Training of Trainers on Enhancing Forecasting Capacities and Crop Capability Prediction Model and Tools

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Workshop Report

CGIAR
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Accelerating Impacts of CGIAR Climate Research for Africa

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About AICCRA reports

Titles in this series aim to disseminate interim climate change, agriculture, and food security research and practices and stimulate feedback from the scientific community.

About AICCRA

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Acronyms

ACPC	African Climate Policy Centre
AICCRA	Accelerating Impacts of CGIAR Climate Research for Africa
CCAFS	Climate Change, Agriculture and Food Security Programme of CGIAR
CGIAR	Consultative Groups on International Agricultural Research
CAMDT	Climate Agriculture Modelling and Decision Tool
CIS	Climate Information Services
CSA	Climate Smart Agriculture
DST	Decision Support Tools
DSSAT	Decision Support System for Agrotechnology Transfer
FNC	Food and Nutrition Council of Zimbabwe
GDP	Gross Domestic Products
GUI	Graphical User Interface
MLAWRSF	Ministry of Lands, Agriculture, Water, Rural Resettlement and Fisheries
MSD	Meteorological Services Department of Zimbabwe
ILRI	International Livestock Research Institute
NASA	National Aeronautics and Space Administration of USA
NMHS	National Meteorological and Hydrological Services
SEBs	Socioeconomic Benefits
SCF	Seasonal Climate Forecasts
ToT	Training of Trainers
UNECA	United Nations Economic Commission for Africa
UoZ	University of Zimbabwe
WMO	World Meteorological Organization
WUA	Women's University in Africa, Zimbabwe
WTD	File with daily Weather data aggregated over many years
WTH	File with one Year's daily Weather data
WISER	Weather and climate Information SERvice program
WMO	World Meteorological Organization

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EXECUTIVE SUMMARY

The negative impact of hydro-meteorological hazards on the agricultural sector often leads to food insecurity. It is, therefore, incumbent upon policymakers to formulate appropriate strategies aimed at minimizing the effects of hydro-meteorological hazards on communities and economies. Hence, there is a need for timely and tailored climate-related knowledge, information and products that support decision-making to reduce climate-related losses and enhance benefits.

A series of studies have been commissioned by the ACPC-UNECA and its regional partners, such as CCAFS, under the WISER program to demonstrate the SEB of CIS in the agricultural sector. One such effort was conducting a study on *Enhancing Forecasting Capacities and Developing Crop Capability Prediction Models in Malawi, Mozambique and Zimbabwe,* where CIS-based DST has been developed. This DST is a critical tool to guide policymakers and communities in making science-informed decisions for optimum productivity through improved efficiencies in agricultural production systems and contributing to minimizing impacts of hydro-meteorological hazards. To operationalize this tool, however, there is a need to conduct a concerted capacity development across the SADC sub-region and beyond.

In this regard, AICCRA, in collaboration with the ACPC and WMO, took the capacity development initiative and commenced roving the ToT workshop. Therefore, the first ToT workshop was held in Harare, Zimbabwe, from 13 -15 July 2022, where about 20 experts were drawn from MSD, MLAWRSF, UoZ, WUA and FNC of Zimbabwe attended.

After providing a conceptual framework about the CAMDT/DSSAT platform, hands-on exercise on data management: quality control and missing values, a template specific to CAMDT/DSSAT, data acquisition and model descriptions (assumption and uncertainties) and model analysis (simulation and validation) were given to the ToTs. The methodology for crop capability prediction is accessible and in formats that make the information actionable.

Participants' feedback showed effective skill transfer on the model and its outputs, thereby becoming proficient in utilizing the tool. They also rated the training as a useful, relevant innovation that will benefit communities. However, they suggested that there is room for model improvement by including local conditions and local cultivars. It was indicated that the time allocated to the training was short of practicing and fully interpreting outputs from the model analyses. The steps included in the training manuals are very useful, but participants called for a simplified programme-assisted procedure so that users with little computer knowledge can appreciate the usefulness and applicability of the model.

In conclusion, the full implementation of the crop capability prediction models and its timely application will significantly save many socioeconomic sectors as productivity improves, given the central role agriculture plays in the region. This will engender a policy environment conducive to better investment in CIS to accrue its uptake and use in agriculture and food security.

