, and water systems in a climate crisis.

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Introduction

The CGIAR Agroecology Initiative (AE-I) is built around the concept and approach of Living Landscapes that promote an integrated approach to engaging with the social system and ecosystems in given spaces in support of agroecological transitions. The Kenyan Agroecological Living Landscapes (ALLs) are established in two different counties: Makueni and Kiambu. This context document provides a literature review assessment of the status of agroecology in the two counties. It summarizes the environmental, economic, social, and political context of Makueni and Kiambu counties, along with the status, opportunities, and areas of interventions along the 13 FAO principles on agroecology.

The Kenyan ALLs will be hosted in CSHEP and DNRC, which are part of the Participatory Ecological Land Use Management (PELUM) association. This document provides an assessment of the status of the two centers in adopting agroecological innovations and a summary of the key ongoing activities along the 13 principles. Some of the key highlights are the current ongoing work on organic farming in the centers, which mainly focuses on composting, application of organic pesticides, water recycling and harvesting, seed saving, and agroforestry, among others. The document also provides a detailed summary of the key relevant stakeholders that are involved in promoting agroecology in Kenya.

Drawing on the results from engagements held with various stakeholders in both ALLs, the document summarizes the key agroecological practices that farmers are already engaged in within the two ALLs along three key focus areas: (1) integrated pest management, (2) soil management, and (3) water management. The practices involve mulching, agroforestry, trenches, Zai pits, cover crops, use of biopesticides, crop rotation, and intercropping, among many others. To support and scale the adoption of a selection of relevant innovative practices, the AE-I will facilitate a co-design process involving farmers and other stakeholders within the ALLs. This co-design process aims at selecting and rigorously monitoring the performance of contextually suitable practices through agronomic trials in the ALL host centers and in farmers' fields.

Several factors have been identified as limiting agricultural production in the two ALLs: limited precipitation and prolonged drought periods, poor linkage to markets for farm produce, limited knowledge on the best-suited agroecological practices, and inadequate information for farmers through extension services. To address these issues, the AE-I will facilitate the formation of a community of place in the ALLs, which will bring together farmers, ALL host centers, and other stakeholders within the county government to identify the key actors that can be involved in addressing these concerns. The AE-I will also co-design and identify the key important agroecological innovations that can be tested within each ALL and provide opportunities for farmers to learn and assess how these practices work best.

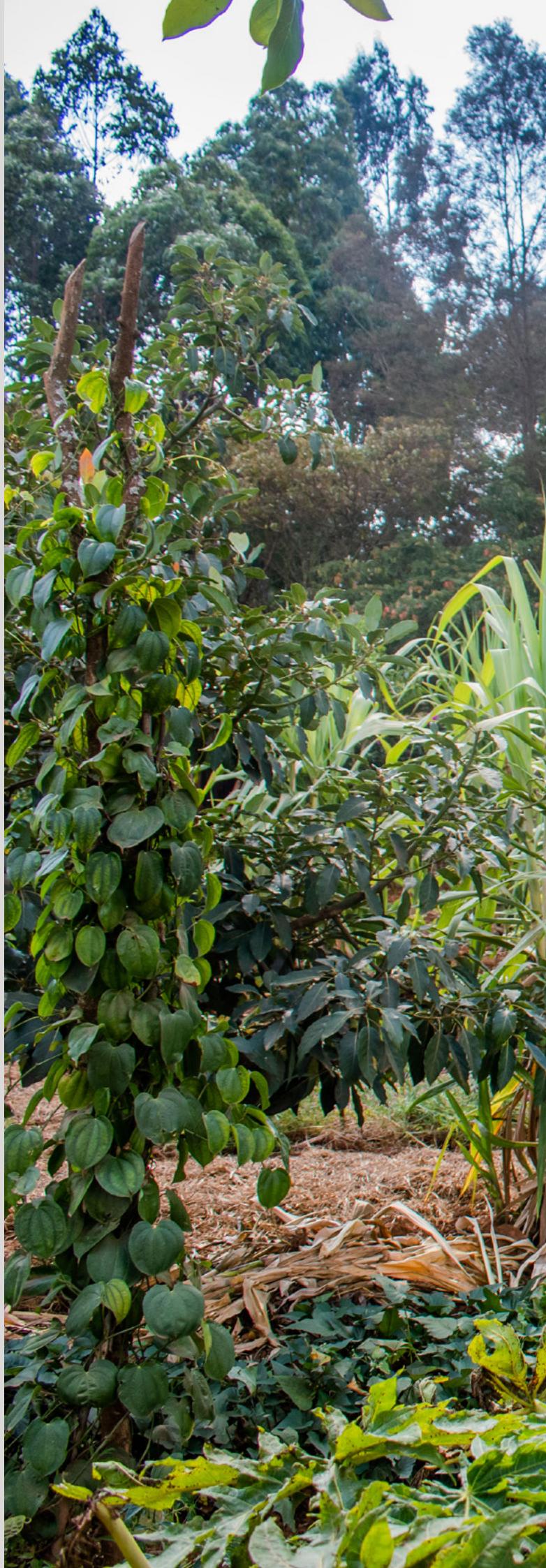
The two Kenyan ALLs are mainly characterized by mixed crop-livestock systems, mainly carried out on smallholder farms. The two ALLs differ in terms of climatic conditions: the Kiambu ALL comprises areas with humid and sub-humid climate and a small portion that is semi-arid, whereas the Makueni ALL mainly has larger areas that are semi-arid. Conventional practices such as continuous monocropping, tillage, and lack of soil cover have resulted in severe soil and land degradation in some of the landscapes in the ALLs, especially in Makueni County. Moreover, with a significant part of the landscapes in the ALLs being semi-arid, farmers at some point have reported total crop failures associated with low and unreliable precipitation, resulting in severe droughts over the years. Thus, innovative ideas that can increase soil organic matter, enhance soil moisture retention, and decrease the use of pesticides are needed for agroecological transition to happen in these ALLs.

From the political perspective, climate change mitigation and adaptation are among the top priorities of national and county government policies. Agroecological innovations play a critical role in tackling these issues. Currently, several non-government organizations and collectives are promoting agroecology in the country, including the network of organizations that are part of the Kenyan chapter of the PELUM association. In addition, the Kenyan government launched the Inter-Sectoral Forum on Agrobiodiversity and Agroecology (ISFAA) in 2020, which provides a platform through which stakeholders can share information and knowledge, and influence policy on agrobiodiversity and agroecology. This body brings together different participants from the government, practitioners, as well as farmers to interact, discuss, and implement different projects. With Kenya's government being devolved, some county governments are already integrating agroecology within their policies through County Integrated Development Plans (CIDPs). In addition, at the county level, other bodies such as the County Agriculture Sector Steering Committee (CASCOM) and the Council of Governors (CoG) can play great roles in terms of mainstreaming agroecology policies. These policies and underlying priorities also have an influence on strengthening the enabling environment for agroecological value chains and businesses. Both are important for promoting agroecological transitions.

Preliminary assessments involving household surveys indicate that numerous agroecological practices fall under these focus areas and are already practiced by farmers in the two ALLs. This document will also serve as a co-basis for the Localization of Indicators Selection Process (LISP) that is planned within the Holistic Localized Performance Assessment (HOLPA) tool.

List of acronyms and abbreviations

AFC	Agricultural Financing Corporation
ALL	Agroecological Living Landscape
ATC	Agricultural Training Center
CASSCOM	Country Agriculture Sector Steering Committee
CBOs	Community Based Organizations
CEC.....	County Executive Committee
CIDPs.....	County Integrated Development Plans
CSHEP	Community Sustainable Agriculture and Healthy Environment Program
DNRC	Drylands Natural Resources Center
FAO.....	Food and Agriculture Organization of the United Nations
HLPE	High-Level Panel of Experts
HOLPA	Holistic Localized Performance Assessment
ISFAA	Inter-Sectoral Forum on Agrobiodiversity and Agroforestry
KALRO	Kenya Agricultural and Livestock Research Organization
KDSP.....	Kenya Devolution Support Programme
KEFRI	Kenya Forestry Research Institute
KOAN	Kenya Organic Agriculture Network
MSPs.....	Multistakeholder platforms
NCPB	National Cereals and Produce Board
NSAs	Non-state actors
PELUM.....	Participatory Ecological Land Use and Management
PGS	Participatory guarantee system
SOC	Soil organic carbon





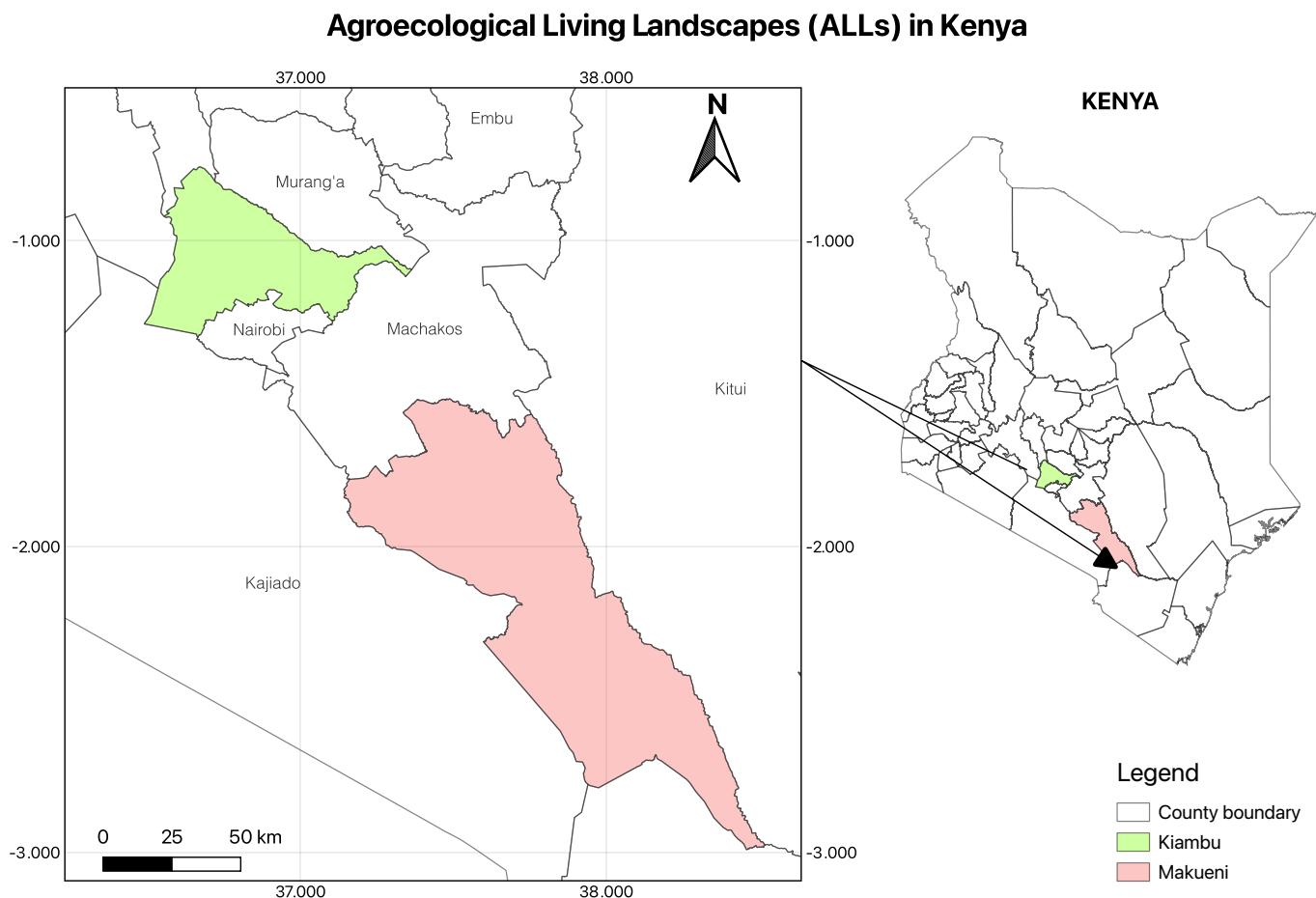
I. Context description

1.1 Location - Agroecological Living Landscapes

The two pre-selected ALLs for this assessment are Makueni and Kiambu counties in Kenya (**Figure 1**). Makueni County is in the eastern part of Kenya, located between latitude 1°35' and 2°59' South and longitude 37°10' and 38°30' East. The county covers an area of 8,214 km² and borders Machakos County to the north, Kitui County to the east, Taita Taveta County to the south, and Kajiado County to the west. Based on the 2019 Kenya Population and Housing Census, the county had a total population of 1,098,584.

Kiambu County lies between latitude 00°25' and 10°20' South and longitude 36°31' and 37°15' East. The county covers an area of 2,543.5 km² and borders Nairobi and Kajiado counties to the south, Machakos to the east, Murang'a to the north and northeast, Nyandarua to the northwest, and Nakuru to the west. It is a peri-urban county located in the Central region (County Government of Kiambu, 2018). Kiambu County is the second most populous after Nairobi City County and the 2019 Kenya Population and Housing Census indicated that it had a total population of 2,417,735.

Figure 1. Map of Kenya showing the location of the two Agroecological Living Landscapes (ALLs) in Makueni and Kiambu counties.



Source: Global Administrative Areas (2012).



1.2 Environmental context

1.2.1 Kiambu and Makueni County ALL locations

The two ALL host sites in Kenya differ in terms of topography, climate, and soil conditions. Makueni County is mainly characterized by a low-lying terrain except for the hilly areas of Kilungu, Mbooni, and Kyulu. The hilly regions receive 800–1,200 mm of rainfall annually, whereas the lower areas such as Kibwezi East receive below-average rainfall of 250–400 mm (**Figure 2**). Mean annual temperatures range from 20.2 to 35.8 °C, with the hilly areas being relatively colder than the low-lying regions. The Drylands and Natural Resources Center (DNRC)¹, which is the key host center within the Makueni County ALL, is located approximately 140 km from Nairobi in Mbooni sub-county, Kisau-Kiteta ward, Kalimani location near Mbumbuni market. The total annual precipitation in the area surrounding the center is 500–750 mm, with April and July being the wettest and driest months, respectively.

Kiambu County is divided into four broad topographical zones: upper highland (1,800–2,550 m.a.s.l.), lower highland (1,500–1,800 m), upper midland (1,300–1,500 m), and lower midland (1,200–1,360 m) (Kiambu County IDP, 2018). The upper highland zone is an extension of the Aberdare ranges and is very wet and steep and acts as the water catchment area for the county. The lower highland zone is characterized by hills, plateaus, and high-elevation areas. It is generally a tea and dairy production zone and other agricultural activities such as maize, sheep, and horticultural farming are also practiced in the area. The soils in the midland zone are dissected and are easily eroded. Other physical features include steep slopes and valleys, which are unsuitable for cultivation. A larger portion of Kiambu County experiences a humid climate.

