REPUBLIC OF KENYA

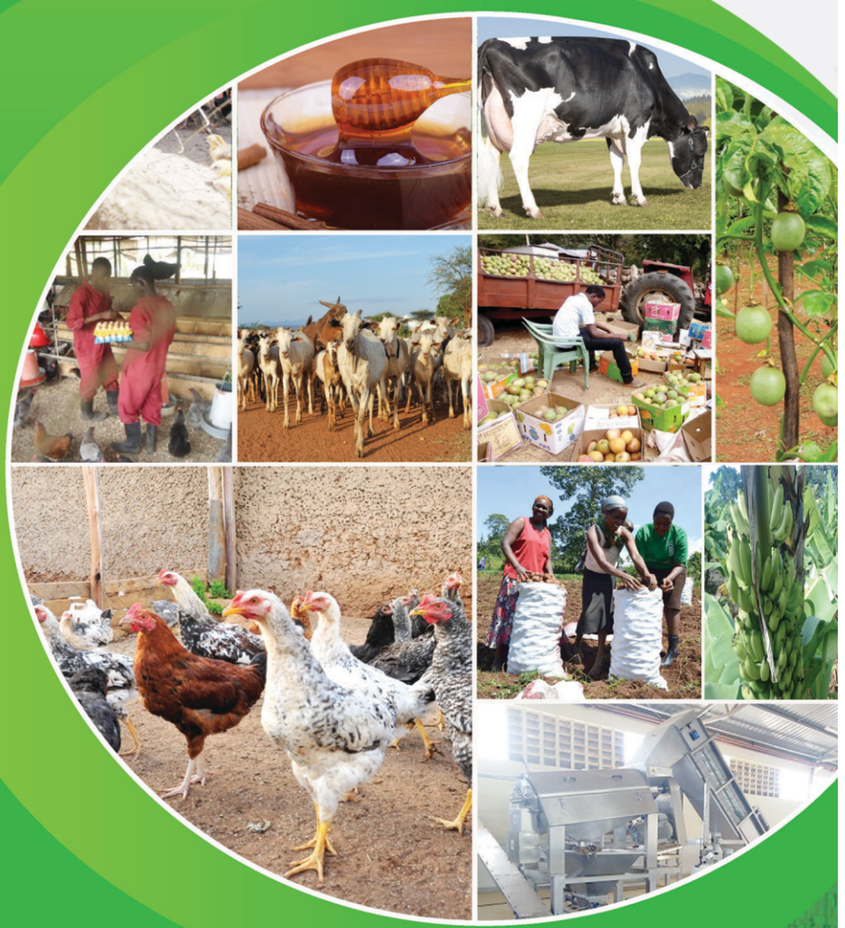
# MINISTRY OF AGRICULTURE, LIVESTOCK, FISHERIES AND COOPERATIVES AND COUNTY GOVERNMENTS

ASDSP
AGRICULTURAL SECTOR DEVELOPMENT SUPPORT PROGRAMME

## AGRICULTURAL SECTOR DEVELOPMENT SUPPORT PROGRAMME II (ASDSP II)

# KIAMBU COUNTY PRIORITY VALUE CHAIN SUITABILITY ATLAS

**August 2020**



*"Transforming Kenya Agriculture Sector"*

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Agricultural Sector Development Support Programme II (ASDSP II)

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# ABBREVIATIONS

| | |
|---|---|
| **AHP** | Analytical Hierarchical Process |
| **AI** | Artificial insemination |
| **ASDS** | Agricultural Sector Development Strategy |
| **AP** | Agricultural Policy |
| **APA** | Apollo Pan Africa |
| **ASALS** | Arid and semi- Arid Lands |
| **ASDSP II** | Agriculture Sector Development Support Programme II |
| **ASTER** | Advanced Space-borne Thermal Emission and Reflection Radiometer |
| **ASTGS** | Agriculture Sector Transformation and Growth Strategy |
| **BDO** | Business Development Officer |
| **CA** | Conservation Agriculture |
| **CECM** | County Executive Committee Member |
| **CI** | Consistency Index |
| **CIC** | Corporate Insurance Company |
| **CIDP** | County Integrated Development Plan |
| **CO** | Chief Officer |
| **CPS** | County Programme Secretariat |
| **CR** | Consistency Index |
| **DEM** | Digital Elevation Model |
| **ESP** | Economic Stimulus Program |
| **FAO** | Food and Agricultural Organization |
| **GDEM** | Global Digital Elevation Model |
| **GDP** | Gross Domestic Product |
| **GIS** | Geographical Information System |
| **IWD** | Inverse Distance Weighted interpolation |
| **ILWIS** | Integrated Land and Water Information System |
| **ILRI** | International Livestock Research Institute |
| **KALRO** | Kenya Agricultural and Livestock Research Organization |
| **KEMFRI** | Kenya Marine and Fisheries Research Institute |
| **KCC** | Kenya Cooperative Creameries |
| **KCEP-CRAL** | Kenya Cereal Enhancement Programme-Climate Resilience and Agricultural Livelihood |
| **KDB** | Kenya Dairy Board |
| **KEPHIS** | Kenya Plant Health Inspection Services |
| **KFA** | Kenya Farmers Association |

| | |
|---|---|
| **KFS** | Kenya Forest Services |
| **KNBS** | Kenya National Bureau of Statistics |
| **KES** | Kenya Shilling |
| **MCE** | Multi Criteria Evaluation |
| **NARIGP** | National Agriculture & Rural Inclusive Growth Project |
| **NDMA** | National Drought Management Authority |
| **NEMA** | National Environment Management Authority |
| **NRM** | Natural Resource Management |
| **NPS** | National Programme Secretariat |
| **PWCM** | Pairwise comparison matrix |
| **PVC** | Prioritized Value Chain |
| **QGIS** | Quantum Geographic Information System |
| **RCI** | Random Consistency Index |
| **RCMRD** | Regional Centre of Mapping of Resources for Development |
| **SID** | Society for International Development |
| **Soil OC** | Soil Organic Carbon |
| **Soil CEC** | Soil Cation Exchange Capacity |
| **Soil AWC** | Soil Available Water Content |
| **Soil pH** | Soil potential for hydrogen |
| **THI** | Temperature humidity index |
| **USD** | US Dollars |
| **VC** | Value Chain |
| **VCA** | Value Chain Actors |
| **VCO** | Value Chain Organization |
| **VRL** | Veterinary Research Laboratories |
| **WB** | World Bank |
| **WETF** | Women Enterprise Trust Fund |
| **WGS** | World Geodetic System |

# FOREWORD

Agricultural sector growth and development is crucial to Kenya's overall economic and social development. Agriculture significantly contributes to the county economy; ensures the county is food secure; generates incomes and provides employment both directly and indirectly for the population. Sustained agricultural growth is therefore critical to uplifting the standards of living of our people. The county however faces several challenges which need to be overcome for this growth to occur. These challenges include high levels of poverty, food insecurity and the negative effects of climate change.

Kenya's development blueprint, Vision 2030 recognizes the agricultural sector as one of the vehicles that will aid the achievements of the targets. The sector's Agricultural Sector Transformation and Growth Strategy (20190 2029) focuses on increasing the income of 3.3 million small scale households; significantly improving sector contribution to the national GDP through enhancement of land productivity and agro-processing to improve agricultural outputs and value addition and boosting household food resilience against environmental and fiscal shocks through cost reduction of nutritious foods and well-targeted support in terms of subsidies and social protection. The county government of Kericho in collaboration with other development partners and specifically with initial support from the government of Sweden has brought the realization of this goal a step closer through the Agricultural Sector Development Support Programme (ASDSP II) that is being implemented at both the national and county governments' levels.

In order to make informed decision on priority value chains (dairy cow milk, indigenous chicken and tomato) for the county, it was necessary to establish the scientific generated resource and suitability maps. It is my strong believe that value chain actors and stakeholders will use this information in addressing the challenges that the sector faces in food security, productivity and natural resource management. The development of these maps was therefore timely and critical for this county as the basis for planning and setting priorities of adaptation intervention in the sector.

The exercise integrated biophysical (climatic and soil factors), economic (population, road network and market outlets), social (agrarian characteristics) and political (framework conditions) parameters to classy the county into regions that are highly and moderately suitable.

The moderately suitable areas require attention by both levels of governments and stakeholders in order to address constraints that affect productivity of the priority value chains. The adaptations, innovations and technologies proposed to improve value chain performance, require resources that require multi sectoral and multi-disciplinary approach to address.

I wish to encourage all stakeholders to not only study the reports but also utilize the data and information for evaluating their activities and improving their implementation profiles to achieve realistic goals. As a department, we are committed to use the findings to inform the process of county domestication of policies and guide current and future programs actions that will lead to realization of food and nutrition secure and wealthy households.

**Mr. Joseph Kamau**
County Executive Committee Member (CECM),
Department of Land Housing, Physical Planning,
Municipal Administration and Urban Development & Department of Agriculture,
Livestock and Irrigation. County Government of Kiambu.

# ACKNOWLEDGMENT

The ASDSP II is implemented at national and county level in the 47 counties through the National Programme Secretariat (NPS) and the County Program Secretariat (CPS). The purpose of the nationwide resource mapping was to provide information to be used in making key decisions in intervening to improve value chain productivity as guided by the suitability maps. The intensive and highly technical resource map development exercise at the county was undertaken from June 2019 by the technical multi-disciplinary teams who concluded the exercise in January 2020 across the 47 counties in the country.

The specific objectives of the surveys were to identify the suitability levels of the ASDSP II value chains and develop adaptation methods ,innovations and technologies which best fit a particular value chain The joint exercise between the County, NPS and the service provider was to enable the counties to own the suitability maps, understand the base maps and be able to interpret the parameters used so as to define innovations and technologies for use in the value chain moving towards commercialization.

Further, the value chain resource maps are intended to avail data to be shared with other stakeholders to guide them in planning and making key decisions. The survey considered the three priority value chains being implemented by the programme. The exercise involved value chain actors and organizations.

I take this opportunity to extend special recognition and appreciation to the following, whose contribution led to the success of this exercise: members of NPS, VCO (respondents), CPS, value chain chairpersons.

We are grateful to the National Programme Secretariat for the support during the exercise. We also take this opportunity to return our gratitude to the management of AL&F department and the entire staff establishment.

**Dennis Omoga Abuya**
Principal Physical Planner

**John Muriuki Maringa**
Senior Agricultural Officer

# EXECUTIVE SUMMARY

The value chain resource/suitability maps development is an important exercise that has generated scientific data and information for the priority value chains for Kiambu County. The results of the maps have showed the suitability of each priority value chain. Considering the biophysical parameters (temperature, rainfall, soil and slope) economic factors (population, roads coverage and access to the market) social and political factors on the Kiambu county priority value chain being implemented by Agriculture Sector Development Support Programme (ASDSP) II different maps have been developed.

The dairy cow milk VC is highly suitable within Kiambaa, parts of Ruiru, Limuru, Kabete, Kiambu, Githunguri and parts of Gatundu North and South Sub-counties. Indigenous chicken VC is moderately suitable within Kiambaa, Kikuyu, Kabete, parts of Limuru, parts of Thika, Ruiru, parts of Juja and Githunguri Sub-counties. Banana VC is highly suitable within Kiambaa, Githunguri and parts of Gatundu North and South Sub-counties.

Adaptation measures, the use of innovations and technologies have been suggested to improve or make the value chains more suitable as follows ;- modification of temperature through Agroforestry and improved range management practices, establishment of milk collection centers, improvement of cow shelter and chicken housing, improvement of milk storage and chicken meat, soil erosion control, improving grazing management, adhering to the right livestock carrying capacities, water harvesting, feed lot improvement, capacity building efforts on entrepreneurial skills and commercialization of the enterprises, market structure improvement, improvement of market access through better road conditions, strengthening linkages of market players, provision of timely market information, passing legislations that safeguard and attract investments in the value chains, agroforestry, irrigation, rain water harvesting, development of water infrastructure, planting cover crops and contour farming.

The use of innovations that improve value chain performance have also outlined in the report. They include agroforestry, use of solar powered coolers, use of refrigerated tracks to transport meat, use of submersible solar powered hybrid water pumps, terracing , use of contour bands, use of cut off drains, supplementary feeding, paddocking, ranching, breed improvement, value addition, expansion of market segments, establishment of milk and chicken collection centers,contractual agreement, establishment of market info sharing platforms, flood water harvesting, roof catchment, value addition, solar drying, the use of improved varieties, and formulation of suitable policies have been suggested as key innovations that will result into improved performance of the value chain.

The use of innovation is strongly backed by technology in order to make the innovations more successful. The report has identified some key technologies which include the replanting of degraded areas with indigenous and other improved tree varieties. The others are:- the use of cold chain storage system, the use of suitable package information, the use of trapezoidal bunds, negarims, terracing, contour bunds, the sinking of boreholes/wells, strip fodder and forage production, the use of gabions, dams and feed formulation/processing , branding, mass media advertisements, the use of e-apps and information sharing through the county website, soil testing, greenhouse and tissue culture bananas.

The suitability analysis reveals that the priority food value chains of dairy milk cow, banana and indigenous chicken vary from moderately to highly suitable in Kiambu County. The maps and the statistical analysis of ranking and weighting provided factual understanding for decision making. This model is very important in physical planning, particularly in preparing spatial development plans, zoning of production areas and

integrating agriculture in the urban form to improve economic competitiveness, food and nutrition security and sustainable development.

Key recommendations arising from this report are as follows:- Integrated and multi sector approach to improve on the meat goat suitability; Biophysical factors to improve on micro climatic conditions; Use of adaptation methods; Innovations and technologies to sustain or improve the value chain performance; and Agriculture related Policies, plans strategies and regulations to attract investment in the sector.

CECMs - Department of Land Housing, Physical Planning, Municipal Administration and Urban Development & Department of Agriculture, Livestock and Irrigation.
County Government of Kiambu

# 1. INTRODUCTION

## 1.1 National Agricultural development landscape

Agricultural development in Kenya was founded on large-scale production as advanced by white colonial settlers in the early 1900s. The development concentrated in the central and rift valley highlands which were found to be ***most suitable*** for the production of wheat, coffee, tea and dairy. During this period, structures were put in place by the colonial government and the settler farmers to support commercial production and marketing of agricultural commodities. These structures included input services and output market organizations such as the Veterinary Research Laboratories in 1910, the Kenya Farmers Association (KFA) in 1923 and the Kenya Co-operative Creameries (KCC) in 1925.

Between 1900 and 1950, the colonial administration established various Ordinances aimed at controlling ***land use*** in the country. The ordinances restricted Africans to ***rural areas*** and also from occupying land that belonged to ***other tribes***. The dual restrictive policy was marked by alienation and overcrowding of Africans in villages leading to agitation and struggle for better living conditions. In the late 1940s, due to escalation of the land use crisis and dwindling economic returns from native agricultural practices, a restructuring of African agriculture by the colonial government was made. This was aimed to support existing colonial production of food and raw materials for exports.

The most radical and comprehensive intervention during this period was the £5 million twenty year Swynnerton agricultural development plan that commenced in April 1954. The main thrust of this plan was to increase household incomes through radical changes in land tenure system mainly in central Kenya. Small parcels of land were consolidated into at least 10 acre units per family. These units were registered and developed to improve productivity and household earnings from agriculture that averaged £10 to £100 in cash sales per year. This action resulted in a dramatic rise in the value of recorded output from the small-holdings from £5.2 million in 1955 to £14 million in 1964 with coffee accounting for 55 percent of the increase. The impact of this policy action resulted in significant decrease in the proportion of small holders living below poverty from over 60% in 1953 to less than 18% in 1974 in Central Kenya. This reduction was significant when compared to near zero poverty reduction levels witnessed in other parts of the country that were not covered by the plan. The major failure of the Plan was the neglect and marginalization of other areas of the country which led to imbalances in development between different regions.

After Kenya attained her independence, the agricultural industry concentrated support on smallholder farming with the goal of attaining food self-sufficiency and rural development. The policy actions at this time saw the former large-scale farms in the highlands subdivided and sold to smallholder farmers. Subdivision of large scale farms into small scale systems compromised the commercial viability of most agricultural enterprises in the productive areas of Rift Valley and Central Kenya. Small scale agricultural production reduced productivity fourfold.

Another policy shift that had far reaching implications to agricultural development was the Sessional paper No. 10 of 1965 on African socialism and its application to planning in Kenya. This policy ensured that the country's wealth would remain in the productive areas, which included the former white highlands and those covered by early registration under the Swynnerton Plan. It stressed that to make the economy grow as fast as possible, development funds would be invested where it would yield the largest increase in net output. This approach clearly favoured the development of areas endowed with natural resources, good land and rainfall, transport and power facilities while areas without such facilities were neglected (Kenya, 1965).

The Sessional paper No. 1 of 1986 on Economic Management for Renewed Growth re-emphasized the place of agriculture as the leading sector in stimulating growth and job creation in the country. This sessional paper prompted the profound structural adjustment process ever initiated by the Kenya government. A key element of this policy development was the liberalization of the production and marketing of important agricultural commodities like maize.

