



Climate resilient potato production

Training Aid



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NATIONAL POTATO COUNCIL OF KENYA



Climate resilient value chains
for improved livelihoods

The National Potato Council of Kenya (NPCK) is a Public Private Partnership (PPP) and a multi-stakeholder organization whose responsibility is to help plan, organize and co-ordinate value chain activities of the potato subsector and develop it into a robust, competitive, and self-regulating industry in Kenya. Its membership include farmers, researchers, public institutions, extension providers, seed producers, traders, processors, regulatory agencies, financial services providers, input providers, Ministry of Agriculture for National and County Governments, Development partners, other value chain actors and players

This Training Aid has been developed to be easy going and flexible to a wide range of training contexts and specifics. In addition, the Training Aid has included climate resilient potato production practices considering gender categories.

Disclaimer

The first version of this publication was produced by NPCK in collaboration with its partners and stakeholders who are acknowledged in this report.

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ACKNOWLEDGEMENT

The National Potato Council of Kenya (NPCK) acknowledges the technical and financial support from the Climate Resilient Agribusiness for Tomorrow (CRAFT) project partners lead by SNV Netherlands Development Organization (SNV) and CGIAR's Research Program on Climate Change, Agriculture and Food Security (CCAFS) for their invaluable contributions towards the development of Climate Resilient Potato Production Training Aid.

The CRAFT project is a multi-country (Kenya, Tanzania and Uganda) five-year effort implemented by SNV in partnership with Wageningen University and Research (WUR), CGIAR's Research Program on CCAFS, Agriterra, and Rabo Partnerships. The overall project goal is to contribute to increased availability of accessible and climate resilient food for the growing population in Kenya, Tanzania and Uganda. The project is funded by the Netherlands Ministry of Foreign Affairs.

Special gratitude goes to the technical team, which included: from SNV, Joseph Muhwanga, Joyce Mbingo and Oscar Nzoka; from CCAFs, John Recha, Joab Osumba and Teferi Demissie, from WeNR Annemarie Groot and Confidence Duku; from NCPK, Wachira Kaguongo and Charity Maina.

Many thanks also goes to the professional technical consultant Judith Oyoo (KALRO-Tigoni), for her hard work and dedication in developing this Training Aid.

FOREWORD

Agriculture directly contributes 25% and indirectly 27% to Gross Domestic Product (GDP). The sector also contributes 65% of export earnings in Kenya. The government of Kenya has outlined the importance of agriculture to the national economy, through the Kenya Vision 2030, the Big Four Agenda, the National Adaptation Plan (2015-2030) and the Kenya Climate Smart Agriculture Strategy 2017-2026 among other policy documents.

Potato (*Solanum tuberosum* L) is an important food and cash crop in Kenya. It is produced by over 1 million farmers and cultivated on an acreage of 161,000ha. In addition, potatoes are grown in almost half of the 47 counties in Kenya. Potato as food is highly versatile because it can be cooked at home and be processed. Potato processed products like crisps and chevdas are favorite snacks among the middle income population and the youth who are the majority population. Potato has been identified as one of the key crops that has the potential to enhance food security and drive economic growth in Kenya. Its increased production will contribute towards achieving food and nutrition security and employment creation especially among women and youth. With urban and rural population growth, consumption patterns, tastes and preferences will change tremendously. For instance, consumption of chips, crisps and other value-added products of potato have evolved in the markets. Despite the evolution in the markets, production does not match demand. Currently, potato productivity is very low, averaging below 10 tons per ha against a potential of 40 tons/ha obtained under research. Factors such as low technical farmer capacity, increased climate variability, inadequate use of certified seeds, pests and diseases, inadequate storage facilities and marketing challenges affect potato value chain. If climate resilient potato production practices are adopted by farmers maximum yields of 40 tons per ha can be achieved and the industry could become a more competitive sector.

Potato production is dependent on two very important elements of weather; rainfall and temperature. Climate change is characterized by changes in these two important elements of weather like rising temperature, varied variability in rainfall patterns, increased frequency of extreme weather events such as droughts and floods as well as outbreak of pests and diseases. These changes in climate and their impacts already are negatively affecting potato value chain development. Such effects include crop damages, crop failure, reduced yields, poor tuber quality, increased land degradation and post-harvest losses. Stakeholders should work with potato farmers and organizations to increase their awareness on climate change, support farmers to implement activities that will help them either adapt, cope, resist, mitigate or become more resilient to climate change shocks.

The Training Aid incorporates Climate Resilient Agriculture (CRA) practices and approaches with a gender equality and youth empowerment lens. It is a tool that will help achieve one of the strategic objectives of increasing sustainable potato production in Kenya. This Training Aid will be used by state and non-state extension actors/trainers to train farmers and other stakeholders engaged in potato value chain. It will also guide trainers on how to train stakeholders on potato production as a business in the climate change vulnerability scenarios. It is important after training the stakeholders to gain new knowledge, change their attitudes and behavior towards a more sustainable potato value chain in the wake of climate change.

We believe the Training Aid will be a reference for the trainers in preparing training materials for farmers, Trainer of Trainers (ToTs), the youth and women in the Industry.

Wachira Kaguongo
CEO, National Potato Council of Kenya

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TRAINING OUTLINE

II: About the Training Aid

This Training Aid is divided into four parts namely;

- Training content
- Training design
- Instructions for trainers
- Training methods/learning experiences

III: How the Training Aid will be used

Logic of design and flow to assist Trainers

- Introduce the module
- Draw out the participant's expectations
- Relate participants' expectations with module objectives or learning outcomes
- Explore the concept and content, switching to different methods of delivery of the content (group exercise, brainstorming, excursions, plenary discussions, role plays) as the session progresses
- Review the module at the end using participatory approaches like tailor made questionnaires
- Distribute the participants hand outs

IV: Instructions for Trainers

1. Preparation of training materials

- ✓ Trainers should familiarize themselves and internalize the guidelines provided by this Training Aid well in advance before commencing the training.
- ✓ The stationery (flip charts, name tags, markers, writing materials) LCD projectors required should be available within the training area at least 24 hours before the training.
- ✓ Visual aids like field equipment and tools should also be arranged in time before the sessions start
- ✓ Copies of the modules are distributed at the end of each module

2. Preparation of training venues/sites – demonstration sites which could be crop land or field where potato is intended for planting

3. Trainees/target groups - Potato farmers growing potatoes for processing or consumption but not seed potato, agriculture extension officers with background on training and extension and other

4. Training methods - Plenary presentations, group exercises, buzz groups, case studies, problem solving exercises, visits and demonstration

V: Training duration – 40 hours 35 minutes

ACRONYMS

ASL	Above Sea Level	KALRO	Kenya Agricultural and Livestock Research Organization
ASDS	Agriculture Sector Development Strategy	KEFRI	Kenya Forestry Research Institute
CA	Conservation Agriculture	KEPHIS	Kenya Plant Health Inspectorate Services
CAN	Calcium Ammonium Nitrate	KM	Kilometer
CCAFS	Climate Change Agriculture and Food Security	KMS	Kenya Meteorological Services
CRAFT	Climate Resilient Agribusiness for Tomorrow	KGS	Kilograms
CRA	Climate Resilient Agriculture	LGS	Length of Growing Season
CIP	Center International Potato	MAM	March-April-May
CM	Centimeter	MAP	Monoammonium Phosphates
DLS	Diffused Light Store	MD	Man Days
DV	Daily Value	NPCK	National Potato Council of Kenya
FAO	Food Agriculture Organization	OND	October-November-December
FYM	Farmyard Manure	PCN	Potato Cyst Nematode
GAP	Good Agricultural Practices	PTM	Potato Tuber Moth
GDP	Gross Domestic Product	PVA	Potato Virus A
GHG	Greenhouse Gas	PVS	Potato Virus S
GIZ	Deutsche Gesellschaft Fur Internationale Zusammenarbeit	PVX	Potato Virus X
GMP	Good Manufacturing Practices	PVY	Potato Virus Y
GM	Gross Margin	RKN	Root Knot Nematodes
GoK	Government of Kenya	SOC	Soil Organic Carbon
HA	Hectare	SG	Specific Gravity
ICT	Information Communication Technology	SMS	Short Message Service
IPCC	Intergovernmental Panel on Climate Change	SSP	Single Superphosphate
IPDM	Integrated Pest and Disease Management	Ton	Tonnes
		ToT	Trainer of Trainees
		TSP	Triple Superphosphate

1 CLIMATE CHANGE, CAUSES, EFFECTS AND CLIMATE RESILIENT AGRICULTURE

1.1 Learning outcomes

This module aims to familiarize trainees with climate change, causes, effects, mitigation and climate resilient agriculture (CRA). By the end of the training the participants should be able to:

- Define climate change
- Understand what are causes and the effects
- Understand climate change hazards and risks
- Understand how gender is affected by climate change
- Explain the relationship between human activities and climate change

1.2 Module duration

4 hours

1.3 Module summary

Table 1: Module summary for introduction to climate change and climate resilient agriculture

Introduction to climate change and climate resilient agriculture (CRA)			
Sessions	Training methods	Training materials	Time
1.3.1 Introduction to the module and levelling expectations	Participants' introductions Presentation	Flips charts Felt pens, masking tape or sticker glue, note books and pens PowerPoint presentation Participants Handout	15 minutes
1.3.2 Introduction to climate change, effects & causes	Plenary Presentations and discussions Group Exercise	Flips charts Felt pens PowerPoint presentations Participants Handouts	30 minutes
1.3.3 Climate change hazards and risks	Plenary Presentations and discussions Group Exercise	Flips charts Felt pens PowerPoint presentations Participants Handouts	1 hour 30 minutes
1.3.4 Climate change and it affects gender	Plenary Presentations and discussions Group Exercise	Flips charts Felt pens PowerPoint presentations Participants Handouts	1 hour 30 minutes
1.3.5 Module review	Plenary presentation	Flip charts pens	15 minutes
TOTAL			4 hours

1.4 Trainer's instructions

1.4.1 Introduction to the module and levelling expectations

*(Trainers introduces the module as well as outline module objectives (15 minutes)
(Trainees writes on flip chart trainees' expectations)*

1.4.2 Introduction to climate change, cause and effects

(Trainer defines what climate change is and explains how each cause affects the climate and their corresponding effect and the difference between climate change and weather).

