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FAO Follow-up AquaCrop training

May 30, 2023

Jorge Alvar-Beltrán – Riccardo Soldan – Andrea Setti
FAO Climate Risk Team (OCB)

Workshop's agenda

- **Riccardo Soldan** holds a Ph.D. in Interdisciplinary Bioscience from the University of Oxford and a Master's in Crop Science. Riccardo has several years of experience in the field of ecosystem modeling. Before joining FAO in 2020, Riccardo worked at several universities, including the Brazilian Space Research Agency where he modeled soil-water fluxes in the Amazon rainforest.

- **Jorge Alvar-Beltrán** holds a Ph.D in Environmental Sciences from the University of Florence, with an emphasis on climate-resilient crops in hot-spot regions of climate change, Burkina Faso. Prior to joining FAO in 2020, he worked for the World Meteorological Organization (WMO) to strengthen the capacities of Met Services to deliver weather-informed agricultural advisories to the last-mile.

- **Andrea Setti** holds an MSc in Natural Resource Management for Tropical Rural Development. Before joining FAO in 2022 he worked at the University of Florence where he modelled Water Productivity for different crops in the horticultural sector of Florence.

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Workshop's agenda

30th May 2023 (4 h)

Content	Panelists
-Welcoming remarks	Ala Druta
-Introduction to AquaCrop Model (15 min) -Creation of Project files (1 h) -AquaCrop Plugin (30min)	Jorge Alvar Andrea Setti Riccardo Soldan
COFFEE BREAK (15 min)	
-AquaCrop Plotter: results' visualization and interpretation (1 h) -Q&A session (30min) -Parametrization of AquaCrop	Jorge Alvar Andrea Setti Riccardo Soldan

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Introduction to AquaCrop

May 30, 2023

Content

- Practical applications of crop models
- AquaCrop compared to other models
- How do crop models work?
- AquaCrop: user interface

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Crop models: what are they useful for?

Crop models are sets of mathematical equations that represent processes within a predefined plant system as well as the interactions between crops and its environment.

Crops models can contribute to agriculture in many ways:

- understanding crop responses to environmental changes;
- comparing attainable and actual yields;
- identifying constraints to crop producton and water productivity;
- developing irrigation schedules for maximizing production;
- studying the effect of climate change and promote agricultural transformation;
- supporting decision-making on water allocations and water related policies;

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OCB applications of AquaCrop in Cambodia

The impacts of climate change on rice yields and crop water productivity are assessed over the Northern Tonle Sap Basin in Cambodia by applying the AquaCrop model over the century under two RCPs.

Short (95 days), medium (125 days) and long (155 days) cycle varieties are tested during the wet and dry seasons.

An assessment of different sowing dates and irrigation strategies (fixed and net irrigation during the dry season) elucidated the variation in response to changing environmental conditions.

CLIMATE CHANGE

Journal of Agronomy and Crop Science WILEY

Modelling climate change impacts on wet and dry season rice in Cambodia

Jorge Alvar-Beltrán[1] | Riccardo Soldan[1] | Proyuth Ly[2] | Vang Seng[3] | Khema Srun[3] | Rodrigo Manzanas[4] | Gianluca Franceschini[1] | Ana Heureux[1]

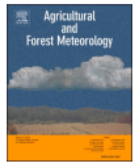
Assess the impact of climate change on the yields and crop water productivity of tomato, pak choi and yard-long bean cultivated year-round under different irrigated conditions (drip, furrow and net irrigation) in Siem Reap, Cambodia.

Contents lists available at ScienceDirect

Agricultural and Forest Meteorology

journal homepage: www.elsevier.com/locate/agrformet

ELSEVIER



Climate change impacts on irrigated crops in Cambodia

Jorge Alvar-Beltrán[a,*], Riccardo Soldan[a], Proyuth Ly[b], Vang Seng[c], Khema Srun[c], Rodrigo Manzanas[d], Gianluca Franceschini[a], Ana Heureux[a]

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OCB applications of AquaCrop in Pakistan

This study assesses the impacts of two climate change scenarios (RCPs 4.5 and 8.5) on soil evaporation and transpiration rates, crop water productivity, wheat and sugarcane yields over the 21st century under two irrigation schedules (less/more frequent irrigation and higher/lower volume) in six locations along the Sindh and Punjab provinces.

Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com/locate/agwat

Assessing the impact of climate change on wheat and sugarcane with the AquaCrop model along the Indus River Basin, Pakistan

J. Alvar-Beltrán [a,*], A. Heureux [a], R. Soldan [b], R. Manzanas [c], B. Khan [a], A. Dalla Marta [d]

Some of the most widely used crop models

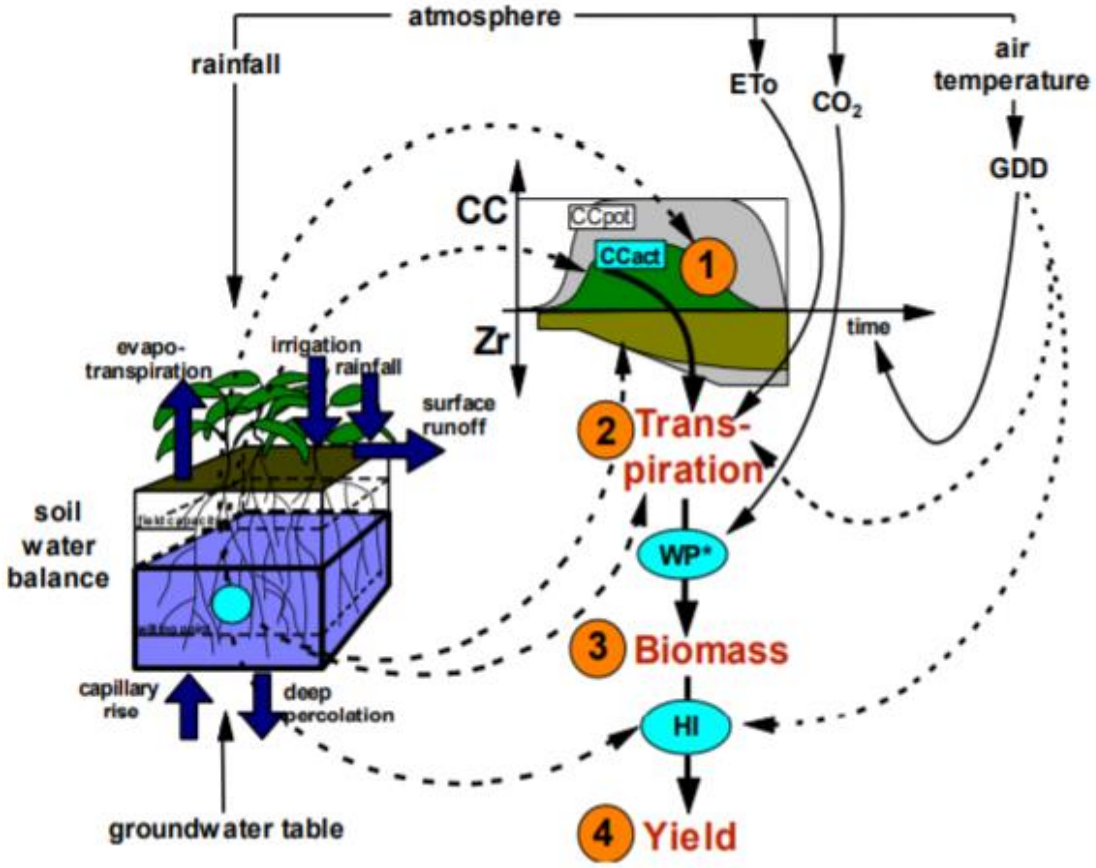
Model name	Main features/advantages	Link
AquaCrop	Crop-water productivity	link
AEZ	Maximum potential yield	link
APSIM	Crops and agricultural inputs	link
EPIC	Focuses on soil erosion	link
DSSAT	Crop growth and development	link
CropSyst	Effect of management on productivity	link

Useful overview of crop models

AquaCrop compared to other crop models

- AquaCrop produces much finer outputs (for site-specific locations) than other models and, as a result, its spatial applications are narrower.
- AquaCrop does not consider the leaf area index (LAI) as done by many other crop simulation models (i.e., GAEZ, DSSAT and CropSyst)
- Uses a relatively low number of parameters and mostly-intuitive input variables that can be determined by simple methods.
- AquaCrop simulates one crop at the time and cannot run multiple crops for comparative economic assessments (GAEZ).
- AquaCrop considers abiotic/biotic stresses (temperature & weeds), while other models do not (WOFOST)
- AquaCrop does not take into account other reducing factors such as pests and diseases

AquaCrop: introduction



AquaCrop simulates crop yield in different steps:

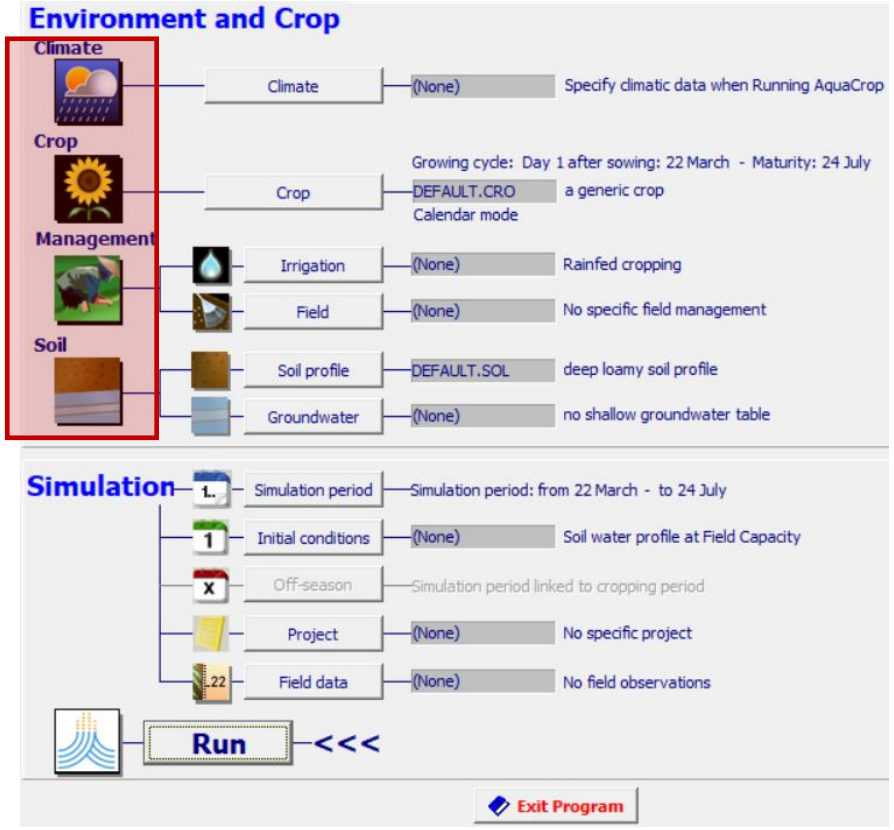
1) crop development
2) crop transpiration
3) biomass production
4) yield formation

Evapotranspiration: location, air temperature, humidity and solar radiation…

Penman Monteith equation:

$$\lambda ET = \frac{\Delta(R_n - G) + \rho_a c_p \frac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \frac{r_s}{r_a}\right)}$$

AquaCrop: the interface



- Weather data collected in the field and or from gridded/point geospatial climate datasets.
- Observed crop characteristics
- Irrigation method, application depth & time etc.
- Soil fertility & practices affecting soil-water balance
- Soil profile characteristics (texture, FC, PWP, SAT)
- Water depth below soil surface and soil salinity
- Simulations coinciding with the growing cycle of the crop
- Soil water content at the date of sowing
- Aggregation of the above files into one project file
- Observations from the field (CC, Biomass and SWC)

Useful documents

- AquaCrop training handbook: link
- Reference manual version 7:
  - Chapter 1: link
  - Chapter 2: link
  - Chapter 3: link
  - Chapter 4: link
  - Chapter 5: link
  - Annexes: link

- 43 YouTube tutorials on how to use the model: link
- The AquaCrop model – 10 years of enhancing crop water productivity: link

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Tutorial: how to make project files

May 30, 2023

Objective

Objective: run AquaCrop to see the effect of future climate projection on rainfed maize yields under two emission scenarios (RCPs) in two locations of Moldova (North – Soroca and South - Cahul).

- GCM: MOHC
- RCPs: 2.6 and 8.5
- Crop: Maize
- Locations: Soroca – Cahul

Project File (.PRM) structure

Experimental design

Locations	North (Soroca) South (Cahul)
GCM	MOHC
RCPs	2.6 8.5
Management	Optimal
Crop	Maize

4 Project files

Time series: 119 years -> 1/01/1981 – 31/12/2099

Maize_Short_Cahul_10May_Optimal_26_MOHC

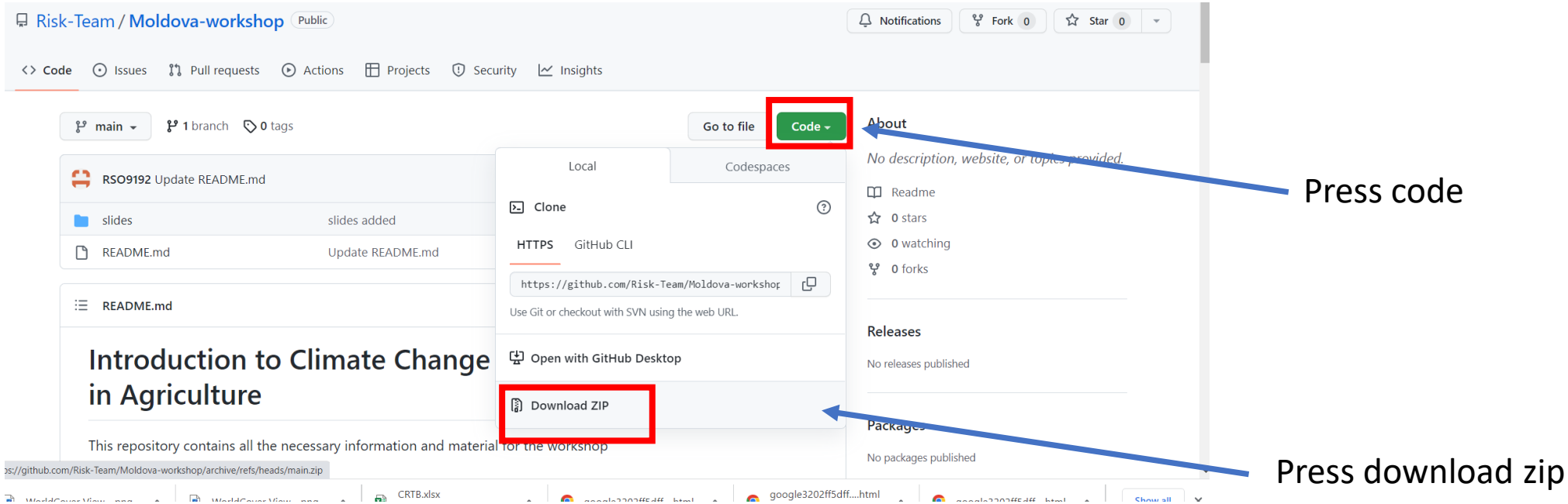
Maize_Short_Cahul_10May_Optimal_85_MOHC

Maize_Short_Soroca_10May_Optimal_26_MOHC

Maize_Short_Soroca_10May_Optimal_85_MOHC

Instruction

- The link to all material and slides presented in this workshop can be found at https://github.com/Risk-Team/Moldova-workshop
- Once you are on the correct page, you can download the whole repository to your local computer (**Desktop**)