Other efforts geared at improving agricultural production by national government aligned to land use planning before the advent of devolution included provision of targeted extension services including the Training and Visits Extension Program, The Catchment Approach to Soil Conservation and the focal area approach of the National Agriculture and Livestock Extension Program (2000). The Economic Stimulus Program (ESP) of 2009/2010 was another national government initiative that committed financial support aimed at jumpstarting the Kenyan economy towards long term growth and development. Priority areas in agriculture were skewed towards construction of horticultural markets and promotion of small holder inland aquaculture. Government interventions and programs in agricultural sector during the intervening period between 1963 to 2013 were not informed by any spatial plans that linked the resource base to agricultural development.

Following the promulgation of Kenya Constitution 2010, the country transited into a devolved government system in 2013 with agriculture becoming a devolved county function. The Kenya 2010 Constitution ushered a new planning system with the national and county governments tasked to develop national and county specific spatial maps to support zoning and designation of areas for production of scheduled agricultural commodities. The Kenya National Spatial Plan 2015- 2045: An integrated Spatial Plan for Balanced and Sustainable National Development, was developed within this constitutional framework and has laid the foundation on which Article 66, on the regulation of land uses, Article 68, on maximum and minimum land holding sizes and Article 69 on environment management will be achieved. The Kenya Crops ACT 2013 designates the Cabinet Secretary in charge of Agriculture with the advice of the Agricultural and Food Authority with the responsibility of developing rules for identifying and zoning agricultural land suitable for the production of the scheduled crops. The Crops ACT 2013 however allows individual land owners to have a final say on the actual land use practice to implement.

The development of suitability maps to inform competitive land use practices aligned to promotion of priority value chains in the 47 counties of Kenya therefore builds on the demands for spatial planning and regulation of land uses by examining the suitability of the Kenyan land resource in supporting some 29 priority value chains (PVC). The maps offer an interim evaluation of and demonstrate to some extent the underlying reasons behind the decline in agricultural productivity based on the potentialities that exist to support commercialization of some 29 priority value chains. The value chain suitability maps provided here are aligned to each of the 29 value chain commodities promoted under the Agriculture Sector Development Support Program (ASDSPII), a five year program (2018-2022) of the Ministry of Agriculture, Livestock, Fisheries and Cooperatives with funding support from the national and county governments, The Swedish government and the European Union. For Embu County, these priority value chains are cow milk, banana and indigenous chicken.

## 1.2 Agricultural resources

The Kenyan agricultural development is mainly land and climate depended. The constitution of Kenya 2010 under Article 260 defines land broadly to mean the surface of the earth and the subsurface rock; any body of water on or under the surface; marine waters in the territorial sea and exclusive economic zone; natural resources completely contained on or under the surface; and the air space above the surface. The constitution under Article 60 calls for efficient, productive and sustainable use of land. Kenya is a diverse country with rainfall and temperature endowments that support a wide scope of crop, livestock and aquaculture systems. The country receives between 250mm to over 2000 mm of rainfall (**Error! Reference source not found.**) with temperature ranges as low as 4.6° C and highs of over 34° C (**Error! Reference source not found.**).

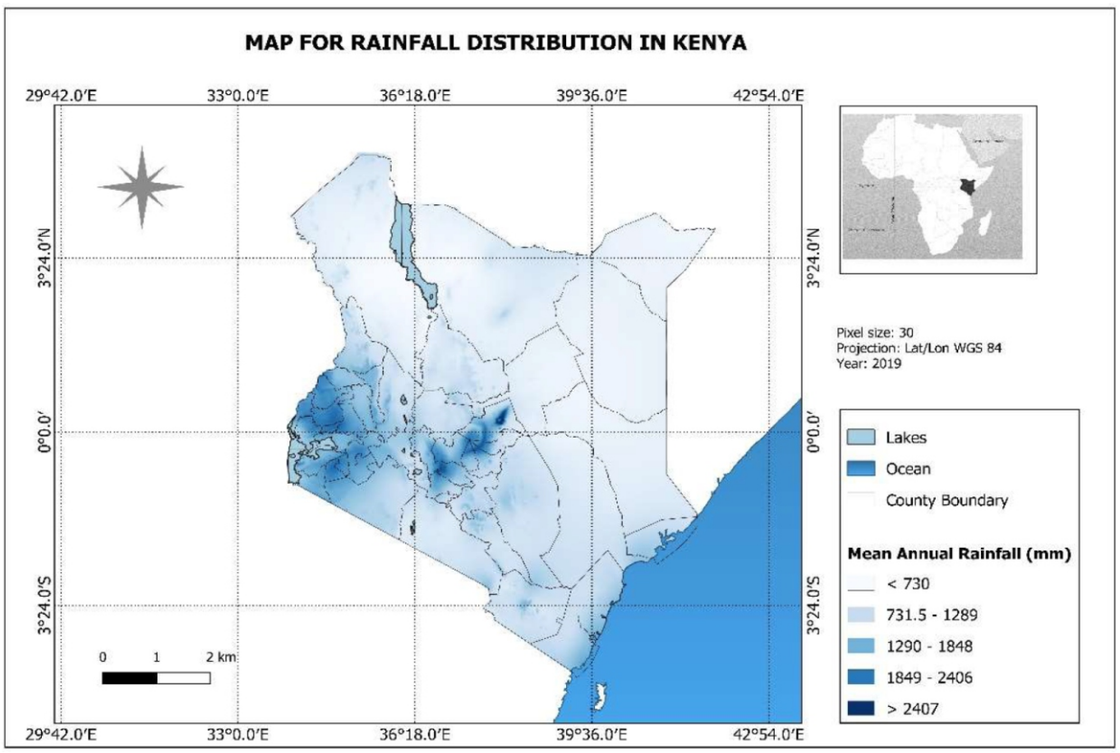



***Figure 1:*** *Kenya Rainfall distribution*

The demand and distribution of agricultural produce within the country is affected by population density (**Error! Reference source not found.**) and infrastructure development (**Error! Reference source not found.**) since these attributes are key proxies to determining internal market access and size. The Kenyan population is not uniformly distributed while over the years the government has invested in the development and expansion of the road and railway networks actions that have contributed to improving market access for both the inputs and agricultural commodities.

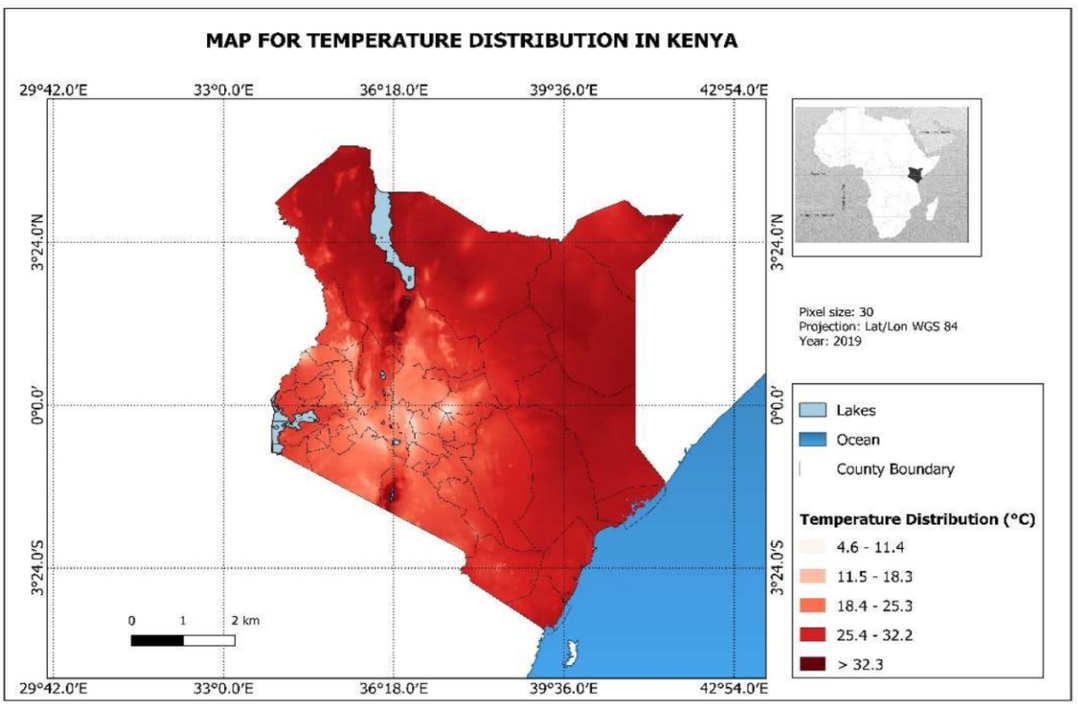



***Figure 2:*** *Kenya Temperature*

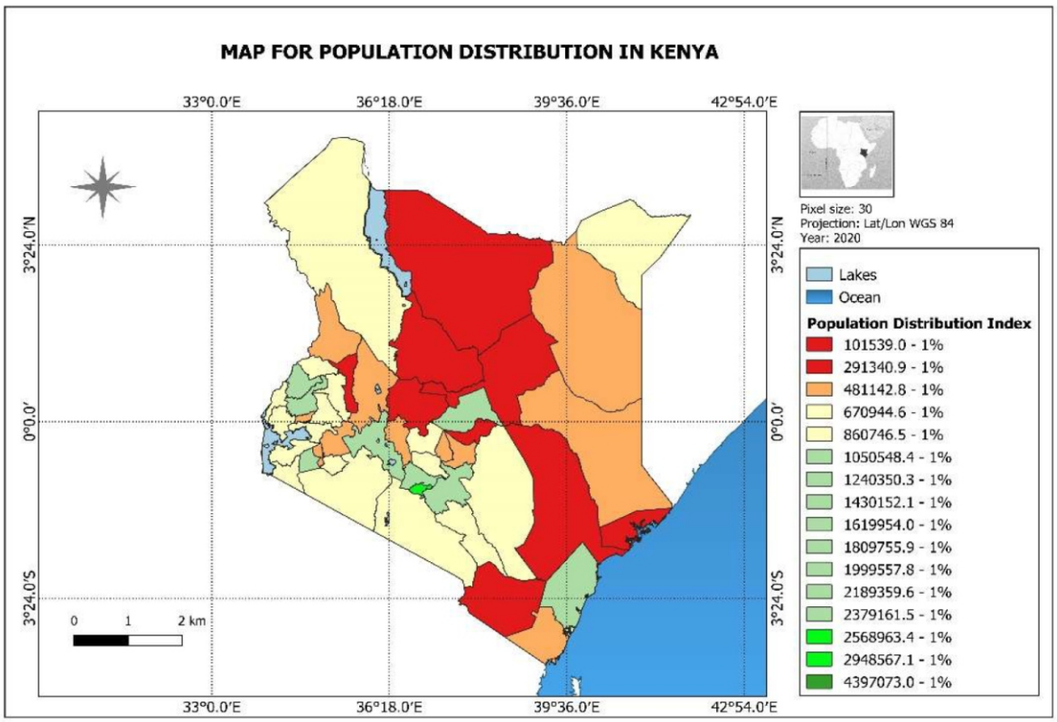



***Figure 3:*** *Kenya Population Density*

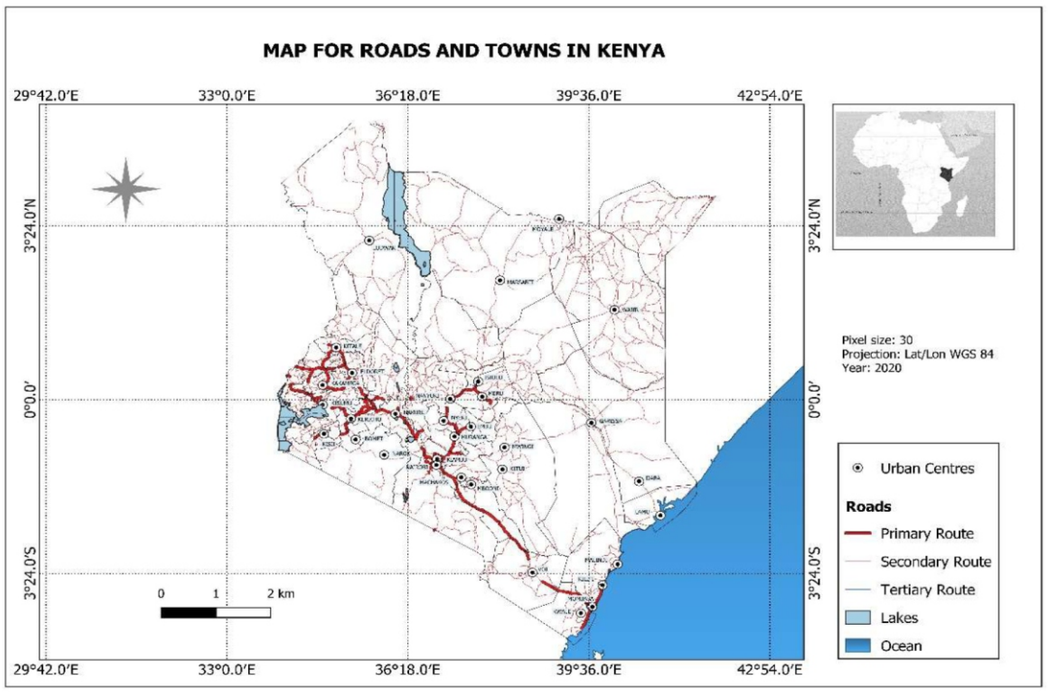



***Figure 4:*** *Kenya Roads and Major Towns*

## 1.3 The Agricultural Sector Development Support Programme

### 1.3.1 ASDSP I

Agriculture Sector Development Support Programme (ASDSP I) was a national formulated and implemented programme financed by Government of Kenya and the Government of Sweden. The first phase was implemented during a period of five years (2012-2017). The developmental objective (purpose) of ASDSP I was *"increased and equitable incomes, employment and improved food security of the target groups as a result of improved production and productivity in the rural smallholder farm and off-farm sector".* It was one of the major programmes implementing the sector strategy, Agriculture Sector Development Strategy (ASDS: 2010-2020) whose goal was to commercialize agriculture. During this programme phase, each county prioritized three agricultural value chains for promotion.

The priority value chains were identified through a scooping and consultative study forums facilitated by a team of experts in each of the seven regions of the country (the then Provinces except Nairobi, which was paired with Central). The 10 point criteria developed to guide the stakeholders in identifying and prioritizing the value chains examined among others; potential to increase in productivity; potential for private sector participation and crowding in; potential for contribution to sustainable land and natural resource management (NRM); competitiveness of the sector; unmet market demand; market size and growth prospects; profitability of enterprise; potential to contribute towards food security; potential to generate employment; potential for value addition; potential for women and youth involvement; potential for participation of vulnerable groups (i.e. low investments/quick returns enterprises) and Cultural Acceptability. Application of these criteria led to the selection of 29 priority value chains (PVCs) three in each of the 47 counties with the most preferred value chains being dairy, indigenous chicken, maize and fish (**Error! Reference source not found.**).

### 1.3.2 ASDSP II purpose

The overall goal of ASDSP II is aligned to the Agricultural Policy and is to contribute to "Transformation of crops, livestock and fisheries production into commercially oriented enterprises that ensures sustainable food and nutrition security". ASDSP II purpose is to commercialize priority VCs with expectations of increasing incomes among the VCAs and assure attainment of food and nutrition security to the VCAs households. The programme is devolved to all the 47 Counties. The identified outcome areas of the programme are; *increasing productivity of priority value chains, enhancing entrepreneurship of priority Value Chain Actors, improving access to market by VCAs* and support to strengthen structures and capacities for consultation, cooperation and coordination (3Cs) in the sector.

During the roll out of ASDSP II, a simpler and easy 5 point criteria (*Income, Food security, Employment creation, Environmental Sustainability and Opportunity to promote social inclusion*) was applied to validate the existing PVCs (**Error! Reference source not found.**) and in almost all the counties, the same PVCs promoted under ASDSP I were retained. Some counties however added an extra PVC and went ahead to invest additional resources on the programme.