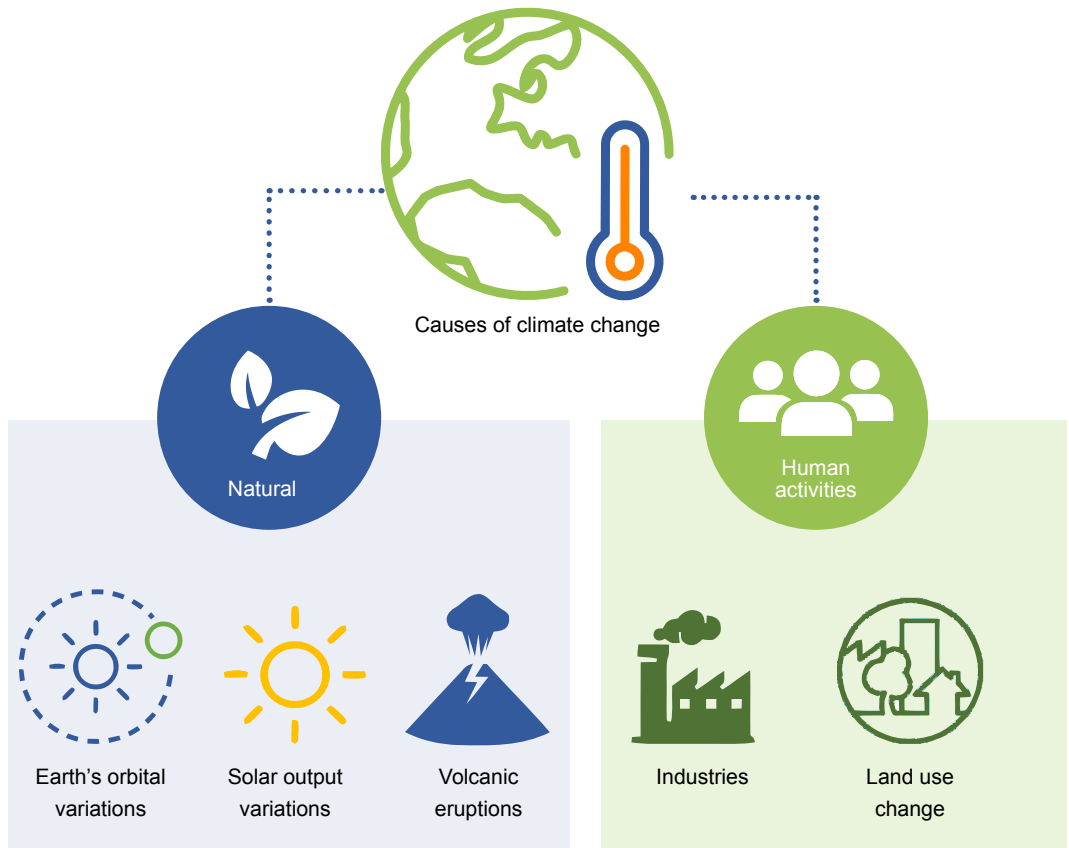
1.4.2.1 Definition of climate change

United Nations Framework Convention on Climate Change
Defines climate change as 'a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods'(UNFCCC fact sheet,2011)

1.4.2.2 Causes of climate change

(Trainer describes how each of the cause contributes to climate change)

Figure 1: Causes of climate change



1.4.2.3 Effects of climate change

(Trainer should discuss effects of climate change such as flooding, drought etc on human life in Kenya)



Figure 2: Flooding Source: www.google.com; [Digital farmers of Kenya, Facebook](#)

Recent climate projections done by CRAFT (SNV, 2020) showed that

1. There will be a definite increase in temperature both in long rains (MAM) and short rains (OND) seasons in the potato growing areas of the Kenya (Figure 3).
2. During long and short rain season, the model projection for both the 2030s and 2050's shows a temperature rise in all parts of Kenya particularly in the western half of the country (Figure 4).

Changes in rainfall patterns

1. While rainfall is expected to increase by 5% in most parts of Kenya during the short rain season, the long rain season is expected to suffer from a long dry spell and a decrease by 5-15 % in seasonal rainfall in potato growing areas.
2. A decrease in the seasonal rainfall and wet spells accompanied by an increase in the number of consecutive dry days (CDD) in the north-western part of Kenya could lead to shortage of water and drought in the region.
3. In terms of planting season results show a late onset of the rainfall as expected in most of the potato counties starting from 21st March.
4. Drought frequency is expected to be higher during MAM compared to OND.
5. In all counties for future, during long rain seasons, the yields under optimum management conditions are likely to decrease by up to 2 t/ha (Narok, Kirinyaga and Embu) to 4 t/ha and even more (for Nyeri and Laikipia). Yields in the short rain season (OND) in the future are likely to increase except in large parts of Meru. Yields in the long rain season (MAM) are generally higher than yields in the short rain seasons though not always.

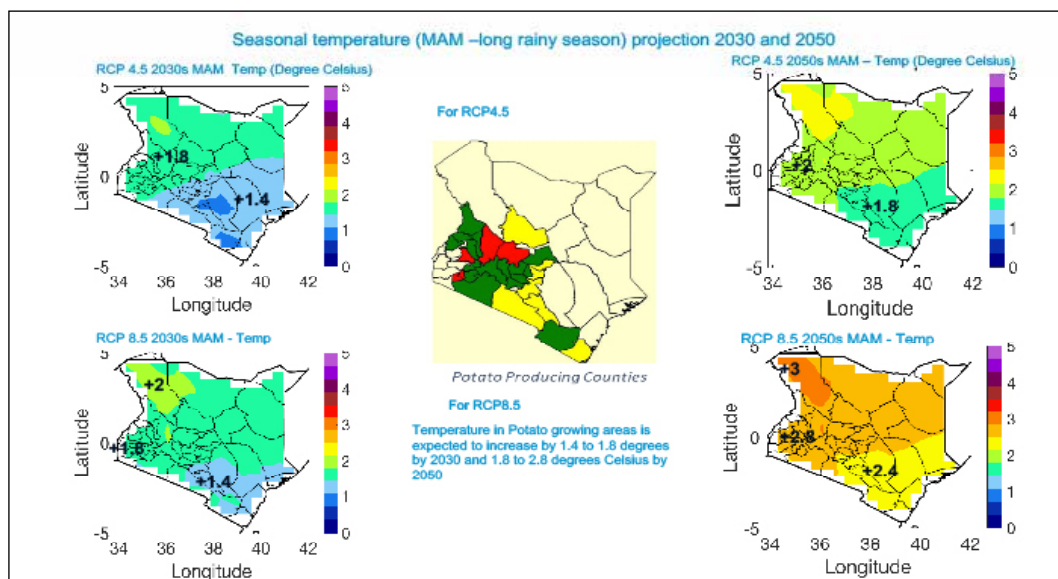


Figure 3: Seasonal temperature projections for long rain season for 2030 –left and 2050 –right
 Source: CRAFT 2020

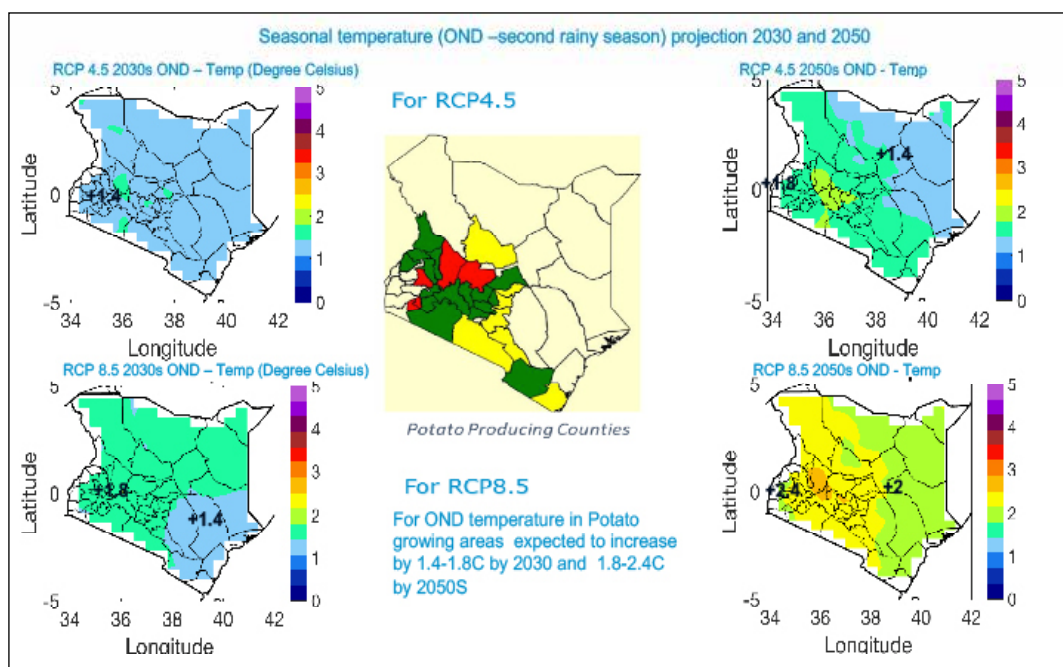


Figure 4: Seasonal temperature projection for short rain season.
 Source: CRAFT 2020

As part of the CRAFT project, the impacts of climate change on potato productivity in the major growing counties were simulated using the WOFOST crop growth model developed by Wageningen University & Research. WOFOST is a simulation model for the quantitative analysis of the growth and production of annual field crops. It is a mechanistic, dynamic model that explains daily crop growth on the basis of the underlying processes, such as photosynthesis, respiration and how these processes are influenced by environmental and climatic conditions.

