

# BUNDLED SERVICES FOR IMPROVED AGRICULTURAL RISK MANAGEMENT

TRAINING MANUAL FOR AGRICULTURAL DOWNSTREAM ACTORS



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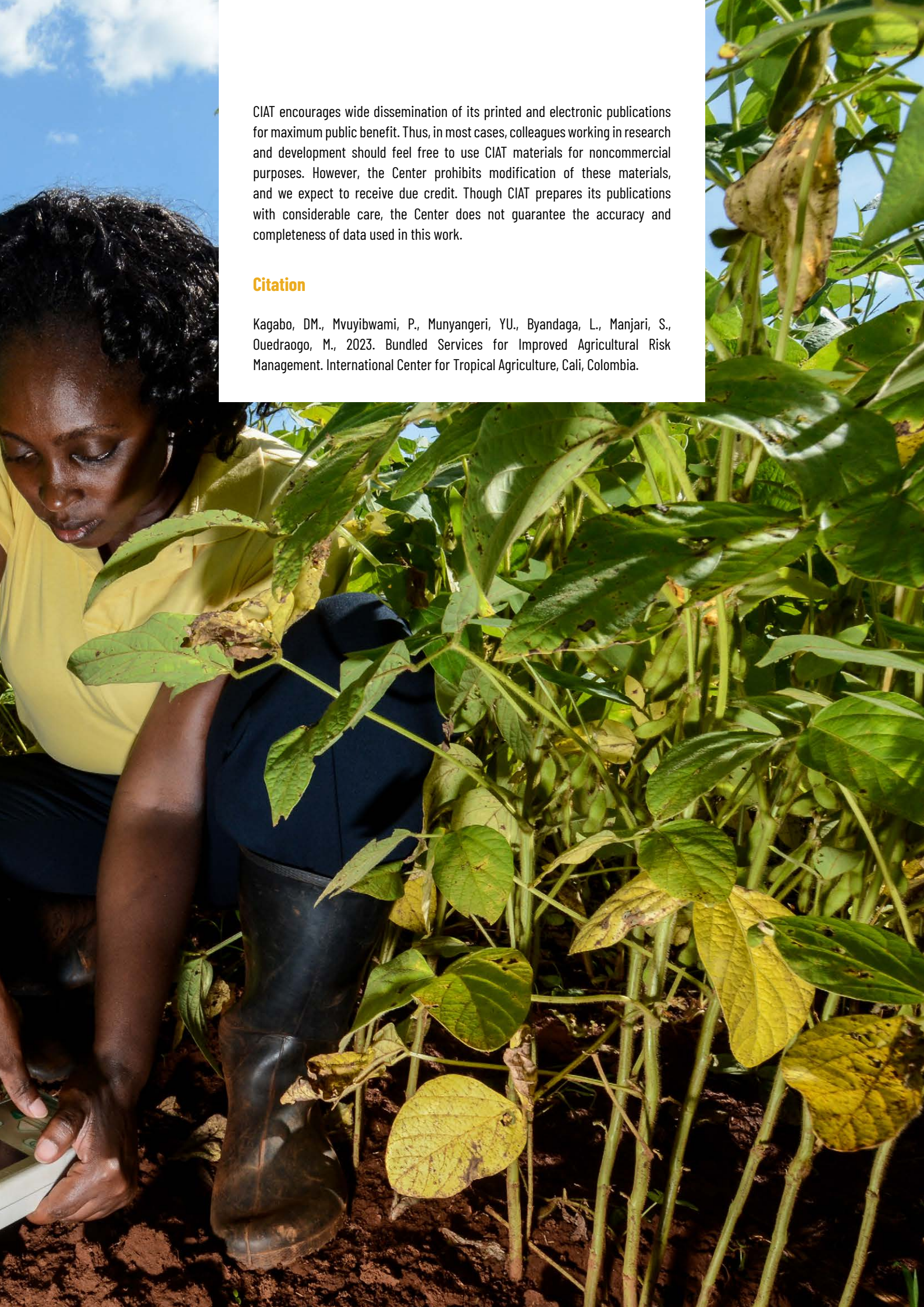
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## Chapter 1: Introduction

Climate change impacts have affected agriculture and food security especially in the sub-Saharan Africa region, affecting mostly smallholder farmers in general and women (Darkwa et al., 2016) and are predicted to contribute to crop production deficits in 2050 due to increase in temperatures and erratic rainfall (Thornton et al., 2010; Adhikari et al., 2015).

However, it was found that timely provision of climate services for agriculture are key to anticipate, prepare for and mitigate climate risks among smallholder farmers who are mostly vulnerable to climate risks that cause crop failure, reduced production, post-harvest losses etc. leading to hunger and food insecurity (Clarkson et al. 2017; Connolly-Boutin and Smit 2016; Njau et al., 2011). In that regard, the bundling of Climate Information Services (CIS), Climate Smart Agriculture (CSA) technologies and other services for Improved Agricultural Risks Management was found to be an efficient tool to enhance farmers' access, understanding and use of bundled services that will improve their ability to make informed decisions hence become resilient to climate risks. Through successive field experimental trials that were conducted by more than 100 farmers in two years in Rwanda, the application bundled CIS and CSA technologies was found to be very effective in improving farm yield and farmers' resilience to climate risks.

Through the support of the Alliance of Bioversity International and International Center for Tropical Agriculture (CIAT), a training manual on scaling and sustaining bundled climate information services and climate smart agriculture for agriculture risk management was developed. This training manual was prepared to support agricultural value chain actors to (1) have access and understanding of CIS and CSA technologies and (2) have the capacity to use CIS and CSA to improve farm yield and resilience to climate shocks. The manual was methodically developed with the diverse needs of all stakeholders in mind. It has been prepared with cutting-edge technologies to facilitate effective learning processes and enable well-informed decision-making. This training manual will help farmers to progressively learn about climate effects on farming activities, understand the role of climate information and services to cope with climate risks and know how to use climate smart agriculture technologies to be able to improve crop productivity and become more resilient to climate shocks. The content is designed to be covered over a period of four consecutive days during a structured training workshop.

## WHAT SETS THIS MANUAL APART?

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- **Integrative:** provides both technical and advisory information and takes into consideration the needs of farmers and extension agents for improved climate informed decisions in crop management
  - **Crop-specific:** focuses on major crops that are important to the economy of farmers in the tropical regions
  - **Economically relevant:** enables improved decision-making for the farmer and agricultural stakeholders
  - **Action oriented:** highlights farmers' own perspectives and recommendations to attain opportunities to overcome current and potential barriers to adoption of CSA practices in the regional context.
- who desire to understand the long-term benefits of their investment options, optimizing their farm practices by presenting cost-benefit analyses for each prioritized option.

### 1.1: What is the target group and why?

Agricultural extension agents and farmers play key roles in the development of the agricultural sector and in addressing climate risks within the agricultural industry. Therefore, this manual will serve as an informative and advisory tool to support them in making improved climate informed decisions which will have potential impacts on:

Better management of climate risks

- Increased crop productivity
- Improved rural livelihoods
- Improved financial independence at household level

### 1.2: Objectives of the training manual

The aim of the bundling Climate Information Services (CIS), Climate Smart Agriculture (CSA) technologies and other services is to support agricultural value chain actors (AVCA) to (1) have access and understanding of CIS and CSA technologies and (2) have the capacity to use CIS and CSA to improve farm yield and resilience to climate shocks. Specific objectives include:

- To enhance AVCA' access, understand and use of bundled CIS & CSA practices in the crop production
- To enable AVCA to understand the impacts of climate change and variability on crops and enhance their ability to make climate informed decisions
- To improve AVCA' capacity in relation to linking climate and crop variables to enhance their ability to make crop choices that are suitable to the season and area
- To explore suitable Climate Smart Agriculture (CSA) technologies for improved crop production and climate resilience
- To improve AVCA capacity in seasonal planning through developing seasonal calendar, seasonal adaptation plan and the cost-benefit analysis to inform AVCA decisions in crop production and for improved resilience to climate risks

### 1.3: Expected outcomes of the manual

- To enable agricultural extension officers to provide more targeted training to farmers based on the priority needs identified.
- To build farmers' knowledge capacity in adequately responding to key climate related hazards to their agricultural production systems.
- To promote broader adoption of climate-smart practices



## Tips for Facilitator

*The facilitator should set the scene for the four-day workshop by introducing the objectives of the workshop and emphasizing the need for promoting integrated climate information services and climate smart agriculture. He/she should use the exercise to help participants to reflect on climate change and variability in their regions. This will be followed by an ice breaker exercise so as to get the participants ready for the training. The facilitator should guide the participants in a participatory exercise in order to establish a few do's and don'ts (for instance, keeping mobile phones on silent mode) for the duration of the workshop so as to ensure optimum utilization of time and resources. He/she should emphasize that the training program is to enhance the understanding of participants on the role of extension and advisory services in promoting and upscaling climate smart agriculture. He/she should apprise the participants that this training program pitched towards gaining adequate expertise on assisting farmers and other actors (both core and supporting) in adapting to the changing climate and building a climate resilient future for farmers.*



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## Chapter 2.

# Basic concepts of Bundled Climate Information Services (CIS), Climate Smart Agriculture (CSA) and other Agro-advisory services

## 2.0: Background

Climate change is now closely linked to most of the SSA economic growth. Agriculture stands at the heart of the economies of SSA countries by providing the population the food and other livelihood activities. Therefore, agriculture, livestock as well as the livestock activities are critically exposed to the looming threat of climate change. The production level from agricultural, livestock and fisheries are extremely sensitive to climate change events, such as changes in temperature and precipitation, which may then lead to outbreaks of pests and diseases – thereby reducing harvests and ultimately affecting the food security of countries.

Bundled Climate Information Services (CIS), Climate Smart Agriculture (CSA) and other Agro-advisory services Integrated Climate Information Services (CIS) play a pivotal role in fostering adaptability to climate variability and change within the agricultural sector. By providing valuable insights to farmers and influencing decision-making at the institutional level, these bundled services contribute to the generation of local climate knowledge (Djido et al., 2021). Acting as a strategic entry point, CIS guides the selection of climate-informed CSA practices and technologies, as highlighted in the research by Bayala et al. (2021). This comprehensive approach not only informs farmers about prevailing climatic conditions but also facilitates the adoption of resilient agricultural practices and technologies, ultimately promoting sustainable adaptation to the evolving climate landscape.

### Outline

- i. Understanding key climate concepts
- ii. Climate adaptation and mitigation
- iii. Agro-climate advisory services
- iv. What does the term “Bundling” mean?

## The expected outcome for this module

The expected outcome of this training module is the development of competent and confident trainers having the skills necessary to explain key climate concepts, interpret climate information and key concepts regarding future climate to best inform climate related decision-making processes in the agricultural sector.

## 2.1: Understanding key climate concepts

**Weather:** The state of the atmosphere conditions that may be described with respect to heat or cold, wetness or dryness, calm or storm, clearness, or cloudiness and based on climate parameters like temperature, pressure, wind, humidity, rainfall.

**Climate:** Climate is the long-term weather pattern in an area, typically averaged over 30 years. More rigorously, it is the mean and variability of meteorological variables over a time spanning from months to millions of years.

### Climate change and Climate variability

The difference between climate change and climate variability is that climate change refers to changes that occur over a longer period, normally over decades or longer while climate variability refers to changes in the climate that occur within a smaller period, such as a day, a week, a month, a season, or a year.

**Probability:** means the chances that a forecasted event will happen for a forecasted area.

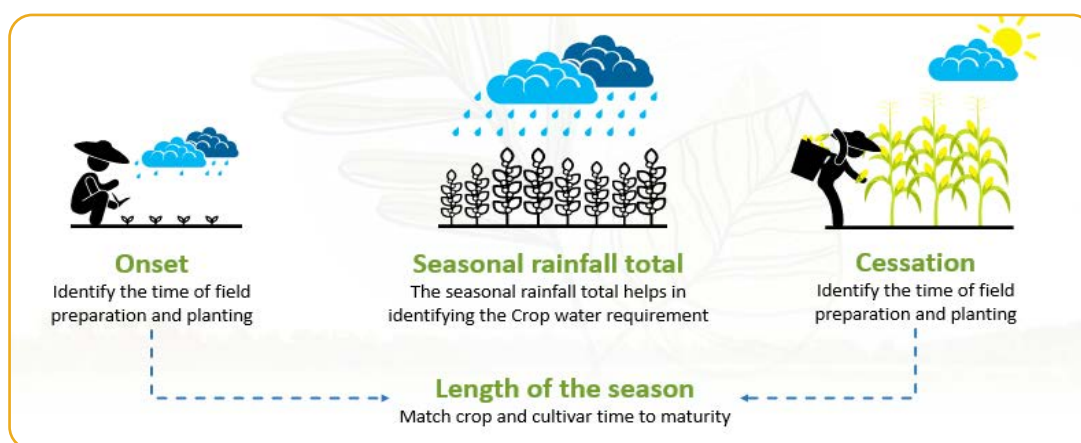
**Forecast:** means climate predictions for future events or trend

**Frequency:** means the number of repeated times of climate variables' events of defined characteristics recorded each year.

**An extreme:** is a remarkably severe weather or climate event that may cause shocking impacts on the environment and population.

**Historical climate information:** Historical climate information can be defined as a set of weather and climate data gathered and analyzed from many years in the past and can be used as reference to predict current and future climate with the use of latest technologies

**Climate data:** are data gathered from automated or manual weather stations and are used to generate climate information tailored to user needs. Below is the most commonly information being used in the agriculture sector:



**Climate Information Services (CIS):** Climate Information services can be defined as gathering of climate information and its dissemination to end users through various communication channels to ensure that beneficiaries are well equipped to anticipate, prepare, and cope with climate shocks.

Climate Information Services (CIS) are the services that facilitate the access to actionable climate information that enable users to make climate informed decisions. The services include among others, the production, translation, and communication of climate information to users in a timely manner for its usefulness

(Machingura et al., 2018). Some examples of the most commonly used climate information are onset of the rain, cessation, length of the season, dry spells and wet spells and rainfall totals.

**Climate Smart Agriculture (CSA):** Can be defined as an integrated approach used to handling climate change and food security related challenges in crop, animal, fisheries, and forest production systems.

The World Bank explains Climate Smart Agriculture (CSA) as an integrated approach that addresses the interlinked challenges of food security and climate change through the management of landscapes including cropland, livestock, forests, and fisheries. It is a new approach, a way to guide the needed changes of agricultural systems, given the necessity to jointly address food security and climate change (FAO, 2013; World Bank, 2021). This approach helps in tackling challenges that result in crop production losses due to climate related shocks, feeding the

increasing global population, reducing agriculture's extreme vulnerability to climate change, improving farmers' resilience to climate change, and reducing greenhouse gases emission from agriculture among others (FAO 2010; World Bank, 2021). The aim of CSA is to achieve three main outcomes including:

- 1. Increased productivity:** Focusing on increasing farm productivity, food security and income
- 2. Enhanced resilience:** Increase the ability to adapt to climate risks and decrease vulnerability to climate related shocks including floods, drought, pests, diseases etc.
- 3. Reduced emissions:** Reduce greenhouse gas emissions from agricultural activities, reduce deforestation and increase afforestation and reforestation to increase carbon sink

## 2.2: Climate change adaptation and mitigation

**Climate change adaptation** involves the adjustment to current or anticipated climate change and its impacts, aiming to mitigate harm and exploit opportunities. Humans may intervene to assist natural systems in adapting, but full adjustment is often challenging, especially for vulnerable ecosystems like coral reefs. Adaptation actions can be either incremental, maintaining the essence of a system, or transformational, fundamentally changing a system in response to climate change. The necessity for adaptation varies based on the sensitivity and vulnerability of different regions, with developing countries being particularly at risk and most affected by global warming.

Adaptation encompasses modifications to ecological, social, or economic systems in response to climatic triggers, aiming to alleviate potential damages or capitalize on opportunities arising from climate change (UNFCCC Website, n.d.). According to UNDP (2005), adaptation is a process refining, developing, or implementing strategies to alleviate, manage, and capitalize on the outcomes of climatic events. (Levina & Tirpak, (2006) defines adaptation as a series of actions leading to a reduction in harm or risk associated with climate variability and change, or the realization of associated benefits.

### Examples of climate change adaptation strategies

- Early warning system
- Sustainable Land Management (CES, DRS, AGF)
- Use of adapted varieties
- Integration of agriculture-livestock-agroforestry
- Diversification of production systems
- Water management (irrigation)
- Use of climate services
- Post-harvest strategies and management (storage, drying...)
- Transformation and valorization of agricultural products.
- Sustainable management and conservation of pastoral resources
- Sustainable system for the collection and conservation of forages
- Use of information including livestock insurance
- Improvement of animal health and productivity
- Genetic improvement of species.

**Climate change Mitigation:** Mitigation in the context of climate change pertains to efforts directed at reducing or preventing the emission of greenhouse gases into the atmosphere and promoting activities that remove these gases from the atmosphere (Kumar, 2022). As defined by the Intergovernmental Panel on Climate Change (IPCC, 2014), mitigation involves managing human-induced factors contributing to climate change and their cumulative effects. This primarily entails addressing the emission of greenhouse gases (GHGs) and other pollutants, including black carbon particles, which also influence the Earth's energy balance.

Mitigation strategies encompass a wide range of actions, ranging from transitioning to renewable energy sources, implementing energy efficiency measures, afforestation (planting trees), promoting sustainable land use practices, to adopting cleaner technologies in sectors such as transportation and industry. These collective efforts aim to reduce the overall impact of human activities on the Earth's climate system.

### Examples of climate change mitigation strategies

- Fossil & Renewable Energy
- Biomass (on the surface & in the soil)

- Soil carbon stock
- Methane emissions
- Organic matter management
- Nitrogen use efficiency
- Breeding more resilient crop varieties, and diversification of crop species
- Using improved agroforestry species
- Capture and retention of rainfall, and use of improved irrigation practices
- Increasing forest cover and Agroforestry
- Use of emerging water harvesting techniques (such as contour trenching, ...)
- Soil erosion control such a terrace
- Climate smart Agriculture practices

## 2.3: Agro-climate advisory services

Agro-climate advisory services refer to the guidance and information provided to farmers, agricultural stakeholders, and decision-makers to support informed decision-making in response to climatic conditions and variability. These services are designed to help individuals involved in agriculture navigate the challenges posed by weather patterns, climate changes, and other environmental factors. Agro-climate advisory services typically include the provision of weather forecasts, climate predictions, and tailored agricultural advice based on these forecasts.

### Components of Agro-climate Advisory Services (ACAS)

To ensure the availability and accessibility and adoption of **Agro-climate Advisory Services** for agricultural stakeholders such as farmers, extension workers, and policymakers, The ACACS implementation follows a value chain with four primary components:

- Producing weather and climate information,
- Translating it into agricultural advice,
- Transferring information to agricultural users, and
- Integrating weather and climate information into agricultural decision-making

### Agricultural Benefits of Agro-climate Advisory Services

Agro-climate advisory services provide tangible benefits for agricultural planning and management. These services, including agro-climatic zoning, support the selection of climate-adjusted crops and management practices, enabling optimal agricultural production by effectively utilizing rainfall, temperature, and solar radiation resources.

