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**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY REPORT  
FOR THE PROPOSED INCLUSION OF GENETICALLY MODIFIED CASSAVA  
RESISTANT TO CASSAVA BROWN STREAK DISEASE INTO NATIONAL  
PERFORMANCE TRIALS (NPTs) AT SEVEN KEPHIS DESIGNATED SITES IN  
KALRO CENTERS**

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**FINAL ESIA STUDY REPORT**

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## **ACRONYMS AND ABBREVIATIONS**

ACC	Assistant County Commissioner
CBSD	Cassava Brown Streak Disease
CFTs	Confined Field Trials
CIDP	County Integrated Development Plan
CMD	Cassava Mosaic Disease
CoK	Constitution of Kenya
CPP	Consultation and Public Participation
DCC	Deputy County Commissioner
DUS	Distinctiveness, Uniformity and Stability
EIA	Environmental Impact Assessment
EA	Environmental Audit
EMCA	Environmental Management and Coordination Act
ESMP	Environmental and Social Management Plan
GM	Genetically Modified
GMO	Genetically Modified Organism
KALRO	Kenya Agricultural and Livestock Research Organization
KEPHIS	Kenya Plant Health Inspectorate Service
NBA	National Biosafety Authority
NEMA	National Environment Management Authority
NPTs	National Performance Trials
NTOs	Non-Target Organisms
PCR	Polymerase Chain Reaction
PPE	Personal Protective Equipment
RNAi	Ribonucleic acid interference
SDGs	Sustainable Development Goals
STI	Sexually Transmitted Infections
TOR	Terms of Reference
WIBA	Workers Injury Benefit Act

UPOV	International Union for the protection of New Varieties of Plants
UV-Index	Ultraviolet Index
VCT	Voluntary Counselling and Testing
VIRCA Plus	Virus Resistant Cassava for Africa plus Nutritional Enhancement

## **EXECUTIVE SUMMARY**

### ***Project Background***

Cassava is the second most important food crop after maize in Coastal and Western Kenya. The crop immensely contributes to increased food supply in the country in line with the Government's Big 4 Agenda. Cassava is also a potential industrial crop especially in the production of livestock feed, starch, flour and ethanol, hence its contribution to the manufacturing pillar of the Big 4. However, cassava production in the recent past has been challenged by two devastating viral diseases, cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). Together they are estimated to cause losses worth US\$1billion annually.

### ***The Project***

The Kenya Agricultural and Livestock Research Organization (KALRO), has successfully developed genetically modified (GM) cassava varieties with robust and durable resistance to CBSD and CMD. The improved cassava has been validated over multiple cropping cycles across six locations in Kenya and Uganda. An application was made to the National Biosafety Authority (NBA) requesting approval for environmental release of the GM cassava in Kenya. After a full review, the NBA approved cassava Event 4046 (and its derivatives and progeny) as safe for food, feed, and the environment, and gave a green light for the proponent to conduct National Performance Trials (NPTs) on condition that other statutory requirements are met, such as undertaking an Environmental Impact Assessment (EIA). This was premised on the fact that release of new crop varieties in Kenya must comply with the Seed and Plant Varieties Act Cap 326. The varieties must also comply with the requirements of the Environmental Management and Coordination (EMCA) Act that require an EIA to be performed and approval licence issued before introduction of GM crops into the environment. The aim of this project therefore is to conduct NPTs for GM cassava varieties containing Event 4046 at seven sites in Kenya. This report by Splend-Peak Consults Solutions Limited (hereafter referred to as the consultant) constitutes the required EIA for the seven project locations.

### ***Project Location***

The NPTs will be conducted in seven KALRO centers designated by the Kenya Plant Health Inspectorate Service (KEPHIS) in six counties (Mtwapa and Msabaha stations in Kilifi County,

Matuga station in Kwale County, Kiboko station in Makueni County, Oyani station in Migori County, Alupe station in Busia County and Kakamega station in Kakamega County) spread across the coastal, lower eastern and western regions. The study sites were selected on the basis of being in cassava growing areas as well as existing in different agroecological zones.

### ***Environmental and Social Impact Assessment (ESIA) Methodology***

The consultant conducted scoping as part of the preliminary assessment, which identified the likelihood of significant environmental and social impacts as a result of the proposed NPTs for genetically improved cassava. In order to further investigate the identified issues, the study team employed various data collection methods. This encompassed both primary and secondary data collection methods that were keenly evaluated and analysed to assist in accurate reporting of this document. Primary methods employed included site visits, key informants' interviews, use of global positioning system (GPS) coordinates, and photography. Secondary sources of data included desktop studies and mapping. The process also employed impact prediction and analysis, impact mitigation as well as public consultations with neighbouring cassava farmers and KALRO staff across all regions. Finally, the outputs of these processes led to the development of this ESIA study report complying with the format prescribed in the Environmental Impact Assessment/Audit Regulations (2003) revised in 2015.

### ***Policy, Legal and Regulatory Framework***

Environmental issues are considered an integral part of any development activity. The country's supreme law, the Constitution of Kenya, 2010 safeguards the environment by stipulating that every Kenyan has a right to a clean and healthy environment. Further, with reference to the schedule II of the Environmental Management and Coordination Act 1999 (Amended 2015), projects that require undertaking of an EIA are categorically listed. The proposed project is classified under high-risk impact project according to the Legal notice 31 and 32 of 2019. Overall, Kenya has over 77 statutes that relate to environmental concerns. Most of these statutes are sector specific, covering issues such as land uses, occupational health and safety, water quality, wildlife, public health; soil erosion; air quality, etc. Therefore, this report has highlighted all the legal, policy and regulatory frameworks as well as institutional arrangements relevant to the implementation of the proposed inclusion of GM cassava resistant to CBSD into NPTs. Some of key legislations and

regulations examined include CoK 2010, Biosafety Act of 2009, Water Act of 2016, Public Health Act (Cap 242), Agriculture Act (Cap 318), Food, Drugs and Chemical Substances Act (CAP 254), EMCA, 1999 (Amended 2015), Occupational Health and Safety Act of 2007, Sexual Offences Act No.3 of 2006, Seed and Plant varieties Act (Cap 326), Biosafety (Environmental Release) regulations, 2011, Environmental (Impact Assessment and Audit) Regulations of 2003, Water Quality regulations of 2006 and Waste Management Regulations of 2006.

### ***Consultation and Public Participation***

The proposed NPTs for GM cassava Event 4046 varieties laid emphasis in promoting stakeholder participation and consultation. Stakeholder involvement and consultation was undertaken at both individual and public levels. This study adopted a multi-stakeholder public participation approach which involved seeking the opinions of the relevant government authorities, project affected and interested persons and the surrounding residents within the designated KALRO sites earmarked for NPTs. Some of the approaches applied to aid in data collection included administration of questionnaires, public participation meetings and key informant interviews for institutions and lead agencies. To reach as many stakeholders as possible, public fora (barazas) were held in each of the seven selected KALRO centres. Interviews and discussion were held with a total of 36 key informants representing various departments/ministries of both National Government and County Governments in jurisdictions where the KALRO stations are situated. Majority of the respondents (99%) were in support of the implementation of the NPTs for the Virus Resistant Cassava as recorded in the questionnaires.

### ***Evaluation of Alternatives***

In analysing alternatives, emphasis was laid on the project locations, cost and benefit criteria, environmental impacts, social acceptability, economics (including productivity of land-use) and any other aspect that was deemed significant. The consultant examined various options that were considered in designing alternatives for the proposed project activities. These included; “No project” alternative, relocation option, “Proposed project” alternative, alternative methods for managing CBSD and solid waste management alternative.

### ***Impact Identification and Management***

The objective of undertaking this ESIA process was mainly to ensure that the proposed project is environmentally, economically and socially feasible; thus, reducing conflict between the project proponent and affected persons as well as interested persons throughout the project cycle. This ESIA report assessed both the social and environmental impacts of the proposed project to conduct NPTs with GM cassava varieties. Under the auspices of the NBA, the application for environmental release of GM cassava event 4046 was reviewed by experts on food safety, environmental safety assessment, and the relevant regulatory agencies, including NEMA, and was found to be as safe as the conventional cassava variety.

Some of the pertinent negative impacts assessed regarding the intended NPTs include;

- Potential weediness and/or invasiveness of Event 4046 Cassava
- Potential Impact of pollen-Mediated Gene Flow from Event 4046 Cassava
- Altered Plant Pest Potential of 4046 Cassava
- Potential Impact of 4046 Cassava on Non-Target Organisms
- Loss of biodiversity
- Solid waste generation

As a result of the NBA comprehensive review, the above-mentioned impacts were found not to impact the environment negatively except for loss of biodiversity and solid waste generation. The application for environmental release of GM Event 4046 cassava was approved by the NBA Board during its 41<sup>st</sup> Full Board Meeting on 18<sup>th</sup> June 2021

Positive impacts of the NPTs include: -

- Creation of employment
- Improved cassava varieties
- Food security as a result of increased cassava production
- Knowledge transfer to farmers during the trials.
- Selection of best performing varieties.

Social and environmental safeguards have been proposed to minimize the anticipated negative impacts and enhance the resultant positive impacts. These are presented in the Environmental and



Social Management Plan (ESMP) in this report for implementation by responsible parties and stakeholders where applicable.

### ***Conclusion and Recommendation***

Overall, the study team concluded that the proposed project will not pose any significant environmental hazard or health and safety concerns. This leads to the conclusion that cassava varieties containing event 4046 are safe and thus not likely to cause an altered risk to the environment relative to conventional cassava. In addition, food and feed emanating from cassava 4046 are considered as safe as food and feed sourced from conventional cassava varieties. The facts presented from the project squarely highlights that there are no additional risks associated with cassava Event 4046 beyond those already linked with the release of conventional cassava varieties. Therefore, cassava Event 4046 is regarded to be as safe as conventional cassava and does not pose any greater risks to the environment, human, or animal health than conventional cassava. In general, the risk of adverse consequences from the environmental release of Event 4046 is negligible. The identified risk mitigation measures if properly implemented according to the guidelines of this report and in compliance with all legal provisions highlighted, will ensure that the project will be environmentally, socially, and economically feasible.

Thus, it is our recommendation that NEMA issues a license for the NPTs to be allowed to proceed on the understanding that the proponent will adhere to the mitigation measures proposed herein and further implement the proposed ESMP. In addition, the proponent ought to perform continuous monitoring and evaluation of the various environmental and social parameters to ensure close adherence to the ESMP.

## **1.0 INTRODUCTION**

### **1.1 Project Background**

Cassava (*Manihot esculenta Crantz*) is the second most important food crop after maize in Coastal and Western Kenya. The crop immensely contributes to increased food supply in the country in line with food security pillar of the Government's Big 4 Agenda. It is an excellent source of carbohydrates and calories. It is a hardy crop, growing relatively well in conditions of heat, drought and low soil fertility prevalent in many African countries. Cassava is also a potential industrial crop especially in production of livestock feed, starch, flour and ethanol, hence its contribution to the manufacturing pillar of the Big 4. However, cassava production in the recent past has been challenged by two devastating viral diseases, CMD and CBSD. Together they are estimated to cause losses worth US\$1billion annually.

KALRO, together with other partner institutions in Kenya, Rwanda, Nigeria, Uganda and the United States has successfully developed biotech cassava varieties, with robust and durable resistance to CBSD and CMD. The cassava has been validated over multiple cropping cycles in several locations in the country. An application for environmental release was submitted to the NBA in pursuance to the Biosafety Release Regulations, 2011, under the Biosafety Act 2009, and this application was subsequently approved on 18 June 2021. The release of new crop varieties in Kenya must comply with the Seed and Plant Varieties Act Cap 326. These varieties must also comply with the requirements of the Environmental Management and Coordination Act (EMCA) that require an EIA to be conducted before introduction into the environment.

### **1.2 Rationale of the ESIA Study**

The National Environmental Management Authority (NEMA) requires that new plant varieties (modified or transformed using biotechnology or imported) must comply with the requirement of Environmental Management and Coordination Act, 1999 (Amended 2015) that requires an Environmental and Social Impact Assessment (ESIA) to be conducted before and/or during the testing and introduction into the environment. Under Legal Notice 31 of 2019, Amendment to the Second Schedule indicates that inclusion of genetically modified cassava resistant to CBSD into NPTs falls under the high-risk projects. Section (8) on Agriculture specifies that major developments in biotechnology including introduction and testing of genetically modified organisms require the undertaking of EIA. Therefore, the main purpose of the ESIA is to ensure

all negative project-related impacts are mitigated while enhancing the positive ones. In addition, the ESIA fundamentally assists NEMA and all other stakeholders in understanding the potential environmental consequences of a given project and thus provides a basis for making informed decisions regarding the project.

### **1.3 Terms of References**

The consultant undertook the EIA within the guidance of the following ToRs;

- 1) Carry out assessment and description of location/ site, objective, scope, nature of the proposed project. To carry out analysis of the proposed project activities during the proposed project cycle; operation, decommissioning phases;
- 2) Establish the suitability of the proposed NPTs in the seven proposed locations;
- 3) Review baseline information (physical, biological and social cultural and economic) and identify any information gaps);
- 4) Description and analysis of policy legal and institutional framework including but not limited to Kenyan policies, laws, regulation and guidelines; international guidelines, international conventions and treaties to which Kenya is party to, related to the proposed project, which have a bearing on the proposed project and will also serve as benchmarks for monitoring and evaluation, and future environmental audits;
- 5) Perform an in-depth description of the proposed NPT trials together with the requirements for carrying out the NPTs;
- 6) Analyze the efficacy of the designs, technology, procedures and processes to be used, in the implementation of the NPTs;
- 7) Carry out Consultation and Public Participation (CPP): Identify key stakeholders and affected persons;
- 8) Identify and analyze the proposed project alternatives including but not limited to: Scale and extent; project site alternatives, no project alternatives, design alternatives, material alternatives, and alternative processes and technologies alternatives. Give reasons for preferring the proposed alternatives;
- 9) Adequately identify, predict and carry out in-depth analysis all actual potential and significant impacts on flora, fauna, soils, air, water, the social, cultural and community settings; the direct, indirect, cumulative, irreversible, short -term and long-term effects

anticipated to be generated by the proposed project, both positive and negative throughout the NPTs;

- 10) Recommend sufficient mitigation measures for all the potential negative impacts identified and analyzed in 9 above;
- 11) Develop an emergency response procedure for the proposed NPTs for the entire project cycle;
- 12) Identify gaps in knowledge and uncertainties which will be encountered in compiling the information;
- 13) Analyze occupational health and safety issues associated with the proposed project;
- 14) Develop an Environmental Management Plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, timeframe and responsibility to implement the measures;
- 15) Prepare a comprehensive EIA project report in accordance with EMCA 1999 (Amended 2015) legislation for submission to NEMA for approval;
- 16) Submit and present draft EIA study report to KALRO management for review;
- 17) Incorporate comments into the EIA study report after review from the proponent into a final EIA project report;
- 18) Submit required hard copies and one soft copy of the EIA study report to NEMA for the purposes of seeking a NEMA license that will approve the proposed cassava NPTs
- 19) Submit to the proponent one copy of NEMA referenced EIA report, one soft copy of the EIA report and acknowledgment letter from NEMA;
- 20) The EIA expert (s) shall follow up processing and issuance of the EIA License for the proposed project from NEMA and inform KALRO on the progress of issuance.

## **1.4 ESIA Methodology**

### **1.4.1 Scoping Process**

The proposed project is classified under the second schedule, Section (8) as a high-risk project. The section states that agriculture more so major developments in biotechnology encompassing introduction and testing of genetically modified organisms is high risk in nature. The Environmental Impact Assessment Regulations as outlined under the Gazette Notice No. 56 of 13th June 2003 established under the Environmental Management and Coordination Act (EMCA),

1999(Amended 2015) was adhered to during the scoping process. The outcome of the scoping process revealed there were significant impacts that required more scrutiny for informed decision making. Therefore, a scoping report was presented to NEMA defining the TORs for the detailed ESIA which was approved.

#### **1.4.2 Documentation Review**

The consultant reviewed various relevant documents to get a clear understanding of the issues relevant to the project as contained in the terms of reference (TOR) and gain more understanding of the cassava Brown streak and Cassava Mosaic diseases as the leading causes of poor cassava production in Kenya. The review was also important in understanding the various climatic conditions as well as the physical characteristics of the NPT sites representing the general character of the surroundings. The literature consulted further covered the existing policy, legal, regulatory and institutional documents.

#### **1.4.3 Field Assessment**

Field visits and assessments of all the seven (7) designated NPT sites were undertaken at various dates. Both the physical and biological environments of the project sites were assessed, and suitability evaluated. The fieldwork was, therefore, aimed at establishing the anticipated positive and negative impacts associated with the NPTs to the farmers and largely to the environment. The specific objectives of the field assessment included to:

- a) Obtain resourceful information and data from the local public offices including departments of Agriculture, Environment, Lands and Public Health.
- b) Evaluate the environmental settings around the proposed designated KALRO sites where the NPT sites would be situated. General observations focused on the present land use, climate, soils among others
- c) Undertake comprehensive consultative public participation exercises such as to reach a large section of the cassava farmers to contribute their inputs in NPTs and to widely capture their concerns and expectation in the improved cassava varieties.

#### **1.4.4 Public Consultations**

The ESIA study used a participatory approach to gain insights into all stakeholders' concerns in the process of undertaking NPTs. The consultant invited the surrounding cassava farmers across all the NPT sites for public consultations through public fora. In addition, all relevant key informants were consulted for their input in the ongoing process of conducting NPTs for the genetically modified cassava to improve its resistance to CBSD. The use of questionnaires was also used to supplement both methods of engagement.

#### **1.4.5 Impact Prediction and Analysis**

All significant effects anticipated as a result of the inclusion of the genetically modified cassava resistant to CBSD into the NPTs were analysed. The effects ranged from environmental, economic as well as social. Availability of the required data aided the consultant to project the possible impacts that are likely to emanate from the pre-set up and set up phases of the project. Further, the assessment of the anticipated impacts was conducted. Therefore, impact prediction involved establishing and quantifying significant positive and negative impacts into various scales such as minor positive, major positive, minor negative and major negative.

The interpretation on the importance or significance of the effects of inclusion of genetically modified cassava resistant to CBSD into the NPT sites was achieved through impact analysis. The information generated from the analysis was very important in decision making regarding the status of the project in relation to impacts generated. The analysis also incorporated professional judgement for accurate prediction.

#### **1.4.6 Impact Mitigation**

The evaluation of the anticipated impacts revealed significant but moderate effects of the project on the environment. The identified effects will be minimised or alleviated through provision of appropriate mitigation measures.

#### **1.4.7 Environmental and Social Management Plan (ESMP)**

Environmental and Social Management Plan (ESMP) provides a practical tool for mitigating adverse negative impacts while enhancing the positive ones. The ESMP categorises the project

phases into; Pre-Set up, Actual Set-up (Operation Phase), and decommissioning. It also summarises the impacts together with their mitigation measures and cost of remedy.

#### **1.4.8 Reporting**

This study commenced by submitting Terms of Reference (TORs) to NEMA for approval. Thereafter, a series of reports were prepared namely; inception, preliminary draft final and final reports. These were submitted within pre-agreed time frames to the client for input prior to the final submission of the report to the National Environmental Management Authority (NEMA).

#### **1.5 Project Justification**

Plant viral diseases can destroy up to 100 percent of a cassava crop yield, threatening livelihoods and leading to hunger. Cassava varieties that are resistant to both diseases could dramatically improve the crop's ability to feed and provide income for smallholder farmers in Africa.

Cassava production in Africa is limited by two viral plant diseases: CBSD, which destroys the edible roots even when rest of the plant looks healthy, and CMD, which can stunt plants to varying degrees or kill them completely. These two diseases are often found together in the same field and can devastate entire crops. Both diseases are spread by white-flies (high populations of which cannot be controlled effectively with pesticides) and by infected cassava stem cuttings shared among farmers.

CMD has been damaging farmers' fields across Africa for decades. Over the last 15 years, CBSD has also spread rapidly and now affects cassava production across East and Central Africa. It threatens to move into West Africa where it would have devastating effects on cassava production and food security in Nigeria, Africa's most populous country and largest cassava producer. As a result, CBSD has been defined as one of the seven most dangerous plant diseases in the world due to its ongoing and potential impact on food and economic security. Conventional plant breeding has been used successfully to develop cassava varieties that are resistant to CMD. Plant breeders have been less successful with CBSD, thus far developing varieties that are merely tolerant to the disease. CBSD tolerant cassava plants may still show some virus symptoms and suffer damage from the disease – and may cause the disease to spread further.

Researchers from KALRO, National Agriculture Research Organisation of Uganda and Donald Danforth Plant Science Centre, USA have used genetic engineering to introduce a small component of the cassava brown streak virus into cassava to make the plants resistant to CBSD by a mechanism called RNA interference (RNAi). RNAi has been used to develop disease resistant crops, most notably saving the papaya industry in Hawaii from the devastating papaya ringspot virus disease. They have successfully developed cassava with strong and stable resistance to CBSD using genetic modification techniques and conducted several confined field trials over a period of 9 years in both Uganda and Kenya, with the approval, oversight and guidance of government regulators in these countries. This has come as a breakthrough to safeguard the production of the crop and maintain its diverse benefits to the human population. The discovery will aid in protecting livelihoods and health of the people and livestock who rely on cassava production.



## 2.0 PROJECT DESCRIPTION

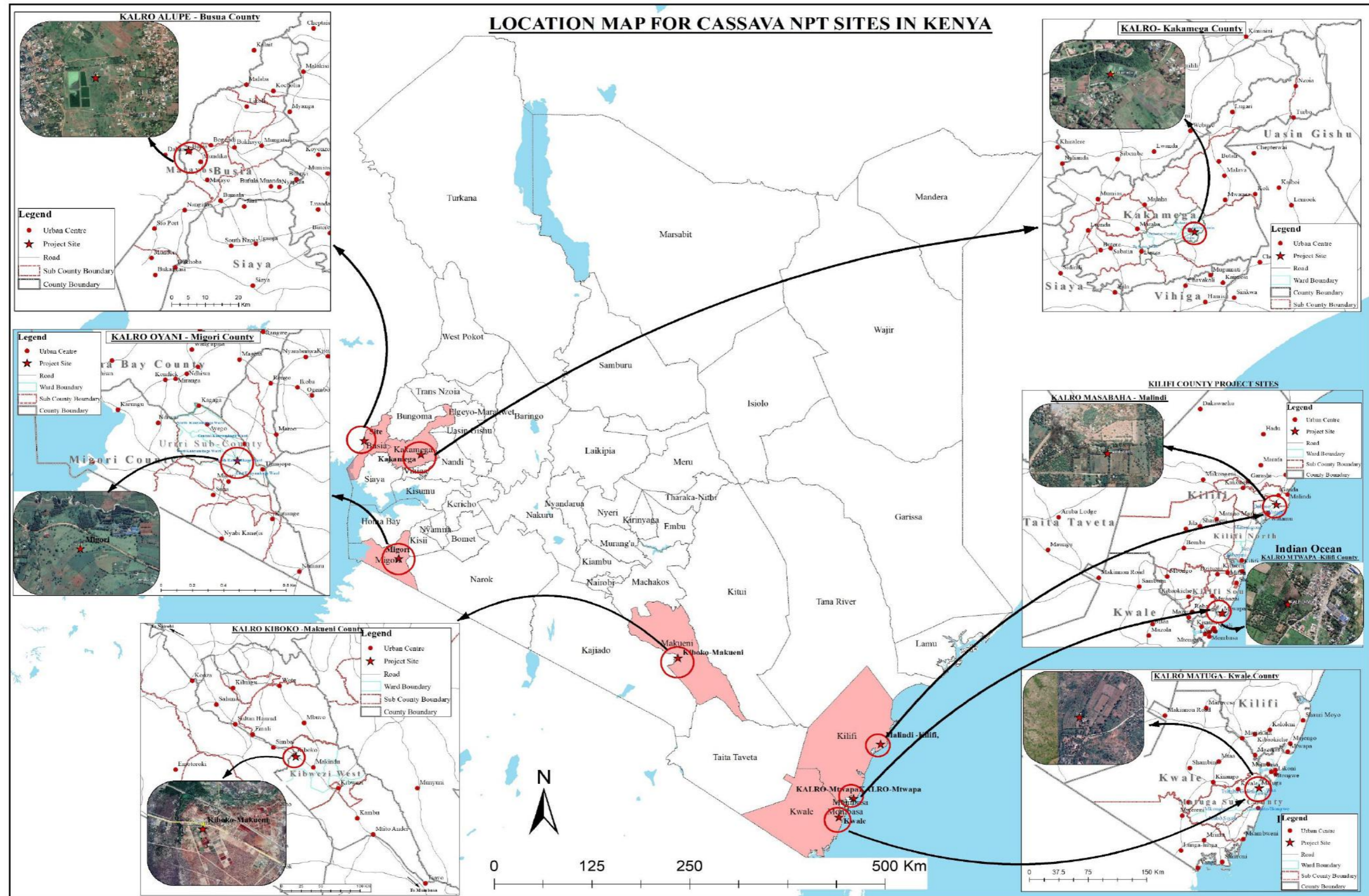
### 2.1. Location of NPT Sites

The proponent (KALRO) identified sites across the country which would serve as a platform for conducting the NPTs. The seven NPT sites were selected based on importance of cassava in those regions and given that they exist in different agroecological zones. The sites are all located within KALRO centres in compliance with KEPHIS guidelines that require all NPTs and DUS trials for GM crops to be conducted in secured and isolated sites for conditional environmental release approval. Three regions were selected which include; Eastern, Coast and Western. The table below show the counties within which the various NPT sites are located.