WOFOST Crop model analysis showed

1. That in the major growing areas such as Narok, Nakuru, Kiambu, Murang'a, Nyandarua, West Pokot, Meru, Uasin Gishu etc., the water-limited yield potential under current climatic conditions ranges between 13 t/ha to 19 t/ha during the first rainy season (i.e. when sowing starts in March-April) and 5 t/ha to 10 t/ha during the second rainy season (i.e. when sowing starts in October-November).
2. That in future, the impacts of climate change on potato productivity will be varied depending on the growing season and the region. During the first rainy season, yields in the north-western growing counties are likely to decrease by between 1 t/ha to 4 t/ha under all scenarios (Figure 5). The worst affected area will be West-Pokot county.
3. That on the other hand, yields are likely to increase by as much as 2.5 t/ha in the southern and central potato growing counties such as Narok, Nakuru, Kiambu, Murang'a, Nyandarua and Taita Taveta. Despite the relatively low yields during the second rainy season under current climatic conditions, yields in the future are likely to increase as a result of climate change (Figure 6). Yield increases of 1 t/ha to 4 t/ha are likely to be experienced irrespective of the climate change scenario. Narok, Nakuru and Nyeri counties are likely to experience the greatest yield increases.

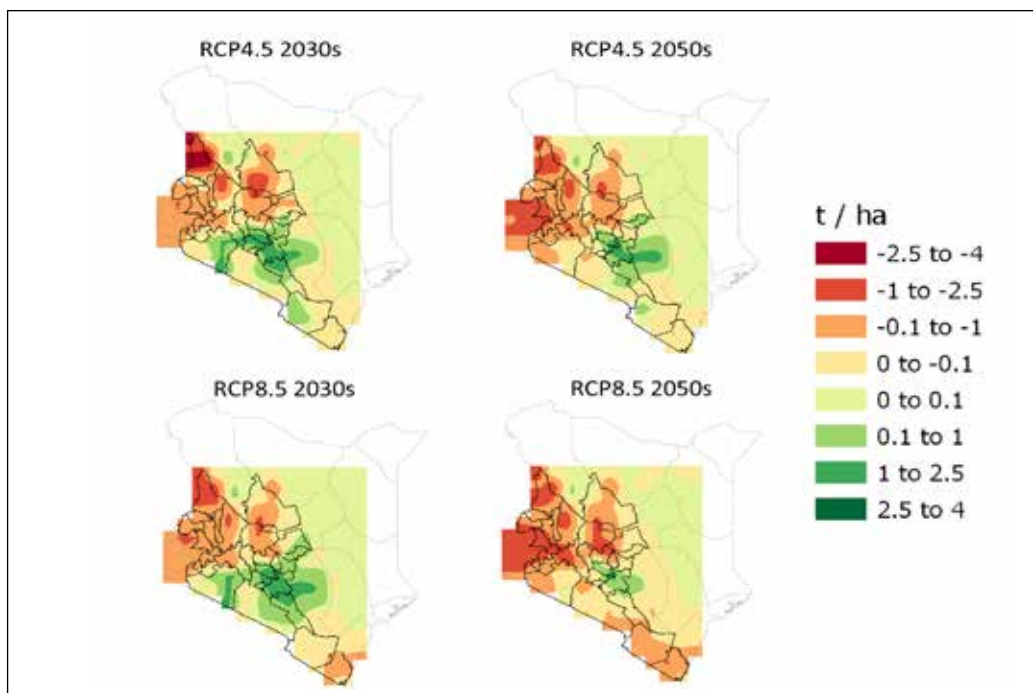


Figure 5: Changes in water-limited yield potential during the first rainy season (i.e. when sowing starts in March-April). Positive values indicate yield increases and negative values indicate yield reductions. The black boundaries indicate the CRAFT targeted potato growing counties.

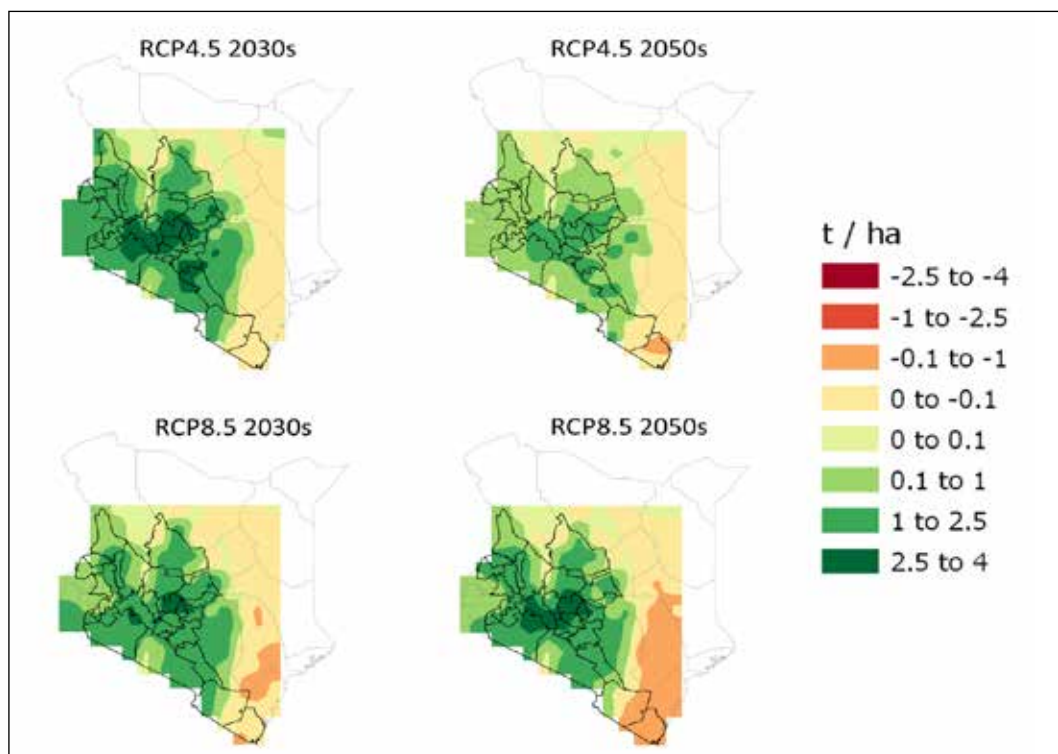


Figure 6: Changes in water-limited yield potential during the second rainy season (i.e. when sowing starts in October-November). Positive values indicate yield increases and negative values indicate yield reductions. The black boundaries indicate the CRAFT targeted potato growing counties.

1.4.3 Climate change hazards and risks

1.4.3.1 Definition of climate change hazards, risks, adaptation, mitigations

(Trainer explains climate change hazards, risks, adaptation and mitigations)

Hazards Physical process or event that can harm livelihoods, human life and natural resource

Risks Potential for consequences where livelihoods, human life or natural resource that contributes to human life is at stake and the outcome is uncertain

Adaptation How individuals, groups and governments or their effects respond or adjust to actual or expected changes in climatic conditions

Mitigations Actions or changes that will reduce emissions of greenhouse gases

1.4.3.2 Climate change hazards and risks to farming communities

Group exercise –highlight climate change hazards and risks to farming and farming communities (Figure 7)

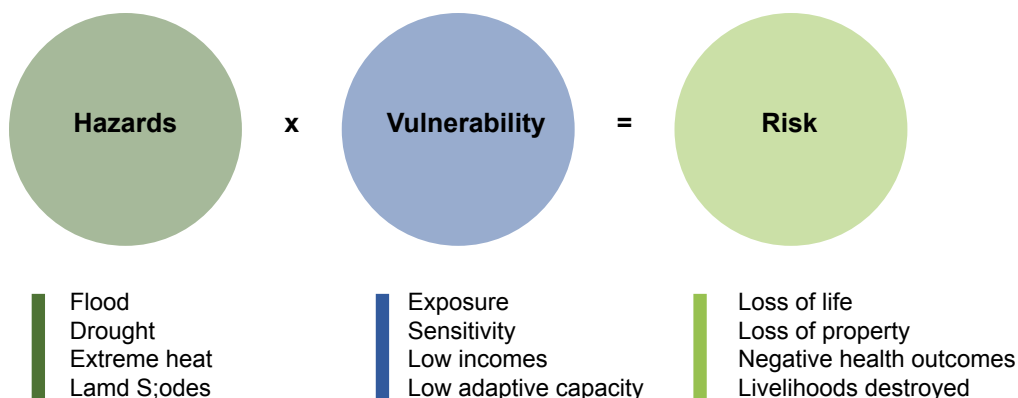


Figure 7: Climate change hazards and risks

1.4.3.3 Effect of climate change on Potato production

1.4.4 Climate change and its effect on gender

(Trainer explains to trainees what gender is and how each gender group responds to the various impacts of climate change)

Group work

Groups present in plenary session

Discussion on how each different gender groups are affected by the climate hazards and risks and how each gender group adapt and mitigate climate change risks and hazards

Table 2: Summary of climate hazards, risks, plant responses and impacts

Climate Hazard	Risk	Plant Positive response	Impact on potato
Heat stress	<ul style="list-style-type: none"> High transpiration of plants raising demand for water High evaporation leading to water deficit Reduced tuber initiation, growth and quality (dry matter content) Disease and pest outbreak frequency and population 	<ul style="list-style-type: none"> Efficient protein repair systems and general protein support survival Acclimation/adaptation of potato plant to heat through reduce growth vigour 	<ul style="list-style-type: none"> Crop failure Reduced yields Poor quality of tubers Seed degeneration High cost of production High pesticide residues due to high frequency of pesticide application
Cold/chilling stress	<ul style="list-style-type: none"> Slow rates of growth (low rate of photosynthesis due to slow water and nutrient uptake) Damaged and irreparable cells membranes 	<ul style="list-style-type: none"> Plant stops growth due to changes in metabolism 	<ul style="list-style-type: none"> Crop failure No yields