Agro-climate advisory services can help optimize resource utilization, and promote sustainable farming practices by aligning agricultural activities with prevailing and anticipated climatic conditions. These services may cover a range of topics, including optimal planting and harvesting times, water management

strategies, crop selection based on climate suitability, and recommendations for mitigating the impacts of extreme weather events.

Agro-climate advisory services contribute to building resilience in agriculture, helping farmers adapt to changing climate patterns and fostering sustainable agricultural practices.

## 2.4: What does the term “Bundling” mean?

Bundling is the synergistic co-delivery of complementary services and products. In the simplest way, a product bundle is a grouping of individual products that can be sold separately but are sold together. This marketing strategy facilitates the convenient purchase of several products and/or services from one company/organization.

Bundling occurs when organizations/companies package several of their products or services together as a single combined unit, often for a lower price than they would charge customers to buy each item separately. A coordinated bundling has a strong potential to build momentum around innovative new approaches by:

1. Lowering cost
2. Increasing use
3. Leveraging on existing/popular product to introduce new/unpopular products

### What typically gets bundled?

There are four categories of products that can be bundled in varying degrees.

- Knowledge products (KP) – CIS, CSA recs, early warning, etc.
- Consumables (C)– certified seed, fertilizer, chemical inputs, etc.
- Financial services (FS) – microloans, insurance products, banking, etc.
- Physical services (PS) – mechanization, milling, solar, etc.

The richness of the bundle is defined by the number of products in the bundle. For example, you can bundle different aspects of knowledge products, physical services with financial services and consumables to get highest benefit. Or alternatively you may bundle knowledge products and Financial services only or financial services and consumable etc.

### Example of Bundling

Suppose that for a farmer to get access to each service separately you pay **GHC 2,500** for CIS& CSA **GHC 3,000** for Consumables, **GHC 3,500** for Financial Services and **GHC 4,000** for Physical services, the total cost would be **GHC 13,000**. Example of bundling discounts:

Combine 2 services, save 10%

Combine 3 services, save 15%

Combine 4 services, save 20%

Save 20% of **GHC 13,000 – GHC 2600**



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## Chapter 3.

# Accessing and Understanding Climate Information Services

## 3.0: Background

The topic of climate change has moved beyond being headlines news. What will continue to be significant for an extended period is the level of awareness, accessibility, and capacity-building for adapting to, and where feasible, mitigating the impacts of climate change, particularly in developing countries (Imam & Babuga, 2021). The saying “Information is power” holds true without dispute. Making well-informed and accurate decisions depends on having awareness, access and understanding of Climate information services.

This module centers on gaining access to climate information and developing an understanding of climate risks and vulnerabilities. This understanding is achieved through the calculation of probabilities using climate information graphs.

### Outline

- a. Access to Climate Information Services and communication channels
- b. Awareness and Understanding of climate risks and vulnerabilities through the calculation of probabilities using climate information graphs

## 3.1: Accessing climate information and communication channels

Effective communication between information providers and users is crucial for accessing and using Climate Information Services (CIS) (Diouf et al., 2019; Muema et al., 2018). However, persistent gaps exist due to socio-economic factors, limited capacity to interpret weather and climate information systems, and insufficient integration of societal perspectives and decision-making processes (Churi et al., 2012).

Timely and accurate access to climate information holds the potential to empower farmers in managing extreme events, thereby minimizing socio-economic disruptions and associated hardships. Additionally, weather and climate information services assist farmers in determining optimal planting times, enhancing farm production, and facilitating adaptation to anticipated climate risks (Tamru et al., 2022).

The spectrum of Weather and Climate Information Services encompasses historical information, short-term and seasonal forecasts, and Early Warnings. These services are primarily accessed through various communication channels, including:

- a. Mass media (Radio, Television)
- b. Participatory meetings
- c. Extension Services
- d. SMS, Toll-free calls, and social media
- e. Peer to peer farmers and
- f. Digital platforms

## An example of Digital platform: Digital Agroclimatic Advisory (DACA)

The Digital AgroClimate Advisory (DACA), <http://tinyurl.com/2nf3ureh>, is a mobile-based platform that was developed to provide easy access to a range of digital information on climate, crops and farm management practices, other products and services to inform farmers' agriculture and climate related decisions. Furthermore, the approach involves Bundling climate and crop information with agricultural details such as fertilizer recommendations to digitally deliver sustainable and actionable guidance throughout agricultural value chains. The procedures encompass collaborating with National Agriculture Research Systems (NARS) to ensure data quality at the country level, bundling, and translating information to facilitate informed decision-making. DACA has two objectives:

- Creation of reliable Agro-climate information services and products for local decision-making.

- Educate and promote 2-way communication loop through tutorials and chats

### Why DACA?

- Overcoming Agro-climate and crop data integration Challenge
- Promoting and application of digital technologies into agricultural value chains for informed decision making
- Provide tailored agro-climate information services and advisories to value chain actors.

### DACA description



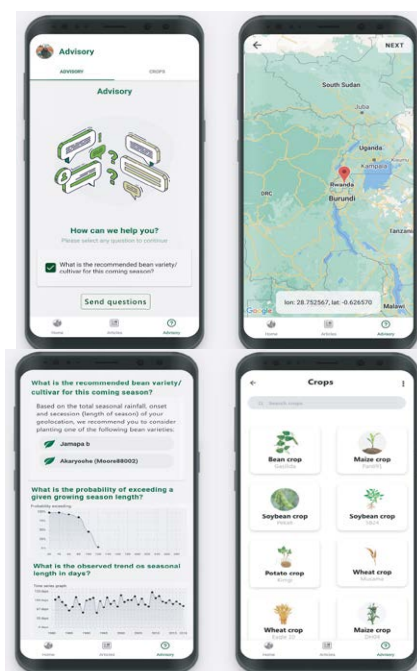
Climate information services have received a lot of attention in timely production, translation and delivery of useful information and knowledge for societal decision making. The question is how can users have access, understand and use climate information for informing their decisions?



DACA is a web and mobile based platform that leverages on existing work by combining global, regional and national information on climate and weather with crop characteristics to digitally provide local, context specific and accurate near real time Agro-Climatic Advisory services.



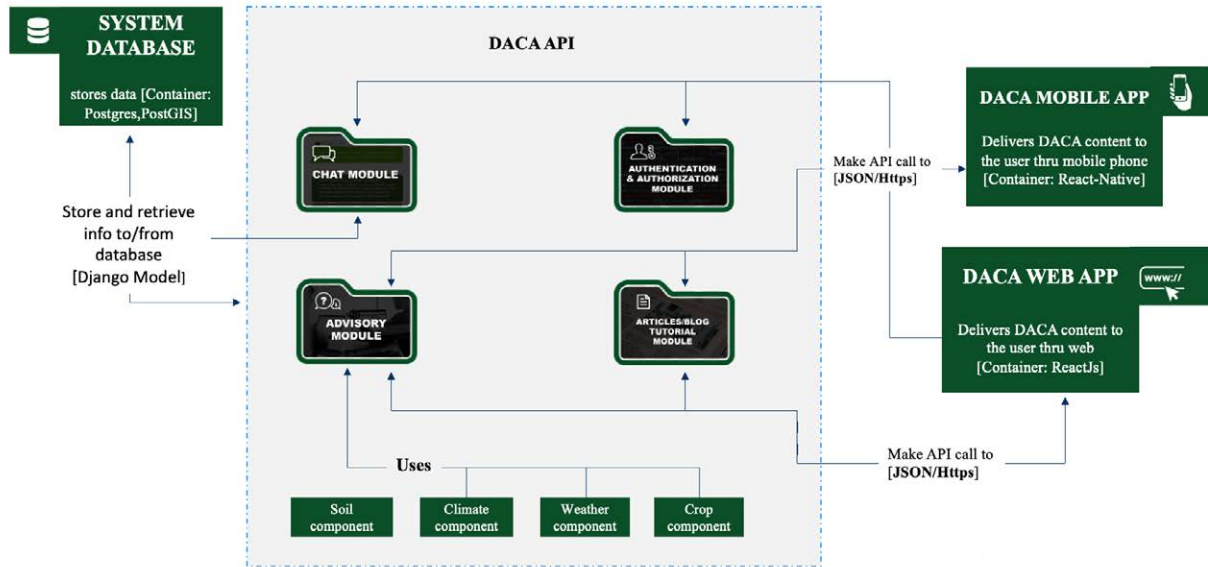
DACA was developed to facilitate the provision and translations of climate information to crop responses for helping agricultural value chain actors to make informed decisions in order to improve outcomes given the expected climate condition of the growing season. Also, it has the quality control data at country level.



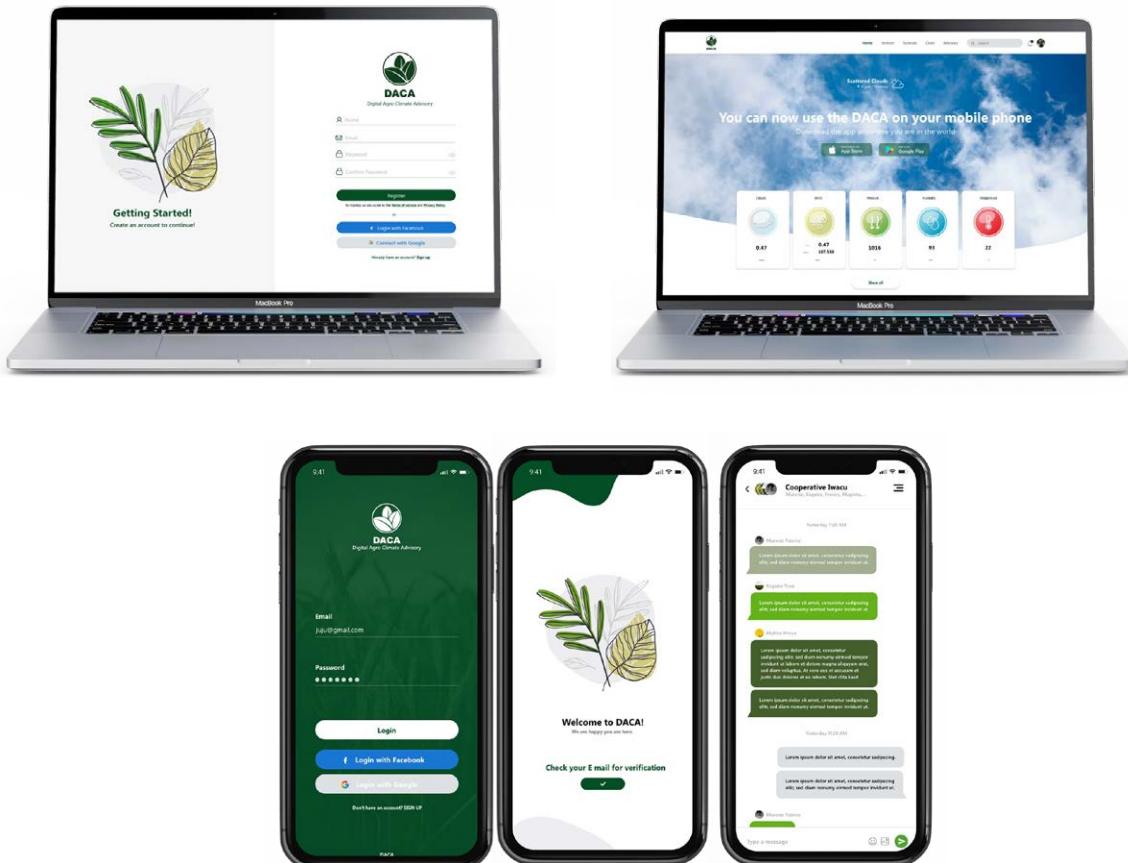


DACA has separate modules for input variables, management conditions, and result outputs. The users after installing the app can have access for the information that the app provides without any payment, have the right to insert comments, like or dislike on a specific article, blog or tutorials in Article module, while the system manager alone has the administrative right to add data in the app. This is done mainly to ensure the availability of accurate data to the public and also to maintain the privacy of the user data.

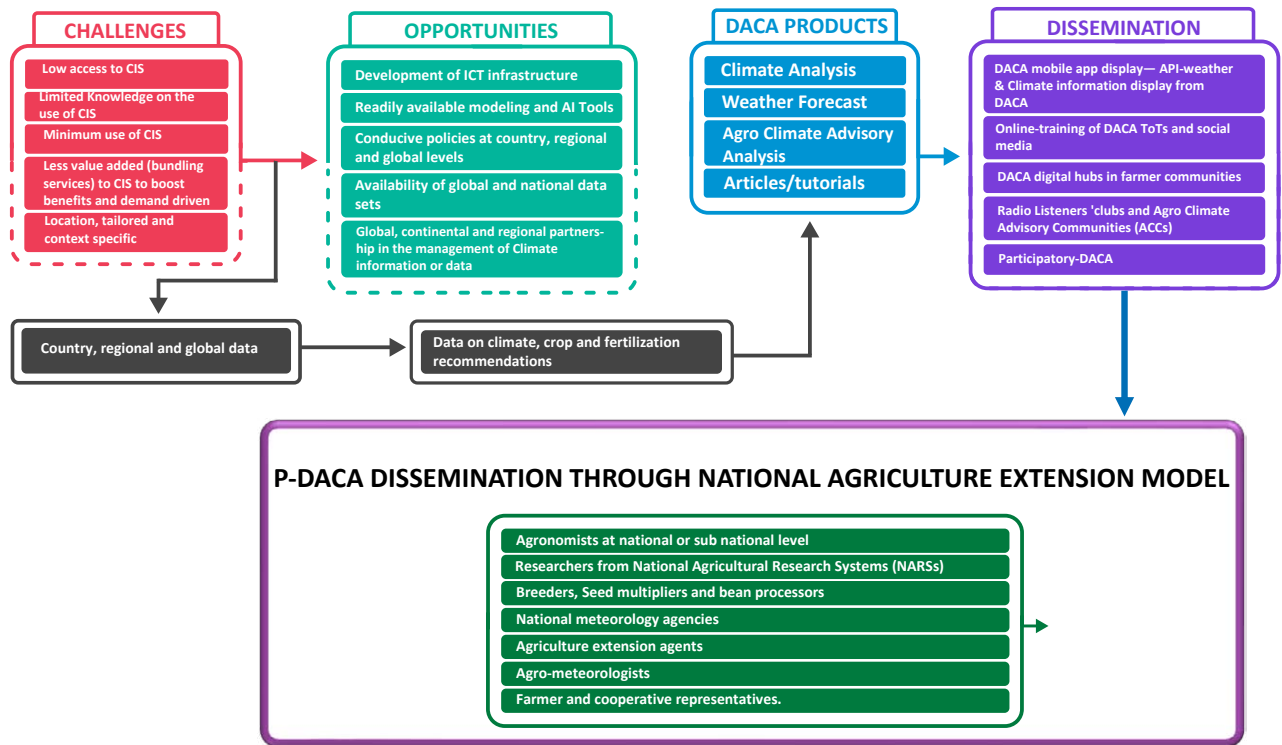
## DACA Architecture



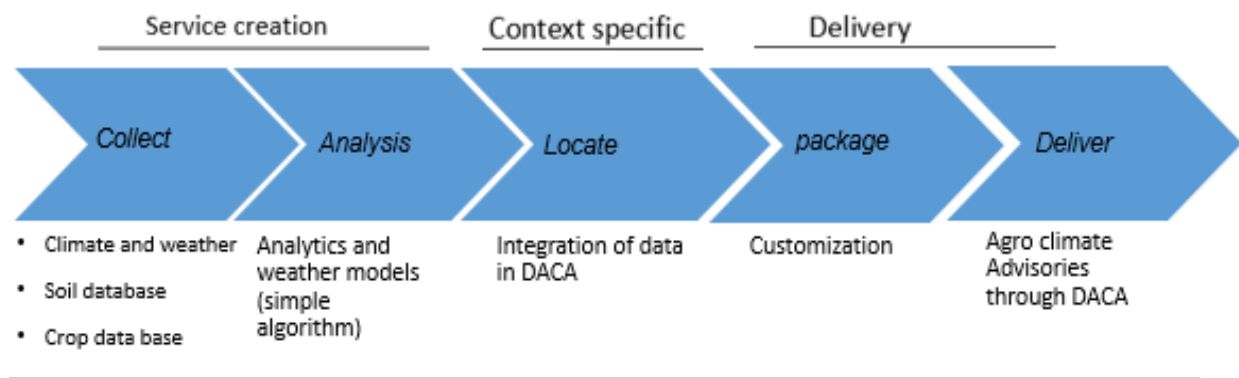
## DACA Web



## Framework for developing and provision of AgroClimate Advisory Services through DACA



### Process of creating localized Agro-climate advisories



## DACA—Outputs: Tailored Information vs Informed decisions Decisions

- Seasonal rainfall total (mm)
- Onset of the season (days)
- Cessation of the season (days)
- Length of the season (days)
- Current and short time forecast
- Crop/information or descriptors including crops' days to maturity, crop water requirement, local fertilizer recommendations (readily available on the market) of crops/varieties, etc.



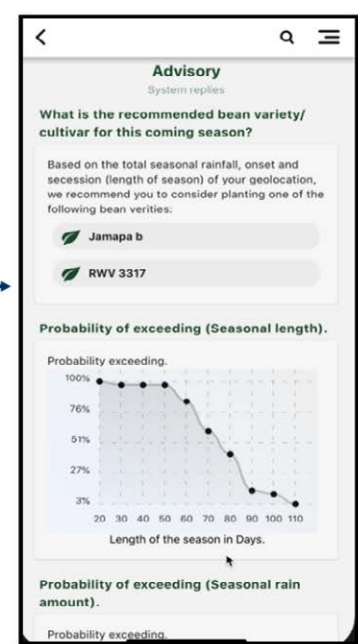
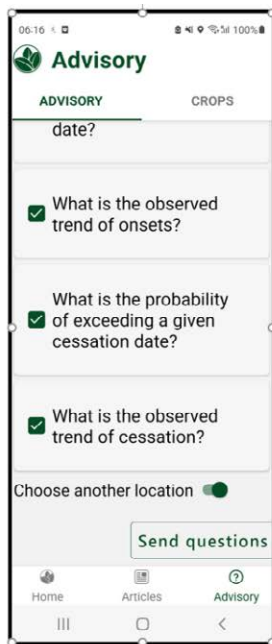
Tailored information

- Time of field preparation and planting
- Match crop and cultivar time to maturity
- Daily decisions such as time to apply inputs, to harvest, etc.
- Fertilizer and organic inputs recommendations
- Plan for budget and crop management, logistics
- Allocation of budget, plan for labor management, type of investments, etc.