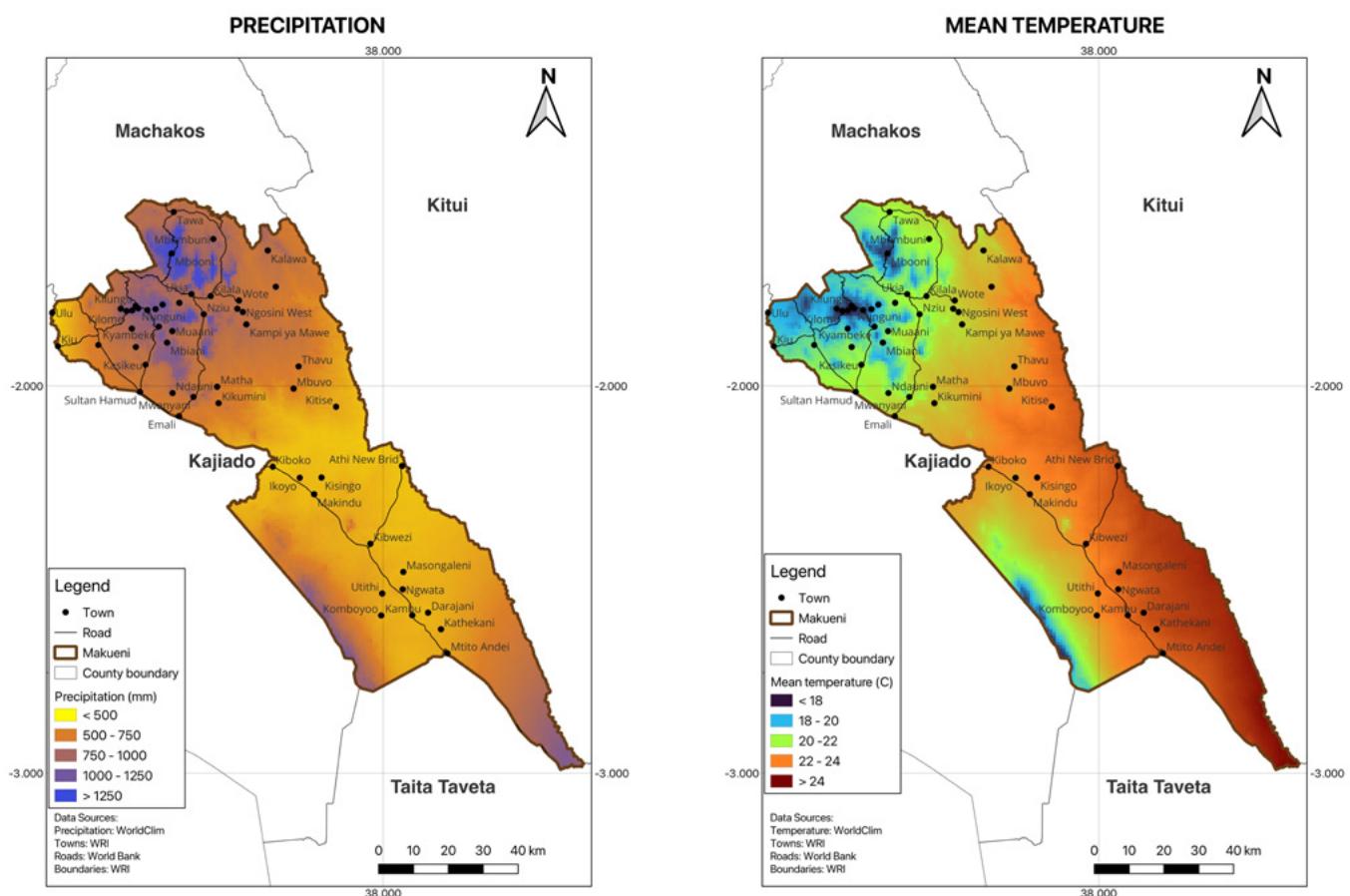
On average, the county receives an annual precipitation of 600–1,600 mm (**Figure 3**), with an average annual temperature of 15–23 °C. Despite this high precipitation, a few regions in the county, including Ndeiya area in Limuru sub-county, are semi-arid. The Community Sustainable Agriculture and Healthy Environment Program (CSHEP)², the ALL host center, is located in Ndeiya, in the lower midland zone characterized by semi-arid climate. The Ndeiya area receives an average of 500 mm of precipitation annually. The wettest month in this region is April while the driest month is July.

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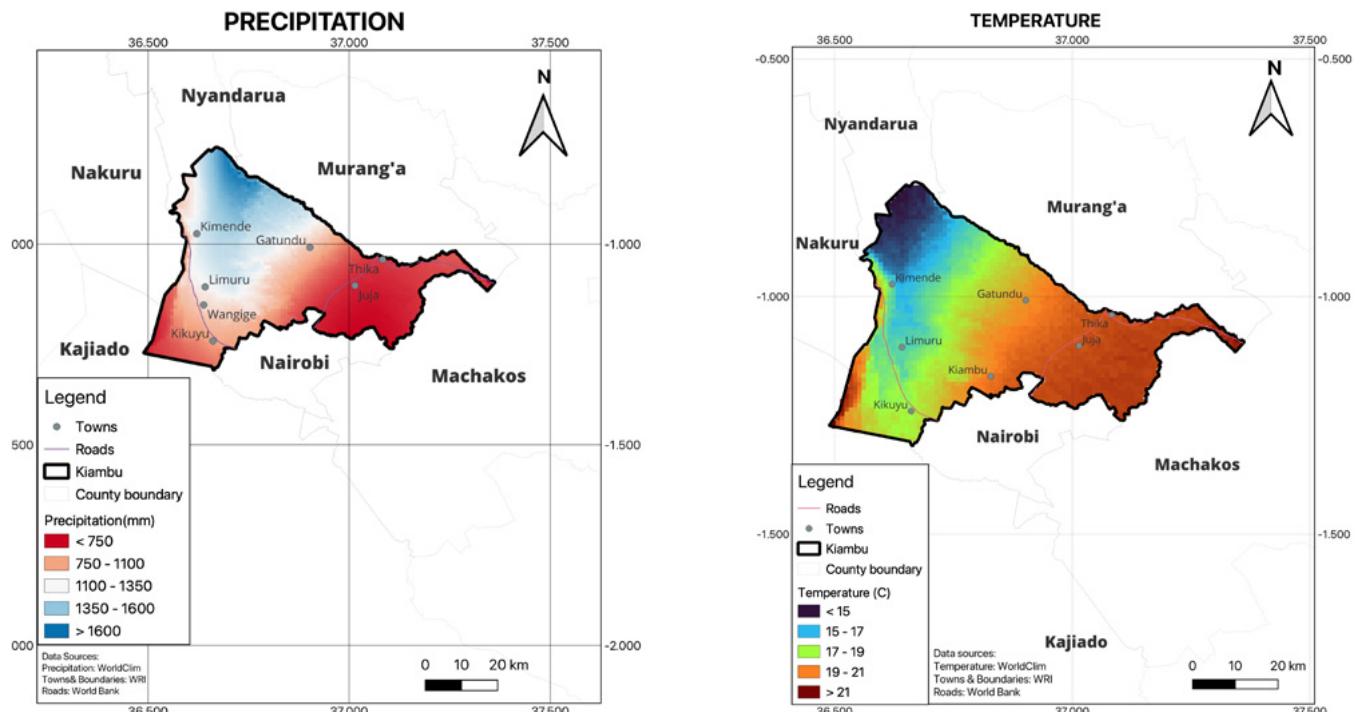
2 <https://cshepkenya.org/>

Figure 2. The annual precipitation (mm) and mean temperature spatial distribution for Makueni County.



Source: <https://test2.biogeo.ucdavis.edu/wc2/#/>

Figure 3. The annual precipitation and mean temperature spatial distribution for Kiambu County.



Source: <https://test2.biogeo.ucdavis.edu/wc2/#/>

1.2.2 Land use description

Makueni County has a larger land mass than Kiambu County. In both counties, cropland occupies the largest proportion of the total land, followed by forestland (**Table 1**). Despite the large extent of cropland area in Makueni County, crop production is relatively lower than in Kiambu County mainly because of poor soil fertility and low precipitation in most areas in the county. Land use data indicate that the agricultural land area in Kiambu County has been decreasing, with a large proportion of the land that was agricultural now being used for real estate and residential buildings (**Figure 4**). A majority of the residents (64%) are poor, which is attributed to the frequent droughts that occur in the area (Centre for Science and Technology Innovation, 2009). Arable area in Kiambu County is larger than the area under other land uses (**Table 1**). However, the area has been decreasing due to the increase in buildings and real estate to accommodate the need for housing for the growing population in the county and its neighboring environs, especially Nairobi City (**Figure 5**).

Makueni County is home to a diversity of both exotic and indigenous plants. Since the county is mainly semi-arid, a large proportion of it is shrubland (**Figure 3**). The county also faces severe land degradation and previous studies have indicated that soil erosion by water is one of the major causes of this degradation (Kieti et al., 2016). Clearing of the vegetation cover through rampant deforestation and tree logging has also contributed greatly to land degradation by leaving the land bare and unprotected from agents of erosion (Muia, 2012). The lack of ground cover contributes to soil erosion in cultivated fields in the county, especially during the rainy seasons when all the minerals on the soil surface are washed away. In addition, rampant erosion is common in the grazing lands because of the high livestock numbers. Kiambu County has a wide range of wildlife such as elephants, primates, and many bird species, especially in the Kinale forest. The county also is host to two wetlands: Ondiri and Manguo wetlands found in Limuru and Kikuyu sub-counties. These wetlands host diverse types of trees, along with more than 30 species of resident and migratory birds (Macharia et al., 2010).

Figure 4. Maps showing land cover in Makueni and Kiambu counties (plots extracted from global data by Karra et al., 2021).

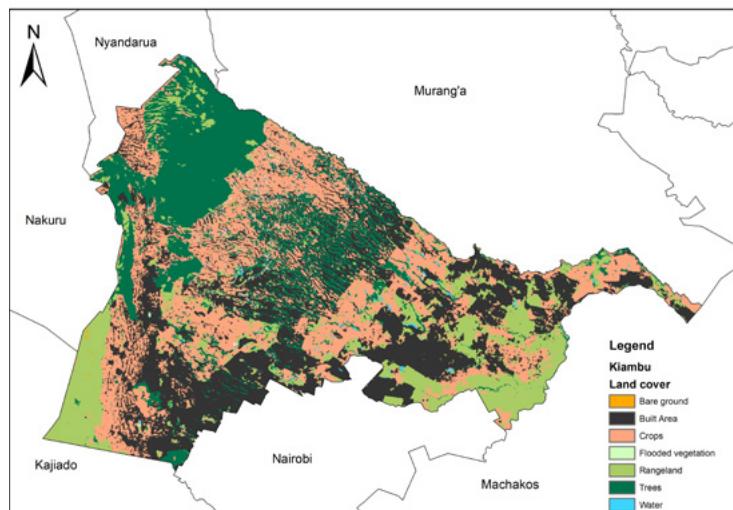
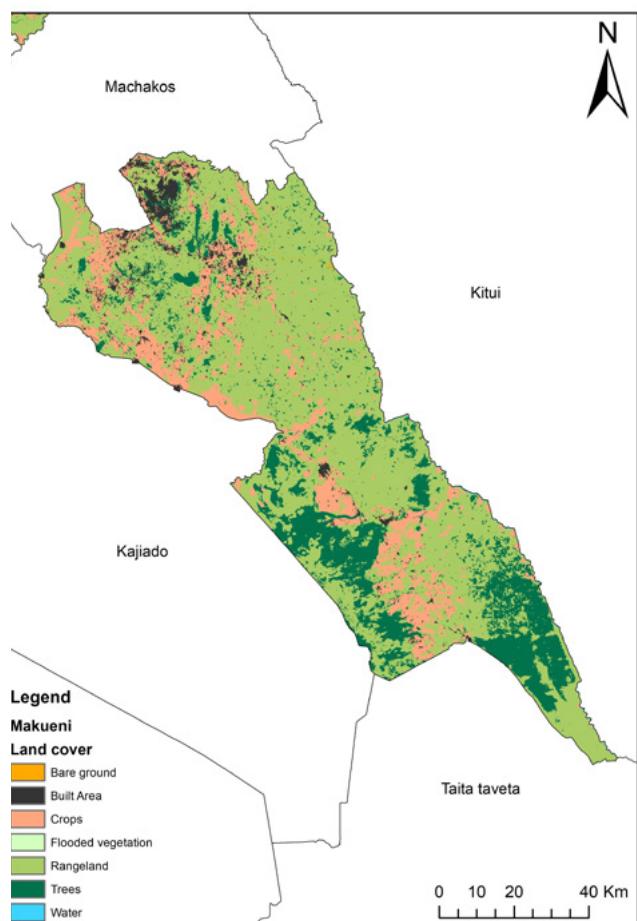
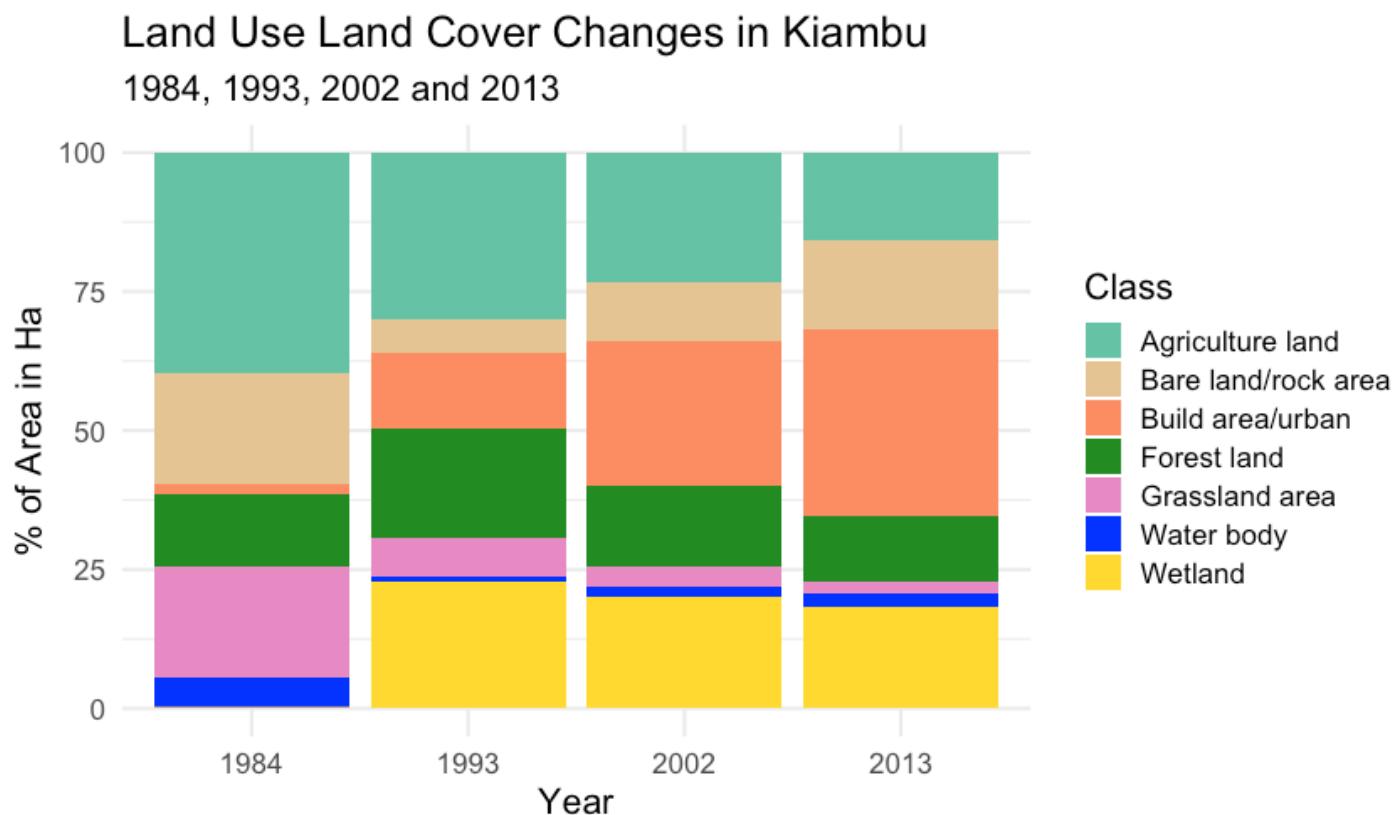


Table 1. A comparison of the area (km^2) under different land use types in Makueni and Kiambu counties. The total areas were obtained from FAO.³

Land use description	Makueni (km^2)	Kiambu (km^2)
Artificial buildings	4.94 (0.06%)	18.06 (0.71%)
Cropland	3,996.5 (48.66%)	1,492.72 (56.69%)
Grassland	483.35 (5.88%)	206.66 (8.13%)
Tree land (forest)	1,885.01 (22.95%)	698.48 (24.46%)
Shrubland	1,882.71 (22.92%)	134.56 (5.29%)
Herbaceous and aquatic	32.48 (39.5%)	33.82 (1.33%)

Figure 5. A bar graph showing the land use patterns for Kiambu County for the period from 1984 to 2013. The data were extracted and adopted from Musa and Odera (2015).