Climate Hazard	Risk	Plant Positive response	Impact on potato
Drought or prolonged dry spell	<ul style="list-style-type: none"> • Heat stress and water stress • Increased frequency of dry spells and droughts • Late onset of rainfall • Early cessation of rainfall • Increase in incidences of attacks by insects pests and diseases • reduced periods of crop growth 	<ul style="list-style-type: none"> • Leaf rolling and other morphological adaptations reducing surface area for photosynthesis • Stomatal closure to reduce transpiration • Due to stomatal closures, reduced photosynthesis hence low biomass accumulation 	<ul style="list-style-type: none"> • Crop failure and death • Low yields • Poor quality
Increased rainfall or floods	<ul style="list-style-type: none"> • Water logging/flooding • Outbreak of pests and diseases. • Increase in fungal infections favored by high humidity when it is raining 	<ul style="list-style-type: none"> • Plants increase water uptake and evapotranspiration 	<ul style="list-style-type: none"> • Crops are washed away loss of crops not tolerant to water logging • Nutrient leaching • Reduced yields and low quality • Tuber decay

2 CLIMATE RESILIENT AGRICULTURE

2.1 Learning outcomes

This module aims to familiarize trainees with climate resilient agriculture (CRA), terminologies, concepts, and also give them a better understanding of how gender is integrated. By the end of the training the participants should be able to:

- Define CRA
- Define CRA terminologies and concepts
- Understand how CRA is integrated in gender
- Understand CRA practices mitigates causes of climate change

2.2 Module duration

4 hours 15 minutes

2.3 Module summary

Table 3: Module summary for introduction to climate resilient agriculture

Introduction to climate change and climate resilient agriculture (CRA)			
Sessions	Training methods	Training materials	Time
2.3.1 Introduction to the module and levelling expectations	<ul style="list-style-type: none"> • Participants' introductions • Presentation 	<ul style="list-style-type: none"> • Flips charts • Felt pens, masking tape or sticker glue, note books and pens • Participants Handout- Module Objectives 	15 minutes
2.3.2 Introduction to CRA	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	30 minutes
2.3.3 Difference between conventional practices and CRA approaches	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	30 minutes
2.3.4 List of CRA practices	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	1 hour 30 minutes
2.3.5 Gender mainstreaming in CRA	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	1 hour 30 minutes
TOTAL			4 hours 15 minutes

2.4 Trainer’s instruction

2.4.1 Introduction of the module and levelling expectations

(Trainer introduces the topic and levels expectations)

NB: Trainees list down their expectations on flip charts/cards/sticker notes

2.4.2 Introduction to CRA

(Trainer introduces the topic of CRA, concepts and terminologies)

2.4.3 Difference between conventional and CRA agricultural approach

Table 4: Comparisons of Climate Resilient Agriculture Approach and Conventional Agricultural Approach

Climate Resilient Agriculture Approach	Conventional Agricultural Approach
<ul style="list-style-type: none"> Reduces Greenhouse gases GHGs sequester and stores carbon in the soil and biomass 	<ul style="list-style-type: none"> Increased generation of Greenhouse gases GHGs
<ul style="list-style-type: none"> Reduced use of chemicals (inorganic fertilizers and pesticides) and fossil fuels 	<ul style="list-style-type: none"> Increased use of chemicals (inorganic fertilizers and pesticides) and fossil fuels
<ul style="list-style-type: none"> Increased intercropping, crop rotation and plant species diversity 	<ul style="list-style-type: none"> Increased mono cropping of monoculture of potato and crop rotation
<ul style="list-style-type: none"> Manages pests and diseases keeping their population below economic thresholds, while conserving environment 	<ul style="list-style-type: none"> Eradicates pests and disease and can lead to pollution, damaging environment
<ul style="list-style-type: none"> Build resilience and adaptation to climate change 	<ul style="list-style-type: none"> Build profit resilience or input efficiency only
<ul style="list-style-type: none"> Use renewable energy efficient technologies for agriculture power (irrigation, storage or tillage) and lighter machinery 	<ul style="list-style-type: none"> Dependence on non-renewable energy sources like fossil fuels and heavy machinery
<ul style="list-style-type: none"> Focus on sustainable intensification of existing potato croplands 	<ul style="list-style-type: none"> Promote expansion or conversion of land leading to deforestation and disappearance of grasslands
<ul style="list-style-type: none"> Value the resilience of traditional varieties 	<ul style="list-style-type: none"> Emphasize use of improved and hybrid crop varieties
<ul style="list-style-type: none"> Has greater diversification in production, input and output marketing system 	<ul style="list-style-type: none"> Promotes specialization of potato production and marketing
<ul style="list-style-type: none"> Focus on healthy diet 	<ul style="list-style-type: none"> Chances of pesticides residues found in the potato diet are high

2.4.4 List of CRA practices

Plenary discussions on CRA practices in potato farming. Trainer guides trainees to list CRA practices and (illustrations/drawings/photos) can be used

The following is a list of CRA practices:

- Use of improved potato varieties
- Integrated pest and disease management (IPDM)
- Conservation agriculture (no till, reduced no of tillage, mulching and cover crops).
- Manure application

- Intercropping (diversification, crop rotation, relay)
- Agroforestry
- Water management (harvesting, irrigation)
- Terracing
- Seed potato bulking
- Value addition
- Improved storage facilities
- Information access (weather, market, extension)
- Crop insurance
- Credit access
- Gender equality
- Renewable energy sources (briquettes/feeds);
- Agro-biodiversity conservation

2.4.5 Integrating Gender in CRA

(Trainer presents the relevance of gender issues in adoption of CRA)

Plenary sessions

Addressing gender concerns in the project cycle means understanding how men, women and the youth allocate their time, as well as their specific needs and access to and control over productive resources, services, and decision making

How different gender groups respond to CRA

- Women
- Men
- Youth

(Trainer leads the discussion to articulate what impact adoption of CRA will have on different gender groups and how their specific concerns will be addressed.)

3 CLIMATE RESILIENT AGRICULTURE (CRA) IN COMMERCIAL POTATO PRODUCTION

3.1 Learning outcomes

This module aims at familiarizing trainees with potato farming business; concepts like 'planting to sell' and 'planting and selling' integrated in climate resilient agriculture (CRA). By the end of the training the facilitators should be able to help the participants to:

- Understand the potato, nutritional benefits and utilization
- Adopt the concept of CRA in potato farming as a business
- Understand CRA crop management practices
- Adopt Integrated crop and disease management
- Describe CRA postharvest handling, value addition and processing

3.2 Module duration

32 hours 20 minutes

3.3 Module summary

Table 5: Module summary for introduction to CRA in commercial potato production

Introduction to CRA in commercial potato production			
Sessions	Training methods	Training materials	Time
3.3.1 Introduction to the module and levelling expectations	<ul style="list-style-type: none"> • Participants' introductions • Presentation 	<ul style="list-style-type: none"> • Flips charts • Felt pens, masking tape or sticker glue, note books and pens • Participants Handout- Module Objectives 	15 minutes
3.3.2 What is commercial potato production?	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	40 minutes
3.3.3 Potato background and utilization	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	40 minutes

Sessions	Training methods	Training materials	Time
3.3.4 Introduction to potato farming business	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	3 hours
3.3.5 Potato marketing	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	4 hours 30 minutes
3.3.6 Ecological requirements	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	4 hours
3.3.7 Crop establishment/ planting	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	2 hours 30 minutes
3.3.8 Crop management practises	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	2 hours 30 minutes
3.3.9 Integrated pest and disease management (IPDM)	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	5 hours
3.3.10 Postharvest handling, value addition and processing	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	5 hours
3.3.11 Potato marketing as CRA practice	<ul style="list-style-type: none"> • Plenary Presentations and discussions • Group Exercise 	<ul style="list-style-type: none"> • Flips charts • Felt pens • PowerPoint presentations • Participants Handouts 	4 hours
3.3.12	<ul style="list-style-type: none"> • Module review 	<ul style="list-style-type: none"> • Flipcharts • Felt pens 	15 minutes
TOTAL			32 hours 20 minutes

3.4 Trainer's instruction

3.4.1 Introduction to the module and levelling expectations

(Trainer introduces the topic and levels expectations)

NB: Trainees list down their expectations

3.4.2 What is commercial potato production?

(Trainer guides the plenary discussion of what commercial potato production is)

3.4.2.1 Description of different parts of a potato

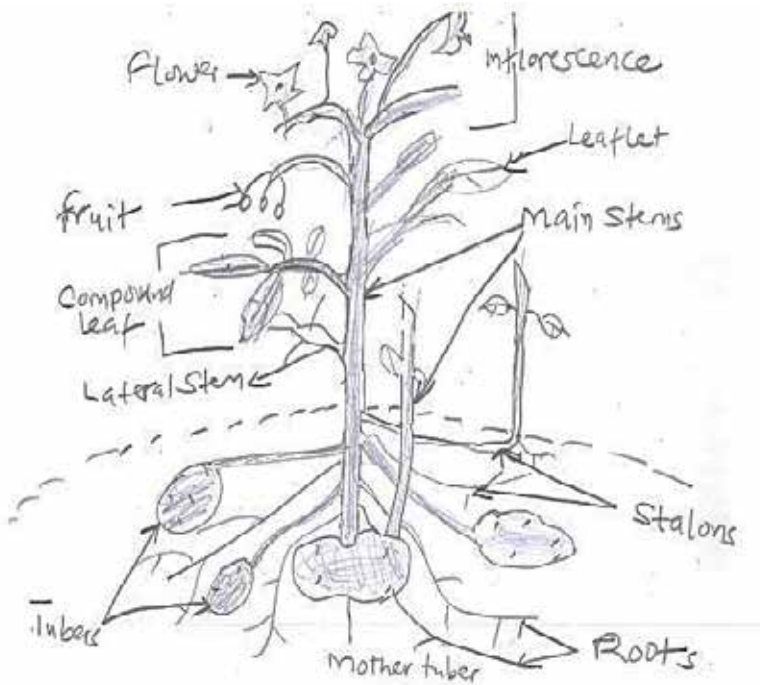


Figure 8: Description of the potato plant

3.4.3 Potato background and utilization

3.4.3.1 History of potato production in Kenya

Trainer explains the historical background of potato in Kenya.