Informed Decisions

## Display of DACA—Outputs on Mobile



## Scenarios of Advisory questions that can be addressed through DACA

Questions	Responses
What is the recommended variety/cultivar for this coming season?	Based on the total rain season, onset and secession (length of the season) and soil characteristics of your location (level of NPK and PH), we recommend you to plant the following varieties: CAB,....
When is the planting window?	Based on geolocation, the planting has already stated: start date 15th and end date: 30 <sup>th</sup> September 2020
Type of fertilizer and quantity recommended for my crop?	CAB: NPK (100kg/ha)
What is the application mode of the fertilizer?	Based on CAB variety characteristics we recommend you this:  Top dressing application: 50Kg  Basal application: 50kg
When is the harvest expected?	Based on your location is the current season is expected to end between 1st December and 15th December, 2020

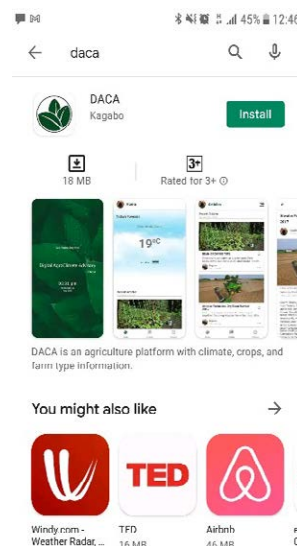
## Digital AgroClimate Advisory: User Manual

### Introduction

Before downloading and Installing the Digital Agro-Climate Advisory (DACA) App, you must first check your internet connectivity, you must have at least 19MB free space on your mobile' storage and your mobile phone must have enough power to run an application. Please follow the next steps to proceed:

### Step 1

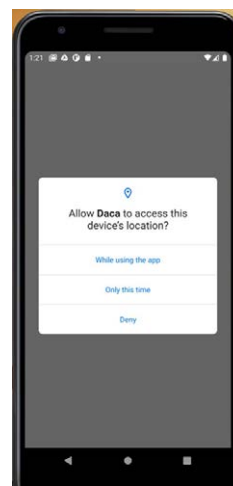
Open the google play store app on your mobile phone, go for search input on the top of the screen, type DACA then Install. Wait until it is installed, it may take a while depending on your internet connectivity speed. When the download is complete, you will see an open button under the App icon. Press on it to launch the application.



### Step 2

Location permission for DACA: When DACA opens up, you will receive a notification requiring you to allow DACA to access your mobile phone's location. Please click **ok** button on the notification.

**N.B:** If you have not permitted DACA to access your location, please read instructions on step 4.

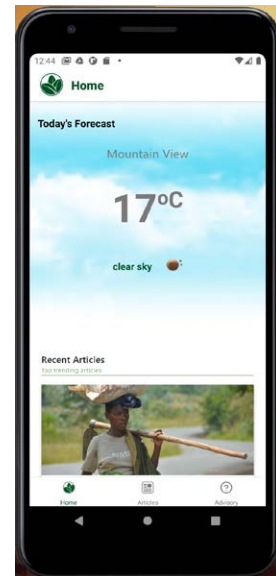


### Step 3

#### Home screen:

On the home screen, you will automatically find the current weather forecast of your location and time. If you didn't allow the app to access your location, you might not have the weather forecast information and time for your location. You can also find recent articles and other popular articles. On the bottom of the home screen, you will find the 3 tabs (Home, Articles and Advisory).

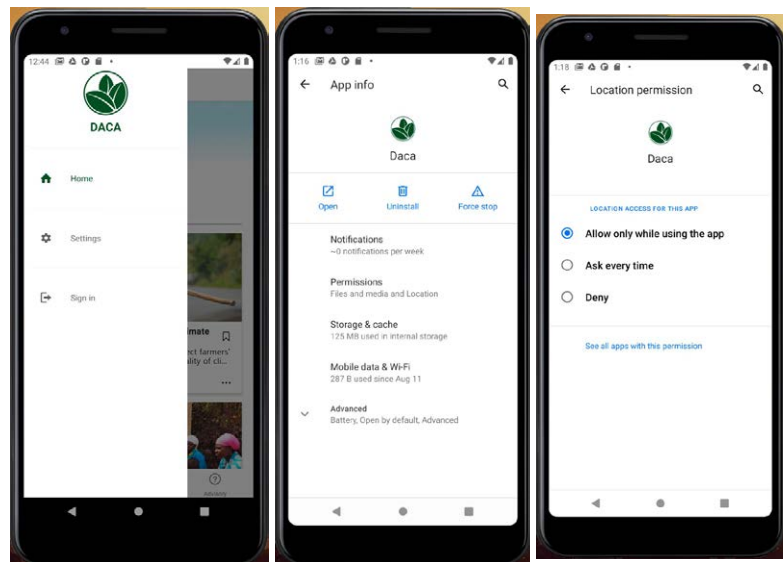
Home will be highlighted in green as it is the current screen that is displayed.



### Step 4

If you have not permitted DACA to access your location, please scroll to the right to find the side bar where you will be able to access settings, click on the setting button which will redirect you to your mobile's settings app info.

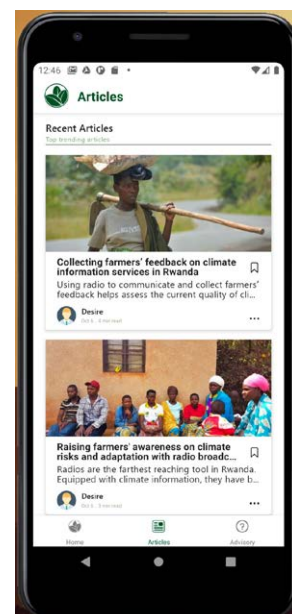
And allow location permissions and go back to DACA and continue.



### Step 5

#### Articles

If you want to access articles' screen, please press on the article tab on the bottom of the home screen. You will find all the available articles and tutorials in DACA. You may choose what's interesting to you by pressing on its title or picture. After opening the article, it might have a text, audio, video and links that can redirect you to other pages in the browser. You can then read, listen or watch and you have an option at the end of the article to put your comment or question on that article. You can also read other readers' comments if you want to. On the far right side of the bottom of the screen, you will find a green button which can be used for more options (Like, dislike, bookmark).



## Step 6

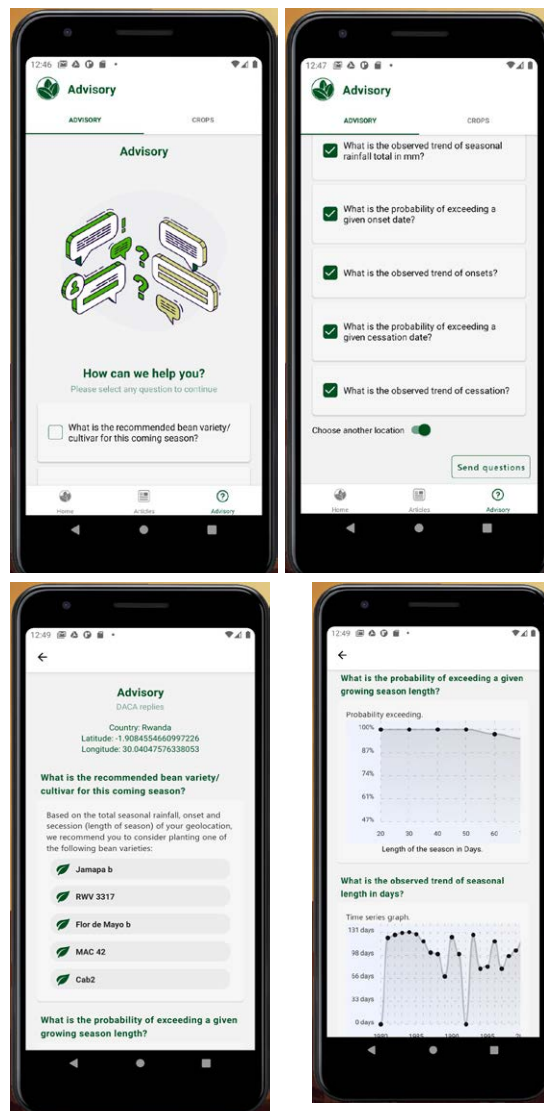
### Advisory

- The advisory tab has two tabs on the top (Advisory and Crops)
- In the Advisory tab, you will see a list of questions that you can select, depending on the type of agro-climate advisories that you need. After selecting questions, you will press the **send questions** button at the bottom right of the screen. After sending your questions, you will receive the advisory that you needed from DACA (related to the selected questions) and they will be location specific (your device' location).

N.B: 1. If you don't want the information for your current location, you can chose another location by pressing the button located at the end of the questions and be able to go to the map and select the location of your choice then press the next button at the top right side of the map

If you do not find advisories, you might be having internet connection issues or you have not allowed DACA to access your device's location. If that is the case, please refer to step 4.

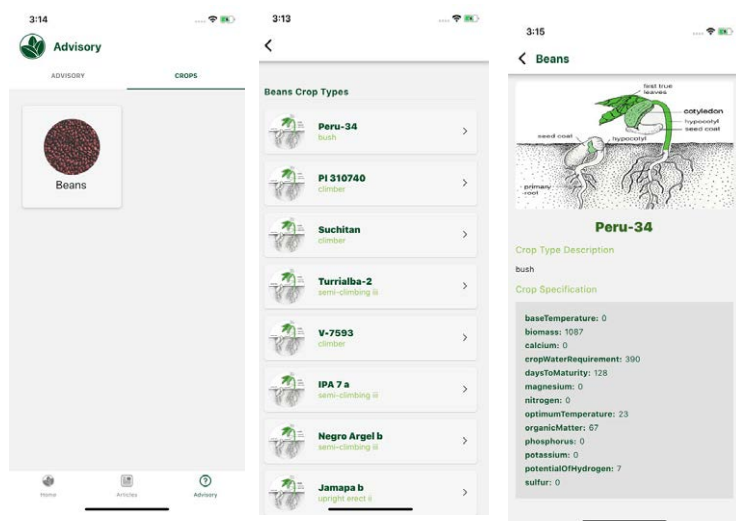
The advisory will include crop and climate information among others.



## Step 7

### Crops

If you want to see more on crop characteristics, you can go to advisory tab and press crop tab. You can then select the crop of your choice and get all the crop varieties, chose the variety you need and have all the information.



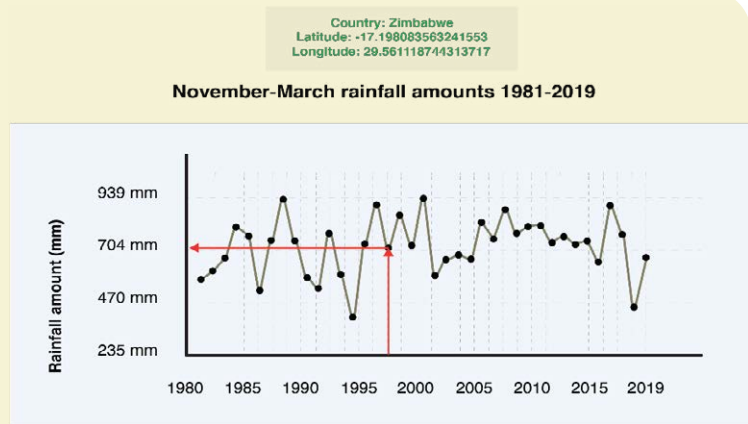
## 3.2: Awareness and Understanding of climate risks and vulnerabilities

### 1. How to read climate variable on a time series graph

#### Procedure

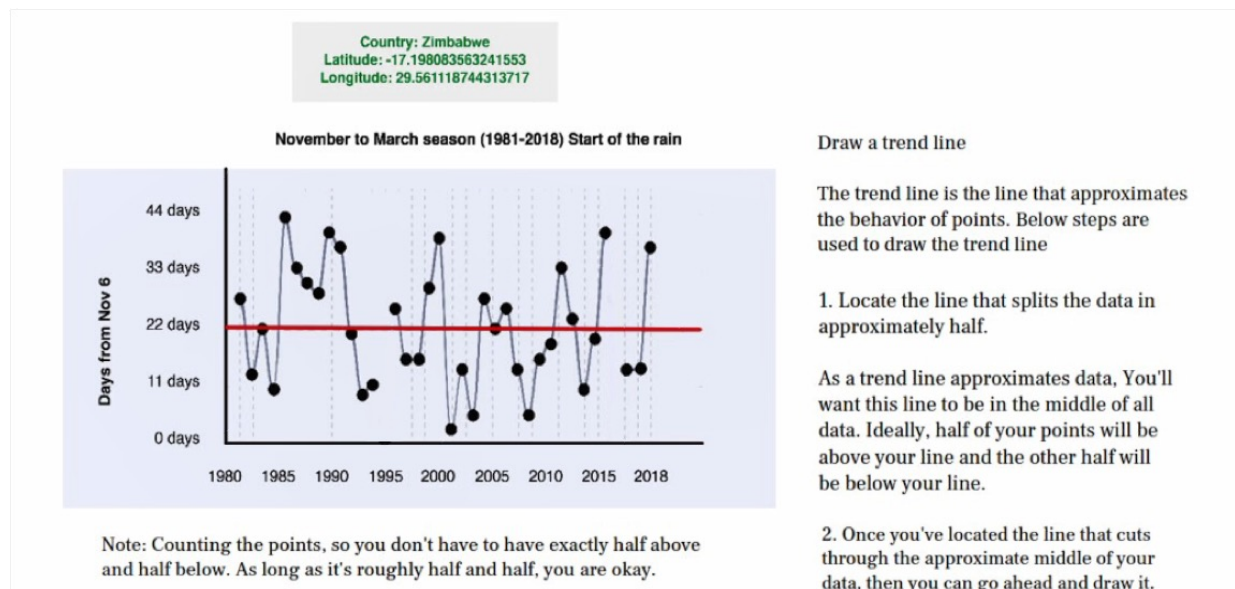
- Identify the year on the horizontal line (X-axis)
- Move up vertically till the dot and
- Move from dot to the left and the place where you meet the vertical axis shows a given observed variable in that year.

For example, this figure indicates that the observed total rainfall in 1997 was 704mm



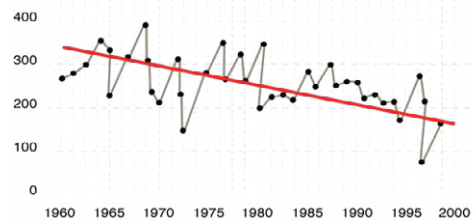
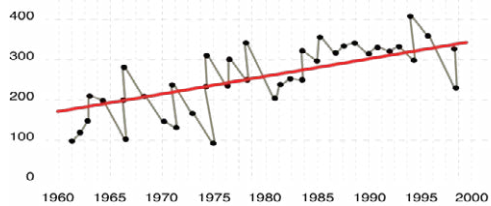
To watch animated voice over narration showing how to read any climate variable, please [Click here](#)

### 2. How to assess whether there is climate change or climate variability

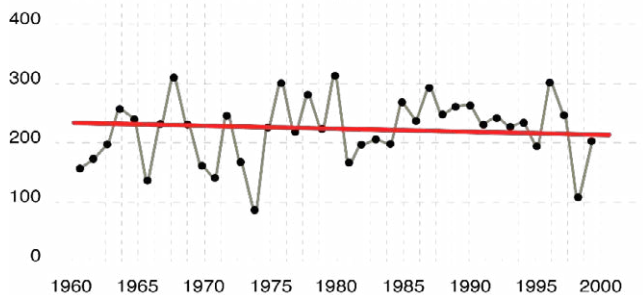


## Rule of thumb

- If the trend line is upward or downward, someone can guess that there is a climate change.



- If the trend line is slightly horizontal, someone can guess that there is climate variability.

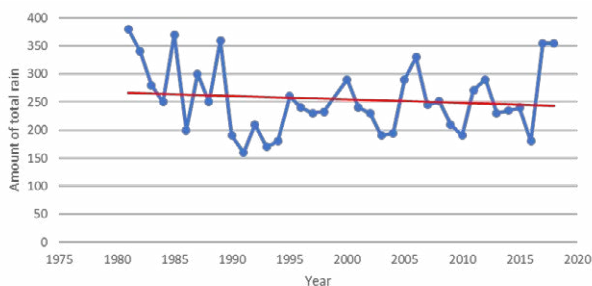


In many instances, it is better to always consider the significant difference between observations

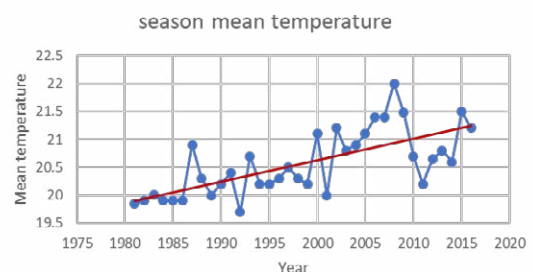
## An example of a CV & CC for Rwanda in SOND Season (for rainfall and temperature)

- Trend analysis for rainfall data for one location in Kigali (Bumbogo) shows variability of seasonal rainfall total for SOND from 1981 to 2016 (with non-significant p-value of 0.912)
- Trend analysis for mean temperature data for the same location in Kigali shows change of seasonal mean Temp for SOND from 1981 to 2016 (with significant p-value of 0.000022).
- Recorded Tmean in 1981 was 19.85°C whereas 21.55°C was recorded in 2015 in this decade. This suggests an increase/(or a change) of 1.7°C over a period of 34 years.

### Climate Variability



### Climate Change



To watch animated voice over narration showing how to assess whether there is climate change or climate variability, please [Click here](#)

## Group work

Please use the time series graphs depicting the onset of rain, seasonal length, and seasonal total rainfall for your specific location to do the following:

- Looking at the graphs – **are you seeing evidence of climate variability?**
- Looking at the graphs – **are you seeing evidence of climate change?**
- Does what the graphs show agree with what you know about the climate of your location?

## Responses

Country: Zambia  
Latitude: -10.817852482201918  
Longitude: 30.786907039582733

November to April season (1981-2018) Start of the rain

Country: Zambia  
Latitude: -10.817852482201918  
Longitude: 30.786907039582733

November-April rainfall amounts 1981-2019

① Looking at the graphs – are you seeing evidence of climate variability?

**Answer:** Yes, there is evidence of climate variability because the trend lines of onset , seasonal length and total rainfall timeseries graphs are slightly horizontal

Country: Zambia  
Latitude: -10.817852482201918  
Longitude: 30.786907039582733

November-April seasonal length 1981-2018

② Looking at the graphs – are you seeing evidence of climate change?

**Answer:** No, there is no evidence of climate change because the trend lines of onset , seasonal length and total rainfall time series graphs are not upward or downward

③ Does what the graphs show agree with what you know about the climate of your location?

**Answer:** Yes, what the graphs show relate with what we have experienced . For example as it is shown in the total rainfall time series graph. In the year 1997 the rain was high and damaged crops which

## 3. Calculating probabilities with climate information graphs

### a. How is calculation of probabilities useful?

Calculation of probabilities helps climate users to quickly obtain and compare probabilities that are of interest to them.