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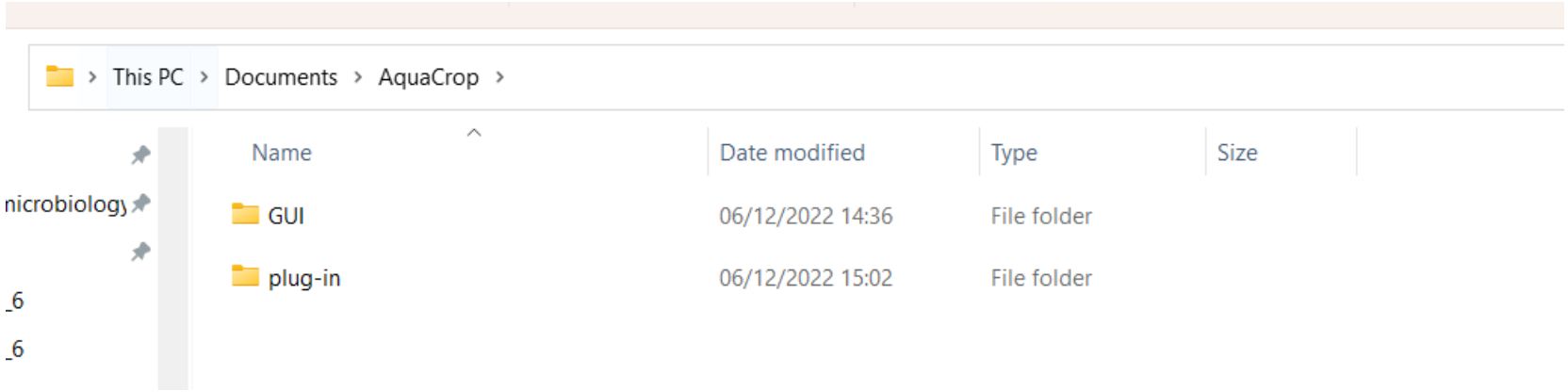
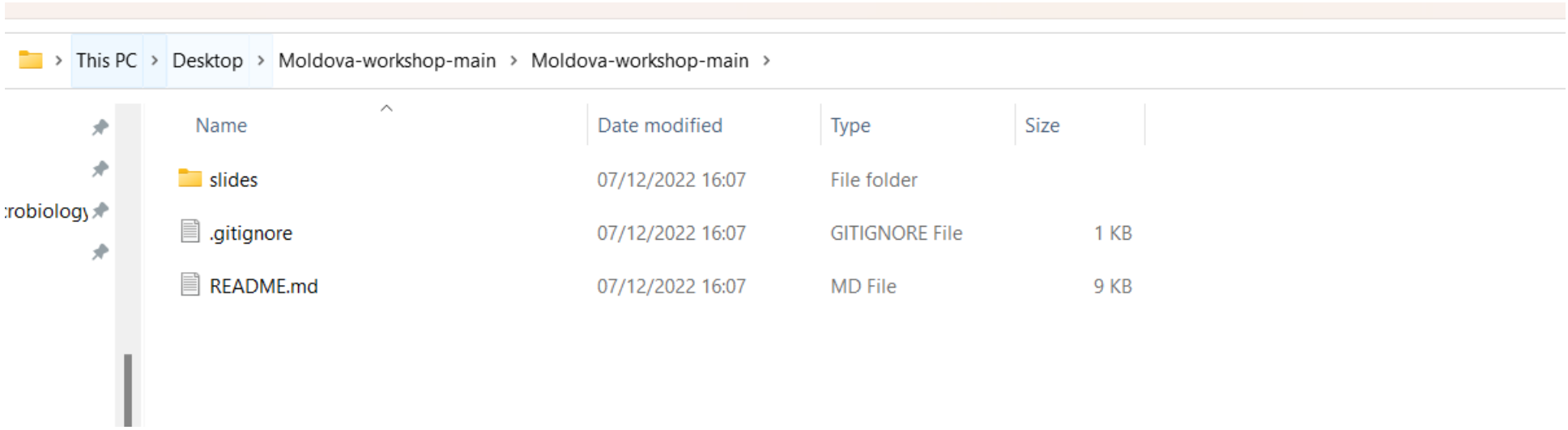
In case you do not have AquaCrop installed

- Install AquaCrop software and AquaCrop Plugin in the documents folder

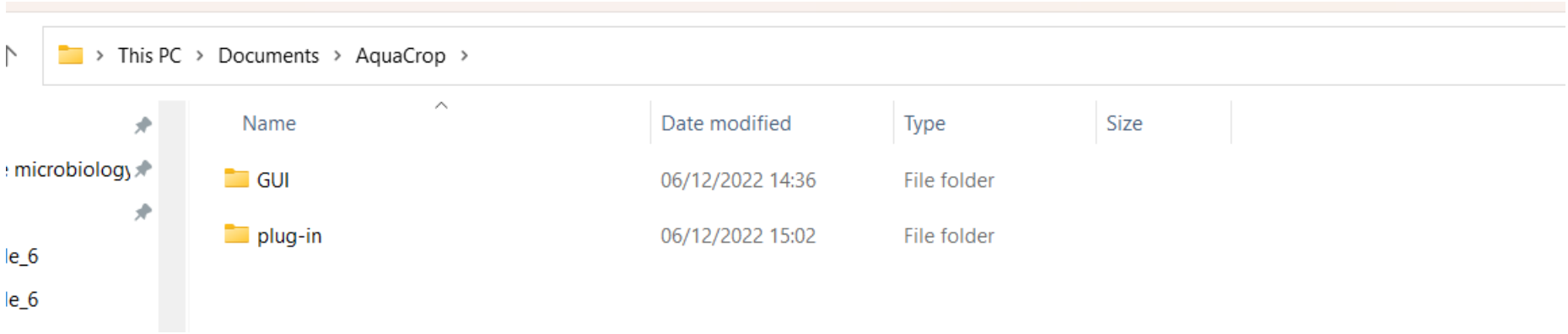


Folders location

- Where your data folder should be



- Where your AquaCrop installations should be



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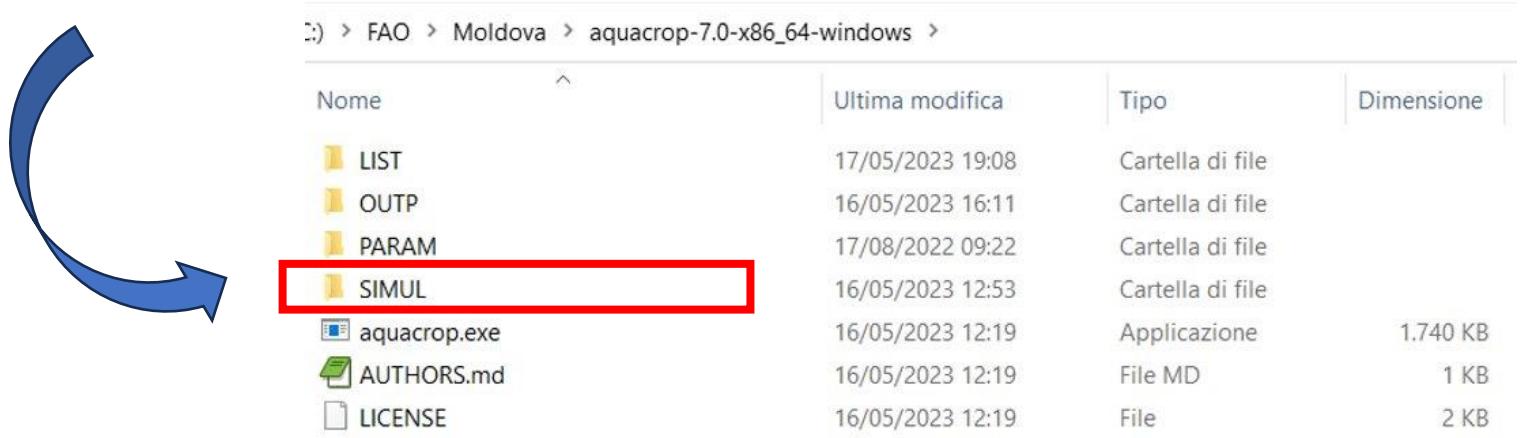
In case you do not have AquaCrop installed

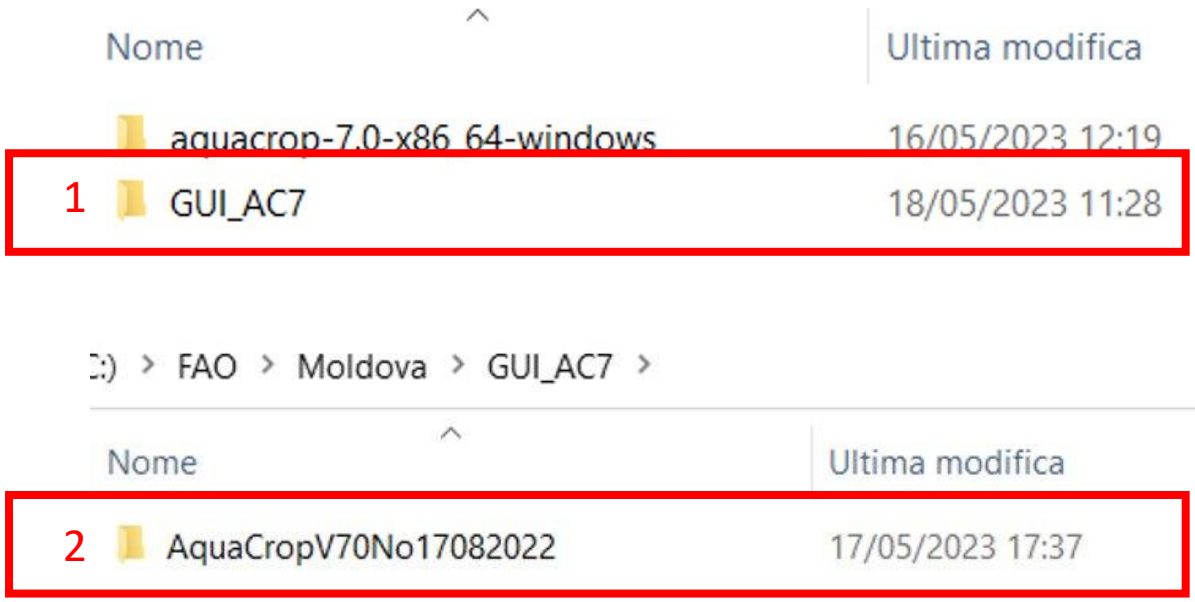
- *To run the plugin the text file DailyResults.SIM is needed to be in the “SIMUL” folder of the plugin. Download and paste this file .

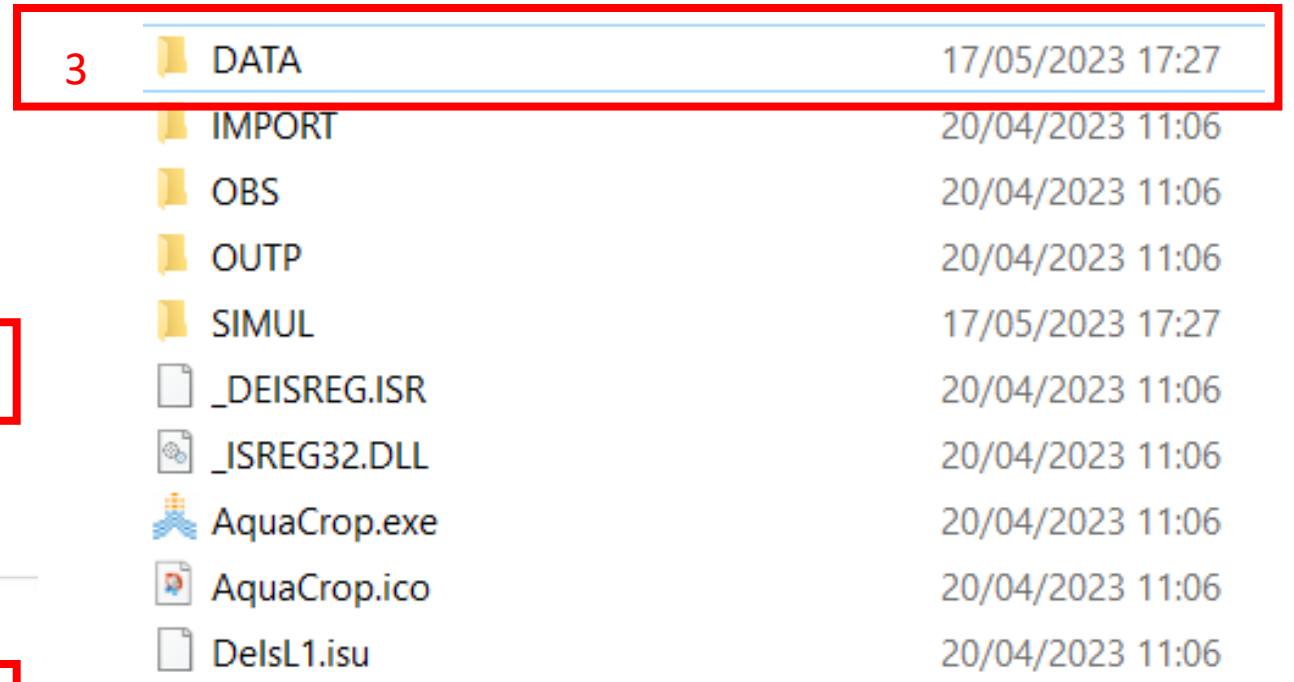


Upload of the files

Go to the downloaded folders and **remove <u>all the content</u>** of your personal “DATA” folder.