3.4.3.2 Production and consumption patterns

(Trainee describes the nutritional benefits of potato, utilization and consumption patterns and how climate change is likely to change this)

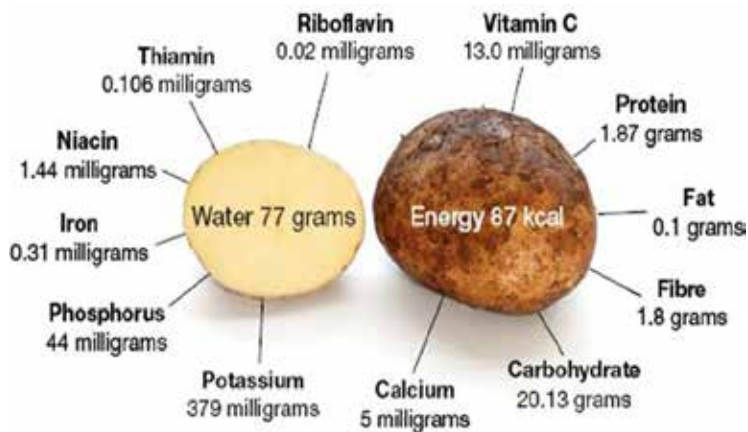


Figure 9: Nutritional benefits of potato

Group work

Trainees list on flipcharts different ways potato is utilized in Kenya

Table 6: Potato utilization and products

Uses	Products
Food products	Mashed, pancakes, cakes, biscuits, dumplings, baked, soups, sauces, stews, salads, crisps, chips, flakes, flour, alcohol, Baby food
Non-food products	<p>Starch used as glue, binder, texture agent, and filler in pharmaceutical, textile, wood, and paper</p> <p>Animal feed: feed your cow 20 kg per day and pig 6 kg per day of tubers. Add chopped tubers to the silage</p> <p>Fuel: Briquettes and ethanol</p>

3.4.4 Introduction to Potato farming business

3.4.4.1 Definition of a business

(Trainer asks questions to initiate the session on definition of a business)

1. What is a business?

(Trainer prepares handouts on Comparisons between retail shops and potato business in terms of aspect of inputs, operations, financing marketing cost and record keeping)

2. Give examples of businesses you know. Examples are listed on flip charts/cards

Group Exercise

- Compare a common retail enterprise (shop) with a potato enterprise on aspect of inputs, operations, financing marketing cost and record keeping
NB: Trainees write on flip charts and then do a presentation during the plenary sessions
- Common characteristics of a good business
*NB: Trainees lists characteristics on the flip chart and discussion done during plenary session
Trainer gives probable indicators of a good business enterprise*
 - Something you are passionate about
 - Has a specific market niche?

- iii. With low start-up capital- let the business grow.
- iv. Has low initial fixed costs
- v. Scalability-has opportunity to grow or scale out

3.4.4.2 Potato farming – normal farming activities undertaken by anybody who plants potatoes for subsistence then sells surplus to raise cash to meet other financial obligation

Trainers make a comparison between subsistence and commercial farming with in relation to input requirements, operational as well as marketing activities in Handouts

(List on comparison done on flip charts)

3.4.4.3 Principles of business management and key requirements for potato production and marketing

Trainer prepares handouts on definition and comparison of businesses, principles of management and key requirements for potato production and marketing

1. Input requirement (seeds, fertilizers, agro chemicals, land, labour, capital, machinery etc)
2. Operational activities (land preparation, sowing, agronomic practices, Harvesting and storage)
3. Marketing activities (transport of the products to the market, processing, packaging, labelling, storage, insurance etc)
 - i. Principles of business management (organizing, commanding, Coordinating & controlling)
 - ii. Key requirements for potato business (inputs required, operational and marketing activities)

Trainer prepares handouts on principles of business management, costs associated with potato production and marketing

3.4.4.4 Potato business planning with climate risks in mind

Trainer defines a business plan, give its importance as well as explain the keys parts of it

Importance of a business plan

- Guide the investor in operation
- Required document especially when looking for external financing
- It is a path to successful future
- An opportunity to test new ideas
- A clear statement of business mission and vision
- A set of values that can help to steer business through turbulence

Parts of a business plan and financing

- **The cover page** (Name of the business, business logo, contact information, contact person, Address, Year)
- **The executive summary** (summary of the entire plan)
- **Business description** (proposed new endeavours, purpose and the target market)
- **Market analysis** (describes the industry and the target market environment)
- **The organizational and managerial section** (explains the envisioned structure of the business; what positions and departments it will encompass)
- **Product** (services) section (details of that you are offering)
- **Marketing and sales section** (how marketing will be done)
- **Financial section** (how the business will be financed? Is financing sought from internal or external sources)

3.4.5 Potato marketing

Trainer guides in provision of knowledge and skills necessary for market assessment and developing market plans

3.4.5.1 Introduction to marketing assessment

- a. Definition of potato market - sum total of all the buyers and sellers of the potatoes
- b. Definition of market assessment - qualitative and quantitative analysis of a market
- c. Dimensions of market assessment –
 - Market size
 - Growth rate of the market
 - Market profitability
 - Market trends
- d. Key success factors (technology progress, economies of scale and efficient utilisation of resources)
- e. Distribution channels
- f. Industry cost structure

3.4.5.2 Market assessment plans

Trainer should be able to explain the steps to follow when doing market assessment

3.4.5.3 Market assessment tools (observations, surveys, focus groups and product testing) and procedures (preparation, field data collection, analysis, conclusion, recommendations and action planning)

Trainer should be able to explain market assessment tools and procedures

3.4.5.4 Practical marketing assessment

Trainer should enable the participants to develop the check list for each of the tools to be used in market data collection

3.4.5.5 Analysis of market data

Trainer should be able to lead the participants in analyzing the market data collected and preparing for development of a marketing plan

3.4.5.6 Developing a marketing plan

Trainer should be able to help the participants to develop a marketing plan

Group work

Brainstorm and come up with:

- i. Description of the target market for the potatoes
- ii. Customer profile
- iii. Competitor profile. Who are the other competitors that I have to be aware of?

3.4.6 Ecological requirement

3.4.6.1 Potato production areas

(NB Trainees lists on flipcharts the production areas)

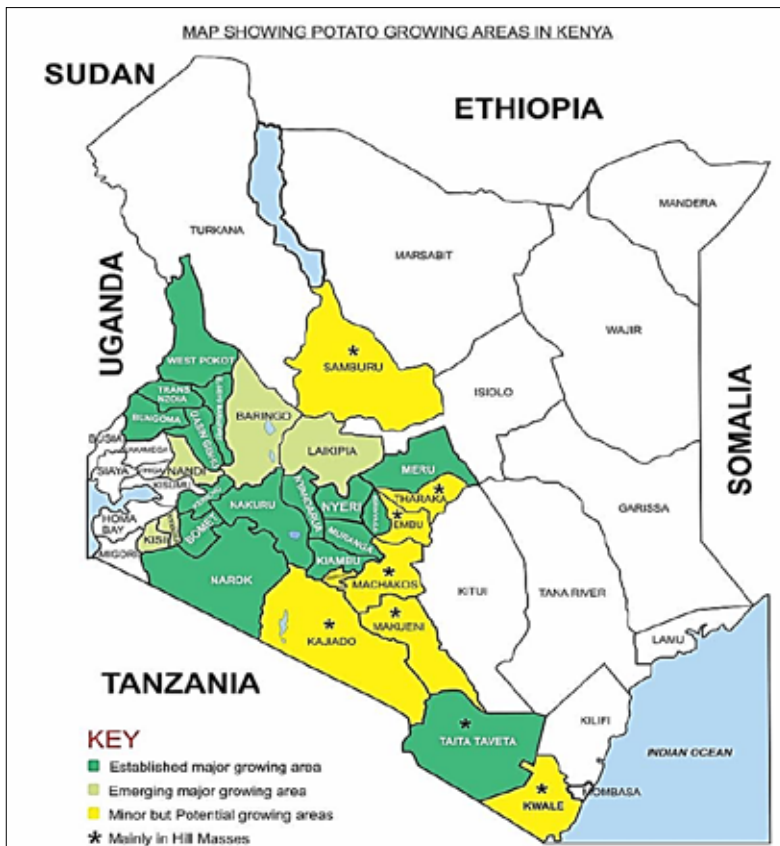


Figure 10: Traditional potato growing areas Source: GoK, 2016

3.4.6.2 Factors to consider during site selection

(Trainer explains the factors to consider and their Importance and how climate change affects these sites)

Soils

- effect of climate change on soils
- CRA practices to improve soils

Topography and drainage

Low-lying areas which are likely to be affected with surface runoffs from higher potato growing zones should be avoided because other than carrying away soil nutrients, run off may contain soil borne disease caused by pathogens such as bacterial wilt, fusarium wilt, blights and soil borne pests like nematodes.

Altitude - 1,500 and 3,000 meters above sea level *(will be linked to section 3.4.5.1)*

Temperature - 15 to 18 °C; above 21 °C have adverse effects on growth of potato as it leads to sharp decline in tuberization; Above 29 °C there is little or no tuber formation

- Relating temperature changes in module 2 to potato production and CRA practices to be adopted

Rainfall - 400 and 800 mm of rains during the growth period or an average of 25mm per week changes in rainfall amounts related to moisture availability and CRA practices for adoption to mitigate

Trainer explains the criteria for site selection

CRA practice for adoption –

- use of improved varieties
- water management (harvesting, irrigation),
- information access (weather, market, extension)
- Agroforestry

Criteria for potato site selection: A farmer should seek the following information when choosing a site;

1. Has the site been used for production of potato or crops in the Solanaceous family such as tomato, tree tomato, brinjals, capsicum, pepino melons and black night shade for the last 4 seasons?
2. Is the site prone to run off from fields where potato or crops from Solanaceous family have been cultivated before?
3. Is the surface topography gently sloping or soils light enough to allow for proper drainage?

3.4.6.3 Soil fertility

Definition

(Trainer introduces the topic in relation to good agricultural practices for optimal yields and increased incomes highlighting the importance of soil testing in light of climate change)

Soil fertility is the ability of soil enhanced through organic and inorganic fertilizers to sustain plant growth and optimize crop yield

Potato requires well-draining soils

Plenary discussion

1. What is soil?
2. How does climate change affect soil and soil fertility?
3. How to determine soil fertility – soil testing

Soil testing

(Trainer describes soil testing as a tool for determining soil fertility)

Soil testing is the analysis done on soil to determine its physical composition, nutrient content, and pH and give status of the fertility.