For example, probability of exceedance can help to know if:

- The rainfall amount will be sufficient
- The growing season will be long enough



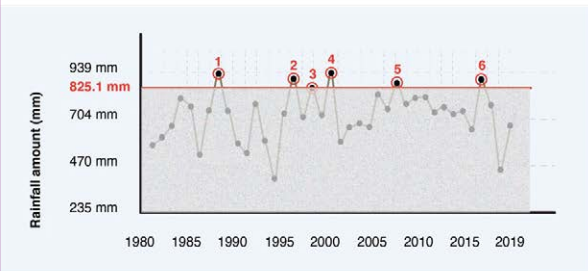
**To meet the requirements of a particular crop or cultivar**

**b. How to calculate probability using a time series graph?**

**Procedure**

Country: Zimbabwe  
Latitude: -17.198083563241553  
Longitude: 29.361118744313717

**November-March rainfall amounts 1981-2019**



Visible rainfall points = 6  
Total number of rainfall points = 38  
PROBABILITY =  $(6/38) \times 100\%$

**This figure indicate that there is a chance of 15.7% to have at least 825.1 mm**

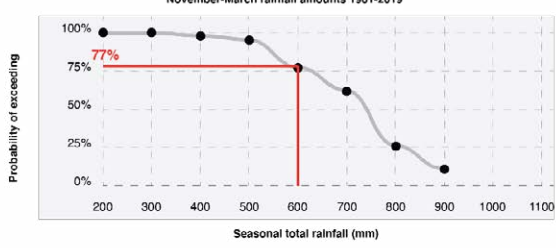
1. Identify the period of time covered by the historical climate information. What is the first year recorded? So how many years are there in total?
2. Select the threshold on the vertical axis.
3. Trace a horizontal line from the threshold to the right.
4. Using a piece of paper cover all of the rainfall points that are below the threshold.
5. Count the rainfall points that are still visible. This tells you how many seasons in the past years that the seasonal rainfall has been over the threshold.
6. Divide the number of visible rainfall points by the total number of rainfall points on the historical climate time series graph to work out your probability

**c. How to calculate probability using a Probability of exceeding graph?**

**How to find the probability of getting at least 600 mm of rainfall in November-March (1981-2019)**

Country: Zimbabwe  
Latitude: -17.198083563241553  
Longitude: 29.361118744313717

**November-March rainfall amounts 1981-2019**



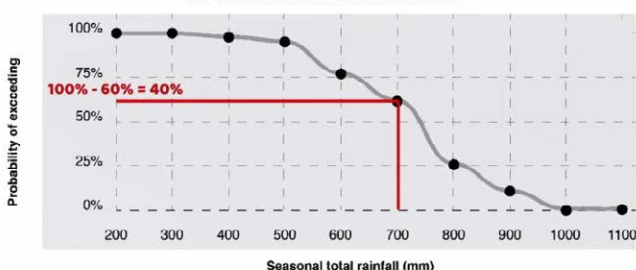
1. Identify 600 mm on the horizontal line (x-axis)
2. Trace a line up from 600 mm until it reaches the probability-of-excedence curve
3. Then trace a line meets the vertical axis (y-axis) shows the probability of getting at least 600 mm of rain

**This figure indicate that there is a chance of 77% to have at least 600 mm**

**How to find the probability of getting less than 700mm of rain**

Country: Zimbabwe  
Latitude: -17.198083563241553  
Longitude: 29.361118744313717

**November-March rainfall amounts 1981-2019**



1. Identify 700mm on the x-axis
2. Trace a line up from 700mm until it reaches the probability of exceedance curve.
3. Then trace a line to the left. The place where the line meets the y-axis shows the probability of getting at least 700mm of rain.
4. Then subtract the probability on the y-axis from 100 percent to find the probability of getting less than that amount of rainfall.

**This figure shows that there is a chance of 40 percent to have less than 700mm of rain.**

To watch animated voice over narration showing how to calculate probabilities, please [Click here](#)

## 4. Examples of climate variables and their importance regarding agriculture related decisions

Climate information variable	Importance/ Services
Seasonal rainfall total	Matched with crop water requirement to decide on the variety or cultivar to grow, anticipate the occurrences of pests and diseases etc to plan mitigation measures appropriately.
Onset of rainfall	Used to provide guidance on timing for field preparation and planting window in a particular season
Seasonal length	Matched with crop and cultivars' time to maturity to decide on the variety or cultivar to grow, either a short maturing or long maturing variety/cultivar.
Cessation of rainfall	Though together with onset information provides the length of the season, cessation also provides guidance on field management decisions such as climate smart agriculture practices (such as irrigation) and guiding preparations for harvesting.

### Group work

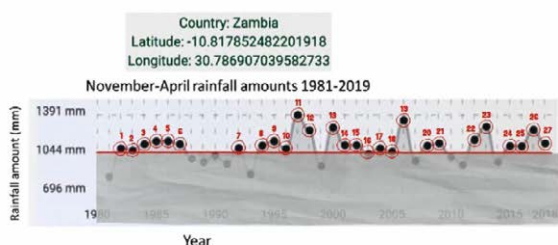
Please use the seasonal length and total rainfall climate graphs specific to your location to perform the following:

1. Find out the probability of having at least 1040 mm of seasonal total rainfall
2. Find out the probability of having a seasonal length which is less than 90 days
3. Suppose that the risk of a particular crop disease greatly increases if seasonal rainfall is more than 780 mm. **What is the probability that this will happen?**
4. Suppose that yields of a high yielding bean variety are likely to fail if seasonal rainfall is below 696 mm. **What is the probability that this will happen?**

### Responses

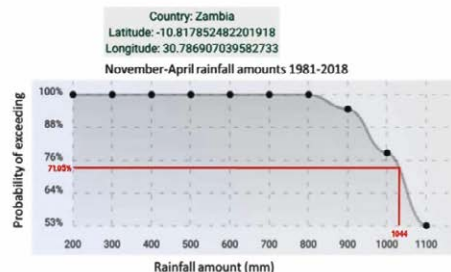
#### Question 1

#### Answer: Using time series graph



- > Visible rainfall points = 27
- > Total number of rainfall points = 38
- > The probability of having atleast 1040 mm of seasonal total rainfall =  $(27/38) \times 100 = 71.05\%$

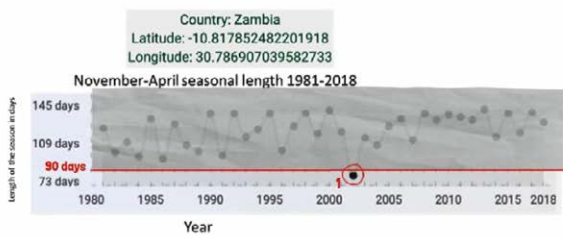
#### Using probability of exceedance graph



- > There is a chance of 71.05% to have at least 1040 mm of seasonal total rainfall

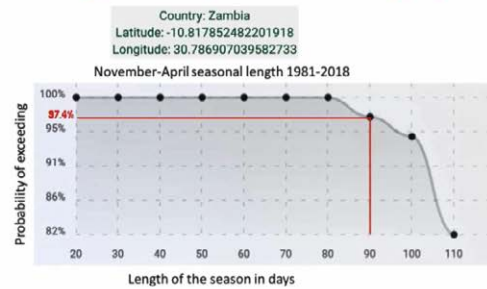
**Question 2**

**Answer: Using time series graph**



- > Visible rainfall points = 1
- > Total number of rainfall points = 38
- > The probability of having a seasonal length which is less than 90 days in % =  $(1/38) \times 100 = 2.6\%$

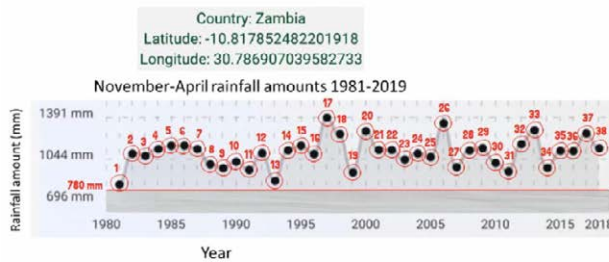
**Using probability of exceedance graph**



- > The probability of having at least 90 days of seasonal length = 97.4%
- > The probability of having a seasonal length which is less than 90 days =  $100\% - 97.4\% = 2.6\%$

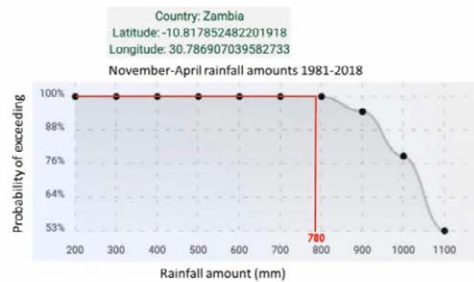
**Question 3**

**Answer: Using time series graph**



- > Visible rainfall points = 38
- > Total number of rainfall points = 38
- > The probability of having more than 780 mm of seasonal rainfall in % =  $(38/38) \times 100 = 100\%$

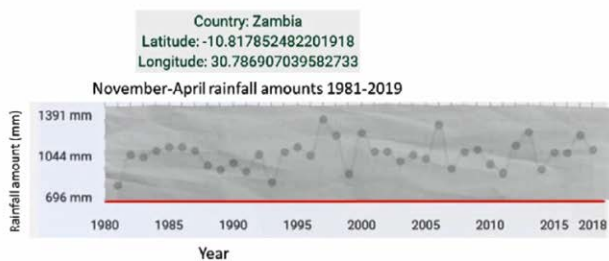
**Using probability of exceedance graph**



- > There is a chance of 100% to have more than 780 mm of seasonal rainfall

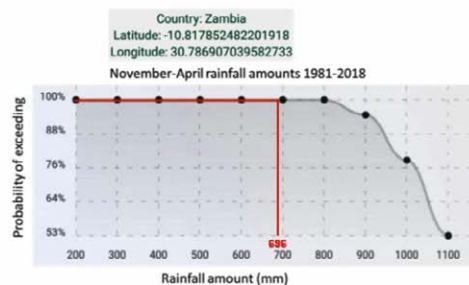
**Question 4**

**Answer: Using time series graph**



- > Visible rainfall points = 0
- > Total number of rainfall points = 38
- > Probability of having a seasonal rainfall which is below 696 mm in % =  $(0/38) \times 100 = 0\%$

**Using probability of exceedance graph**



- > Probability of having at least 696 mm of seasonal rainfall = 100%
- > Probability of having seasonal rainfall which is below 696 mm =  $100\% - 100\% = 0\%$



## Chapter 4.

# Matching climate information (CIS) and crop characteristics and their use in agriculture value chain

### 4.0: Background

Crops cannot grow without having the necessary quantity of water, sunlight, and other nutrients. Most of the water used in growing crops comes from rainfall, irrigation, other crop management, and soil conservation methods. This stage focuses on information on weather and climate conditions related to crop growth. Focus will be specifically on information on rainfall, Crop Water Requirement (CWR), length of the season, onset of the season and cessation of the season. Understanding the role and impact of the above-mentioned climate related information in farming will enable farmers and other agriculture stakeholders to make informed decisions on crop choice, variety choice, seed type and other inputs, planting time and harvesting time.

In addition, CIS helps in crop breeding and seed systems. Through the digital agro-climate database, breeders can have access to location specific climate information that can assist them in producing seeds that are suitable for specific locations. Drought resistant seeds, early maturing varieties/ seeds, high yield varieties/ seeds, pests and disease resistant varieties/ seeds and location specific varieties/ seeds can be produced with reference to climate information. This module has three main components.

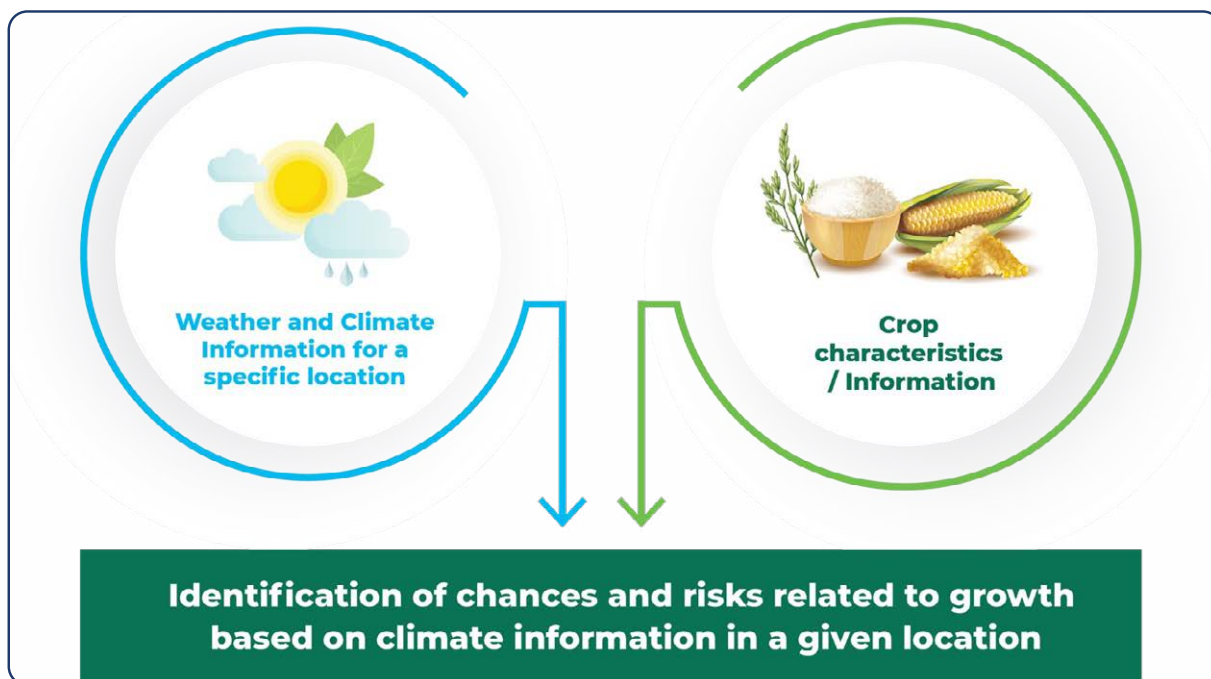
To be able to understand components of this stage, farmers are encouraged to participate in exercises on calculating probabilities for them to see how knowing the changes in climate related variables can impact their choices and decisions in farming activities.

#### Outline

- a. Understanding the crop characteristics that are related to climate
- b. Using probabilities to explore opportunities and risks in each season
- c. Using probabilities to inform crop choices in each season

## 4.1: Understanding the crop characteristics that are related to climate

Understanding the relationship between crop growth and climate variables such as temperature, humidity, atmospheric pressure, wind, and precipitation is very important for farmers to be able to have optimal harvests from their farms. In this component, farmers will be able to understand the link between crops and climate variables that affect their growth.



### Days to maturity and crop water requirement

When we are comparing crops / bean varieties, it is important that we are more specific. Each crop/ bean variety requires a certain amount of time to grow to maturity (days to maturity) and each crop/ bean variety has a certain water requirement during this period. Any rainfall after this period is not helpful for the crop and so should not be considered when comparing different crops/bean varieties. Therefore, we need to use rainfall totals and length of the season that match the maturity period and crop water requirements of specific crops, and these will be provided in the crop information table.

### Using crop information tables

Crop Information tables help farmers to understand the requirements of specific crops and varieties which are crucial in understanding the crops that best fit the local climate. Crop information tables can be used to assess the climate related risks of different crops at a given location. The table below shows some bean varieties from Zimbabwe, their crop water requirements and their days to maturity.

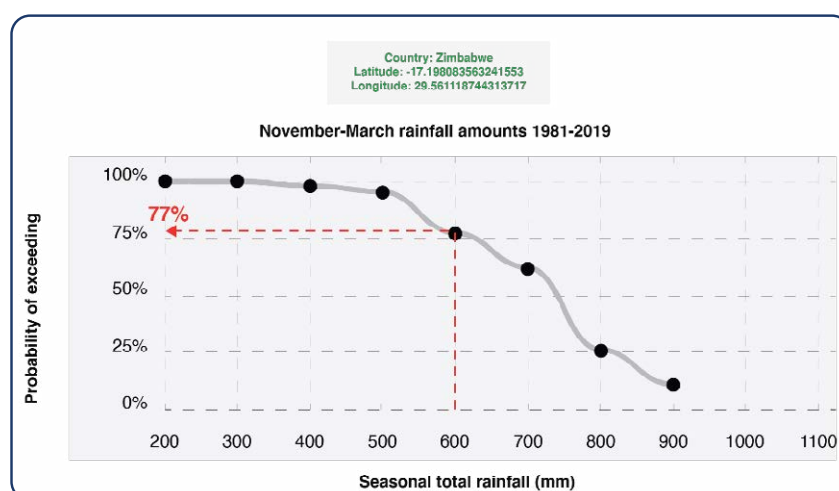
Bean Varieties	Crop water requirement (mm)	Days to maturity (Days)
Gloria	550	95-104
NUA45	350	85-94
Sweet violet	600	105-115
Sweet William	600	105-115
Protea	600	105-115
Bounty	550	100

Bean Varieties	Crop water requirement (mm)	Days to maturity (Days)
Gadra	500	95
Kware	300	85
Hohodza	300	85
Ukulinga	450	90
NUA674	500	105
Iris	300	80

## 4.2: Using probabilities to explore opportunities and risks in each season

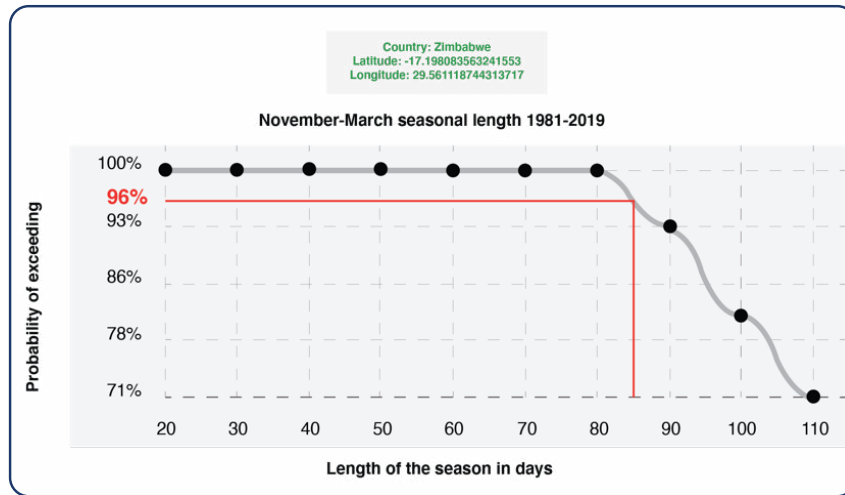
Comparing different bean varieties suitability in the season based on historical climate information on seasonal total rainfall helps farmers in making decisions. For example, we can use the above table for beans and graphs from DACA to calculate probabilities of having a certain crop grown in a given season depending on the availability of information.

Bean Varieties	Crop water requirement (mm)	Days to maturity (Days)
Gloria	550	95-104
NUA45	350	85-94
Sweet violet	600	105-115
Sweet William	600	105-115
Protea	600	105-115
Bounty	550	100
Gadra	500	95
Kware	300	85
Hohodza	300	85
Ukulinga	450	90



**Question 1:** Referring to the crop table and graph on rainfall totals, what is the probability of growing Protea variety?

**Answer 1:** From the above example, we can easily see that the probability of having sufficient rain to grow Protea variety equals to 77% in the given location in Zimbabwe

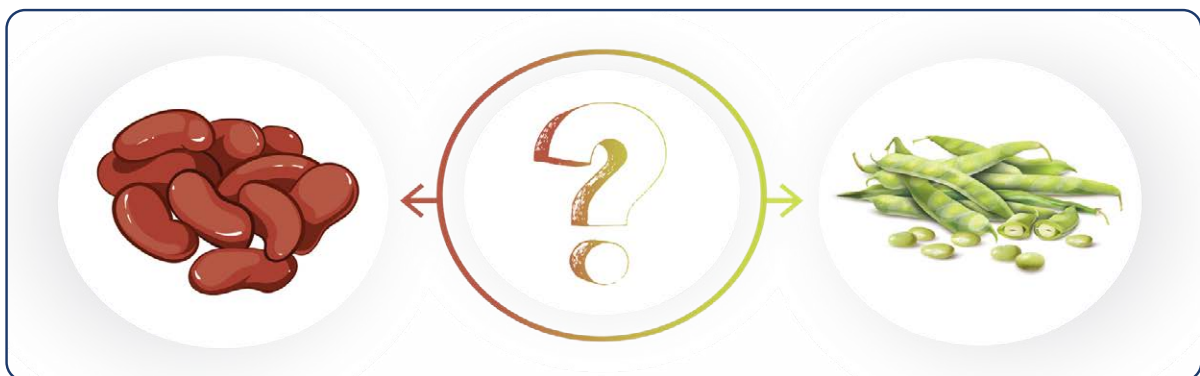


**Question 2:** Referring to the crop table and graph on length of the season, what is the probability of growing Protea variety?