1. INTRODUCTION

Natural climate variability and man-induced climate change are the most critical factors affecting land and water resources and significantly impacting agricultural production and food security. Agricultural crops, like other plants, generally depend on light, temperature, moisture, and carbon dioxide concentration to produce grains and other products. The levels of climate inputs, particularly rainfall, vary between locations and years, partly due to natural climate variability and climate change. Temperature and water supply also vary over the long term, with major implications for crop production and the livelihood of crop producers. Besides agricultural inputs and cultural practices, crop management is about managing climate risks to have financially viable and sustainable agricultural systems. Moreover, climatic effects on crop production could influence agricultural trades, with implications for national and global food security. Therefore, it is important to find ways of estimating crop yields before the harvest to manage or control the adverse climate risk impacts on the economy and vulnerable communities.

In Sub-Saharan Africa, agriculture plays a key role in food security and employment, contributing to gross domestic product (GDP) typically between 20 and 40%. However, the sector is predominantly rain-fed and dominated by smallholder farmers. The productivity of the smallholder farmer is more than four to five times below the well-established potential levels in commercial settings. Similarly, the cost of production is relatively high in the case of smallholder farmers compared to its return. Hence, there should be efforts to make significant improvements toward reversing this region's largely uncompetitive agricultural production systems. In this respect, there is a great potential for increasing agricultural productivity by using tailored Climate Information Services (CIS) in supporting farm strategic and tactical decisions, thereby increasing the sector's contribution to GDP. Moreover, crop growth modeling and simulation can be used as decision-support tools in agricultural research and production systems.

1.1. Crop Growth Simulation Models

The crop growth simulation models have been evolving since the 1960s, with much promise for greater usability in the 1980/90's. Models used in agrometeorological studies, for instance, are developed to substantially improve the income, reduce soil degradation, reduce dependence on off-farm inputs and exploit local market opportunities of resource poor farmers in the tropics and sub-tropics as per objectives of IBSNAT (International Benchmark Sites Network for Agrotechnology Transfer) that began in 1982 at the University of Hawaii at Manoa, USA. IBSNAT was an attempt to demonstrate the effectiveness of understanding options through systems analysis and simulation for the ultimate benefit of farm households across the globe. The major product of IBSNAT was a Decision Support System for Agro-Technology Transfer (DSSAT) (Jones et al, 2003).

The DSSAT has been largely used as a research and teaching tool where its products enable users to match the biological requirements of crops to the physical characteristics of land to provide them with management options for improved land use planning

(Kazeem and Rasaq, 2015). DSSAT has the potential to substantially reduce the time and cost of field experimentation necessary for adequate evaluation of new cultivars and new management systems. Moreover, it helps decision-makers by reducing the time and human resources required for analyzing complex alternative decisions (Tsuji, 1998). DSSAT was developed to operationalize this approach and make it available for global applications although there are several crop simulation models that have been developed from many academic and research centres across the globe (Hoogenboom et al., 2019). Hence, crop models can be developed at various levels of complexity depending on the objective of the modelling exercise.

Crop growth simulation models require inputs of weather parameters such as solar irradiance, temperature and rainfall as these variables affect crop phenology. However, the skills for usable accuracies of climate forecasts are on seasonal timescales, typically three months. A need to find ways of marrying seasonal climate forecasts (SCFs) with crop simulation models is, therefore, critical to develop crop capability prediction models. Seasonal forecasts, when connected to crop simulation tools, can be used to assess implications for crop productivity as well as to guide crop management decisions (Capa-Morocho, et al, 2016). Tools that can objectively assess the value of CIS in decision making in socioeconomic areas that are sensitive to climate variations such as water and humanitarian assistance planning are also available. Crop prediction is benefiting in applying seasonal climate forecast (Coelho and Costa, 2010), confirming the use of seasonal climate forecasts earns good benefit cost ratio. Hence, weather generating models can be adapted for crop capability prediction using probabilistic seasonal climate forecasts (Hans and Ines, 2017) and greatly benefit decision support in agricultural and food security sectors.