**Table 1: List of Counties hosting the NPT sites and their respective KALRO stations**

Region	County	KALRO NPT Site
Eastern	Makueni	Kiboko
Coast	Kilifi	Mtwapa
		Msabaha
	Kwale	Matuga
Western	Busia	Alupe
	Kakamega	Kakamega
	Migori	Oyani

Map 1: NPT sites Location Map within the National Context



## **2.2 Genetically Modified Cassava NPT Protocol**

This protocol involves several considerations in its implementation. These are as discussed in the subsequent sections;

### **2.2.1 Cultural Practices**

The following cultural practices will be observed during the execution of the NPTs;

- a) Spacing –1 m within rows, 1 m between rows
- b) Number of rows per plot – 5, collect data from 3 inner rows
- c) Length of rows 6m; Expected SAH / plot= (5 hills\*3 rows)=15 plants (exclude border plants)
- d) Space between adjacent replicates – 1.5 m
- e) Trial surrounded by at least 1 guard rows, with 1.5 m space between the guard rows and the experiment
- f) Planting cuttings – at least with 5 nodes, cross-section of at least 2cm.
- g) Manual weeding process will be adopted
- h) No pre-sprouting of cuttings for planting
- i) Cuttings should be planted within five days of their preparation.

### **2.2.2 Data Collection**

- a) Planting date-This will be conducted either when wet or consideration of irrigation as an option.
- b) Crop establishment – Conducting of stand count at 30 days after planting is done.
- c) Diseases - Data for diseases and pests are collected both on incidence and severity, on a scale of 1-5 specifically at three, six and nine months after planting where 1 is no symptoms and 5 is severe.
  - Cassava mosaic disease (CMD)
  - Cassava brown streak disease (CBSD) (See Fig. 1)
  - Cassava bacterial blight (CBB)
  - Cassava anthracnose disease (CAD).
- d) Pests- The following pest will also be checked during data collection
  - Cassava green mites
  - Cassava mealy bugs
  - Scales
- e) Establishing the number of stems at harvesting

- f) Recording the branching height at harvesting
- g) Taking data on the plant height at harvesting
- h) Noting the stand count on each NPT site- This encompasses the number of plants harvested
- i) Analysis of the root yield which will include;
  - Number of roots per net plot
  - Number of marketable roots per net plot (widest root diameter > 3 cm; and CBSD score  $\leq 2$ )
  - Number of non-marketable roots per net plot
  - Weight of marketable roots per net plot
  - Weight of non-marketable roots per net plot.
- k) Testing of the levels of cyanide content
- l) Establishing the actual root dry matter content

**N.B:** Since it is difficult to determine the maturity status of cassava, it is the breeder who will indicate the time at which the variety should be harvested. This will be done at submission of entries.

### 2.3 New cassava varieties submitted to KEPHIS for NPT and DUS trials

The table below shows the various cassava varieties to be planted across the 7 identified national performance trail sites. They are all resistant to CBSD and CMD.

**Table 2: Cassava varieties selected for National Performance Trials**

Line	Unique trait
1807	CMD & CBSD resistant
2087	CMD & CBSD resistant
1812	CMD & CBSD resistant
2113	CMD & CBSD resistant
1720	CMD & CBSD resistant
173	CMD & CBSD resistant
1329	CMD & CBSD resistant
1507	CMD & CBSD resistant

(Source: KALRO, 2022)

**N.B: The Cassava varieties to be used as commercial checks are;** KME 4 and Tajirika

## 2.4 CBSD Symptoms, Scoring and Detection

Characteristic symptoms for CBSD include; venial chlorosis, angular chlorotic blotches, and chlorotic spots on leaves, necrotic spots, lesions, streaks, withering, and dieback on stem; and yellow to dark-brown necrotic spots, and corky necrotic masses within the storage roots

**Table 3: Severity rating scale for cassava brown streak disease in the field**

<b>Score Scale</b>	<b>Symptom description</b>
<b>Leaf</b>	
1	No symptoms on leaves or stems
2	Mild vein yellowing; chlorotic blotches on leaves No brown streaks; lesions on green stem or leaves
3	Mild vein yellowing; chlorotic blotches on leaves Mild brown streaks; lesions on green stem portions
4	Sever; extensive vein yellowing; chlorotic blotches on leaves Severe brown streaks; dark lesions on green stem portions No defoliation; stem die-back and stunting
5	Severe/extensive vein yellowing; chlorotic blotches on leaves Severe brown streaks; dark lesions on green stem portions Defoliation, stem die-back and stunting
<b>Storage Root</b>	
1	No symptoms on storage roots
2	less than 5% of storage root tissue is necrotic
3	5-10% of storage root tissue is necrotic
4	10-50% of storage root tissue is necrotic
5	More than 50% of storage root tissue is necrotic



**Figure 1: Image of CBSD severity scale**

(Source: KALRO, 2022)

## 2.5 Detection of cassava brown streak viruses

The table 4 below shows the reference genes, CBSD virus species and primer sequences used for reverse-transcription polymerase chain reaction (RT-PCR) and quantitative reverse-transcription polymerase chain reaction (RT-qPCR)

**Table 4: Detection of Cassava Brown streak Viruses**

Gene description	Primer code	Primer sequence	Amplicon length (bp)	Reference
Cytochrome oxidase (COX)	COX F	Fwd 5'-CGTCGCATTCCAGATTATCCA-3'	79	Adams <i>et al.</i> 2013
	COX R	Rev 5'-CAACTACGGATATATAAGRRCRRAACTG-3'		
Serine-threonine phosphatase (PP2A)	PP2AF	Fwd 5'-TGCAAGGCTCACACTTTCATC-3'	187	Moreno <i>et al.</i> 2011
	PP2AR	Rev 5'-CTGAGCGTAAAGCAGGGAAG-3'		
Uganda cassava brown streak virus (UCBSV)	UCBSVqF	Fwd 5'-AAGGCAAGGGTGGCTCTAAC-3'	112	This study
	UCBSVqR	Rev 5'-GCGTCCTTGTGGCCCATTA-3'		
Cassava brown streak virus (CBSV)	CBSVqF	Fwd 5'-GCCAACTARAACCTCGAAGTCCATT-3'	88	Adams <i>et al.</i> 2013
	CBSVqR	Rev 5'-TTCAGTTGTTTAAGCAGTTCGTTCA-3'		
3' untranslated (3'UTR) region of CBSV and UCBSV	CBSVDF2	Fwd 5'-GCTMGAATGCGYGGRTAYACAA-3'	437 (UCBSV)	Mbanzibwa <i>et al.</i> 2010
	CBSVDR	Rev 5'-GGATATGGAGAAAGRKCTCC-3'	343 (CBSV)	
Cassava brown streak viruses, CBSV and UCBSV	CBSVF2	Fwd 5'-GGRCCATACATYAARTGGTT-3'	1670 (UCBSV)	Mohammed <i>et al.</i> 2012
	CBSVDR	Rev 5'-GGATATGGAGAAAGRKCTCC-3'	1607 (CBSV)	

(Source: KALRO, 2022)

## 2.6 Detection of integrated trait

In order to provide unambiguous identification of new cassava varieties containing event 4046 as part of quality assurance during the production of planting material, an event-specific detection method has been developed. The method is based on PCR amplification of a unique DNA sequence spanning the junction of the 5' (LB) terminus of the inserted T-DNA and the flanking cassava genome. PCR amplification using primer pair 1 (Table 5) yields an amplified fragment of 1,618 bp that is diagnostic for the presence of event 4046.

**Table 5: Primers used for event-specific detection of 4046 cassava and for amplification of the endogenous cassava phytoene desaturase gene**

Primer Pair	Primer Name	Primer Sequence	Description	Amplicon Size (bp)
1	1470	5'GAAGATCTGAAGCTGGACTCTCTGG T-3'	T-DNA –left border event specific primer pair for 4046 cassava	1618
	1469	5'-TGATCTGGACGAAGAGCATCAGG-3'		
2	1088	5'-CAAGGGCAAAAATGACACGGAA-3'	Primer pair for amplification of a portion of the endogenous cassava PDS encoding gene	528
	1089	5'CCTGAGAGTGAGAAATCCAGATGA AGA-3'		

(Source: KALRO, 2022)

As a control to ensure the presence of template DNA, PCR amplifications are performed using primer pair 2 (Table 5) that results in the production of a 528-bp amplicon derived from the endogenous cassava phytoene desaturase (*PDS*) gene (accession number: Manes.05G193700)

## 2.7 Road Map to the Development of CBSD resistant Cassava in Kenya

Cassava (*Manihot esculenta* Crantz) is one of the most important staple food crops and sources of income in Africa, with an annual production of more than 178 million metric tons grown on 20 million hectares. Two devastating viral diseases of cassava, CMD and CBSD are the most important economic constraints to cassava production in East and Central Kenya. CMD is caused by related but distinct geminiviruses, the most important in sub-Saharan Africa being African cassava mosaic virus and the East African cassava mosaic virus. CBSD is caused by two closely related RNA viruses, Cassava brown streak virus (CBSV) and Uganda cassava brown streak virus (UCBSV). Both CMD and CBSD are transmitted between cassava plants by insect vectors white flies (*Bermisa tabaci* Gennadius), and via exchange of infected stem cuttings by farmers as planting materials.

Cassava (*Manihot esculanta* Crantz) was genetically modified via *Agrobacterium*-mediated transformation of cassava cultivar TME 204 to create Event 4046 cassava that is highly resistant to CBSD. The resistance is mediated by ribonucleic acid interference (RNAi) via the expression of small interfering RNAs (siRNA) derived from the coat protein encoding sequences of CBSV and UCBSV, the causal agents of CBSD. Over 100 candidate events were obtained and challenged in greenhouse trials. More than 20 events were multiplied from initial plants by *in vitro* micropropagation for 14-17 clonal cycles, they were further evaluated under contained confined field trials, across six locations in Kenya (Alupe, Kandara, Mtwapa) and Uganda (Namulonge, Serere Kasese) in 2015 and 2016 respectively, for initial agronomic evaluation. The events documented robust, durable resistance over multiple vegetative cropping cycles CBSV and UCBSV, the two causal agents of CBSD. Under high disease pressure, best performing VIRCA Plus events recorded up to 20 times increase in marketable storage root yields compared to non-modified controls.

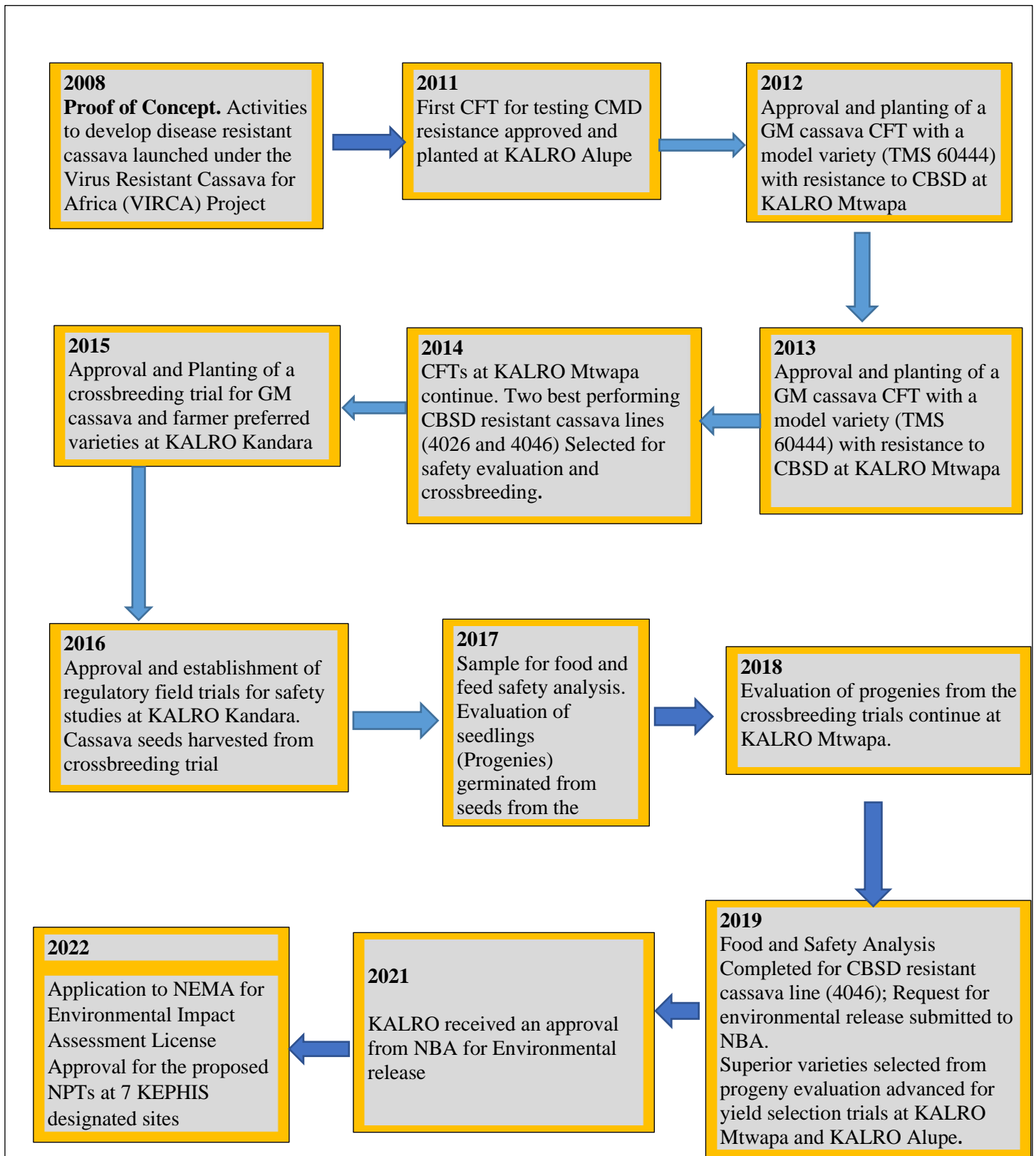
The CBSD-resistant cassava lead event, Event 4046 was selected and advanced to regulatory field trials (RFTs) at the same locations over two cropping seasons (one year growing cycle), between 2016-2018. This was to generate material for compositional analysis (analysis of key nutrients and anti-nutrients) and molecular characterization. For new varieties, compositional assessment is part of the weight-of-evidence approach for evaluating any unintentional consequences of the genetic modification. Compositional components were assessed in 100 samples of cassava Event 4046. The parameters were those recommended in the OECD consensus document on new cassava varieties. There was no change in the nutritive value of storage roots or leaves which occurred as a consequence of the genetic modification resulting in cassava Event 4046. Multi season analysis of the data from the regulatory field trials demonstrated that the genetic modification did not have any unintended effects on plant growth, habit, morphology, reproductive biology, diseases and pest susceptibility. The Environmental safety assessment established that cassava Event 4046, there was no likelihood of weediness, pollen-mediated gene flow, impact on non-target organisms, biodiversity or cultivation practices.

An application for environmental release and placing on the market of cassava Event 4046 cassava and its progeny lines of cassava Event 4046 introgressed into farmer preferred varieties was submitted by KALRO to NBA in December 2019. The application seeks approval for



environmental release, for the cassava Event 4046 and its progeny lines to be entered into the variety release evaluation according to the Seeds and Variety Act of Kenya. This involves evaluation under NPTs for two cropping cycles as well as a test for DUS for one season under the supervision of KEPHIS.

The NBA subjected the application to rigorous review, by local and international reviewers. A virtual National Dialogue was held on 10<sup>th</sup> June 2020 after placing a notification in the Kenya Gazette, and an advert in two widely read newspapers, as well as the KALRO and NBA websites. The virtual dialogue was attended by 1,197 people on Facebook live and zoom, the highest number NBA has ever had in a national dialogue. NBA received 3,342 comments about the cassava Event 4046. KALRO received an approval from NBA for Environmental release on 18<sup>th</sup> June 2021. The figure 2 below shows the road map of the development of CBSD resistant cassava since commencement in 2008 to the current phase of application of EIA license from NEMA for the various designated KEPHIS sites within KALRO centres.



**Figure 2: Road map to the development of CBSD resistant cassava in Kenya**  
(Source: KALRO, 2022)

## **3.0 BASELINE INFORMATION**

### **3.1 Introduction**

This study was limited to the seven KALRO sites selected for the NPTs and one site (Kiboko) for DUS trials for the Event 4046 in six counties (Mtwapa and Msabaha stations in Kilifi County, Matuga station in Kwale County, Kiboko station in Makueni County, Oyani station in Migori County, Alupe station in Busia County and Kakamega station in Kakamega County) in coastal region, lower eastern region and western region. The study sites were selected as they are considered cassava growing agro ecologies. In these sites, the biophysical and socio-economic environments were surveyed in the view of understanding the general characteristics of the project areas.

### **3.2 KALRO Alupe NPT Site in Busia County**

#### **3.2.1 Overview and location of the Centre**

KALRO Food Crops Research Institute-Alupe Centre has been in existence since 1956 when it was established by the East African Community to serve as a cotton research centre. With the breakup of the East African Community in 1970, the Centre was taken up by Scientific Research Division (SRD) of the Ministry of Agriculture. When KARI was formed in 1989, the Centre was made a sub-centre of Kakamega Research Centre. Later, when KALRO was formed through a Government Act of 2013, Alupe was upgraded to a full centre status.

KALRO Alupe Centre is situated in Alupe area, Burumba Ward, Matayos sub-county in Busia County at latitude **-0.497644**, longitude **+34.125107** and altitude 1010 m. It is approximately 10 km from Busia town along Busia-Malava main road. The centre is about 200 acres and serves mostly smallholder farmers in the region comprising of Bungoma, Siaya and Busia counties. The majority of farmers engage in cultivation of multiple crops as well as rearing of domestic livestock. The low agricultural productivity has contributed to rampant poverty experienced in the region. For example, maize, the major staple food crop, produces less than 0.5t per hectare while research indicates that up to 2.5 t per hectare is reachable. As a result, the average household, with up to 8 persons per household usually get a deficit of up to 1,000 kg per year. Low soil fertility, presence of many aggressive weed species, insect pests and regular droughts contribute immensely to food deficit in the region.

Important crops cultivated in the region include maize, sorghum, finger-millet, cassava, common beans, groundnuts, simsim and local vegetables.

### **3.2.2 Climate**

Alupe has the tropical rainforest climate prevailing. It is usually (very) warm, humid and rainy all year round. The average annual temperature for Alupe is 28°C and there is about 1245 mm of rain in a year. It is dry for 40 days a year with an average humidity of 74% and an UV-index of 6-50% of the rainfall falls in the long rain season which is at its peak between early April and late May, while 25% falls during the short rains between August and November. The dry season with scattered rains falls from December to March. The rainfall is moderate throughout the year allowing the area to experience conducive conditions for crop agriculture. Cassava, millet, ground nuts, sweet potatoes, cotton, sugar cane, beans, and maize are grown though in small scale.

### **3.2.3 Topography and physiography**

The part of the county where the KALRO Alupe centre is located is occupied by a peneplain marked by low flat divides of approximately uniform height, often capped by lateritic and a shallowly incised swampy drainage system. The area has a wide range of slopes ranging from 0 to 8%.

### **3.2.4 Hydrology**

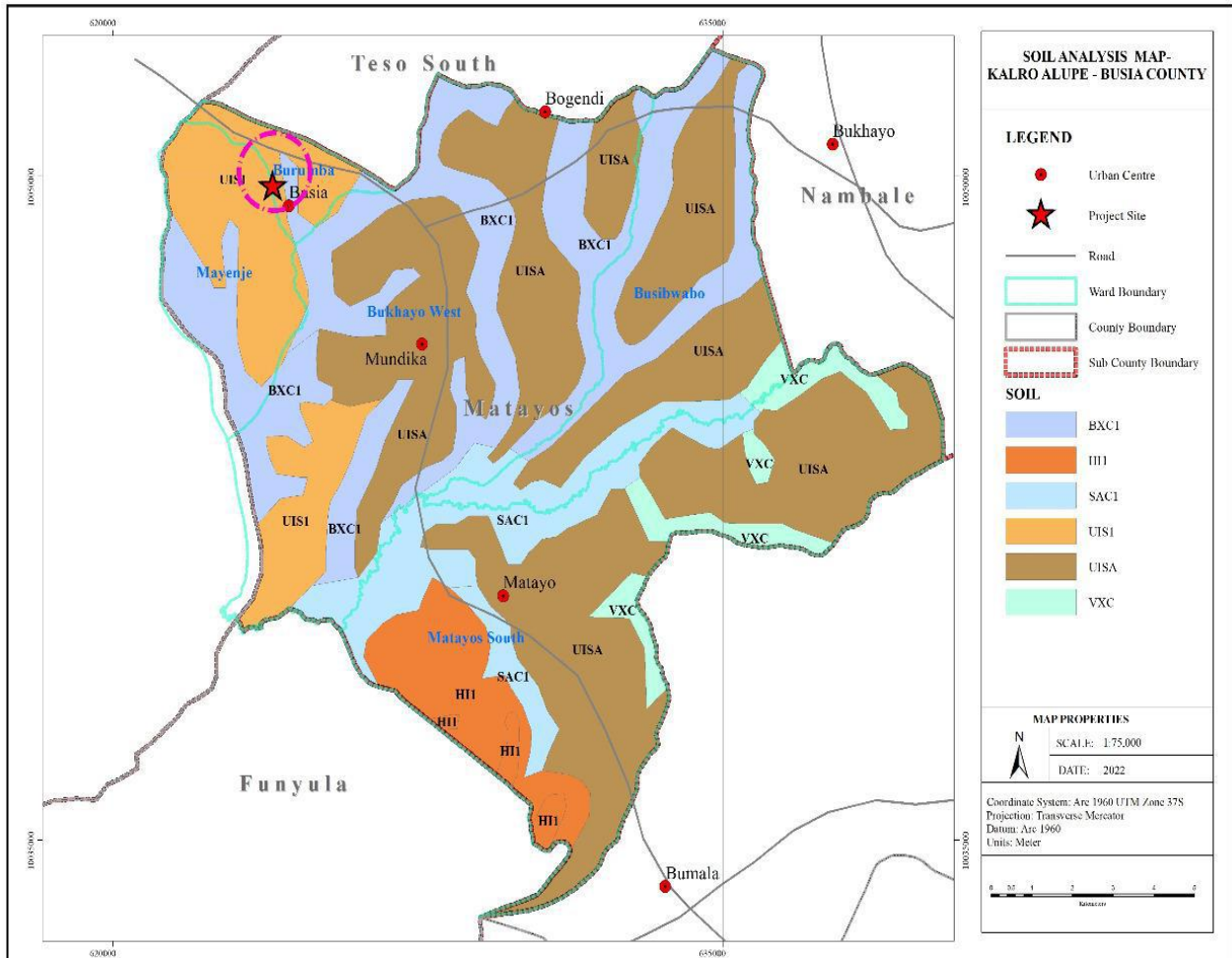
The centre lies at the junction of two streams, the Alupe and Okame. These water resources serve the community for various purposes including domestic and agricultural uses.

### **3.2.5 Soils and Geology**

The soils in the centre are well drained, shallow to moderately deep, dark brown to dark reddish brown sandy clay loam. They are slightly acid to moderately acid and have moderately high organic matter content. In order to attain potential yields the fertility status needs to be enhanced. Alupe area has suitable land formations and structure that supports cultivation of cassava. The Kavirondo series rocks are developed around Alupe centre whereas the adjacent northern part features granitic outcrops, which are essentially part of the peneplain and is characterized by the presence of large granitic hills and tors such as Amukura. The predominant soil type with Alupe research station is UIS1. This type of soil is usually considered to be well drained, moderately deep to deep, dark reddish brown to strong brown sandy clay loam to clay, over petroplinthite; in some places shallow: Orthic ACRISOLS, with orthic FERRALSOLS, partly petroferric phase.