**Answer2:** From this example, we can easily see that the probability of having sufficient days to grow Kware variety is 96% in the given location in Zimbabwe.

### 4.3: Using probabilities to inform crop choices in each season

Calculating probabilities for a certain crop to grow in the season gives farmers the opportunity to think about various crops and varieties available in their location or outside their location to be able to make choices that are suitable for their situation. It is important that the facilitator give enough time to farmers to think about different options that may be more profitable to them



Use of probabilities to explore Opportunities – Chances - Risks
➔
Associated to variables of climate for decision making

November-March rainfall amounts 1981-2019

A farmer or a group of farmers are taught how to relate climate information to crop information and compute risks associated with any of the climate variables. This leads to a farmer or group of farmers to think of the chance of having sufficient rainfall amount (mm) or length of the season (days) to grow one of the available crop cultivars.

Variety	Crop water requirement (mm)
Protea	600
Bounty	550
Gadra	500
Jamap	400
Kware	300
Iris	300

↔

November-March seasonal length 1981-2019

A farmer or group of farmers select the best crop cultivars, additional agricultural management options may be required. **Below farmers compute the chance of having sufficient rainfall and sufficient days to grow Kware, Gadra and Protea bean varieties**

Variety	Probability of having sufficient rainfall	Probability of having sufficient days to grow
Kware	100	95
Gadra	90	80
Protea	77	71

Variety	Days to maturity (Days)
Protea	105-115
Bounty	100
Gadra	95
Jamap	70
Kware	85
Iris	80

## Limitations

It is crucial to acknowledge that the Crop Information tables are subject to certain limitations:

1. The crop water requirement is calculated for achieving maximum yield under field trial conditions, which may be unrealistic and not aligned with the objectives of most farmers.
2. The probability is based on sufficient rainfall throughout the maturity period but does not consider the timing of the rainfall within that period.
3. The probabilities do not incorporate other factors that may impact crops, such as dry spells, wet spells or diseases.

## Group work

Please use climate graphs from your area and crop information to do following:

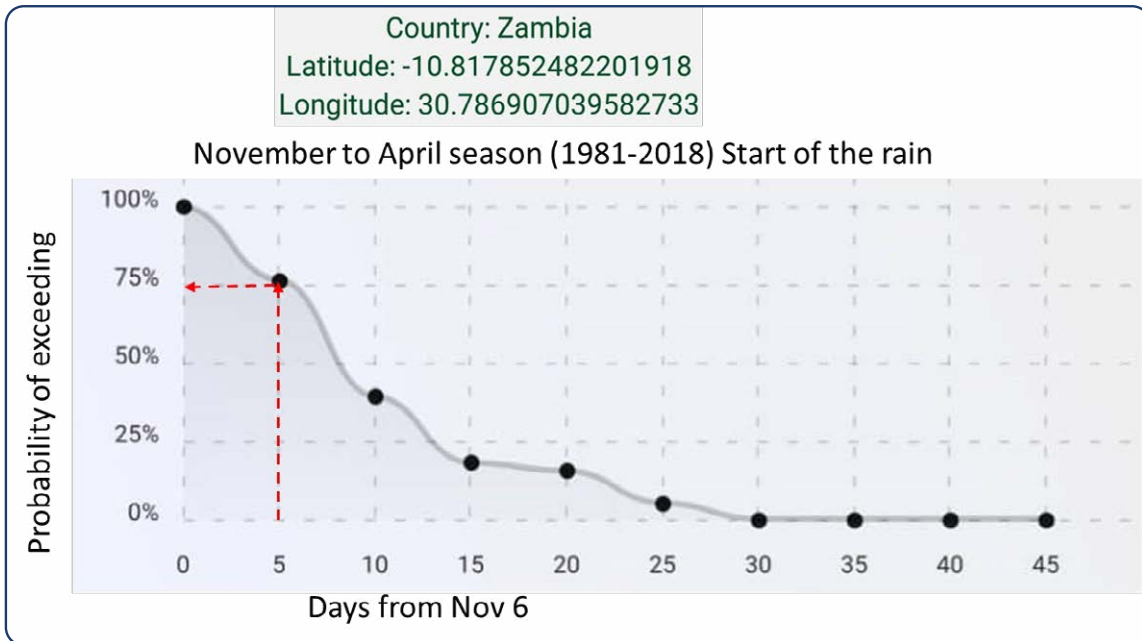
1. The probability for a season to start before 5<sup>th</sup> November
2. The probability to have sufficient rainfall and days to grow Peru-34, and GLP-190-S bean varieties

## Procedure

- a. Please use climate graphs from your area
- b. Choose climate graphs on seasonal rainfall, onset, cessation and seasonal length of the season
- c. Make a table with a list of bean varieties that you grow in your country/area
- d. Include crop water requirement and days to maturity information to the bean table
- e. Compare bean table and climate graphs to calculate probabilities

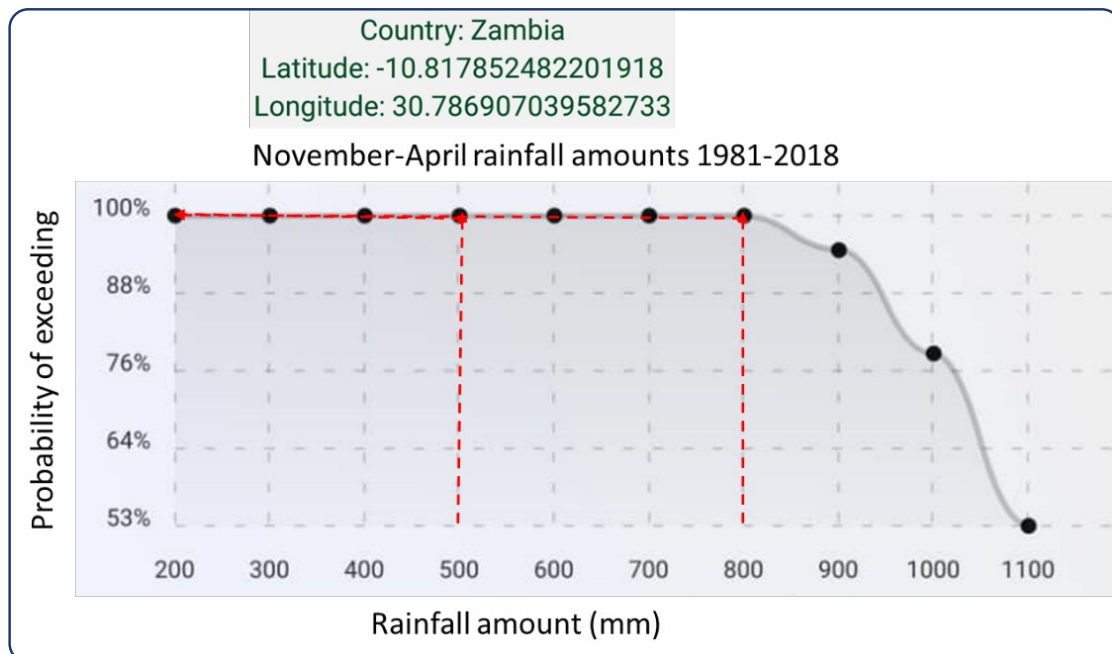
## Responses

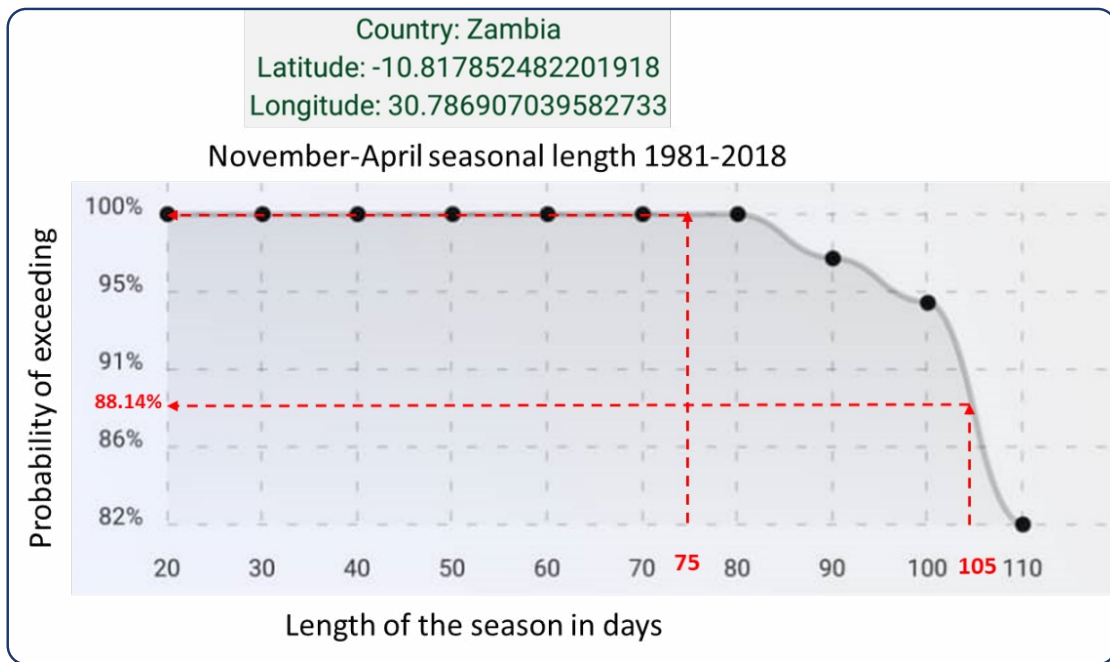
### Question 1



- The probability for a season to start after/beyond 5<sup>th</sup> November =75%
- The probability for a season to start before 5<sup>th</sup> November =100%-75%=25%

### Question 2





Bean variety	Crop water requirement in mm	Probability to have sufficient rainfall to grow the variety	Days to maturity	Probability to have a season that will be long enough to grow the variety
NUA674	500	100%	105	88.14%
GLP-190-S	800	100%	75	100%



## Chapter 5.

# Exploring climate smart agriculture practices for risk management

## 5.0: Background

Research indicates that Climate-Smart Agriculture (CSA) practices play a significant role in strengthening farmers' resilience to climate change, reducing greenhouse gas emissions, and enhancing crop productivity on a global scale (Clay & Zimmerer, 2020; Uzamukunda, 2015). CSA encompasses integrated options, including agro-ecological approaches, sustainable natural resource management, and ecosystem management, and all crucial components of climate change adaptation. Additionally, CSA practices contribute to the improvement of crop production, increased resilience to climate change, and environmental protection through effective crop, water, and soil management practices. This chapter aims to enhance users' understanding how to explore CSA options for climate risk management.

## 5.1: Determining Climate-Smart Agriculture Practices through tailored Climate Information Services and Crop/Livestock Information

Tailored climate information services (CIS), through appropriate communication channels, enhances the use and adoption of climate information (CI), thereby impacting people's livelihoods. Through CIS, farmers receive details such as the total amount of rainfall, the onset and cessation of rainfall, and the length of the season, aiding in determining optimal planting times, selecting suitable crops or varieties and exploring various options related to livestock and livelihood activities. As CIS can be presented in the form of probability, farmers and extensionists can collaboratively plan management practices to develop strategies for reducing and mitigating climate risks in crop, livestock, and livelihood domains.

## Below is an example of determining climate smart agriculture practices based on crop and climate information

### CLIMATE INFORMATION (CIS)

From the crop table and climate information graphs, the farmer compares the crop water requirement with the amount of rainfall to compute the chance of having sufficient rainfall to grow Kware, Gadra and Jamap bean varieties.

### CROP INFORMATION (CI)

Variety	Crop water requirement (mm)
Protea	600
Bounty	550
Gadra	500
Jamap	400
Kware	300
Iris	300

Variety	Days to maturity (Days)
Protea	105-115
Bounty	100
Gadra	95
Jamap	70
Kware	85
Iris	80

After comparing the crop table and the climate information, the farmer identifies risks. From our example he chooses to grow Jamap but there is a risk of 16% of not having sufficient days to grow it. **To minimize the risks, a farmer translates them into climate smart agriculture practices**

Variety	Percentage of having sufficient rainfall	Percentage of having sufficient days to grow
Kware	100	63
Gadra	98	33
Jamap	100	84

## Proposed climate smart agriculture practices to mitigate the identified risks

### FARMER CHOICES BASED ON THE LEVEL OF RISKS

#### Tied ridges

To increase storage and allow more time for rainfall to infiltrate the soil, the stored water can be usable to the plants for a longer period of time and better than it can be used in a situation of runoff.

### FARMER CHOICES BASED ON THE LEVEL OF RISKS

#### Mulching

To conserve soil moisture and lower soil temperature around plant roots for several days.

As **Tied Ridges** and **Mulching** are the soil moisture conservation Strategy, this will help to Improve the Yield.

## 5.2: Procedures for Selecting Climate-Smart Agriculture Practices

There exists a diverse range of Climate-Smart Agriculture (CSA) practices aimed at optimizing crop yields. In this section, we will delve into the process of identifying CSA practices most beneficial for farmers in a specific location. These practices should effectively address climate and weather challenges, mitigating the risks identified in the probability calculations discussed in the previous sections.

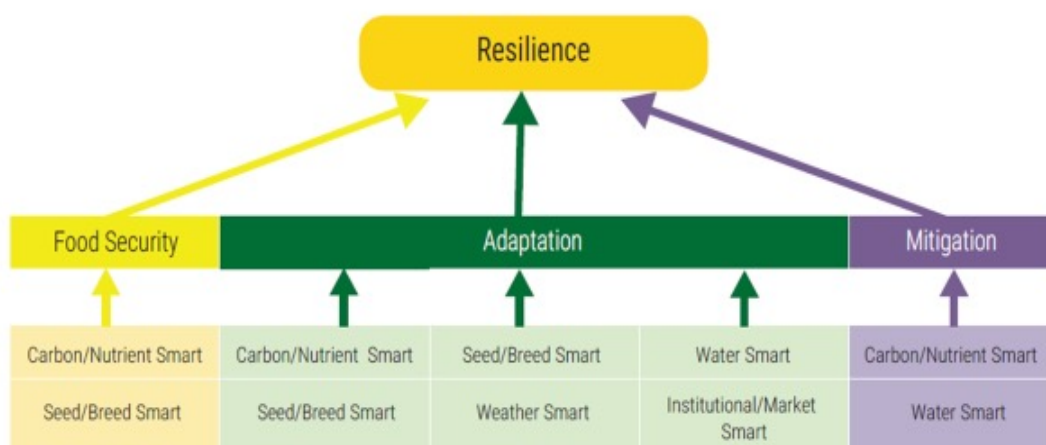
**Note:** It is not feasible to include all possible crop-related practices; instead, the focus is on identifying those most likely to be advantageous for farmers in the given location.

The following procedures outline the steps for selecting CSA practices:

- 1. List all CSA practices:** Compile a comprehensive list of CSA practices that have the potential to mitigate the identified risks.
- 2. Assess effectiveness:** Evaluate the extent to which each practice can mitigate the identified risks. Rank the practices based on their performance.
- 3. Evaluate investment requirements:** Consider the investment required to implement each practice.
- 4. Determine implementation time:** Assess the time each practice may take for implementation.
- 5. Decision-making:** Based on the assessments, choose the practices that align best with the specific context and needs.

Types of Climate Smart Options				
Weather and Knowledge Smart	Water Smart	Seed/breed Smart	Carbon/nutrient Smart	Institutional/market Smart

All these climate-smart options ultimately contribute to the three pillars of CSA as illustrated in the figure below.



(Source: Adopted and modified from Pudasaini et al., 2018)

By systematically following these steps, farmers can make informed decisions about adopting any of the following climate-smart agriculture practices tailored to their location, ensuring effective risk mitigation and improved agricultural outcomes.

### a. Water-smart practices

- 1. Tied ridging:** It is a conservation technique by which ridges are vertically tied at shorter intervals to make four-sided water harvesting structures. They facilitate the infiltration of water to the soil during the rainy season. The slight sloppiness in the tied ridges facilitates draining of excess water infiltrate into the soil.



Figure2: Tied ridges (source: PICSA experimental trials in Burera district/ Rwanda)

- 2. Mulching:** It is a practice used to save water by reducing the evaporation, suppress weeds and improve the soil around plants hence reducing the time spent in watering and weeding. A mulch is a layer of material applied to the surface of soil to keep soil moisture, improve soil fertility and improve the overall soil health. Mulching can be made with compost, banana leaves, dry corn and beans residues, rice straw, dry bean leaves, wood wastes, vetiver grass and other crop residues. Mulching also enhances grain yields and yield stability (Kiboi et al., 2017, Uwizeyimana et al., 2018; RHS, 2021).



**Photo: G.Nsengiyumva (CIAT-Rwanda)**

Figure 3: Beans with maize stem residuals mulching. (Source: PICSA experimental trials in Bugesera district/Rwanda)

- 3. Irrigation** is the artificial application of water to the soil through various systems of tubes, pumps, and sprays. Irrigation is usually used in areas where rainfall is irregular or dry times or when drought is expected. There are many types of irrigation systems, in which water is supplied to the entire field uniformly. Irrigation water can come from groundwater, through springs or wells, surface water, through rivers, lakes, or reservoirs, or even other sources, such as treated wastewater or desalinated water. It is important that farmers take care of their source of irrigation water to avoid any type of contamination by mud or other toxins.

There are many types of irrigation including:

- Surface irrigation: Water is distributed over and across land by gravity, no mechanical pump involved.
- Localized irrigation: Water is distributed under low pressure, through a piped network and applied to each plant.
- Drip irrigation: A type of localized irrigation in which drops of water are delivered at or near the root of plants. In this type of irrigation, evaporation and runoff are minimized.
- Sprinkler irrigation: Water is distributed by overhead high-pressure sprinklers or guns from a central location in the field or from sprinklers on moving platforms.



Figure4: Irrigation image display the irrigation system in Rwanda (Source: The new Times, Rwanda to days and Business Africa).

- Center pivot irrigation: Water is distributed by a system of sprinklers that move on wheeled towers in a circular pattern. This system is common in flat areas of the United States.
- Lateral move irrigation: Water is distributed through a series of pipes, each with a wheel and a set of sprinklers, which are rotated either by hand or with a purpose-built mechanism. The sprinklers move a certain distance across the field and then need to have the water hose reconnected for the next distance. This system tends to be less expensive but requires more labor than others.
- Sub-irrigation: Water is distributed across land by raising the water table, through a system of pumping stations, canals, gates, and ditches. This type of irrigation is most effective in areas with high water tables.