1.2. Combination of CAMDT-DSSAT models

The Climate Agriculture Modelling and Decision Tool (CAMDT) was used in tandem with DSSAT for the crop yield prediction modelling. CAMDT is a computer desktop tool designed to guide decision-makers in adopting appropriate crop and water management practices that can improve crop yields under a given climatic condition. It was originally developed using data and environmental conditions, yield calibrations and production system management for the Bicol region, Philippines (Han et al., 2017). The model works on Python platform. The CAMDT tool enables the stakeholders to have an overview of the feasibility of a desired prediction horizon (farming season) and offer scientifically backed advice to the farmers in the particular homogeneous rainfall zones. Used to specify the period for which SCF is released, the prediction horizon can be set for two to six-month period. CAMDT uses the prediction horizon set for Nov-Jan (NDJ), Dec-Jan-Feb, (DJF) or Jan-Feb- Mar (JFM) depending on when the users run the CAMDT. The observed weather data in CAMDT to run the DSSAT should be done a month before the planting date. The weather realizations downscaled from probabilistic SCF will be used for the periods NDJ, JFM, FMA, etc. The weather conditions beyond the SCF availability are generated based on climatology.

In this context, DSSAT has been used for more than 30 years by researchers, educators, consultants, extension agents, growers, private industry, policy and decision makers, and many others in over 174 countries worldwide (https://dssat.net/). This package incorporates models of 16 different crops with software that facilitates the evaluation and application of the crop models for different purposes. Crop simulation modelling approach can also contribute to assessments of the effects of future global climate change, thus helping in the formulation of national policies for mitigation purposes. Other policy issues, like yield forecasting, agribusiness planning, operations management, consequences of management decisions on environmental issues, can benefit from the modelling efforts. By applying CIS in crop yield prediction modelling (CAMDT-DSSAT combination), farmers can avoid losses that might result from unforeseen inter-annual climate variability; and they can maximize productivity more efficiently under conditions of favourable climatic patterns when these are predicted in advance.

2. BACKGROUND

Climate information services (CIS) in agriculture aims to provide a full range of advice regarding climate and its impacts on crops, livestock, fisheries, and management practices to prevent, reduce and/or manage climate risks in agricultural production systems. This tailored information assists farmers in making management decisions to minimize the risks and benefit from the opportunities of our variable and changing climate. Thus, CIS in agriculture provides valuable information to agricultural support services/institutions, suppliers, local cooperatives, or community-based organizations to help farmers make practical, feasible, and relevant decisions under the changing climate.

Despite rapid scientific and technological progress in climate, small farmers do not use much of the available weather and agrometeorological information, which results in poor productivity. To address this gap, the UNECA, in collaboration with its regional partners, commissioned a study to develop a series of simple and robust scientific tools, methods, and services that can guide planning and policy to better understand climate impacts on food security and livelihoods. The study was conducted in three southern African countries, Malawi, Mozambique, and Zimbabwe. The study developed a methodology or tool for predicting crop capability in the various agro-ecological zones to enhance agricultural productivity and food security. The tool was validated in Victoria Falls, Zimbabwe, by a range of experts from Malawi, Mozambique, and Zimbabwe.

This tool is essential to save millions of dollars in enhanced agricultural productivity, identify deficits/surpluses with unprecedented time leads, and provide enormous potential to assure food security to nations. Livestock producers can also use the information on weather and climate patterns to plan for the optimum numbers of animals in a given piece of land at any particular time. For instance, if a drought is forecasted, it helps farmers make evidence-based decisions to destock or buy extra stock feed to see the animals through the drought. Farmers have often had to see their herds decimated by droughts because of poor planning caused by a lack of knowledge of the availability of climate prediction services. Hence, there is a need to develop a cadre of experts who will ensure the application of optimum CIS in specific sectors using this crop yield prediction model tool.

In this regard, there is an urgent need to train both producers of climate information and end-users in the proper application of CIS to mitigate the adverse effects of climate-induced hazards and benefit the economy. It is, therefore, imperative to provide the much-needed tools for producers of CIS and the end-user community from agricultural and related sectors regarding crop capability prediction. As a continuation of the previous efforts, the Accelerating the Impact of CGIAR Climate Research for Africa (AICCRA), in partnership with UNECA-ACPC, aim to establish a cohort of CIS practitioners and users to help communities improve their efficiencies in agricultural production systems. This will be through roving a ToT workshop in Zimbabwe, followed by Malawi and Mozambique.