Follow the shown path:



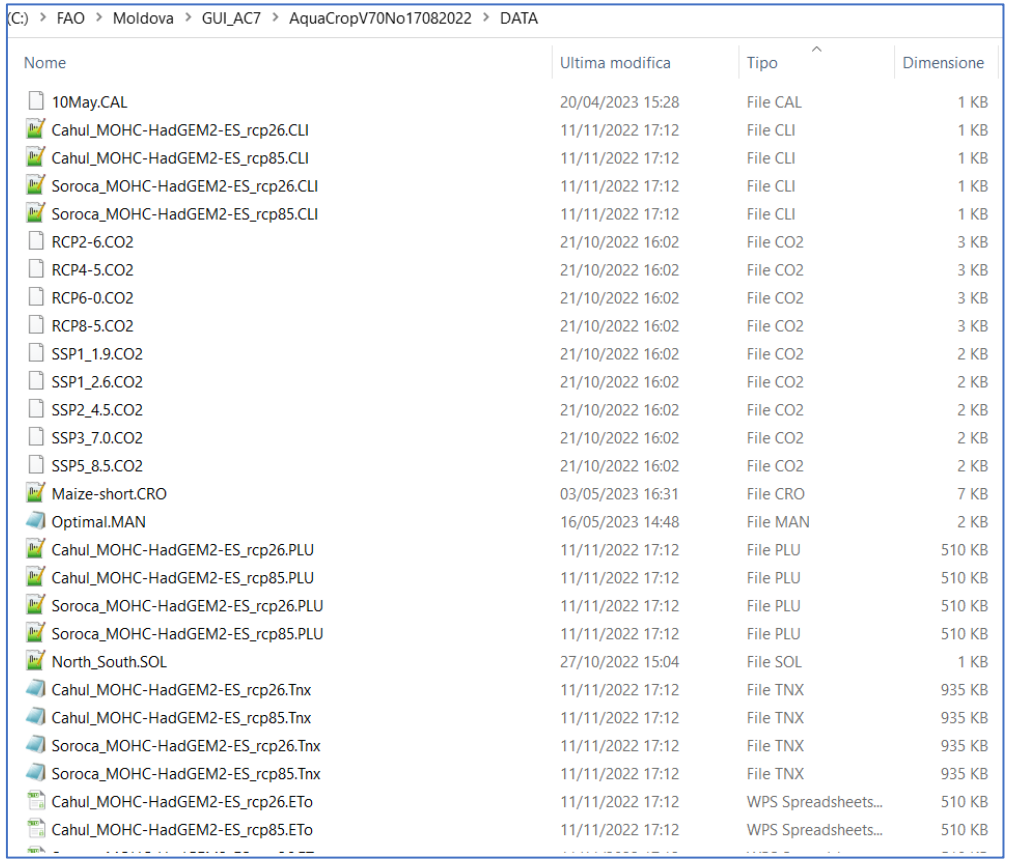


In case you would like to repristinate the AquaCrop default data you can find it in the “<u>Data with default AquaCrop files</u>” folder at the following link : <u>https://github.com/Risk-Team/Moldova-workshop/tree/main/material_for_training_sessions</u>

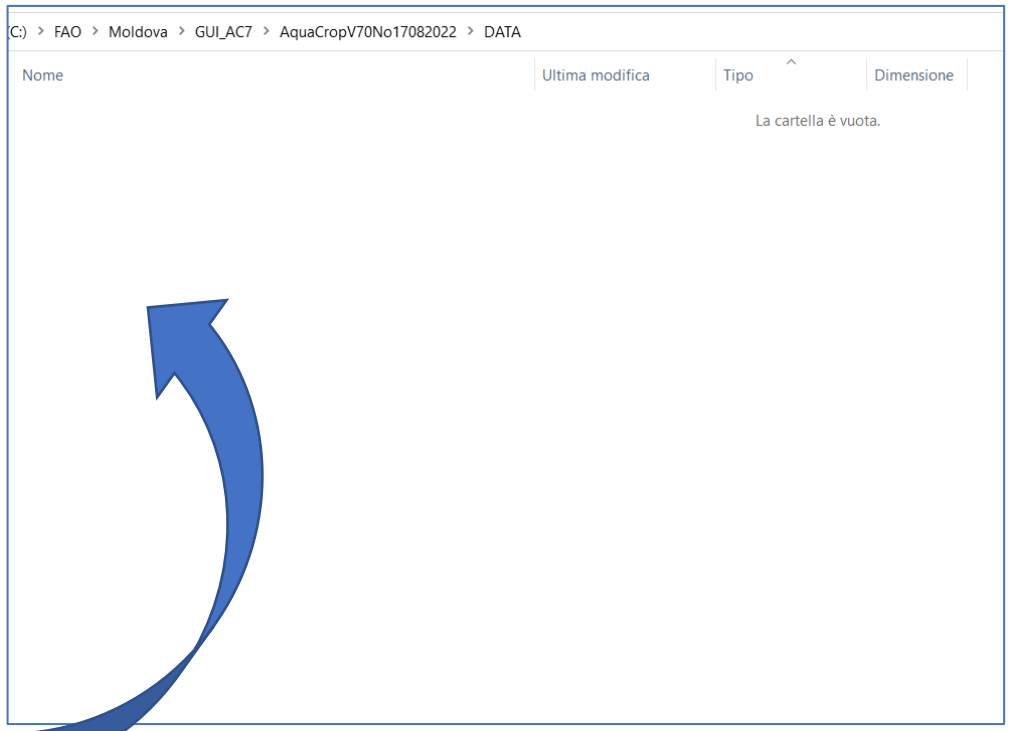
Upload of the files

Copy and paste the “Follow_up” folder content to your personal **DATA folder**.

[Here](#) **you can find the "Follow_up”** data folder content



Personal DATA folder



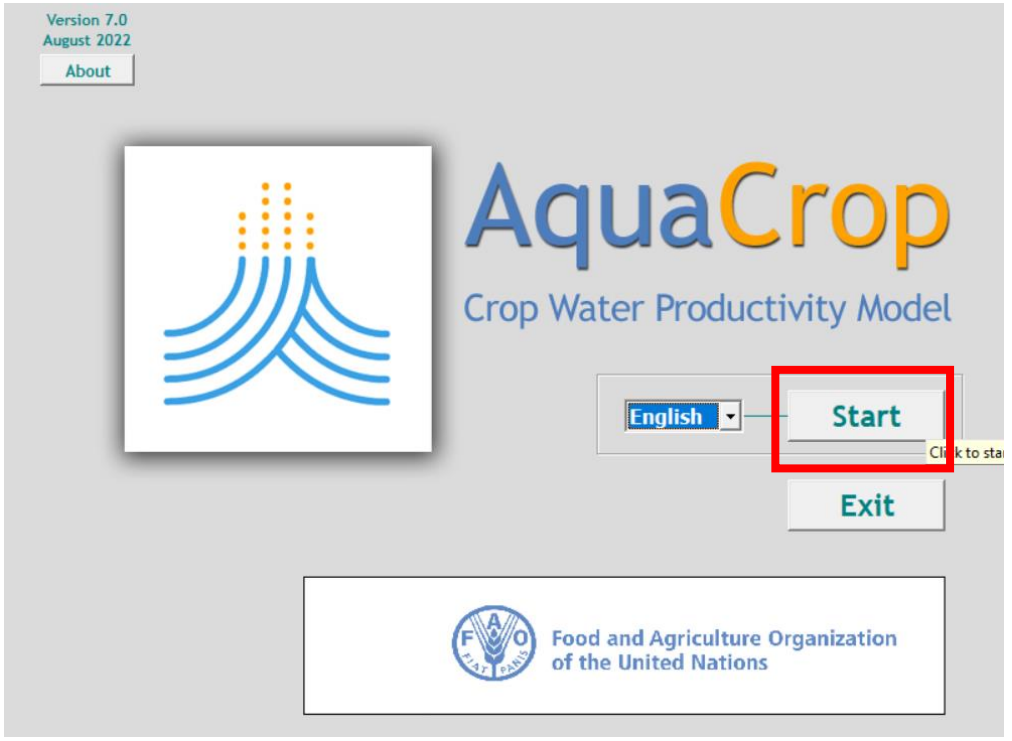
CTRL + C - CTRL + V

Creation of the project files (.PRM)

1. Open AquaCrop software (double click on “AquaCrop.exe”)

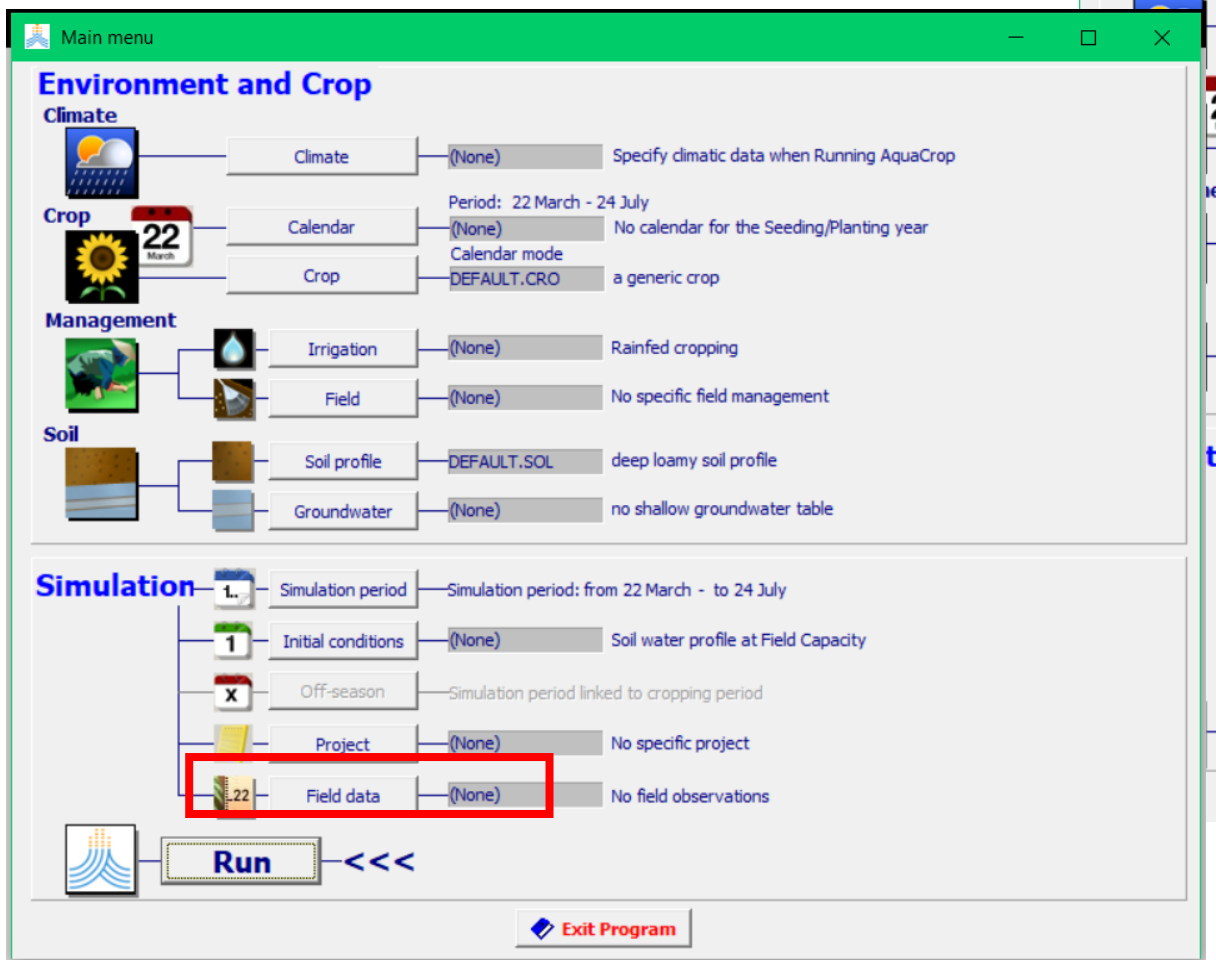
DATA	17/05/2023 17:27
IMPORT	20/04/2023 11:06
OBS	20/04/2023 11:06
OUTP	20/04/2023 11:06
SIMUL	17/05/2023 17:27
_DEISREG.ISR	20/04/2023 11:06
_ISREG32.DLL	20/04/2023 11:06
AquaCrop.exe	20/04/2023 11:06
AquaCrop.ico	20/04/2023 11:06
DelsL1.isu	20/04/2023 11:06

2. Select language and press Start

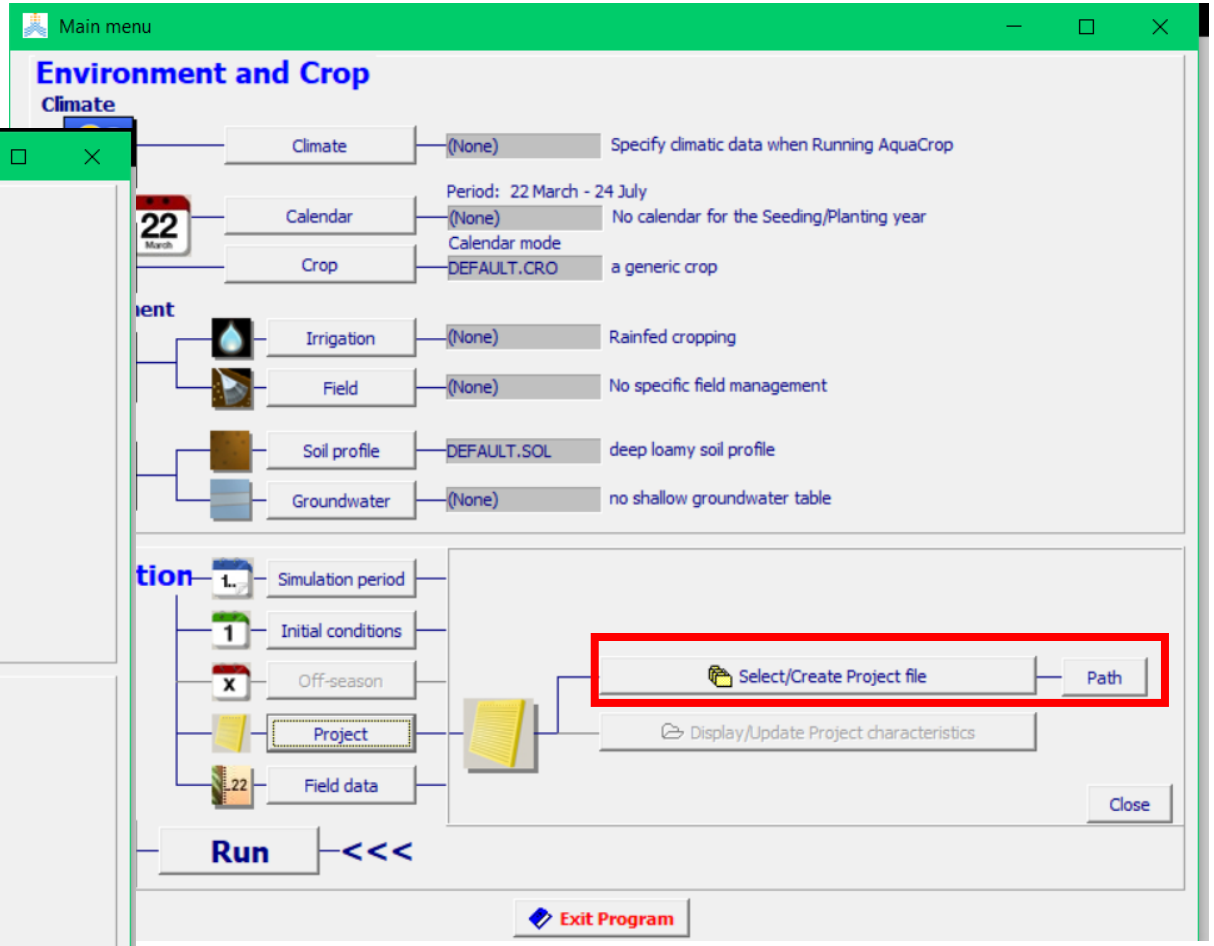


Creation of the project files (.PRM)