***Table 1:*** *Priority value chains*

| | **County** | **Prioritized Value Chain** | | | **County** | **Prioritized Value Chain** |
|---|---|---|---|---|---|---|
| 1 | Baringo | Meat Goat | | 25 | Marsabit | Meat Goat |
| | | Honey | | | | Camel Milk |
| | | Cow Milk | | | | Sukuma Wiki |
| 2 | Bomet | Cow Milk | | | | Indigenous Chicken |
| | | Maize | | 26 | Meru | Maize |
| | | Indigenous Chicken | | | | Cow Milk |
| | | Irish Potato | | | | Indigenous Chicken |
| 3 | Buugoma | Cow Milk | | 27 | Migori | Cow Milk |
| | | Indigenous Chicken | | | | Sweet Potato |
| | | Tomatoes | | | | Indigenous Chicken |
| 4 | Busia | Indigenous Chicken | | 28 | Mombasa | Fish |
| | | Fish | | | | Local Vegetables |
| | | Ground Nut | | | | Cow Milk |
| 5 | Elgeyo Marakwet | Cow Milk | | 29 | Muranga | Banana |
| | | Irish Potato | | | | French Beans and Snow Peas |
| | | Maize | | | | Cow Milk |
| 6 | Embu | Cow Milk | | 30 | Nairobi | Broilers |
| | | Banana | | | | Sukuma Wiki |
| | | Indigenous Chicken | | | | Cow Milk |
| 7 | Garissa | Tomatoes | | 31 | Nakuru | Pyrethrum |
| | | Camel Milk | | | | Fish |
| | | Beef | | | | Cow Milk |
| 8 | Homa Bay | Indigenous Chicken | | 32 | Nandi | Maize |
| | | Fish | | | | Indigenous Chicken |
| | | Sorghum | | | | Fish |
| 9 | Isiolo | Beef | | | | Maize |
| | | Camel Milk | | 33 | Narok | Beef |

***Table 1:*** *County Priority Value Chains cont'd.....*

| | County | Prioritized Value Chain | | | County | Prioritized Value Chain |
|---|---|---|---|---|---|---|
| | | Tomatoes | | | Cow Milk | |
| 10 | Kajiado | Cow Milk | | | | Maize |
| | | Tomatoes | | 34 | Nyabururu | Irish Potato |
| | | Beef | | | | Fish |
| 11 | Kakamega | Cow Milk | | | | Cow Milk |
| | | Maize | | 37 | Nyamira | Banana |
| | | Indigenous Chicken | | | | Local Yege tables |
| 12 | Kericho | Cow Milk | | | | Cow Milk |
| | | Tomatoes | | 36 | | Irish Potato |
| | | Indigenous Chicken | | | | Indigenous Chicken |
| 13 | Kiambu | Cow Milk | | | | Beef |
| | | Indigenous Chicken | | 37 | Samburu | Maize |
| | | Banana | | | | Honey |
| 14 | Kilifi | Cassava | | | | Indigenous Chicken |
| | | African Eye Bird Chilli | | 38 | Siaya | Mango |
| | | Indigenous Chicken | | | | Fish |
| 15 | Kirinyaga | Cow Milk | | | | Cow Milk |
| | | Banana | | 39 | Taita Taveta | Banana |
| | | Rice | | | | Indigenous Chicken |
| 16 | Kisii | Cow Milk | | | | Mango |
| | | Banana | | 40 | Tana River | Beef |
| | | Indigenous Chicken | | | | Fish |
| r | Kisumu | Indigenous Chicken | | | | Banana |
| | | Fish | | 41 | Tharaka Nithi | Cow Milk |
| | | Cotton | | | | Indigenous Chicken |
| is | Kitui | Indigenous Chicken | | | | Banana |
| | | Gadam Sorghum | | 42 | Tran-Nzoia | Maize |
| | | Green Gram | | | | Indigenous Chicken |
| 19 | Kwale | Indigenous Chicken | | | | Fish |
| | | African Eye Bird Chilli | | 43 | Turkana | Sorghum |
| | | Passion Fruit | | | | Meat Goat |
| :o | Laikipia | Maize | | | | Fish |
| | | Cow Milk | | 44 | Uasin Gishu | Passion Fruit |
| | | Sheep and Goats | | | | Indigenous Chicken |
| 21 | Lamu | Indigenous Chicken | | | | Cow Milk |
| | | Fish | | 4? | Vihiga | Indigenous Chicken |
| | | Cashew Nut | | | | Cow Milk |
| | Machakos | Cow Milk | | | | Banana |
| | | Indigenous Chicken | | 46 | Wajir | Watermelon |
| | | Mango | | | | Indigenous Chicken |
| 23 | Makueni | Indigenous Chicken | | | | Camel Milk |
| | | Mango | | 47 | West Pokot | Honey |

***Table 1:*** *County Priority Value Chains cont'd.....*

| | County | Prioritized Value Chain | | | County | Prioritized Value Chain |
|---|---|---|---|---|---|---|
| | | Green Gram | | | | Indigenous Chicken |
| 24 | Mandera | Tomatoes | | | | Meat Goat |
| | | Camel Milk | | | | |
| | | Meat Goat | | | | |

## 1.4 Rationale

The Kenya Vision 2030 aims at developing "an innovative, commercially-oriented and modern Agriculture". This Vision is embedded in the Agricultural Policy (2016) and in Agriculture Sector Transformation and Growth Strategy (ASTGS: 2019-2029). Two flagship areas of the ASTGS of relevance are those that aim at strengthening and launching priority digital and data use cases to drive decision making and performance management of the sector and establishment of systems for active monitoring of sustainable and climate-smart natural resource management of water basins, soil quality and land use. The preparation of priority value chain suitability maps was made in response to these policy directives. The maps will inform development actions of priority value chains in each leading to agricultural transformation and growth.

The ASDSPII outcome area one seeks to increase productivity of the priority value chains through enhanced application of climate smart agricultural interventions, practices and technologies. Suitability maps are important decision tools that shall be applied to demonstrate the feasible baseline productivity of geographical regions (county, ward, country etc.) and guide in generating adaptive actions to counter the excesses of climate change and unsuitable conditions. Identification and application of climate smart technologies to meet the production needs of value chain systems will facilitate commercialization.

Transformation and growth of the agricultural sector will only be achieved when the problems and challenges of rapid and unregulated urbanization is addressed. Unplanned urbanization leads to conversion of rich agricultural land to urban use; environmental degradation, unbalanced development of high potential areas at the expense of other areas, poor economic performance of agriculture and sub-optimal use of land and the rich natural resource endowment. The priority value chains suitability maps provide a framework for addressing challenges by providing strategies to address the challenges based on land capability classes.

The priority value chains suitability maps considered biophysical, economic, social and political attributes as they affect productivity and commercialisation of the value chains. This is a departure from the conventional agro ecological zoning procedures (**Error! Reference source not found.**) and the soil suitability mapping (Figure 6) processes.

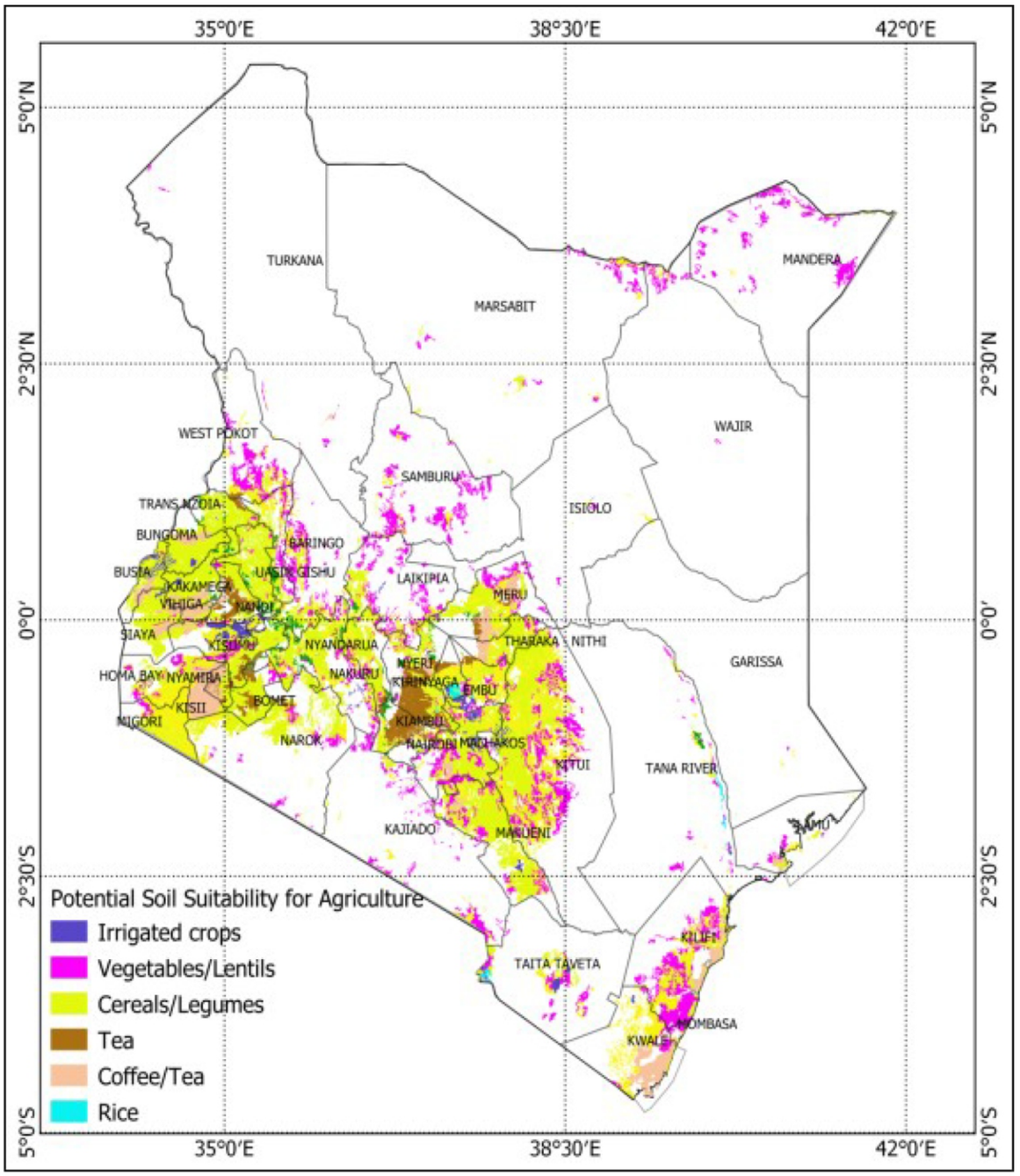



***Figure 5:*** *Soil suitability classification*

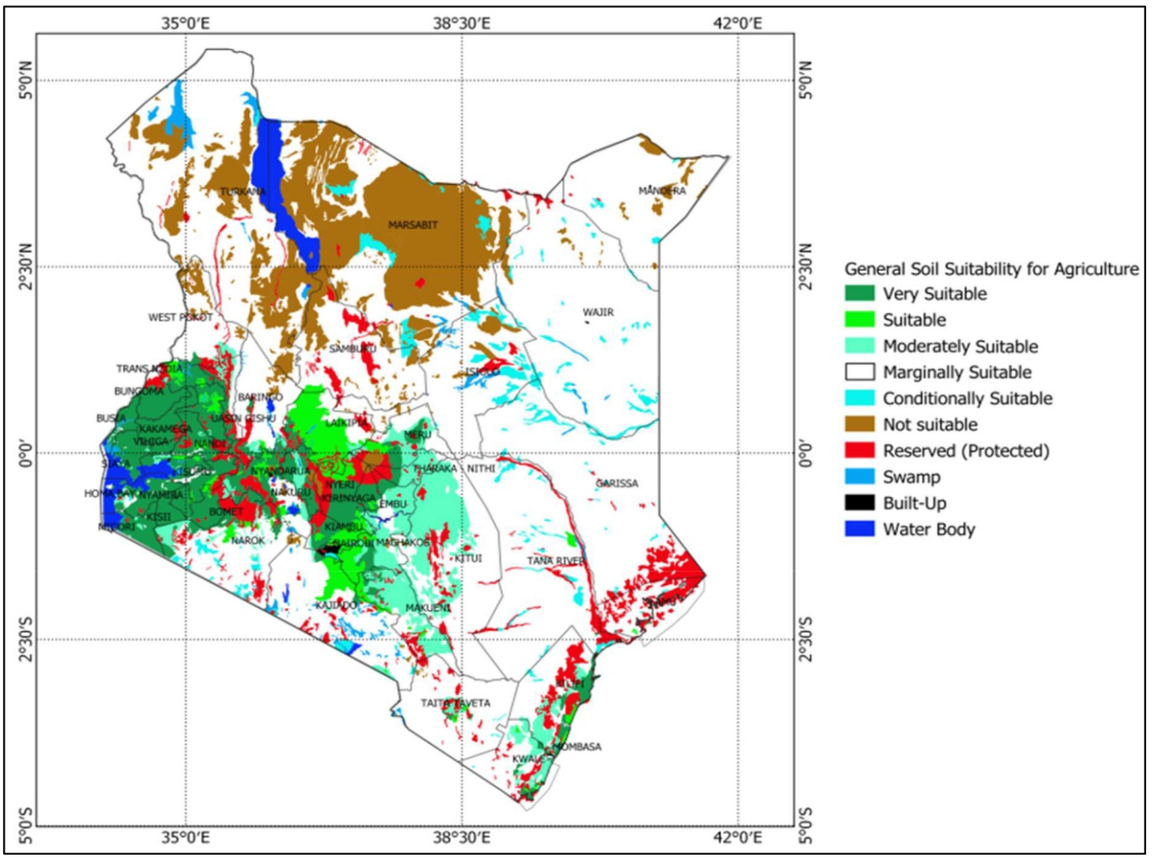



***Figure 6:*** *Soil suitability classification*

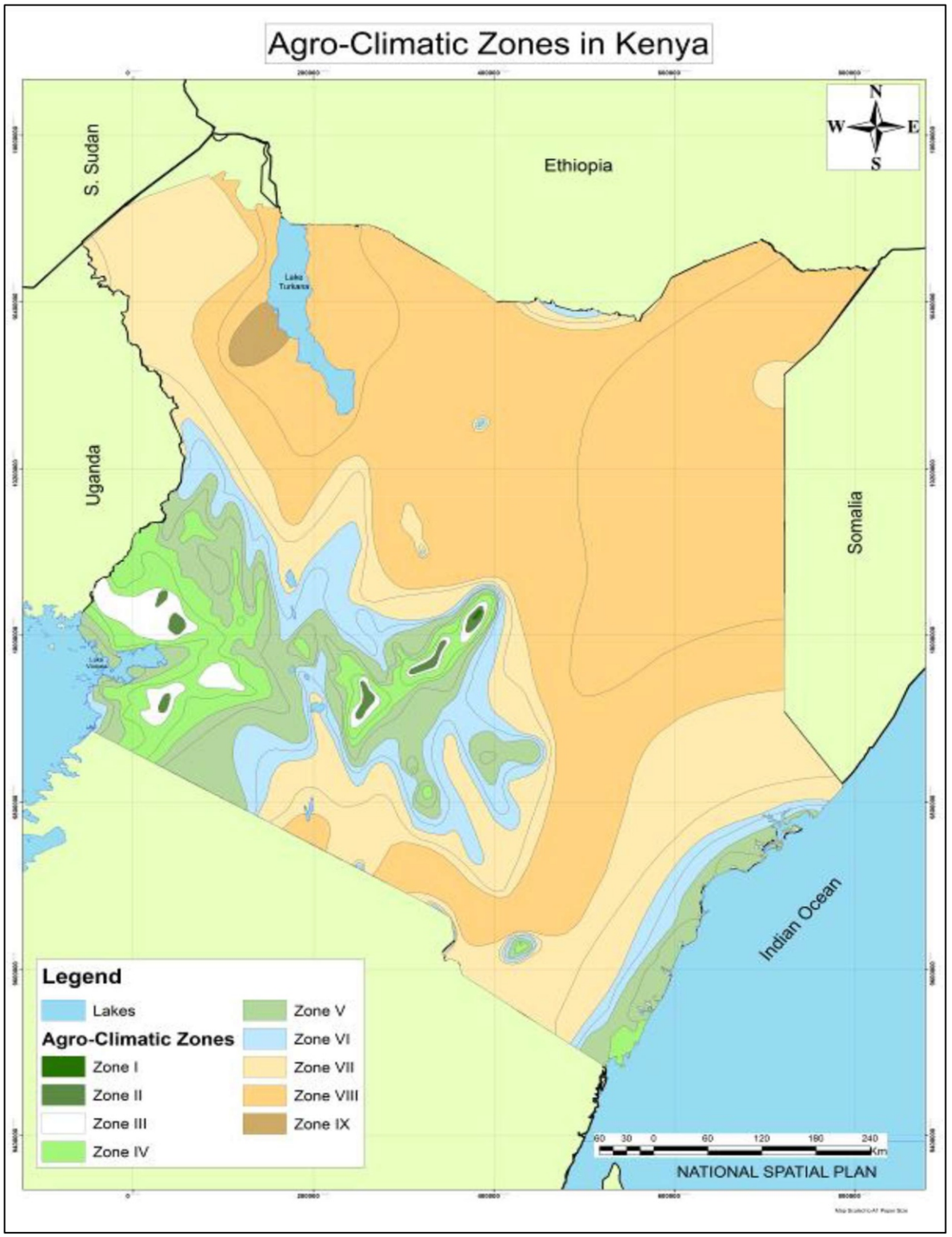



***Figure 7:*** *Agro ecological zones*

## 1.5 Objectives

The objectives of the priority value chain suitability atlas are:

i. To create a spatial planning context to strengthen priority value chain competitiveness;

ii. To optimize allocation and utilization of land, natural human and capital resources to increase value chain productivity;

iii. To secure the natural environment for high quality of life;

## 1.6 Principles

The principles that guided the preparation of priority value chains suitability maps are;

i. Transformation and commercialization of agricultural value chains. That the value chain development must be anchored on scales that are commercially viable and technically feasible with direct benefits accruing to VCAs in incomes and food security terms. The maps were prepared to address the needs to plan resource allocation to drive commercialization and transformation of agriculture

ii. Consultation and effective public and cross sectoral participation and engagement: All the maps were prepared in a participatory and consultative manner with relevant stakeholders and sectoral actors. The process involved experts from Survey of Kenya, county physical planners, Kenya Agricultural Research Organization, Kenya Marine and Fisheries Research Institute, State and County agricultural personnel, value chain actors, universities and the private sector.

iii. Value chain approach to agricultural and rural development. Development of the maps considered factors that affect production, trade and marketing to derive parameters that most represent the ease of commercializing a value chain represented as suitability classes.

iv. Knowledge driven and evidence based planning and development. The process was driven by application of scientifically proven processes and tools to capture, query, analyze data, synthesize information for presentation and use by stakeholders.

v. Climate smart agriculture and green growth: The maps present measures that promote sustainable use of natural resources, increase resilience to climate change effects with low carbon footprints.