Figure 1. Participants of the ToT in Harare, Zimbabwe

The specific aims are to train experts on:

- forecasting and crop capability prediction tool to benefit policymakers and the user community for the strategic provision of appropriate inputs to the Agriculture (livestock and crops) and Food Security Sector;
- Strengthening the platform for collaboration by key stakeholders involved in the production and application of timely climate information;
- Strengthening capacity for improved production, better access, and sustainable operations for CIS;

- Developing a methodology for predicting crop capability in the various agro-ecological zones to enhance agricultural productivity and food security; and
- Hands-on exercise on modified CAMDT/DSSAT crop yield prediction model using country data.

3. OPENING SESSION

3.1. Welcoming remarks

Dr Murombedzi of the ACPC welcomed all the guests and participants to workshop. He touched on the importance of embracing CIS in addressing climate change and its impacts, with special mention to SADC. He recalled that this study was incepted during the 'Building Back Better' workshop held in Oct 2020, Harare, Zimbabwe, to respond to Cyclone Idai that devastated Malawi, Mozambique and Zimbabwe. In that meeting, the late Minister of Agriculture, Rt Air Marshall Perence Shiri requested UNECA and its partners to develop a DST by which government could make informed decisions in agriculture sector. The crop capability prediction model was, then, developed and validated to respond to this call. He further noted that UNECA will continue to collaborate with AICCRA and expressed his pleasure that this capacity building ToT exercise has begun the road to operationalization of the CAMDT model by end-users.

Dr Teferi (AICCRA-ESA) began his welcoming remarks by articulating the role of AICCRA. In this regards, AICCRA's mission is to advance Agri-food science and innovation in Africa. He informed the workshop participants that AICCRA is working in three sub-regions (West, Southern and Eastern Africa). He also noted that AICCRA had three components: (i) Knowledge generation, technology and service sharing (*where interventions, among others, development of national Agri-data hub and Integration of CIS and digital agro-advisories addressed*); (ii) Partnership and capacity for delivery (*building a partnership for adoption and scaling and strengthening NMHS with forecasting, data generation*) and (iii) CIS and CSA technology promotion, delivery for scaling strategies for validated and tailored CIS. Finally, he welcomed all to the seminar and wished them a fruitful training.

Dr Makarau from the WMO-ROA congratulated AICCRA and UNECA for their efforts, in respectively, for supporting capacity building through ToT and developing the tool. This ToT workshop is essential to prepare the groundwork for the operationalization of the tool so that communities could be benefited from it. The WMO representative noted that agriculture is the mainstay of Africa's economy and such decision-making support tool will have significant importance in guiding pre-planning and on-farm planning. This initiative is, therefore, consistent with WMO's five pillars and affirms his commitment for such kind of initiative.

3.2. Opening statement

Ms. Manzou R, Director of MSD, welcomed everyone and applauded all institutions involved in the development of DST for agriculture and food security sector. She noted that the mandate of MSD is to protect lives and properties from extreme weather and climate impacts and expressed her believe that such DST will play a critical role in addressing MSD's mandate.

Factoring CIS into policy, planning and practices are crucial for Africa to achieve its socioeconomic development aspirations such as building resilient society, enhanced trade competitiveness, reduced poverty and sustainable economic growth. They are also important to shape our understanding of climate risks and guide decision-making across scales. However, accelerating the uptake and use of CIS require an enabling environment that enhances investments in the production of CIS.

The key barrier to managing current and future climate risks are limited availability and accessibility of timely, reliable and relevant weather and CIS by large numbers of climate-vulnerable people. The mismatch between available information and what is needed to support on-the-ground decision-making is another barrier that reduces resilience to climate risk and thereby weaken adaptation efforts.

She commended AICCRA and UNECA for their works on the crop capability prediction tool for SADC countries as the region's economy is mainly agricultural based. In this regard, MSD noted the need to support end users in areas of:

- forecasting and crop capability prediction tool to benefit policymakers and the user community for the strategic provision of appropriate inputs to the agricultural (livestock and crops) and food security sector, taking into account specificities of agro-ecological zones;
- strengthening the platform for collaboration by key stakeholders involved in the production and application of timely climate information; and
- strengthening capacity for improved production, better access, and sustainable operations for CIS by end-users.