Press the “Project” button to create the project file

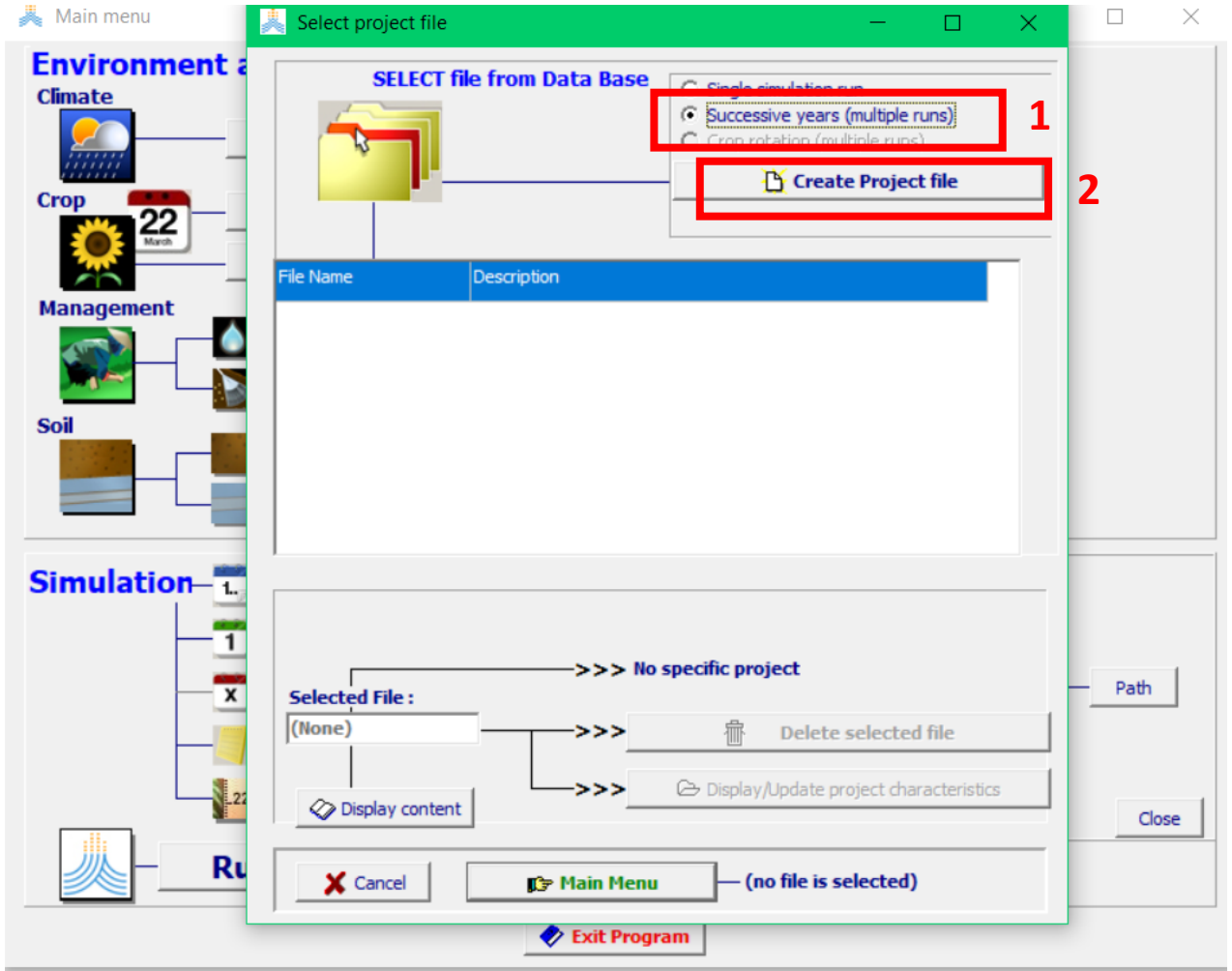


Click on “Select/Create Project file”



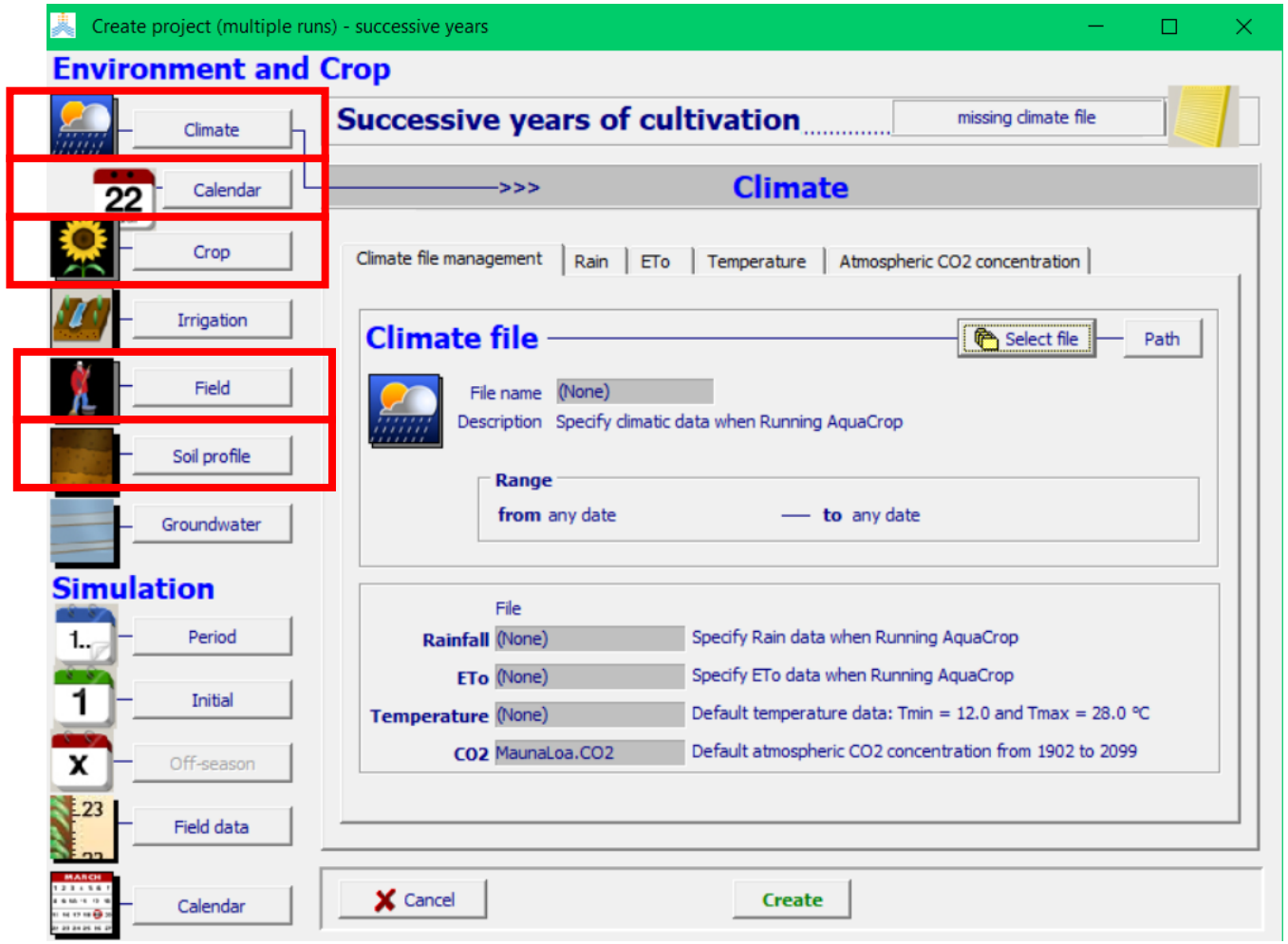
Creation of the project files (.PRM)

1. Press “successive years (multiple runs)” since we are using a climate file with data from 2030 to 2099
2. Click the below “create project file” button



Creation of the project files (.PRM)

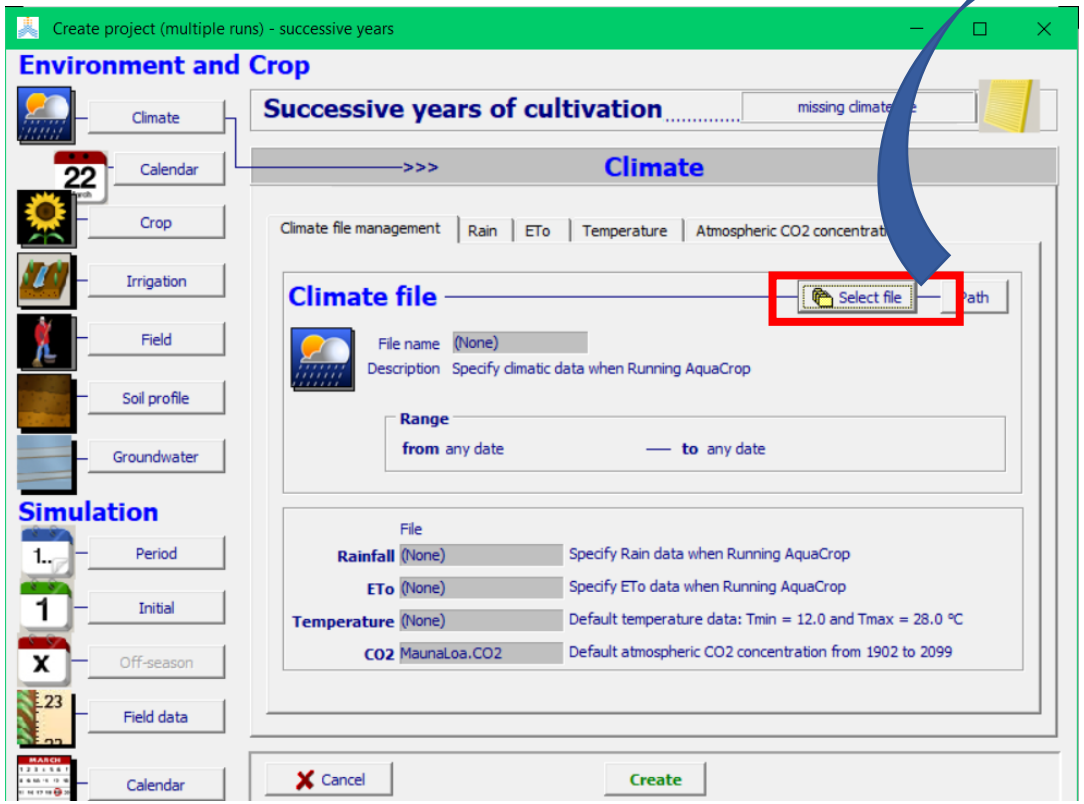
One by one, we will go through each of the highlighted components of the menu and select the correct files to create the PRM file.



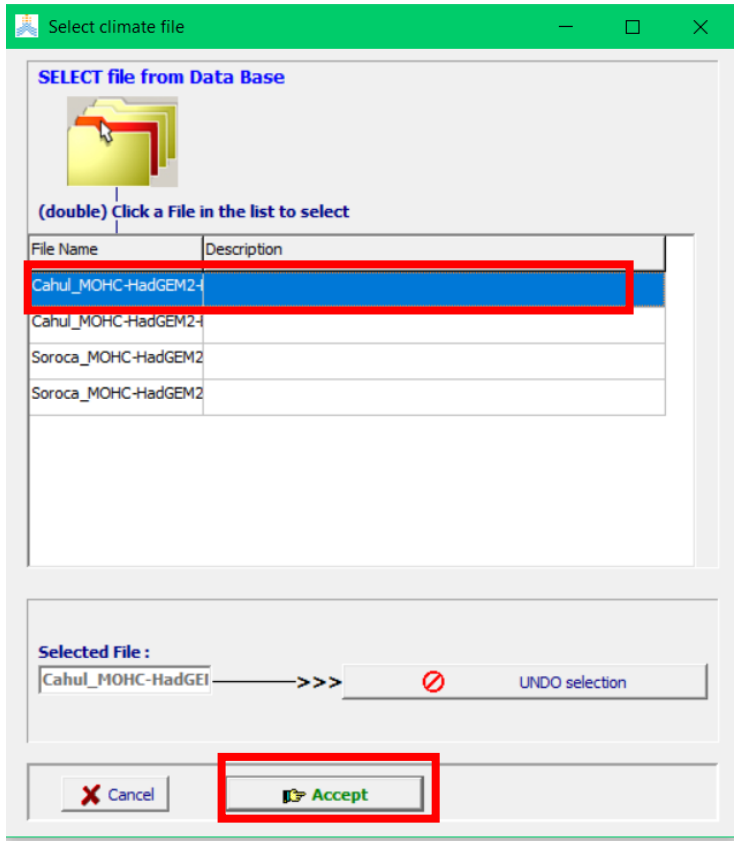
Climate module

1. Climate file

Press “Select file”