# 2. METHODOLOGY

The suitability maps were generated through integration of a set of parameters that were derived through expert opinion and literature review. The criteria considered were grouped into four main categories namely; biophysical (land, water, climate), economic (population density, proximity to roads and markets and poverty index), social (agrarian orientation) and political (policies and supportive framework conditions). The parameters were processed as thematic maps and consolidated by overlaying to produce suitability classes of land use practices on a GIS environment using QGIS, ILWIS, SAGA and R Studio. This approach was a progression from the traditional land suitability and land evaluation mapping process.

## 2.1 Selection of evaluation criteria

The biophysical parameters were assessed on the basis of climatic (rainfall, temperature, humidity and temperature humidity index) and soil (soil pH, soil CEC, soil organic carbon, soil texture, soil drainage, soil depth, available soil water and soil fertility, topography, length of growing period, stoniness and proximity to water resources) criteria. The economic criteria were based on total population, population density, proximity to roads/rail, and proximity to marketing points. The proxy indices were applied as representations for establishing market demand and access. The agrarian culture of the people was a proxy for examining the potential growth and adoption of a value chain. These parameters were used to determine suitable areas for promoting any crop, livestock or fish value chain through a methodological process illustrated below.

An Analytical Hierarchical Process (AHP) as a Multi Criteria Evaluation was used to determine relative importance of each criterion and the resulting weights were used to construct the attribute maps/layers on the GIS platform. It was preferred because of its capacity to integrate a large quantity of the heterogeneous data. A further processing of the attribute maps was done overlaying them to generate suitability composite maps. The composite maps were then subjected to a validation process from where the explanatory notes were made and incorporated in this atlas

### 2.1.1 Data gathering and preparation

Soil data was obtained from Kenya Soil Survey (KSS) Land Information Cradle (online) and also from the ILRI GIS (online). Climate data was obtained from Kenya Meteorological Services (KMS – online services). The socio-economic data was obtained from Kenya National Bureau of Statistics (KNBS). The huge climate data from the KMS were interpolated to get the climate information of all the 47 Counties. Satellite image and Digital Elevation Model (DEM) were obtained from Regional Centre for Mapping of Resources for Development (RCMRD) at 30-meter spatial resolution and re-projected to WGS84 coordinate system. The slope information was obtained from Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model Version 2 (GDEM V2) and processed on ILWIS and SAGA to analyze the terrain.

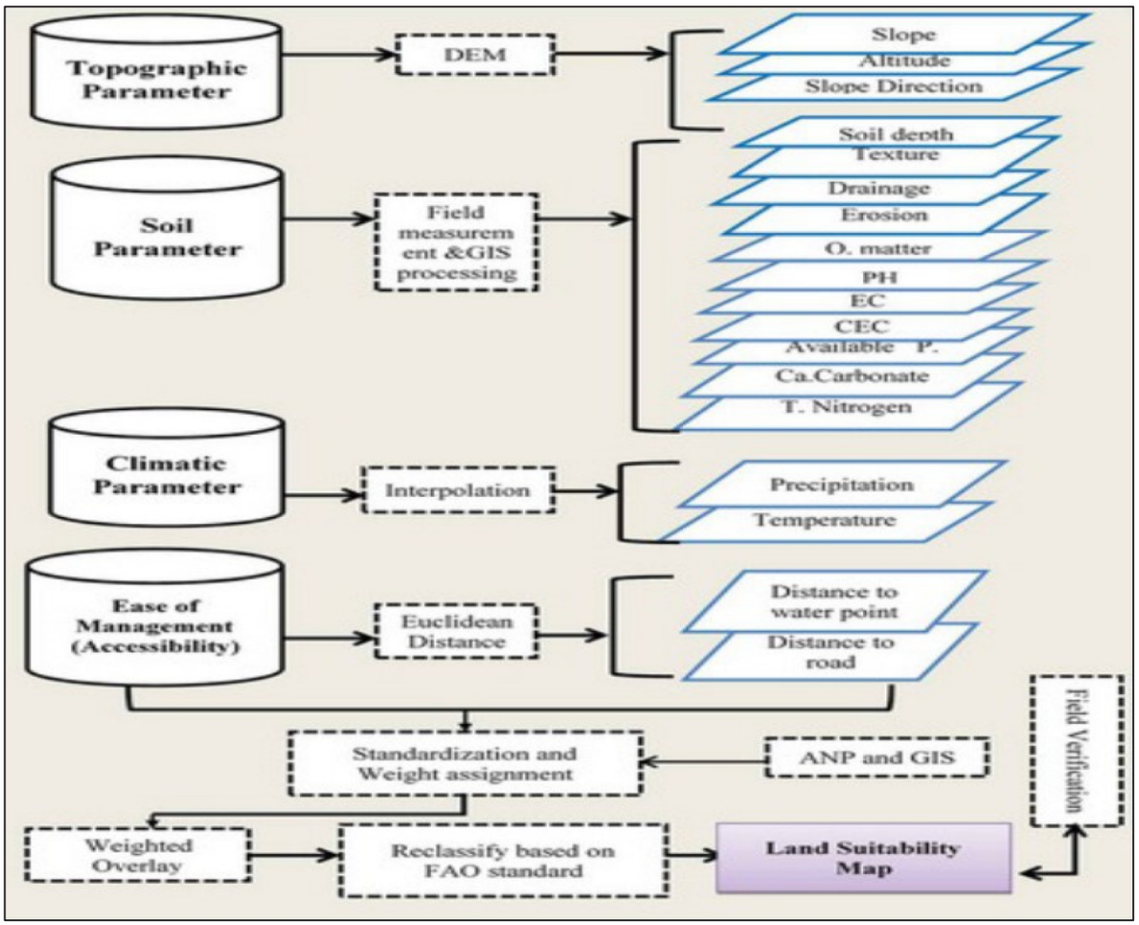



***Figure 8:*** *Suitability mapping process*

Thematic maps for the slope and the soil parameters were developed using QGIS 3.4.2 software. Annual rainfall and mean annual temperature thematic maps were generated using Inverse Distance Weighted (IDW) interpolation. IDW interpolation determines cell values using a linearly weighted combination of a set of sample points. All the maps were geo-referenced to WGS84 coordinate system. Suitability levels Highly Suitable S1, Moderately Suitable S2, Marginally Suitable S3and Not Suitable N were assigned score 1, 2, 3, and 4 respectively. Pairwise ranking and weighting was done to the sub-criteria and classes with higher scores subjected to suitability evaluation. The thematic maps were resampled and reclassified before being run on the SAGA and ILWIS for the final output.

### 2.1.2 Applying MCE and Assigning weight of factors

To determine relative importance/weight of criteria and sub criteria, AHP method of MCE was used. In order to compute the weights for the four (4) criteria (biological, physical, social and economic aspects) and the sub-criteria (Soil pH, Soil Texture, Soil Depth, Soil Drainage, Soil Fertility, Soil OC, Soil CEC, Stoniness, Soil AWC, Slope, Rainfall, Temperature, Relative Humidity, Length of Growing Period, Market Proximity, Road Proximity, Temperature- Humidity Index, and Agrarian Culture), a pairwise comparison matrix (PWCM) was constructed

using information obtained from Agricultural Sector Development Support Programme (ASDSP) experts gathered at the Morendat Training Centre, Naivasha in June/July 2019 during an ASDSP sponsored validation workshop. During this exercise, each factor was compared with the other factors, relative to its importance, on a scale from 1/9 to 9 according to Saaty rating scale (**Error! Reference source not found.**). During the pairwise ranking, inconsistencies were checked by ensuring that the corresponding consistency ratio (CR) was less than 10% according to Triantaphyllou et al, 1995. The CR was obtained by working with the Consistency Index (CI) and the Random Consistency Index (RCI).

***Table 2:*** *Saaty Rating Scale*

| Intensity if importance | Definition | Explanation |
|---|---|---|
| 1 | Equal importance | Two factors contribute equally to the objective. |
| 3 | Somewhat more important | Experience and judgement slightly favour one over the other. |
| 5 | Much more important | Experience and judgement strongly favour one over the other. |
| 7 | Very much more important | Experience and judgement very strongly favour one over the other. Its importance is demonstrated in practice. |
| 9 | Absolutely more important | The evidence favouring one over the other is of the highest possible validity. |
| 2,4,6,8 | Intermediate values | When compromise is needed |

***Table 3:*** *Sample of Pair wise comparison matrix for the soil sub-criteria (Biological Aspects)*

| | PH | Texture | Depth | Drainage | Fertility | OC | CEC | Stoniness |
|---|---|---|---|---|---|---|---|---|
| pH | 1 | 1/3 | 1/3 | 1/3 | 5 | 7 | 1/4 | 3 |
| Texture | 3 | 1 | 3 | 3 | 1/7 | 1/3 | 1/3 | 3 |
| Depth | 3 | 1 3 | 1 | 1/2 | 3 | 5 | 6 | 1/3 |
| Drainage | 3 | 1 /3 | 2 | 1 | 5 | 9 | 7 | 5 |
| Fertility | 1/5 | 7 | 1/3 | 1/5 | 1 | 1/3 | 1/3 | 5 |
| OC | 1/7 | 3 | 1/5 | 1/9 | 3 | 1 | 4 | 5 |
| CEC | 4 | 3 | 1/6 | 1/7 | 3 | 1/4 | 1 | 6 |
| Stoniness | 1/3 | 1/3 | 3 | 1/5 | 1/5 | 1/5 | 1/6 | 1 |

***Table 4:*** *Sample of Pair wise comparison matrix of Physical Aspects sub-criteria with respect to climate*

| | Temperature | Rainfall |
|---|---|---|
| Temperature | 1 | 1/3 |
| Rainfall | 3 | 1 |

***Table 5:*** *Sample Pair wise comparison matrix of soil, climate and topography criteria*

| Parameters | Soil | Climate | Topography (slope) |
|---|---|---|---|
| Soil (Biological) | 1 | 3 | 7 |
| Climate (Physical) | 1/3 | 1 | 5 |
| Topography (slope) | 1/7 | 1/5 | 1 |

***Table 6:*** *Sample Pair wise comparison between the economic aspects*

| Parameter | Road proximity | Market proximity | Total population |
|---|---|---|---|
| Road proximity | 1 | 4 | 5 |
| Market proximity | 1/4 | 1 | 6 |
| Total population | 1/5 | 1/6 | 1 |

***Table 7:*** *Pair wise comparison between the social aspects*

| | Population density | Agrarian culture |
|---|---|---|
| Population density | 1 | 3 |
| Agrarian culture | 1/3 | 1 |

***Table 8:*** *Pair wise comparison between the soil, climate, topography and socio-economic aspects*

| | Soil | Climate | Topography | Socioeconomics |
|---|---|---|---|---|
| Soil | 1 | 5 | 3 | 9 |
| Climate | 1/5 | 1 | 7 | 5 |
| Topography | 1/3 | 1/7 | 1 | 3 |
| Socioeconomics | 1/9 | 1/5 | 1/3 | 1 |

### 2.1.3 Overlaying map layers

The reclassified thematic maps/layers of each variable were weighted using the weights derived from the AHP process and the Boolean algebraic logic. The weighted maps/layers were combined by performing the weighted overlay using SAGA, Raster calculator and ILWIS to produce the final suitability map.

# 3 MAPPING COUNTY RESOURCES

## 3.1 County Background

Agriculture is the predominant economic activity in the county and contributes 17.4 per cent of the County 's population income. It is the leading sub sector in terms of employment, food security, income earnings and overall contribution to the socio-economic wellbeing of the people. Majority of the people in the County depend on agriculture for their livelihood, with 304,449 people directly or indirectly employed in the sector. Key among them are dairy farming, tea and coffee farming, horticulture farming, indigenous chicken rearing and banana farming.

Areas around Kinale forest (Lari, Gatundu north, Gatundu south, Limuru) have large tracts of tea farms interspersed with wood plantations with fast growing tree species for provision of firewood. In parts of Ruiru, Kiambu and Kiambaa, coffee is more predominant whereas areas of Ndeiya, Juja and Thika exhibit grassland vegetation characteristics. The main forests types in the county are natural/indigenous and plantation forests. The county has several forests which include Kinale, Kereita, Dagoretti, and Anmer forest occupying total area of 42,118ha. Against the county area of 254,473ha, this represents 16.55% of the total area. (Kenya Forest Service: 2015). The county has eight gazette forests with the major ones being Kieni and Kinale forests. The total acreage of Kiambu county gazette forest is 40,032.81 ha.

Kiambu County has few wildlife resources whose ecosystem constitutes of a dense forest with elephants, hyenas, bush baby, baboons, colobus monkeys, dik-dik, bush pigs, tree and ground squirrels, porcupines and many species of birds such as weaver, guinea fowls, sparrow among others.

The ASDSP programme in the County has been promoting dairy cow milk, bananas and indigenous chicken value chains that were prioritized by the stakeholders in 2013. A total of 270 value chain organizations (VCOs) were formed with a membership of 20,948 during the first phase of ASDSP. The discussions below provide an analysis of the value chain in relation to the suitability maps generated from different parameters or base conditions forming the scientific basis hence guiding in determining the area as being suitable or not suitable.
The County occupies an area of 2,543.5 $Km^2$ of which 1,878$km^2$ is arable while 649.7$km^2$ is non arable and 15.5$Km^2$ is under water mass. There are three categories of land; public land is approximately 5%, community land 0.01%, whereas private land is approximately 94.99 % (Kiambu CIDP,2018-2022). The average mean holding size of land is approximately 0.36 hectares on small scale and 69.5 hectares on large scale (Kiambu county development profile, 2013). The small land holdings are mostly found in upper parts of Gatundu North, Gatundu South, Kiambaa, Limuru and Kikuyu constituencies. Indeed, the registered land regime facilitated the fragmentation of land beyond what was economical hence majority of farmers are converting their farms into residential plots to supplement the meagre income from the farms. According to the KNHBS (2005/06), 85% of the population with land in the county have title deeds; the remaining 15% have not received their title deeds due to unfinished land adjudication process and non-payment of the necessary levies.

## 3.2 County Resources

### 3.2.1 Biophysical Parameters for Kiambu County

The biophysical parameters considered included temperature, rainfall, soil and slope. These parameters are described in the sections below.

### 3.2.1.1 Mean Annual Temperature

The mean temperature in the County is 26°C with temperatures ranging from 7°C in the upper highlands areas of Limuru, Lari and some parts of Gatundu North, Gatundu South, Githunguri and Kabete sub-counties to 34$^{0}$C in the lower midland zone found partly in Thika (Gatuanyaga), Kikuyu (Karai) and Limuru (Ndeiya). July and August are the months during which the lowest temperatures are experienced, whereas January, February and March are the hottest months. The county's average relative humidity ranges from 54 percent in the dry months and 300 per cent in the wet months of March up to August. The mean annual temperature is shown in figure 9 below.

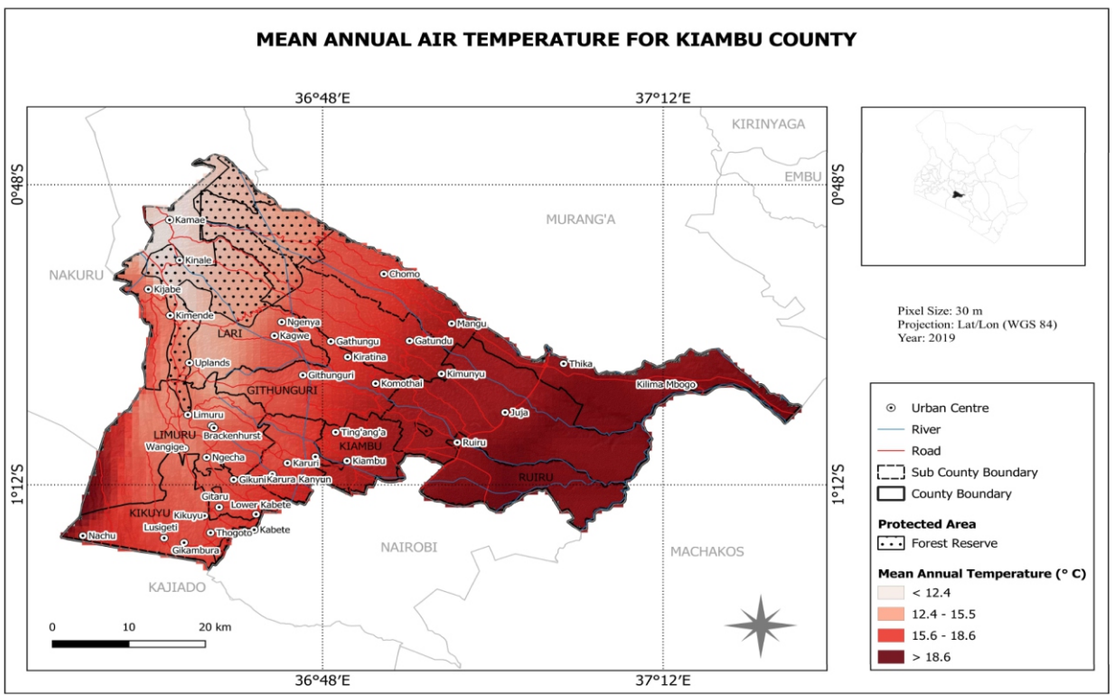



***Figure 9:*** *Mean annual temperature for Kiambu County*

### 3.2.2.1 Mean Annual Rainfall

The County experiences bi-modal type of rainfall. The long rains fall between mid-March to May followed by a cold season usually with drizzles and frost during June to August and the short rains between mid-October to November. The annual rainfall varies with altitude, with higher areas receiving as high as 2,000 mm and lower areas of Thika sub-county receiving as low as 600 mm. The average rainfall received by the county is 1,200 mm.