MSD will, therefore, continue to play its roles in the production, analysis, translation and dissemination of timely and tailored CIS to the end-users. For that, she applauded the recent development at MSD in installing and operationalizing three radars in Harare, Bulawayo and Buffalo Range with more to follow in order to respond to users needs. As part of fulfilling the Minamata convention, MSD is also working to replace the existing infrastructure in all 47 observational stations with automatic weather equipment.

Mrs Manzou reiterated MSD's commitments for such and similar capacity building initiatives and declared the ToT workshop is officially opened.

4. INTRODUCTION TO CROP CAPABILITY PREDICTION MODEL

In order to set the scene, Dr Bradwell G. made a presentation on the conceptual framework of crop capability prediction modelling and the following main points highlighted:

- Overview of weather and CIS and their utility for crop yield prediction,
- Motivation for developing actionable DST in agriculture,
- Brief overview of methodology,
- Concepts and application of DSSAT,
- Rationale for using CAMDT.

There was also a presentation on the summary of the manual, which is a combination of three User Guides to be used in tandem. The crop capability prediction modelling platforms used in this User Guide are the CAMDT as the weather generator for the DST for Agro-technology Transfer (DSSAT), the crop weather simulation model. CAMDT/ DSSAT platforms are very sensitive to the data formats. In this regard, there is a need to manipulate the climatological data for exporting into CAMDT/DSSAT programmes to be compatible for ingestion into these environments. For instance, using the example of data downloaded from NASA website (https://power.larc.nasa.gov/data-access-viewer/), there is need for downloaded daily climatological data to be manipulated into and across both MS Excel and CSV environments. The necessary steps to be followed in order to make the data formats compatible with CAMDT/DSSAT are also presented.

5. HANDS-ON EXERCISE ON CAMDT/DSSAT ANALYSIS

Trainees were provided with the three user-guide manual. The trainers made demonstrations on the key steps in CAMDT/DSSAT analysis based on the manual. The participants were then taken through the steps that are important in running the simulation of crop yield prediction.

5.1. Data and Implementation into the Model

Participants were taught data collection frameworks for crop yield prediction modelling, in particular, the template specific to CAMDT/DSSAT. Participants were shown the steps to be carried out in order to run simulations of crop yield prediction, data analytics including quality control and missing data issues. This was a participatory session with questions seeking clarifications on steps to follow to rectify errors that occurred at times.

 

Figure 2. Participants engaged in the ToT workshop

5.2. Data Acquisition and Processing

In order to for participants to be able to process the data from the identified website, CAMDT/DSSAT software were uploaded onto their laptops and tested**.** Once the softwares were installed and working, participants were shown to the data sources site, NASA. From the website, they downloaded the required data for ingestion into the CAMDT/DSSAT platform in order to generate the crop capability predictions. These data were historical daily climatological parameters (*solar irradiance, minimum and maximum temperatures and rainfall*) for specific meteorological station for the period January 1 1984 to 31 December 2021. This period was used because development of crop yield prediction model requires at least continuous 30 years of daily data in four parameters.

5.3. Formatting and Splitting NASA Data to CAMDT Format

Participants were shown how download data in *CSV format* and saved into MS Excel to enable the necessary processing as per the requirements of CAMDT/DSSAT. The data were then split into complete period – 39 years daily data as one file, WTD, and another set of files with individual yearly data, WTH. In order to do that more efficiently, the following digiSoft tools were used:

- WTD_Main_Template_format.xlsx
- WTH_Main_Template_format.xlsx
- basSplitExcelDataByColumn.bas

Accordingly, participants were able to split Excel Workbooks into: "WTD file" with all the downloaded rows of years and climate data (one) and "WTH files" where each file holding data for a single year (making a total of 39 files).

5.4. Exporting to Text Format and Renaming WTH Files

After the participants split the data into WTD and WTH formats, they were shown 'how to export the files'. This entailed use of digiSoft tool set macro: basExportSheets2PRN.bas

Participants were also shown the procedure on how to rename files so that these were compatible or ingesting by the CAMDT/DSSAT system for further processing. In this regard, they used the "*Bulk Rename Utility*"**,** which required participants to carry out three basic steps to complete the renaming exercise.