³ <https://data.apps.fao.org/map/catalog/static/search?keyword=landcover>

1.2.3 Soils

The soils in Makueni County can be broadly categorized as follows:

- 1) **Sandy soils:** located in the eastern and southeastern parts of the county, including areas such as Kibwezi and Kalamba.
- 2) **Clay soils:** found in the more central parts of the county, including areas such as Makindu and Nguumo.
- 3) **Loamy soils:** found in the western and northwestern parts of the county, including areas such as Kathonzweni and Wote.
- 4) **Volcanic soils:** found in the southern and southwestern parts of the county, including areas such as Emali and Mtito Andei.

The major soil type in Makueni County is sandy clay loam (**Figure 5**). The soils in the county are generally of low quality and fertility, with soil organic carbon (SOC) content of 0-10 g/kg (**Figure 6**).

According to the Kiambu County IDP (2015), the soils in this county are classified into three categories:

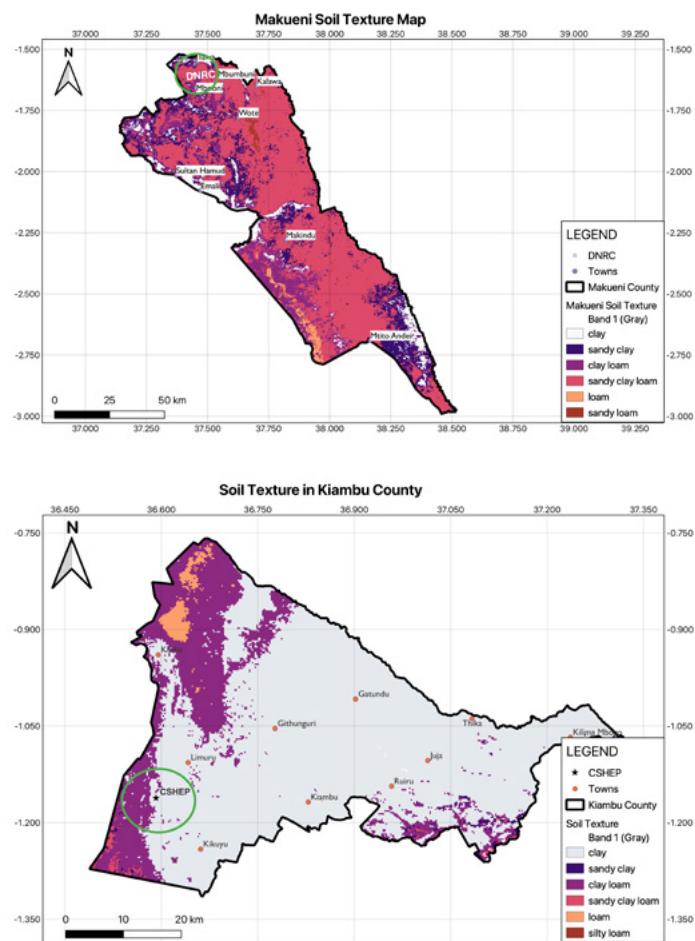
- 1) **High-level upland soils:** These are very fertile soils that originate from volcanic rocks that support the growth of crops such as tea, coffee, horticultural products,

pyrethrum, vegetables, maize, beans, peas, and potatoes, along with livestock keeping. This soil category can be found in Gatundu South, Gatundu North, Githunguri, Kiambu, Kiambaa, Lari, Kikuyu, Kabete, and Limuru constituencies.

- 2) **Volcanic soils:** These are red to dark clays that are well drained with moderate fertility, mostly suited for cash crops such as tea, coffee, and pyrethrum. These soils cover a large extent of the county.
- 3) **Low-fertility soils:** These are sandy or clay soils found in the middle zone and eastern parts of the county, which make up the semi-arid areas. They are suited for drought-tolerant crops such as soya bean and sunflower, and support ranching. This soil is found in some parts of Juja, Thika Town, Ruiru, Kabete, Limuru, Gatundu North, and Gatundu South constituencies. The CSHEP ALL host center is in an area with low-fertility soils.

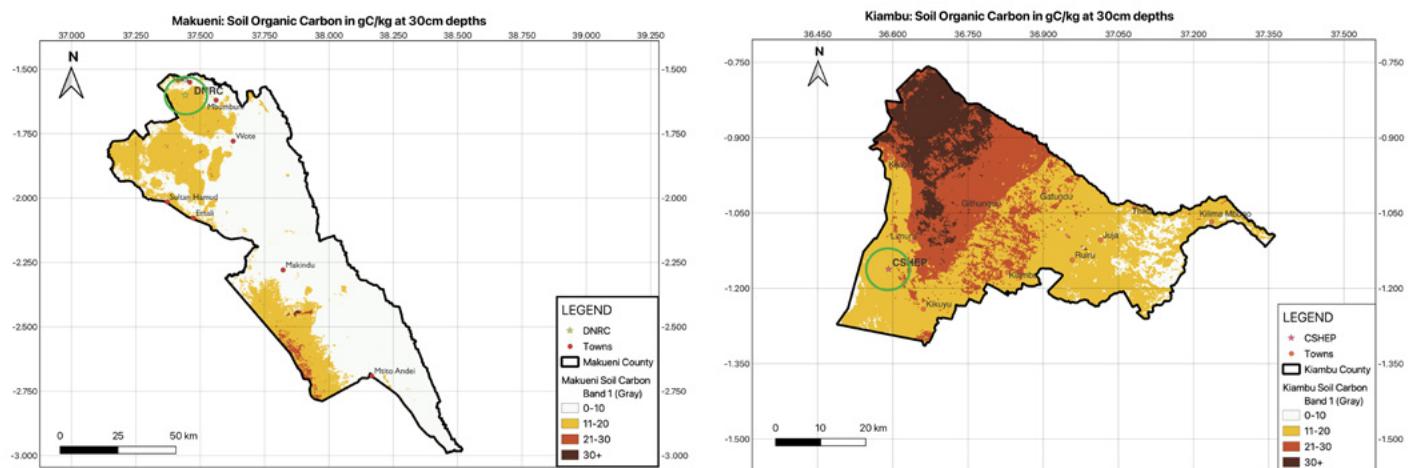
The soil organic carbon content in the upland areas ranges from 21 to 30 g/kg (**Figure 7**). Low-fertility soils are mainly found in the middle zone and the eastern part of the county, which form part of the semi-arid areas (e.g., the area around CSHEP, the Kiambu County ALL host center). The soils are sandy or clay and can support drought-tolerant crops such as soya beans and sunflower (**Figure 6**). The SOC content for this semi-arid area ranges from 11 to 20 g/kg (**Figure 7**).

Figure 6. Maps showing soil types in Makueni and Kiambu counties.



Source: [ISCRIC soil database](#)

Figure 7. Maps showing SOC content from 30-cm depth of topsoil for Makueni and Kiambu counties.



Source: [ISCRIC soil database](#)

1.2.4 Water availability for production

Water scarcity is a major problem in most parts of Makueni County. The county faces several challenges regarding water resource development and management (Makueni County Water Policy, 2019): water catchment degradation, over-abstraction and illegal abstraction of both groundwater and surface water resources, limited assessment and monitoring of the water resources in the county, severe water scarcity due to unsustainable sand harvesting and quarrying, increasing water demand due to increasing population and expansion of agricultural and economic activities across sectors, and low practice of harvesting and storing water due to low investment in and financing of requisite infrastructure. The county also experiences frequent droughts, with several regions recording relatively high temperatures. This constrains sustainable food production, proper vegetation growth, as well as above- and below-ground soil biodiversity.

The major rivers in Makueni County are the Thwake, Kaiti, Kikuu, Muooni, Kiboko, Kambu, Tsavo, Mtito Andei, and Kibwezi, all of which channel their waters into the Athi/Sabaki River system that flows to the Indian Ocean. Other sources of water are protected springs, boreholes, water pans, dams (sand and earth dams), shallow wells, rock catchments, and roof catchments. Overall, these water sources are spread across the county and supply a total production of 18,490 m³ per day. This supply covers less than half of the daily demand for water in the county, which stands at 40,794 m³, implying a deficit of 22,304 m³ per day (Makueni County Vision, 2025). This translates to water coverage of 45.3%, out of which only 17.7% have access to piped water. On average, households walk about 8 km to and from water sources. Whereas 36% of the residents use improved water sources, the rest rely on unimproved sources.

Kiambu County has several water sub-catchments and permanent rivers. Water in the county comes from two principal sources: surface and subsurface. About 90% of the county's water resources comprise both surface-water resources and underground water. The county is divided into several sub-catchment areas (Kiambu County Water and Sewerage Services Sector Policy, 2017). The first one is Nairobi River sub-catchment, which occupies the southern part of the county, with the major rivers being Nairobi, Gitatu, Gitahuru, Karura, Ruirwaka, and Gatharaini. The second one is Kamiti and Ruiru River sub-catchments, which are located to the north of the Nairobi River sub-catchment. It has eight permanent rivers: Riara, Kiu, Kamiti, Makuyu, Ruiru, Bathi, Gatamaiyu, and Komothai. The third one is the Aberdare plateau that contributes to the availability of two sub-catchment areas comprising Thiririka and Ndarugu Rivers. The main streams found in the two areas are Mugutha, Theta, Thiririka, Ruabora, Ndarugu, and Komu. They flow from Nairobi, Kamiti, Ruiru, Thiririka, and Ndarugu sub-catchments to form the Athi River sub-catchment. The fourth is the Chania River and its tributaries comprising Thika and Kariminu Rivers, which rise from the slopes of Mt. Kinangop in the Aberdare Range. The last one is Ewaso Kedong sub-catchment, which runs in a north-south direction and occupies the western part of the county. It has several streams that normally form swamps.

Based on available data, the current number of household connections from water service providers (WSPs) stands at 127,775 (Kiambu County Water and Sewerage Services Sector Policy, 2017). However, there are no data from community water projects. The water demand based on data from WSPs is 244,778 m³/day against a supply of 131,179 m³/day, which translates to 113,599 m³/day of unmet demand. However, the area around Ndeiya (where the CSHEP ALL host center is located) faces severe water problems, with a majority of the residents not connected to a water supply.

1.3 Economic context

1.3.1 Major agricultural commodities and market information

Both Makueni and Kiambu counties are dominated by mixed crop-livestock farming systems, carried out by farmers who hold small pieces of land (commonly referred to as smallholder farmers). The type of crops grown in the two counties differ because of the varying climatic conditions. In Makueni County, the main cereal crops grown are maize, sorghum, and millet, while the main pulses cultivated are green gram, cowpea, pigeon pea, and common dry beans. The common root crops produced are sweet potato, cassava, and arrowroot (Eidt et al., 2020). In addition, fruit trees, including mangoes, oranges, and avocados, are widely grown in the county. Onions, French beans, and watermelons are common in areas where farmers have access to irrigation water. Other crops that are cultivated are pumpkin, cucumber, and sweet potatoes that also act as cover crops. Input suppliers are small-scale agrovets and a few companies such as Dryland Seed Company. Various private organizations, NGOs, and government institutions such as Kenya Agricultural and Livestock Research Organization (KALRO) supply farmers with inputs (Kiambu County Climate Risk Profile, 2021).

Farmers in Makueni sell their produce in the available local markets within the sub-counties. Some of the farmers also sell their produce, mainly cereals and fruits, to middlemen/brokers, who then sell it to high-end markets in Nairobi and Mombasa. The Makueni government established the Makueni Integrated Grain Value Chain Development Project, which was funded by the World Bank through the Kenya Devolution Support Programme (KDSP). The objective of the project was to promote value addition to pulses and improve the income of small-scale farmers. Through this project, Makueni has a grain plant in Makindu. The plant processes pulses and grains through drying, cleaning, destoning, sorting, polishing, grading, and packaging. In addition, the plant identifies market segments and delivers through organized distribution channels. Makueni County has a mango processing plant: Kalamba Fruit Processing Plant. The capacity of this plant is 1,182 metric tons of mangoes per year (Kiambu County Climate Risk Profile, 2021), and farmers can deliver their mangoes for processing into purée and fruit juices. However, this capacity is far below the annual mango production by the county (Onyango et al., 2023), which has forced most farmers to sell their produce to middlemen.

The main food crops grown in Kiambu County are beans, maize, cabbages, Irish potatoes, and bananas (Karanja, 2006). Coffee, tea, and vegetables (e.g., kale and spinach) are common cash crops in the county. However, the area under these crops has been decreasing because of the growth of real estate and commercial houses among other factors that push the production to unsuitable areas. In Kiambu County, dairy production is the leading agricultural enterprise, with 70% of the farm families keeping an average of two to three cows under zero-grazing systems (Kiambu County, 2018). Milk is the major livestock product in the county and currently

leading in Kenya. Poultry and pig keeping follow dairy farming. According to 2017 data provided by the Department of Agriculture, Livestock, and Fisheries of Kiambu County, the numbers of livestock in the county were as follows: 247,706 cattle, 139,605 sheep, 102,366 goats, 2,550,523 poultry, 52,588 pigs, and 10,227 donkeys. Agro-processing industries in the county include Brookside Dairies, Githunguri Dairies, Ndumberi Dairies, Limuru Milk, and Palmside Dairies and local food-processing factories such as Farmers' Choice Ltd. and Kenchic Co. Ltd. The county has 216 communal cattle dips, of which 7 are functional and 209 are non-functional.

 Most agricultural products are marketed through local markets and the prices are determined by market forces.

Kiambu County has a farmer-led dairy cooperative society to which farmers sell their milk, while pig farmers mainly sell mature animals to Farmers' Choice Ltd. Because Kiambu is a peri-urban area with favorable infrastructure, both farmers and retailers have access to the Nairobi City market and can easily transport and sell their produce to the city residents. In addition, the proximity to the neighboring counties of Muranga, Nyandarua, Nakuru, Kajiado, and Machakos provides readily available markets for the agricultural produce. The county is well endowed with 118 designated markets spread across it (Kiambu County, 2018). The main markets are Gatundu Modern Market in Gatundu South, Kamwangi Market in Gatundu North, Juja Market in Juja sub-county, Jamhuri and Madaraka Markets in Thika, Githurai and Ruiru in Ruiru sub-county, Githunguri Market in Githunguri sub-county, Wangige Main Market and Wangige Egg Market in Kabete sub-county, Kangangi Market in Kiambu sub-county, Limuru Barter Hawker Market in Limuru, Karuri Market in Kiambaa sub-county, Dagoretti and Kikuyu Markets in Kikuyu sub-county, and Kimende Market in Lari sub-county. Wangige Egg Market is the biggest open egg market in the entire region of East and Central Africa.