The county is characterized by equatorial climatic conditions with rainfall which is highly influenced by altitude. Rainfall patterns in the county and other neighboring counties are affected by the movement of the Inter-Tropical Convergence Zone (ITCZ). The Aberdare Ranges plays a major role in modifying the climate in the county. The rainfall availability is shown in figure 10 below.

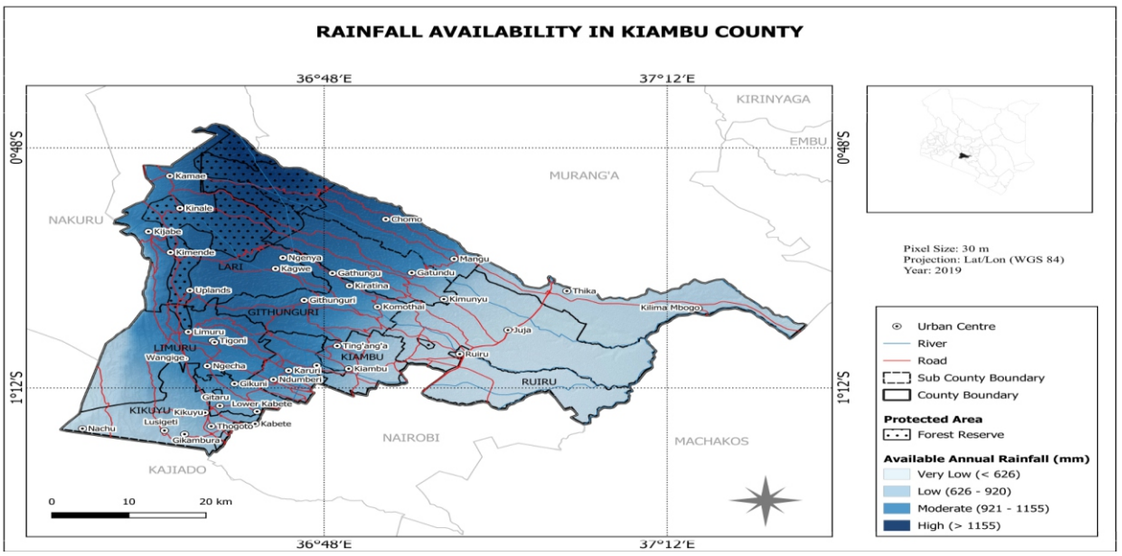



***Figure 10:*** *Rainfall availability in Kiambu County*

### Topography and Slope

Aberdare ranges and is dominated by highly dissected ranges and is very wet, steep and important as a water catchment area. The lower highland zone is mostly found in Limuru and some parts of Gatundu North, Gatundu South, Githunguri and Kabete constituencies and the area are characterized by hills, plateaus. The landscape comprises of volcanic middle level uplands. The lower midland zone partly covers Thika Town (Gatuanyaga), Limuru and Kikuyu constituencies. The Aberdare Ranges have to a great extent influence on the physiography of Kiambu County. The central landscape is dominated by undulating to rolling topography as well as high elevations (volcanic foothill ridges). Figure 11 below presents the slope of Kiambu County.

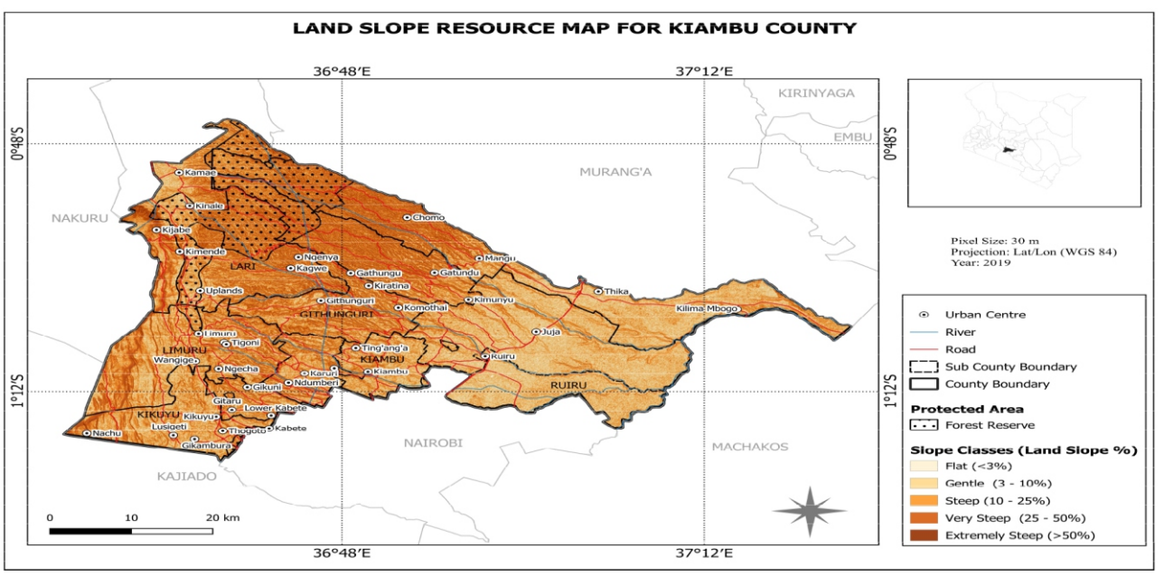



***Figure 11:*** *Land slope resource map for Kiambu County*

The soils of this area (units RB2 and RB3) are moderately to highly fertile. On the mountains, soils developed on olivine basalts and ashes of major older volcanoes are found. They may be shallow or leached and very acidic (PH 3.5 – 4.5). Soils of the hills are generally variably fertile and can only be found in the western part of the county. Fertile upland soils occur in the western part, others of moderate- to low-fertility in the very eastern part of Kiambu County especially in East of Ruiru, where the plateaus have soils of variable fertility. On the lower topographical sites soils which have developed on alluvium, are found. They are moderately to highly fertile. Dominant soil types in the county are humid (Andosols and Nitosols); which were developed from pyroclastic rocks during the tertiary period.

### Heat Stress Levels in Kiambu County

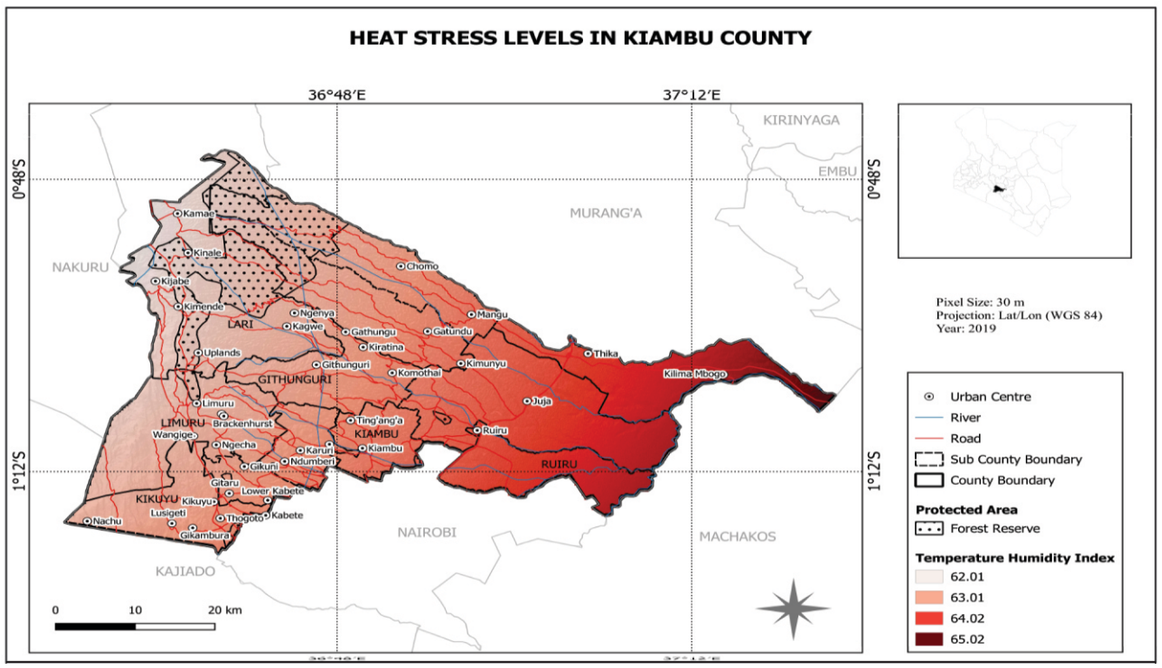



***Figure 12:*** *Heat stress levels in Kiambu County*

### 3.2.2 Agrarian (Social) Parameters

The most dominant community in the County is Gikuyu, their social and cultural practices are pre-dominant. Traditions and culture of land inheritance influences land resources use and management. The practice of land inheritance has led to continuous sub-division of land to uneconomical sizes. The extractive nature in their livelihood has led to environmental degradation. There is a general perception that nature's wealth is infinite. This has led to the Gikuyu people to engage in farming especially in dairy cow milk, indigenous chicken and banana production.

Social and cultural traditions in the society are also affecting politics, religion, education which in turn are influencing existing economics and environmental conditions in the county. The culture has both positive and negative influence on development. Positive influence on development is attested by their attachment to land

and work ethics. The Gikuyu till their land for domestic consumption and surplus crops traded to neighboring less productive areas and urban areas to create wealth.

The Gikuyu traditional governance through *ciama* allowed for consultations and participation in decision making. The *ciama* were responsible for setting up independent schools and inculcated social responsibility through informal education and religion. Learning and the acquisition of knowledge and skills for making implements were also emphasized.

### 3.2.3 Economics Parameters

#### 3.2.3.1 Roads

The county has a total road network of about 5333.19kms with a total road length of about 249.78kms being yet to be opened or established. The road network consists of bitumen, gravel surface and earth surface. The road network within the county is characterized by class "A" trunk road which covers 157.68kms, class "B" – 18.08kms, class "C" – 233.87kms, class "D" – 360.15kms and Class "E" – 740.02kms. Government roads cover 14.14kms, rural access roads – 141.27kms and tea roads - 69.59kms. Some of the major class A roads serving the county include Thika Superhighway (A2) which runs from Githurai, Ruiru, Juja up to Thika on an average of 50Kms and A104 road which runs from Uthiru, Kikuyu, Kamandura up to Kinungi on an average of 65kms.

About 25.1km of the A104 road which serves Kiambu County is under rehabilitation and expansion program. Generally, about 53.34% of the total road network within the county is in poor condition while about 32.31% of the total road network is in fair conditions. Only about 10.09% of the total road network is in good conditions and only about 0.16% of the total road coverage is in excellent conditions. Figure 13 below presents the road network in Kiambu County.

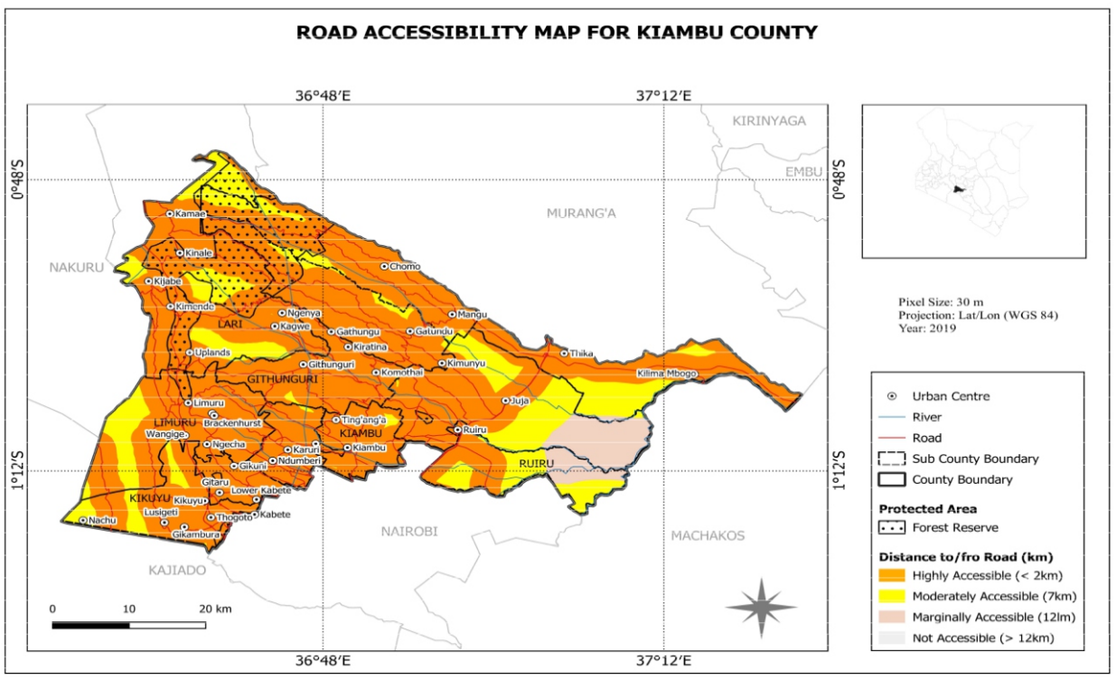



***Figure 13:*** *Road accessibility map for Kiambu County*

### 3.2.3.2 Markets

The 37 market centers in Kiambu were designated to serve a rural population of approximately 15,000 people in the surrounding hinterland which could support a primary school and a junior secondary school as well as a medical facility primarily offering family planning services. These centers were designed for the development of public water supply, sub-post office, telephone facilities, police post and a local bus service (with an airstrip in remote areas) and other social, commercial, and local administrative services. Market centers were served by at least one minor road and had a residential population of not less than 2,000.

However, areas such as Ruaka, Dagoretti and Kinoo have outgrown the designated given with increased and rapid population growth without the requisite infrastructure provision. The figure 14 below presents the market accessibility at Kiambu County.

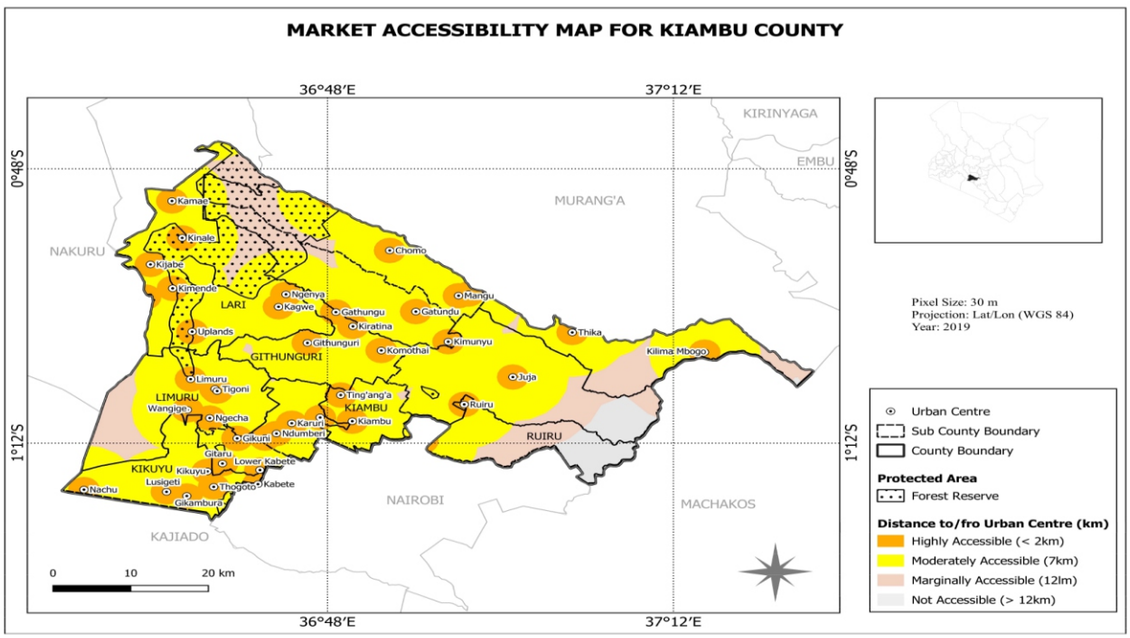



***Figure 14:*** *Market accessibility map for Kiambu County*

### 3.2.3.3 Population

According to 2009 Population and Housing census, Kabete sub-county had the highest population density which stood at 2,534 persons/Km$^2$ followed by Kiambaa which had 2,153 persons/Km$^2$. This is due to their proximity to the city of Nairobi. It is projected that in 2028 this density will grow to as high as 5,278persons/Km$^2$ and 4485 persons/Km$^2$ in Kabete and Kiambaa respectively. The least densely populated sub-county is Lari with 307 persons/Km$^2$, mainly because a considerable part of the sub-county is covered by forests. High population density exerts pressure on the available land leading to subdivision of land into uneconomical units. Ruiru sub-county had the highest population with a total of 219,752 people while Gatundu North sub-county had the lowest population of 109,460 people.