The map below highlights the distribution of soils within Matayos Sub-county and at the KALRO Alupe research station.

**Map 2: Soil Analysis Map for Alupe NPT site within the sub-county context**



### 3.2.6 Biodiversity

Flora within the Centre include *Bischofia javanica*, *Thevetia peruviana*, *Eucalyptus* spp, *Markhamia lutea*, *Podocarpus* spp, Cypress spp, *Gravillea* spp, *Casuarina equisetifolia*, *Artocarpus heterophyllus* (jack tree/ jackfruit) locally called fenesi, shrubs and grasses among others. Fauna within the centre include avifauna, small mammals and reptiles.

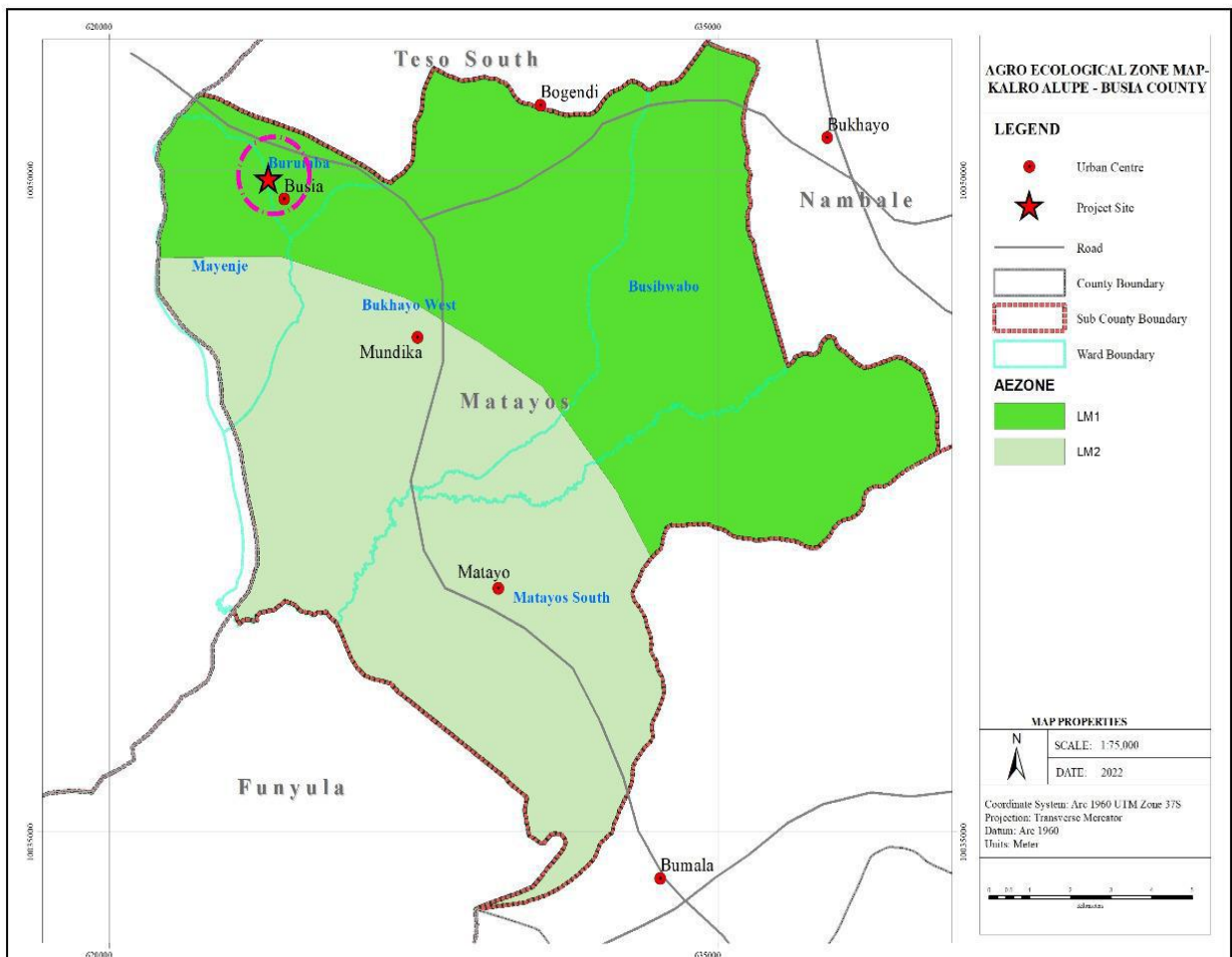
### 3.2.7 Agro-Ecological Zone

The Alupe centre hosting the NPT site in Migori County falls within LM1 (Low Midland Humid zone). This Agro-ecological zone is known as a sugarcane growing zone and has permanent cropping possibilities.

**Table 6: Agro-ecological Zone for Alupe NPT site in Busia**

Agro Ecologic Zone	Description
LM1 (Lower Midland Sugarcane Zone)	Lower Midland Sugar Cane Zone with permanent cropping possibilities, dividable in two variable

**Map 3: Agro-ecological Zone for Alupe NPT Site within the sub-county context**



### **3.2.8 Present Land Use**

The centre conducts agricultural research on cassava, maize, sorghum, sweet potatoes and pasture. Approximately half of the farm is cultivated.

### **3.2.9 Water supply**

The existing water supply scheme that serves Busia Town and its environs is Sio River Water Supply.

### **3.2.10 Health Access**

KALRO Alupe station is proximate to Alupe Sub county Hospital. The hospital is a Level 4 health facility that provides emergency medical care services, comprehensive medical and surgical services.

## **3.3 KALRO Kakamega NPT Site in Kakamega County**

### **3.3.1 Overview and location**

KALRO Kakamega hosts the Non-ruminant Research Institute whose main focus is to develop improved technologies that support the upgrading and commercialization of the various non-ruminant value chains including poultry, pigs and emerging livestock. The Institute has the mandate of generating and disseminating knowledge, innovative technologies and services on non-ruminant livestock for sustainable livelihoods.

KALRO Kakamega is situated within Kakamega Municipality, Shieywe Ward in Lurambi Subcounty within Kakamega County, at Milimani area. The institute neighbours Masinde Muliro University on one side and Kakamega Golf Course on the other. The institute is georeferenced at latitude **0.278079** and longitude **34.763522** at an altitude of 1533M asl. The centre is accessible through Khasakala road within Kakamega municipality.

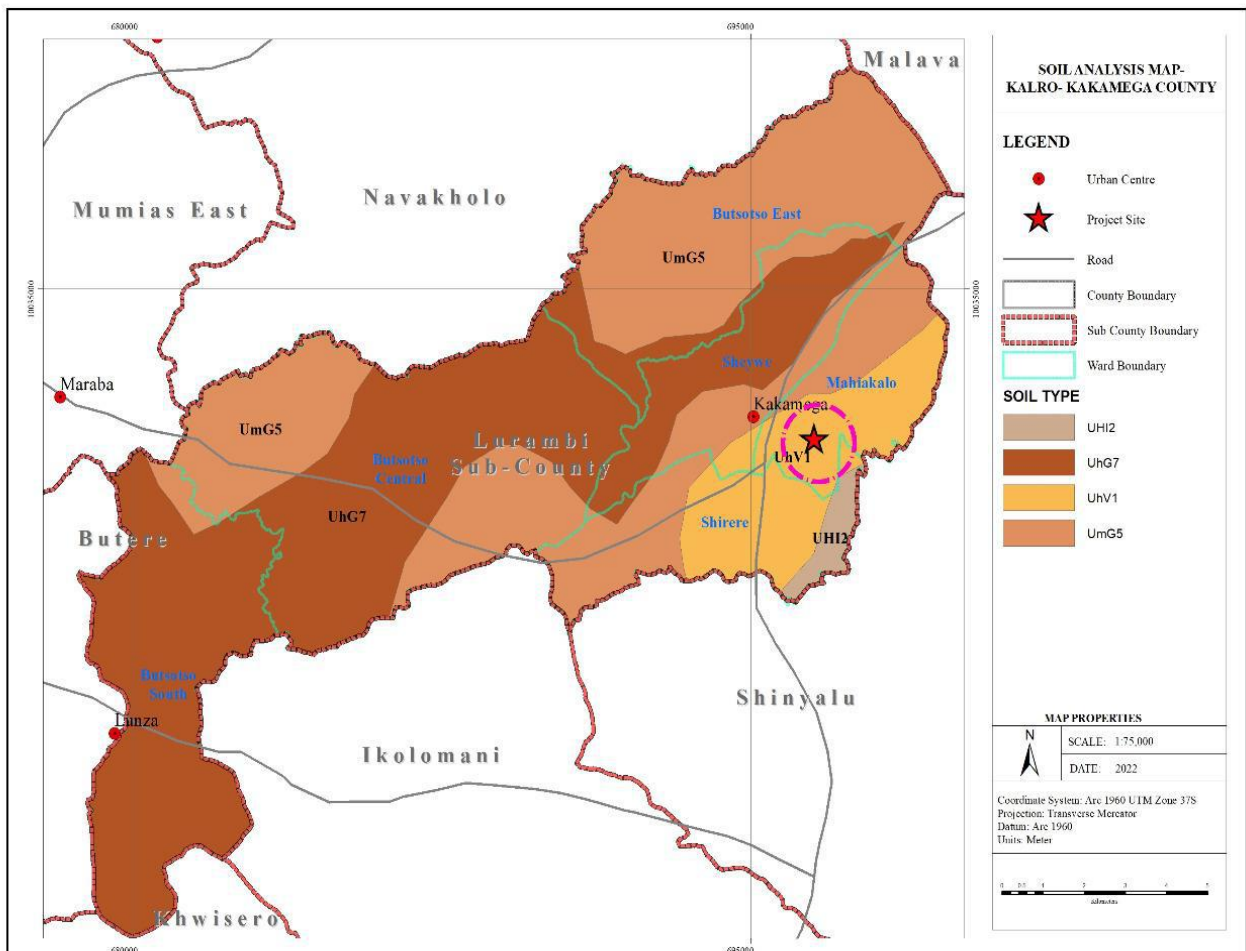
### **3.3.2 Climate**

KALRO Kakamega Institute experiences tropical monsoon climate. The institute is situated in humid zone. The annual rainfall in the centre is 850 mm. There are two rainy seasons - March-May (long rains) and October-December (short rains) periods. The mean annual temperature ranges from 18 °C to 20 °C.

### 3.3.3 Soils and Geology

Geology of the centre and its surrounding can be described by underlying rocks that include basalt, phenolites and ancient gneisses of the Kavirondo and Nyanzian Systems which are associated with gold bearing quartz veins. The rocks form moderately fertile clay-loam soils. The ability of the project area soils to hold and exchange nutrient cations is therefore seen to be primarily dependent upon the organic matter and leaves the soils susceptible to nutrient losses. The soil type within the centre is UhV1 whose characteristics are; well drained, extremely deep, dark red, friable clay, in places with a humic topsoil: dystric NITISOLS, with dystro-mollic NITISOLS. Map 3 below shows the various types of soils within Lurambi Sub- County.

**Map 4: Soil Analysis Map for Kakamega NPT Site within the sub-county context**





### 3.3.4. Hydrology

The Kakamega area is drained towards Lake Victoria by River Isiukhu. The River Isiukhu is a tributary of Nzoia River which drains to Lake Victoria. It originates from the Nandi Escarpment and flows through Kakamega Forest before reaching Kakamega Town.

### 3.3.5 Biodiversity

It is important to note that there are no ecologically sensitive environments; endangered, rare, keystone or endemic species or wetlands at or near the proposed trial site. There are various indigenous forests in the area. The area has both exotic and indigenous tree species. The trees mainly found in the area include *Croton megalocarpus*, *Caltis duratii*, *Anigeria altissimo*, *Ficus exasperata*, *Funtumia clastica* and *Bosquea phoberos*, among others. This vegetation is inhabited by birds, insects, rodents, reptiles among others. There is also livestock reared within the institute.

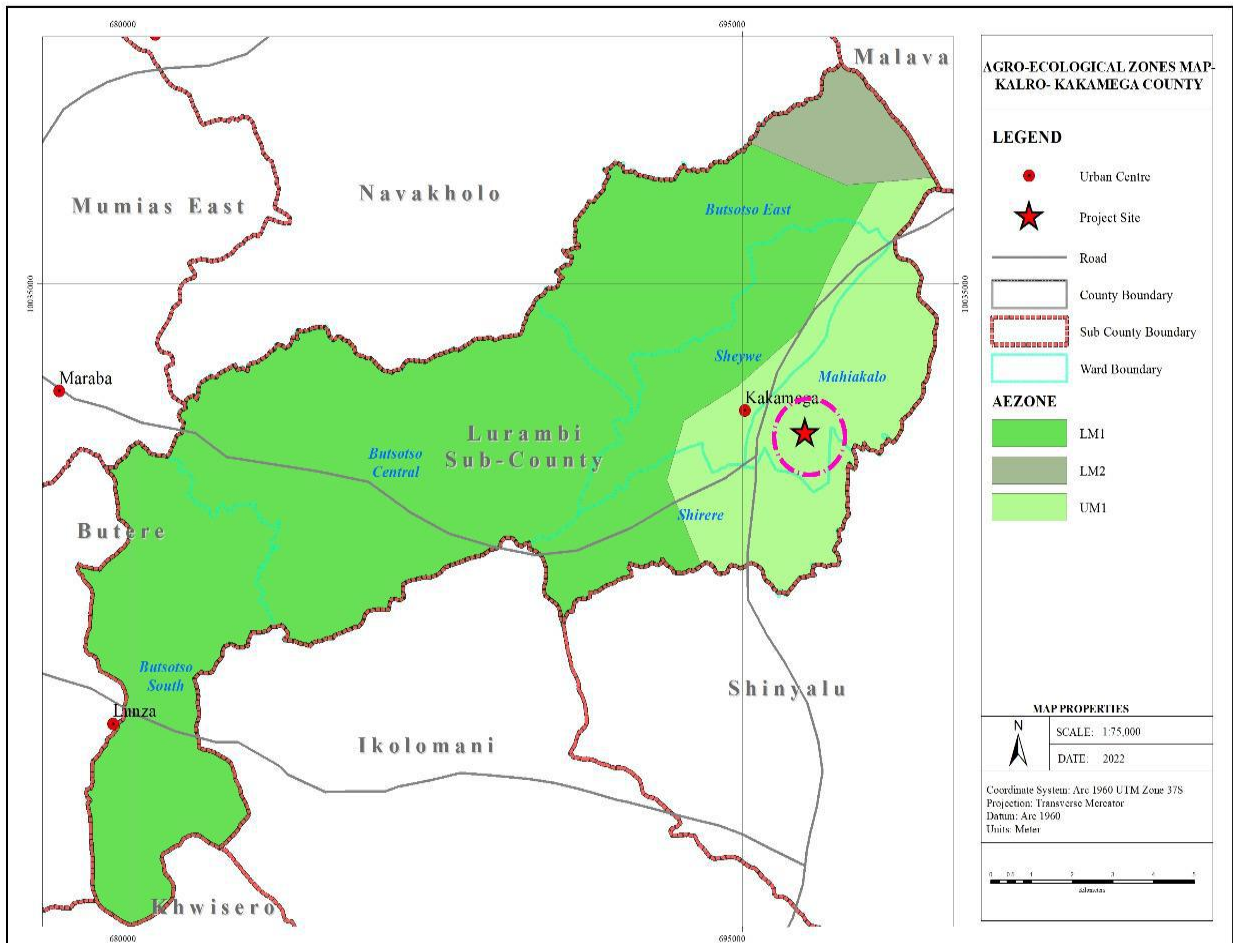
### 3.3.6 Agro-Ecological Zone

The institute is within UM1 zone which is humid upper midland zone. This zone supports growth various crops e.g. sugarcane, maize, beans, cassava, sweet potatoes and tea.

**Table 7: Suitable crops within UM1 AEZ**

Agro-ecological zone	Characteristics
<b>UM1 (Upper Midland Zone)</b>	<b>First rainy season</b> <ul style="list-style-type: none"><li>✓ Hybrid maize</li><li>✓ Hybrid maize</li><li>✓ Beans</li></ul> <b>Second rainy season</b> <ul style="list-style-type: none"><li>✓ Local maize and beans</li><li>✓ Potatoes</li></ul> <b>Permanent crops</b> <ul style="list-style-type: none"><li>✓ Tea</li></ul>

**Map 5: Agro-ecological Zone for Kakamega NPT Site within the sub-county context**



### 3.3.7 Present Land Use

The centre conducts research on cassava, maize, sorghum, sweet potatoes and pasture. A greater portion of the farm is cultivated.

### 3.3.8 Water Supply and Sanitation

The source of water in the centre is from the municipality, boreholes and streams.

Sanitation refers to the provision of facilities and services for the safe disposal of human urine and faeces as well as the treatment and proper disposal of sewage and wastewater. An improved sanitation facility is one that hygienically separates human excreta from human contact and includes: a flush or pour/flush facility connected to a piped sewer system, a septic system or a pit latrine; pit latrines with a slab; composting toilets or ventilated improved pit latrines. The centre has proper sanitation facilities for safe disposal of human excreta.

### **3.3.9. Health Access**

KALRO Kakamega station is approximately 2 km away from Kakamega County Referral Hospital. The Hospital is a level 5 facility that offers both inpatient and outpatient services. This encompasses laboratory services, comprehensive medical and surgical services and 24hr emergency medical care.

## **3.4 KALRO Oyani Farm NPT Site in Migori County**

### **3.4.1 Location**

Oyani sub centre is under Food Crop Research Institute, KALRO Kisii Centre. The sub centre is situated within Oyani Animal Improvement Centre in West Kanyamkago ward, Uriri subcounty in Migori county. The farm is approximately 14km north of Migori town. The farm is georeferenced at latitude **-0.983331** and longitude **34.516649** at an altitude of 1450masl. The site is off Kisii-Sirare Highway at Koigo junction, a distance of about 2.3km.

### **3.4.2 Climate**

Oyani Farm Institute experience two main rainy seasons. The first rainy seasons starts in March and ends in May and is called long rains. The second season called "opon" starts in September and ends in November. The driest months are between January and March and September and November. The minimum average temperature is usually 15.5<sup>0</sup>C and a high of 25.5<sup>0</sup>C. Rainfalls come in the afternoon and the heat is often dry and thus bearable. The Farm receives bimodal rainfall with an annual average of 1600 mm and has an annual mean temperature of 21.1<sup>0</sup>C. Land preparation for the main food crops which include maize, cassava, sweet potatoes and pineapples falls between November-February and July-September. Harvesting is done between June-September and December-February.

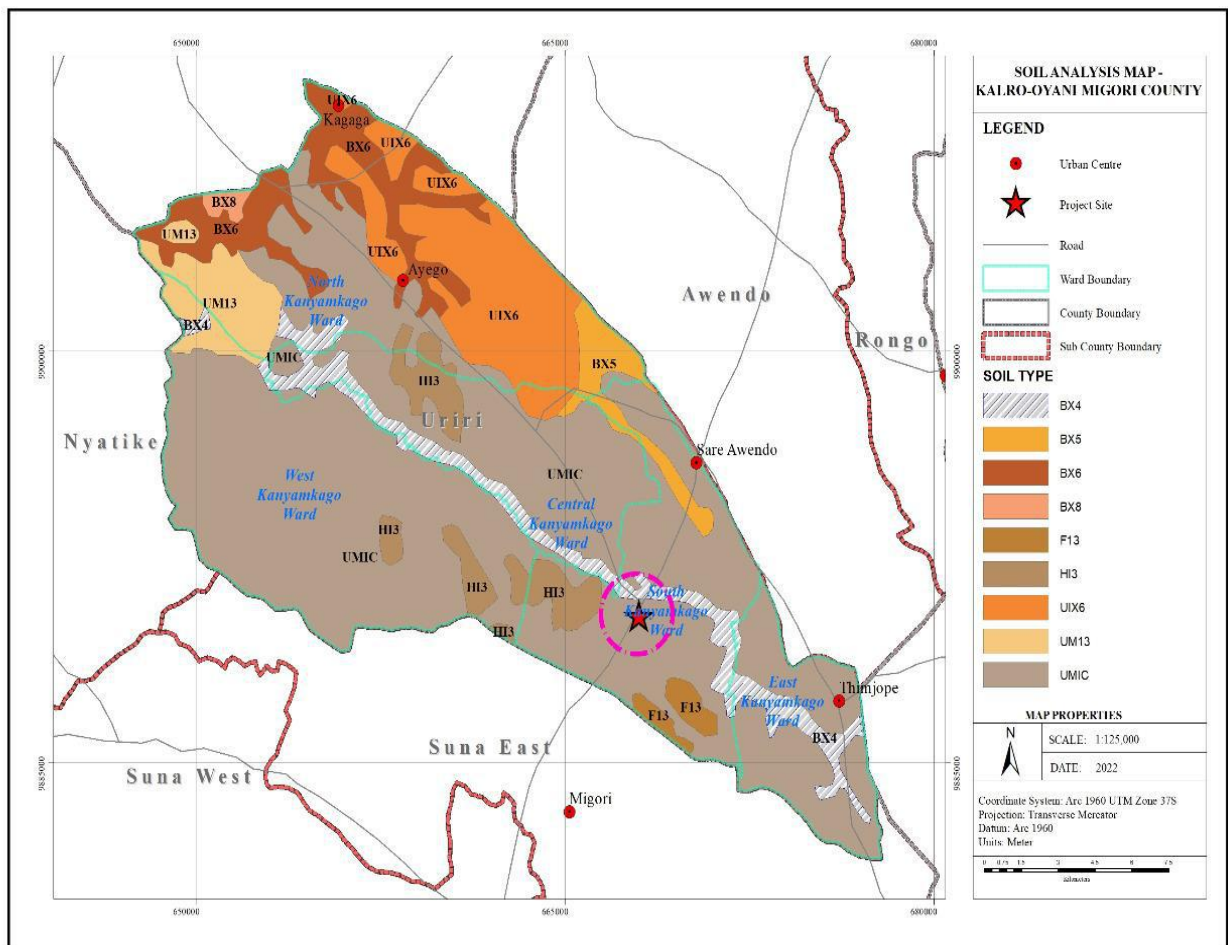
### **3.4.3 Topography and Hydrology**

The project area is located within in what is known as the Lake Victoria Catchments area. It has an altitude of 1400m. It is separated from the Kisii highlands on its southern side of the highlands the town's slopes are generally moderate in the area. The project area is drained by River Oyani which joins River Gucha flowing into Lake Victoria.

### 3.4.4 Geology and Soils

The geology of the area is characterized by metamorphic rocks. These rocks are rich in gemstones like ruby, topaz, aquamarine, garnets among others. The region is located on the southern part of the Nyanza rift, with the Nyanza system (2.8 - 3.1 Ga). The centre possesses UMIC soils. These soils are characterised by a complex of; well drained, moderately deep to deep, reddish brown to brown, friable, gravelly clay loam to clay; over petroplinthite; in many places with a humic topsoil; in places shallow: chromo-luvic PHAEZEMS with orthic LUVISOLS and partly petroferic phases. The map below demonstrates the soil type with Oyani centre as well as across Uriri Sub-County.

**Map 6: Soil Analysis Map for Oyani NPT site within the sub-county context**



### 3.4.5 Biodiversity

There are food crops such as maize, finger millet, and beans grown in the farmland. Tree species observed within the farm include *Euphorbia spp*, *Gravellia spp*, *Mangifera spp*, *Makhamia lutea*, *Psidium guajava*, *Lantana camara*, Cactus, *Thevetia peruviana*, variety of grasses among others. Fauna include birds, insects, variety of ants and burrowing animals. Domesticated animals include livestock, poultry, and dogs, among others.