Manual irrigation: Water is distributed across land through manual labor and watering cans. This system is very labor intensive (CDC 2016)

4. **Water harvesting:** It is the process of collecting and storing water from the source. The source might be the rain, well, faucet, river or lake and water is harvested through pipes to a prepared reservoir.

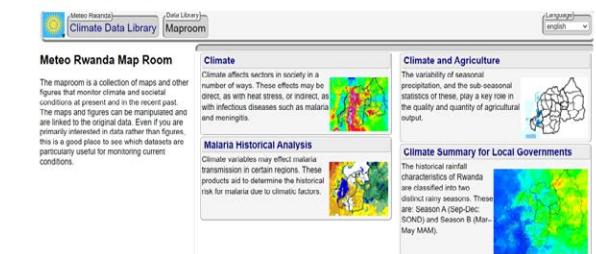
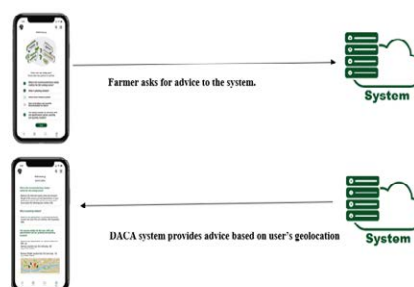


Figure 5: Water harvesting from lake (left) and from rain (right) to the reservoir

## b. Weather and knowledge - smart practices: (DACA, radio, smart phone, TV, etc.)

Technology has been found to be a solution in almost all sectors of life. Through the latest technologies, Climate information, services and advisories can be easily and quickly disseminated to users with less effort and time. This greatly contributes to the easy access, understanding and use of CIS&CSA technologies. For example, as discussed in the second module, DACA was developed to enhance access, use and uptake of CIS&CSA and agriculture advisories to inform climate related decision-making processes. Other practices include, the use of radio, TV, smartphones and map room as not only the source of information but also as a tool to aid in climate related decision making.

Use of climate information in farming: Studies suggest that using climate information such as seasonal forecast to know the right planting date, daily weather forecast and historical climate information of a location, contributes to better farm management, increased crop yield, managing climate related risks among others. Having information on planting time, total seasonal rainfall, length of the season, wet and dry spells is key for



farmers to handle farm activities through the season. Localized climate information products and services in agriculture aim to provide a full range of advice regarding climate, its impacts on crops, livestock, fisheries and management practices to be followed to prevent, reduce and/or manage risks. (WMO, 2013).



Figure 6: Farmer collecting rainfall data with a rain gauge (source: Seep, 2019)

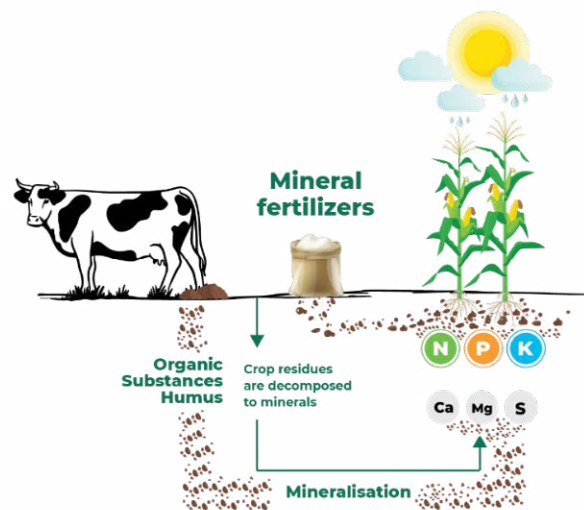
## Carbon-smart/Nutrient-Smart: (manure, tillage etc.)

**1. Use of fertilizers:** There are many types of fertilizers including organic and Inorganic Fertilizers. Organic fertilizers are made from natural and organic materials—mainly manure, compost, or other animal and plant products while inorganic fertilizers are mainly classified as

- Nitrogen Fertilizers
- Phosphate Fertilizers
- Potassium Fertilizers
- Others

The main role of fertilizers is that they provide crops the macronutrients they need that might be in short supply in the soil. Organic fertilizers are natural, and the nutrients they possess are strictly comprised of plant- or animal-based materials. Some examples of organic fertilizer include cow manure, decaying leaves and food composts. Inorganic fertilizer is synthetic, comprised of minerals and synthetic chemicals.

Inorganic nitrogen is commonly made from petroleum. Most of the minerals in inorganic fertilizers are mined from the earth, and balanced inorganic fertilizers are high in all three macronutrients and can contain ammonium sulfate, magnesium sulfate, and potassium chloride.



**2. Minimum tillage:** Minimum tillage is the practice that minimizes soil manipulation necessary for a successful crop production. Minimum tillage is the tillage method that does not turn the soil over. The invention of minimum tillage was stimulated by the need to reduce production costs, time and energy (labor). Tillage benefits include creating a seed bed, relax solid soil, soil aeration, incorporate crop and wed residue, incorporate fertilizers and pesticides, facilitate water penetration, irrigation and soil moisture storage, Stimulate net nitrogen mineralization (Mitchell et al., 2004)

**3. Terrace Farming:** Terrace farming involves earthworks made at right angles to the steepest slope consisting of an excavated channel on the uphill side, the spoil from which forms a bank on the downhill side. It converts a steep slope into a series of steps with horizontal or nearly horizontal ledges and vertical walls of stone, brick or timber between ledges. Terraces role is mainly to reduce soil losses through enhanced retention and infiltration of runoff and promote permanent agriculture on steep



Figure 7: Terraces in Karongi, Rwanda (Source: Alex Nyandwi, 2017)

slopes (WOCAT 2014). Terraces are built by various techniques and called (according to method of construction) bench terraces; diversion terraces with mangu; Nichols terraces; broad-based and narrow-based types; channel terraces; retention terraces etc. Although commonly found in many parts of the world, and effective in soil and water conservation, terraces are too expensive, relative to returns from subsistence farming, to construct and maintain.

#### **d. Seed-smart/Breed-smart: (Quality seeds, early maturing varieties, Improved livestock breeds, resilient seeds etc.)**

Good quality seeds, certified cultivars, drought tolerant and pest tolerant cultivars. Good quality seeds are highly linked to high crop production by various experts. This is due to the fact that the seeds' capacity to provide optimal yield is highly dependent on its genetic purity. The main attributes of high-quality seeds is a required degree of physical (shape, size, color, weight, vigor...) and genetic purity, which must be above 90%. These seeds demonstrate high germination, are free from seed-borne diseases, weed seeds, pests and do not require the use of herbicides. Good quality seeds may also be certified cultivars that went through seed certification standards to maintain its varietal purity. These seeds are tested in the field and in laboratories before they are approved and released to be commercialized as certified seeds. Drought tolerant seeds are seeds that can grow despite the shortage in water and can survive with minimal water availability. Pest tolerant seeds are genetically modified to be able to expel some insects and grow without being attacked by insects. For any farmer, it is important to consider the quality and type of a seed before purchase to be able to expect optimal crop yield.



Figure 8: Different types of seeds (Source: Livingtowers)

### e. Other CSA practices:

Many more practices are considered CSA depending on their contribution in improved farming. Crop insurance, agroforestry, crop-livestock systems, establishing strong institutions and policies, proper nutrition to livestock, reduction of food losses, efficient energy use, increasing soil carbon stocks, pests and diseases control, increasing landscapes and field diversity and controlled grazing.



Figure 9; Farmer applying pesticides. (Source: TODAY, 2021)

**Pest Control:** Pest control is a practice that focuses the management of pests that impact farming activities. Pest control is achieved through monitoring of pests and use of pesticides. Pesticides include herbicides and insecticides, which are mainly used in the pre-harvest stages; rodenticides, which are employed while storage of the crops; and fungicides, which can be applied at any stage of the process.

### Application of CSA practices

The implementation of Climate-Smart Agriculture (CSA) practices is feasible, yet poses challenges, including a shortage of tools and experience, among other factors. However, in many countries, these practices were very beneficial to farmers including farmers in Rwanda. The CSA practices informed by historical rainfall analyses and forecasts were implemented in farmers' field trials for four growing seasons for beans and maize to demonstrate the benefits of bundling CIS and CSA. A network of 120 on-farm trials (2018 to 2019), CSA practices informed by historical rainfall analyses and forecasts were tested to assess the effect of undertaking adaptive agricultural practices on productivity of maize and beans in Rwanda. This is the most extensive effort that we are aware of in the developing world to engage farmers in assessing impacts of bundled CIS and CSA through controlled field trials. On the use of climate information

in farming, in Rwanda, a recent study' data analyses show that farmers use climate services to make decisions on the types of crops to grow (75%), the types of crop varieties to plant (58%), timing of planting and land preparation (75%) and when and how to prepare land (65%)(Birachi et al., 2020).

### Selecting suitable CSA practices for a given crop in a given season

The selection of suitable CSA practices depends on farmers' particular context and conditions. In addition to that, a CSA practice will be suitable depending on the type of crops, location, land type and size, weather and climate conditions of an area and socio-economic characteristics of the farmer. Therefore, through the following exercises/ group work, farmers and agriculture extensionists are able to determine which CSA practices are suitable in each given scenario.

## Group work

From the previous exercises on calculation of probabilities

1. Would you confidently grow x variety?  
If yes, why? Please explain your answer
2. If not, why? Please explain your answer  
Do you anticipate any risk of growing x variety?  
If yes, why? Please explain your answer  
If not, why? Please explain your answer
3. Do you see the risks that can stop you from growing x variety?  
If yes, why? Please explain your answer  
If not, why? Please explain your answer
4. Kindly list at least three context specific CSA practices around each type of Climate Smart classes (weather & Knowledge smart, water smart...etc) that you would choose to address the identified risk and why?

## Procedure

To address these questions, refer to the following guide:

### 1. Confidence in growing x variety:

#### a. Yes, I would confidently grow x variety.

**Explanation:** Provide reasons supporting your confidence, such as positive outcomes from previous exercise on calculating probabilities, favorable environmental conditions, or strong performance indicators for the x variety.

#### b. No, I would not confidently grow x variety.

**Explanation:** Provide reasons for your lack of confidence, such as unfavorable conditions of seasonal rainfall amount and seasonal length, historical data indicating poor performance, or concerns about specific risks associated with growing x variety.

### 2. Anticipation of risks in growing x Variety:

#### a. Yes, I anticipate risks in growing x variety.

**Explanation:** Identify and elaborate on the potential risks associated with growing x variety, such as susceptibility to diseases, weather-related risks, market fluctuations, or other factors based on previous exercises.

#### b. No, I do not anticipate risks in growing x variety.

**Explanation:** Provide reasons for your lack of anticipation of risks, such as risk mitigation strategies, positive outcomes from probability calculations, or specific features of x variety that reduce potential risks.

### 3. Identification of risks preventing growth of x and other Varieties:

#### a. Yes, I identify risks that can prevent me from growing x and other varieties.

**Explanation:** Based on results of calculating probabilities, enumerate and explain the specific risks that may act as preventions to growing x variety

#### b. No, I do not identify risks that can prevent me from growing variety x.

**Explanation:** Provide reasons for your confidence, such as effective risk management plans, comprehensive understanding of potential challenges, or mitigation strategies in place.

### 4. Context-Specific CSA Practices for addressing identified Risks:

List at least three context-specific Climate-Smart Agriculture (CSA) practices for each type of Climate-Smart class (weather smart, knowledge smart, water smart, etc.) that you would choose to address the identified risks.

**Explanation:** Provide detailed explanations for each chosen CSA practice, demonstrating how they address specific risks associated with growing the x variety. Consider factors like resilience to weather changes, knowledge-based strategies, or water-efficient practices.





## Chapter 6.

# Managing Agricultural Risks through scaling and sustaining of Bundled CIS and CSA with other services

### 6.0: Background

Climate-Smart Agriculture (CSA) is driving transformative changes in African food systems through the adoption of innovative and climate-resilient practices. These practices, including crop rotation, crop diversification, irrigation, soil management, fertilizer application, pest control, and more (Abegunde et al., 2020; Ogada et al., 2021). The tangible positive impacts of CSA have been distinctly observed in various countries, notably Zimbabwe, Kenya, Uganda, and Tanzania, as underscored by studies such as those conducted by Egeru et al. (2022). To facilitate effective adaptation among rural small-holder farmers, the integration or bundling of CSA with climate information services (CIS) is considered essential, as emphasized by Tesfaye et al. (2022). The bundling of CIS and CSA, along with other services like insurance, credit, and farm inputs is recognized as a viable strategy for enhancing agricultural risk management and sustainable agriculture in a changing climate. Furthermore, it is imperative to provide bundled CIS alongside CSA practices tailored to the specific needs of communities. This necessitates a participatory approach aligned with the priorities of local communities in the context of CIS-CSA innovations.

This bundling approach maximizes benefits for both farmers and business innovators. Bundling functions serve as a crucial tool for creating synergistic value-addition in the CIS-CSA ecosystem, fostering the widespread adoption of combined CIS-CSA practices by farmers. Bundling CIS with CSA equips farmers with the capacity to adapt to new or existing technologies, mitigate climate risks, make informed decisions regarding climate variability, enhance soil fertility, increase production, generate income, reduce costs, achieve food security, and build climate resilience (Chang, 2017; Long et al., 2017; Tesfaye et al., 2021). This comprehensive module comprises eight key components.

## Outline

- a. Value Creation in bundling
- b. Forms and types of Bundling
- c. Bundling modalities: Networking is Key
- d. Categories of bundled services or products based on the services they offer (trusted services, trusted agents, trusted products and direct provisions).
- e. CIS- CSA Business Models
- f. Bundled business models, networked private sector approach and revenue streams

## 6.1: Value Creation in bundling

Bundling means repurposing value that you already created to create even more value by combining multiple individual services into one bundle. The more offers contained in a bundle, the higher the Perceived Value of the bundle will be.

Product bundling works well because it is deeply rooted in a psychological process called customer value perception. As a general rule, farmers favour products that they find valuable or worth it to buy e.g., Fertilizers, Crop protection products (herbicides/pesticides/vet drugs e.t.c.) or certified seeds. Customers perceive that they will save if they purchase a bundled item at a cheaper price instead of buying them as individual products. Bundled products greatly affect the farmers' subconscious judgment with a feeling like 'they have bought several products at a bargain'.

Bundling should create efficiency and productivity benefits for all stakeholders (service providers, agriculture input suppliers, farmers etc) in the CIS, CSA and other services ecosystem.

### For the financial services providers, bundling is an opportunity:

1. Leverage existing innovations/ services to increase outreach and penetration and compensate for lack of own staff/distribution in the rural market
2. Utilize the partner's goodwill and get customers to try the financial service offering
3. Reduce costs of distribution, customer education and premium collection through pre-financing by the partner or the aggregator
4. Have reduced anti-selection/fraud due to bundled nature (especially for mandatory products)

### For the Provider of Agricultural Inputs, bundling with other services can offer several advantages like:

1. Use of an attractive service as a sale promotion tool for farming inputs
2. Increase loyalty to the product
3. Additional revenue stream in terms of commission or several fees from the insurer
4. Reduction of agriculture lending risk

## From the farmer's point of view, a bundled product can provide:

1. Access to different products and services on a cost-effective basis
2. Easier access to farm inputs and credit
3. Easy payment of premiums (subsidized premium)
4. Access to multiple services at a competitive price through the one- stop-shop
5. Loan repayment relief and access to loans for the next season (in case of default due to unfavorable production)

## 6.2: Forms and Types of Bundling

### Bundling takes two forms:

- Those where one product/service is compulsory for the smallholders when using a complementary product or service, such as inputs or credit (note: the insurance component may be invisible to the farmer)
- Those where a product is voluntary and presented as part of a menu or set of solution options.

### Bundling of CIS And CSA with other services such as agricultural insurance/financial services emerges as a possible solution when:

- Services are made more accessible/tangible,
- enable schemes to scale faster, and
- achieve better social outcomes

### For effective bundling, farm inputs should have the following characteristics:

- available,
- affordable,
- accessible, and be of
- good quality.

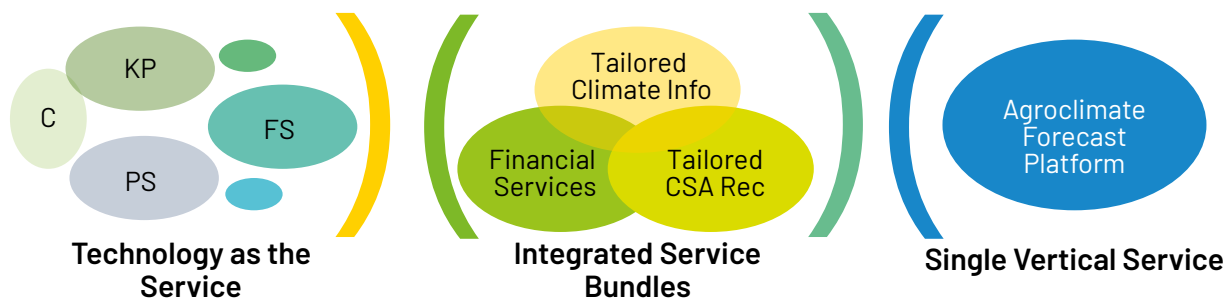
### Types of bundled products or services

There are four broad categories of products and services. Bundling can be done within a category and between one category and another. **These categories are:**

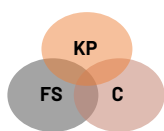
- **Knowledge Products (KP):** This type of bundling encompasses CIS and CSA advisory recommendations, early warning systems, and related informational resources.
- **Consumables (C):** This includes tangible goods essential for agricultural activities, such as certified seeds, fertilizers, chemical inputs, and other related consumable items.
- **Financial Services (FS):** Under this classification, various financial products and services are provided, including microloans, insurance products tailored for the agricultural sector, and traditional banking services.
- **Physical Services (PS):** This category involves tangible services that contribute to agricultural processes, such as mechanization services, milling facilities, solar-powered solutions, and other physical services designed to enhance productivity and efficiency.

There has been a tendency where products and services have sold/ promoted as silos and they consumption has been limited or not to the required standard. However, a combination of two or more of the services has read to the uptake of both or more of the products in the bundle.

### Bundling “Sweet Spot”



### Possible bundling examples



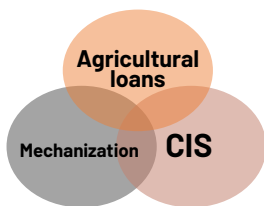
**Options:**

1. Bundle all the three
2. Bundle KP with FS
3. Bundle KP with C
4. Bundle FS with C



**Options:**

1. Bundle all the three
2. Bundle Insurance products with CIS
3. Bundle insurance products with CSA
4. Bundle CIS with CSA technologies



**Options:**

1. Bundle all the three
2. Bundle Agriculture Loans with CIS
3. Bundle Agriculture Loans with Mechanization
4. Bundle CIS with Mechanization



**Options:**

1. Bundle all the three
2. Bundle credit facilities with CIS
3. Bundle insurance products with CIS
4. Insurance products to promote access to credit facilities

## 6.3: Bundling Modalities, Networked Approach: Intentionally building effective relationships around a shared vision

Networking is key to the success of any bundling endeavor. This is based on the premise that:

- » Often no single arbitrator of relevant information.
- » Multiple value-add opportunities in the information chain.
- » Environment of “coopetition” (including pre-competitive space).