Kiambu County is endowed with resources, there is wealth distribution which has been coupled with the high number of commercial enterprises and farming such as tea and with high returns due to the close proximity to Nairobi City with ready market and good infrastructure as well as demand with the high population within the metropolis.

### 3.2.4 Political Parameters

The Third Medium Term Plan MTP III which builds on the First and Second MTM outlines the Legal, Policy and Institutional reforms with key projects and programmes to be implemented within the period of 2018-2022. The main priority of the MTP III is the Big Four Agenda focuses on enhancing food security. Foundations and enablers for transformation within the County intends to:

- Promote Food Security through preservation and promotion of agricultural potential areas such as Githunguri, Lari, Limuru, Gatundu North and Gatundu South Sub-Counties
- Coordination and Collaboration with the National Government in improvement of access roads and providing missing links
- Development and improvement of the existing markets across the county
- Improve the transport network

The County has formulated physical planning regulations to enhance the control of land subdivision and conversation especially in agricultural zones. The Integrated development Plans for Urban areas also provide areas for agriculture.

There is distribution of milk coolers to dairy cooperative societies, farm input subsidies, free AI services to dairy VC actors especially the producers. All this has been successful because of the political goodwill from the Kiambu County Government. The administrative boundaries for Kiambu County are shown in figure below.

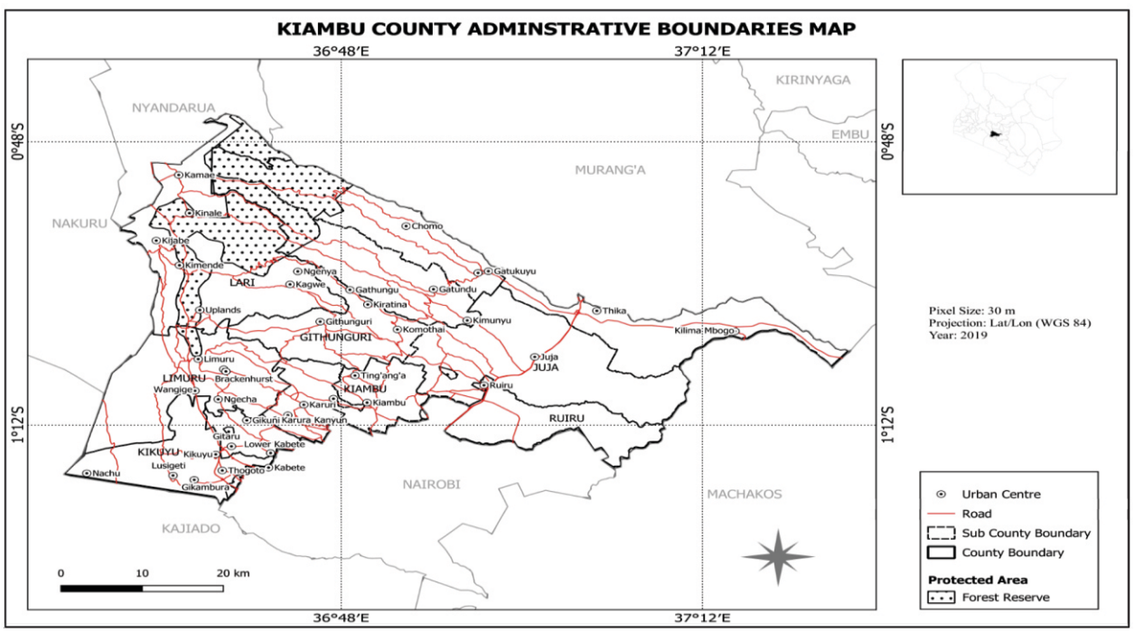



***Figure 15:*** *The administrative boundaries for Kiambu County*

# 4. PRIORITY VALUE CHAIN SUITABILITY MAPS

## 4.1 Dairy Cow Milk Value Chain

### 4.1.1 Background

Dairy products are high quality food and are important source of income for many farmers in the county. Therefore, sustaining livestock production in changing climate is one of the priorities in the agriculture sector. Dairy industry is the leading enterprise with nearly 70% of the farm families keeping an average of 2-3 cows under zero grazing systems. Milk is the major livestock product in Kiambu County and currently leading in Kenya. In order to facilitate milk value addition, eleven bulk milk coolers with a cumulative capacity of 39,000 litres have been procured and issued to dairy societies including Muguga, Kiriita, Mangu, Karatu, Gatamaiyu, Ndumberi, Bibirioni, Githiga and Ngewa. Two pasteurizers of 5000 litres per hour capacity were installed in Muguga dairy and Kiambaa dairy society.

### 4.1.2 Biophysical parameter analysis for dairy milk cow value chain

The Kiambu County has zones which are classified as highly suitable, moderately suitable and marginally suitable. The suitability of these zones is determined by bio physical factors such as rainfall, temperature, relative humidity heat stress amongst others. These factors affect the type of breeds and the pastures in the specific areas and hence they affect the productivity of this value chain. For instance, in upper highlands, most of the producers keep fresian due to the favorable climate and high yields favored by conducive temperature and rainfall. These areas include Gatundu, Limuru, Lari and some parts of Githunguri.

### 4.1.3 Economic parameters

In the entire County it's economically suitable for in dairy value chain because of favorable proximity to markets, good road networks. Growing populations and reduced access to arable land mean that animal production systems will either need to intensify and/ or produce more from a reducing land and other resource base.

### 4.1.4 Political Parameters

There is a political good from both national and county governments on the dairy milk value chain. There is need to have land use policies in place which control unregulated massive land use subdivision and conversion in areas which are suitable for farming. In addition, promote cooperative societies movements to increase their bargaining power to avoid exploitation by middlemen. Table 9 below presents the parameter analysis for dairy milk value chain.

***Table 9:*** *Parameters analysis for dairy cow milk value chain*

| | **Highly Suitable** | **Moderately Suitable** | **Marginally Suitable** | **Not Suitable** |
|---|---|---|---|---|
| **Nutrient Availability (%N in Fodder)** | >1 | 0.8 - 1 | 0.5-0.7 | >0.7 |
| **Drinking Water Availability (Distance to water in Km)** | <2 | 2 - 5 | 6 - 9 | >9 |
| **Biological Hazards (Tsetse fly infestation risk)** | None | Slightly to moderate | Moderate to severe | Severe |

*Table 9: Parameters analysis for dairy cow milk value chain*

| | Highly Suitable | Moderately Suitable | Marginally Suitable | Not Suitable |
|---|---|---|---|---|
| **THI (Heat Stress Levels %)** | <65 | 65-72 | 72-80 | >80 |
| **Potential for Mechanization (Slope %)** | 10 | 20 | 30 | Any |
| **Slope Ratings for Cattle, Goats, Camels accessibility (Slope %)** | Cattle (0-16) | Cattle (16-30) | Cattle (30 - 40) | |
| **Root Ratings for Forage Growth (Soil Depth in cm)** | >100 | 50 - 100 | 25-50 | <25 |
| **Rainfall regime (mm)** | >1500 | 1100-1500 | 900-1100 | <900 |
| **Agrarian culture** | >4.2 | 3.5-4.2 | 1.5-3.5 | <1.5 |
| **Market Index** | >7.5 | 3-7.5 | 1.5-3 | <1.5 |

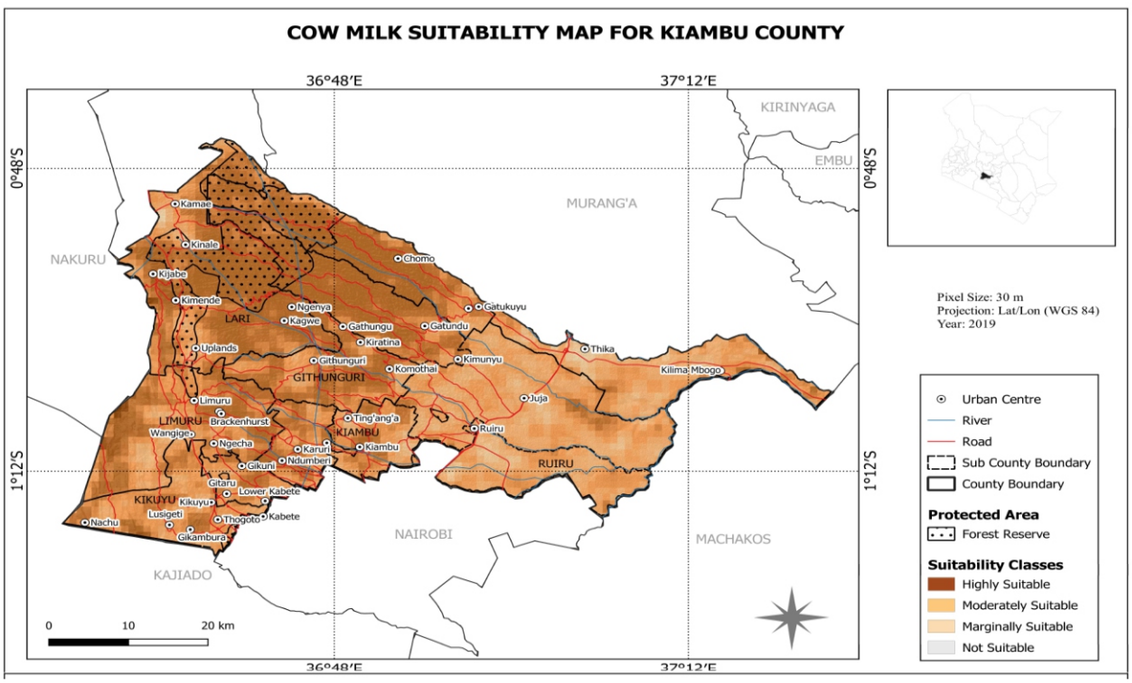



*Figure 17: Cow milk suitability map for Kiambu County*

### 4.1.3.1 Heat management adaptation measures

There is need to provide shade/housing to ensure there is adequate shade and water to reduce heat stress. Figure 18 below presents the heat stress management strategies in Kiambu County for improved productivity of the dairy cow milk value chain.

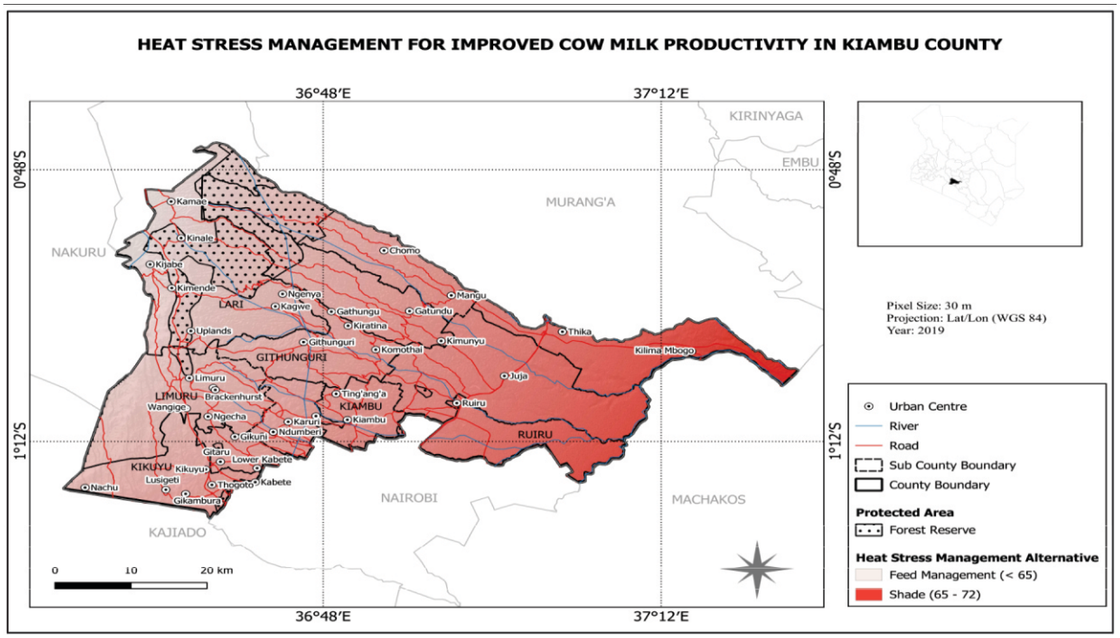



***Figure 18:*** *Heat stress management for improved dairy cow milk productivity Kiambu County*

### 4.1.3.2 Soil and water management strategies

The soil and water management needed to enhance soil and water management include: Water harvesting both off and on farm. It's important to maintain the suitable breeds like friesian in the highly suitable areas. Water harvesting both off and on farm should be encouraged. There is need to practice contour and terracing in steep areas soil and water management technologies to be put in place to control erosion and leaching. The figure below presents the water management strategies for dairy cow milk value chain.

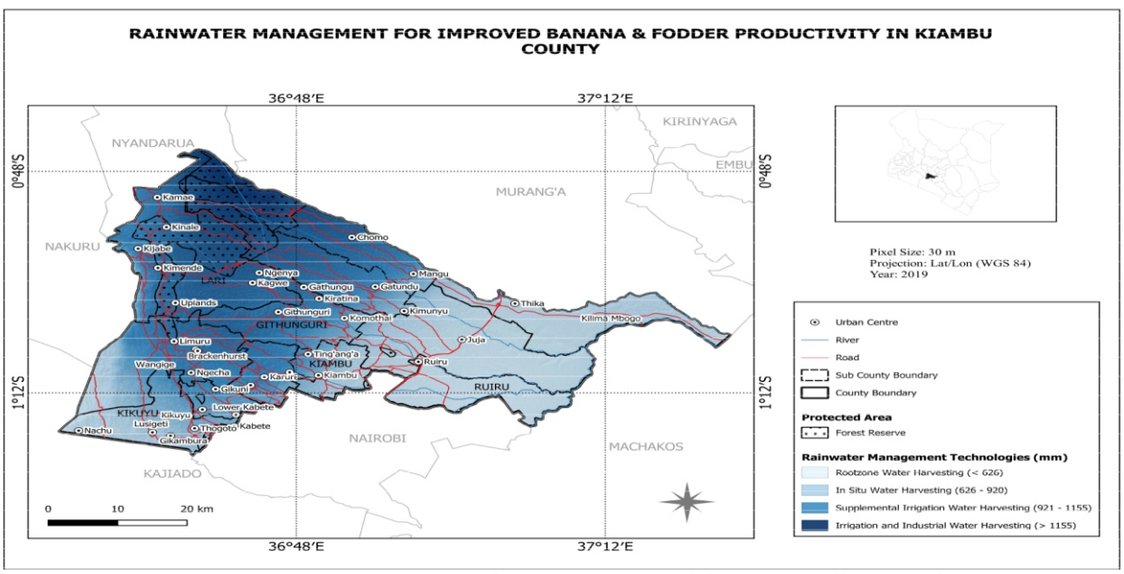



***Figure 19:*** *Rainwater management strategies for improvement of dairy cow milk in Kiambu County*

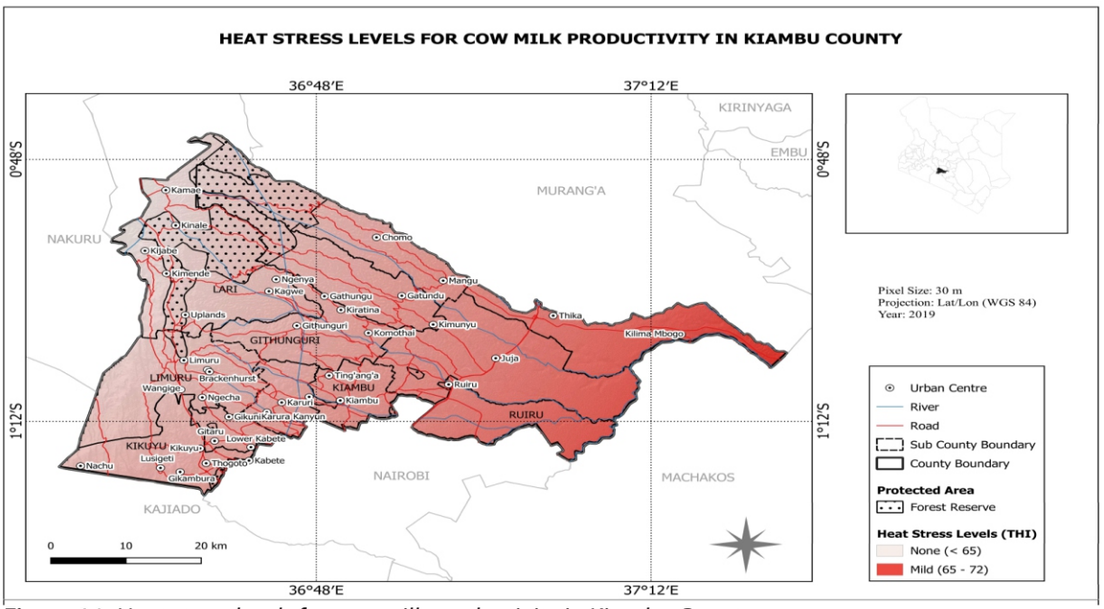



***Figure 20:*** *Heat stress levels for cow milk productivity in Kiambu County*

### 4.1.5 Adaptation measures

In very temperate zones like in Kereita forest and high temperatures in Nachu and Karai areas bordering Maai mahiu are marginally suitable because the dairy cows are more susceptible to heat stress. Some intervention measures should be emphasized to enhance the value chain including keeping appropriate breeds with genetic adaptation where VCAs select the genotypes suited to their bio physical characteristics, water harvesting for fodder production, proper housing and conserving the feeds during the times of plenty(Silage and hay making).