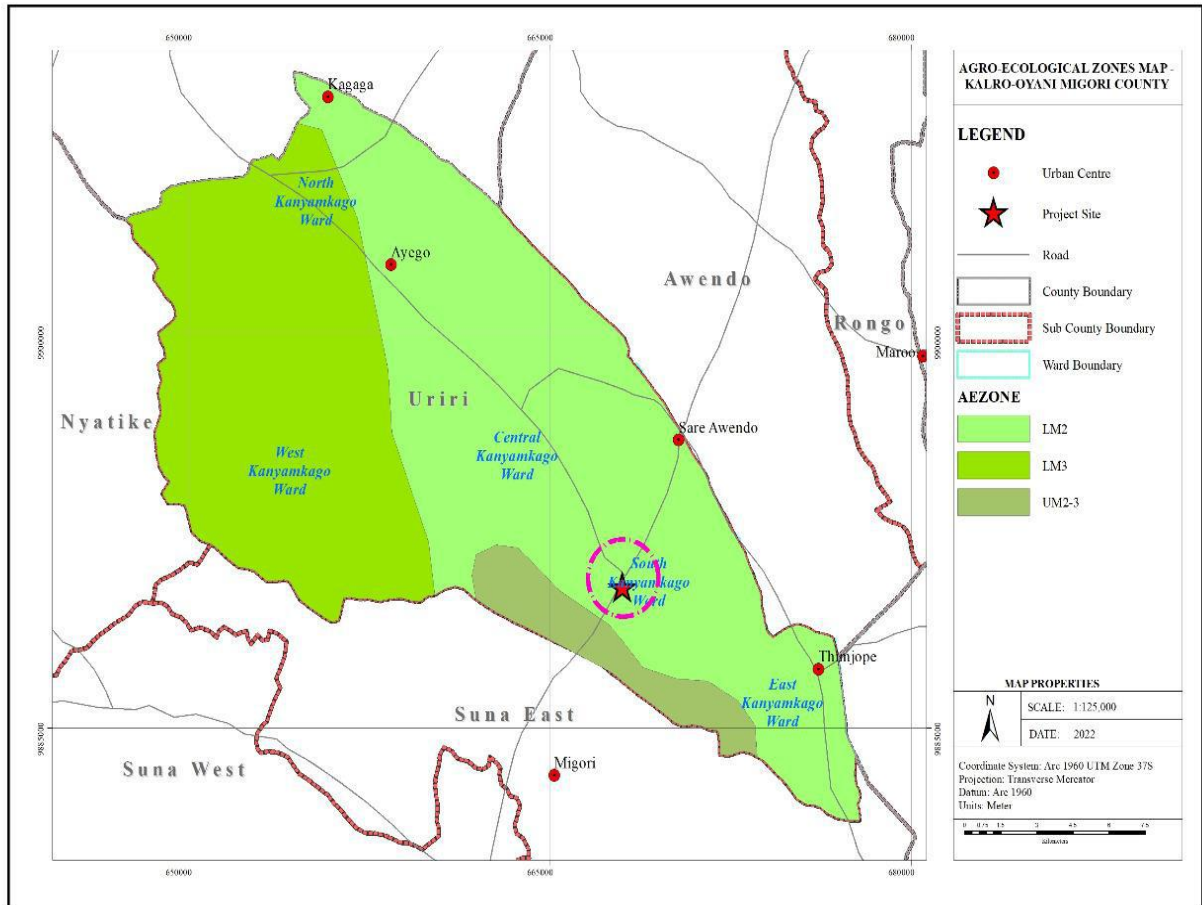
### 3.4.5 Agro-Ecological Zone

The proposed Oyani NPT site is within LM2 zone as shown in the map 6 below. This zone is known to support the growth of maize, millet, cassava, sorghum, beans, and tomatoes, among many others. The table below shows the crops grown during the first and second rainy season and those that are planted the whole year.

**Table 8: Suitable Crops within the NPT site Agro-ecological Zone**

Agro ecological zone	Description
LM2	<p data-bbox="524 1062 1382 1136"><i>Marginal Sugarcane Zone with a long to medium cropping season, followed by a (weak) medium one and intermediate rains</i></p> <p data-bbox="524 1184 1382 1304"><b>1<sup>st</sup> Rainy season:</b> maize, sorghum, finger millet; beans, dolichos beans, pigeon peas groundnuts, soya beans like magoye; tomatoes, onions, roselle, kenaf; pumpkins</p> <p data-bbox="524 1352 1081 1388"><b>2<sup>nd</sup> Rainy season:</b> green grams, sunflower</p> <p data-bbox="524 1436 1382 1472"><b>Whole year:</b> cassava, pawpaws, bananas, <i>yam bean</i><sup>4</sup>, sisal, guavas</p>

**Map 7: Agro-ecological Zones for Oyani NPT Site within the sub-county context**



**3.4.6 Present Land Use**

Crop farming and livestock rearing takes place within the farm.

**3.4.7 Water Supply**

The centre obtains water from a borehole within the farm as well as rainwater harvesting.

**3.4.8 Health Access**

The nearest health facility to Oyani Farm is Oyani Malo Health Center. In case of medical referral cases, Uriri sub county Hospital is about 3.6km away. It is a level 4 facility, better than the health centre in terms of comprehensive medical care.

### **3.5 KALRO Kiboko NPT Site in Makueni County**

#### **3.5.1 Overview of the Institute**

The KALRO Kiboko is under the Arid and Range Lands Research Institute that was created under the Kenya Agricultural and Livestock Research Act of 2013. Research on arid lands started in 1969 in Kiboko. Its focus is in developing, adapting and up-scaling scientific research innovations, information and knowledge geared towards sustainably managing livelihoods of communities living in the arid and semi-arid lands. This then entails addressing livestock, dry land crops and alternative livelihood options.

The Institute is located in ecological zone V which is not suitable for arable agriculture but ideal for extensive production of cattle, goats, sheep and camels. There is however need to develop drought tolerant varieties to support household food production. Dry land farming research was based in Katumani, Machakos County, and focused on the development of technologies for soil and water management for the dry areas to improve crop varieties which tolerate various stresses, pests and diseases.

#### **3.5.2 Location, Size and Access**

The Institute is located at Kiboko area, Makindu Ward in Kibwezi West Sub-County of Makueni County, about 160 km Southeast of Nairobi, along Mombasa - Nairobi Highway. The Institute head office is 6 km south of the Kiboko market, on Mwilu Hill. It lies between latitude 2° 10' and 2° South and longitude 37° 40' and 37° 55' East. The size of the land is 15,512 ha.

#### **3.5.3 Climate**

Kiboko has the tropical savanna climate prevailing. It is warm every month with both a wet and dry season. The average annual temperature for Kiboko is 31°C and there is about 676 mm of rain in a year. It is dry for 160 days a year with an average humidity of 74% and an UV-index of 7. Kiboko experiences two rainy seasons, the long rains occurring in January/February while the short rains occur between October and December.

#### **3.5.4 Ecological Conditions**

The county is largely arid and semi-arid and usually prone to frequent droughts. The lower side which is very dry receives little rainfall ranging from 300 mm to 400 mm. The depressed rains in the lower part of the county hardly sustain the major staple food of maize and beans. Unfortunately,

the traditional crops which are drought tolerant have largely been abandoned. This means livestock rearing remains the common viable economic activity being undertaken by the local people in the lower region. The condition has negatively affected agriculture which is the main economic activity in the county.

### **3.5.5 Physical and Topographic features**

The area lies in the arid and semi-arid zones of the lower eastern region of the country. The major physical feature in the subcounty include the volcanic Chyulu hills which lie along the southwest border of the county in Kibwezi West Subcounty. Kiboko area has an elevation of 936 m.

### **3.5.6 Hydrology**

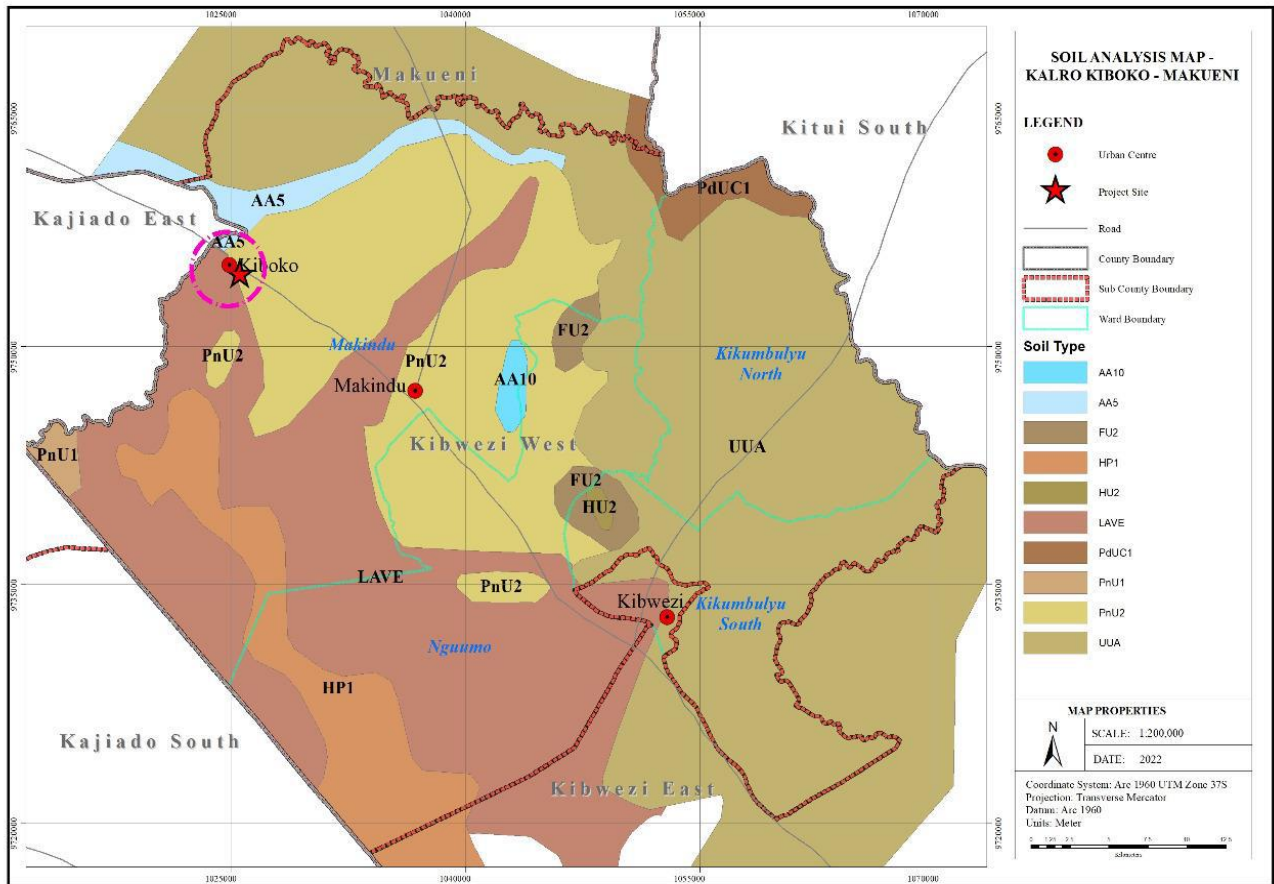
The centre is in close proximity to Kiboko spring where water is sourced for its agricultural activities. This water source provides a high potential for both large and small-scale irrigation.

### **3.5.7 Geology and Soils**

Generally, Kibwezi west sub-county where the project site falls is under laid with basement rock system. The basement rock system is represented in the area by stratified succession of originally sedimentary rocks all of which have metamorphosed and granitized. Other rock types are derived from lavas and volcanic fragment rocks characterised by their porous nature and ability to percolate pollutants to ground water. The soils in the centre are PnU2 which are generally; well drained, deep to very deep, dark red to strong brown, friable sandy clay to clay: Rhodic and orthic FERRALSOLS. The map below shows the extents of the various soil types across Kibwezi West Sub- County in which the centre is located.



**Map 8: Soil Analysis Map for Kiboko NPT site within the sub-county context**



### 3.5.8 Biodiversity

**Flora:** The area is dotted with occasional acacia trees. Shrubs, grasses and forbs have grown on undisturbed areas. The farms are planted with *Zea mays*, *Cajanus cajan*, *Mangifera indica* and *Sorghum bicolor*

**Fauna:** The vegetation provides habitat to avifauna, insects, monkeys, small ungulates such as dik dik, and squirrel, among others. Reptiles such as snakes, monitor lizards etc.

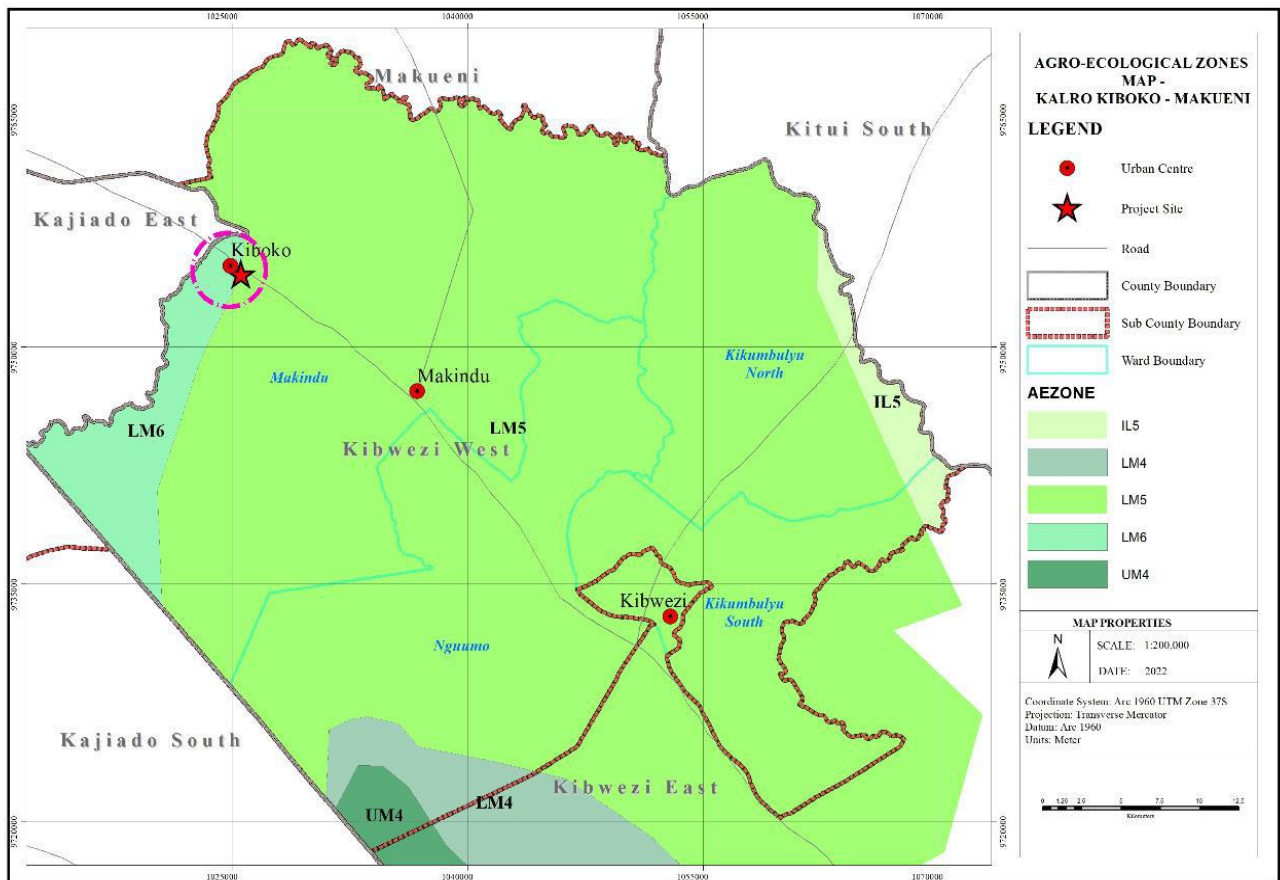
### 3.5.9 Agroecological zone

The centre is situated within Lower Midland, (LM<sub>5</sub>) zone that is considered to be a millet zone. Various crops are favoured for growth by the agro-ecological zone conditions. The table below illustrates the range of crops suitable for both short and long rainy seasons. In addition, it also showcases the crops that can be grown all year round

**Table 9: Suitable crops for LM5 Agro-ecological Zone in Kiboko NPT and DUS Site**

Agro-ecological zones	Description
LM5	<p><i>Lower Midland Livestock - Millet Zone</i></p> <p><i>Millet Zone with a weak very short to short and a very short to short cropping season</i></p> <p><b>1<sup>st</sup> rainy season:</b> proso millet; cowpeas and green grams (KVR 26)</p> <p><b>2<sup>nd</sup> rainy season:</b> Dryland Comp. maize, pearl millet, mat proso millet (Kat Pro 1), bulrush millet, sorghum like KAR, pumpkins, onions</p> <p><b>Whole year:</b> Sisal</p>

**Map 9: Agro-Ecological Zone for Kiboko NPT site in sub-county context**



### **3.5.10 Present land use**

A greater portion of the station's farm is cultivated with maize, pigeon peas, millet and sorghum. The station has micro forest of both indigenous and exotic tree species.

### **3.5.11 Water Supply and Sanitation**

The main source of water for the centre is Kiboko spring. Access to sanitation within the area is challenged by lack of adequate water. However, there are several pit latrines and flushing toilets, most located near offices. The area is not served by a sewer network.

### **3.5.12. Health Access**

Within the Kiboko area, there is Kiboko medical clinic that offers outpatient services with limited medical care. Makindu sub-county level 4 hospital is about 14.6km from the station and it is vital for comprehensive medical services.

## **3.6 KALRO Matuga NPT Site in Kwale County**

### **3.6.1 Overview of the Centre**

KALRO Matuga Centre is under the Horticulture Research Institute with headquartered in Kandara, Muranga County. The centre's main focus is research on horticultural crops: vegetables, fruits, flowers and Medicinal Aromatic Plants (garlic, aloes, mushrooms and chillies). Agricultural research in coastal Kenya dates back to 1957, when research on fruits (mainly citrus) was started at Matuga in Kwale County under the Ministry of Agriculture.

### **3.6.2 Location and Access**

KALRO Matuga is situated in Matuga Sub-location, Waa Ward in Matuga sub county within Kwale County. The Centre is approximately 14.8 km East of Kwale town. The centre neighbours Kenya School of Government Matuga Campus. The centre is along Likoni-Kwale road, 2.5 km off Kwale road at Matuga junction. The centre is georeferenced at **-4.166214, 39.572056**.

### **3.6.3 Climate**

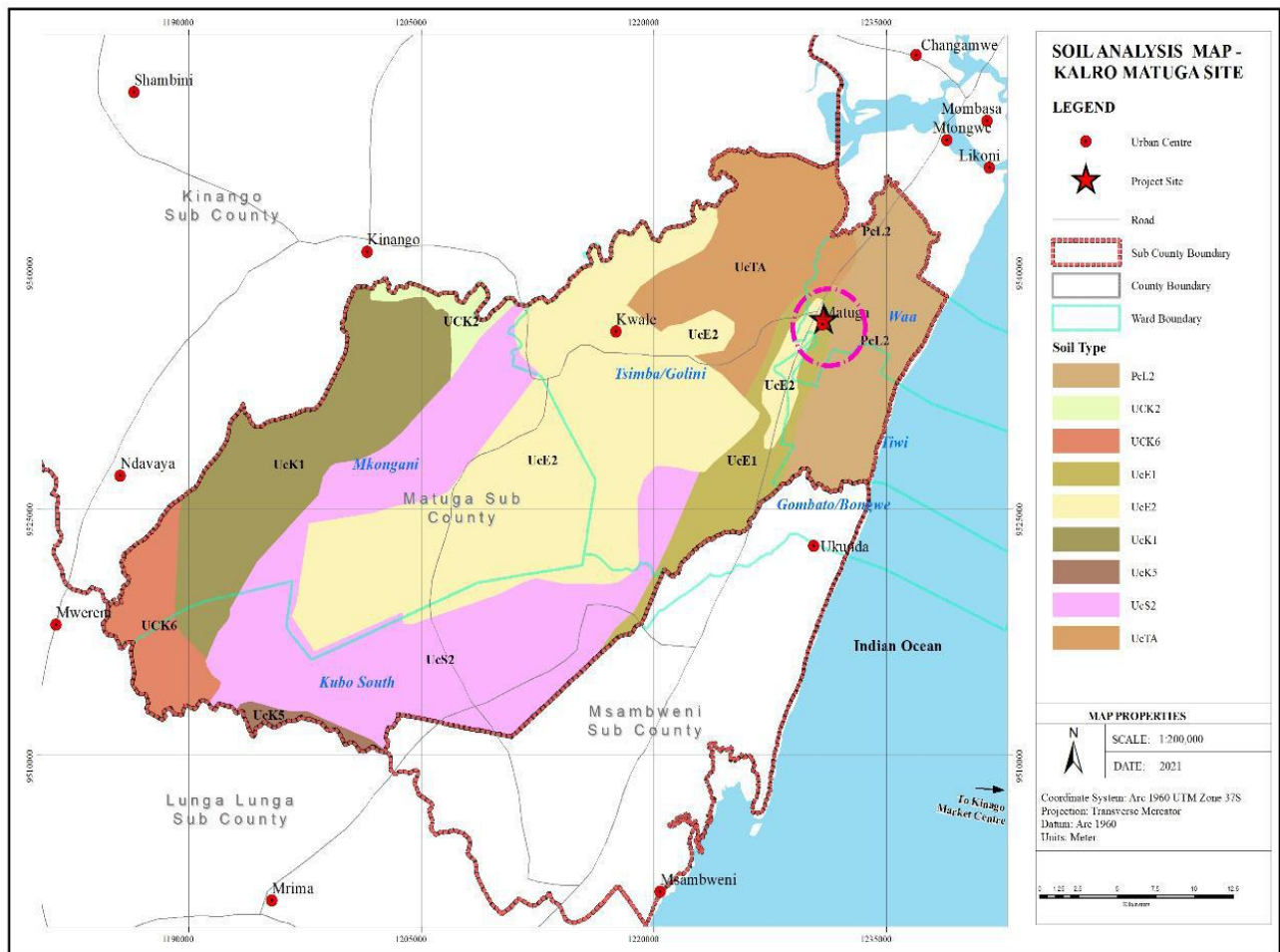
Matuga experiences tropical savanna climate. It is warm every month with both a wet and dry season. It is dry for 151 days a year with an average humidity of 76% and an UV-index of 7. The average temperature is about 30°C with maximum temperature of 32°C being experienced in

March and minimum temperature of 27°C experienced in July a month after the start of the southwest monsoon (also known as *Kusi*). Rainfall is bimodal with short rains (*Mvua ya Vuli*) being experienced from October to December, while the long rains (*Mvua ya Masika*) are experienced from March to May.

### 3.6.4 Soils

The common type of soil within Matuga KALRO station is Uce1. This type of soil is characterised by; well drained, extremely deep, dark red to yellowish red, friable clay: eutric NITISOLS

**Map 10: Soil Analysis Map for Matuga NPT Site within the sub-county context**



### 3.6.5 Hydrology

Matuga has about three streams that flow into River Ramisi which drains into Indian Ocean at Bodo. It has estimated volume of 8190 m<sup>3</sup>/day. The water quality of the river is good but desalinizes at destination.