Importance of soil test

- Gives knowledge on the current soil condition and how to improve
- Reduces fertilizer expenditures
- Helps to avoid over-fertilization which leads to leaching
- Gives information on right fertilizer to use
- Helps in preventing soil/land degradation

Group work

Trainees in groups discuss the features of fertile soils (high in nutrients, rich in organic matter, good water holding capacity, pH, good soil structure)

Trainer guides the discussion by highlighting importance of soil test, how to conduct soil sampling and interpretation of soil test results

Soil sampling

Types of soil sampling

1. Zigzag for flat surfaces

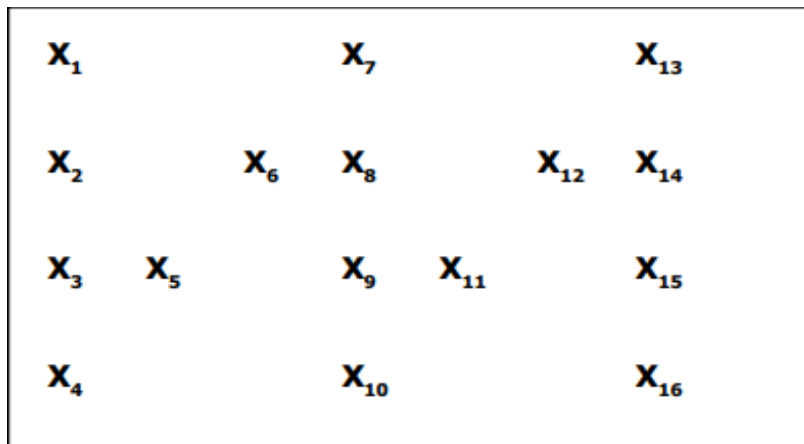


Figure 11: Zigzag sample collection method for square or rectangular flat field.

Source: Gelderman et al., 2006

How to sample on contour strips

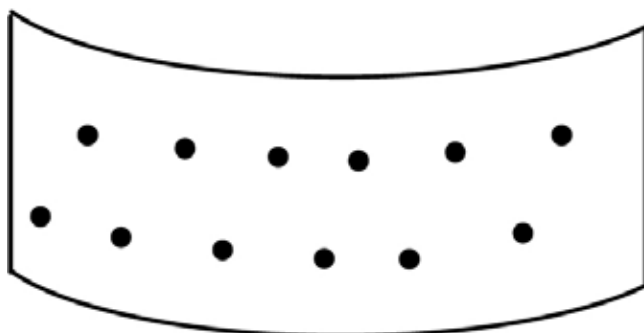


Figure 12: Sample collection method on contours

For contour strips, take 6 samples 20 feet in (6m) from the edge of the entire strip and 6 samples from the opposite side of the strip also 20 feet from the edge.

Sampling tools (Soil auger, soil box/ bags, clean bucket preferably stainless container of plastic, pen/marker pen, note book, tape measure and knife)



Figure 13: Soil sampling tool. Source: Gardeningknowhow.com

Sampling procedure/guidelines (illustrated)

- i. Identify the area to be sampled. Remove plant remains, leaves and any trash
- ii. Avoid areas where manure is collected, anthills, under forests or shaded areas or differ in colour
- iii. Using the soil auger or shovel, scoop soil from the top 15cm deep and place in the bucket
- iv. Scoop more cores following a W or zigzag pattern
- v. Place in the bucket and mix thoroughly
- vi. Afterwards, scoop half kg of mixed soils, dry & put in the soil bag/ brown paper bag and seal properly
- vii. Write name of farmer, field of interest, crop to be planted, ward, location, county and date sampled

3.4.6.4 CRA practices to be adopted in soil conservation

(Trainer explains how the CRA practices conserve the soil, improve fertility at the same time mitigate on climate change)

- i. intercropping (diversification, crop rotation, relay)
- ii. agroforestry
- iii. Terracing
- iv. Manure application (Use of manure [Farmyard Manure (FYM) Compost, vermiculture, green manure, poultry manure and pig manure)

- v. Mulching
- vi. Use of lime
- vii. Appropriate use of inorganic fertilizer
- viii. Use of cover crops

3.4.6.5 Potato nutrient requirements

(Trainer explains how climate change impacts on nutrient availability and CRA practices to adopt)

Table 7: A summary of important plant nutrients for potato production

Macro nutrients	Function	Application requirements	Deficiency symptoms
Nitrogen (N)	<ul style="list-style-type: none"> • N promotes formation of chlorophyll, amino acids, vitamins and carbohydrates for growth of leaves, stems, branches and initiation of tubers. 	<ul style="list-style-type: none"> • N is needed in early stages for growth. • Too much will enhance overgrowth of canopy leading to chances of blight infection, delayed maturity and tuberization • Too much N also affects the tuber quality causing starch imbalance 	<ul style="list-style-type: none"> • Yellowing of older leaves and younger leaves
Phosphorus (P)	<ul style="list-style-type: none"> • Photosynthesis, energy production, transfer of sugars and their storage as starch, respiration, and cell division • Promotes root formation, initiation development and maturity of tubers. • Support the plant to be tolerant to cold, frost and low moisture 	<ul style="list-style-type: none"> • Required during early stages of the plant 	<ul style="list-style-type: none"> • Purple coloration on the edges of the potato leaves.
Potassium (K)	<ul style="list-style-type: none"> • regulates the opening and closing of stomata carbon dioxide uptake and water in plants (osmo-regulation). ATP energy production, protein and starch synthesis. 	<ul style="list-style-type: none"> • Application should be dependent on soil test results • 10 kg/ha per day required at early (during 6 weeks of planting) 	<ul style="list-style-type: none"> • Foliage-Inter-venial chlorosis from older to younger leaves, dark-green or silver colorations on leaf margins and stunted growth. • Tubers -hollow hearts.
Calcium (Ca)	<ul style="list-style-type: none"> • Proper cell division, elongation and wall development • Reduce acidity. • enhances immunity to plants through mechanical 	<ul style="list-style-type: none"> • Application should be dependent on soil test results • Application should be done at planting 	<ul style="list-style-type: none"> • Chlorosis of young leaves, tips of leaves, curling of leaves, stunted growth

Macro nutrients	Function	Application requirements	Deficiency symptoms
Magnesium (Mg)	<ul style="list-style-type: none"> Chlorophyll formation: it is an enzyme activator and a constituent of many enzymes; it helps in sugar synthesis; it helps starch translocation; enhances plant oil and fat formation and controls nutrient uptake. 	<ul style="list-style-type: none"> Required in the early sprout development and vegetative growth stages to produce green tissue 	<ul style="list-style-type: none"> Leaf yellowing with brilliant colors and the excess causes calcium deficiency.
Sulphur (S)	<ul style="list-style-type: none"> Protein and amino acid synthesis for plants to utilize nutrients e.g. nitrogen. Produces chlorophyll. Makes the plants' resilience to disease e.g. <i>Streptomyces scabiei</i> 	<ul style="list-style-type: none"> Required in small quantities (sources include soil organic matter, ammonium sulfate or potassium sulfate) to avoid its oxidation leading to acidity 	<ul style="list-style-type: none"> Pale bright yellow young leaves.

Deficiency symptoms

Trainer describes the nutrient deficiency symptoms and location

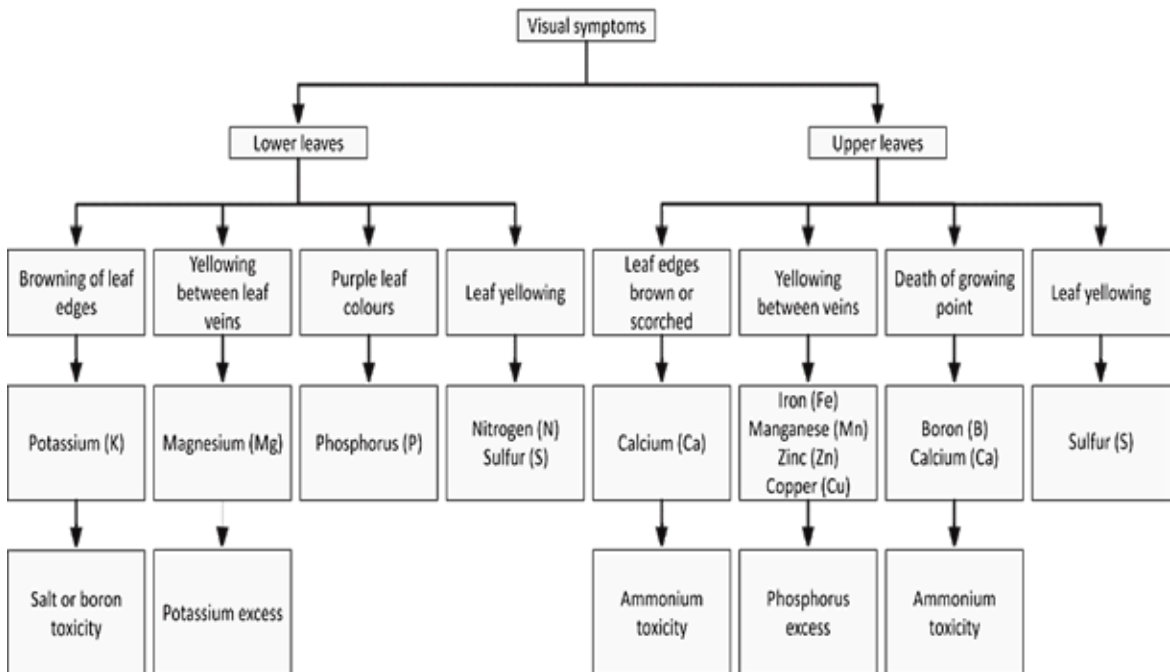


Figure 14: Simple visual nutrient deficiency symptoms diagnosis chart



Figure 15: Nitrogen deficiency
Source: vikaspedia.in; ephytia.inra.fr



Source: ephytia.inra



Figure 16: Phosphorus deficiency
Source: alamy.com; ephytia.inra



Figure 17 : Potassium deficiency
Source: KALRO-Tigoni/J. Oyoo



Figure 18: Calcium deficiency
Source: *vikaspedia.in*



Figure 19: Iron deficiency
Source: *phytia.inra.fr*



Figure 20: Sulfur deficiency
Source: *alamy.com*



Figure 21: Magnesium deficiency
Source: *KALRO-Tigoni/J. Oyoo*



Figure 22: Zinc deficiency
Source: *naturepl.com*

3.4.7 Crop establishment

(The Trainer facilitates the topic by explaining how potato crop is established)

and importance of each practice/activity)