There is need to maintain the right breeds and the feeding systems i.e. matching the right number of livestock to the available resources. It's important to understand the impact of environment and nutrition stress on animal performance and develop breeds suited to specific areas. There is need to rear the breeds suited in these zones e.g. Sahiwal, feed conservation during periods of plenty, RW harvesting on and off farm, planting of agroforestry trees.

For example, develop drought and heat tolerant pastures/fodder, developing a heat tolerant breed is of little value if there is insufficient feed and water to allow the genetic expression of the desired traits.

### 4.1.6 Adaptation technologies and innovations

In the midlands in some parts of Kabete, Limuru and Kiambaa, dairy enterprise is moderately suitable as it is favored by the above biophysical factors. Lower areas of Juja, Ruiru and Thika are also suitable but require some interventions needs to be put in place to promote the suitability hence they are currently marginally suitable. The strategies to be adopted includes involving climate smart technologies to moderate the effects of heat stress and feed production. There is need to introduce shade through roof technologies and agroforestry trees to lower the heat stress and for feeds. Promote value addition, provide cold storage facilities in marginally and conditionally accessible areas.

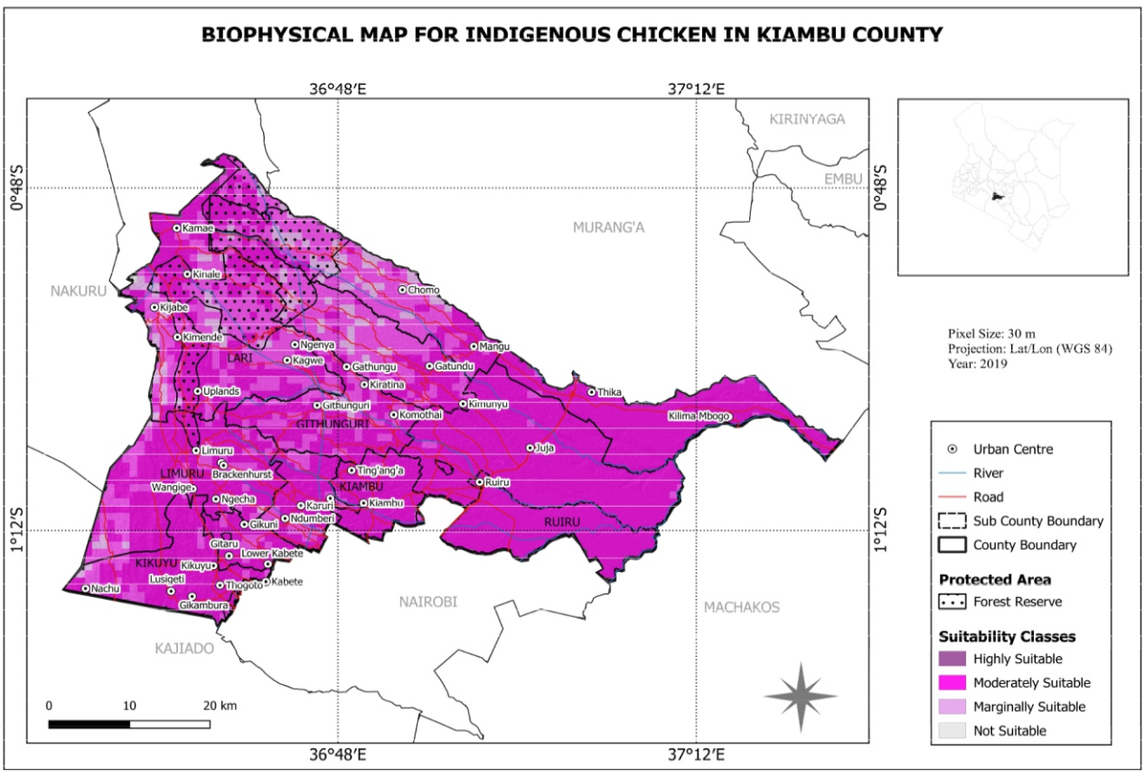
## 4.2 Indigenous Chicken Value Chain

Poultry farming is a very important sub sector of agriculture in the county because it helps in solving the problem of food and nutritional security, provides employment opportunities directly or indirectly to the people involved. The poultry industry in the county has been experiencing a steep decline in output which is attributed to the soaring cost of production driving some farmers out of business. The principle barriers to promoting productivity in poultry farming is due to lack of knowledge towards the factors affecting production as observed by many researchers. The demand for poultry products is increasing whereas supply cannot sustain the growing demand.

### 4.2.1 Biophysical Parameter analysis for indigenous chicken value chain

The ideal temperature for chicken production should not exceed 26.7°C. The recommended range is between 18-24°C. Temperatures between 30-35°C are marginally suitable for indigenous chicken production and thus there is need to modify the temperature with adaptation measures and technologies such as housing improvement and agro-forestry.

The recommended Relative Humidity ranges between 50-80% for poultry. Relative humidity below 70% is highly suitable for indigenous chicken production and therefore is moderately suitable for indigenous chicken production. Between 75-80%, these areas are deemed to be marginally suitable for indigenous chicken value chain. To make these areas suitable, technological measures needs to be put in to promote the suitability.



### 4.2.2 Economic parameters

The demand for the poultry source food has been growing exponentially particularly due to the high rate of urbanization, income and population growth. Despite the growing demand for poultry products, the poultry farmers face numerous challenges due to rising costs of farm inputs, pest and diseases, competition for poultry inputs with other industries, lack of high productive breeds with high maturity and resistant to pests and diseases. The inability of the poultry farmers to control disease related to poultry is as a result of the increasing costs of vaccines and management fees of veterinary doctors. Lack of market information and stiff competition within the industry makes the indigenous chicken more vulnerable. Farmers in the county lack organized market channels and therefore no bargaining power. The gap between the producers and consumers is usually filled by the middlemen who exploit farmers.

### 4.2.3 Suitability maps

The indigenous chicken production is moderately suitable in the county within Kiambaa, kikuyu, Kabete, parts of Limuru, parts of Thika, Ruiru, parts of Juja and Githunguri Sub-counties. This is attributed to favorable parameters such as relative humidity and temperature. Population density, good road network enhancing accessibility and availability of market thus promoting its suitability. The other areas such as parts of Gatundu North and South, parts of Thika are marginally suitable because of the unfavorable parameters such as high and low temperatures which affect the productivity. Population density is affecting the urban areas due to limited space for indigenous chicken production. To make the unfavorable areas suitable, various technologies and adaptation measures should be put in place especially on feed, housing and the breeds. Table 10 below presents the suitability analysis of indigenous value chicken.

***Table 10:*** *Suitability analysis of indigenous value chicken*

| | **Highly Suitable (SI)** | **Moderately Suitable (S2)** | **Marginally Suitable (S3)** | **Not Suitable (N)** |
|---|---|---|---|---|
| Average Temp | <25°C | 25-27°C | 27-30°C | >30°C |
| Average Humidity | <70% | 70-75% | 75-80% | >80% |
| THI (%) | <65 | 65-68 | 68-72 | >72 |
| Land slope °C/% | <1 (0.3%) | 1-9 (0.3-3%) | 9-25 (3-7%) | 25 (>7%) |
| Agrarian culture | >4.2 | 3.5-4.2 | 1.5-3.5 | <1.5 |
| Market Index | >8 | 3-7.5 | 1.5-3 | <1.5 |

The figure below presents the indigenous chicken suitability at Kiambu County.

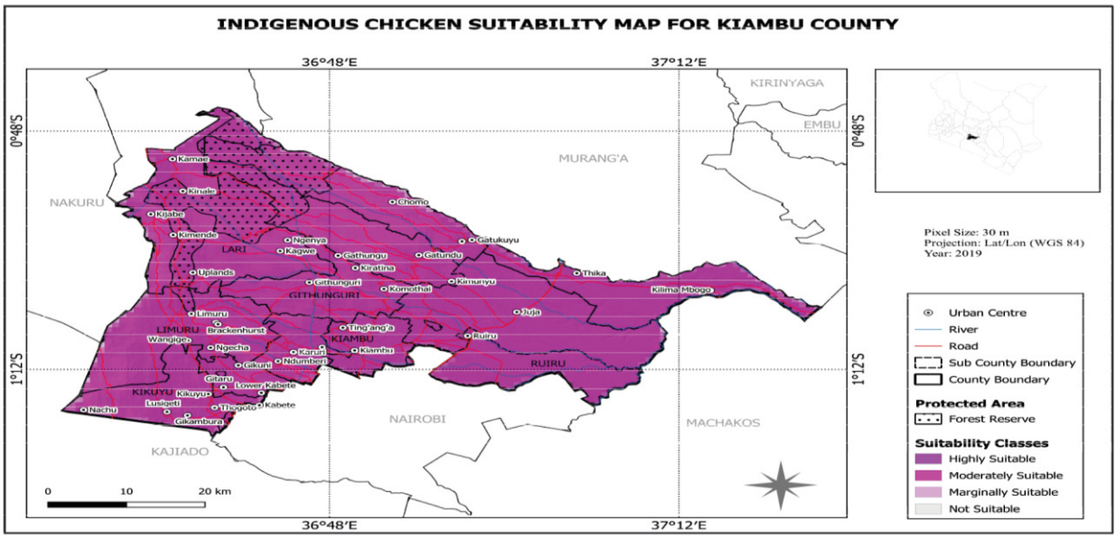



***Figure 21:*** *Indigenous Chicken suitability map for Kiambu County*

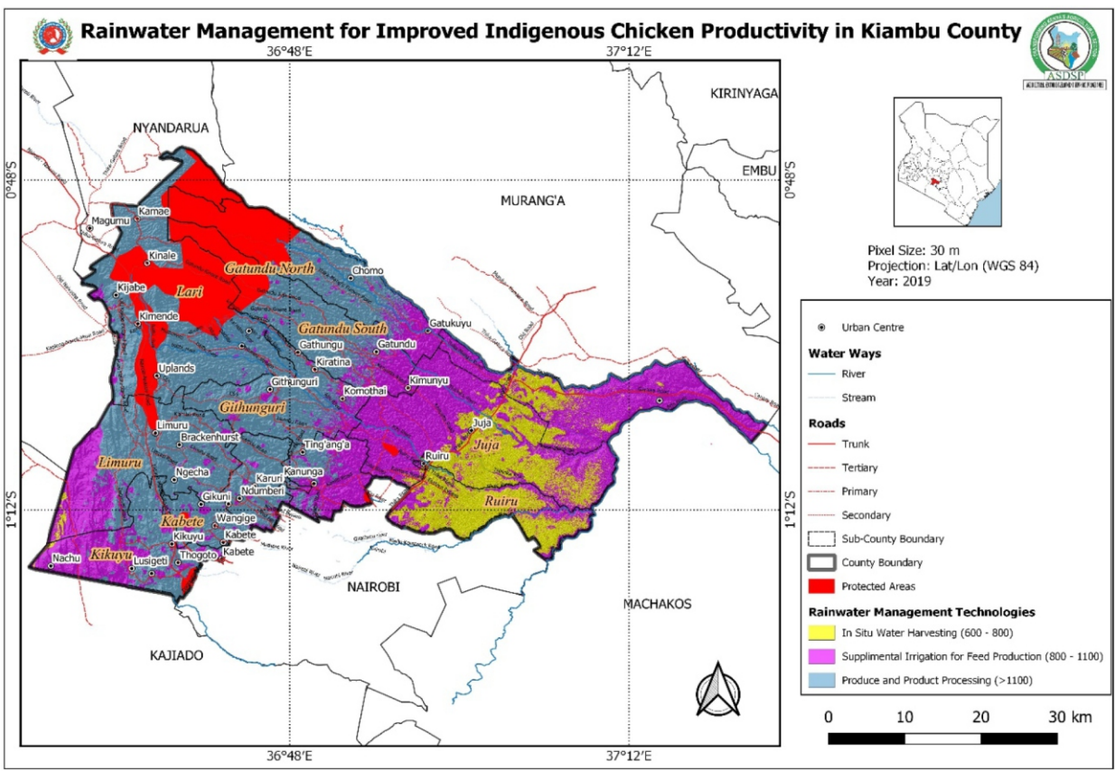



***Figure 22:*** *Rainwater management for improved productivity of indigenous chicken Kiambu County*

***Figure 23:*** *Adaptation measures*

Farmers could adopt the dual-purpose breeds that provide high meat and egg production. Poultry flocks are particularly vulnerable to climate change because birds can tolerate narrow temperature changes. Poultry farmers need to consider making adaptation to help reduce cost and promote productivity. Housing systems need to be managed to maintain optimal seasonal temperature and reduce the risk of heat stress; housing will also ensure reduction of the impact of high temperature and relative humidity. For increased investment ventilation and cooling to be installed to effectively control the heat stress. There is need to increase the scale of production to raise the average cost per unit. Promote the improvement of breeding stock for high productivity characterized by maturing breeds. There is need to improve feeding through promotion of homemade feed formulations. There is need to improve the pest and disease management by use of disease tolerant breeds. Promoting and use of appropriate breeding technologies such as the incubators should be encouraged in production. It is recommended that farmers use the required unit and size of the flock for better production. The water management for the indigenous value chain are presented in the plate below.

### 4.1.4 Adaptation technologies and innovations

Improved poultry management can be enhanced by technology characterized by adoption of genetic improvement for increased productivity. The farmers can have improved breeds from KALRO with indigenous chicken. The brooding technologies can also enhance production levels if farmers are facilitated to get such modern technologies. Use of superior crossbreed with different IC ecotypes from various selected Kenyan localities such as KARLO with the indigenous chicken. There is need to improve the inadequate technological knowledge to improve the productivity.

## 4.3 Banana Value Chain

Bananas are major staple food as well as each crop for majority of small-scale farmers. Bananas are consumed either as ripe state or cooked using different methods. Banana is considered as a food security crop. TC techniques has been promoted in the county to produce large quantities of disease-free banana planting material. The major cultivars grown in are grand nain and Williams among others. Banana is a tropical crop and thrives from 0 -1800m above sea level. Banana annual yield depends on climatic conditions, plant management and plant variety.

### 4.3.1 Biophysical Parameter analysis for banana value chain in Kiambu County

Banana is a fruit for tropical and sub-tropical regions. For adequate growth, bananas require warm and humid climate where temperature range from 20-30°C. Growth reaches an optimum at 27°C then declines and come to stop at 38°C.

Annual rainfall ranging from 1000-2500mm is ideal for the growth. Banana can be grown in all types of soils provided they are deep, well drained and are fertile especially with potassium nutrient which enhances the ripening. The soil PH range of 4.5-7.5 is favourable for banana production. A slope of below 3% to 5% is suitable for banana production. Most parts of Kiambu are moderately to highly suitable for banana production. The main varieties grown in the county include short varieties (dwarf Cavendish, giant Cavendish); medium variety (Valery, Williams) and tall varieties like the grand nain amongst others.

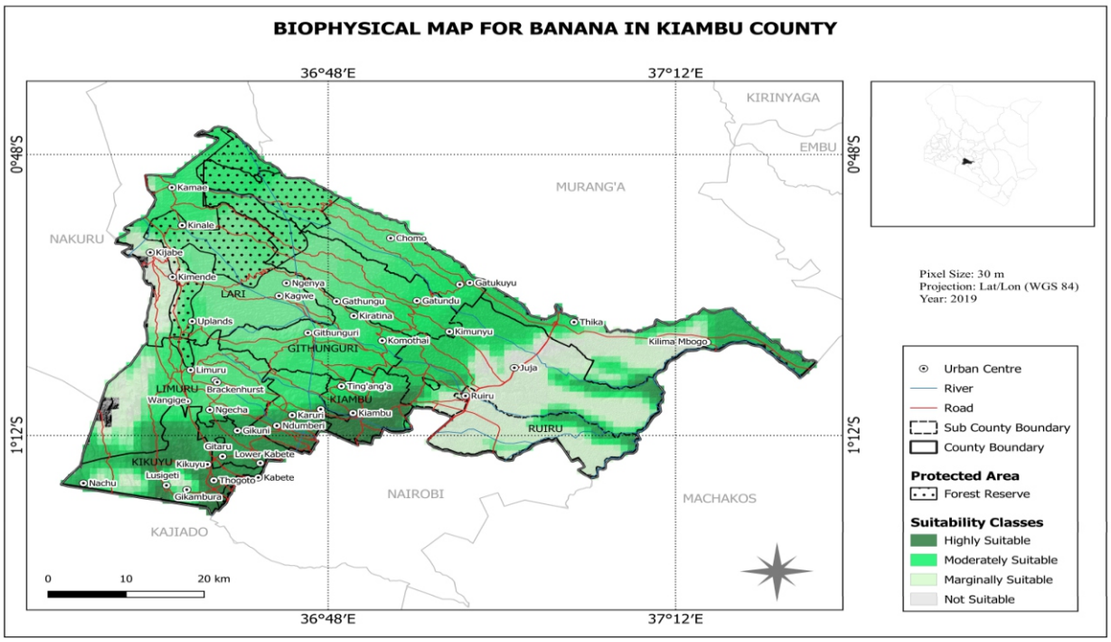



***Figure 24:*** *Biophysical map for banana value chain in Kiambu County*

The required altitude for Banana production is 1800m ASL. The County Slope ranges between <1 (0.3%) - >80%. Bananas do well in a slope with a range of <1 (0.3%) which is highly suitable, 1-9 (0.3-3%) which is moderately suitable, 9-25 (3-7%) marginally suitable and a range of 25 (>7%) is not suitable. The slope contributes to soil erosion in steep areas such as parts of Gatundu North, Gatundu South and Lari Sub-Counties and therefore soil conservation structures should be incorporated such as terracing and contour farming.