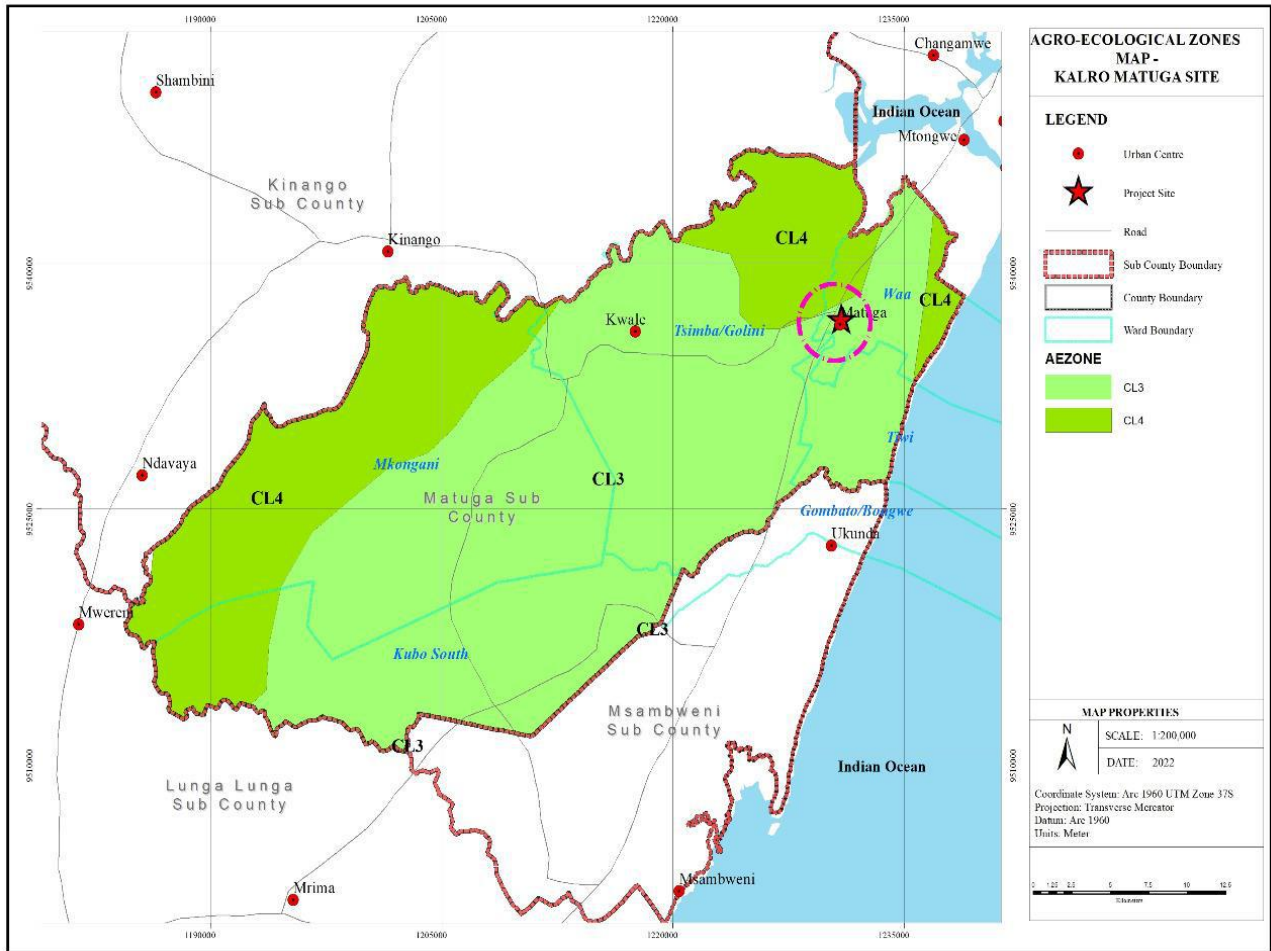
### 3.6.6 Agroecological zone

Matuga station lies within Coastal Lowland (CL3) agroecological zones. These zones are adaptable and suitable for various agricultural activities. CL 3 is commonly known as coconut - cassava zone with is Coastal Lowland Semi Humid and supports growth of tree crops, food crops and livestock rearing. The zone is consistent in supporting the crops shown in the table 10 below in both the 1<sup>st</sup> rainy season and throughout the year.

**Table 10: Suitable Crops for CL3 Agro-ecological Zone within Matuga NPT site**

<b>Agro ecological zone</b>	<b>Characteristics</b>
CL3 (Coastal Lowland Zones)	<i>Coconut-Cassava Zone - with a long to medium growing period, intermediate rains and a (weak) very short to short one</i>  <b>1<sup>st</sup> rainy season:</b> maize, white sorghum; sweet potatoes (on light soils fair only), cowpeas, dolichos beans; nearly all vegetables, esp. chillies, brinjals, tomatoes, onions, kales, cabbages (better in higher places), luffa gourds <b>Whole year:</b> coconuts, cassava, bixa, mangoes, bananas, pawpaws, avocados, sisal, pineapples, guavas, senna, castor, citrus

**Map 11: Agro-ecological zone for Matuga NPT Site within the sub-county context**



**3.6.7 Biodiversity**

Vegetation on site consists of trees, shrubs, grass and forbs. The centre farms several horticulture crops. Small mammals, reptiles such as monitor lizards, insects and avifauna inhabit the area.

**3.6.8. Present land use**

A larger portion of the station is vegetated with natural vegetation including different grass and tree species as other cultivated farms are planted with vegetables, fruits, flowers and medicinal aromatic plants

### **3.6.9 Water supply and sanitation**

The centre has a constant supply of water supplied sourced from Mwazidi stream. There are several toilets within the centre, both pit and flush.

### **3.6.10 Health Access**

The nearest health facility for the centre is Matuga sub-county hospital. The hospital will play a critical role during the NPTs in handling worker's injuries and accidents, control of spread of HIV/AIDS, COVID-19 management including vaccination and promotion of health through awareness creation.

## **3.7 KALRO Mtwapa NPT Site in Kilifi County**

### **3.7.1 Overview of KALRO Mtwapa Institute**

The Industrial Crops Research Institute was created by the Kenya Agricultural and Livestock Research Act of 2013 and is headquartered in Mtwapa in Kilifi County. Agricultural research in coastal Kenya dates back to 1957, when research on fruits (mainly citrus) was started at Matuga in Kwale County under the Ministry of Agriculture. In 1962, research was extended to Mtwapa mainly focusing on tree crops (coconut) research under the Coast Agricultural Research Station (CARS). In 1989 the Centre was renamed the Regional Research Centre Mtwapa under the Kenya Agricultural Research Institute (KARI).

The Institute caters for the main industrial crops except tea, coffee and sugar. These include cotton, sunflower, pyrethrum, barley, tobacco, sisal, coconut, cashew and bixa. Other industrial crops are kenaf, safflower, soybean and castor oil. Industrial crops provide a significant source of income to many people and are recognized as important in the attainment of the country's Vision 2030 and the national industrialization strategy.

The current challenges along the industrial crops value chains are low productivity, aged orchards, high infestation of pests and diseases and limited value addition due to lack of skills in processing and packaging. In addition, producers face marketing difficulties due to undeveloped marketing chains thus limiting the exploitation of the crops. Mtwapa Institute was one of the three KALRO stations where CFTs for the GM cassava resistant to CBSD were carried out

### 3.7.2 Location and Access

The Institute is located 20 km North of Mombasa City near Mtwapa Township, 200 m to the right of the Mombasa - Malindi Highway. The institute is adjacent to Mtwapa Country Resort. The coordinates for the institute are **-3.936385, 39.743050**. The institute is in Mtwapa township, Mtepeni Ward, Kikambala Division, Kilifi South subcounty in Kilifi County.

### 3.7.3 Climate

Mtwapa's climate is classified as tropical. In winter, there is much less rainfall in Mtwapa than in summer. The temperature here averages 26.0°C. In a year, the rainfall is 997 mm. Precipitation is the lowest in February, with an average of 16 mm. With an average of 228 mm, the most precipitation falls in May. At an average temperature of 27.7°C, March is the hottest month of the year. July has the lowest average temperature of the year. It is 24.1°C. Between the driest and wettest months, the difference in precipitation is 212 mm. During the year, the average temperatures vary by 3.6°C. The month with the highest relative humidity is May (79.9 %). The month with the lowest relative humidity is February (71.7 %).

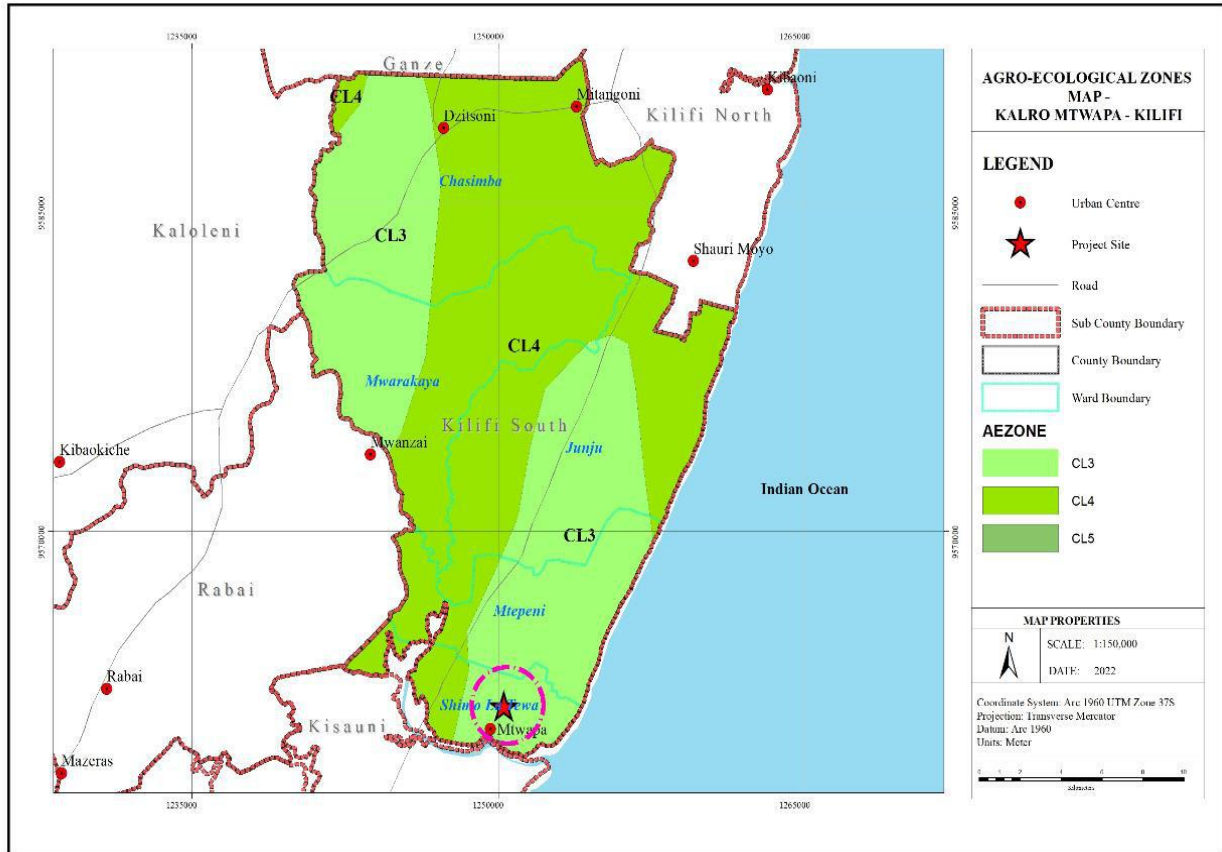
### 3.7.4 Ecological Conditions

Both Kilifi North and South sub counties are known as Coconut Cashew Nut – Cassava Zone. The regions lie between the altitude of 30 m and 310 m above mean sea level, with mean temperature of 27°C and an annual precipitation of 900 mm per annum. Mtwapa KALRO centre falls within CL3 agro-ecological zone. The Coastal low land AEZ supports various crops both in the long and short rains as well as across the whole year. The table below illustrates the suitable crops favourable for this zone.

Agro-ecological zone	Characteristics
CL3	<i>Coconut-Cassava Zone - with a medium cropping season, intermediate rains, and a (weak) short to very short one</i> <b>1<sup>st</sup> rainy season:</b> white sorghum; cowpeas, sweet potatoes; soya beans, sunflower, nearly all vegetables <b>2<sup>nd</sup> rainy season:</b> sweet potatoes, green grams, simsim, groundnuts <b>Whole year:</b> mangoes, sisal, avocados, bixa, pawpaws, guavas, senna, castor, cassava, pineapples



**Map 12: Agro-ecological for Mtwapa NPT Site within the sub-county context**

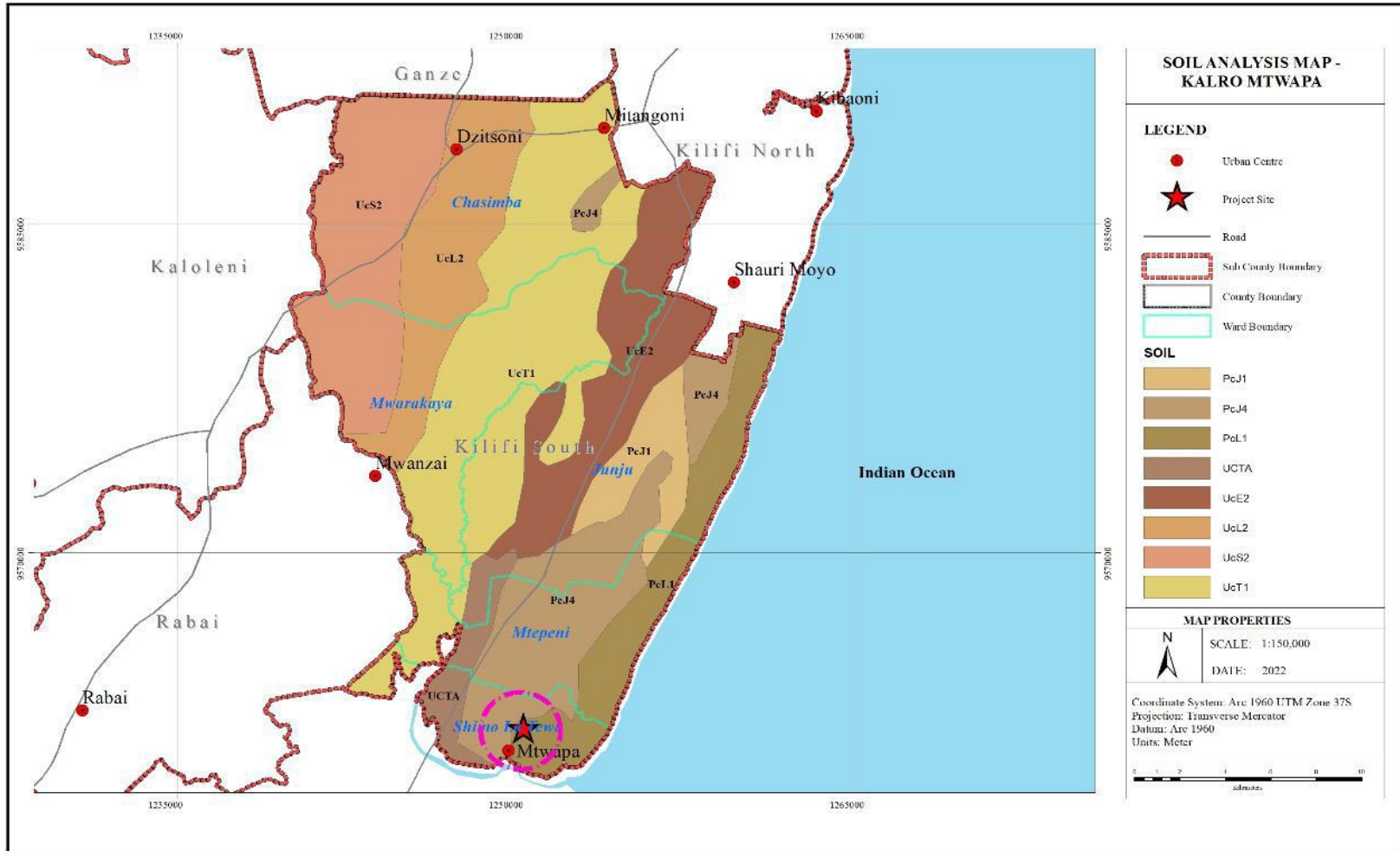


### 3.7.5 Geology and Soils

Geologically, the Kilifi South sub-county where the station lies is part of a system of Mesozoic and Cainozoic rocks, with a general Northeast- Southwest strike, deposited against the African shield. Outcrops of different ages and nature have boundaries, which run almost parallel to the coastline and so have landforms and soils.

The soil type within KALRO Mtwapa station is PcL1. This type of soil can be described to be Somewhat excessively drained to well drained, very deep, yellowish red to yellowish brown, loose to very friable, medium sand to loamy medium sand, 80 to 120 cm thick, overlying more than sandy loam to sandy clay loam: albic and ferralic ARENOSOLS. The map 12 below show the most dominant soil type within the NPT centre and around the entire Kilifi South Sub-County.

**Map 13: Soil Analysis Map for Mtwapa NPT Site within the sub-county context**



### **3.7.6 Topographic features**

This area is generally below 30m in altitude except northwards where the land rises to 60m in some places. The coastline consists of beaches, mangrove forests, dunes north of the Sabaki River, arid creeks of which the main ones are Mtwapa, Kilifi, Mida and Ngomeni. The creeks include marine swamps covered by mangrove forests.

### **3.7.7. Present land use**

A large portion of the farm is cultivated and grown with cotton, sunflower, bailey, sisal, coconut, sisal and cashew nuts for research purposes.

### **3.7.8 Water Access**

Kilifi South sub-county has great potential for shallow wells and has a high-water pipeline connectivity. Mtwapa KALRO research centres is supplied with water from an existing borehole.

### **3.7.9 Health Access**

Mtwapa town has several private health facilities with those nearing the project area being Blissfam Medical Centre, Oasis Medical Centre and Greenpark Hospital.

## **3.8 KALRO Msabaha NPT Site in Kilifi County**

### **3.8.1 Overview of the centre**

KALRO Msabaha centre is under the Dairy Research Institute headquartered in Naivasha. The Institute focuses on development and dissemination of appropriate sustainable innovations and cost-effective technologies to enhance productivity, food security and improved livelihoods.

### **3.8.2 Location and Access**

KALRO Msabaha is about 124km North of Mombasa town. The site is 300m off Mombasa-Malindi Highway. The centre is georeferenced at **-3.2663S +40.0519E**. The centre is situated in Msabaha area, Watamu ward in Malindi subcounty within Kilifi County. The centre is accessible through Mombasa-Malindi highway.

### **3.8.3 Climate**

In Msabaha area, the climate is tropical, hot all year round, with a cooler season from June to September, when the daytime temperatures are around 28°C, and a hotter and humid season from November to April, when the daytime temperatures are just above 30°C, with May and October as

intermediate months. The temperature in Malindi varies little throughout the year, but the differences are sufficient to make the warmest period more unpleasant, whose peak is reached in April, at the onset of the rains (see below). However, the heat is tempered by sea breezes.

As regards to the rainfall, it is not particularly abundant, in fact, it amounts to about 1,000 mm per year, however, there are two rainy seasons due to the two annual zenith passages of the sun (that is, when it shines directly overhead in the sky at mid-day), as often happens at the Equator. The presence of the sea, however, complicates a bit the situation. The rains are abundant from April to June, in the so-called "long rains season", and reach a peak in May, of about 300 mm. From July to September, there would be a dry season, but the south-east trade winds which prevail in this period are able to generate some thunderstorms, since the winds come from the sea, from which they collect heat and humidity, especially in the first part, that is, in July, when the sea is warmer. From December to March, there is another dry season, when showers are rare, especially in January and February, which are the driest months, and it almost never rains. In October and November, there would be the second rainy season, called "short rains season", which is more evident in other areas of Kenya.

#### **3.8.4 Topographic features**

Msabaha station falls within the coastal plain. The plain lies below 30 m above sea level with a few prominent peaks on the western boundary such as Mwembetungu hills. Across this plain are several creeks with excellent marine swamps that are richly endowed with mangrove forests and present great potential for marine culture. This zone is composed of marine sediments, including coral, limestone, marble, clay stones and alluvial deposits that support agriculture.

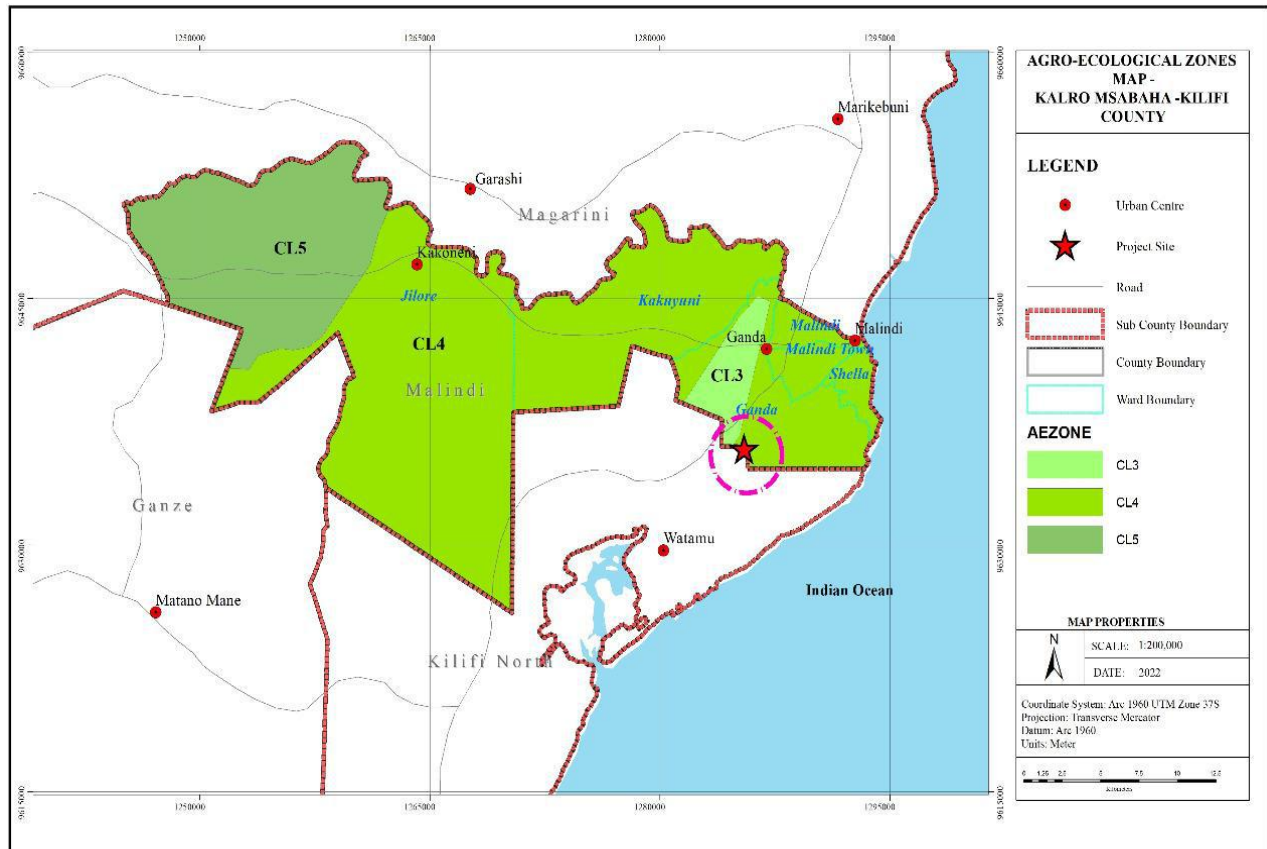
#### **3.8.5 Ecological conditions**

The Coconut-Cassava Zone covers the coastal uplands and the low-level coastal plains and has the highest potential for crop production in the county. The zone has a mean annual temperature of 24 °C. Msabaha station lies within CL4 agroecological zone which has the potential to support growth of various crops as shown in the table 11 below;

**Table 11: Favourable crops within CL4 Agro-ecological Zone in Msabaha NPT site**

Agro ecological zone	Characteristics
CL4	<p><i>Cashewnut-Cassava Zone - with a medium cropping season, followed by intermediate rains, and towards inland with a (weak) very uncertain 2nd rainy season</i></p> <p><b>1<sup>st</sup> Rainy Season:</b> maize, sorghum; sweet potatoes, soya beans, dolichos beans; kales, onions, okra, aubergines, sweet pepper, egg plants, chillies, chinese cabbage, water and sweet melons, cucumbers, pumpkins, zucchini, mchicha</p> <p><b>Whole year:</b> cashew nuts, cassava, sisal, mangoes, castor</p>

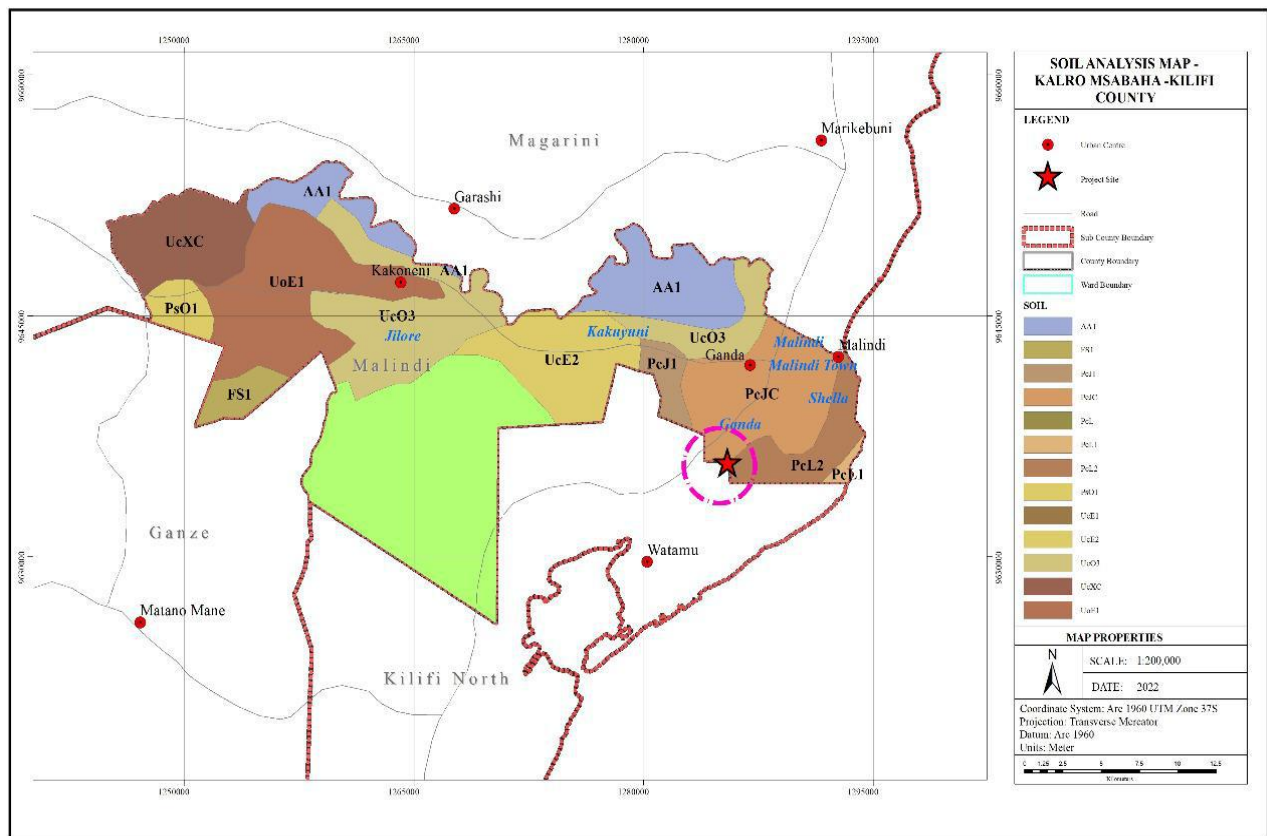
**Map 14: AEZ for Msabaha NPT Site within the sub-county context**



### 3.8.6 Geology and Soils

The geology of Mtwapa is made up of quaternary sediments. These are of Pleistocene (recent) era and occupy the areas immediately bordering the coastline. They consist of coral reefs, coral breccias, sandstones and sands of alluvial and marine nature. These soils here have developed on coral limestone and sands (Kilindini Sands). The soils are generally well drained and of loamy sand to sandy clay texture. The latter are also well-drained and are sandy to sandy loamy.