Collaboration resulting from research conducted jointly by usually competing companies for the purpose of developing new commercially applicable technologies

Pre-competitive collaboration in agricultural risk Management involves two or more stakeholders, such as Innovators, agricultural organizations, and relevant institutions, within the agricultural sector, joining forces to collectively address and mitigate shared risks and challenges that impact the resilience and sustainability of the broader agricultural community.

This collaborative effort aims to foster proactive measures and innovative solutions before individual competitive interests come into play, ensuring the overall well-being and stability of the agricultural industry.”

Before entering into a pre-competitive partnership, it's important to ask the following questions:

1. Do your goals in providing services depend on shared climate data and collaborative efforts with meteorological agencies or research institutions for accurate and timely information?
2. Considering the nature of climate-related risks in agriculture, how are these risks influenced by the specific Agro-ecological zones and their susceptibility to climatic variations?
3. In implementing services to mitigate climate-related risks, how important is the involvement of local farming communities, and what strategies can be employed to ensure their active participation and adherence to recommended practices

Once the institutions are satisfied with the need for collaboration, bundling becomes feasible and companies enter co-competition process.

**Co-competition** among innovators in agriculture risk management refers to the collaborative and competitive dynamics between individuals or entities involved in agricultural innovation. In this context, innovators, which could include farmers, researchers, technology developers, and other stakeholders, engage in a cooperative environment to share knowledge, resources, and expertise while simultaneously competing to advance their individual innovative solutions. This cooperative-competitive synergy aims to accelerate overall progress, fosters mutual learning, and drive advancements in agricultural technologies and practices for the benefit of the entire agricultural value chains.

In a co-competitive ecosystem among agricultural innovators, bundling can be a strategic approach to create value for end-users and enhance market competitiveness if the following conditions apply:

### **Identifying Complementary Products:**

Innovators collaboratively identify areas where their products complement each other. For example, one company may specialize in soil health, while another focuses on climate Information provision.

### **Creating Bundled Solutions:**

These innovators then work together to create bundled solutions that integrate their complementary products. For instance, a bundled solution might include a comprehensive precision farming package that combines soil health data, climate and weather forecasts, and crop characteristics to produce advisories.

### **Market Collaboration:**

While still competitors in some aspects, the innovators agree to collaboratively market and sell these bundled solutions. This can lead to the creation of a unified brand or platform that showcases the collective benefits of the bundled products at a cheaper Unit costs for each individual innovator.

### **Value Proposition for End-Users:**

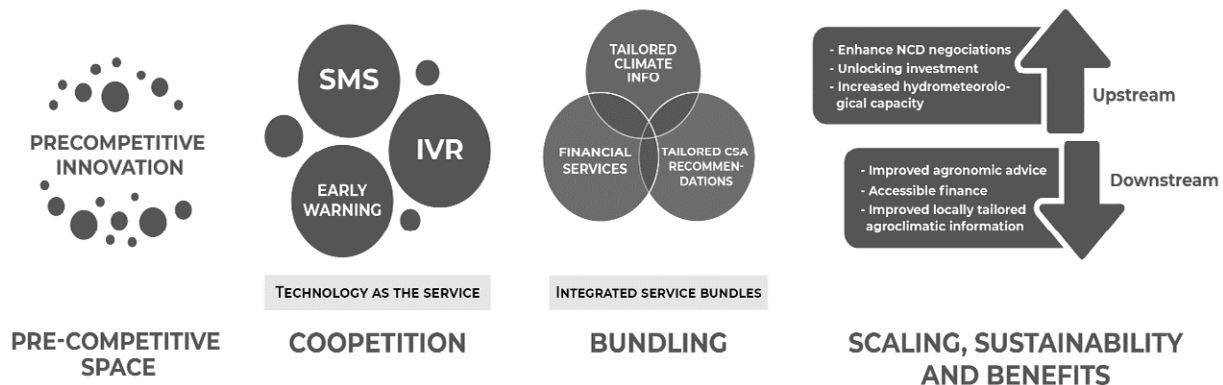
The bundled solutions provide enhanced value to farmers and agricultural stakeholders, offering a one-stop, integrated solution that addresses multiple aspects of modern farming challenges. This can result in increased efficiency, cost-effectiveness, and overall improved farm management.

## Market Differentiation:

Through bundling, innovators maintain their competitive edge by offering unique combinations of products. This encourages continuous innovation and differentiation within the cooperative ecosystem.

In this scenario, bundling becomes a collaborative strategy that leverages the strengths of individual innovators, promotes joint marketing efforts, and delivers comprehensive solutions to end-users. This cooperative bundling model allows innovators to tap into each other's expertise while maintaining a competitive edge in the market.

The following figure summarizes the bundling processes:



## 6.4: Bundling delivery Modalities:

The bundled business model will need a trusted broker for introducing CIS, CSA, or other services to improve access, uptake and use of the technologies by value chain actors.

There are four different types of networks that must ultimately be considered in relation to the business models built around the delivery of bundled services and products.

### 1. Trusted Services

The service-led bundling modality positions a trusted service, frequently a financial service such as crop insurance or credit, at the front of the bundling process.

In this modality, the service product is sold to the consumer with bundled options, including climate advisory and localized CSA recommendations



### 2. Trusted Products

In this bundling modality, CIS and CSA advisories are bundled together with physical inputs such as certified seed, fertilizer, agrochemicals, and farm products such as pumps and solar.

The advisories add value through a range of mechanisms including improved seed selection



decisions (and higher quality seed generally), more efficient use of nutrients and agrochemicals, and locally tailored recommendations around agriculture practices consistent with the purchased products.

### 3. Trusted Agents

The trusted agent bundling modality does not have a single leading product or service, rather the agents function as a service consolidator. This modality is typically realized as an extension agent (either public or private) or as an agribusiness specialist or similar.

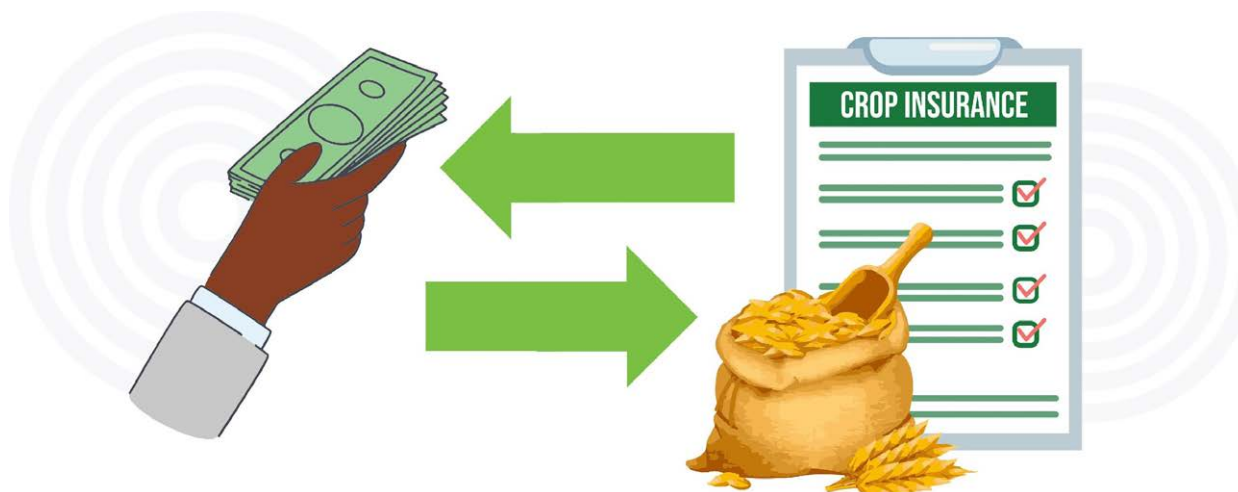
In this modality, the agent makes recommendations on CIS-CSA integrations, either as a core service or as a complement to other services and products in a manner analogous to the trusted products and services above.

Trusted agents may also include development researchers and implementing partners such as NGOs and aid organizations.



### Direct provision

In this model, the services may be paid for by farmers themselves, or by an intermediary (e.g., a trusted agent), or by the provider themselves (e.g., as in the case of a met service providing information direct to producers).



## 6.5: Bundled business models, networked private sector approach and revenue streams

Detailed study by Winrock International (Usher et al., 2018) defined eight distinct business models including:



**Business to Business (B2B)**



**Business to Donor (B2D)**



**Business to Government (B2G)**

Variations of the same with diverse levels of intermediation, such as B2D2C, B2D2G, B2G2C, B2B, B2B2C and B2C.

There are cases where the business model is predominantly in the public domain and in these instances the model is "G2X" (Government to X) rather than "B2X" (Business to X)



While initially viewed as perhaps not having a business model, these successful CSA/CIS bundling examples demonstrate how integrated CIS and CSA can serve as part of the available public services to lower risk and improve climate outcomes for both farmers and the government alike.

For CIS & CSA business models to achieve long-term sustainability, it is imperative that they generate diverse revenue streams. These may include:

- Revenues and profits derived from a variety of bundled services offered.
- Transactions involving goods.
- Transactions related to services.
- Commissions and direct sales.
- Subscription fees.
- Licensing.
- Brokerage fees.
- Advertising revenue.
- Income generated from lending, leasing, or renting.
- Government-related revenues such as goods and services tax, income tax, corporate tax, non-tax revenues, and union tax duties.
- Earnings from jobs and side gigs.
- Interest income.
- Loyalty programs.
- And other potential sources of income.

By diversifying their revenue streams in this manner, CIS & CSA business models can fortify their financial foundation and enhance their overall sustainability.

### Group work

1. Would you please list any bundling related to CIS, CSA and other services/products that you know?
2. List the added value(s) of the bundles you would/could envision
3. Please provide a brief on that bundling services/products and actors involved
4. Channels being used to communicate and disseminate the bundled Services/Products
5. List the impacts of the bundled services/Products.

6. Please advise a business model that a private/or corporate can use to generate benefits/revenues.
7. What are the Challenges (if any) experienced by the bundling listed above?
8. Do you think bundling can significantly improve the adoption of CIS and CSA? Answer by yes or no. Please explain your response.

## Example of responses

### Responses to Questions #1, 2, & 3

Institution/ organization	CIS/CSA	Climate-Smart Classes					
		Weather and Knowledge Smart	Water smart	Nutrition/ Carbon Smart	Seed/Breed Smart	Institutional/ Market smart	On Health
	bundles						
Dizengoff GH-Tech	-certified seed	X			x		
	-Cotton mix and pots	x	x	x		National frame work	
	-drip irrigation	x	x				
	-plant nutrients			x			
AICCRA							
	-improved cowpea varieties (e.g. Padi Tuya)	x	x		X		
	-biopesticide use						x
	-soil organic amendments			X			
	-Maize /cowpea intercropping/rotation	x		x			
	-extension services	x				x	

Institution/ Organization	CIS/CSA	Climate-Smart Classes					
		Weather and Knowledge Smart	Water smart	Nutrition/ Carbon Smart	Seed/Breed Smart	Institutional/ Market smart	On Health
	bundles						
MASARA N ARIZIKI	Improved seeds	x			X		
	Inorganic Fertilizer			X			
	Extension services					X	
	Market services					X	
	Pesticides						x
Cocoa Production system in Ghana							
Cocoa Abrabopa							

Institution/ Organization	CIS/CSA	Climate-Smart Classes					
	Improved seedlings	x				X	
	Fertilizer			X			
	Extension					X	
	Market services					x	
	Pesticides						x

#### 4. Channels to communicate Bundled information

- Extension services (MoFA)
- Mass media (community info centres, radio, TVs, etc)
- Smart Phones (WhatsApp, SMS, Facebook, etc)

#### 5. Impacts of Bundled services

- Reduction in cost of doing businesses
- Increased production /income/profits
- Increased accessibility to CIS
- Reduction in risk
- Reduction in fatigue

#### 6. Business models private/corporate can use to generate benefits/revenues

- Masara N Ariziki Business model:
- B2C:
- Masara-Farmers: Masara supplies
- Input supply to farmers
- Extension services to farmers
- Buys maize produced by farmers (Market service to farmers)

#### 7. Challenges to Bundling listed

- Cost effectiveness of bundles
- Information asymmetry can hinder to provision of effective bundles
- Uncertainty (natural disasters, policy environment, etc.)
- Lack of commitment/trust among actors

#### 8. Do you think bundling can significantly improve the adoption of CIS/CSA? Yes/No, Explain your response

Yes, because, bundling enhances affordability, accessibility and makes technologies user friendly, thereby increasing adoption.





## Chapter 7.

# Additional tools supporting farmer's decisions

## 7.0 Background

Several tools and approaches have been developed to support farmers' decision-making, either in water management (ICRISAT, 2016) or managing seasonal variability (McCown et al., 2012; Crane et al., 2010). In this course, different tools are used to guide farmers' decisions and seasonal planning. Through successive training sessions, farmers are enabled to access, understand, and use Climate Information Services (CIS) in combination with Climate Smart Agriculture (CSA) practices to make informed decisions and seasonal plans. This stage will focus on discussing how different CIS products like length of season, planting date, total seasonal rainfall and cessation and CSA practices such as mulching, tied ridges, irrigation, application of fertilizers and good quality seeds, by the use of different tools can help a farmers' decision-making. In addition, with the digitalization of agro-climate advisories, the process of making decisions and planning for the season is made easy through the enhanced accessibility to climate information with reduced costs, and increased understanding and use through communication networks including websites, mobile phones, Radio, TVs and training among others. The seasonal planning includes among others, the land preparation, crop choice, seeds preparation, fertilizers and pesticides preparation, labor and market preparation and other inputs preparation. Having information on weather and climate will help a farmer to prepare for the cropping season with better understanding and preparedness towards any climate risks by preparing a seasonal calendar and a seasonal adaptation plan. In addition, for better seasonal planning, a farmer must have an idea of how expensive the season will be based on the current situation and previous experiences including climate related risks that may occur and have a detailed budget for the whole season to ensure the optimum yield no matter how the season may perform. A detailed budget also known as Cost-Benefit Analysis (CBA) must be developed before the season starts, based on previous experience. This may include all the costs for all inputs, labor, transport, CSA practices and incidentals among others. At the end, this seasonal planning helps the farmer to conclude if they have benefited or not during the season and informs future seasonal plans. This module has the following components:

- a. Developing a seasonal calendar
- b. Seasonal adaptation plans comprising management practices options
- c. Budget baselines for different options

## 7.1: Developing a seasonal calendar

A seasonal calendar is important for farmers not only for preparation and planning purposes but also for facilitating the understanding of the farming system. With a seasonal calendar for growing a given crop variety, all activities are set based on weather conditions of the location, and are implemented in the right time. With a seasonal calendar, each activity is identified and related challenges can be addressed within time and assistance can be demanded and provided if needed.

### An example of a seasonal calendar (adapted from Bhusal et al., 2020)

Hazard		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Floods	Before				■	■				■	■		
	Now				■						■		
Drought	Before						■	■					
	Now						■	■					
Hailstorms	Before				■	■						■	■
	Now				■	■						■	■
Pest and diseases	Before	■	■							■	■		
	Now	■	■							■	■		

### An example of a crop calendar

CROP/LIVESTOCK	DRY	SUNNY/LIGHT SHOWERS	RAIN	HEAVY RAINS	HEAVY RAINS/ LIGHT SHOWERS	DRY/LIGHT SHOWERS	DRY/LIGHT SHOWERS	RAIN	HEAVY RAINS	DRY/LIGHT SHOWERS	DRY	DRY
	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
MAIZE	Land preparation; Inputs purchase	Seeds purchase; Planting	First weeding	Second weeding; Fertilizers purchase; Top dressing; Pest control	Pest control	Land preparation	Harvesting; Drying	Drying; Shelling; Packaging; Selling	Selling			Land preparation; Fertilizer usage; Manure
BEANS						Land preparation; Inputs purchase	Planting	First weeding; Pest control	Second weeding	Harvesting; Drying; Sorting		Selling
DAIRY CATTLE	Planting fodder	Weeding	Weeding	Weeding	Fodder harvest							Land preparation
						Land preparation	Planting fodder	Weeding	Weeding	Weeding		Fodder harvest

























The seasonal crop calendar enables the farmers to explore the timing of the main activities that they will carry out on their farms and how these are influenced by weather and climate hence making plans accordingly.

## 7.2: Developing a seasonal adaptation plan

The seasonal adaptation plan is a detailed plan of the season that describes various incidents that may happen during the season due to weather and climate conditions and how these incidents can be anticipated, prepared for and handled if they can't be prevented in the first place. The seasonal calendar helps the farmer to identify climate risks at any crop stages and appropriate management options.

Through capacity building activities, farmers are enabled to develop a seasonal adaptation plan for their crops in a season. The seasonal adaptation plan must include various CSA practices that a farmer can use to cope with unexpected climate shocks like floods, drought, pests, diseases etc.

## An example of a seasonal adaptation plan for crops

DISTRICT	COOPERATIVE	CROP/LIVESTOCK TYPE	CRITICAL STAGES OF THE VALUE CHAIN	RISKS/ VULNERABILITIES	RISKS MANAGEMENT OPTIONS/ POSSIBLE RESPONSE STRATEGIES
Nyanza	UBUSHAKEBWIZA	Maize 	Input and Production 	Crop yield reduction due to high water stress from continuous or repetitive dry spells 	Crop watering 
		Maize 	Input/ Equipment and Production 	Crop yield reduction due to high water stress from continuous or repetitive dry spells 	Crop watering 
	MPANGA Maize	Beans 	Input/ Equipment and Production 	Crop yield losses due to heavy rains/hails/storms, Pests 	Build drying facilities for dry up the harvest, Planting on time, Pest control 
		Maize 	Input/ Equipment and Production 	Crop yield reduction due to high water stress from continuous or repetitive dry spells 	Crop watering 
	DUFATANYE UMURIMO	Beans 	Input/ Equipment and Production 	Crop yield losses due to heavy rains/hails/storms 	In-field soil conservation and water retention 
		Tomato 	Input/ Equipment and Production/harvest/Market 	Heavy rain that increases the incidences of pests and diseases, Water stress due to prolonged dry spells 	Pests control by using fungicides, Watering, Mulching, Timing the harvest with days that are relatively dry, Proper storage of harvested tomatoes, Planting driven by the market; promote contracting farming. 

## 7.3: Budget baselines for different options

The cost-benefit analysis serves as a measure to determine the effectiveness of implementing a CSA practice on-farm. It is also a logical process, which is used to analyze the costs and benefits of a project or activity to be able to make appropriate decisions before any implementation. The cost-benefit analyst puts together all costs expected from that activity and gathers all potential benefits that can be expected. Sometimes, other non-material benefits are also valued to broaden the explicit analysis before making decisions. A decision is made based on how convincing the benefits in comparison to expenses are.