In the two ALLs, agricultural inputs are mainly bought from local agro-dealers and the National Cereals and Produce Board (NCPB), which is a government parastatal. Subsidized inorganic fertilizers and planting seeds are available through the NCPB. Most agricultural products are marketed through local markets and the prices are determined by market forces. Besides the local markets, the NCPB buys produce such as grains from farmers.

1.3.2 Land ownership and agricultural financing

Kenya has three categories of land: public, community, and private land. The proportion of households with title deeds in Makueni County is 30% (Makueni County IDP, 2020). Although the average farm size in the county is 1.2 ha, farmers in the southern parts of the county have larger pieces of land than in the upper parts because of the variation in climatic conditions that is prevalent in the two regions. In Kiambu County, for all three categories of land, public land makes up approximately 5%, community land 0.01%, and private land 94.99% (Kiambu County, 2018). The private landholdings in Kiambu can be differentiated into small-scale and large-scale holdings. The latter are typically used for large-scale agricultural production. The average mean size of landholdings is 0.045 ha on a small scale and 69.5 ha on a large scale. The small landholdings are mostly found in the upper parts of Gatundu North, Gatundu South, Kiambaa, Limuru, and Kikuyu constituencies. About 85% of the landowners in the county have title deeds (Kiambu County IDP, 2013).

Farmers in the two counties have access to agricultural extension officers from national and county governments and the private sector. Kiambu County has extension officers deployed at the ward, sub-county, and county levels. Waruhiu Agricultural Training Center (ATC) in Githunguri hosts both residential and non-residential farmer training. The ATC has a demonstration farm that farmers can access year-round. The Agricultural Technology Development Centre in Ruiru provides training to farmers. Kiambu County in partnership with the Cereal Growers Association also has enhanced extension service delivery that focuses on maize value chains to ensure that farmers adopt good agronomic practices for increased food production. Similarly, Makueni County also has extension offices at the ward, sub-county, and county levels. For example, the county government recently began a program under the Makueni Enhanced Extension Programme facilitated with motor bikes and vehicles targeting about 200,000 farm families (Kilimo News, 2020). Despite these deliberate efforts by the county governments to enhance

extension on education services, studies indicate that gaps remain in terms of accessibility to the field officers and the frequency of meetings between the farmers and extension officers (Mwania et al., 2021).

Agricultural financing in Kenya is usually done through the government. The Agricultural Financing Corporation (AFC) is the main lender for the agricultural sector. AFC also has targeted products for women, but recent surveys indicate that access to loans remains low for women (KIPPRA, 2019). In addition, banks and microfinance enterprises have different loan products targeting different agricultural production activities.

1.3.3 Factors affecting agricultural production

In Makueni County, land degradation and soil erosion are the most severe natural factors affecting agricultural productivity. As mentioned above, the soil organic carbon in the county is extremely low and the lack of vegetation cover in most of the cultivated lands contributes highly to soil erosion and land degradation there. The county is in a semi-arid area where precipitation is extremely low. Climate change has affected the precipitation patterns in the county and farmers have reported total crop failures in some cropping seasons. Additionally, the farmers are no longer able to predict rains as before because of the problems from climate change. Thus, inadequate precipitation is another key factor affecting the county's agricultural productivity. The dryland areas of Kiambu (e.g., Ndeiya) also experience soil degradation. Recent demand for housing to cater to the needs of the growing urban population in Nairobi has resulted in a wide conversion of agricultural lands into real estate. This might contribute to land fragmentation with a majority of the farmers being smallholder farmers with a maximum of 1 acre left for agricultural production. In addition, the problem of water pollution and contamination from industries and sewers from the water catchment areas reaches farmers downstream. Farmers in both counties have limited access to agricultural inputs, credit, training, and extension officers.





1.4 Social context

Makueni County is predominantly occupied by members of the Kamba community. They are also referred to as Kikamba, Kekamba, Masaku, Ukamba, Kitui, and Mumoni. Their religious affiliation is approximately 60% Christian, 39% traditional religion, and 1% Muslim (Canada, 1998). Perhaps the most spectacular manifestation of Kamba culture is the traditional dance. It is characterized by some exceptional leaping, flinging dancers in the air, and acrobatics of other kinds. Several of the dances have military themes, directly derived from the participation by Kamba in large numbers in the country's armed forces. Unfortunately, except for official functions and a few establishments that cater to visitors from overseas, traditional Kamba dancing can be seen only on rare occasions these days (Canada, 1998). The average household size consists of six family members. Men are the household heads and make most of the decisions in the household. Facilities such as schools, hospitals, etc., are available in the county and provide good services to the residents, despite some facilities being relatively far from some residents. There are more than 1,000 primary schools (both public and private), more than 400 secondary schools (both public and private), more than 230 adult training institutions, two universities (Lukenya University and Southeastern Kenya University), teacher training colleges, technical training institutions, and youth polytechnics. As in most parts of Kenya, the biggest proportion have basic primary, followed by secondary (and sometimes tertiary) education. A total of 64.3% of the households in the county use unimproved water

sources, 35.7% have access to improved water sources, while 17.7% have access to piped water (according to the National Environment Management Authority).

Kiambu County is dominated by members of the Kikuyu community, one of the biggest ethnic groups in Kenya. However, being a county in a peri-urban area and close to the capital city, members of many other communities have settled and bought land. According to the 2019 census, the county has a total population of 2,417,735 (KNBS, 2019). A total of 50.9% of the population is female while 49.1% of the population is male. A total of 70.6% of the population in the county live in urban areas, while only 29.4% live in rural areas. The average household size in Kiambu County is four members (KNBS, 2019). Some 39.2% of the population has reached secondary school or higher, which is 1.5 times the rate in Kenya (22.8%). More than half (51%) of the population is employed. Kiambu County has 1,515 early childhood development centers, 948 primary schools, 365 secondary schools, 33 youth polytechnics, 165 adult education centers, one technical training institution, and one institute of technology. There are eight universities. The public ones are Kenyatta University, Jomo Kenyatta University of Agriculture and Technology, St. Paul's University, and Mama Ngina University College, while the other four are private universities: Gretsia, UMMA, Mount Kenya, and Zetech University. Most people living in Kiambu County are Christians. Among other religions living there are Catholic, Presbyterian, Methodist, Baptist, and in small numbers Hindu and Muslim.

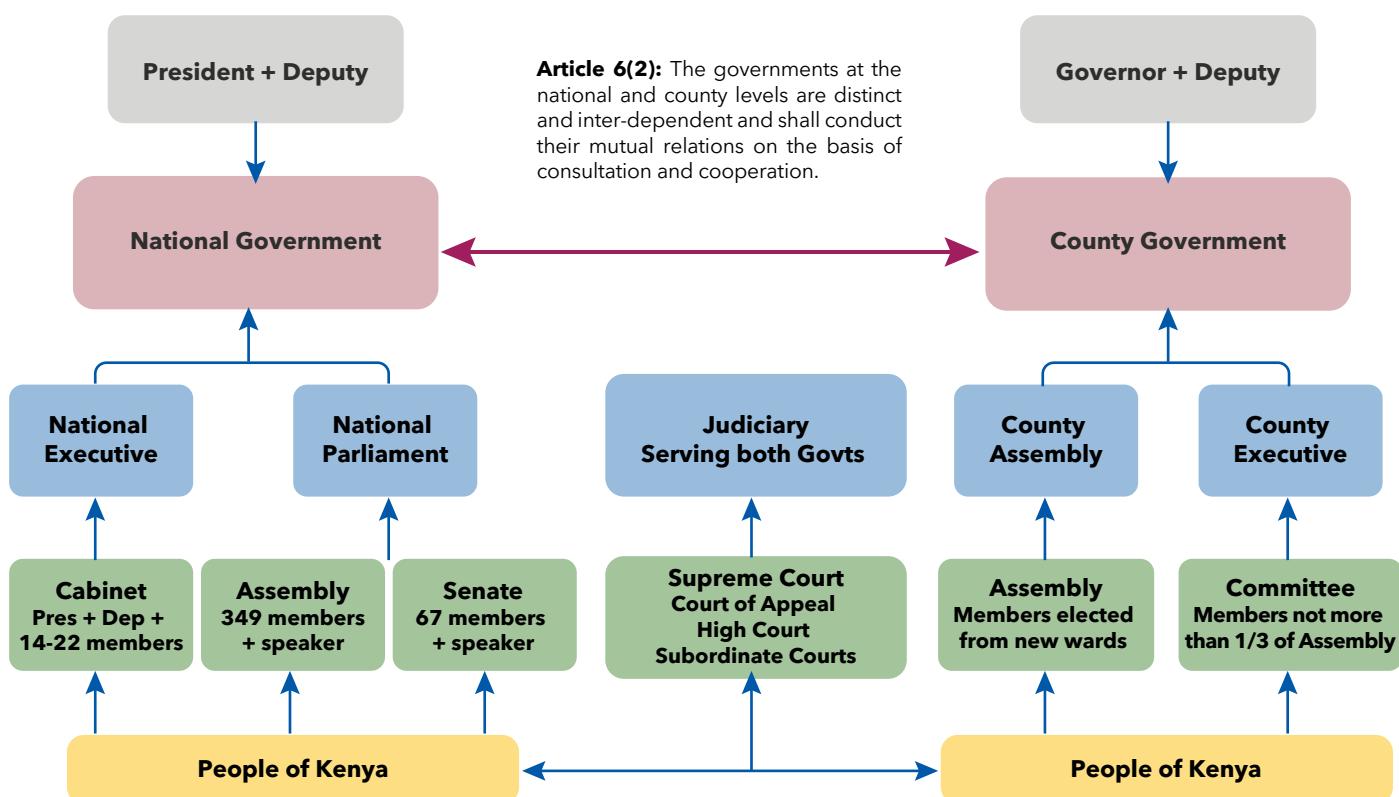
1.5 Political context

1.5.1 Political history and governance structure

Historically, Kenya is a highly centralized country. After fighting for independence from the British Empire for more than ten years, Kenya became a republic in 1963. Shortly after gaining independence, the Kenya African National Union (KANU) became the single party in the de facto one-party state. While it emerged about 1969, Kenya legally became a single-party state with the introduction of Article 2A into the Constitution in 1982. Under considerable internal and external pressure, Article 2A was repealed in 1991, which officially reinstated multi-party democracy. However, the country experienced a real political transition only when long-term President Daniel arap Moi stepped down and handed over power to the winning NARC Coalition after his KANU party lost the presidential election in December 2002.

The 2010 Constitution, adopted after decades of societal and political struggles to bring about political change, introduced devolution and decentralization of the country. Kenya now has two levels of government: the national government and the county governments (**Figure 7**). These changes in territorial organization also entailed changes in administrative structures. Kenya used to be organized in eight regions (provinces), which held numerous districts. The 47 districts (that existed by 1992) effectively became the 47 counties that now make up Kenya's decentralized structure. The former divisions became sub-counties, followed by wards and villages. Although the eight provinces and 47 districts were abolished, the locations and sub-locations, a remnant of the previous centralized state, were de facto maintained.

Figure 8. Division of powers and levels of governance in Kenya.





Kenya also experienced the decentralization of numerous competencies as part of the devolution process, including in agriculture, and some elements of natural resource management, including water, forests, wildlife, etc. – apart from areas of “national interest.” This decentralization thus contributed to the counties becoming key actors in these sectors. In that vein, it is important to consider the five-year County Integrated Development Plans (CIDPs), because counties fund only what is in the respective CIDPs.

Looking at leadership at the county level, each county is led by a directly elected governor, who is assisted by a deputy governor. Each county has a county executive composed of appointed ministers, so-called County Executive Committee members (CECs). Furthermore, each county has its own county assembly, in which Members of County Assemblies (MCAs) represent their constituents’ interests. Counties also have different committees. County Agriculture Sector Steering Committees (CASSCOMs) are perhaps the most important committees at the county level. The CASSCOMs are an already institutionalized cross-sectoral entity that includes agriculture, environment, and trade, among other departments, and is chaired by the CEC for Agriculture. They also include civil society and other actors. The CASSCOMs observe the implementation of CIDPs and vet new projects coming into the counties. Other important committees at the county level are the County Environment Committees.

Although their establishment has been slow in some counties, both Makueni and Kiambu have functioning CASSCOMs and County Environment Committees.

At the local level, chiefs and assistant chiefs who are appointed by the President are in charge of administrative leadership at the location and sub-location levels, a remnant of the previous centralized state order. Counties’ interests are represented nationally by elected senators, who, together, have formed the upper house of Parliament since 2010. Another powerful institution to represent county interests nationally is the Council of Governors (COG).

Altogether, all Kenyan adults above the age of 18 are eligible to vote in national and local elections. Currently, Kenyans cast a total of six votes during each general election, which typically ends the five-year terms of all elected political positions in the country. At the national level, voters elect the President (head of state and government) and the Members of Parliament (MPs) for their respective constituencies, who, together, form the National Assembly, the lower house of Parliament (national legislative). At the sub-national or county level, voters elect the governors (county executive), senators (national legislative), as well as one women’s representative per county (who are included as members of the national assembly, and hence part of the national legislative), and members of the county assembly (county legislative).



1.5.2 Women's and social groups' participation in local leadership and political decisions

Kenya's 2010 Constitution established the no more than two-thirds gender principle in elective and appointive bodies. However, in Makueni County, there is still the traditional view that it is only men who can take up political leadership and thus the women remain under-represented in political and local leadership. According to the Makueni County Gender Policy (2020), gender inequality has been a major hinderance to the political development of its people. The policy report indicated that development planning has not been partitioned to cater to gender, youth, and persons with disability, and in most cases these groups have been excluded when making decisions. Therefore, their needs are not well met. The Makueni County Integrated Development Plan (CIDP 2018-2022) document affirms that there is a need to include women and other social groups in key decision-making processes of the county. A recent survey carried out in Makueni County by Kathini et al. (2020) revealed that women there are still under-represented in leadership and decision-making processes.

1.5.3 Policies that support agroecological transitions

Nationally, an ISFAA was established by the Ministry of Agriculture, Livestock, Fisheries, and Cooperatives; the Ministry of Environment and Forestry; and non-state actors in 2020. The ISFAA aims to provide a platform through which stakeholders at the intersection of biodiversity conservation and agricultural production can interact to discuss, share knowledge and information, influence policy, fundraise,

and implement joint programs. Similar county-level multistakeholder platforms are developed in several parts of the country, including in Makueni and Kiambu, but also in Murang'a, Siaya, and others.

Looking at the supreme law, the Constitution of Kenya (2010) recognizes the right to a clean and healthy environment and emphasizes the need to promote sustainable development in the agricultural sector. To address this, the following policies relating to agroecology in Kenya have been formulated in recent years:

1. National Agriculture Policy (2010), which recognizes the need to promote sustainable agricultural practices that enhance productivity while conserving natural resources.
2. National Climate Change Action Plan (2013-2017), which highlights the need to promote climate-smart agricultural practices to help mitigate and adapt to climate change.
3. Agriculture Sector Development Strategy (2010-2020), which promotes sustainable agricultural practices, including agroecology, to enhance productivity, food security, and income generation for smallholder farmers.