### 4.3.2 Economic parameters in promotion of Banana Value chain

From the above bio physical characteristics, the county is moderately suitable for banana production. This is further reinforced by the proximity to market due to the capable population within the county and the neighbouring Nairobi City County. All these makes the market for both cooking and ripe bananas available. The major road networks are accessible and thus making linkages easier between the various value chain actors.

Population density in the county is higher and therefore causing a lot of pressure to the arable land. This together with the upcoming profitable real estate business have made some parts of the county not suitable for banana production. This is despite having conducive bio physical, economic, social and political factors.

### 4.3.3 Suitability maps

The Banana value chain is moderately suitable in the county. It is highly suitable within Kiambaa, Githunguri and parts of Gatundu North and South Sub-counties. This is attributed to favorable parameters such as rainfall distribution, temperature and well drained soils. Population density, good road network enhancing accessibility and availability of market thus promoting its suitability.

The other areas such as parts of Nachu, Karai, Kinale, Kamae and Kijabe are marginally suitable because of the unfavorable parameters such as high and low temperatures which affect the productivity. To make the unfavorable areas suitable, various technologies and adaptation measures should be put in place especially soil and water management, water harvesting and suitable varieties. The suitability for the banana value chain is shown below.

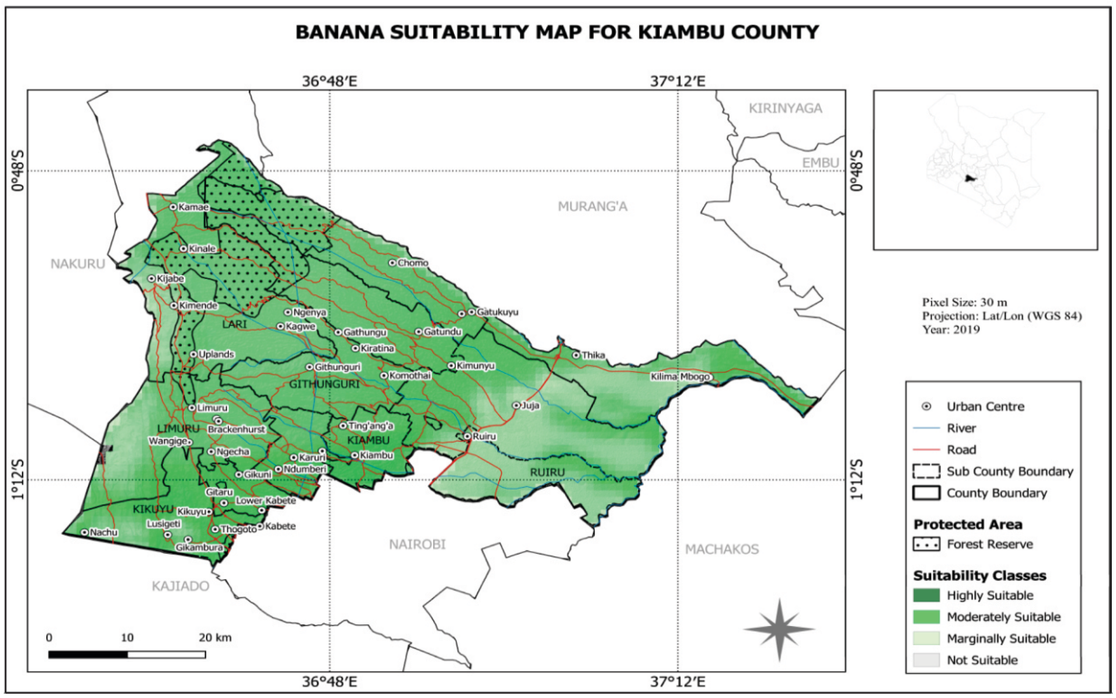



***Figure 25:*** *Banana value chain suitability map for Kiambu County*

***Figure 26:*** *The banana value chain suitability map in Kiambu County*

### 4.3.4 Adaptation measures

There are areas with extreme temperatures like Nachu and Karai in Ndeiya where banana growing is marginally suitable. These areas also receive scanty rainfall both in distribution and amount. The soils are also varied. Market, roads and support from the county government is available but for these areas to commercialize from banana VC, adaptation measures are required to be put in place. Cost implications measures to make these areas suitable should be considered. In addition, the actors should promote agroforestry to create a microclimate to lower evapotranspiration. The other areas with very low temperatures like in Kimende and areas around the forests are conditionally suitable for banana production. To make them suitable, the actors must consider the adaptations versus the cost implications. There is need to use the correct spacing for the crop population and canopy maintenance. In addition, mulching should be applied to reduce the evaporation and recycling of nutrients. There is need to promote agroforestry along the perimeters for wind and temperature controls. Promotion and construction of water and soil management structures should be encouraged. The producers should harvest the rainwater both in and off farm to supplement crop development, practice

conservation agriculture to maintain soil properties, put soil and water conservation technologies in place, use the right varieties in relation to the AEZ, drought and disease tolerant varieties which are early maturing. The rainwater management strategies are presented in figure below.

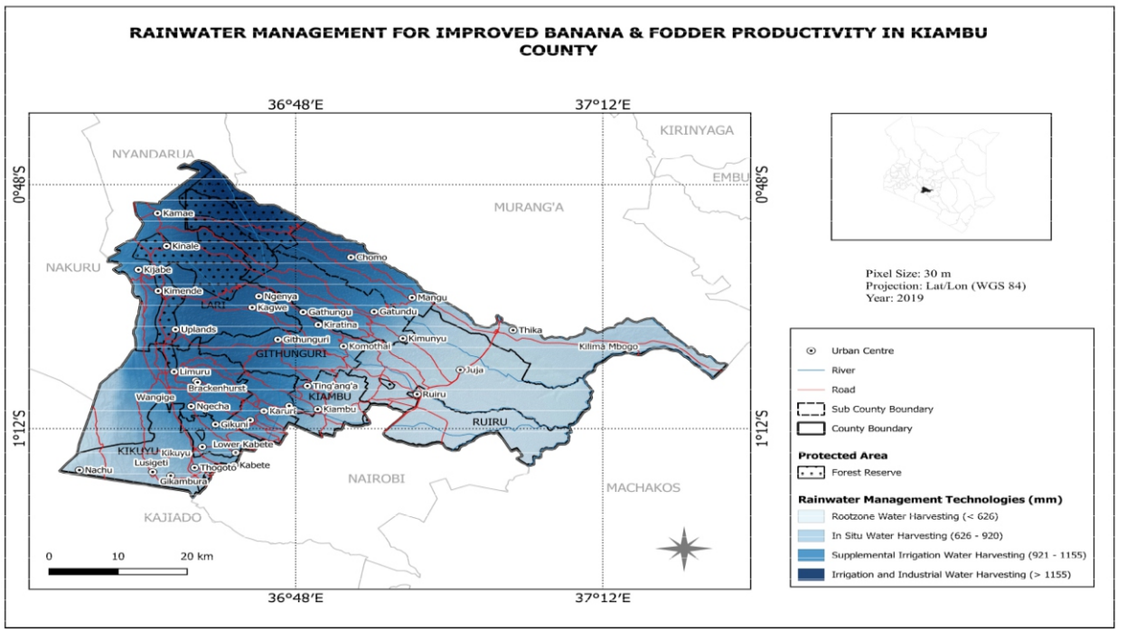



***Figure 27:*** *Rainwater management for improved banana productivity in Kiambu County*

### 4.5.3.1 Land modification

Land modification for banana value chain strategies include terracing, contour farming as presented in the plate below.

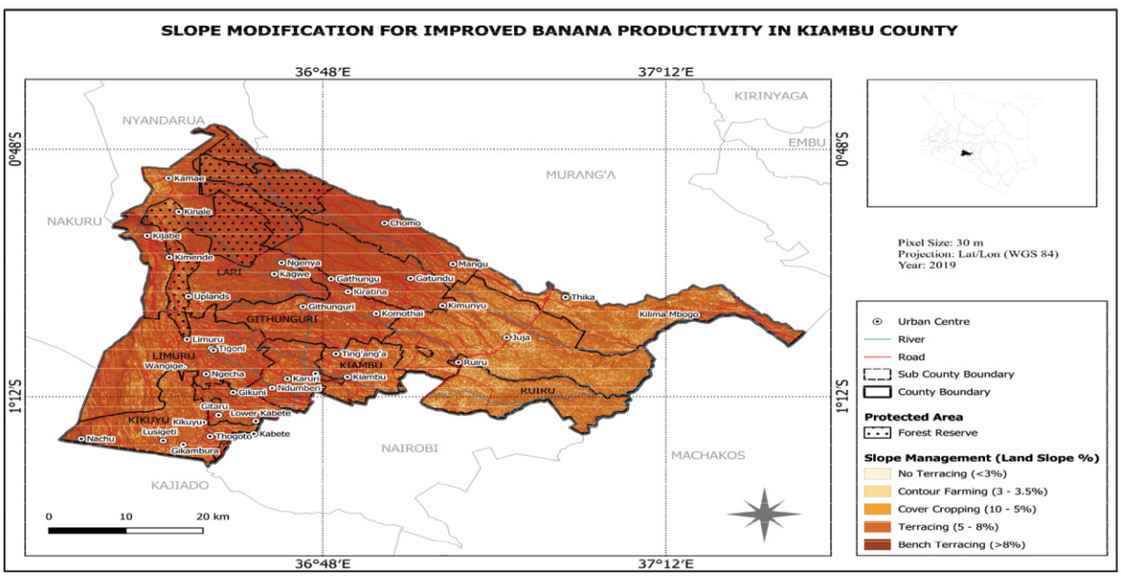



***Figure 28:*** *Slope modification for improved banana productivity in Kiambu County*

### 4.5.3.2 Land Mechanization for banana chain

The land mechanization strategies range from use of hand tools to large machinery depending on the slop of the land. The table below shows the mechanization for improved banana productivity Kiambu County.

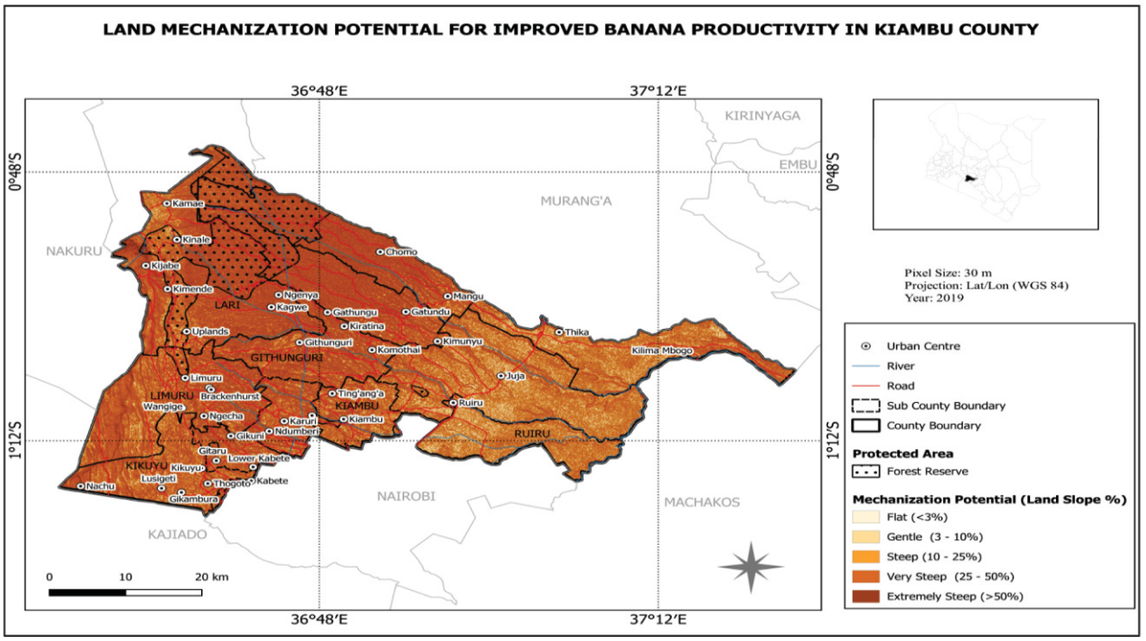



***Figure 29:*** *Land mechanization potential for improved banana productivity in Kiambu County*

***Figure 30:*** *Land mechanization for banana value chain in Kiambu County*

### 4.3.5 Adaptation technologies and innovations

The innovations to be undertaken to make the VC more suitable should focus in all the nodes. At production level, innovations on increasing the production such as use of the high yielding varieties should be emphasized especially the Tissue Culture bananas. In situ water harvesting in areas with poor rainfall distribution and open ridges and earthing-up in areas prone to flooding.

At the input supply level, the actors should have nursery hardening techniques and organic composting. The marketing levels the actors plus the supporters should put in place designated banana selling areas fully with refrigerated structures. Refrigeration, containerization or use of pallets or boxes during transportation to control temperature and RH. The government should ensure regular maintenance and upgrade of the existing infrastructure and provide missing links for easy market accessibility. There is need to establish e marketing platforms for bigger market access that would enhance supply to entire parts of the country. Capacity building on entrepreneur and marketing skills among value chain actors. In addition, there is need to establish automated appropriate ripening technologies chambers; use of bio safety technologies in ripening (natural ethylene) for quality and standard of the products. There is need to facilitate transporters with proper handling

technologies to ensure to maintain quality of the produce. Integrated Pest and Disease Management techniques to promote product quality and quantity should be emphasized. Bagging of bunches to protect the fruits from sun burns, insect attack, and dust which improves the colour of the fruits should be integrated.

# 5.0 CONCLUSION

The suitability analysis reveals that the priority food value chains of cow milk, indigenous chicken and banana value chain vary from marginal to highly suitable for Kiambu County. The maps and the statistical analysis of ranking and weighting provided factual understanding for decision making. This model is very important in physical planning, especially when preparing spatial development plans, zoning of production areas and integrating agriculture in the urban areas to improve economic competitiveness, food security and sustainable development.

## 5.1 RECOMMENDATIONS

- Unsuitable biophysical factors can be managed to improve micro climatic conditions
- Use of adaptation methods, innovations and technologies is highly recommended
- Agriculture related Policies, plans strategies and regulations are required to attract investment in the sector
- There is need to partner with other programs and projects implementing similar value chains for synergy.

It was established that dairy cow milk production is highly suitable, chicken and banana production are moderately suitable in the county. Dairy cow milk VC is highly suitable within Kiambaa, parts of Ruiru, Limuru, Kabete, Kiambu, Githunguri and parts of Gatundu North and South Sub-counties. This is attributed to favorable parameters such as rainfall distribution, temperature and THI. Population density, good road network enhancing accessibility and availability of market thus promoting its suitability. The other areas such as parts of Nachu, Karai, Kinale, Kamae and Kijabe are marginally suitable because of the unfavourable parameters such as high and low temperatures which affect the productivity. To make the unfavourable areas suitable, various technologies and adaptation measures should be put in place especially on feed, housing and the breeds.

Indigenous chicken VC is moderately suitable within Kiambaa, Kikuyu, Kabete, parts of Limuru, parts of Thika, Ruiru, parts of Juja and Githunguri Sub-counties. This is attributed to favorable parameters such as relative humidity and temperature. Population density, good road network enhancing accessibility and availability of market thus promoting its suitability. The other areas such as parts of Gatundu North and South, parts of thika are marginally suitable because of the unfavourable parameters such as high and low temperatures which affect the productivity. Population density is affecting the urban areas due to limited space for indigenous chicken production. To make the unfavourable areas suitable, various technologies and adaptation measures should be put in place especially on feed, housing and the breeds.

Banana VC is highly suitable within Kiambaa, Githunguri and parts of Gatundu North and South Sub-counties. This is attributed to favorable parameters such as rainfall distribution, temperature and well drained soils. Population density, good road network enhancing accessibility and availability of market thus promoting its suitability. The other areas such as parts of Nachu, Karai, Kinale, Kamae and Kijabe are marginally suitable because of the unfavourable parameters such as high and low temperatures which affect the productivity. To make the unfavourable areas suitable, various technologies and adaptation measures should be put in place especially soil and water management, water harvesting and suitable varieties.

It should be noted that there are no organized marketing channels for bananas and indigenous chicken and thus the market is controlled by middlemen. This also affects their suitability. We recommend the various VC actors in these value chains to form marketing groups to have higher bargaining power.

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**COUNTY GOVERNMENTS**