Select the first file “Cahul_MOHC-HadGEM2-”
Press the “Accept” button



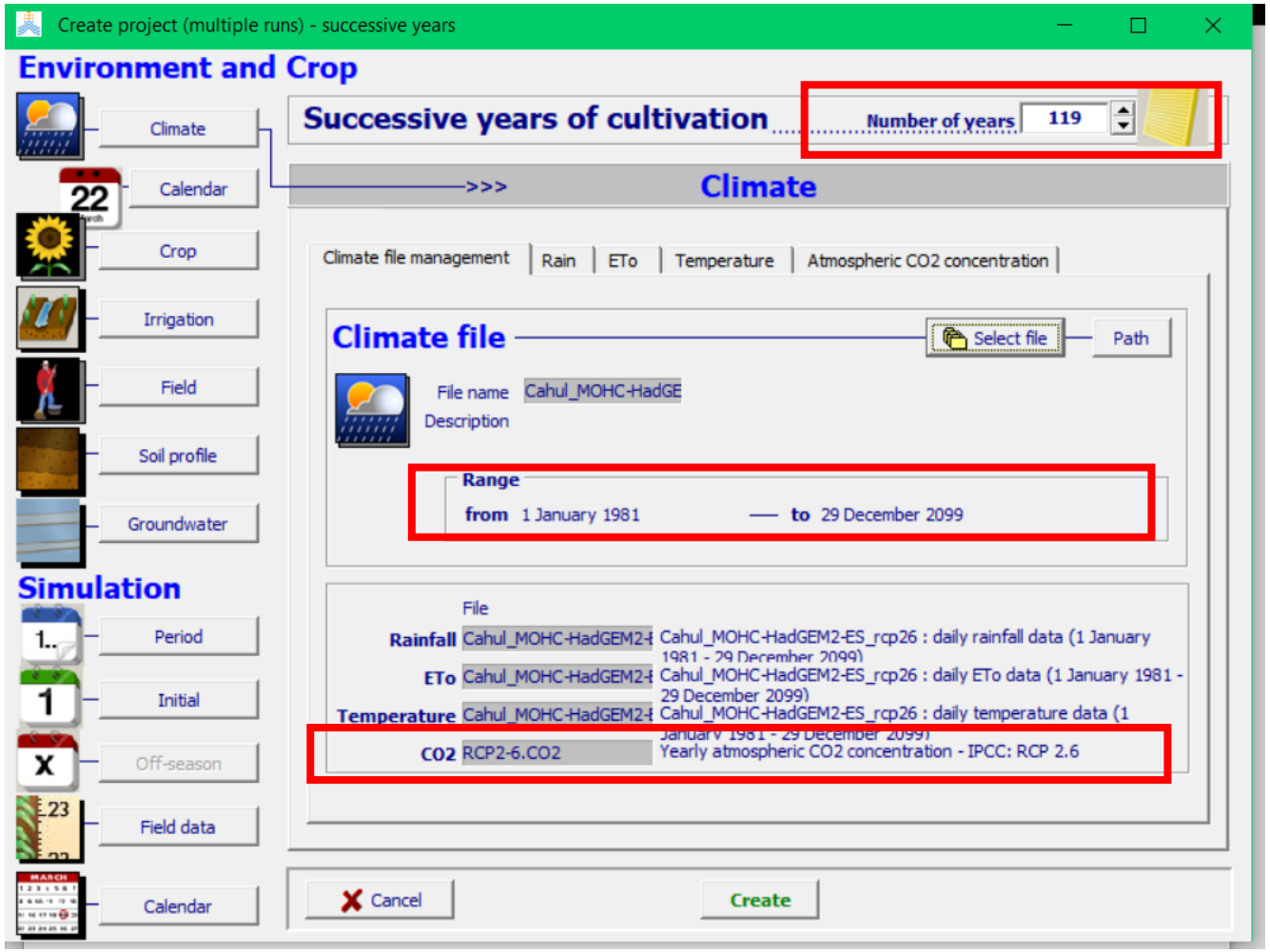
Creation of the project files (.PRM)

Here you can check the content of the selected file:

- **119 years**: 1 January 1981 to 29 December 2099

- **MOHC**: Global Climate Model

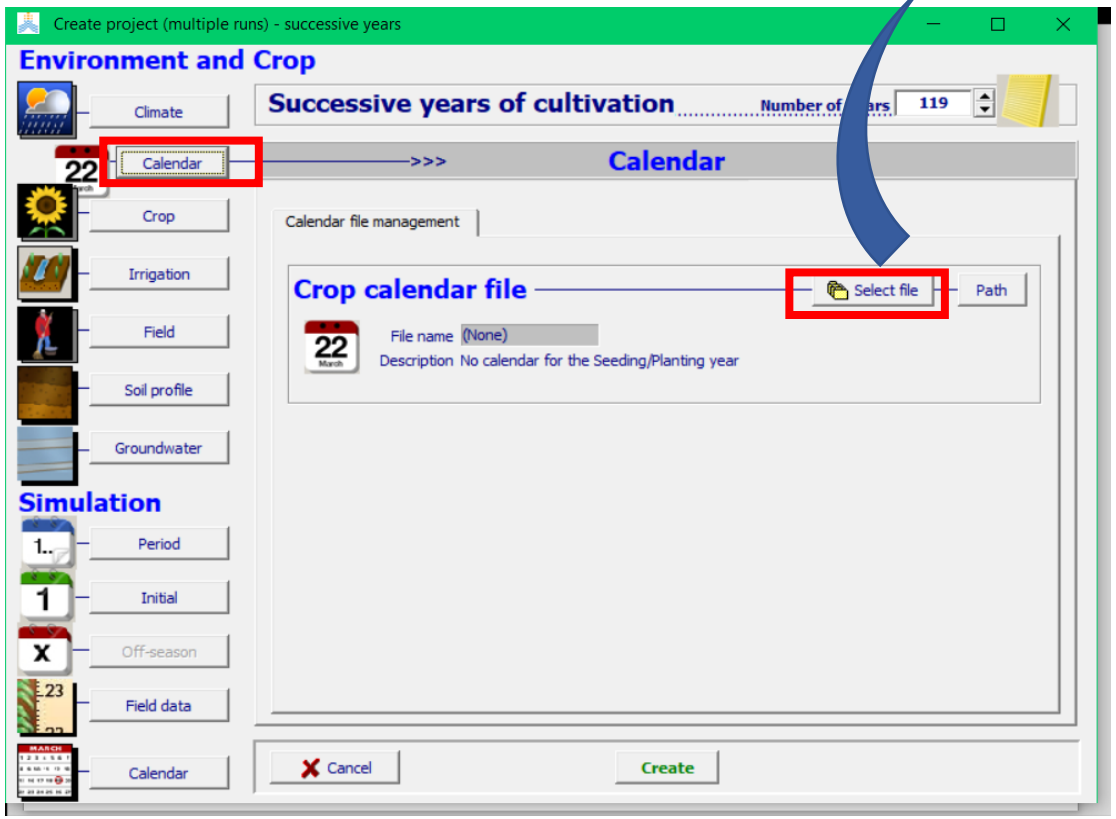
- **RCP2.6**: representative concentration pathway (2.6 - low emission scenario)



Calendar module

2. Calendar file

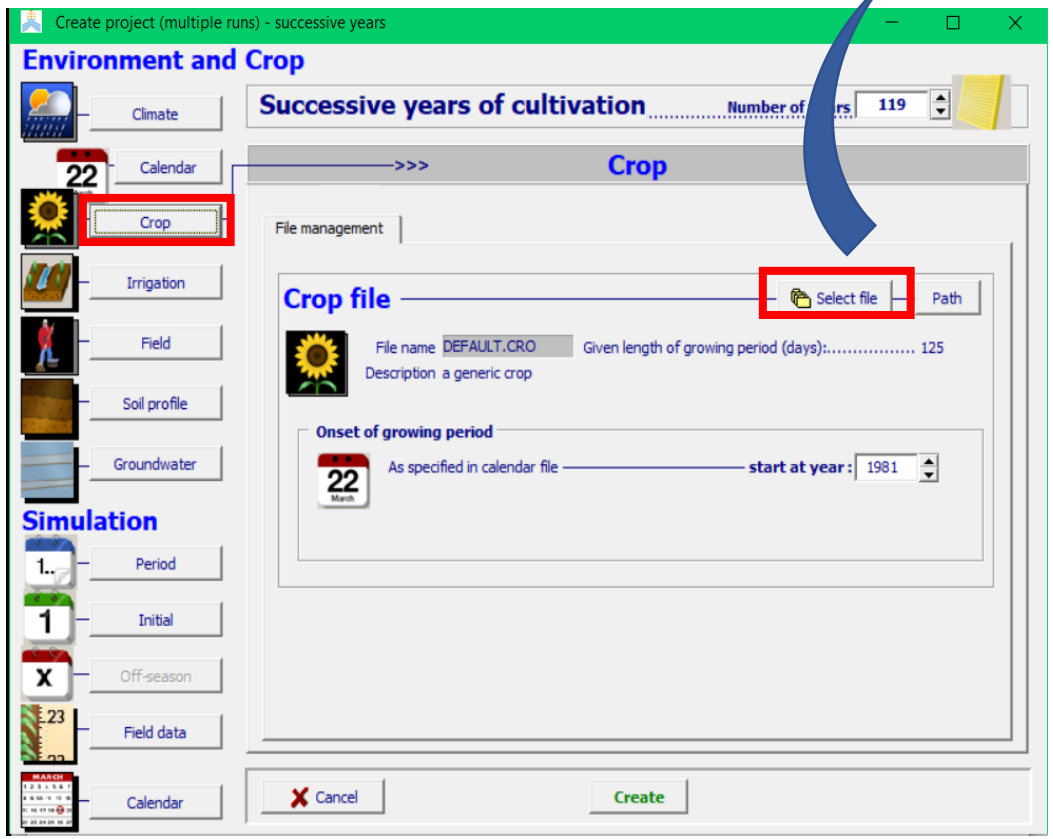
Press “Select file”



Select the file “10May”
Press the “Accept” button

3. Crop file

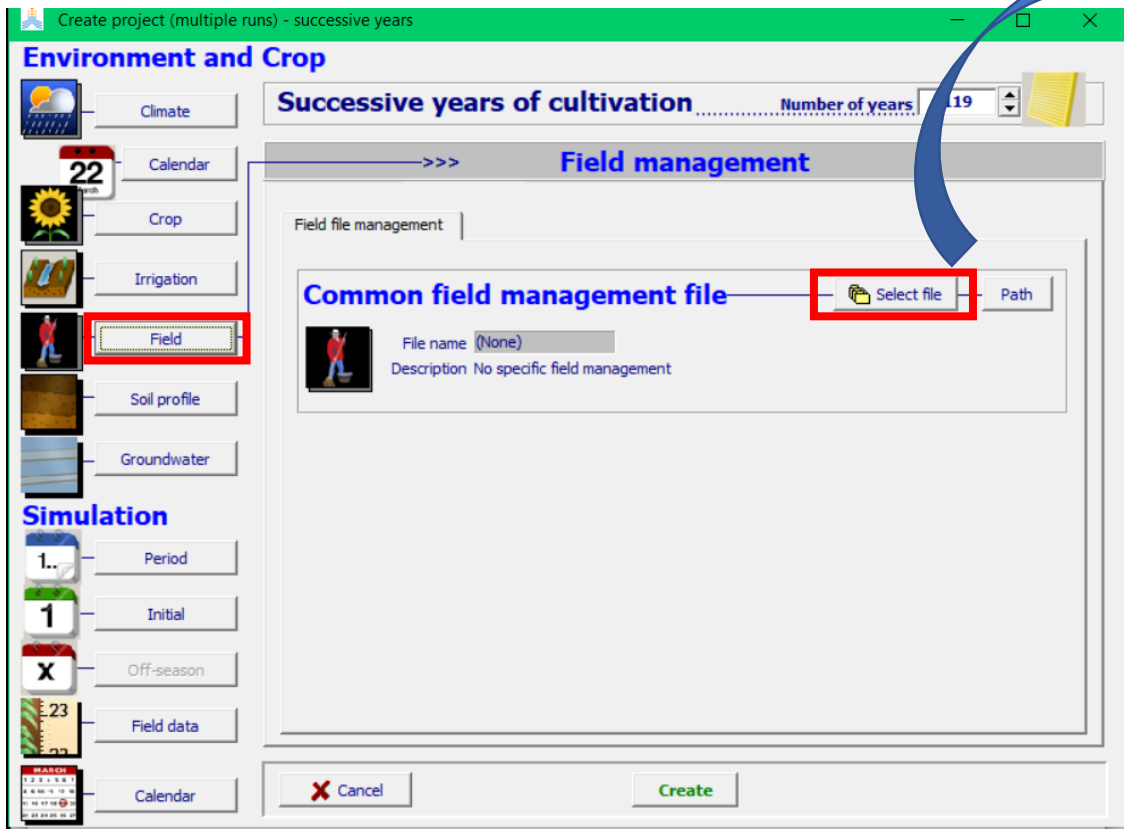
Press “Select file”



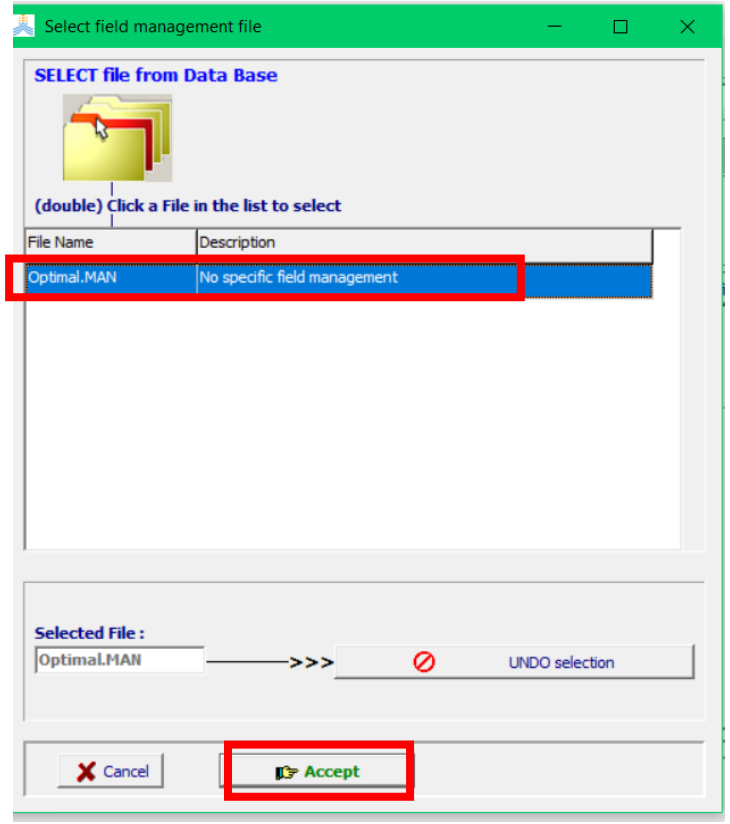
Select the file “Maize-Short”
Press the “Accept” button