6. RUNNING CAMDT GRAPHICAL USER INTERFACE

Participants were introduced to model descriptions and model analysis. Participants experienced some challenges in installation software due some inadequacies in their hardware. These were resolved through assisting with the downloads to ensure that all the participants had requisite software on their laptop computers.

Participants were shown how to create two folders in the C: directory of the laptop and name them CAMDT and DSSAT. Within the CAMDT folder there were sub-folders for: Rice; Maize and Sorghum under which each were sub-folders for the respective meteorological station, down to two sub-folders at the same level of hierarchy for *above-normal* rain and *below-normal* rain. These were the working directories where CAMDT would be pointed to for necessary information to simulate rice yield predictions depending on whether the anticipated seasonal forecast for the station in above-normal or below-normal rain. The results from the simulation would be output to the respective working directory.

6.1. Running Rice Crop Yield Simulation

The 2017 edition of CAMDT is only automated for the RICE crop and was originally developed to model rice production in the Philippines, mostly the PILI meteorological station. The participants were shown how to add working directory related to their meteorological station into file "CAMDT_2017_0310-py". There were two optional environments, MS Windows Explorer, which was a default one; and a Command Prompt, which is more general and a prerequisite environment for conducting simulation of non-rice crop capability predictions. Participants were showed how to run Python programme as it displays the GUI, which is laid out clearly in the Manual (User Guide 2). Participants familiarised with CAMDT displaying some of interesting outputs (predicted yields, water stress and gross margin) easily.

6.2. Running CAMDT/DSSAT Crop Modelling for Non-Rice Cereals

Digitron made changes to some of the CAMDT system file in order to make it simulate other crops capability prediction. These changes were provided in the User Guide 3 of the Manual. In this regard, trainers demonstrated the necessary additional procedures to the participants for them to manipulate to enable them to run the CAMDT in order for it to simulate non-rice cereals like maize and sorghum. Participants were shown how to copy the successful outputs of the working directory as per an appropriate seasonal climate forecast, say that related to above-normal rain into a corresponding working directory for the new crop variety. After that, participants were shown to make the necessary changes to some of the rice output files. This was so that respective working directory now had the specifications of the new cereal maize or sorghum such as the cultivar variety type its variety number, its population distribution at planting. Once the working directory had these new specifications, participants were made to run CAMDT as if it was simulation rice. The outputs were now for the respective crop, either maize or sorghum. The participants were shown how to process the outputs further in order to display graphical information on the non-rice cereal.

7. GENERAL DISCUSSION AND RECOMMENDATIONS

i) *Need to specify specification on the compatibility of the computers*: It could be difficult to have homogenous computer systems for the training of this nature as some computers had difficulties running MS Windows and Excel efficiently, periodically slowing down and freezing. Hence, specify the computer specification compatible to the phyton software for the follow-up ToT workshop.

ii) *Need to use of LCD by the trainers*: Some participants recommended having a page from the training manual constantly displayed on the projector as required. However, this might be virtually difficult when trainees have different speeds due to varying user proficiency and individual computer performance. In order to abate such challenge, participants provided with step-by-step User Manuals to refer to, though only available on soft copy, which slowed them down as they constantly switched from User Manual to the modelling software and back.

iii) *Need for automated procedure*: The taxing formatting and preparation of NASA data proved tough for some users who less conversant with MS Excel. Digitron will continue to find ways of streamlining the process, with the objective of developing an automated module and hoped this would be ready for the next workshop. Participants this ToT workshop will be apprised of such developments and will be provided with new codes as necessary.

iv) *Need to customize the model to capture local crops*: The capacity in DSSAT is there but localization of crop varieties will require obtaining the specifications from the Ministry of Agriculture and other stakeholders such as the country's Seed Houses. DSSAT is not limited to the three crops shown in the demonstrationsrather over 20 crops that can be modelled.

v) *Need to strengthening linkage with policy makers*: There is need to look at how to strengthen relationships between policy makers, stakeholders, practitioners and end users – last mile. The models believed to help end-users if efforts made to disseminate information from the model outputs swiftly and effectively. A case in point is – how long it took for information to reach communities.

vi) *Need for sustained capacity building training for better model's uses in the region*: There is a need to upskill producers and users of CIS through a Training of Trainers workshop.