3.4.7.1 Land preparation

Group Work – Importance of land preparation

CRA practices that can be adopted - conservation agriculture (no till, reduced no of tillage, mulching and cover crops), early land preparation using ox-drawn plough



Figure 23: making furrows (left) and ridges (right)

Source: KALRO-Tigoni/J. Oyoo; Agrico

3.4.7.2 Seed selection – only certified seed obtained from reputable registered seed merchants should be used as planting material. Seed bulking as CRA practice to be emphasized; timely availability of certified seed; accessibility of certified seed; high quality availability of planting material



Figure 24: Front and back of the certification label of certified seed potato

Source: KALRO-Tigoni/J. Oyoo

3.4.7.3 Type of seed for planting

(Trainer emphasizes on use of sprouted seed to establish potato crop and how it is a CRA measure)



Figure 25: The right kind of seed potato to use in planting

Source: KALRO-Tigoni/J. Oyoo

3.4.7.4 Planting – spacing is 75cm by 30cm

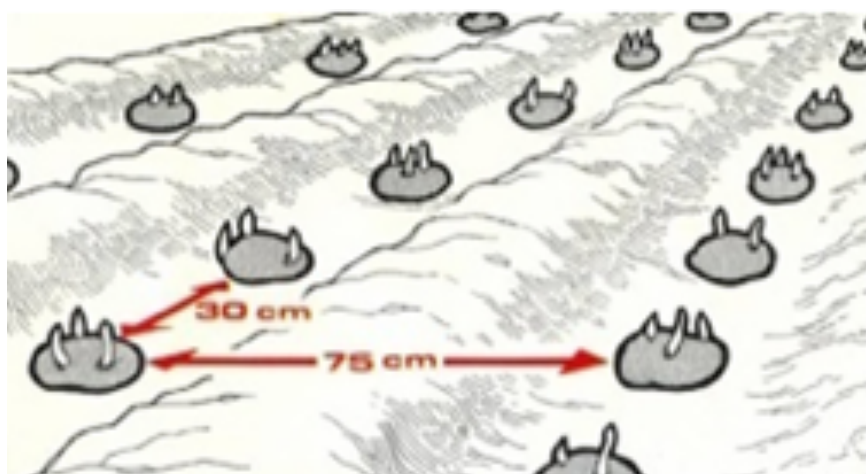


Figure 26: Spacing of potato

Source: Otieno et al., 2015

Seed rate

Table 8: Seed rates for different seed sizes x

Class of seed	Average tuber diameter size (mm)	Average tuber weight (grams)	Number of 50kg bags of seeds needed per acre
1 (Small)	25-35	39-45	14-16
2 (Medium)	35-45	50-57	18-20
3 (Large)	45-55	60-73	24-26

3.4.8 Crop management practises

3.4.8.1 Weeding – can be done manually, mechanically or by use of herbicide

CRA practice for weed management – mulching or intercropping



Figure 27: Weeding a potato crop (left) mulched with maize stalks and on the right is a normal weed free plot

Source: KALRO-Tigoni/J. Oyoo



Figure 28: Intercropping potato with beans and maize

Source: Facebook-Digital Farmers

3.4.8.2 Earthing up/hilling

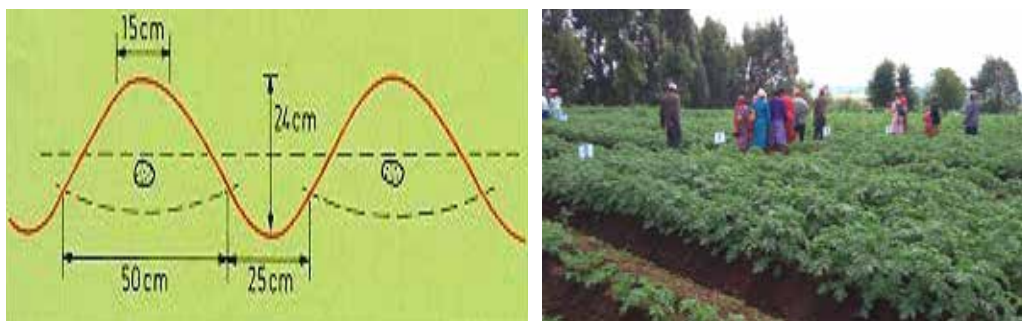


Figure 29: Height of a ridge (on the left) and earthed up crop on the right

Source: *Climate Resilient Potato Production; KALRO-Tigoni/J. Oyoo*

3.4.8.3 Water supply/irrigation – water is needed for transportation of nutrients and photosynthesis.

Types of irrigation include sprinkler, furrow and drip CRA method of water supply

1. Water harvesting -
2. Drip irrigation
3. Soil moisture conservation measures

3.4.8.4 Dehaulinging

(Trainer describes this practice and emphasize how it affects the postharvest life of potatoes as a CRA)

3.4.8.5 Harvesting – normal practice is that it can be done manually or mechanically



Figure 30: Harvesting manually (left) and mechanically (right)

Source: *KALRO-Tigoni/J. Oyoo*

Group work

1. Maturity indices
 - i. Yellowing of foliage
 - ii. Number of days from emergence
 - iii. Random checking of tuber size and skin set
2. What CRA measures can be adopted during harvesting to mitigate climate change?
(Presentation done on flip charts and discussions held during plenary sessions)

3.4.9 Integrated Pest and disease management

(Trainer introduces the topic and describes how it is a CRA practice)

Group work

1. List normal pest and disease management practices
2. Comparison between normal practice and CRA practise
(Trainees present their work in panel sessions where discussion takes place)

Table 9: Summary of types of potato diseases, causing agents, symptoms and management practices

Type	Name	Agent of cause/ Spread	Symptoms	Management practice
Fungal diseases	Potato late blight	<i>Phytophthora infestans</i> (water mold)	Necrosis – death of tissues (leaves)	Certified seed potato and IPM practices such as cultural control-field hygiene practices chemical control-use of Mancozeb and Metalaxyl fungicides
	Potato early blight	<i>Alternaria solani</i>	Brown scorching spots	tolerant varieties and IPM practices such as use of certified seed potato
	Black scurf/stem canker	<i>Rhizoctonia solani</i>	Hard brown masses on tubers	IPM practices Certified seed potato, don't plant in soils with temperature < 7 °C or wet soils
	Fusarium dry rot	<i>Fusarium spp</i> (dry rot)	Necrotic spots outside and browning inside tubers	Certified seed potato, crop rotation of 4 seasons and store freshly harvested tubers in clean-ventilated store (15-21 °C and RH 90% for 3 weeks)
Bacterial diseases	Bacterial Wilt	<i>Ralstonia solanacearum</i>	Wilting, stunting and yellowing of the foliage	Crop rotation of up to 7 years and certified seed potato
	Blackleg or soft rot	<i>Pectobacterium atrosepticum</i>	Black lesions on infected stem and tuber	Certified seed potato, IPM practices such as crop rotation, ventilated cool storage
Viral diseases	Potato leaf roll virus (PLRV)	Vector is Aphid (<i>Myzus persicae</i>)	Leaves curl upwards and roll inwards, tighten and turn pale green	Certified seed potato, rogueing, monitoring traps and control aphids with recommended insecticides
	Potato virus Y (PVY)	Vectors Aphid (<i>Myzus persicae</i>)	Yellowing of leaves and necrosis of tubers	
	Potato Virus X (PVX)	Vectors	Potato interveinal mosaic	
	Potato virus S (PVS)	Aphids (<i>Myzus persicae</i>) and <i>Aphis nurstatii</i> ,	rugosity of leaf surfaces, vein deepening and leaf bronzing occur in susceptible cultivars	
	Potato virus A (PVA)	Aphids (<i>Myzus persicae</i>) and <i>Aphis nurstatii</i> ,	yellowish or light green patches alternating with patches of very dark green is present on most potato cultivars	

3.4.9.1 Potato Diseases

Symptoms of fungal diseases




Physica symptom of disease	Name of fungal disease	Management
	Symptoms on underside of leaves Late potato blight <i>Phytophthora infestans</i>	IPM <ul style="list-style-type: none"> • Use healthy seeds • Use varieties that have high levels of late blight resistance • Always cover tubers with soil during hilling to prevent tuber infection • Before harvesting destroy leaves that are infected • Harvest tubers when fully mature
	Symptoms on potato stem Late potato blight	Pesticides <ul style="list-style-type: none"> • Susceptible varieties – Spray <i>Mancozeb</i> after emergency and every 7 days thereafter • Resistant varieties – Spray <i>Metalax</i> when symptoms appear and alternate with <i>Mancozeb</i> every 7 days
	Early blight on potato leaves <i>Alternaria solani</i>	Pesticides <ul style="list-style-type: none"> • Susceptible varieties – Spray <i>Mancozeb</i> after emergency and every 7 days thereafter • Use preventive fungicides like <i>Mancozeb</i> as above

Table 10: Summary presentation of signs, identity and management of fungal diseases

Symptoms of bacterial diseases



Figure 31: Black leg in the field stem becomes black rot and exudes slime

Photo: Judith Oyoo/KALRO Tigoni



Figure 32: Symptoms of soft rot on potato tubers

Photo: KALRO Tigoni/J. Oyoo

Simple test for bacterial wilt



Figure 33: Bacterial wilt diagnosis Source: GIZ TOT potato production manual (2017)