Table 2 summarizes some of the key policies, actions, and strategies relating to agroecology and highlights some of the key principles of agroecology that they focus on. The existing policies and strategies provide a framework for promoting agroecology in Kenya and ensuring that sustainable agricultural practices are integrated into national development plans. The ISFAA, with support from numerous

stakeholders, has been developing a National Agroecology Strategy since mid-2022. In addition to the national policies, county governments are developing more specific policies, acts, and action plans. An agroecology readiness assessment carried out in 2020 showed that, although no CIDP explicitly mentioned agroecology, Kiambu came out on top in terms of readiness (Mureithi and Ng'asike, 2020). Kiambu indeed developed a draft agroecology policy after that (including soil management practices, agroforestry, marketing, and working with schools), while other counties have adopted policies that include agroecology while not mentioning it explicitly. Important progress was also made in other counties, such as in the biodiversity policy in Busia, a draft agroecology policy in Meru, a bill on social and economic rights in Kericho that comes close to a right-to-food law under which agroecology can be supported, or Kirinyaga in support of organic farming. Some of these advances were hampered by the 2022 general elections. In other cases, more progress was made. Murang'a County, for instance, launched its agroecology policy and a dedicated agroecology act in April 2023. More agroecology forums have been held on county bills and policy drafting in Machakos and Makueni counties. Some NGOs (e.g., Route to Food) also work on fiscal tools to foster transition, alongside water pollution control, sand harvesting control, etc.

Despite the growing recognition among policy- and decision-makers on the importance of sustainable agricultural practices, including agroecology, in enhancing food security, reducing poverty, and conserving natural resources, the implementation of the existing policies has faced several challenges: limited funding and weak institutional capacities and mechanisms, alongside a lack of political will. In addition, competing interests such as subsidies on inorganic fertilizers are likely to hinder the adoption of agroecological practices. For example, competition from multinational companies dealing in agrochemicals that give these inputs free of charge to the farmers (who in turn accept such inputs) threatens the adoption of agroecology. Despite these challenges, there are increasing efforts to promote agroecology in Kenya (see **Figure 9** for an initial mapping of agroecology stakeholders in Kenya). Some of the specific organizations that are involved in promoting agroecology are the following:

1. Participatory Ecological Land Use Management (PELUM)⁴ Kenya: This network of more than 35 civil society organizations promotes agroecology and sustainable agricultural practices through farmer field days, policy advocacy, and training programs. CSHEP and DNRC are both members of PELUM. PELUM is also represented in other African countries, and, together, PELUM has more than 200 member organizations.
2. Kenya Organic Agriculture Network (KOAN)⁵: This membership-based organization promotes organic agriculture and agroecology through capacity building, policy advocacy, and network linkages. KOAN's *Kilimo*

hai mark is widely recognized in Kenya. KOAN works through a participatory guarantee system (PGS) for group certification and operates through a network of compliance officers and field staff on the ground. KOAN also has several donor-funded aggregation centers for avocados and chilis for export in Murang'a and Machakos.

3. Green Belt Movement (GBM)⁶: This organization works with rural communities to promote agroforestry, ecological land use management, and sustainable agricultural practices that enhance food security and conserve natural resources.
4. Regenerative International (RI) Kenya: This global organization works with local partners to promote sustainable land use practices and agroecology, including regenerative agriculture.

Other relevant stakeholders are the following:

- Heinrich Böll Foundation-funded Route to Food Initiative (RtF)
- Kenya Institute of Organic Farming (KIOF)
- Biovision Africa Trust (BvAT)
- Institute for Culture and Ecology (ICE)
- Seed Savers' Network Kenya (SSN-Kenya)
- Grow Biointensive Agriculture Center of Kenya (G-BIACK)
- GIZ-funded Knowledge Centers for Organic Agriculture (KCOA) all over the country (2021-2024); hubs to promote organic farming; master trainers train multipliers who are supposed to train farmers; also have a digital knowledge platform that includes material from other platforms; are also setting up an East African hub with the five EAC countries and Ethiopia; local implementing partners are BvAT and PELUM
- Dutch-funded Youth in Agroecology and Business Learning Track Africa (YALTA)
- Rodi Kenya, based in Ruiru
- SNV and World Vegetable Centre

Some relevant private sector actors are the following:

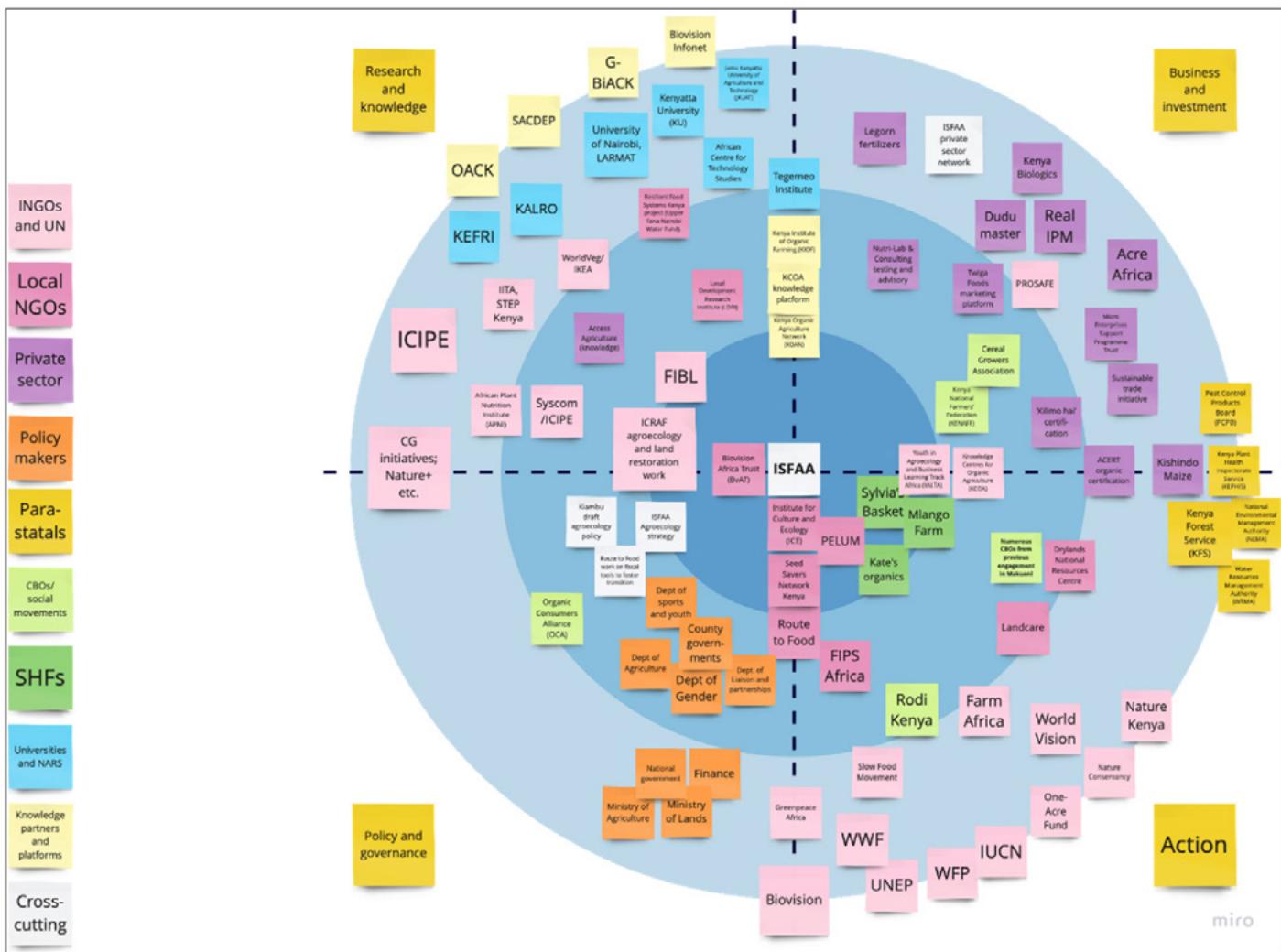
- Certification services: ACERT
- Marketing platforms, such as Twiga Foods (engaging farmers on contract and marketing their produce), Greenspoon, Sylvia's Basket, Kate's Organics, Mlango Farm
- Technical service providers, such as Nutri-Lab & Consulting - a private lab that offers testing information on soils and water, and manure, and provides an advisory on good agricultural practices
- Biopesticides and organic input providers, such as Real IPM (fairly expensive), Kenya Biologics (bought by the French company Éléphant Vert), Dudu Masters

4 <https://www.pelumkenya.net/>

5 <https://www.koan.co.ke/>

6 <http://www.greenbeltmovement.org/>

Figure 9. Initial agroecology stakeholder mapping, June 2022.



Source: AE-I Kenya country lead.

1.5.4 Policies and regulations hindering agroecological transitions

Kenya has regulations that govern the sale, distribution, and use of chemical fertilizers, pesticides, and herbicides that are common in conventional agriculture. The Act of Parliament on Fertilizers and Animal Foodstuffs is the law that regulates the importation, manufacture, and sale of agricultural fertilizers and animal foodstuffs in the Kenyan market. This Act describes the procedures of fertilizer approval before it is accepted for the market. In addition, the government recently introduced subsidies on fertilizer use for farmers. This subsidy brings down the cost of a 50-kg bag of fertilizer from KES 6,500 to KES 3,500. This subsidy is likely to increase the use of fertilizer on many farms, thus hindering the adoption of agroecological practices that can enhance farm productivity.

Regulations governing the use of chemical fertilizers might in some cases specify the types of chemicals that can be used, their recommended dosages, and safety guidelines. Small- and large-scale vegetable farming is accompanied by extensive use of chemical pesticides. In addition, the production of food crops such as maize relies strongly on

pesticides to control various pests, fungal diseases, and weeds. According to the Agrochemical Association of Kenya (AAK), pesticide imports to Kenya increased rapidly from 6,400 tons in 2015 to 15,600 tons in 2018. The overreliance on chemical fertilizers as well as the regulations allowing for their use might to some extent hinder the adoption of IPM approaches used in agroecology.

The Kenyan government on 8 November 2012 through a Cabinet decision instituted a ban on the importation of all genetically modified products. This followed from a study led by a French scientist that linked consumption of GM foods to cancer in rats. However, in October 2022, the Kenyan government lifted the ten-year ban in an aim to combat climate change and foster food security because of the global food crisis driven by extreme weather. This decision has, however, been halted by the Kenyan courts. Genetically modified products are often associated with engineering of crop varieties, which is contrary to what agroecology advocates for. If allowed by the courts, the use of GM products could endanger indigenous seed varieties.

Table 2. A summary of some of the key national policies relating to agriculture and the extent to which they touch different agroecological principles.

2. Assessment of agroecological principles in the Makueni and Kiambu ALL counties

2.1 Recycling

The target will be mainly mixed crop-livestock farmers. The assumption is that there is an existence of diverse crops and animal breeds; hence, crop residues and animal manure can be recycled and applied back to the farms. Because of the animal food scarcity associated with frequent droughts, particularly in Makueni County, crop residues are mainly used as feed for livestock and are scarcely returned to the cropping fields. Manure from livestock is used for crop production, thus representing an internal recycling. Poultry manure is mostly used for growing vegetables in kitchen gardens. A key challenge is that most animals graze outside in fields or along roads during the day and little manure is available for collection. In the lower parts of Makueni, where farmers have large pieces of land, the available manure is not enough for most of the farms. The DNRC host center is set up in a permaculture approach in which organic waste materials from animal wastes can easily move within the farm. Manure from the farm comes mainly from the poultry kept on the farm. In addition, there is vermicomposting in which the worms are fed to the chickens while the liquid manure can be used for producing crops. The center also has eco-toilets from which human waste is recycled by combining it with ashes and sawdust and then using this to grow vegetables on the farm.

Dairy cattle farming is common in Kiambu County and is mainly practiced through zero grazing. Therefore, more manure is available on farms in the county and, in some cases, farmers have surplus manure for sale. Pig manure is also widely available in the county. The CSHEP host center in Kiambu carries out waste water recycling that is used in vegetable production. Kitchen waste, crop residues, and chicken manure are composted before use. Furthermore, the center saves indigenous seeds, and these seeds are readily

available for selling or planting in the next season. These practices are spreading out to the county. Although crop residues and tree leaves are available, composting is done by only a few farmers within the two counties. In Kiambu County, bokashi is becoming common among organic farmers. Bokashi is a fertilizer composed of a variety of household and farmyard materials such as rice, wheat, or maize; molasses; and topsoil to introduce more microorganisms. Centers such as G-BIACK offer training on the production of bokashi. In addition, CSHEP and DNRC have been training farmers in composting.

Water scarcity is a key challenge in Makueni County and in the semi-arid areas of Kiambu County. A majority of the population in Makueni County relies on community-centered boreholes as the main source of water for use in their households. Statistics show that only 17.7% of the households in Makueni have access to piped water (Makueni County, 2018). For soil water conservation on farms, technologies such as Zai pits, water ridges, and sub-surface water-retaining membranes for sandy soils have been widely promoted in the county. About 90% of Kiambu County's water sources have both surface water and groundwater potential. The domestic water supply has recorded a noticeable growth over the past 5 years: 35% of the population has access to potable water (Kiambu County Water Resources, 2021). Irrigation is common on a few selected farms within areas such as Gatundu (Kiambu County Water Resources, 2021). Similarly, irrigation farming also takes place on a few selected farms within Makueni County. In both DNRC and CSHEP ALL host centers, there is evidence of water harvesting using roof catchments and storage in tanks for domestic and agronomic use. In addition, DNRC promotes the distribution of tanks to individual farmers within the groups they are working with, based on merit.

Priority interventions

Because of the poor soils of Makueni and in some parts of Kiambu, crop production will continue facing challenges. Farmers urgently need to apply soil management techniques that can increase organic matter in the soil and improve crop production. With crop residues and waste materials being available on most farms, the continuous application of farmyard manure would help farmers in building up organic matter in the soil. Another key priority for the AE-I would be to train farmers on how to produce and make compost from locally available materials. The available tree and crop residues can be used in producing compost manure that can be applied on farms. To address the recurrent crop failures associated with the erratic precipitation patterns in Makueni and in the dryland areas of Kiambu, water recycling and water use efficiency innovations are also needed. In Kiambu, water recycling and water use efficiency with green leafy vegetables as a priority value chain would be key in achieving maximum production on farms. In addition, measures to decrease soil moisture losses (e.g., mulching, cover cropping) will be a key priority, especially in the semi-arid areas. These mulches decompose to allow incorporating soil organic carbon and other essential plant nutrients back into the soil. The harvested crops used as mulching materials aid in recycling nutrients that had been mined by the crop back to the soil as well as suppressing weeds.

2.2 Input reduction

A majority of the farmers in Makueni and Kiambu counties are conventional farmers who apply farmyard manure, inorganic fertilizers, and pesticides on their farms. Only 26.9% of the farmers in Kiambu County apply FYM on their farms (Kiambu County, 2018). Seventy percent of the Kiambu farmers use inorganic fertilizers on their farms, while about 50% use pesticides. Statistics for Makueni County remain scarce, but the use of organic manure is less there because of the limited availability. In Kenya, inorganic fertilizers are also subsidized.