### Example of Budget for one option

Production		Harvesting		Revenues from harvest	Balance (Gain or loss)	
Expense detail	Amount (\$)	Harvesting and Selling	Amount (\$)	Harvested beans (Kg)	Amount (\$)	Balance (\$) [+/-]
Plot/Farm (1ha)	0	Harvesting		30	3,000	18,000
Seeds (100kg)	200	Drying and sorting		40	Total Revenues (E) 18,000	17,274
Organic fertilizers/Manure	60	Packaging		40		
Chemical fertilizers (N,P,K, )	40	Labor		40		
Pesticides	20	Transport		40		
Mulching	20	Total (B)	<b>190</b>			
Soil erosion control	30					
Supplimental irrigation	30		Total cost (A+B)	<b>660</b>		
Water harvesting	30		Unexpected costs (10%) (C)	66		Balance= E – D18000-726=17,274
Labor	40		Total (D)=A+B	<b>726</b>		
Total (A)	<b>470</b>					

## Group work

1. Develop the Agricultural calendar and adaptation plan for one crop and one livestock system.

## Procedure

- a. Select a cropping and livestock systems. Then develop a crop calendar, identifying seasons, climate risks, and normal management practices appropriate for each system
- b. The worksheet is divided into 12 months, each month is split into 2-week periods
- c. For each season, first identify a "normal weather pattern ": start and end of the rainy season? Dry spell and dry seasons? Draw a line of the corresponding months.
- d. In the row below, draw a line and describe perceived changes for each season
- e. Identify the main climate risks throughout the year and impacts on cropping systems. Draw a line for the corresponding months.
- f. In the row below, draw a line and describe perceived changes.
- g. For each system identified on step 5 draw a line and put a code for the different management practices throughout the year.
- h. In the row below, draw a line for current changes in management

## Agricultural calendars and adaptation plan template

Date:		Country:					Region:						
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Seasons</b>	Rainy season under normal condition												
	Changes in rainy season												
	Dry season under normal condition												
	Changes in dry season												
	Other: _____												
	Changes												

		Seasonal Calendar																				
Climate risks	Risk 1: _____																					
	Changes																					
	Risk 2: _____																					
	Changes																					
	Risk 3: _____																					
	Changes																					
	Risk 4: _____																					
	Changes																					
	Risk 5: _____																					
	Changes																					
		Seasonal Adaptation plan																				
Cropping/livestock practices	Cropping																					
	#1 _____																					
	Changes																					
	Livestock																					
	#2 _____																					
	Changes																					
	Other																					
Changes																						

### Management practices options:

- Cropping systems: Land preparation: LP / Seeding: SD / Fertilizer and manure application: FA / Pesticide application: PA / Irrigation: IR / Harvest: HR / Other: ----, Code: -----, other: ----, code-----
  - Livestock systems: Cut and carry: CC / Irrigating Fodder: IF / Baling: BA / Watering: WT / Herding: HD / Manure management: MM / PA / Health management: HM / Breeding: BR / Other: ----, Code-----, other: ----, Code-----
2. Develop the budget for each system (for crop and for Livestock)

### Procedure

- Choose the cropping or livestock system.
- Identify all activities required in a season, from land preparation to harvest and selling, and include Climate-Smart Agriculture (CSA) practices along with their associated costs.
- Identify all inputs such as seeds, fertilizers, etc., and determine their related costs, encompassing both recurrent and non-recurrent expenses.
- Aggregate the labor costs and inputs.
- Estimate unexpected costs, equivalent to 10% of the total investment (sum of labor costs and inputs).
- Convert the harvested yield into monetary value.
- Deduct the total amount obtained from the harvest from the combined investment and unexpected costs to determine the balance, which may result in either a loss or gain.

Production		Harvesting		Revenues from harvest		Balance (Gain or loss)
Detailed activities	Amount (GHC)	Harvesting and Selling	Amount (GHC)	Harvest (Kg)	Amount (GHC)	Balance (GHC) [+/-]
						Total revenue-Total costs
				Total Revenues (E)		
		Total (B)				
			Total cost (A+B)			
			Unexpected costs (10%) (C)			Balance= E - D
			Total (D)=A+B			
Total (A)						

### Budget template.

3. After completing the above 2 exercises, which system would you recommend to the farmers in your region in the next season?
4. Explain why you made that choice



## Chapter 8.

# Monitoring, Evaluation and Learning (MEL)

Monitoring, Evaluation and Learning (MEL) helps in determining if activities are being implemented as planned, identify challenges, and find solutions through the implementation to ensure that activities are completed successfully. In addition, MEL processes enable the designers and planners of interventions in assessing the quality and expected outputs of interventions, facilitating information gathering on progress, challenges, adoption level, successes and opportunities hence putting together the lessons learnt for future initiatives and improved use of resources. In addition to the usual reporting, in the bundling CIS and CSA courses, different tools were developed to support the MEL processes to capture information before, during and after training are completed. Among developed tools, DACA as a web and mobile based platform has the capacity to generate monthly reports on its registered users' information and feedback. Other tools include data collection tools like the stakeholder identification form, registration form, training evaluation form, dissemination plan form, Tracking stories of changes form, etc.

### CIS-CSA' Monitoring, Evaluation and Learning tools (CIS-CSA MEL TOOLS)

#### Annex1: Attendance list form

Training of Bundling Climate Information Services (CIS) and Climate Smart Agriculture (CSA) Practices for improved agricultural Risks Management

Date: ...

Registration form: Day ....

No	Name	Location	Phone No	Age U: ≤35 A: Above 35	Sex F: Female M: Male	Signature

## Annex 2: Training feedback form to be filled by the participants at the end of Training workshop

Please can you provide the following information as it will help us to improve the training

### SECTION 1 - INTRODUCTION

1. **NAMES** .....

2. **GENDER**

Male

Female

3. **AGE**

≤ 35

>35

4. **Country**.....

5. **Institution/Region:** .....

6. **Position**.....

Farmer

Lead Farmer

Researcher

Agriculture extension officer (Government or NGOs)

Business person

Policy maker

Finance (government or NGO finance department)

Agro-dealers (inputs sellers...)

Other

7. **Email Address**.....

8. **Phone Number**.....

9. **Education Level**

Never attended the school

Only Primary School certificate

High school Secondary School diploma or equivalent

Only Professional courses/training

Bachelor's degree

Master's degree

Doctoral or professional degree

Other

## SECTION 2 – ELEMENTS OF THE TRAINING

### 1. What was new for you in the training? Select all that apply

- Basics of Agro-climate Advisories
  - Understanding and Use of Climate Information/services
  - Reading and interpreting the time series and probability of exceedance graphs
  - Understanding Climate-Smart Agriculture (CSA) and its processes
  - Crop Based CSA Technologies and Practices
  - Principles of bundling CIS, CSA and others services/products
  - Exploring the relationship between Climate Information Services and Crops/livestock/Fisheries
  - DACA Platform
  - Developing Seasonal Calendar and seasonal adaptation plan
  - Cost benefits analysis
  - Training Methodology
  - Other, please specify if the response is other
- 

### 2. Which part of the training was more interesting to you in training? Select all that apply

- Basics of Agro-climate Advisories
  - Understanding and Use of Climate Information/services
  - Reading and interpreting the time series and probability of exceedance graphs
  - Understanding Climate-Smart Agriculture (CSA) and its processes
  - Crop Based CSA Technologies and Practices
  - Principles of bundling CIS, CSA and others services/products
  - Exploring the relationship between Climate Information Services and Crops/livestock/Fisheries
  - DACA Platform
  - Developing Seasonal Calendar and adaptation plan
  - Cost benefits analysis
  - Training Methodology
  - Other, please specify if the response is other
- 

#### 2.1 Please explain your choices

---

### 3. Which part of the training was hard to understand in training? Select all that apply

- Basics of Agro-climate Advisories
- Understanding and Use of Climate Information/services
- Reading and interpreting the time series and probability of exceedance graphs
- Understanding Climate-Smart Agriculture (CSA) and its processes

- Crop Based CSA Technologies and Practices
- Principles of bundling CIS, CSA and others services/products
- Exploring the relationship between Climate Information Services and Crops/livestock/Fisheries
- DACA Platform
- Developing Seasonal Calendar and adaptation plan
- Cost benefits analysis
- Training Methodology
- Other, please specify if the response is other

.....

**3.1 Please explain your choices**

.....

**4. Which part of the training was easy to understand in training? Select all that apply**

- Basics of Agro-climate Advisories
- Understanding and Use of Climate Information/services
- Reading and interpreting the time series and probability of exceedance graphs
- Understanding Climate-Smart Agriculture (CSA) and its processes
- Crop Based CSA Technologies and Practices
- Principles of bundling CIS, CSA and others services/products
- Exploring the relationship between Climate Information Services and Crops/livestock/Fisheries
- DACA Platform
- Developing Seasonal Calendar and adaptation plan
- Cost benefits analysis
- Training Methodology
- Other, please specify if the response is other .....

.....

**4.1. Please explain your choices**

.....

**5. What is your level of confidence to properly deliver the same training workshop to others (Agricultural extension agents, lead farmers, ...)**

- Very highly
- High
- Good
- Low
- Very low

**6. Would you use a part or all the content of the training workshop in your professional work?**

- yes
- No

**6.1. If yes, why?**

.....

**6.2. If no, why?**

---

**7. Would you recommend this training to others (colleagues or partners...)?**

- Yes
  - No
- 

**7.1. If yes, why?**

---

**7.2. If no, why?**

---

**8. How can you describe the training methodology?**

- Very good
  - Good
  - Fair
  - Bad
  - Very bad
- 

**8.1 Please explain your choice**

---

**9. Was the training scheduling and time appropriate and enough for you?**

- Very sufficient
  - Sufficient
  - Fairly sufficient
  - Not sufficient
- 

**9.1 Please explain your choice**

---

**10. Would you please list at least three things you have benefited from the training?**

---

**11. What do you think can be improved for future trainings? Select all that apply**

- Content of the training
- Training methodology
- Duration of the training
- None of the above

**11.1. Please provide any other comment(s) or recommendation (s) that would help to improve the quality and content of the training workshop**

---

*Thank you for your feedback!!*

### Annex 3: Dissemination plan form to be filled by the Trainers of Trainers (TOTs) at the end of Training workshop

Month	Week 1		Week 2		Week 3		Week 4	
	Number of participants		Number of participants		Number of participants		Number of participants	
	Male	Female	Male	Female	Male	Female	Male	Female
1st Month								
2nd Month								
3rd Month								

**Name of a trainer:** .....

**Phone Number of a trainer:** .....

**Organization/ Institution:** .....

**Position/ Role:** .....

**Address:**

**Community/ District/Region:** .....

**Date and Signature:**

### Annex 4: Evaluation form to be filled during the deployment of training in communities

PLEASE FILL THIS FORM AFTER EVERY SESSION OF THE TRAINING ON BUNDLED AGRO-CLIMATE ADVISORIES FOR IMPROVED AGRICULTURAL RISKS MANAGEMENT

**Date:** ..... **Municipal/District:** ..... **Names of the trainer:** .....

**Number of male participants:** Above 35: ..... Below 35: .....

**Number of Female Participants:** Above 35: ..... Below 35: .....

**Number of Participants with disabilities:** Male: ..... Female: .....

What are the lessons you learnt (please tick in the table below)?

Basics of Agro-climate Advisories	Accessing climate information through the digital AgroClimate Advisory (DACA)	<ul style="list-style-type: none"> <li>Understanding and Use of Climate Information/ service</li> <li>Reading and interpreting the time series and probability of exceedance graphs</li> </ul>	<ul style="list-style-type: none"> <li>Understanding Climate-Smart Agriculture (CSA) and its processes</li> <li>Crop Based CSA Technologies and Practices</li> </ul>	Principles of bundling CIS, CSA and others services/ products	<ul style="list-style-type: none"> <li>Developing Seasonal Calendar and seasonal adaptation plan</li> <li>Cost Benefits analysis</li> </ul>

**How was the training Session?**

Very good	Good	Moderate	Bad	Very bad

Explain your answer:

.....

The training session has taken how many hours?

.....

Which way or medium did you use to share the knowledge on the use of bundled agro-climate advisories for improved agricultural risks management?

.....

What are the decisions taken by the trainees after the training session?

.....

**This form of evaluation has to be given to the Municipal/District Director**

**Municipal/District Director:** .....

**Signature:** .....

**Annex 5: Tracking stories of changes form: Bundling CIS & CSA for Improved Agricultural Risks Management**

Date	
Name of interviewee (farmer)	
Sex	
Age	
Household size	
Land size	
Country	
District/Region name	
GPS coordinates if applicable	

1. Do you receive Bundled CIS & CSA services?

.....

2. What are the types of Bundled CIS & CSA services do you receive, from where and how often?

.....

3. Do you think it's important to know information about Bundling CIS & CSA services? If yes/no, what are the reasons?

.....

4. What are your main livelihood activities?

Crops:

Animals:

Other business activities:

5. Do you use Bundled CIS & CSA services to make informed decisions in your livelihood activities?

If yes, when	What informed decisions	The impact of these decisions

If no, why?

.....

6. Over the last 6 months, did you make any changes in your agricultural activities?

Yes

No

7. What are the impacts of these decisions on the agricultural activities (yields and income)?

Bundled CIS & CSA services	For what decisions	Time (year and season)	Impact on yield		Impact on Income	
			before	after	before	after

8. Participatory budget

Enterprise ..... Change .....

Scale ..... Replacement / addition .....

<b>With changes</b>		<b>Period1:</b>	<b>Period2:</b>	<b>Period3:</b>	<b>Period4:</b>	<b>Period5:</b>	<b>Period6:</b>	<b>Period7:</b>	<b>Period8:</b>	<b>Overall balance</b>
.....										
	What activities happen in each month									
	Cash inputs incl. hired labour									
	Family / in kind labour									
	Cash outputs									
	Consumption outputs									
	Balance (cash)									
	Balance (produce)									

Comparison

Enterprise ..... Scale of comparison .....

<b>Comparison</b>		<b>Period1:</b>	<b>Period2:</b>	<b>Period3:</b>	<b>Period4:</b>	<b>Period5:</b>	<b>Period 6:</b>	<b>Period7:</b>	<b>Period 8:</b>	<b>Overall balance</b>
.....										
	What activities happen in each month									
	Cash inputs Inc. Hired labour									
	Family / in kind labour									
	Cash outputs									
	Consumption outputs									
	Balance (cash)									
	Balance (produce)									

Notes on comparison - please use this space to give detail / explain the comparison that has been made and why it was used

If the change is/was an addition - what practices have had resources reduced

	Practices reduced	Cash income lost (GHC)	Food for consumption lost (KGs, Litres etc...)
(i)			
(ii)			
(iii)			
(iv)			

Difference to take into Effects diagram

		Cash balance (GHC)	Produce for consumption (e.g. litres or bags)
(a)	Post-change		
(b)	Pre-change		
(c)	Difference (a-b)		

Please reproduce the effects diagram on a PowerPoint slide and attach alongside this template

Use this space to explain the effects diagram - i.e. give a written summary of the effects described by the farmer

## Annex 6: Case studies of bundled services or products in different part of the world.

CIS -CSA bundled business case	Location	KP	C	FS	PS	Source	Target group
1. ZFU Eco Farmer Combo	Zimbabwe	✓		✓		Kakooza 2014; CTA, 2020	Farmers union and extension agents and agro-dealers
2. FARMIS	Uganda	✓		✓		Kakooza, 2015	Small farmers, extension agents and agro-dealers
3. MUIIS	Uganda	✓		✓		Chiang, 2017	Small farmers and agro-dealers
4. 8 villages	Indonesia	✓		✓	✓	FAO, 2021	Farmer cooperatives, individuals, extension agents and agro-dealers
5. IFFCO-Kissan	India	✓	✓	✓	✓	Vedeled et al. 2019	Large, small farmers, cooperatives and extension agents
6. Lima Links, Rupaya and Vitality	Zambia	✓	✓	✓	✓	Vitalite et al. 2021	Small farmers, cooperatives and agro-dealers
7. Kilimo Salama	Kenya	✓	✓	✓		IFC, 2015	Small farmers, cooperatives, women, extension agents and agro-dealers
8. Services for CSA and CIS consulting and capacity building	East Africa	✓	✓			Ngigi & Muange, 2022	Cooperatives, small farmers and agro-dealers
9. Participatory integrated climate services for agriculture (PICSA)	Global	✓				Dorward et al. 2015	Small farmers, cooperatives, extension agents and agro-dealers
10. ESOKO	Ghana	✓	✓	✓		Nii-Koi, 2021	Individual, small farmers, extension agents and agro-dealers
11. Farmer links	Philippines	✓		✓		Chiang, 2017	Cooperatives, extension agents and agro-dealers
12. One Acre fund	East Africa	✓	✓	✓		Tinsley and Apapitova, 2018	Small farmers
13. Digital Agro-Climate Advisory (DACA)	Africa	✓				Onyango, 2020	Individuals, small & large farmers, cooperatives and extension agents
14. Solutions for cereals and livestock farmers in Southern Africa	Southern Africa	✓	✓	✓		CTA, 2020	Cooperatives, individuals, agro-dealers and extension agents
15. CIMMYT/BISA	India	✓	✓		✓	Vernet, 2017	Large and small farmers, cooperatives, extension agents and agro-dealers
16. Climate-Smart Villages approach	Global	✓	✓	✓		Aggarwal et al., 2018	agro-dealers, small farmers and cooperatives

<b>CIS -CSA bundled business case</b>	<b>Location</b>	<b>KP</b>	<b>C</b>	<b>FS</b>	<b>PS</b>	<b>Source</b>	<b>Target group</b>
17. aMaizing	Kenya	✓	✓	✓		Prager et al., 2021, GSMA, 2021	Individuals, small & large farmers, cooperatives and extension agents
18. Rwanda Climate Services for Agriculture	Rwanda	✓				Prager et al., 2021	Farmers, agro-dealers, cooperatives, extension workers
19. Manobi Africa	Africa	✓		✓		Manobi Africa, 2022	Farmers, financial institutions, value chain actors
20. Bundled Advisory Services Kits for Enabling Transformation in Agriculture (BASKET-A)	Senegal	✓		✓		Prager et al., 2021	Farmers, agro-dealers, extension workers, value chain actors
21. PPP business models for CIS delivery in Climate Smart Villages in Northern Ghana	Ghana	✓				Partey et al.2019	Small and large farmers, agro-dealers, value chain actors, private sector, extension workers,
22. Shamba Shape Up and i-Shamba	East Africa	✓				(iShamba, 2022; GSMA, 2021)	Farmers (small and large) agro-dealers, financial institutions, cooperatives,
23. Bundling CIS with agricultural inputs, in Senegal	Senegal	✓	✓	✓		Prager et al., 2021	Small farmers, extension workers, value chain actors,
24. Integrated soil nutrient and climate risk management (ISN-CRM) in Mali.	Mali	✓	✓			Prager et al., 2021	Small and large farmers, extension workers, agro-dealers,
25. Lersha	Ethiopia	✓	✓	✓	✓	Prager et al., 2021	Farmers, private sector, financial institutions, value chain activities
26. Climate risk insurance and information in Zambia (CRIIZ)	Zambia	✓		✓		Prager et al., 2021	Farmers, financial institutions
27. Viamo platform	Global	✓				Usher et al., 2018	Private sector, farmers, financial institutions
28. Acre Africa	Africa	✓				CTA, 2019	Financial institutions, farmers,
29. aWhere	Africa	✓		✓		Usher et al. 2018; GSMA,2021	Farmers, financial institutions, private sector, agro-dealers
30. MasterCard Farmer Network- MFN	Africa	✓	✓	✓		MasterCard foundation (2015)	Farmers, financial institutions, private sector, agro-dealers.



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