4. Field management file

Press “Select file”

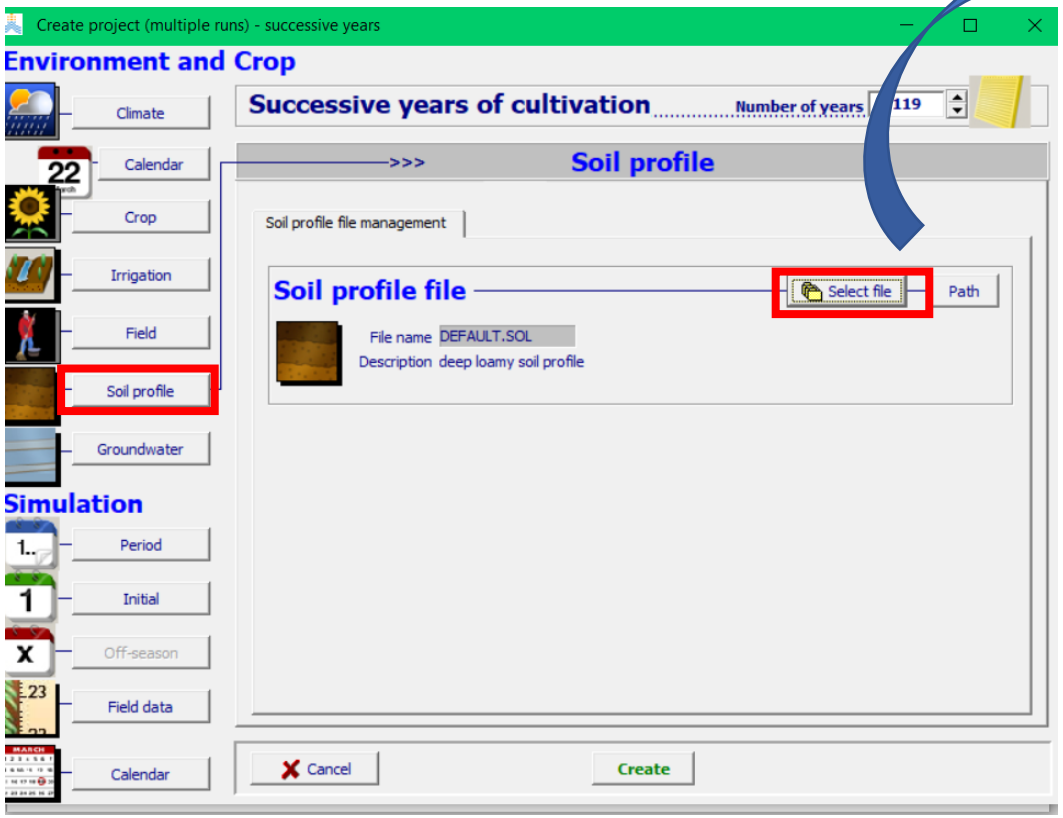


Select the file “Optimal”
Press the “Accept” button

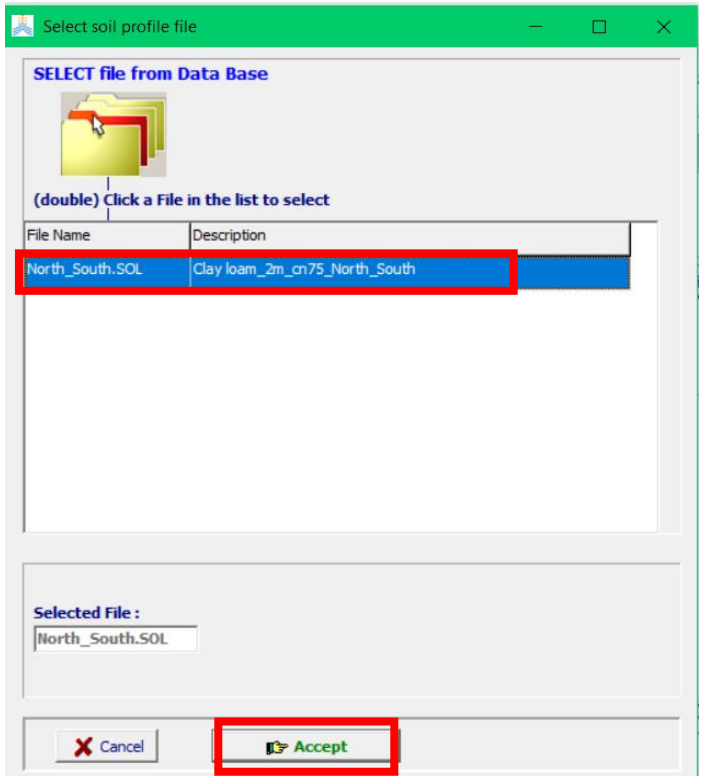


5. Soil file

Press “Select file”

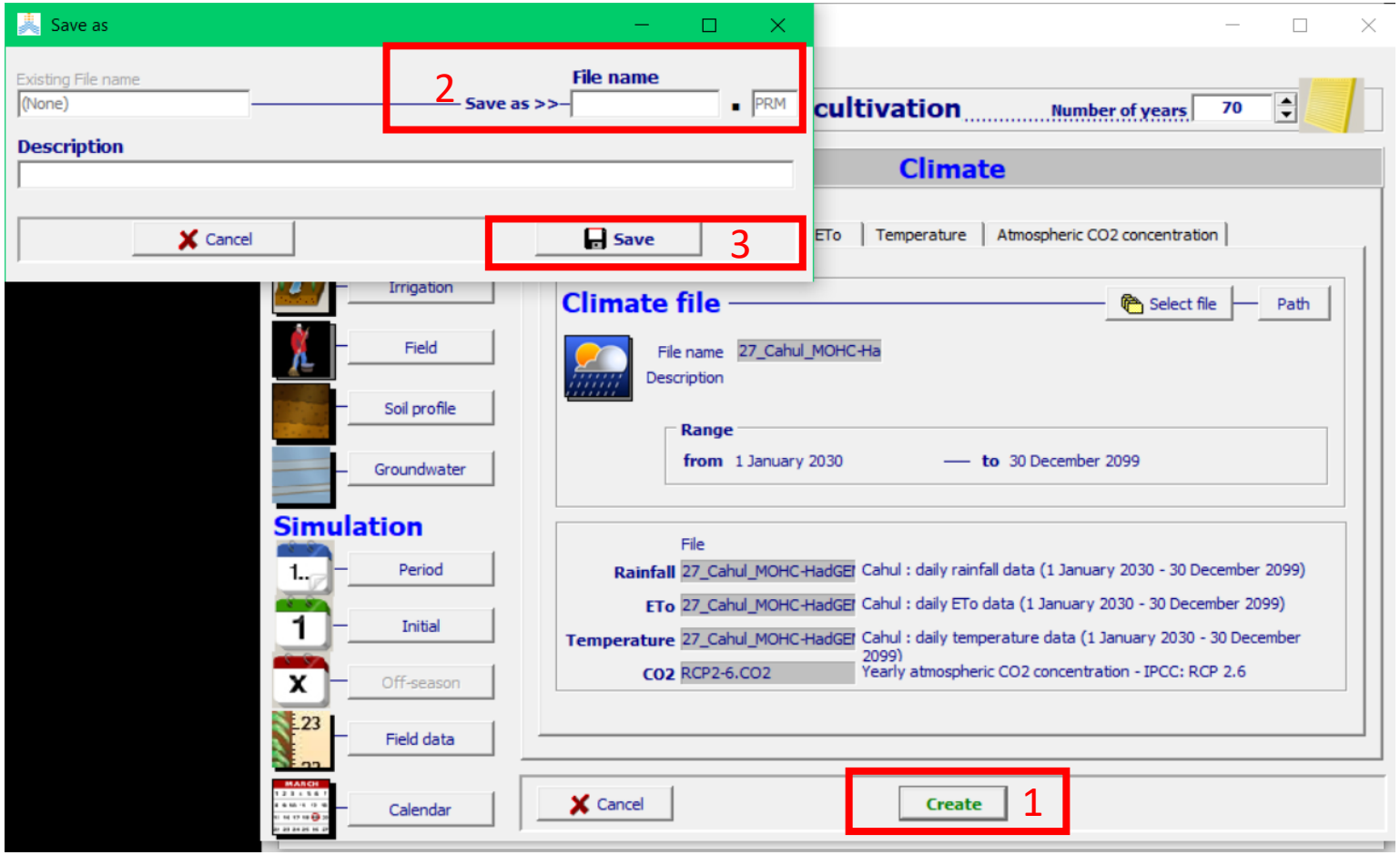


Select the file “North_South”
Press the “Accept” button



Saving project files (.PRM)

1. Press “CREATE”
2. Fill the “File name” with the name: **Maize_Short_Cahul_10May_Optimal_26_MOHC**
3. Press the “Save” button



Creation of new project files (.PRM)

HOW TO CREATE OTHER PROJECT FILES WITH DIFFERENT VARIABLES

Creation of new project files (.PRM)

Variables scheme

Maize_Short_Cahul_10May_Optimal_26_MOHC [X]

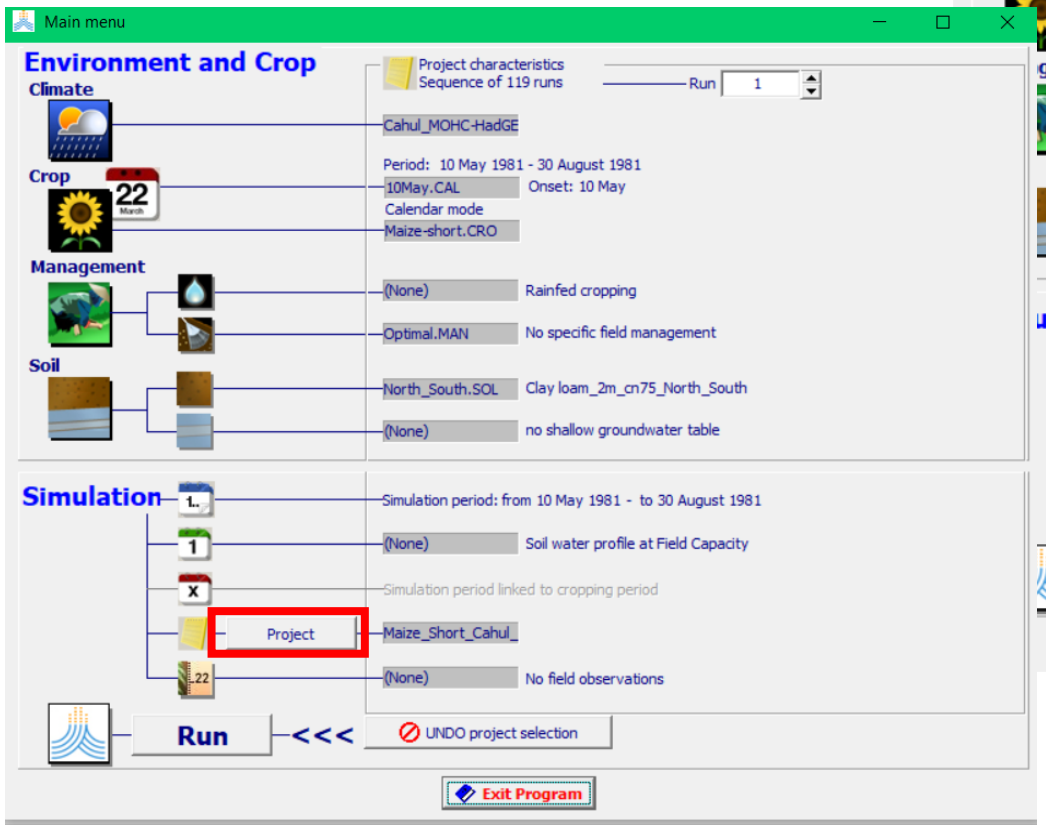
Maize_Short_Cahul_10May_Optimal_85_MOHC [ ] Step → Change the Climate file to Cahul RCP 8.5

Maize_Short_Soroca_10May_Optimal_26_MOHC [ ] Step → Change the Climate file to Soroca RCP 2.6

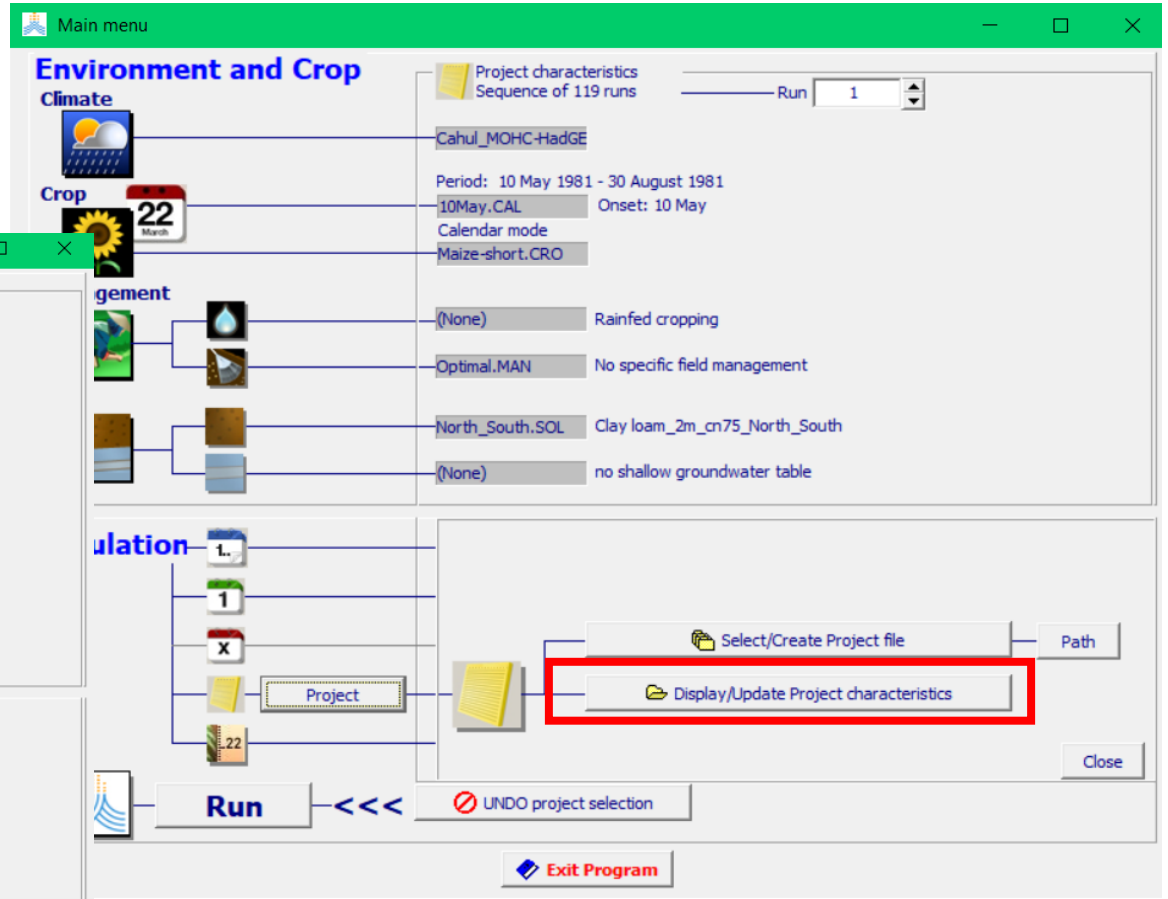
Maize_Short_Soroca_10May_Optimal_85_MOHC [ ] Step → Change the Climate file to Soroca RCP8.5