Organic farming is gaining popularity in both ALLs, with some farmers already using less inorganic fertilizer and pesticide on their farms. However, preliminary analysis of data collected among a small sample of farmers in both Kiambu and Makueni counties indicates that more farmers in the Kiambu ALL use natural methods to control pests than in Makueni (**Table 3**). This has been made possible by the promotion of agroecological practices to decrease or eliminate dependency on purchased inputs by carefully planning and managing rich and diverse ecosystems that create synergies between different components of the agricultural system. It is important that agroecological practices be promoted, such as intercropping, since farmers are often able to achieve a greater total production on their land with mixtures than if their land were divided and planted to a combination of monocultures.

Table 3. A summary of the integrated pest management (IPM) practices that selected farmers in Kiambu and Makueni use. This information was collected from 40 farmers in each of the counties. The percentage in parentheses indicates the percentage of the respondents per ALL that use the IPM practice. The information was obtained from WP 1 and will inform the co-design exercise.

IPM practice	Kiambu ALL (no. of respondents)	Makueni ALL (no. of respondents)	Total (no. of respondents)	Overall percentage (%)
Plant-based biopesticides	35 (88%)	15 (38%)	50	63
Repellent crops	10 (25%)	1 (2.5%)	11	14
Crop rotation	6 (15%)	0 (0%)	6	8
Intercropping	6 (15%)	1 (2.5%)	7	9
Natural predators	3 (7.5%)	0 (0%)	3	4
Ash-based biopesticides	2 (5%)	0 (0%)	2	3
Traps	2 (5%)	0 (0%)	2	3
Soap	1 (2.5%)	0 (0%)	1	1

Priority interventions

In the AE-I, priority is likely to be given to innovations that diminish the dependence on inorganic fertilizer to ensure the long-term buildup of soil organic matter. In addition, practices that help in weed management such as mulching, cover cropping, and intercropping can help decrease the

application of herbicides in controlling these weeds. In both ALLs, farmyard manure and compost application are likely to be prioritized. Integrated pest management practices that decrease the use of pesticides such as repellent plants and botanicals will also be a key priority in both ALLs.



2.3 Soil health

Several practices in place among the farmers in the two ALLs promote soil health. The diversification of nutrient sources with emphasis on organic sources is a potential option for improving soil health. In Makueni County, several farmers use different soil amendments involving inorganic fertilizer, inorganic fertilizer combined with animal manure, or the sole application of animal manure for crop production. Kangethe et al. (2017) reported that only 17.9% of the farmers in Makueni were not using any soil amendments. Most smallholder farmers in the county practice conventional tillage involving tilling the land using animal-drawn ploughs during land preparation, along with manual weeding (mechanization is dismal, especially on smallholder farms). The adoption of climate-smart technologies, especially in a bid to adapt to climate variabilities, is being promoted. Therefore, more emphasis should be given to using organic soil amendments since, for instance, the use of manure not only improves soil nutrient content but also enhances SOC content and the ability of the soil to retain moisture.

The main agroecological technologies adopted by the farmers in the county are integrated farming systems (such as incorporating small animals and birds [poultry] with higher liquidity of capital [as the investment in feed and space is less and for a short time]). These animals are reared on on-farm inputs, and their excreta are used for improving soil health. Incorporating crop by-products for enrichment of soil such as a vermicomposting unit and composting unit and planting leguminous plants such as *Leucaena leucocephala* and *Gliricidia* have been adopted. Some of the practices used to decrease soil erosion are no-tillage and minimum tillage, mulching, and agroforestry, in addition to physical soil conservation measures such as water-retaining pits, bench terraces, and planting cover crops, among other practices aimed at improving overall soil conditions (**Table 4**). Some common types of cover crops grown in Makueni County are legumes, such as beans, *Dolichos lablab* (hyacinth bean), and peas, which fix nitrogen from the air and enrich the soil. Other cover crops are pumpkin, sweet potato, cucumber, and watermelon. Cover crops are grown between rows of crops or in fields that are not being actively used for food production.

They are left in the ground to decompose and enrich the soil or they can be incorporated back into the soil through tillage or other means.

In the DNRC ALL host center, agroforestry trees are promoted, such as those that fix nitrogen, including both perennial and annual, such as Acacia, etc. These have the potential to not only fix nitrogen but also improve SOC sequestration deep into the soil, moderate soil temperature through shading, decrease evaporation of soil moisture (live mulches), as well as promote diverse soil microbiome. Moreover, some trees are fed to animals as feed. The leaves that fall off the plant also act as mulches that enrich the soil with nutrients and improve soil drainage capacity. The diversified cropping systems integrating crops and trees are a plus for improving soil health in the DNRC center. The center has opportunities to work on biofertilizers for soil and production system improvement. However, currently, no scientific research has been done at the center to quantify these possibilities.

In Kiambu, at the CSHEP ALL host center, emphasis is on organic farming, promotion of diversification in agriculture, development and adoption of land use classification, and adoption of a farming system-based approach rather than using a cropping system alone. Some soil health practices follow:

- Diversifying nutrient sources (manure and compost).
- Using green manure, which involves growing leguminous plants and incorporating them in the soil.
- Using crop residues (as a source of crop nutrition) as a win-win situation, as this helps to decrease the unused waste in agricultural production and its contribution to pollution and carbon footprint.
- Using weeds as manure (they have a positive effect on soil just like the effects of crop residues).
- Adopting modern tillage systems (minimum/zero tillage).
- Carrying out efficient resource cycling through an integrated farming system such as incorporating small animals and birds (poultry) with higher liquidity of capital (as investment in feed and space is less and for a short time).

Table 4. Some of the major soil management practices used by farmers in Kiambu and Makueni counties. The data were obtained from a few respondents from the two counties to inform the co-design exercise for WP 1.

Practice	Kiambu (no. of respondents)	Makueni (no. of respondents)	Total (no. of respondents)	Overall percentage (%)
Farmyard manure	24 (60%)	25 (62.5%)	49	61
Compost manure	25 (62.5%)	17 (42.5%)	42	53
Intercropping	12 (30%)	12 (30%)	24	30
Crop rotation	13 (32.5%)	10 (25%)	23	29
Agroforestry	7 (17.5%)	16 (40%)	23	29
Terraces	8 (20%)	13 (32.5%)	21	26
Mulching	10 (25%)	6 (15%)	16	20
Cover crops	6 (15%)	3 (7.5%)	9	11
Biogas sludge	7 (17.5%)	0 (0%)	7	9
Raised beds	5 (12.5%)	0 (0%)	5	6
Double digging	4 (10%)	1 (2.5%)	5	6
Zai pits	4 (10%)	0 (0%)	4	5
Sunken beds	3 (7.5%)	0 (0%)	3	4
Hugo culture	2 (5%)	0 (0%)	2	3
Timely planting/cultivation	1 (2.5%)	0 (0%)	1	1
Fallow	1 (2.5%)	0 (0%)	1	1

Priority interventions

Sustainable intensification of mixed crop-livestock systems is key in improving soil health. In addition to compost and FYM application, intercropping, cover cropping, and crop rotation particularly with legumes can be useful in improving soil fertility through increased nitrogen fixation. Although some farmers in Kiambu and Makueni practice agroforestry, its adoption rate remains low (**Table 4**). Tree species that are suitable for different environmental conditions can be useful in providing shade for the crop and diminishing the adverse

effects of the sun on the crops in dryland areas as well as being sources of timber. The tree species that can be used in this area include mango, pawpaw, *Melia volkensii*, *Senna siamea*, neem, and moringa, among others. Some of these tree species can be used to make biopesticides (e.g., neem is being used to control tomato leafminer, *Tuta absoluta*). Furthermore, mulching and integration of cover crops would be useful in providing organic matter and decreasing soil erosion.



2.4 Animal health

Livestock are an important component in the food system in both Makueni and Kiambu counties. A variety of livestock are present and follow different grazing or rearing systems. Some of the widely kept livestock in Kiambu County are dairy cattle, sheep, pigs, goats, poultry, donkeys, and camels. Zero grazing is the most common mode of dairy and pig keeping in the county, while free-range grazing is common for sheep, mostly in areas of Limuru. In the region, mixed farming with several species on the same farm is undertaken, which limits the contact that each species has with its specific pathogens by clearing of parasites using non-susceptible species. Growth in the livestock sub-sector has been encouraged by a ready urban market in Thika, Ruiru, Kiambu, and Nairobi and the availability of local food-processing factories. There are no ranches within the county and the livestock are mainly owned by smallholder farmers. Farmers mostly rely on chemical pesticides for spraying their animals, particularly dairy cattle. Another opportunity for improving animal health is based on their feed; for instance, the feed mainly consists of perennial forages, banana stems, crop residues, and store-bought feed concentrates. This enables farmers to use less medication through the presence of bioactive secondary metabolites in the feed. Some of this feed is tannin-rich and has some indirect effects by increasing the host resistance of the animals. Villalba et al. (2010) reported that lambs infected with parasites slightly increased their intake of food containing tannins while experiencing a parasite burden. In Kiambu, forage resources of the push-pull system, using native grasses and legumes, contribute to the sustainability of livestock systems by improving animal health. This is in line with the report of Hassanali et al. (2008) about the push-pull system in Kenya. Furthermore, animals mainly drink the tap water available in households, as water is available in most regions in the county.

Keeping of poultry and dairy cattle is most common in Makueni County. Outside grazing is the most common mode of animal feeding within the county for dairy cattle, where animals mainly feed on natural grasses and shrub trees. These practices, especially rotational grazing and mixed farming with several species on the same farm, limit the contact that each species has with its specific pathogens by clearing of parasites using a non-susceptible species. In addition, animals mainly drink water from rivers and natural water pans, and from the well-fetched water within households. Animals such as oxen are widely used for ploughing within the county. Donkeys are also important in the area in terms of providing labor, involving pulling of carts. In Makueni, feed conversion efficiency of livestock is increased by using feed sources (e.g., crop residues, agricultural by-products, backyard wastes, grasslands, rangelands, browsing) that do not compete with the human food supply, thereby increasing food security and decreasing environmental damage. Also, the permanent pastures and rangelands are cheap natural resources. Contrary to this, overstocking leads to compaction of the soil, thus promoting surface runoff. However, in both ALLs, many unconventional sources of animal feed can be integrated into the feeding system, including multiple by-products from plant production and food processing. Since agroecology usually enhances the diversity of crop species produced and processed within the farm, it opens up many options for designing livestock feeding systems using less energy, fertilizer, and irrigation water inputs.

Priority interventions

The AE-I focuses on smallholder farmers who keep birds and animals. Although the Initiative is likely to concentrate on crop production and related innovations, these are also expected to have long-term impacts on animal welfare, particularly production.





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2.5 Biodiversity

The rural communities of both Kiambu and Makueni produce a diversity of crops. Farmers in Kiambu have continued to diversify plant types and have introduced crops such as bamboo, characterized by fast growth, wide range of uses (food and fodder), and other services such as soil erosion control. Additionally, in Makueni, planting of trees has become a common on-farm adaptation practice that increased forested land by 3.04% from 2011 to 2020 (Kitinya et al., 2012). Some of these trees are *Melia volkensii* and *Thevetia peruviana*, and shrubs such as *Euphorbia tirucalli*. A program previously begun by Bioversity International also promoted the production and diversity of African leafy vegetables in Kiambu and other parts of Kenya (Gotor and Irungu, 2010). The program also promoted *in situ* and *ex situ* repositories and seed systems that remain to be fully assessed by small-scale farmers country-wide. The major food systems involve mangoes, green grams, tomatoes, and other vegetables. At the DNRC ALL host center in Makueni, for example, tree nurseries, beehives, moringa, and sunflower help to promote biodiversity in agroecology. For instance, apiculture contributes not only to honey production, but the bees also promote cross-pollination among different crop species, thus increasing food productivity. By supporting a diverse range of species and habitats within the agroecosystem, farmers can promote its health and resilience, while also contributing to the long-term sustainability of agriculture. The biodiversity is characterized by mixed crop-livestock systems. In DNRC, the permaculture method of farming is practiced. It consists of three zones that promote co-existence between the animals and plants. The animals and birds contribute to the overall ecosystem through fertilization and pest control. The diverse presence of the animals helps to create a balanced and self-sustaining system. Opportunities in the center are

related to reviving the underused crops that have received less attention. These crops are under threat of extinction and the conservation of such biodiversity is needed within the community. The center is affecting soil health and production systems in the region.

Kiambu features the production of a diverse portfolio of crops, such as tea, coffee, pineapple, potatoes, bananas, wheat, pyrethrum, maize, and macadamia nuts. Livestock breeds vary depending on the type of animals. Exotic breeds are common among dairy and pig farmers, while indigenous (*Kienyeji*) chicken is common in many households that have poultry farming. Kiambu has continued to diversify plant types and has introduced crops such as bamboo owing to its fast growth, wide range of uses (food and fodder), as well as services such as soil erosion control. The CSHEP ALL host center has a rich biodiversity of vegetables (asparagus, kale, spinach, beetroot, chayote, cabbage, lettuce, celery); indigenous vegetables (black nightshade), herbs, cassava, and lentils; indigenous foods such as sweet potatoes; and fruits such as avocado, mango, oranges, and pawpaw. The center also has a wide range of herbs such as mint and sage. A wide range of other agrobiodiversity practices exists within the center. Support and collaboration are needed for tree biodiversity, including good agricultural practices for agroforestry systems. Food forest biodiversity and below-ground biodiversity are of potential interest, which might lead to business models for the communities.

Priority interventions

Biodiversity should be addressed by promoting multi-species crops and trees that provide multiple benefits at the farm level. For instance, plant-based biopesticides of different diversity can be integrated at the farm level.



2.6 Synergy

There is evidence in both Kiambu and Makueni counties that animals, crops, native and exotic trees, soil, and water are integrated to optimize food and nutrition security, and enhance adaptation and mitigation to climate change, while minimizing environmental degradation. Both counties are pioneering sustainable agriculture by combining crop rotation, livestock farming, and agroforestry. Farmers in both areas use intercropping to increase productivity while decreasing inputs such as water and fertilizer. To supplement crop fertilization and boost farm income, livestock such as cattle, goats, sheep, and poultry, among others, are often included in farming systems. Mixed crop-livestock systems also offer a platform for diversification such that, when total crop failure occurs because of drought, these smallholder farmers can still survive by earning income from sales of animals. Planting multipurpose trees such as Grevillea and fruit trees (e.g., mangoes, avocados) alongside crops and livestock is an example of agroforestry and it has many benefits, such as nutrient enrichment of soil, prevention of soil erosion, maintenance of stable crop yields, and creation of new revenue streams.

In Kiambu, planting fodder crops within coffee farms (Ndiritu et al., 2022), planting trees within crop fields and their effect on productivity (Njoroge et al., 2020), and the differences in market preferences between smallholder irrigators and non-irrigators (Mwangi and Crewett, 2019) are some examples of synergies in the ALL. Other studies also look at some synergies in the ALL and their contribution to mitigating climate change and minimizing environmental degradation (Crovatto et.al., 2022). The CSHEP has several instances of synergies and positive interactions between and among systems in the area. For instance, animal manure is used to produce biogas used to power the kitchen, while the slurry is applied on the farm. The center hosts several species of animals such as chickens and rabbits, which also eat plant remains from the farm. The animal manure is also used in the

production of azolla or duckweed, which is dried and used as chicken feed. On the farm, Mexican marigold is intercropped along the vegetable beds to act as a pest repellent. For this same role, parsley is intercropped with cabbage, resulting in healthier plants. Water used on the premises is recycled and cleaned using simple filters stored in drums. The filters used include sand and small rocks. The filtered water is then applied to the farm after serving a dual purpose of household use. Composting also exists that helps to balance the need to minimize waste and provide additional sources of organic nutrients to the farm. This is a widespread practice among the farmers who are registered and receive training from the center.