8. WRAP-UP AND VOTE OF THANKS

On behalf of AICCRA, Dr Teferi commended the participants for their dedication to duty in efforts to understand the workings of the model. He also acknowledged the trainers in their efforts in skill transferring. He expressed readiness of AICCRA and partners to source for resources to continue with scaling up this activity to other countries.

On behalf of WMO, Dr Makarau noted the enthusiasm of the participants in efforts to learn the skills of the trade in crop yield modelling. This would help in the acceleration of capacity development efforts for the operationalization of the tool so that its benefits reach the last mile, the rural community. On their part, WMO was ready to engage other partners to get resources in order support the initiative of capacity building through review of the outcome of the implementation of the tool in countries. He thanked everyone for their dedication in acquiring skills in the crop yield prediction modelling for the purposes of furthering climate resilience of communities.

Dr Yosef Amha reaffirmed continued support of these initiatives by AICCRA and its partners. From the feedback received, the ToT workshop can be rated as a success but the model needs improvement to include local conditions and local cultivars. He finally thanked the organizers, trainers and participants for their dedication and commitments and declared the closing of the ToT Workshop.

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10. FEEDBACK FROM PARTICIPANTS

Participants were engaged by requesting them to complete questionnaires on six survey questions and the summary of the survey results are given below.

*Question #1***.** Is the training relevant to you and your institution?

Survey results: All participants (100%) strongly agreed on the relevance of the training in their institutions.

Question #2. Are the presentations and training manual meet the workshop objective?

Survey Results: Participants responses showed that they were unanimous in endorsing that the training manual met the ToT Workshop objective(s).

Question #3. What improvement(s) do you recommend on the training approach?

Survey results:

- More than half of participants (55%) said the number of days shall be increased by one or two to allow testing of all packages and scenarios. As a hands-on training programme, some also suggested a need for more resource personnel so that all participants get assistance regularly as necessary instead of waiting for long periods because the few resource persons are busy elsewhere.
- 23% of the respondents requested for prior information on the type of computer/laptop compatible to the software has to cut on time for installation and trouble shooting.
- 15 % of participants demanded for the software that simplify data arraignment could help
- Nearly half of the respondents (46%) suggested that facilitator should use LCD screen to demonstrate the steps using their computer rather than visiting every member's laptop.

Question #4: What is your view on the model workability?

Survey results: About 62% of the respondents said the model has very great potential while 38% said the model has some potential. However, 78% of the respondents believed that the model might be workable but there is need for either ground truthing or comparing the results with other similar studies. Moreover, they recommended that the model needs to incorporate local conditions in terms of the crop varieties.

Question #5. What limitation(s) do you observe/recognize on the model?

Survey results:

- Almost all respondents believed that the model needs powerful computer; data preparation for the required format is taxing and therefore seeks automation for steps to be followed.

Question #6. What do you suggest for the model improvement?

Survey results:

- 55% of the respondents suggested that reducing the number of steps required before one can run the model. Upgrading the modelling software so that it operates on one-platform and one-dashboard and eliminate sessions covered on day one. This will be useful for those people who may not be computer experts but still want to use the software for planning and decision-making.
- 20% suggested the model that can work across the different operating systems.
- 25% responded that the model accommodate more crops for prediction. We need also customized model as feed in local genotypes.

11. LIST OF PARTICIPANTS

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12. ANNEX I: PROGRAM

Title: Workshop on the training of trainers on crop yield prediction modelling for Zimbabwe
Venue: Harare, Zimbabwe
Date: 13-15 July 2022