Creation of new project files (.PRM)

1. Press “Project” button

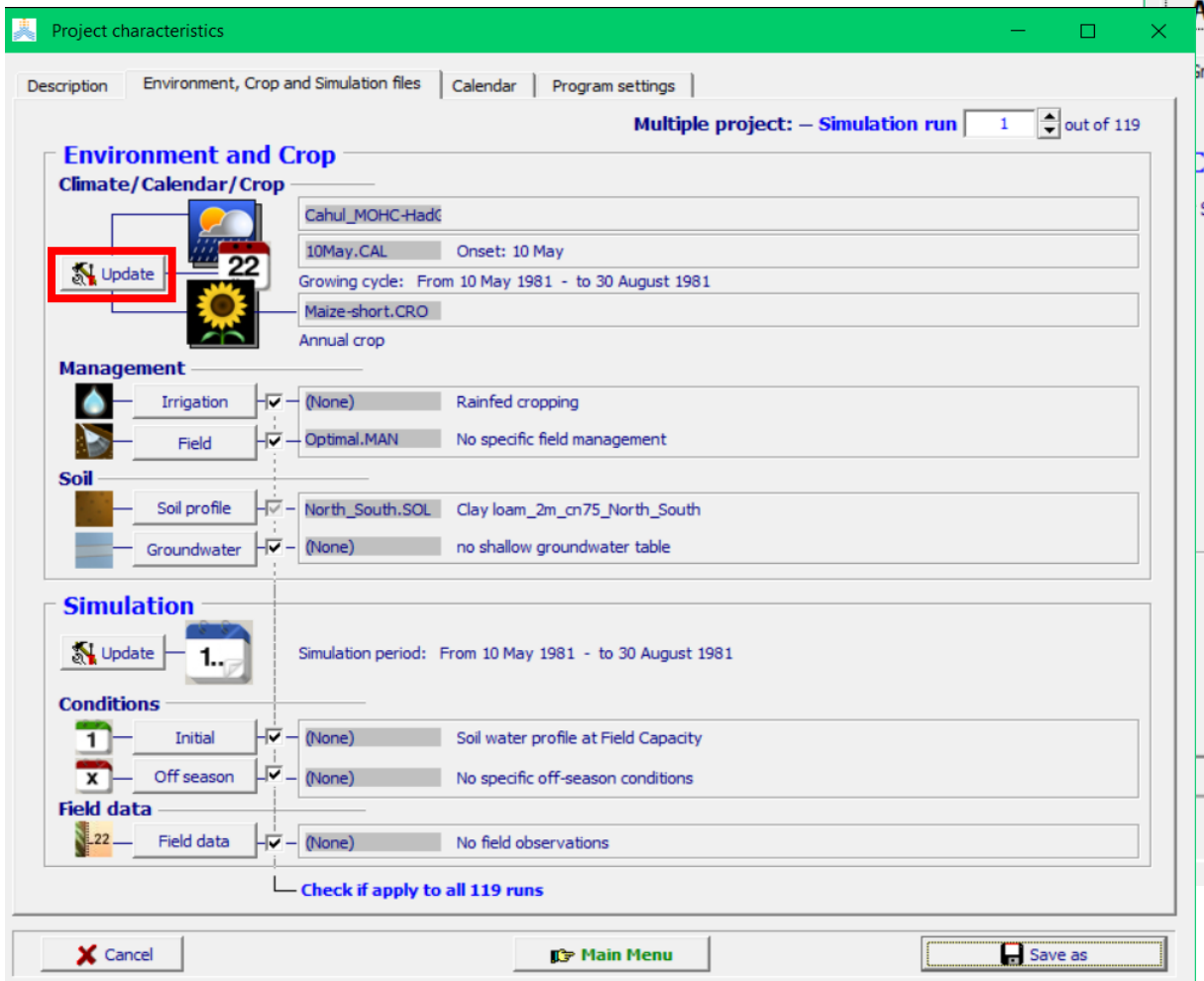


2. Select Display/Update Project characteristics

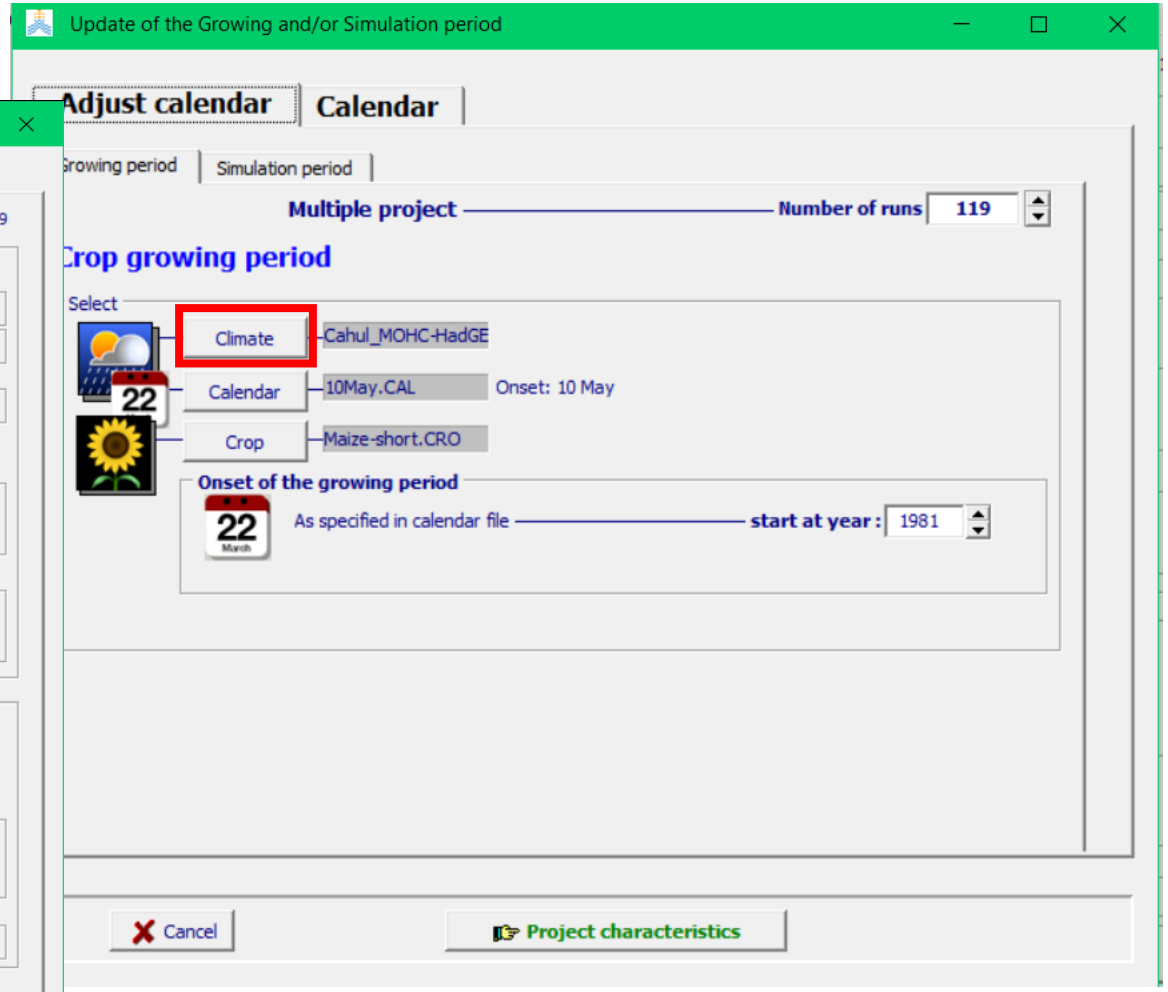


Creation of new project files (.PRM)

3. Press “Update” button

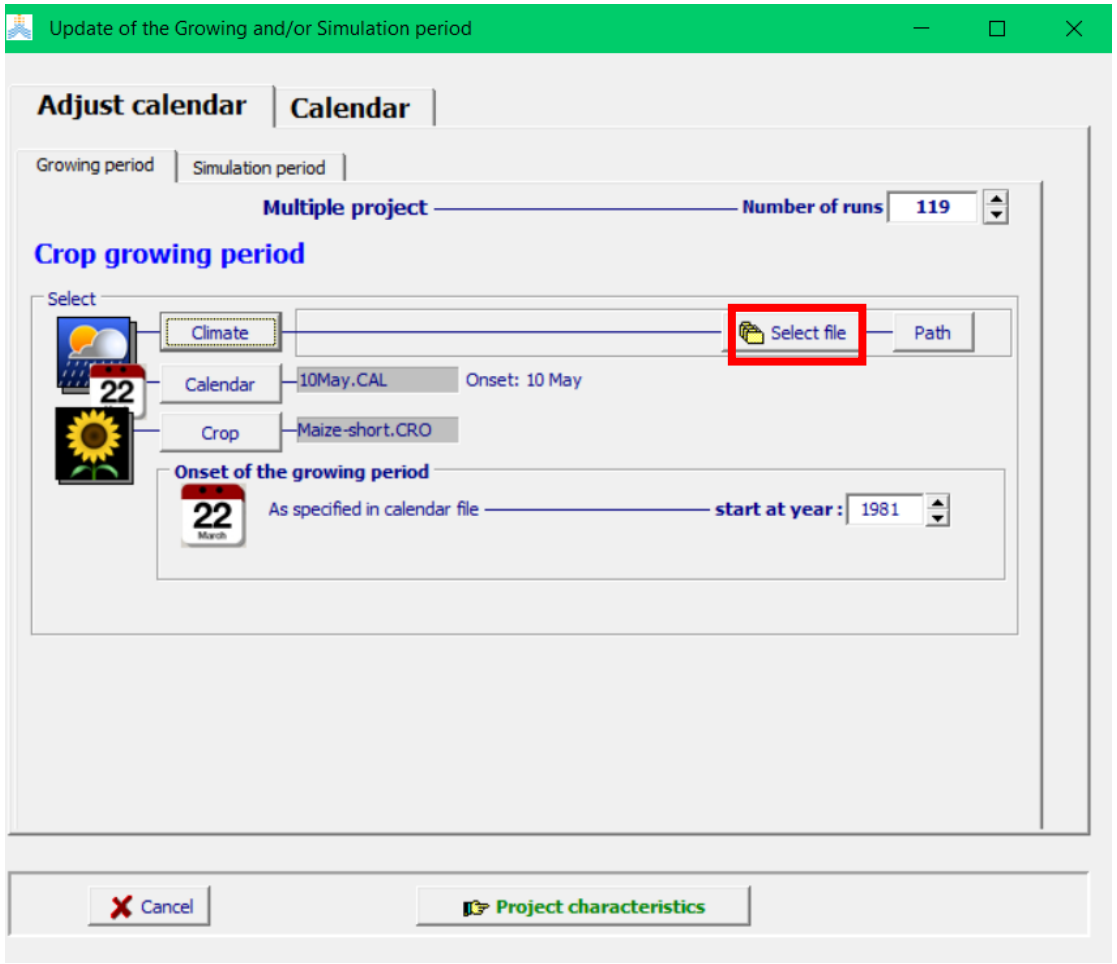


4. Click on Climate

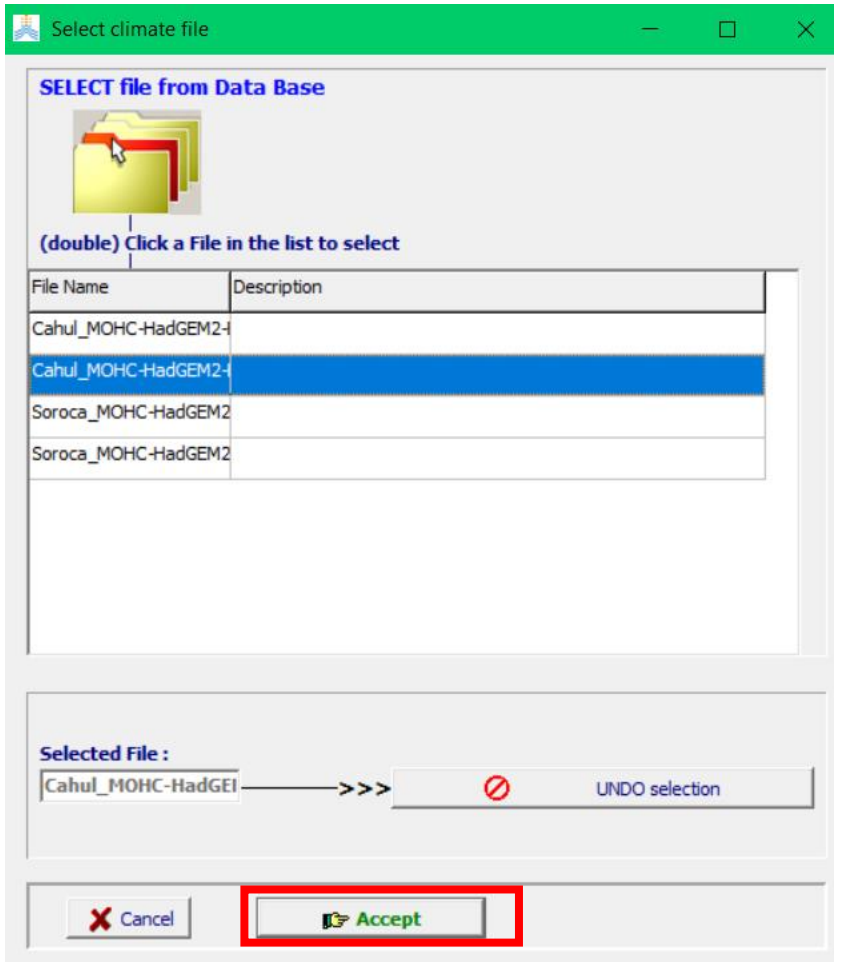


Creation of new project files (.PRM)