Trees-crops-animals (TCA) is an approach highly promoted at the DNRC, both there and for the communities. It presents synergies that exist among trees, crops, and animals in an agroecosystem. This approach involves planting trees alongside crops and integrating livestock to create a more diverse and productive farming system. The trees provide shade and nutrients to the crops, while the crops provide food for the livestock. In turn, the livestock provide manure, which fertilizes the crops and trees. TCA also helps to control soil erosion, improve soil fertility, and provide additional sources of income for farmers. This approach is a great example, as it recognizes the interdependence of ecological, social, and economic systems within agriculture, and it promotes the creation of diverse and resilient farming systems.

Priority interventions

At the farm level, the co-design process will be useful for identifying practices that can be useful in fostering synergies at the farm level. Practices such as intercropping, crop rotation, and agroforestry will be considered. Agroforestry can be useful in improving soil fertility as well as providing fodder for livestock and biomass for cooking (i.e., charcoal). In addition, because water is a problem in the two landscapes neighboring the ALL host center, technologies that are also useful in enhancing water retention will be considered.

2.7 Economic diversification

The agricultural sector is the most important driver of economic growth in Makueni County, accounting for 78% of the total household income. The county has two farming systems: small-scale and large-scale. Large-scale farmers have an average of 30 ha while small-scale farmers have an average of 3.4 ha. Cash crops occupy 23,356 ha (5% of the arable land) while food crops occupy 65,453 ha (13% of the arable land). A large proportion of the population undertakes subsistence farming with only a few practicing commercial farming. In terms of subsistence farming, the main crops are maize, beans, pigeon peas, millet, sorghum, sweet potatoes, and cassava, among others. The county produces a limited number of cash crops, such as cotton, coffee, and sisal. The county has a high potential for horticulture crops, specializing in the commercial production of fruits (such as mangoes, avocados, oranges, pawpaw, bananas, watermelons, and lemons, among others), French beans, tomatoes, onions, capsicum, cabbages, Indian vegetables, and other green vegetables. Fruit production is high in the upper and middle parts of the county and is a significant source of income for households.

Livestock production is also high in Makueni County, with the major livestock being poultry, goats, beef cattle, and dairy cattle. Dairy farming is gaining prominence because of increased demand for milk and ongoing government interventions such as subsidized artificial insemination services and milk collection and cooling centers. Dairy farming is undertaken for both subsistence and commercial purposes. However, the potential in this sector is not fully exploited. Fish production in ponds has also been promoted in the county under the economic stimulus program to diversify farm income and improve nutrition.

Makueni County has several tradable commodities: crop produce, livestock, and natural resources. Crops produced are cereals, pulses, legumes, and horticulture produce (fruits and vegetables). The county is a major supplier of poultry, goats, and cattle to Nairobi and other surrounding urban areas. Most of the trading takes place at the farm gate and at the open-air markets. Natural resources traded in the county include sand, charcoal, timber, and ballast. Another source of income is eco-tourism, with Makueni boasting of a rich culture and hosting Tsavo West National Park and parts of Tsavo East and Chyulu National Parks. The DNRC features several economic diversification practices highly promoted to increase sustainability and resilience: tree planting, beekeeping, training, charcoal making from pruning trees, moringa cultivation, sunflower farming, and mango production.

According to the County Government of Kiambu (2017), agriculture is the predominant economic activity and it contributes 17.4% of the county's income. It is the leading sub-sector in terms of employment, food security, income earnings, and overall contribution to the socioeconomic well-being of the residents. The main food crops grown in the county are maize, beans, Irish potatoes, and cabbages.

Coffee and tea form the major cash crops grown, especially in the upper and lower highlands. Pineapples are also being produced in large quantities, especially in Gatundu North and South constituencies.

The main livestock produced in the county are cattle, sheep, and goats, along with poultry, pigs, donkeys, and camels. The county is a major producer of milk, beef, mutton, eggs, poultry meat, honey, and pork. Growth in the livestock sub-sector has been encouraged by a ready urban market in Thika, Ruiru, Kiambu, and Nairobi and the availability of local food-processing factories such as Farmers' Choice Ltd., Kenchic Co. Ltd., Brookside Dairies, Githunguri Dairies, Ndumberi Dairies, Limuru Milk, and Palmside Dairies, among others.

“ The main products from gazetted forests are poles for the transmission of electricity and construction, timber, and firewood.

On the other hand, the main products from un-gazetted forests (farm forests) are poles, timber (sawn timber), charcoal (mainly from wattle trees) and firewood, honey, and fruits. These are sources of income for Kiambu households. The main income-generating activity in the county from agroforestry is commercial forestry, in which farmers plant trees for commercial purposes in the form of timber and poles. Other activities that generate income are tree nurseries from which farmers sell tree seedlings. Dairy farmers also plant fodder trees such as *Calliandra*, *Sesbania sesban*, and *Leucaena leucocephala*, among others, which they use to feed their livestock. There is also beekeeping. Farmers also plant fruit trees on which they produce mangoes, avocados, macadamia nuts, oranges, guava, and loquats, mainly for sale.

Wage earning represents 51.6% of the total household income in the county. Laborers are either skilled or unskilled. Most of them are employed in coffee plantations, tea farms, industries, quarry sites, and other agricultural farms. Because of the dwindling availability of formal jobs in the county, most of the people have reverted to self-employment, which contributes to 31% of household income.

Priority interventions

- Creating awareness about the benefits of mixed farming, intercropping, sunken beds, and agroforestry compared to monocropping.
- Composting might be a key focus of the ALLs in Kenya. Given that crop and tree residues can be used for composting, but also as livestock feed, a detailed cost-benefit assessment that considers all actual inputs as well as the costs, and the trade-offs at the farm level, might, in the future, be informative to stakeholders.

2.8 Co-creation of knowledge

At the national level, KALRO is mandated to undertake, streamline, coordinate, and regulate all aspects of research in agricultural and livestock development. KALRO has centers in the different counties. In Makueni County, the KALRO institute is located in Makindu sub-county. The site has been used for crop variety experiment trials by both KALRO and partners such as the Kenya Plant Health Inspectorate (KEPHIS) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The center is also involved in breeding and seed bulking. The Biotechnology Research Institute is a similar center in Kiambu County, but its mandate is to generate and promote animal, plant, and environmental biotechnology knowledge, information, and technologies that respond to different clients' demands and opportunities.

Kiambu County also has the Waruhiu Agricultural Training Center that is being upgraded into a modern center of learning where farmers in the county and beyond can be trained on the most modern and appropriate agricultural technologies (agriculture, livestock, and irrigation)⁷. The county also holds an annual field day at the center through which more than 10,000 farmers are trained on various agricultural practices. The field days also provide a platform for farmers to network and link with different stakeholders and other farmers.

Both Makueni and Kiambu counties have extension officers who educate farmers at the ward and village levels. In Makueni, ward-level farmer field days have gained popularity in recent years. In addition, NGOs such as DNRC and CSHEP provide platforms in which farmers and other stakeholders can exchange knowledge and share experiences on agroecological innovations. Some of these centers also host community seedbanks, where indigenous seeds from farmers are preserved and made available to interested farmers. In addition, training for farmers on organic farming is open to interested community members. For example, DNRC in Makueni promotes joint sharing of knowledge through the establishment of community resource centers. These centers serve as hubs for knowledge sharing and capacity building, and provide a platform for farmers, researchers, and other stakeholders to collaborate and exchange ideas. DNRC also facilitates farmer-to-farmer exchanges, which allow farmers to learn from each other and share their experiences and knowledge. DNRC works closely with local universities and research institutions and encourages collaboration between researchers and community members to develop locally relevant solutions. Through these and other initiatives, DNRC can promote joint sharing of knowledge and expertise and support the development of sustainable natural resource management practices in the region.

In Kiambu, CSHEP promotes joint sharing of knowledge through training programs on the use of biopesticides. In addition, CSHEP facilitates farmer exchange visits, which allow farmers to visit other farms and learn practically about

new technologies and practices. PELUM also provides a forum for interacting with other groups working toward the same goal of promoting agroecological methods. The Kenya Television Network has an agroecology element, and it is also looking into training extension officers and journalists.

Priority interventions

In the AE-I, the co-creation of knowledge is mainly supported by the ALL and the participatory visioning and innovation co-designing that allow us to set the priorities and innovations to achieve them. The two selected ALLs will be anchored around the ALL host centers (i.e., DNRC for Makueni and CSHEP for Kiambu). These ALL host centers will foster the sharing of knowledge among farmers through farmer field days and exchange visits.

2.9 Social values and diets

Exchange of cultural knowledge at DNRC in Makueni is highly promoted. Furthermore, there is a culture conservation area that has structures known as *Thome*, which have been designed to inform different stakeholders about the Kamba community. This is a traditional wooden structure that the Kamba people use for various purposes such as socializing among males of the community. It is a valuable structural artifact that is used to preserve tradition and knowledge of the Kamba community. In DNRC, the sharing of cultural and technical knowledge fosters fairness in agroecology. This has a strong connection to regional ecosystems and can provide important information about how to manage natural resources sustainably. Agroecology aids in developing food systems that are more egalitarian and inclusive by fostering the interchange of cultural knowledge. This could support more social and environmental justice in agriculture and help solve systemic inequities.

Makueni County is mainly dominated by the Kamba community (agro-pastoralists), with almost every household planting food crops. In the county, cereals (maize, sorghum, and millet), vegetables, dairy products, oils and fats, sweet potatoes, spices, condiments, and beverages predominate in the local diet. Maize is the main staple food in Makueni County, and thus largely cultivated. Maize and sorghum are consumed as ugali and/or porridge and *muthokoi* (traditionally dehulled maize, cooked together with beans or pigeon peas). Maize and sorghum in the form of *uji*, *githeri*, and ugali are used for weaning children. Children younger than 1 year and from 1 to 5 years old eat more sorghum *uji*. Legumes such as cowpeas, green grams, beans, and pigeon peas are also extensively grown for food in the county. However, up to 15% of the households do not consume legumes, nuts, or seeds. The consumption of fruits, white roots and tubers is notably low, as they are consumed by only 14% (white roots) and 31% (tubers) of the households. Consumption of fish, eggs, and meat is also very low. Potato/cassava is planted by minorities (less than 10% of the

7 <https://www.kenyanews.go.ke/tag/waruhiu-agricultural-training-centre/>

households). Vegetables, on the other hand, are grown by households living along the rivers, with some households practicing kitchen gardening.

Traditional crops in Makueni County are mainly millet, sorghum, cassava, sweet potato, pigeon pea, and cowpea. However, over the years, there was a complete shift to maize and beans, which are sensitive to drought and pests. The reason for shifting to maize was mainly because maize was to serve as both a food and cash crop, as well as its characteristics related to processing and preparation. Some cultural beliefs also label millet and sorghum as inferior foods meant for the poor (AMREF, 1996). Culturally, various foods are consumed more during certain seasons/events. After childbirth, mothers tend to consume millet-based meals accompanied by fermented milk. Young men are fed with millet and sorghum ugali, fermented milk, and cowpea leaves, believed to promote rapid healing. During marriage ceremonies, families celebrate with meals made from *Dolichos lablab*, *mukimo* (a mixture of yam, cowpea leaves, and green maize), and *kaluvu*, a local alcoholic drink made largely from sorghum and millet. During the dry seasons, the community consumes pigeon peas, pumpkins, pumpkin leaves, sorghum, cowpea grains, cassava, and cowpea leaves. Because of the current overreliance on maize, the community relies on purchases from other counties during the dry seasons. Thus, the community should be encouraged to cultivate locally adapted plants such as sorghum, millet, and cassava to provide food in the dry seasons.

According to the Kiambu County Nutrition Action Plan (CNAP, 2020), the main food crops in Kiambu are maize, beans, Irish potatoes, bananas, and vegetables, while milk and poultry products are the main animal products. Notably, maize, which is the staple food, is mainly imported from other counties. The main fruits grown in the county are pineapples, mangoes, and avocados. Horticultural crop production plays an important role in the economy of Kiambu County. Major vegetables are French beans, snow peas, kale, cabbage, garden peas, tomatoes, spinach, and carrot, among others. Herbs and spices grown are coriander, basil, mint, rosemary, parsley, and asparagus, and these are marketed within the country while others are for the export market. Poultry and

pig keeping continue to take precedence after dairy farming in terms of livestock production. Egg and pig production are second, more so in income generation. Kiambu is relatively food secure but nutritional value seems to not be well considered, leading to a manifestation of hidden hunger. In Limuru sub-county, where the ALL host center is based, the area is dominated by the Kikuyu community. The main foods consumed by the residents are maize (as ugali, *githeri*, or porridge), Irish potatoes, *mukimo*, cabbage, carrots, beans, *Dolichos lablab*, beef, chicken, and eggs. Because of the promotion of African leafy vegetables, the community has embraced their consumption, including black night shade, spider plant, cowpea leaves, and amaranth. In Ndeiya area, being the drier part of Kiambu, residents run out of own-produced food early and rely on the markets for their food supply. The government also occasionally supplies food relief, mostly maize and beans, during dire situations.

Both ALL host centers contribute to upholding and celebrating their traditional crops and diets in numerous ways. DNRC, for instance, hosts biannual parties for the community members, which provide an opportunity for the community to showcase traditional dance and other cultural expressions. To further honor their traditional food crops, the parties also include cooking competitions during which both the nutritional and cultural value of indigenous varieties are celebrated. CSHEP mainly celebrates local diets and cultures in terms of having established a seed-saving facility and process at its center. Trained by the Seed Savers' Network, and supported by PELUM, CSHEP now supports a seed bank with numerous indigenous seeds. G-BIACK center, likewise located in Kiambu, and closely related to CSHEP, has the biggest private seed bank in the county.

Priority interventions

The Kiambu ALL host center has prioritized green leafy vegetables as the key value chain. In this regard, an analysis of how the increased production of organic leafy vegetables affects dietary consumption would be needed. Furthermore, intercropping and crop rotation are likely to integrate more legumes in the cropping systems. An assessment of how this would change diet patterns would therefore be important.



2.10 Fairness

In Kenya, agricultural market liberalization aimed at improving efficiency by increasing the participation of the private sector to give producers a wider choice of marketing channels. However, the marketing chains of agricultural produce are long, with many players, and they lack transparency (Shiferaw et al., 2006). In Makueni County, mango farming is a major source of family income. A direct market, such as to the Makueni Fruit Development Authority Processing Plant, offers better terms to the farmers in terms of better pricing. The Authority is buying mangoes through pre-qualified suppliers at KES 18/kg, with a minimum farm-gate price of KES 15/kg. To obtain this fair pricing, the Makueni County government is encouraging farmers to form producer groups to enable linkages with the formal markets. However, a recent study by Vamba et al. (2023) reported that the county is lacking sufficient marketing options for the mango farmers, leading to limited market access and low prices for their produce. This has led to some farmers still selling their produce to brokers, who sometimes refuse to sign contracts and exploit them with very low farm-gate prices.