Figure 34: Bacterial wilt pathogen oozing (left) and infected tuber (right)

Symptoms of Viral diseases



Figure 35: Symptoms of PVY infection in tubers
Photo: KALRO Tigoni/J. Oyoo



Figure 36: Chlorosis or yellowing of foliage due to PVY
Photo: KALRO Tigoni/J. Oyoo



Figure 37: Upward curling and rolling of leaves due to PLRV

Photo: Judith Oyoo/KALRO Tigoni



Figure 38: Mosaic pattern on potato foliage due to PVX

Adopted from *Diseases and Physiological disorders of Potato in Ireland*








Figure 39: Mottling and shiny leaves due to PVA




Source: [www.teagasc.ie/Crops/Potato/knowledge transfer](http://www.teagasc.ie/Crops/Potato/knowledge%20transfer)

3.4.9.2 Potato Pests

Table 11: The signs of the common pests, their identity and management options

Insect pest-	Symptoms	Management
<p>Common name: Aphids</p> <p>Scientific name: <i>Myzus persicae</i></p>  <p>Figure 40: Adult aphids Source: KALRO Tigoni</p>	<ul style="list-style-type: none"> - The aphids will fly long distances aided by the wind. They infest the leaves, flowers and stems and the sprouting tubers. They suck the sap from the plant and in the process transmit the potato leaf roll virus (PLRV), PVA, PVS and PVY. Young plants are more susceptible to viral infections than older plants. The leaves are cupped, distorted and yellowish. - Moulds may form on the upper side of the leaves - Chlorotic leaves - Flower abortions 	<ul style="list-style-type: none"> - use certified seeds, - practise crop rotation and good seedbed hygiene. - field sanitation should be observed. - Chemical control of aphids is achieved by spraying insecticides that contain Alpha cypermethrin and Dimethoate molecules at the rate of 30 to 40 ml / 20 l (1 to 2 L /ha), but seek more advise from the extension officer nearest to you.

Insect pest-	Symptoms	Management
 <p>Figure 41: Shiny sticky surfaces are symptoms for presence of aphids Source: KALRO Tigoni</p>		
<p>Common name: Cutworms Scientific name: <i>Agrotis ipsilon</i></p>  <p>Figure 42: Larvae stage of cut worm. Photo: infonet biovision</p>	<p>Seedlings that are cut at the base of the plant</p> <p>Foliage with holes are characteristic of larvae feeding on them</p> <p>Destroys exposed tubers in the field and with cracks or leaving holes. These holes serve as entry points for secondary infections.</p>	<ul style="list-style-type: none"> • Early weeding • Rogueing of volunteer plants • Planting at recommended depth to avoid exposed tubers during tuber set • Hilling and earthing up to cover exposed tubers • Chemical control where spraying with contact or systemic insecticides at the recommended rates on product labels example Decis EC
 <p>Figure 43: Adult stage of cut worm. Photo: infonet biovision</p>		
 <p>Figure 44: Seedling destroyed by cutworms. Source: KALRO Tigoni</p>		

Insect pest-	Symptoms	Management
<p>Common name: Potato tuber moth Scientific name: <i>Phthorimae operculella</i></p>  <p>Source: KALRO Tigoni/J. Oyoo</p> <p>Figure 45: Adult tuber moth</p>  <p>Figure 46: Larvae of potato tuber moth infesting a potato tuber</p> <p>Source: KALRO Tigoni/J. Oyoo</p>	<ul style="list-style-type: none"> • infests the potato while in the field and in storage. • Prefers warm, dry weather in high altitude zones. • Larvae bores through stems, leaf petioles, shoots and tubers and leaves. • On tubers, the larvae creates tunnels and leaves excretes on them leading to secondary infection and rotting 	<ul style="list-style-type: none"> • Deep planting • Hilling at least twice during the growing period. • Dug out tubers must be stored by the afternoon to prevent the moths from laying eggs on the tubers. • The store should be clean and cool. • Farm sanitation. • Sorting and apply insecticide on new crop. • Apply plant rich in essential oils such as <i>Euchalyptus</i> or <i>Lantana camara</i> which helps to drive away the moth. • Chemical control; Imidacloprid 6-10 ml/20L or 0.3-0.5 L/ha
<p>Common name: Potato cyst nematodes Scientific name: <i>Globodera rostochiensis</i></p>  <p>Figure 47: Cysts attached on roots of potato plant</p> <p>Source: KALRO Tigoni/M. Nyongesa</p>	<ul style="list-style-type: none"> • poor plant growth, wilting during water stress and early plant senescence. • poor plant development, premature yellowing of foliage, defoliation and wilting particularly during hot periods; and eventual plant death. • reduced main root system with several lateral roots that have brown coloration. The plant has cysts attached on the roots. • The pest is spread by physical movement of cysts in the soil that's attached to potato tubers, human feet, machinery, wind and rain water. 	<ul style="list-style-type: none"> • Use tolerant potato varieties where available • Use certified seed • Crop rotation (1 potato crop every 4 seasons) • Avoid movement in your potato plot • Disinfect machinery before using • Field sanitation • Chemical control by fumigation using <i>metham sodium</i>, <i>fumigant (1,3 dichloropropene and methyl isothiocyanate)</i> and <i>non-fumigant (aldicarb and oxamyl)</i> nematicides • Plant <i>Mexican marigold</i> and night shades in potato farms as trap crops

Insect pest-	Symptoms	Management
 <p>Figure 48: Cysts are the fruiting bodies of <i>G. rostochiensis</i> Source: KALRO-Tigoni/M. Nyongesa,</p>		
 <p>Figure 49: Roots of potato plant affected by root knot nematodes Source: Facebook- Digital farmers of Kenya Common name: Root Knot nematodes Scientific name: <i>Meloidogyne</i> sp</p>	<ul style="list-style-type: none"> • poor plant development, premature yellowing of foliage, • defoliation and wilting particularly during hot periods. • Nematodes attack roots and tubers causing lesions that create avenues for bacteria and fungal infestation. • Roots when attacked by the nematodes develop knotty swellings and galls which disrupts vascular vessels resulting in stunted growth. • Tubers are also galled and deformed. Severe infestation results in plant death. 	<p>Soil nematicides such as metam sodium; <i>fluopyram</i>; <i>pyridinylethyl benzamide</i> are used</p> <p>Practice crop rotation plan of 4 seasons (1 potato crop every 4 seasons)</p> <p>Plant mexican marigold (below) and night shade in potato farms as trap crops</p>
 <p>Figure 50: Root knot nematodes on tubers Source: Judith Oyoo, KALRO Tigoni/J. Oyoo</p>		 <p>Figure 51: Mexican marigold Source: KALRO Tigoni/ J. Oyoo,</p>

NB: By the end of this module trainees should be able to 1) describe the difference between normal pest and disease management and intergated pest and disease management as CRA practise 2) adopt the IPDM practise

3.4.9.3 Safe use of pesticides

(Trainer introduces the topic and explains how it links with climate change)

Illustrations of PPEs, classification of pesticides, signs of communication for danger, storage, identify sprayed fields with no entry until PHI elapses, first aid etc

3.4.10 Postharvest handling, value addition and processing

(Trainer introduces the topic and explains how it links with climate change)

3.4.10.1 Postharvest handling

Trainer explains what postharvest handling is and what role it plays in mitigating climate change

Plenary sessions

1. Storage
2. Improved storage facilities

3.4.10.2 Value addition

(Trainer defines what value addition is and how it mitigates climate change as a CRA)

Reference can be made to section 3.4.3, Table 6 on potato utilization and products

Group work

How does value addition mitigate against climate change?

3.4.10.3 Processing

(Trainer explains how processing can be a CRA hence mitigate climate change)

Plenary sessions

- i. Normal processing
 1. Use of electricity – non renewable energy; very expensive
 2. Use of non renewable petroleum fuels- diesel, petrol to run processing equipment
 3. Discarding of byproducts of processing
- ii. CRA processing
 - Use of renewable energy sources (Sustainable improved charcoal like briquettes, Improved cook stoves, fireless cookers, solar, biogas)
 - Use of potato byproducts to manufacture biofuels
 - Access to credit

3.4.11 Potato marketing as a CRA practise

(Trainer explains what marketing is and compares normal marketing activities with marketing as a CRA practise)

3.4.10.1 Definition of marketing

Normal marketing activities

1. Sorting
2. Grading
3. Packaging
4. Aggregation

3.4.10.2 Marketing as a CRA activities (reference to section 3.4.4)

1. Improved sorting and grading
2. Improved packaging and transporting
3. Improved drying and curing
4. Improved storage

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ANNEXES

Annex 1: Evaluation of the Training

Table 12: Evaluation of the modules and their relevance

Module	Rating		
	Very useful	Useful	Of limited use
Module 1 – What is climate change, causes and effects			
i. Introduction to climate change, causes and effects			
ii. Climate change hazards and risks			
iii. Climate change and its effect on gender			
Module 2- Climate resilient Agriculture (CRA)			
i. Introduction to climate resilient agriculture (CRA)			
ii. Differences between conventional agricultural approach and CRA approach			
iii. List of CRA practices			
iv. Integrating gender in CRA			
Module 3 – Climate resilient agriculture in potato production			
i. What is commercial potato production?			
ii. Potato background and utilization			
iii. Introduction to potato farming business?			
iv. Potato marketing			
v. Ecological requirements			
vi. Crop establishment			
vii. Crop management practices			
viii. Integrated pest and disease management			
ix. Postharvest handling, value addition and processing			
x. Potato marketing as CRA practise			

After the training and evaluation of the training, plan for way forward



NATIONAL POTATO COUNCIL OF KENYA



CRAFT

Climate resilient value chains
for improved livelihoods

National National Potato Council of Kenya
KALRO Kabete Campus, off Waiyaki Way
P.O. Box 29982-00100 Nairobi, Kenya
Tel: +254 712 338 633/ +254 799739578
Email: npck@npck.org

SNV Netherlands Development Organisation
Ngong Lane, off Ngong Road
P.O. Box 30776, 00100 Nairobi, Kenya
Tel: +254 724 463355
Email: kenya@snv.org