DAY 1: July 13, 2022			
Time	**Events**	**Responsible**	**Chair**
08:30 – 09:00	**Registration**	DIGITRON	
09:00 – 09:10	**Welcoming Remarks**	Dr. Teferi Dejene (AICCRA-ESA) Dr. Amos Makarau (WMO-ROA)	Dr. James Murombedzi (ACPC)
09:05 – 09:15	**Official Opening**	Ms. Becky Manzou (Director Zimbabwe MSD)	
09:15 – 09:30	**Introduction of Participants**	Participants	
09:30 – 10:15	**Introduction to Crop Capability Prediction Model** – Overview of Weather and Climate Information Services and Their Utility for crop Yield Prediction – Concepts and Application – Rationale for using CAMDT – The Key Steps in the CAMDT/DSSAT Analysis	Dr. Bradwell Garanganga/ Mr. Trymore Nyakutambwa Dr. Yosef Amha (DIGITRON)	
10:15 – 10:45	**Discussion**	Participants	
10:45 – 11:15	**COFFEE/TEA BREAK (Group Photo)**		**Organizers**
11:15 – 12:30	**Data and implementation into the model** – Data Collection Framework for Crop Yield Prediction Modelling – Template Specific to CAMDT/DSSAT - Data management: Quality Control and Missing Values	Dr. Bradwell Garanganga/ Mr. Trymore Nyakutambwa (DIGITRON)	Dr. Teferi Dejene (AICCRA-ESA)
12:30 – 13:00	**Discussion/ Q & A**	Participants	
13:00 – 14:00	**Lunch**		**Organizers**
14:00 – 14:30	**Data acquisition** - Steps to follow - Data sources sites; downloading	Participants	Dr. Yosef Amha (AICCRA-ACPC)
14:30 – 16:00	CAMDT/DSSAT Software to be loaded onto participants' laptops **and testing**	Participants	
16:00 – 16:30	Coffee/Tea		
16:30 – 17:00	**Introduction to Crop Capability Prediction Model modeling on CAMDT software** – Model descriptions (*assumption and uncertainties*) Model analysis (simulation and validation)	Dr. Bradwell Garanganga/ Mr. Trymore Nyakutambwa (DIGITRON)	
17:00 – 17:30	**Discussion/Q & A**		
Day 2: July 14, 2022			

Time	Events	Responsible	Chair
09:30 – 10:00	**Hands-on exercise with CAMDT software using data** – Steps to follow – Data sources sites; downloading; – Data preparations – Data analysis – Modifications in the original (Rice) model – Running the model – Analyzing model results	Dr. Bradwell Garanganga/ Mr. Trymore Nyakutambwa (DIGITRON)	Dr. Teferi Dejene (WMO-ROA)
10:00 – 10:30	**Coffee/Tea**		
10:30 – 11:30	**Continuing with hands-on exercise with CAMDT software using data**	Dr. Bradwell Garanganga/ Mr. Trymore Nyakutambwa (DIGITRON)	
11:30-13:00	**Discussion/ Q & A**		
13:00 – 14:00	**Lunch**		
14:00 – 15:30	**Techniques for synthesizing data for current seasonal climate forecasting** – Observed data – Synthesized data – Forecast data – Simulation horizon set up	Dr. Bradwell Garanganga/ Mr. Trymore Nyakutambwa (DIGITRON)	Mr. Frank Rutabingwa (ACPC)
15:30 - 16:00	**Using Chinhoyi for forecast simulation example (---to continue---)**		
16:00 – 16:30	**Coffee/Tea**	Organizers	
16:30- 17:30	**(...continued....)** **Using Chinhoyi for forecast simulation example** **Discussion/Q&A**	Dr. Bradwell Garanganga/ Mr. Trymore Nyakutambwa (ACPC)	

Day 3: July 15, 2022

Time	Events	Responsible	Chair
09:30 - 10:00	**Recap of second day**	Dr. Bradwell G.	Dr. Amos Makarau (WMO-ROA)
10:00 – 11:00	**Breakout session and feedback** – Workings of the model – Limitations of the model – Potential improvements for country adaptation	All participants	
11:00 – 11:30	**Coffee/Tea**		Dr. Yosef Amha (AICCRA-ACPC)
11:30 – 12:00	**Reporting back major points on** – Model workability – Limitation – Suggestion for improvement	All Participants	
12:00 – 13:00	**General Discussion and Recommendations to facilitate country uptake**		
13:00 – 13:30	**Wrap-up and Vote of Thanks**	AICCRA-TBA	

13:30 -	**Lunch**		

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Accelerating Impacts of CGIAR Climate Research for Africa

About AICCRA

Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) is a project that helps deliver a climate-smart African future driven by science and innovation in agriculture.

It is led by the Alliance of Bioversity International and CIAT and supported by a grant from the International Development Association (IDA) of the World Bank.

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