Fairness as an agroecology principle is promoted through the establishment of marketplaces for organic producers in Kiambu as promoted by CSHEP to their registered farmers. To begin with, it levels the playing field for organic farmers, who frequently receive lower prices than they deserve because of a lack of regulated markets and information asymmetry. This improves farmers' access to markets and their ability to negotiate prices and it gives farmers a voice by giving them a place to sell their goods, a network with other farmers, and educated consumers. Furthermore, most vegetable farmers in Kiambu County are selling their produce to supermarkets by entering into a contractual agreement (Ochieng et al., 2016). This study, however, points out that most vegetable producers believe that they are not getting a fair deal when it

comes to the supermarkets declaring that some quantity of their produce is spoiled, without physically proving it. They are also supposed to sort, wash, and bundle the vegetables ready for the supermarket shelves, which increases the cost. The vegetable farmers also complained about delays in their payments as per the contracts with the supermarkets (Ochieng et al., 2016).

Priority interventions

The proposed interventions are likely to affect men and women differently. For example, the upscaling on agroecological innovations such as composting, farmyard manure, and vermicomposting will affect men and women differently in terms of both provision of labor and actual ownership of the harvested produce on the farms. A detailed assessment of the gender dynamics and impacts of adoption of the selected agroecological innovations would be critical in identifying how the issues relating to gender can be addressed.

2.11 Connectivity

The primary level has three main modes of distribution chains in the two counties: (1) no intermediary and farmer-to-farmer contact, (2) farmer to middlemen or local aggregators, and (3) farmer to agribusiness. At the secondary level, small aggregators link to processors, who in turn operate with the large commodity buyers supplying finished products to wholesale consumer markets. Farmers in Kiambu County have easy and direct access to consumers because of the close connectivity to the urban market in Nairobi. In addition, the county has more processing cooperatives at which farmers can easily sell their animal produce (see Section 1.2 on Economic context). The county also has more tarmacked roads than Makueni, which makes it easy for farmers to move easily and sell their produce to consumers in the markets.



Farmers in Makueni and Kiambu counties connect through various platforms such as groups. They engage in different community functions for different purposes, such as agroecological training, marketing, farm machine, and equipment groups (Karuga, 2022). Farmer-to-farmer and field school training forums have been at the front line to disseminate farming information. The existing farmer and communal networks have enabled the success of these platforms. Kiambu County has good road networks, which make movement within the county easy. Farmers have easy access to different markets within the county and can easily transport their produce to the city. On the contrary, the roads in Makueni are mostly murram. In addition, traveling within the county and to the key towns within it is quite difficult as the population relies on scheduled local public transportation, which, in most areas, is limited to specific times within the day. This can also limit the transportation of local products within the county and to the different neighboring counties.

In Kiambu County,
CSHEP promotes the principle of connectivity through a participatory guarantee system (PGS), seed-saving programs, and farmer field days.

The PGS, for instance, promotes connectivity by building trust and relationships among farmers, consumers, and other stakeholders in the food system. By actively involving farmers in the certification process, strengthening farmer-to-farmer networks, and promoting knowledge sharing, this supports the adoption of agroecological practices. Through the farmer field days, farmers are brought together to share knowledge and spaces. In addition, they foster a sense of community and build stronger relationships among farmers, which promotes the adoption of agroecological practices. CSHEP has promoted seed exchange programs to enable farmers to promote a diversity of local seeds and enhance seed sovereignty. The program helps maintain a wide range of crop varieties, including locally adapted ones, which can in turn support the resilience and productivity of agroecosystems.

For Makueni County, at DNRC, some examples are cultural days celebrating the cultural diversity of farming communities. By showcasing different traditions, food cultural practices, and local knowledge systems, the cultural days build pride and a sense of community among farmers that promote the adoption of agroecological practices. Another example of connectivity is internal exchange programs that provide opportunities for farmers to exchange knowledge and experience within their own communities. By creating platforms for farmer-to-farmer

learning, internal exchange programs can help relationships, promote knowledge sharing, and encourage the adoption of agroecological practices at the local level. An example is mango, an important value chain within Makueni County. Technical assistance is provided to farmers by various sources, including the county, overseen by the Sub-County Agricultural Office and Ward Agricultural Office. This assistance includes training on various aspects of good agricultural management practices, such as pest and disease management, weeding, water management, manure management, and harvesting practices (Onyango et al., 2023). The county also facilitates the linking of farmers into groups and to markets, such as aggregators, exporters, and processors. Additionally, NGOs such as the DNRC offer technical assistance and training to farmer groups and individuals (Onyango et al., 2023). These linkages help to promote a more resilient and diverse agroecosystem, enhance ecosystem services, decrease negative environmental impacts, and ultimately lead to improved agricultural productivity and food security.

Priority interventions

- Assessing the current strengths and weaknesses of the existing business models for the selected value chains within the ALLs, assessing current markets for commodities, and making recommendations on how these can be improved at the ALL level can contribute to addressing the connectivity principle more comprehensively.
- Strengthening the capacity of the ALL host center to offer training on different agroecological innovations to ensure that field officers can also reach more farmers and educate them on agroecology can also be an important avenue for improvement.

2.12 Land and natural resource governance

Nationally, different policies govern the use of land and natural resources and open opportunities for agroecology (Alliance for Food Sovereignty in Africa, 2020):

- I. National Climate Change Response Strategy (2010)
- II. National Climate Change Action Plan (2018-2022)
- III. National Climate Finance Policy (2018)
- IV. Agricultural Sector Development Strategy (2010-2020)

Ninety percent (90%) of the farmers in Kiambu County own land that they use for farming, with a few having extra land for rent (Karuga, 2022). Residents have title deeds and the land is owned through two forms: family and lease. Family land ownership is acquired through buying, inheritance, or ownership by the extended family, through which the farmer (mostly male) is given a piece of land to cultivate. Nuclear family land ownership is more secure as the owner can develop the land without consultation, unlike in extended ownership, in which farm development must be discussed with the extended family due to a lack of defined boundaries in some cases. The second type of land ownership is under a lease. Leasing land is done per year or for several years and

the owner can retain the land at the end of the agreed time or lease it again. Land ownership in Makueni is also like in Kiambu. However, only 19.8% of the landowners in Makueni have title deeds (National Government Policy Documents, 2013). The percentage is low compared to the national figure (39.4% of landowners in the country have title deeds).

Socioeconomic and cultural factors as well as the land tenure system are key factors that influence the short-term to long-term adoption of agroecological practices. In this sense, farmers on leased land find it risky to make substantial investments as the owners 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.

Makueni County has established the Climate Change Fund to allocate 1% of its annual budget to climate change action. The county has taken steps to prepare for and adapt to climate change through its Climate Change Integrated Development Plan (Alliance for Food Sovereignty in Africa, 2020).

Sustainable land management and protection of the planet's natural resources are at the heart of the plan. Makueni County has worked with other groups, such as USAID and the national government, on several projects to prepare for and respond to climate change. Therefore, agroecology promotes sustainable land management and environmental conservation as a major mission in the County Integrated Development Plan.

A climate change directorate has been established by the Kiambu County government with the goal of assisting locals in adapting to and diminishing climate change effects. This would enable the county to implement agroecological techniques to help mitigate and adapt to climate change. The county is also trying to develop an agroecology policy. Kiambu County embraces the idea of sustainable land management as one of its purposes through its CIDP (Alliance for Food Sovereignty in Africa, 2020). It seeks to preserve biodiversity by restoring natural forests. The CIDP also highlights the county's problems with soil health. It identifies actions to support agroforestry, expand forest cover, and boost soil conservation while also capturing soil and water conservation as county functions. Communities are urged by the CIDP to adopt organic farming, particularly the use of organic fertilizer.

Priority interventions

The priority is to provide a secure environment sustainably by strengthening the capacity of agroforestry practices in DNRC. Agroforestry helps to restore degraded land by maintaining good soil structure, among other key contributions. The production of tree seedlings at DNRC should be enhanced to achieve this priority. Tree planting also helps to mitigate the effects of climate change.



2.13 Participation

Nationally, the Inter-Sectoral Forum on Agrobiodiversity and Agroecology (ISFAA)⁸ provides a platform through which stakeholders on agrobiodiversity and agroecology can interact to share knowledge and information, influence policy, and fundraise. Different NGOs have been involved in promoting agroecological practices within Kiambu County. For example, the 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 has been at the forefront of supporting county-level multistakeholder platforms (MSPs) that promote civil participation in policy dialogues and processes. Through a similar MSP process, PELUM and the Institute for Culture and Ecology (ICE) have been supporting a draft of agroecology policy for Kiambu County. PELUM, with the support of the AE-I, also works on strengthening an MSP for Makueni. During the stakeholder assessment, numerous other important actors were identified, many of whom explicitly target smallholders' and consumers' participation in food system governance matters, including Kenya Organic Agriculture Network (KOAN), the Green Belt Movement (GBM), Heinrich Böll Foundation-funded Route to Food Initiative (RtF), Biovision Africa Trust (BvAT), Seed Savers' Network Kenya (SSN-Kenya), the GIZ-funded Knowledge Centres for Organic Agriculture (KCOA), the Dutch-funded Youth in Agroecology and Business Learning Track Africa (YALTA), and others. Other NGOs and Community Based Organisations (CBOs) involved in promoting agroecology and supporting the ALLs specifically, of course, include CSHEP in Ndeiya and G-BIACK in Juja, both in Kiambu, as well as DNRC in Makueni (see Section 1.4 on Political context for more details on the partners).

Many methods that exemplify the idea of involvement in agroecology are encouraged at DNRC in Makueni County. One such activity is collective tree planting, which entails bringing together farmers and locals to grow trees and other vegetation (**Table 5**). In addition to enhancing soil fertility and decreasing erosion, this practice gives locals a chance to collaborate on a common undertaking. The organized farming groups that control its operations are another illustration. Currently, 17 such organizations are running, which aid in ensuring that nearby farmers have a say in the creation and use of agroecological methods. These

organizations give farmers a venue for knowledge sharing, idea exchange, and collaborative decision-making around the use of natural resources. The DNRC also organizes farmer exchange trips so that farmers can share knowledge about sustainable farming methods and gain insight from one another's experiences. These outings provide farmers with the chance to observe directly how others are putting agroecological practices into practice and to learn from their triumphs and setbacks.

“ Collective tree planting in addition to enhancing soil fertility and decreasing erosion, gives locals a chance to collaborate on a common undertaking.

In Kiambu and specifically at CSHEP, the PGS highly promotes the principle of participation in agroecology. It involves the active engagement of farmers and other stakeholders in the development and implementation of the system (**Table 6**). Under the PGS, farmers work together to develop and enforce standards for organic and sustainable farming practices. They also collaborate to conduct peer reviews and inspections to ensure that these standards are being met.

Possible interventions

To further improve a holistic integration of this principle, the AE-I can continue to explicitly engage with organizations that are involved in agroecology (e.g., ISFAA and PELUM). In addition, all activities should be implemented in close collaboration with the county governments of Kiambu and Makueni to ensure that their suggestions and inputs are incorporated during the implementation of the AE-I activities.

8 <https://isfaa.ke/>

Table 5. A preliminary assessment of the different activities in which DNRC is involved along the 13 HLPE agroecology principles.

13 HLPE principles of agroecology - Makueni ALL host center	
1. Recycling <ul style="list-style-type: none"> - Rainwater harvesting - Farmyard manure 	8. Co-creation of knowledge <ul style="list-style-type: none"> - Internal exchange - University students - Local interns - Use of indigenous knowledge for processing sugarcane - Doing research with KEFRI - Farmer exchange - Agroecological policy
2. Input reduction <ul style="list-style-type: none"> - Compost - Vermiculture 	
3. Soil health <ul style="list-style-type: none"> - Compost - Vermiculture 	
4. Animal health <ul style="list-style-type: none"> - Bees - Goats - Chickens - Turkeys - Trap termites 	9. Social values and diets <ul style="list-style-type: none"> - Promote local diets and integrate Kamba community culture - Exchange local foods (twice a year)
5. Biodiversity <ul style="list-style-type: none"> - Tree species nursery - Beehives - Moringa - Sunflower 	10. Fairness <ul style="list-style-type: none"> - Exchange cultural knowledge
6. Synergy <ul style="list-style-type: none"> - Trees-crops-animals 	11. Connectivity <ul style="list-style-type: none"> - Farmer exchange visits - Cultural days - Tree planting days - Internal exchange program
7. Economic diversification <ul style="list-style-type: none"> - Tree planting - Beekeeping - Training - Charcoal making from pruning trees - Moringa - Sunflower - Mango 	12. Land resource use and governance <ul style="list-style-type: none"> - Agroecology policy
	13. Participation <ul style="list-style-type: none"> - Collective tree planting - Organized farming groups governing DNRC activities (17 groups) - Training hall for the community - Farmer exchange visits

Table 6. A preliminary assessment of the different activities CSHEP is involved in along the 13 FAO agroecology principles.

13 HLPE principles of agroecology - Kiambu ALL host center	
1. Recycling <ul style="list-style-type: none">- Water- Composting- Seed saving- Biogas- Solar energy	8. Co-creation of knowledge <ul style="list-style-type: none">- Biopesticides- Training on biopesticides- Farmer exchange visits- CSHEP collects information from farmers (use of plants common to farmers)
2. Input reduction <ul style="list-style-type: none">- Locally available materials for compost- Seed saving- Pest and disease management	9. Social values and diets <ul style="list-style-type: none">- Organic farm produce
3. Soil health <ul style="list-style-type: none">- Farmyard manure for compost	10. Fairness <ul style="list-style-type: none">- Participatory guarantee system (PGS)- Markets
4. Animal health <ul style="list-style-type: none">- Rabbits- Chickens- Using aloe vera and garlic for treatment of chickens	11. Connectivity <ul style="list-style-type: none">- PGS- Farmer field days- Seed exchange program
5. Biodiversity <ul style="list-style-type: none">- Crops in the field- Intercropping with pest control (coriander with cabbage or onions)	12. Land resource use and governance <ul style="list-style-type: none">- Agroecology policy for Kiambu County is in process (PELUM)
6. Synergy <ul style="list-style-type: none">- Composting system- Animals-crops	13. Participation <ul style="list-style-type: none">- Training at the center- PGS
7. Economic diversification <ul style="list-style-type: none">- Sell organic produce -> value addition- Sell multi-story gardens	

3. Concluding remarks

Much of the information in this document was mainly obtained from the literature. The information presented from the ALL host centers was documented during an initial visit to the centers to establish a working relationship and assess the focus of the centers in terms of agroecology. The existing information on the two counties where the ALLs are located (i.e., Makueni and Kiambu) shows that some farmers have made efforts in terms of adopting agroecological innovations. For example, the DNRC ALL host center in Makueni already has a network of 800 farmers who have benefited through access to trees for planting on their farms. Some farmers also participate in beekeeping and moringa farming and have benefited through training at the center. The CSHEP center also has a network of farmers involved in organic farming of indigenous green leafy vegetables. A survey on the different agroecological practices that exist in the two ALLs indicates that different farmers are already using many practices on their farms (e.g., terracing, mulching, agroforestry, intercropping, and application of biopesticides, among others). This information shows that great potential exists among the farmers in the two ALLs to transition to agroecological farming. However, more research is still needed to inform on the effectiveness of some of the existing practices. Furthermore, training of farmers on these practices would be crucial for enhancing scaling across the two ALLs.

The information in this document is not only vital for the AE-I in the localization of the indicator selection process that is planned for the HOLPA tool; it would also provide a baseline for the co-design of innovation exercises that will be conducted by the AE-I's WP 1.

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