**Map 15: Soil Analysis for Msabaha NPT Site within the sub-county context**



### **3.8.7. Present land use**

The station rears livestock and has a huge plantation of mango trees. The farm also a great portion of grazing field for livestock feeding. There are also staff houses within the station.

### **3.8.8 Water Access**

Malindi Sub-County has the highest daily water demand at 30,637 m<sup>3</sup>/d. Msabaha centre gets its water from a borehole operated by the centre. Access to fresh water is a challenge considering salt intrusion in ground water.

### **3.8.9 Health Access**

In the Msabaha area, the nearest health facility is St. Mary's Msabaha Catholic Dispensary.

## **4.0 POLICY, LEGAL AND REGULATORY FRAMEWORK**

### **4.1. Introduction**

The EIA/EA Regulations require that relevant environmental guidelines and standards which include Kenya government policies and strategies, national legislation, multilateral environmental agreements and the institutional arrangements are reviewed during an ESIA process. This section therefore provides a review of the sets of policies, laws, regulations, international agreements as well as institutions relevant to the undertaking of the EIA for the GM cassava resistant to CBSD into the NPTs.

### **4.2. Policies**

#### **4.2.1. National Environmental Policy, 2013**

This broad aim of this policy is to protect the environment. This is a national policy which aims to develop, operate and maintain an efficient, cost effective, safe, secure and integrated transport system that links the transport policy with other sectoral policies, in order to achieve national and international development objectives in a socially, economically and environmentally sustainable manner.

#### ***Relevance***

*This policy offers the framework for an integrated approach to planning and sustainable management of natural resources. It also recognises the various vulnerable ecosystems and further recommends various policy measures in order to protect the quality of the environment.*

#### **4.2.2. The National Biodiversity Strategy, 2007**

The overall objective of the National Biodiversity Strategy and Action Plan (NBSAP) is to address the national and international undertakings elaborated in Article 6 of the Convention on Biological Diversity (CBD). It is a national framework of action to ensure that the present rate of biodiversity loss is reversed, and the present levels of biological resources are maintained at sustainable levels for posterity. The general objectives of the strategy are to conserve Kenya's biodiversity to sustainably use its components; to fairly and equitably share the benefits arising from the utilization of biological resources among the stakeholders; and to enhance technical and scientific cooperation nationally and internationally, including the exchange of information in support of



biological conservation. The project falls in an area with no protected habitats. Therefore, should the project encounter endangered flora and fauna then their conservation is of primary importance.

#### **4.2.3. National Root and Tuber Crops Development Strategy 2019-2022**

This strategy has been developed to provide a clear roadmap for sustainable growth and development of the root and tuber crops subsector. It aims at accelerating the growth of agriculture sector in order to improve the standard of living of Kenyans by substantially reducing the number of people affected by hunger, famine and starvation. A thriving agriculture sector will lead to increased production, incomes and employment opportunities. This strategy will ensure well-functioning producer institutions and markets, availability of quality planting materials, economic volumes and opportunities for processing, employment creation and increased incomes. Implementation of this strategy will take an integrated approach where all stakeholders will be involved in a coordinated manner to achieve the desired results.

#### **4.2.4. National Gender and Development Policy, 2011**

The National Gender and Development Policy provides a framework for advancement of gender equity and an approach that would lead to greater efficiency in resource allocation and utilization to ensure empowerment of women. The National Policy on Gender and Development is consistent with the Government's efforts of spurring economic growth and thereby reducing poverty and unemployment, by considering the needs and aspirations of all Kenyan men, women, boys and girls across economic, social and cultural lines. The policy is also consistent with the Government's commitment to implementing the National Plan of Action based on the Beijing Platform for Action (PFA).

The overall objective of the Gender and Development Policy is to facilitate the mainstreaming of the needs and concerns of men and women in all areas in the development process in the country. This law will be of relevance to the proponent in ensuring that all genders are given an equal opportunity during recruitment during the operation phases of the project. The proponent will also provide adequate facilities for all genders within the project sites.

#### **4.2.5. The Sustainable Development Goals**

The 2030 Agenda comprises 17 new Sustainable Development Goals (SDGs), or Global Goals, which will guide policy and funding for the next 15 years, beginning with a historic pledge to end poverty. The concept of the SDGs was born at the United Nations Conference on Sustainable

Development, Rio+20, in 2012. The objective was to produce a set of universally applicable goals that balances the three dimensions of sustainable development: environmental, social, and economic. The MDGs drove progress in several important areas:

- Income poverty
- Access to improved sources of water
- Primary school enrolment
- Child mortality

With the job unfinished for millions of people—we need to go the last mile on ending hunger, achieving full gender equality, improving health services and getting every child into school. Now we must shift the world onto a sustainable path. The Global Goals aim to do just that, with 2030 as the target date. This new development agenda applies to all countries, promotes peaceful and inclusive societies, creates better jobs and tackles the environmental challenges of our time—particularly climate change.

### **4.3. Legal Framework**

#### **4.3.1. Constitution of Kenya, 2010**

Article 42 states that every person has the right to a clean and healthy environment. The constitution provides guidance on steps that may be taken in case any of any infringement on these rights. In addition, the constitution provides for the establishment systems for carrying out environmental impact assessment, environmental audit and monitoring of the environment.

In addition to the protection of the environment, the constitution states that the land in Kenya belongs to the people of Kenya collectively as a nation. Chapter 5 deals with the land and environment with part two providing the obligations of a developer with regards to environmental protection.

#### ***Relevance***

*The proponent and NPT site supervisors must ensure that all the activities pertaining to the trials do not infringe on the right of the people of clean and health environment.*

#### **4.3.2. Biosafety Act 2009**

Biosafety Act, 2009 Part III Section 18 (1) states that a person shall not conduct any contained use activity involving genetically modified organisms without the written approval of the National

Biosafety Authority. Section 19 (1) of the Act states that no person shall introduce into the environment a genetically modified organism without the written approval of the Authority. Section 20 (1) emphasizes that no person is allowed to import into Kenya a genetically modified organism without written approval of the Authority.

This law is an Act of Parliament to regulate activities in genetically modified organisms, to establish the National Biosafety Authority, and for connected purposes. This Act may be cited as the Biosafety Act, 2009 and came into operation 1 July 2011.

### ***Relevance***

*An application was made to NBA to approve environmental release of the GM cassava and the authority has given a green light for the proponent to conduct NPTs on condition that other statutory requirements such as initiating an EIA study are met.*

### **4.3.3. Water Act 2016**

Part II, section 18, of the Water Act, 2016 provides for national monitoring and information systems on water resources. Following on this, sub-section 3 allows the Water Resources Authority to demand from any person or institution, specified information, documents, samples or materials on water resources. Under these rules, specific records may require to be kept by a facility operator and the information thereof furnished to the authority.

Section 73 of the Act allows a person with license (licensee) to supply water to make regulations for purposes of protecting against degradation of water sources. Section 75 and sub-section 1 allows the licensee to construct and maintain drains, sewers and other works for intercepting, treating or disposing of any foul water arising or flowing upon land for preventing pollution of water sources within their jurisdiction.

### ***Relevance***

*The proponent will ensure that NPT sites that near water bodies do not pollute the water resources through surface runoff and/or soil erosion.*

### **4.3.4. Public Health Act (Cap 242)**

The Public Health Act is the principal instrument for ensuring the health and safety of the people. Its core function is the prevention of disease, treatment and care of the sick (curative services) and control of nuisance. The Act therefore makes regulations and lays standards for a healthy living

environment. Part XI Section 129 of the Act places the responsibility of protecting water supplies on the local authorities. The Ministry of Health is in charge of administration of the Act, with the Director of Medical Services as the Principal Officer. However, where a municipality is capable of discharging responsibilities under the Act, such a municipality is designated as a local health authority. In such a situation, the relevant powers under the Act are delegated to the municipality, but the Director of Medical Services may take over if the Authority is in default. During the execution of the proposed project, this Act is relevant in various ways. The Director of Public Health is a member of the National Biosafety Board due to the significant role of the sector in modern biotechnology.

#### **4.3.5. Agriculture Act (cap 318)**

The Agriculture Act (cap 318) is the principal land use statute covering inter alia soil conservation agricultural land use and conservation issues such as the preservation of soil fertility. The Act prohibits any land use practices that may intensify soil erosion. The act prohibits cutting down or destroying vegetation on any land of which the slope is 35 per cent. The rules stipulate strict regulations on the cultivation of any land whose slope is between 12 percent and 35 per cent when the soil is not properly protected from erosion. The Act also provides for protection of watercourses setting aside a riparian zone of a minimum 2 meters equivalent to the width of river to a maximum of 30 meters.

#### ***Relevance***

*The act is important because the proposed project impacts on land use and the agricultural sector once the project is commercialised.*

#### **4.3.6. Seeds and Plant Varieties Act Cap 326**

Section (4) states that subject to the provisions of this section, it shall be an offence— (a) to sell seed of a new plant variety to which this section applies; or (b) to advertise any such seed for use, until seed of that plant variety has been submitted for the purpose of performance trials in accordance with this section, and until a report on the result of such trials has been published in the prescribed manner, and this subsection shall apply whether or not an offer or advertisement relates only to sales after the trials and report.

### ***Relevance***

*The proponent has adhered to this Act by following the right procedure for release of the GM cassava to the environment through an application to NBA and after the NPTs, placing in the market.*

#### **4.3.7. Food, Drugs and Chemical Substances Act (CAP 254)**

This Act (which has been invoked for the consumption of genetically modified food), requires that food, drugs, cosmetics, devices and chemical substances should not be sold if they are unwholesome, poisonous, or adulterated. It further prohibits deceptive labelling. The statute also gives powers to authorized officers to inspect and examine any premises for evidence of contravention of the provisions of the law. There is thus no explicit policy and legal framework for the development and introduction of modern biotechnology in Kenya. All concerned parties must comply with this Act,

#### **4.3.8. Environmental Management and Coordination Act (EMCA) of 1999, (Amended-2015).**

**Part II** of the Act states that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. **Part VIII, Section 72**, prohibits discharging or applying poisonous, toxic, noxious or obstructing matter, radioactive or any other pollutants into aquatic environments. **Section 74** demands that all effluent generated from the sources are discharged only into the existing sewerage system upon issuance of the prescribed permits from approving authorities. The act categorizes all the projects that require EIA among other environmental assessments. The Act shall therefore, highlight all projects that may require; EIA as per the requirements of Environmental Management and Coordination Act (EMCA).

### ***Relevance***

*This is the Act provides the basis for undertaking of EIA in Kenya. It highlights all projects that require EIA and identifies this proposed project as a high-risk project that requires EIA study Report. In addition, it establishes NEMA which is the regulatory authority that will approve this report.*

#### **4.3.9. The Occupational Health and Safety Act (2007)**

This is an Act of Parliament to provide for the safety, health and welfare of workers and all persons lawfully present at workplaces, to provide for the establishment of the National Council for Occupational Safety and Health and for connected purposes. The Act has the following functions among others:

- Secures safety and health for people legally in all workplaces,
- Prevents employment of children in workplaces where their safety and health is at risk,
- Encourages entrepreneurs to set achievable safety targets for their enterprises,
- Promotes reporting of work-place accidents, dangerous occurrences and ill health with a view to finding out their causes and preventing of similar occurrences in future, and
- Promotes creation of a safety culture at workplaces through education and training in occupational safety and health.

#### ***Relevance***

*Workers safety at workplace is regarded as an important component of protecting them from any work-related injuries. Therefore, this Act promotes advocates for a safe, healthy and a sound welfare for all workers in their workplaces. All workers to work in al the 7 NPT sites will be protected by the provisions of this Act which are well captured in the existing KALRO human resource management policy.*

#### **4.3.10. Sexual Offences Act No.3 of 2006**

The Act defines sexual offences and makes provisions for prevention and the protection of all persons from harm resulting from unlawful sexual acts. The Act describes the types of sexual offences punishable by law and this includes rape, attempted rape, assault, defilement, gang rape, and indecent act with a child or adult, promotion of sexual offence with children, child trafficking, child sex tourism, and child prostitution, child pornography, and sexual harassment, cultural and religious sexual offences, among others. Section 8 Sub section 2 states that if the person commits an offence of defilement with a child aged eleven years or less shall upon conviction be sentenced to imprisonment for life.

Section 3 explains that any person who commits an offence of defilement with a child between the age of twelve and fifteen years is liable upon conviction to imprisonment for a term of not less

than twenty years. Section 23 warns those in a position of authority, or holding a public office, from persistently making sexual advances or requests which are unwelcome and states that they will be guilty of the offence of sexual harassment and shall be liable to imprisonment for a term of not less than three years or to a fine of not less than one hundred thousand shillings or to both.

***Relevance***

*The Act empowers Kenyans to take legal action in the event of a sexual offence. The code of conduct for the proposed NPTs should uphold the provisions of this law.*

**4.3.11. The Work Injury Benefits Act (WIBA), 2007**

The WIBA Act provides for compensation to employees for work related injuries and diseases contracted in the course of their employment and for connected purposes. Section 7(a) of the Act, on the obligations of the employer, requires an employer to obtain and maintain an insurance policy with an insurer approved by the State in respect of any liability that the employer may incur under this Act to any of his employees.

Section 10(1) States that an employee who is involved in an accident resulting in the employee's disablement or death is subject to the provisions of this Act and entitled to the benefits provided for under this Act. It also states explicitly that an employer is liable to pay compensation in accordance with the provisions of this Act to an employee injured while at work.

On First Aid covered in section 45(1), an employer is supposed to provide and maintain such appliances and services for the rendering of first aid to the employees in case of any accident as may be prescribed in any other written law in respect of the trade or business in which the employer is engaged.

***Relevance***

*Casual workers who may be employed by the proponent or even those already working on the selected sites may face challenges to their health and safety during the activities of the proposed NPTs. WIBA offers legal backing on the incidents or accidents at the workplace or while on duty, including First Aid and compensation aspects. It is thus important to integrate the relevant provisions of this Act in the proposed project activities.*

#### **4.4. Regulatory Framework**

##### **4.4.1. Biosafety (Environmental Release) regulations, 2011**

Section 5(1) states that no person shall make an environmental release without the written approval of the Authority. Section 6: Where the application is for introduction into the environment of a genetically modified organism that is not locally developed, the Authority, after a risk assessment, may require that the applicant carries out field trials of the genetically modified organism and the provisions of the Contained Use Regulations shall apply.

##### **4.4.2. Environmental (Impact Assessment and Audit) Regulations, 2003**

The Environmental (Impact Assessment and Audit) Regulations of 2003 provide guidelines on conduct, report preparation, submission, and other relevant information on EIA/EA studies. It outlines the methodology of carrying out EIA and contents of an EIA study report.

The EIA and Audit Regulations state in Regulation 3 that “the regulations should apply to all policies, plans, programmes, projects and activities specified in Part IV, Part V and the Second Schedule of the Act. Part II of the Regulations indicates the procedures to be taken during preparation, submission and approval of this project report. The Regulation also stipulates when Environmental Audits in a bid to promote environmental soundness.

#### **Relevance**

*The proposed project must undergo Environment Impact Assessment and a report written following the outline recommended in this regulation. It also recommends the period under which an Environmental Audit will be conducted.*

##### **4.4.3. Water Quality Regulations, 2006, (Legal Notice No.121)**

Water Quality Regulations apply to water used for domestic, industrial, agricultural and recreational purposes; water used for fisheries and wildlife purposes; and water used for any other purposes. Different standards apply to different uses. These regulations provide for the protection of lakes, rivers, streams springs, wells and other sources. The overriding objective of the regulations is to protect human health and the environment. Proper enforcement of the regulations can lead to marked reduction in water-borne diseases. The regulations provide guidelines and standards for the discharge of poisons, toxins, radioactive and other pollutants into the aquatic



environment. Standards have also been set for discharge of effluent into the sewer and aquatic environment. The National Environment Management Authority regulates discharge into the aquatic environment.

The regulations provide for the creation of a buffer zone for irrigation schemes of at least fifty (50) metres in width between the irrigation scheme and the natural water body. The Ninth Schedule of the Regulations stipulates standards for irrigation water. Persons (real or legal) discharging effluent into the environment are required to submit quarterly discharge monitoring records to NEMA.

#### **4.4.4. Environmental Management and Coordination (Waste Management) Regulations, 2006**

This regulation was published in the Kenya Gazette Supplement No. 69, Legislative Supplement No. 37, and Legal Notice No. 121 of 29<sup>th</sup> September 2006. The regulations provide details on management (handling, storage, transportation, treatment and disposal) of various waste streams including:

- Domestic waste;
- Industrial waste;
- Hazardous and toxic waste;
- Pesticides and toxic substances;
- Biomedical wastes; and
- Radioactive waste.

Regulation No. 4 (1) makes it an offence for any person to dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle. Regulation 5 (1) provides categories of cleaner production methods that should be adopted by waste generators in order to minimize the amount of waste generated and they include:

(i) Improvement of production process through

- Conserving raw materials and energy;
- Eliminating the use of toxic raw materials and wastes; and
- Reducing toxic emissions and wastes.

(ii) Monitoring the product cycle from beginning to end by

- Identifying and eliminating potential negative impacts of the product;
- Enabling the recovery and re-use of the product where possible;

- Reclamation and recycling; and
- Incorporating environmental concerns in the design and disposal of a product.

Regulation 6 requires waste generators to segregate waste by separating hazardous waste from non-hazardous waste for appropriate disposal. Regulation 15 prohibits any industry from discharging or disposing of any untreated waste in any state into the environment. Regulation 17 (1) makes it an offence for any person to engage in any activity likely to generate any hazardous waste without a valid EIA licence issued by NEMA.

### **Relevance**

*The project activities during planting, growing and harvesting seasons are anticipated to generate waste in form of wrappings, used PPEs, food leftovers, stripped off vegetation etc. All these sorts of wastes should be disposed as per the guidelines stipulated in the regulations.*

## **4.5. Relevant Multilateral Environmental Agreements (MEAs)**

### **4.5.1. Introduction**

A multilateral environmental agreement (MEA) is a legally binding agreement between three or more states relating to the environment. They are predominantly produced by the United Nations. It is called a bilateral environmental agreement if the agreement is between two nation states.

### **4.5.2. Cartagena Protocol on Biosafety**

The **Cartagena Protocol on Biosafety** is an international agreement on biosafety, as a supplement to the Convention on Biological Diversity. The Biosafety Protocol seeks to protect biological diversity from the potential risks posed by genetically modified organisms resulting from modern biotechnology.

The Biosafety Protocol makes clear that products from new technologies must be based on the precautionary approach and allow developing nations to balance public health against economic benefits. The Protocol for example, lets countries exercise stricter regulatory oversight for genetically modified organisms if they feel there is not enough scientific evidence that the modified product is safe or let countries proceed with use of such products where there is considerable experience in use of the product.

The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result.

#### **4.5.3. Convention on Biological Diversity (CBD-1992)**

Article 14 of the CBD (Impact Assessment and Minimizing Adverse Impacts) calls on member states to take measures to prevent the degradation of systems that support biodiversity such as seas and oceans. Specifically, the Convention calls upon contracting Parties to act as follows:

- i) Introduce appropriate procedures requiring Environmental Impact Assessment and audits of its proposed or on-going projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effects and, where appropriate, allow for public participation in such procedures;
- ii) Introduce appropriate arrangements to ensure that the environmental consequences of its programmes and policies that are likely to have significant adverse impacts on biological diversity are duly taken into account;
- iii) Promote, on the basis of reciprocity, notification, exchange of information and consultation on activities under their jurisdiction or control which are likely to significantly affect adversely the biological diversity of other States or areas beyond the limits of national jurisdiction, by encouraging the conclusion of bilateral, regional or multilateral arrangements, as appropriate;
- iv) In the case of imminent or grave danger or damage, originating under its jurisdiction or control, to biological diversity within the area under jurisdiction of other States or in areas beyond the limits of national jurisdiction, notify immediately the potentially affected States of such danger or damage, as well as initiate action to prevent or minimize such danger or damage; and
- v) Promote national arrangements for emergency responses to activities or events, whether caused naturally or otherwise, which present a grave and imminent danger to biological diversity and encourage international cooperation to supplement such national efforts and, where appropriate and agreed by the States or regional economic integration organizations concerned, to establish joint contingency plans.

#### **4.5.4. The International Union for the Protection of New Varieties of Plants (UPOV)**

The International Union for the Protection of New Varieties of Plants (UPOV) is an intergovernmental organization based in Geneva, Switzerland. UPOV was established in 1961. The mission of UPOV is to provide and promote an effective system of plant variety protection, with the aim of encouraging the development of new varieties of plants, for the benefit of society. The UPOV Convention provides the basis for members to encourage plant breeding by granting breeders of new plant varieties an intellectual property right: the breeder's right. The Convention is domesticated in Kenya in the Seeds and Plant Varieties (Plant Breeder's Rights), Regulations, 1994 (2002) within Chapter 326 - The Seeds and Plant Varieties Act (1991).

### **4.6. Institutional Framework**

#### **4.6.1. Introduction**

Environmental management is highly interdisciplinary and transcends legal and institutional differentiation. Therefore, the legal and regulatory framework outlined in the preceding section and the specific institutional roles refers to relevant institutions with regards to this project. NEMA works in tandem with over 20 institutions and departments in dealing with environmental issues in the country. Key among them being Kenya Forest Service; the Kenya Wildlife Service (KWS); Ministry of Agriculture, Livestock, Fisheries and Cooperatives; Ministry of Water, Irrigation and Sanitation; the Kenya Forestry Research Institute (KEFRI); the National Museums of Kenya (NMK); the Kenya Agricultural and Livestock Research Organization (KALRO); the Kenya Marine and Fisheries Research Institute (KEMFRI); and Regional Development Authorities. The Ministry of Environment and Forestry is the parent ministry for the NEMA, and the authority works closely with other directorates and departments of the ministry.

Under EMCA, several institutions have been established, but there are two key ones i.e., the National Environment Council (NEC) and the National Environmental Management Authority (NEMA). In addition, matters of modern biotechnology are dealt with under the lead agency called the National Biosafety Authority. In the Biosafety Act, there are 8 regulatory agencies listed in the First Schedule that should work in harmony to regulate and monitor genetic engineering.

#### **4.6.2. National Environment Council**

NEC is chaired by the Minister for Environment and Natural Resources with membership from all relevant ministries as well as a broad range of other interests. It functions to formulate national policies, goals, and objectives and the determination of policies and priorities for environmental protection. The Council also promotes co-operation among all the players engaged in environmental protection programmes.

#### **4.6.3. National Environment Complaints Committee**

The National Environmental Complaints Committee (NECC) was established under Section 31 of the Environmental Management and Co-ordination Act, 1999. It was formerly known as the Public Complaints Committee (PCC) but its name changed in the EMCA (Amendment) No. 5 of 2015). It is an important institution in the assessment of the condition of the environment in Kenya. It plays an important role in the facilitation of alternative dispute resolution mechanisms relating to environmental matters. The NECC makes recommendations to the Cabinet Secretary and thus contributes significantly to the formulation and development of environmental policy. The membership of NECC is drawn from key stakeholders in environmental management.

The Committee consists of seven members headed by a chairperson, who is appointed by the Cabinet Secretary and qualifies to be a judge of the Environment and Land Court of Kenya. Other members are; a representative of the Attorney General, a representative of the Law Society of Kenya, one person who has demonstrated competence in environmental matters to be nominated by the Council of Governors and who is the Secretary to the Committee, a representative of the business community and two members, appointed by the Cabinet Secretary for their active role in environmental management.

#### **4.6.4. National Environment Management Authority**

NEMA is a corporate body responsible for the administration of the EMCA 1999 (Amended, 2015). The Authority is headed by Director General appointed by the President on recommendation of the board. The authority functions include the coordination of various environmental management activities, initiation of legislative proposals and submission of such proposals to the Attorney General, research, investigations and surveys in the field of environment. NEMA also undertake to enhance environmental education and awareness on the need of sound environmental management. In addition, NEMA advises the Government on regional and

international agreements to which Kenya should be a party and issue of an annual report on the state of environment in Kenya. NEMA is charged with the responsibility of the execution of EIA and Environmental Audit (EA) as well as provisions of other Legal Notices emanating from EMCA, 1999 (Amended, 2015). NEMA has initiated various Regulations so as to fully operationalize the EMCA 1999 (Amended, 2015). The Authority implements policies relating to approval, through NBA, and conducts environmental impact assessment of GMOs intended for release into the environment.

#### **4.6.5. Kenya Plant Health Inspectorate Service**

KEPHIS is a State Corporation under the Ministry of Agriculture, Livestock and Fisheries that is mandated to regulate and facilitate all plant materials coming into the country or produced locally. They are responsible for implementing phytosanitary and quarantine measures. They are also mandated to implement the national policy on the introduction and use of GM plant species in liaison with the NBA. KEPHIS is also responsible for regulating imports of GM seeds. KEPHIS is the lead Agency in the conduct of NPTs to ensure the country is compliant with the UPOV convention and the Seeds and Plant Varieties Act.

#### **4.6.6. National Commission for Science, Technology and Innovation**

The National Commission for Science Technology and Innovation is a body corporate established under the Science, Technology and Innovation Act, No. 28 of 2013, succeeding the National Council for Science and Technology which was in operation since 1977. The Commission is mandated to regulate and assure quality in the science, technology and innovation sector and advise the government on matters related thereto. The Commission is managed by a Board appointed by the Cabinet Secretary responsible for matters of science and technology and is a member of the National Biosafety Authority Board.

#### **4.6.7. National Biosafety Authority**

The National Biosafety Authority (NBA) was established by the Biosafety Act No. 2 of 2009 to exercise general supervision and control over the transfer, handling and use of genetically modified organisms (GMOs). The objective and purpose for which the Authority was established is to regulate research and commercial activities involving GMOs with a view to ensuring safety of human and animal health and provision of an adequate level of protection of the environment. To achieve this objective, the Authority has established a transparent science-based process to guide

decision making on applications for approval of research and commercial activities involving GMOs.

The NBA implements the Cartagena Protocol on Biosafety, a protocol under the Convention on Biological Diversity, which Kenya has also signed and ratified, in order to address safety for the environment and human health in relation to modern biotechnology. The National Biosafety Authority is under the Ministry of Education, Science and Technology and has the following duties and responsibilities:

- Creating a National Biosafety Clearing House (BCH) where information on all approvals is posted.
- Data sharing with the International Biosafety Clearing House located in Montreal Canada.
- NBA is Kenya's Focal Point for Cartagena Protocol on Biosafety which Kenya has signed and ratified.
- Co-ordinating Biotechnology and Biosafety issues in the country to all the relevant stakeholders.
- Collaborating with relevant Government Departments and University faculties, to develop strategies in the fields of Biotechnology and Biochemistry.
- Conducting Environmental Risk Assessment for all GMO and products of modern biotechnology.

To do this, the NBA board is comprised of representatives of the following institutions.

1. Department of Public Health.
2. National Commission for Science Technology and Innovation
3. Ministry of Agriculture, Livestock, Fisheries and Cooperatives.
4. Ministry of Education Science and Technology
5. Ministry of Finance

#### **4.6.8. Kenya Agricultural and Livestock Research Organization**

KALRO is a corporate body created under the Kenya Agricultural and Livestock Research Act of 2013 to establish suitable legal and institutional framework for coordination of agricultural research in Kenya with the following goals:

- Promote, streamline, co-ordinate and regulate research in crops, livestock, genetic resources and biotechnology in Kenya.
- Expedite equitable access to research information, resources and technology and promote the application of research findings and technology in the field of agriculture.

The mandate of KALRO as stated in the KALRO Act is to:

- (a) formulate policy and make policy recommendations to the Cabinet Secretary on agricultural research;
- (b) prioritise areas for, and co-ordinate, agricultural research in Kenya in line with the national policy on agriculture;
- (c) determine and advise the Government on the resource requirements for agricultural research in Kenya both at the national and county level;
- (d) regulate, monitor and ensure that all agricultural research undertaken by research institutes and other institutions or persons undertaking agricultural research is consistent with the national priorities specified in the relevant policy documents;
- (e) establish and exercise control over the research institutes, committees and research centres established pursuant to this Act;
- (f) formulate or approve medium and long-term research plans, strategies and budgets of research institutes, committees and organisations established pursuant to this Act;
- (g) provide grants to research institutes and persons desirous of carrying out research and training programs which are consistent with the national research priorities and plans of the Organisation;
- (h) support and promote the training and capacity building in relation to agricultural research;
- (i) promote the dissemination and application of research findings in the field of agriculture and the establishment of a Science Park;
- (j) liaise with and ensure the co-ordination of institutions, agencies and persons involved in agricultural research;
- (k) establish platforms for the purposes sharing of research information, advancing research and transfer of technology and dissemination of information relating to advancements made in agricultural research;
- (l) ensure continuance of performance improvement in the field of agricultural research; and



(m) perform such other functions as may be conferred on it by this Act or any other written law.

## **5.0 CONSULTATION AND PUBLIC PARTICIPATION**

### **5.1 Introduction**

The Public Participation Process is a policy requirement by the Government of Kenya (CoK, 2010) and a mandatory procedure as stipulated by EMCA 1999 (Amended 2015) section 58, on ESIA. It is an important process through which stakeholders including beneficiaries and members of public living within the project sites, both public and private, are given an opportunity to contribute to the overall project undertakings by making recommendations and raising project concerns before they are implemented. In addition, the process creates a sense of responsibility, commitment and local ownership for smooth implementation.

The role of public consultation and involvement in ESIA process is to assure the quality, comprehensiveness and effectiveness of the assessment and ensure that the public views are adequately taken into consideration in the decision-making process. This chapter describes the process of the public consultation and participation that was followed in order to identify the key issues and impacts of the proposed NPTs for genetically modified cassava resistant to CBSD and CMD at seven KALRO centres.

### **5.2 Objectives of Consultation and Public Participation**

The objectives and purpose of the stakeholder's consultation and participation was to:

- Disseminate and inform the stakeholders about the project with special reference to its key components and location,
- Create awareness among the public on the need for the ESIA for the proposed NPT,
- Gather comments, suggestions and concerns of the interested and affected parties,
- Enhance ownership of the project by local leadership, the community and local cassava farmers,
- Understand and characterize potential environmental and socio-economic impacts of the NPT sites,
- Incorporate the information collected in the ESIA study, and
- Comply with EMCA 1999 (Amended, 2015) Section 58 regulations.

In addition, the process enabled the establishment of communication and the fostering of a synergy channel among the general public, consultant, project proponent and both county and national

governments. The views collected were very crucial in helping decision makers to fully understand the concerns of the stakeholders and the anticipated impacts of the project at an early phase of project planning.

### **5.3 Methodology for conducting CPP**

Stakeholder's engagement started from an early stage of the scoping and continued throughout the assessment to ensure legislative requirements and standards were met. Just as the degree of stakeholder relevance may vary throughout the Project lifecycle, the most appropriate communication and consultation method also vary between stakeholders. Consultation with stakeholders was initiated by undertaking stakeholder analysis and identification. The stakeholder identification and analysis were undertaken by the consultant in close collaboration with the proponent (KALRO).

The stakeholders were categorized into two major groups;

- a. Primary Stakeholders - Those directly affected by the project such as cassava farmers around the proposed NPT sites and the KALRO staff within the selected stations.
- b. Secondary Stakeholders – Those indirectly affected by the project but who influence development as part of its project implementation. They included the responsible agencies of both the County and National Government as well as civil organizations.

Both participatory methods and analytical tools were applied to ensure the inclusion of the opinions of all stakeholders. Data collection involved consultations meetings held with cassava farmers and KALRO staff, discussions and interviews with key informants and administration of questionnaires.

#### **5.3.1 Questionnaire Administration**

The consultant prepared questionnaires which were administered to cassava farmers, KALRO staff and key informants within the NPT project areas. The questionnaires were mainly open-ended in order to give the target groups an opportunity to express their views and concerns appropriately and widely. These instruments of data collection were then analysed, and information synthesized in this ESIA report.

### 5.3.2 Public Fora (Barazas)

Public participation meetings were held in the seven KALRO stations as a way of reaching as many stakeholders as possible. The meetings aimed at giving an opportunity to the stakeholder community to express their views, fears and expectations, if any, about the proposed NPTs. The main objective of the meetings was to share information on the proposed project with the farmers and staff within the stations and also accord them the chance to further express their views about the undertaking. However, due to the prevailing COVID-19 pandemic, all precautionary measures were taken by the consultant by ensuring that; social distancing was maintained, all members had face masks on, sanitizers were availed, and a limited number of attendees are allowed to avoid congestion and any possible spread of the diseases.

**Table 12: A list of Consultative Public Meetings Held within NPT Sites**

S/No.	VENUE/COUNTY	NATURE OF MEETING	DATE	NUMBER OF PARTICIPANTS
1.	KALRO Kakamega in Kakamega County	Public baraza	14/01/2022	24
2.	KALRO Alupe in Busia County	Public baraza	13/01/2022	25
3.	Oyani Farm in Migori County	Public baraza	12/01/2022	37
4.	KALRO Msabaha in Kilifi County	Public baraza	07/01/2022	31
5.	KALRO Mtwapa in Kilifi County	Public baraza	07/01/2022	36
6.	KALRO Matuga in Kwale County	Public baraza	06/01/2022	36
7.	KALRO Kiboko in Makueni County	Public baraza	05/01/2022	34



**Figure 3: Public Barazas with local cassava farmers and KALRO staff across the NPT Sites**  
(Source: Field Survey, 2022)

### 5.3.3 Key Informants Interview

These interviews aimed at obtaining responses from both National and County Government officials from the 6 counties where the NPT sites are situated. These officials included representatives from the Ministry of Interior and Coordination of National Government particularly the ACCs and DCCs as well as selected county departmental representatives within the regions where the NPT sites are located. Some of the sub-county departments visited included; Agriculture, Water; Environment, Lands and Physical Planning, Public Health and Trade. A total number of thirty-six (36) key stakeholders were interviewed during the consultation and public participation process. Their comments were sought through questionnaire administration and engaging them in discussions about the proposed project and the impacts likely to occur as a result of its implementation. This kind of engagement gave the respondents the opportunity to give insights and details about the issues at hand.

*A list of Key Stakeholders interviewed has been attached to this report*



**Figure 4: Discussions and interviews with Key Informants representing various departments/ ministries of both National Government and County Government**  
*(Source: Field Survey, 2022)*

#### **5.4 Views of stakeholders and public regarding the national performance trials**

From all the consultation and public participation forums, various opinions and views were collected. All the relevant stakeholders and interest holders expressed the anticipated benefits likely to emanate from the proposed inclusion of the GM cassava into NPTs. The project is generally acceptable to a majority of the stakeholders and members of the public on condition their views and concerns were put into consideration.

The stakeholders expressed that cassava farming has been and continues to be beneficial to them in the following ways;

- Cassava is a cash crop which provides income to families due to its demand in the market.
- Cassava has a higher calorific value hence considered a staple food.
- It can act as a feed for both livestock and poultry since the roots are crushed and dried and fed to poultry while livestock feed on the roots and leaves wholly.
- Extensive ground cover hence protecting the soils from soil erosion agents
- With value addition, cassava can be useful in producing flour which in turn can be used for baking various products; in the manufacture of carrier bags; in the production of ethanol among others.
- Socio-cultural benefits- Coastal communities believe that cassava boosts sexual performance in men. Another scenario is when one is drunk, he/she is poured with crushed cassava leaves to sober up. Also, to prevent thieves from stealing cassava on farms, the bitter ones are normally planted on the periphery of the farms.
- The improved GM cassava will be act as the much-desired impetus to encourage the farmers who ceased the farming of cassava to embark. This will translate in more production and increased yield thus helping the farmers better their lives through meeting the high market demand.
- They also expressed that the improved GM cassava will boost food security in the regions mainly occasioned by post-harvest losses from cassava affected by CBSD and CMD.
- Cassava being a drought resistant crop, it is reliable because it produces well even in areas within minimal rainfall.
- Cassava is regarded to have low cost of production owing to the minimal demand for external inputs such as fertilizer and pesticides.

- Employment creation during trials will be a source of income to some local farmers within the communities surrounding the NPT sites.
- The NPT sites will act as demonstration farms for the local farmers to compare the conventional cassava and the improved GM cassava in terms of yields, disease susceptibility, and profitability among other factors.

The stakeholders expressed the following as the existing and anticipated negative impacts affecting cassava productions in the regions of NPT;

### **Existing negative Impacts**

- Climate variability due to unpredictable weather patterns has led to little harvest.
- Negative perception as a result of cultural and societal beliefs on the GMOs.
- The consumption of virus infected cassava thus negatively impacting on the health of status of the consumers
- Some cassava varieties have low dry matter content hence reduction in quantity during harvesting.
- Post-harvest losses occasioned by poor storage/preservation mechanisms of cassava.
- Long maturation period for cassava making it less preferred compared to short duration food crops such as maize.
- Shift to other crops considering the unreliability of cassava farming affected by CBSD and CMD leading to huge losses considering the long maturity period and little or no harvest.

### **Anticipated negative impacts**

- Waterlogged areas within the sites may increase the risk of malaria transmission.
- Expected loss of natural habitats in some sites earmarked for vegetation clearing to pave way for the execution of the field trials.
- Possibility of having health and safety of workers compromised during the undertaking of the NPTs.
- Possible rise in exposure to HIV/AIDS and other STIs within the NPT sites due to an increase in farmer population within the sites.
- Soil erosion may be experienced in areas where poor farm management practices are been undertaken.



The stakeholders (both community and key informants) proposed the following recommendations:

- Ensure the best quality cassava cultivars obtained during the CFTs are propagated for the trials.
- The number of NPT sites ought to have been increased to have a good representation of the agro-ecologies in the country.
- Different data should be collected from the NPTs ranging from agronomic, morphological, post-harvest and processing tests.
- Farmers should be invited to participate in field days during the NPTs. There is need to involve farmers or their representatives in every stage of the trials right from planting to selection of suitable varieties for adoption. They also requested to be involved in assisting KEPHIS to assigning names to the selected varieties which currently have scientific codes.
- NPTs to be done under good agronomic packages.
- Involvement of public health personnel for awareness creation, health education and food safety promotions.
- Ensure appropriate means of propagating the cultivars is adopted.
- Consider sustainable environmental practices to maintain biodiversity.
- Subject the selected varieties to natural environmental conditions with minimum soil enrichment.
- Mainstream climate change actions into the adoption of the virus resistant cassava.
- Embrace low usage of fertilizer and pesticides during the trials
- The trial fields should be located away from environmental sensitive areas and cassava growing farms.
- Ensure grassroots agricultural extension officers are engaged to disseminate the acquired knowledge to farmers.
- Ensure physical and chemical properties of soils are undertaken and analysed prior to the field trials.

Majority of the respondents (99%) were in support of the implementation of the NPTs for the Virus Resistant Cassava as recorded in the administered questionnaires and evidenced in the various public forums held across the seven NPT sites.

**NB:** Copies of minutes, attendance list and the questionnaires used to collect the local community members' view on the project have been annexed in this report.

## **6.0 ANALYSIS OF PROJECT ALTERNATIVES**

### **6.1 Introduction**

This chapter examines and analyses feasible alternatives to the proposed project, location and waste management. The benefits of the proposed project will be considered against any potential environmental cost. The general principle involved in identifying alternative option(s) to a proposed development is to ensure that the option chosen would result in optimal social, environmental and capital benefits not only for the farmers and proponent but also for the environment and other stakeholders in the sector. These take into account the cost and benefit criteria: environmental impacts, social acceptability, economics (including productivity of land-use) and design feasibility.

### **6.2 The “No Project” alternative**

Under the “No Project” alternative, the proponent will not carry out the intended release of the genetically modified cassava into the environment; the anticipated impacts resulting from operation as a result of the proposed NPTs, would thus not occur. Additionally, the resultant socio-cultural/economic benefits that would be created by the proposed development would also be foregone. The “No Project Alternative” alternative would imply that the cassava production that is currently challenged by the devastating viral disease of CBSD continues to cause sustained losses to cassava famers as has been the case in the recent past. Further, considering cassava is a potential industrial crop, then lack of its production/low quality production will be a big blow to the manufacturing sector that highly depends on it for in the production of livestock feed, starch, flour and ethanol. The No action Alternative is the least favourable to the proponent, farmers, investors and the government. This option is a suitable alternative in case the action will result in an extreme environmental impact.

### **6.3 The “proposed project” alternative**

This option means that this EIA study report will be presented to the NEMA for approval (after approval by KEPHIS, NBA has already approved for environmental release). This will help in evaluating and examining the effects of the project on the biophysical and socio-economic environment. After the evaluation and under the proposed development alternative and Environmental Impact Assessment License would be issued. This way, NEMA would approve for the implementation of the project subject to compliance with all environmental and safety measures and legislations. The alternative consists of the proponent’s final proposal with the

inclusion of the NEMA guidelines and regulations and procedures as stipulated in the Environmental Management and Co-ordination (Amendment) Act (EMCA) of 2015; this aims at reducing environmental impacts to minimum extent practicable. With this alternative, the NPTs will result to selection of the best varieties suitable for different agroecological zones for placing in the market. Further, the introduction of the eight improved cassava varieties has been approved by KALRO, KEPHIS and National Biosafety Authority allowing for growing in the farms.

#### **6.4 Relocation option**

The relocation option to different sites is an option totally unavailable to the project. This option would mean resorting to other KALRO centres or any other site designated by KEPHIS which may lack required conditions for the NPTS for genetically improved cassava. Besides, the said project is already underway in terms of seeking approvals in various government departments. In case of relocation to a different site, the project planning before the stage of implementation would call for cost; already encountered in the VIRCA Plus project i.e. whatever has been done and paid for to date would be loss to the proponent. This project will be located in areas where cassava farming is already practiced hence the project will be consistent with the activities in the surrounding areas and is not likely to result in increased negative environmental impacts as opposed to implementing the project in a virgin land.

The KALRO centres of Msabaha, Mtwapa, Matuga, Kiboko, Migori, Kakamega and Alupe have been specially selected by KEPHIS which is in charge of conducting the NPTS. The centres offer adequate security for experiments and have enough land to host the NPTs. The centres have past experience in hosting NPTs. Furthermore, in those centres, breeders and agronomists are in place to monitor the experiments and interact with stakeholders during the NPT process. Therefore, alternative location may not be feasible.

#### **6.5 Alternative methods for managing CBSD**

Common phytosanitary has been considered as one of the methods for managing CBSD. This involves community-wide compliance with the initial requirement to replace local CBSD-infected material with newly introduced disease-free planting material of improved varieties. This method is however challenged by the fact that most cassava farmers lack adequate information on how to observe proper ways and mechanisms of growing cassava to avoid spread of CBSD.

The development of genetically modified cassava with resistance to virus diseases was conceived about 15 years ago and since then, a series of more than 25 CFTs have been carried out to be able to attain eight improved varieties for environmental release after regulatory approvals. In the process, the two main cassava diseases have been managed: CMD and CBSD. After the NPTs and subsequent approval for placing in the markets, the developed cassava varieties will result in 95-100% yields for there will be no or minimal losses to the diseases.

## **6.6 Solid waste management alternative**

Solid waste will be generated from wrappings, stripped off vegetation, used PPEs, and food leftovers.

### *Burying*

This technique involves collecting the wastes, dumping them in a dug ditch and then covering with soil. This may lead to soil and water pollution as the packages may contain traces of chemicals.

### *Burning*

Burning is an easy disposal method however it can lead to serious negative environmental and health impacts. Burning of the wastes containing plastics generate dioxins and other pollutants that are cancerous, allergens, respiratory system irritants among others.

### *Adherence to waste guidelines outlined by KEPHIS*

In this case, the waste particularly the harvested cassava will be collected and disposed in compliance with KEPHIS and NBA. This can be easy and convenient.

**NB:** KEPHIS guidelines on NPTs and DUS on GM crop highlight that in case of conditional environmental release, which may limit consumption or cultivation, the harvested materials shall be milled and/or disposed as per procedure provided by NBA regulations.

## **7.0 KEY POTENTIAL ANTICIPATED IMPACTS**

### **7.1 General**

Cassava brown steak disease (CBSD) is regarded as one of the main constraints in the production of cassava in Sub-Saharan Africa. This crop is vital since it serves as a major staple food as well as a fundamental source of industrial starch and ethanol. CBSD foliar symptoms vary depending on the existing varieties from non-apparent to interveinal chlorosis. The major concern is the rampant development of brown necrotic rot precisely within the storage roots which impacts on CBSD rendering them inedible and without economic value. Therefore, the existence of Cassava brown steak disease tends to threaten food and economic security for smallholder farmers throughout our country which necessitates intervention to remedy the situation.

### **7.2 Positive Impacts during Trial Phase**

#### **7.2.1 Creation of Employment**

During the trial phase across the 7 selected sites for NPTs, there will be employment opportunities for both professionals (scientists monitoring the process) and unskilled workers to be engaged in the planting, weeding and harvesting process. Semi-skilled, unskilled labourers and formal employees are expected to obtain gainful employment during the trial phase period.

#### **7.2.2 Improved Cassava Varieties**

KALRO has conducted analysis and identified eight varieties to be escalated NPTs. These improved varieties will all be resistant to CBSD and CMD which has impacted the production of cassava across nationally particularly within cassava growing areas.

#### **7.2.3 Increased Cassava production**

The new improved cassava varieties not only have resistance to CBSD and CMD but also are considered to be more productive in yields as compared to the existing varieties. This is expected to be a plus for future cassava farmers once the varieties are certified for environmental release.

#### **7.2.3 Knowledge transfer to farmers**

KALRO intends to indulge the farmers of cassava around the regions selected for the NPTs. The farmers will be called upon to witness the entire process of planting to harvesting. Their engagement will contribute to knowledge transfer from the experts who will be foreseeing the

process to the farmers who will be witnessing the performance of the existing cassava varieties vis a vis the improved ones.

#### **7.2.4 Selection of best performing varieties**

The NPTs are geared towards ensuring the planted improved varieties are adaptable to the local conditions in the various regions. The trials will test a total of 8 varieties across the 7 NPTs with the view of selecting the best performing varieties in each region. The most adaptable varieties will be selected as the most suitable for the particular agro-ecological zones.

#### **7.2.5 Precursor to environmental release**

NPTs are an advanced step for new planting materials to determine that an improved potential variety will be accepted or rejected for distribution to farmers. Upon completion of NPTs, the existing channels for varietal release will be followed and approval from NBA will be sought for full commercial release.

#### **7.2.6 Optimum crop security**

The selected NPTs where the research activities are designated for undertaking are all secured. The sites are located within KALRO research stations across the identified counties. This form of protection is regarded as important in ensuring the experiment is not interfered with by external factors.

### **7.3 Negative impacts of the projects**

#### **7.3.1 Pre-Set up considerations/ Impacts**

##### **7.3.1.1 Potential weediness and /or invasiveness of cassava 4046**

Weediness of plant is considered to be the ability to persist and spread in managed ecosystems. On the other hand, invasiveness is the ability to do the same in the unmanaged ecosystems. The assessment of agronomics and phenotypics of event 4046 cassava revealed that characteristics associated with the reproductive and the survival biology of the cassava encompassing; vegetative vigour, morphology of the plant and growth habit, time to flower are all within the normal range of expression visible in the conventional cassava. Therefore, the trait of resistance introduced to CBSD does not offer a competitive advantage that renders the cassava more weedy or invasive of natural habitats. This is because none of the reproductive or characteristics of growth are modified.

### **7.3.1.2 Potential Impact of pollen-Mediated Gene Flow from 4046 Cassava**

Cassava cultivars are usually propagated entirely by stem cuttings commonly known as stakes. The process of vegetative propagation is preferred by farmers since it the best way to maintain the desirable trait combinations available in the farmer-preferred cultivars. Therefore, the pollen grain mediated gene flow precisely from event 4046 cassava to the other cultivated cassava has no impact on the production of conventional cassava planting materials. The only naturalised relative of cassava in Africa is *Manihot cathaginensis subsp. Glaziovii* which is a tree species not distributed widely. In addition, lacks any weedy characteristics as well as is not invasive. The hybrids between cassava and *M. glaziovii* are generally fertile even though they are not common since they are usually obtained after deliberate hybridisation particularly in cassava manual breeding programmes.

Therefore, the potential consequences of pollen-mediated gene flow from CBSD-resistant cassava to *M. glaziovii* were carefully considered by experts especially on the aspects of gene flow, risk assessment as well as cassava biology and breeding. The conclusion was that the gene flow from the CBSD-resistant cassava to *M. glaziovii* were not anticipated to reduce the genetic diversity of the germplasm. It was concluded that it is even helpful in the preservation of the African diversity of this wild relative in the event it protects *M. glaziovii* from the disease. There is no evidence of *M. glaziovii* been considered a weed or invasive anywhere across Africa hence it is highly unlikely that introgression of the CBSD-resistance trait into *M. glaziovii* would constitute in making it more weedy or invasive of natural habitats.

### **7.3.1.3 Altered Plant Pest Potential of 4046 Cassava**

The desired effect of the introduced CBSD resistance trait in event 4046 cassava is not related to plant pest potential. In addition, the cassava itself is not regarded as a plant pest. Further, the agronomic and phenotypic characteristics of 4046 cassava are established to be within the range of values evident in the conventional cassava hence shows that the cassava growing habit was not inadvertently altered. The only aspect that was altered is the intended resistance to CBSD. The observations in field did not reveal any modifications to disease and pest susceptibilities of 4046 cassava compared to conventional cassava. This thus concludes that there will be no indirect plant pest effects on other agricultural crops that are grown in close proximity to event 4046 cassava.



#### **7.3.1.4 Potential Impact of 4046 Cassava on Non-Target Organisms**

Event 4046 cassava was not developed to confer pest resistance, thus there are no 'target' species and no 'nontarget' species either.

Sufficient data has been presented illustrating the compositional equivalence of 4046 cassava to conventional cassava and revealing the lack of toxicity and allergenicity of the only newly expressed protein. Based on this, it can be concluded that the consumption of event 4046 plant or plant products by mammals as well as any other NTOs is unlikely to bring about any adverse impact on their survival and reproduction.

#### **7.3.1.5 Potential Impact of 4046 Cassava on Biodiversity**

Data on the Event 4046 cassava indicated that it lacks novel phenotypic characteristics (e.g., abiotic stress tolerances) that would spread its use beyond the current area of cassava production in Kenya. Therefore, in the absence of any altered reproductive or survival biology characteristics, it can be concluded that event 4046 cassava does not present any significant altered impact on biodiversity in comparison to currently cultivated cassava varieties.

#### **7.3.1.6 Potential Impact of 4046 Cassava on Cultivation Practices**

Agronomically, event 4046 cassava remains unchanged from conventional cassava. The adopted local cultivation practices currently in use for the conventional cassava varieties that encompasses; application of fertilizer, crop protection, as well as labour, are similarly directly applicable to the cultivation of those varieties containing event 4046.

It is anticipated that there will be no changes in either the type of production input, or in amounts, with the cultivation of 4046 cassava varieties. It is further expected that no changes in farm management or cultivation practices are anticipated for cassava varieties containing event 4046 in approved in Kenya.

**NB:** Following approval by NBA, the Cassava event 4046 is regarded to be as safe as conventional cassava and does not pose any greater risks to the environment, human, or animal health than conventional cassava. A summarized risk assessment report has been annexed in this report.

### **7.3.2 Operational Impacts**

#### **7.3.2.1 Occupational Safety and Health Impacts**

Farm workers are likely to have injuries and hazards at the NPT sites owing to the use of farm hand tools or equipment. Any of such accidents or incidents in the workplace are considered to be occupational hazards. Therefore, all workers should be protected reasonably from any anticipated risk or safety concern while in the workplace.

#### **Mitigation**

1. The proponent should provide workers with appropriate tools for the right task.
2. Drinking water should be availed to the workers within the farms to rehydrate as a result of long exposure to working under direct sunlight.
3. Farms workers to be equipped with appropriate personal protective equipment during their undertakings to minimise any injuries or health related impacts e.g. face masks, gumboots
4. A standard first aid kit to be availed in the farmland during the undertaking of farming activities. Also, a knowledgeable trained person should be within the site to help handle any potential casualty.
5. The employed farm workers to be trained on the appropriate usage of farm hand tools and the appropriate postures during farming activities to prevent back-related injuries.

#### **7.3.2.2 Loss of biodiversity**

Site visits to identify the selected sites selected for the NPTs of the cassava varieties revealed that most of them are currently unutilised. The sites are full of vegetation mainly grass and shrubs in some. This will call for site clearance to pave way for the farming of the cassava on the identified land parcels. Vegetation clearance has an impact on the environment since it leaves the land bare and susceptible to soil erosion. In addition, the organisms and micro-organisms whose depending on the existing vegetation as habitat would be destabilised within the ecosystem.

#### **Mitigation Measure**

To reduce the adverse effect of loss of biodiversity, the proponent should ensure that vegetation clearance is conducted on the identified parcels of land earmarked for the conducting of NPTs.

### **7.3.2.3 Public Health**

Issues concerning public health are a major concern in the identified sites. Some sites are located far from the existing structures within the KALRO research centres. Casual labourers working on the identified farms will certainly require responding to the calls of nature. Therefore, in the unlikely event these sanitation facilities are not within a reasonable distance within their work environment, they may be forced to defecate on the environment which is regarded as unhealthy and indecent considering both genders are represented in the labour force.

#### **Mitigation Measures**

- Sanitation facilities existing at KALRO centres hosting NPTs will be availed for use by workers.
- Provide mobile toilets for farmworkers especially on sites far from existing sanitation facilities in KALRO centres.
- The sanitation facilities in place should always be maintained in clean and hygienic state.
- The department of public health should advise on the appropriate locations for establishing the mobile toilets.
- Ensure that all temporary/portable toilets are secured to the ground to prevent toppling due to wind or any other unanticipated cause.
- The proponent to ensure that no spillage occurs when the toilets are cleaned or emptied. In addition, care should be taken to ensure that the contents are removed from site to an approved disposal site.

### **7.3.2.4 Solid Waste Generation**

The NPTs will involve the planting of the identified 8 cassava varieties across the 7 designated KALRO sites. All the varieties will be vegetatively propagated and tendered to maturity. Upon harvesting and data collection, usable stakes will be replanted in CFTs while the remaining plant debris and roots will be milled and buried in compliance with KEPHIS and NBA guidelines.

#### **Mitigation Measures**

Appropriate agrochemical waste management system will be put in place during the harvesting period. KEPHIS as the regulator will provide appropriate measures to adopt while handling and conducting actual disposal of the harvested material.

### **7.3.2.5 Gender Discrimination, Sexual Exploitation and Child Abuse**

Whenever there is an open opportunity to engage in any remunerative activities, the surrounding communities within a project area tend to seek to offer their labour services. In this exercise, it is expected that employment will be sought by the community members near the KALRO sites identified for NPTs nationwide. Therefore, care should be taken so that children below 18 years of age are not offered opportunity to work on the farms as well issue of gender representation is achieved to avoid gender inequality. Sexual exploitation is also an issue of common occurrence and therefore should be discouraged at all costs within the workplace.

#### **Mitigation Measures**

- Adherence to the existing KALRO Human Resources Policy and manuals that provide guidance in the hiring of temporary workers
- The proponent (KALRO) should ensure that proper records of the on-farm workers is kept to avoid child and forced labour across all the NPT sites
- Deliberate efforts should be fostered enforce 1/3 gender rule of either women/men as labourers during execution of farming activities
- The proponent should ensure that the provisions of WIBA 2007 are complied with as required.

### **7.3.2.6 HIV/AIDS**

Working environments bring together people of diverse characters and morals. Affairs may emerge which can propagate the spread of STI's including the deadly HIV/AIDS. In addition, unprotected sex may lead to unwanted pregnancies within the workplace. Therefore, to safeguard both permanent and casual labourers within the national performance trail sites nationally from the negative effect of contracting STIs and HIV/AIDS, then appropriate measures need to be in place.

#### **Mitigation Measures**

- Conducting sensitization and awareness activities for both on-farm workers as well as staff within the research station on the unwanted effects of engaging in casual sex.
- Establish VCT services within the research station and encourage workers to voluntarily know their status for a better living.

- Supply workers with male and female condoms and encourage their usage in order to promote safe sex that does not leave any of the partners vulnerable to HIV/AIDs or sexually transmitted infections.

### 7.3.3 Decommissioning Phase

#### 7.3.3.1 After Successful completion of the Trials

Once done with the utilisation of the sites across all the KALRO stations for the NPTs, each land parcel will be handed over to the respective centre or Institute director. Procedurally, a hand over letter will be addressed to the centre director notifying them on completion and exit from the trials.

#### 7.3.3.2 Project transfer to a different user

In reference to the permit issued by NBA to KALRO (Proponent) the issued approvals are not transferable to any other user/ vendor.

#### 7.3.3.3 Abandonment of the Project

In the unexpected event the NPT sites are abandoned then the proponent shall ensure that all materials pertaining to the NPTs across all the 7 sites nationally are removed properly and appropriately disposed.

**Table 13: Summary of Environmental and Social Impacts and Mitigation Measures**

No.	Environmental Impact Issues	Impact Scale	Mitigation Measures
1.	<b>Alteration in Soil properties such as fertile loss, salinisation and water logging</b>	N+	Soil properties can be affected by poor management practices thus affecting productivity negatively. Appropriate farm inputs such as fertilisers are recommended to maintain the productivity of soil and reduce degradation effects. The cassava plantation is projected to be ground under normal conditions of the areas through rain-fed agriculture
2.	<b>Soil erosion</b>	N+	The NPT site will not be subject to excavations apart from the normal

No.	Environmental Impact Issues	Impact Scale	Mitigation Measures
			ploughing. Adoption of the recommended agronomic and soil fertility maintenance will be vital in controlling soil erosion.
3.	<b>Crop production</b>	P++	CBSD and CMD are a big challenge to the production of cassava. Therefore, production of a resistant cassava to the two diseases once approved will serve as a big boost for farmers.
4.	<b>Water Resources</b>	No	Cassava plantation will be executed with reliance on rain as the source of water.
5.	<b>Quality effects on Rivers</b>	NO	All the 7 NPT sites are not in close proximity with any river source
6.	<b>Waste Generation and Disposal</b>	N++	Majority of the NPT sites are currently not in use and therefore engulfed with vegetation which will require clearance. Once harvest is conducted, KEPHIS will be instrumental in guiding the disposal of all the harvested stems.
7.	<b>Air pollution mainly dust</b>	N+	When conducting initial land preparation especially during dry weather, minor dust generation may be experienced. However, thereafter, the crop will provide land cover
8.	<b>Occupational Health and Safety</b>	N+	The workers will be sensitized on proper use of the provided handheld farm tools as well as be equipped with personal protective equipment such as masks, gloves and gumboots
9.	<b>HIV/AIDS and other STIs</b>	N++	Despite the few employees projected to be employed on the NPTs across the country, issues of risk and

No.	Environmental Impact Issues	Impact Scale	Mitigation Measures
			subsequent prevention of HIV/AIDs shall be promoted. Therefore, provision of condoms for voluntary use will be ensured.
10.	Site Safety	P++	The cassava production will be undertaken in fields with restricted entry across 7 KALRO sites. This will ensure that data remains intact during the plantation seasons hence preserving the integrity of the findings over the plantation seasons.

Scale of Impacts	Magnitude of Impact
P+	Minor Positive
P++	Major Positive
N+	Minor Negative
N++	Major Negative
NO	None

## **8.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN**

### **8.1 General Overview**

An Environmental and Social Management Plan (ESMP) for developing projects is used to provide a logical framework within which identified negative environmental impacts can be avoided, mitigated and monitored. In addition, the ESMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures and monitoring can be done. The ESMP is a vital output of an ESIA Study as it provides a checklist for project monitoring and evaluation. The ESMP outlined below addresses the identified potential environmental and social impacts emanating from the project activities as also highlighted in the chapters of Key potential anticipated impacts.



**Table 14: Environmental and Social Management Plan**

No.	Impact	Mitigation Measures	Responsibility	Cost (KES)
<b>A. Pre-Set up Impacts</b>				
1.	<b>Potential Impact of Pollen-Mediated Gene Flow from 4046 Cassava</b>	<ul style="list-style-type: none"> <li>The development has ensured that the pollen-mediated gene flow from event 4046 cassava to other cultivated cassava has no impact on the production of conventional cassava planting materials because it is vegetatively propagated</li> </ul>	Proponent	No Direct Cost
		<ul style="list-style-type: none"> <li>By ensuring that the gene flow from CBS-resistant cassava to <i>M. glaziovii</i> would not reduce the genetic diversity of the germplasm but rather preserve the African diversity from the disease.</li> </ul>		
2.	<b>Altered Plant Pest Potential of 4046 Cassava</b>	<ul style="list-style-type: none"> <li>Agronomic and phenotypic characteristics of 4046 cassava are within the range of values displayed by conventional cassava and indicate that the growing habit of cassava was not inadvertently altered.</li> </ul>	Proponent	No Direct Cost
		<ul style="list-style-type: none"> <li>No modifications to disease and pest susceptibilities of 4046 cassava compared to conventional cassava hence no indirect plant pest effects on other agricultural crops grown in proximity to event 4046 cassava.</li> </ul>		No Direct Cost

No.	Impact	Mitigation Measures	Responsibility	Cost (KES)
3.	<b>Potential Impact of 4046 Cassava on Non-Target Organisms</b>	<ul style="list-style-type: none"> <li>Ensuring the lack of toxicity and allergenicity thus making the consumption of event 4046 plant or plant products by mammals and other Non-Target Organisms (NTOs) unlikely to cause any adverse impact on their survival and reproduction.</li> </ul>	Proponent	No Direct Cost
4.	<b>Potential Impact of 4046 Cassava on Biodiversity</b>	<ul style="list-style-type: none"> <li>The absence of any altered reproductive or survival biology characteristics, therefore, means that event 4046 cassava does not present a significant altered impact on biodiversity in comparison to currently cultivated cassava varieties.</li> </ul>	Proponent	No Direct Cost
5.	<b>Potential Impact of 4046 Cassava on Cultivation Practices</b>	<ul style="list-style-type: none"> <li>Event 4046 cassava is agronomically unchanged from conventional cassava thus no changes to farm management or cultivation processes</li> </ul>	Proponent	No Direct Cost
6.	<b>Potential Weediness and/or Invasiveness of 4046 Cassava</b>	<ul style="list-style-type: none"> <li>By assessing the agronomic and phenotypic event 4046 cassava to ensure that the characteristics related to the reproductive and survival biology of cassava, such as vegetative vigour, plant morphology and growth habit, and time to flowering, are within the normal range of expression of these traits displayed by conventional cassava.</li> </ul>	Proponent	No Direct Cost

No.	Impact	Mitigation Measures	Responsibility	Cost (KES)
<b>B. Actual Set-Up Impacts (Operational Phase)</b>				
1.	Loss of Biodiversity	<ul style="list-style-type: none"> <li>Clearance of vegetation should be designated at the confined sites targeted for growing of cassava particularly where lands are unutilised.</li> </ul>	Proponent	No Direct Cost
2.	Soil Erosion	<ul style="list-style-type: none"> <li>Site clearance to be undertaken when the planting season is due to avoid the land remaining bare and exposed to agents of erosion</li> </ul>	Proponent	No Direct Cost
		<ul style="list-style-type: none"> <li>The methods of cultivation should not expose the soils to agents of soil erosion</li> </ul>		No Direct Cost
		<ul style="list-style-type: none"> <li>The selected areas for trials should not be susceptible to soil erosion.</li> </ul>		No Direct Cost
3.	Public Health	<ul style="list-style-type: none"> <li>Sanitation facilities existing at KALRO centres hosting NPTs will be availed for use by workers</li> </ul>	Proponent	100,000
		<ul style="list-style-type: none"> <li>Provide mobile toilets for farmworkers especially on sites far from existing sanitation facilities in KALRO centres</li> </ul>		
		<ul style="list-style-type: none"> <li>The facilities should be always maintained in clean and hygienic state</li> </ul>		No Direct Cost
		<ul style="list-style-type: none"> <li>The exact location of the toilets shall be approved by the Public Health Department prior to establishment.</li> </ul>		No Direct Cost

No.	Impact	Mitigation Measures	Responsibility	Cost (KES)
		<ul style="list-style-type: none"> <li>The proponent shall ensure that no spillage occurs when the toilets are cleaned or emptied and that the contents are removed from site to an approved disposal site</li> </ul>		No Direct Cost
		<ul style="list-style-type: none"> <li>All temporary/portable toilets shall be secured to the ground to prevent them toppling due to wind or any other cause.</li> </ul>		No Direct Cost
4.	<b>HIV/AIDS and STI infections</b>	<ul style="list-style-type: none"> <li>Sensitization and awareness activities for on-farm workers as well as staff within the research station</li> </ul>	Proponent	150,000
		<ul style="list-style-type: none"> <li>Have VCT services within KALRO research station and encourage all workers to voluntarily state to know their status.</li> </ul>		30,000
		<ul style="list-style-type: none"> <li>Provide male and female condoms to workers and encourage their utilisation to promote safe behaviour within the workplace.</li> </ul>		80,000
5.	<b>Water Logging effects</b>	<ul style="list-style-type: none"> <li>Areas that are prone to water logging to be avoided considering cassava is a drought resistant crop</li> </ul>	Proponent	No Direct Cost
6.	<b>Occupational Health and Safety</b>	<ul style="list-style-type: none"> <li>Workers using farm hand tools to be trained on their appropriate usages as well as the recommended postures while farming to prevent back-related injuries.</li> </ul>	Proponent	No Direct Cost

No.	Impact	Mitigation Measures	Responsibility	Cost (KES)
		<ul style="list-style-type: none"> <li>The proponent to provide appropriate farming tools for the right task</li> </ul>		300,000
		<ul style="list-style-type: none"> <li>Appropriate personal protective equipment should be provided to farm workers in the course of their undertakings e.g. masks, gloves, gum boots etc</li> </ul>		250,000
		<ul style="list-style-type: none"> <li>Clean drinking water should be offered to the farmworkers</li> </ul>		50,000
		<ul style="list-style-type: none"> <li>The supervisor should ensure that there is a standard first aid kit at the active site(farmland) and knowledgeable person to be trained to handle any potential casualties</li> </ul>		20,000
7.	<b>Waste disposal (generation, collection and disposal)</b>	<ul style="list-style-type: none"> <li>The project will put in place an appropriate agrochemical waste management system. During the harvesting time, KEPHIS as the regulator will provide appropriate measures in disposal of the material</li> </ul>	Proponent KEPHIS	80,000
8.	<b>Gender Discrimination, Sexual Exploitation and Child Abuse</b>	<ul style="list-style-type: none"> <li>Adherence to the existing KALRO Human Resources Policy and manuals that provide guidance in the hiring of temporary workers</li> </ul>	Proponent	No Direct Cost
		<ul style="list-style-type: none"> <li>Proper records of on-farm workers to avoid child and forced labour</li> </ul>		No Direct Cost
		<ul style="list-style-type: none"> <li>Foster efforts to include at least 1/3 of women/men as employees during execution of farming activities</li> </ul>		No Direct Cost
		<ul style="list-style-type: none"> <li>Compliance with provisions of WIBA 2007</li> </ul>		No Direct Cost

No.	Impact	Mitigation Measures	Responsibility	Cost (KES)
		<ul style="list-style-type: none"> <li>Ensure existence of a code of conduct to prevent sexual harassment / exploitation of female employees;</li> </ul>		No Direct Cost
9.	<b>Alcohol and Drugs abuse at Workplace</b>	<ul style="list-style-type: none"> <li>Proper communication to employees and transients that the project has “zero tolerant policy”</li> </ul>	Proponent	No Direct Cost
		<ul style="list-style-type: none"> <li>Enforce to the letter all applicable KALRO policies on alcohol and substance abuse.</li> </ul>		No Direct Cost
9.	<b>Poor farm Management Practices</b>	<p>The following cultural practices shall be adopted for effective NPTs;</p> <ul style="list-style-type: none"> <li>Spacing –1 m within rows, 1 m between rows</li> <li>Number of rows per plot – 5, collect data from 3 inner rows</li> <li>Length of rows 6m; Expected SAH / plot=(5 hills*3 rows)=15 plants (exclude border plants)</li> <li>Space between adjacent replicates – 1.5 m</li> <li>Trial surrounded by at least 1 guard rows, with 1.5 m space between the guard rows and the experiment</li> <li>Planting cuttings – at least with 5 nodes, cross-section of at least 2cm.</li> <li>Weeding – Manual methods will be applied</li> </ul>	Proponent KEPHIS	No Direct Cost

No.	Impact	Mitigation Measures	Responsibility	Cost (KES)
		<ul style="list-style-type: none"> <li>No pre-sprouting of cuttings for planting</li> <li>Cuttings should be planted within five days of their preparation.</li> </ul>		
<b>C. Decommissioning Phase</b>				
1.	<b>Air Pollution i.e. Dust</b>	Plant vegetation on sites not subjected to post harvest usage to ensure the land is covered hence minimise dust generation especially in dry and windy seasons	Proponent	

## **9.0 CONCLUSION AND RECOMMENDATION**

The deployment, environmental release, and cultivation of the new CBSD resistant cassava varieties containing event 4046 are unlikely to pose an altered risk to the environment relative to conventional cassava. In addition, both food and feed obtained from 4046 cassava is considered safe just like those contained in the conventional cassava. The establishment of cassava varieties that contain event 4046 will go a long way in addressing the fundamental constraints of cassava production in Kenya. This is projected to substantially enhance smallholder incomes and their general well-being.

Collectively, the data presented in this ESIA study report has not identified any significant environmental hazards and/or health and safety concerns. This leads to the conclusion that cassava varieties encompassing event 4046 are safe and thus not likely to cause an altered risk to the environment relative to conventional cassava. In addition, food and feed emanating from cassava 4046 are entirely as safe as food and feed sourced from conventional cassava varieties.

It is our strong recommendation that NEMA issues a license to allow the undertaking of the NPTs across the seven designated KALRO sites to provide farmers with a long-lasting solution to the burgeoning problems caused by CBSD and CMD. The perennial losses caused by these diseases leading loss of livelihoods will be adequately tackled after the environmental release of improved cassava varieties containing event 4046. The facts presented from the roadmap of VIRCA plus project in Kenya squarely highlights that there are no additional risks associated with cassava event 4046 beyond those already linked with the release of conventional cassava varieties. Therefore, cassava event 4046 is regarded to be as safe as conventional cassava and does not pose any greater risks to the environment, human, or animal health than conventional cassava. In general, the risk of adverse consequences from the environmental release of event 4046 is negligible.



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## **APPENDICES**

**Appendix A: Photo catalogue**

**Appendix B: NEMA Approved TORs Letter**

**Appendix C: Stakeholders' Questionnaires**

**Appendix D: Proceedings for Public Fora held and List of Attendances**

**Appendix E: Summary Risk Assessment Report (Application for the Environmental Release of the GM cassava)**

**Appendix F: National Biosafety Authority Approval Letter**

**Appendix G: Lead Expert License**

**Appendix A: Photo catalogue**



**Public participation meeting at KALRO Matuga in Kwale County**





**Public Participation meeting at KALRO Msabaha in Malindi Subcounty**



**Public participation meeting at KALRO Kiboko, Makueni County**



**Public participation meeting at Oyani Farm Institute**





**Public Participation meeting at KALRO Kakamega Conference room**

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