5. Click on “Select file”

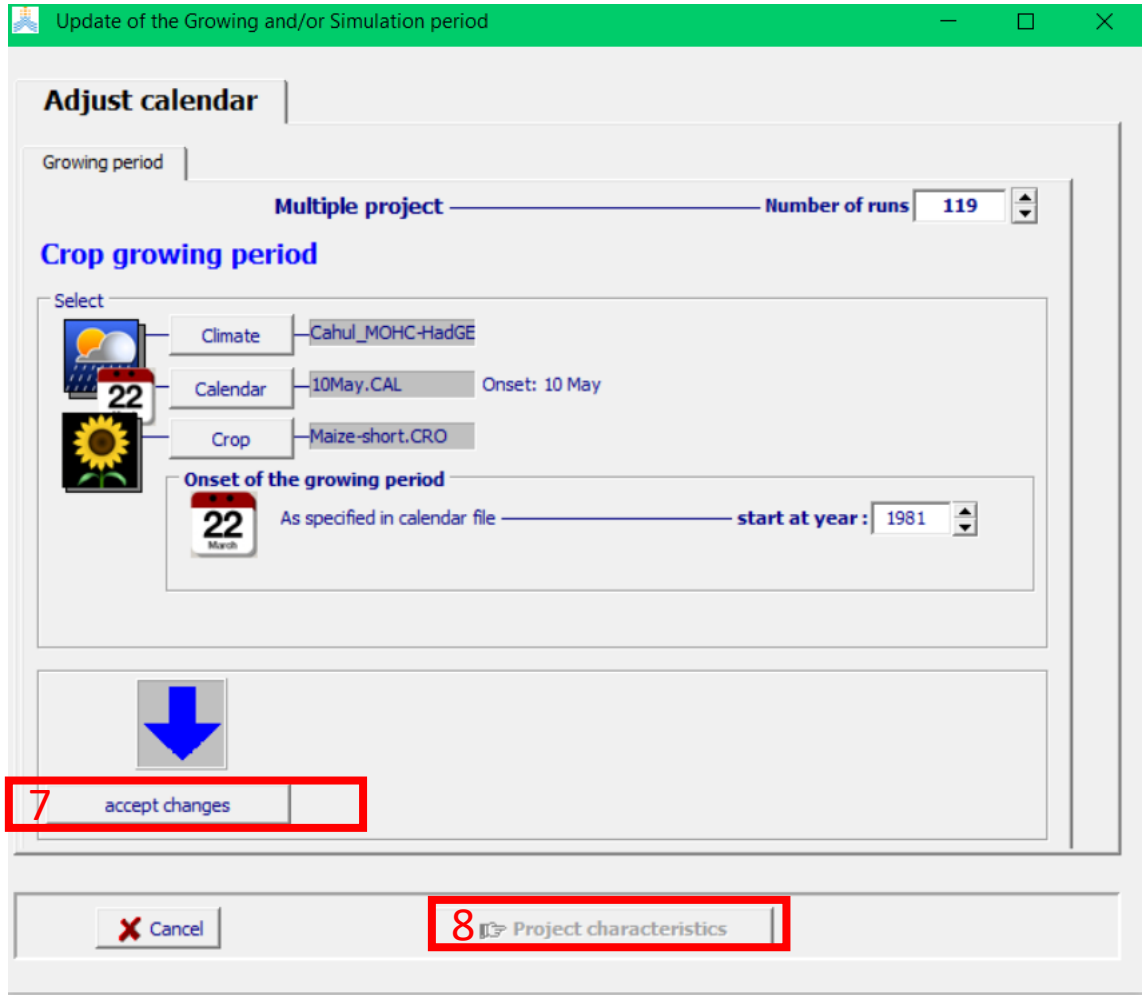


6. Select the second file “Cahul_MOHC-HadGEM2-”



Creation of new project files (.PRM)

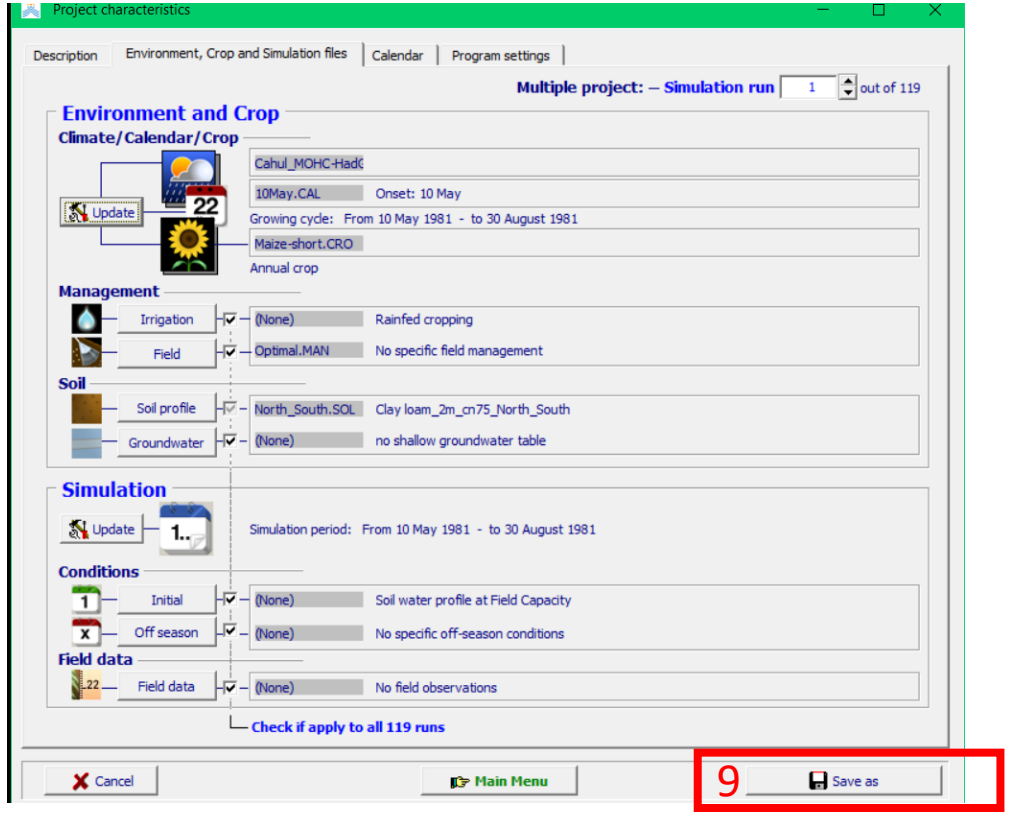
7. Press “Accept changes” button

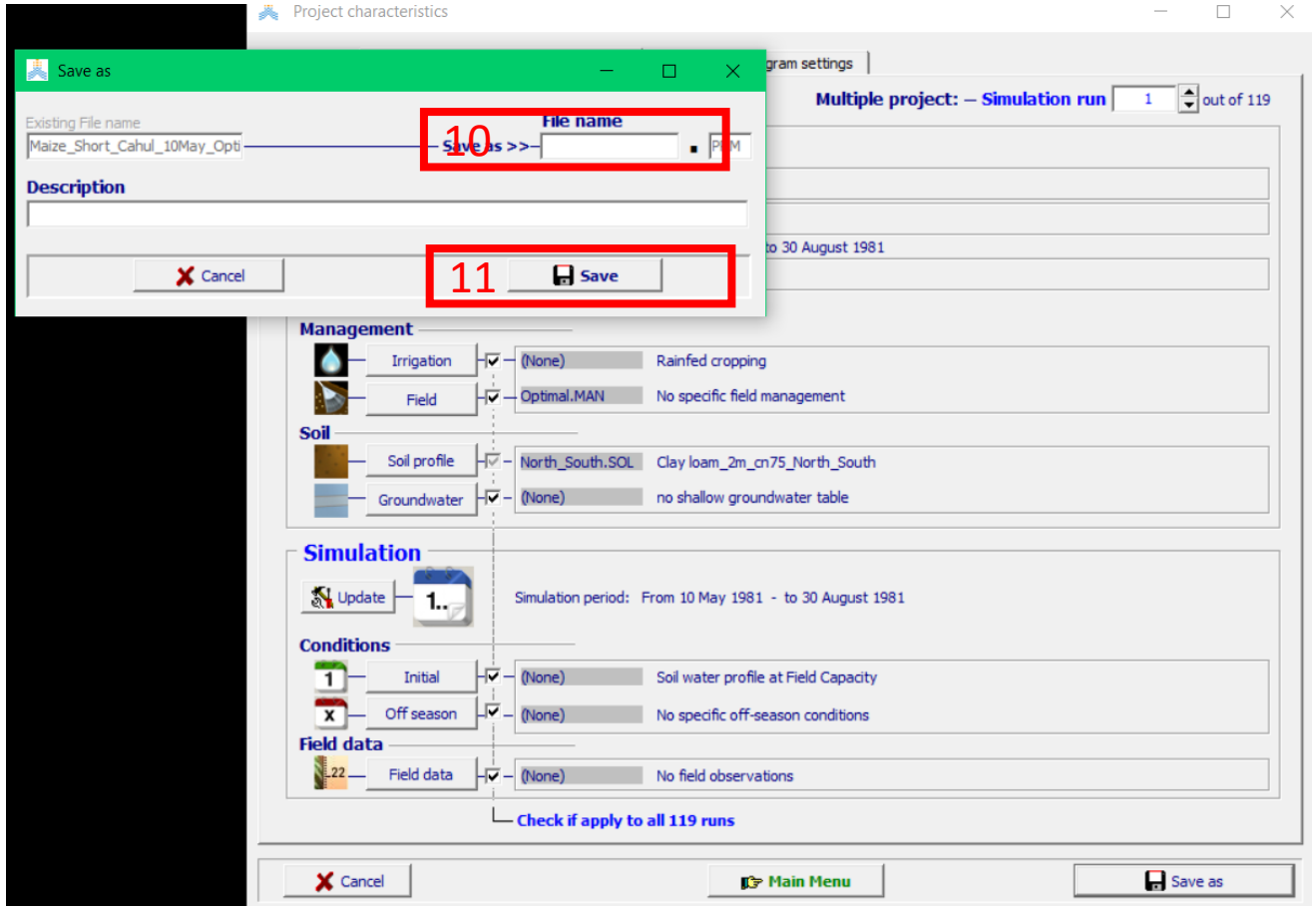


8. Click on “Project Characteristics” to go back on the main project page

Creation of new project files (.PRM)

9. Press “Save as” button
10. Fill the “File name” with: Maize_Short_Cahul_10May_Optimal_85_MOHC
11. Press the “Save” button





Next project files (.PRM)

Variables scheme

Maize_Short_Cahul_10May_Optimal_26_MOHC [X]

Maize_Short_Cahul_10May_Optimal_85_MOHC [X]

Maize_Short_Soroca_10May_Optimal_26_MOHC [ ] → Step → Change the Climate file to Soroca RCP 2.6

Maize_Short_Soroca_10May_Optimal_85_MOHC [ ] → Step → Change the Climate file to Soroca RCP8.5

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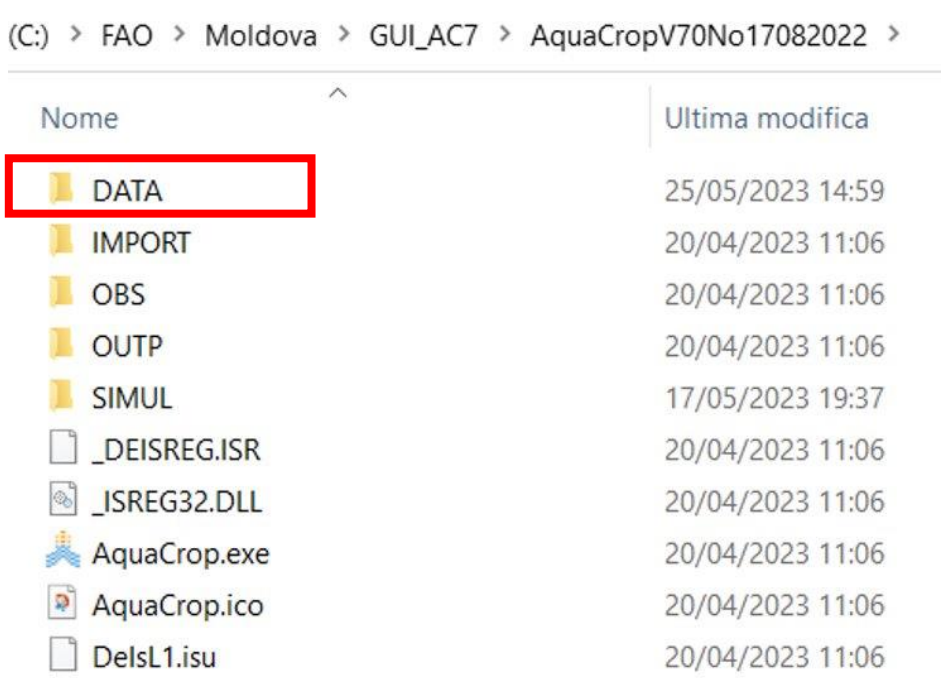
AquaCrop Plugin

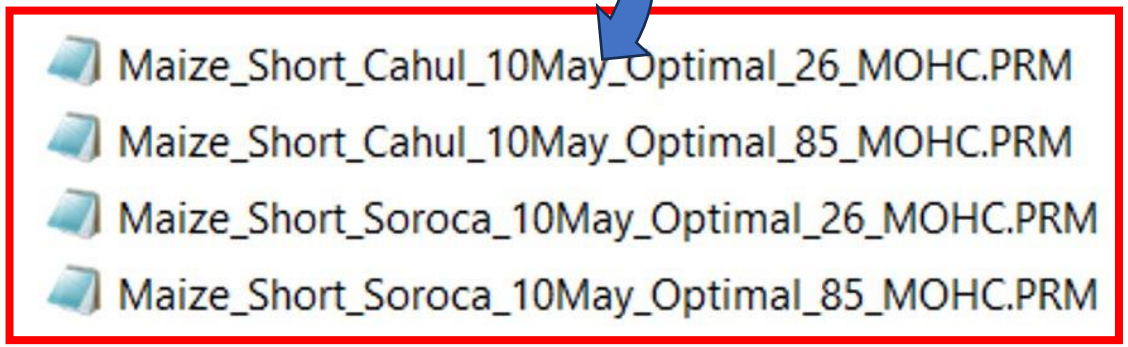
May 30, 2022

Plug-in data

- Go to the DATA folder of "AquaCrop standard" and copy the .PRM files

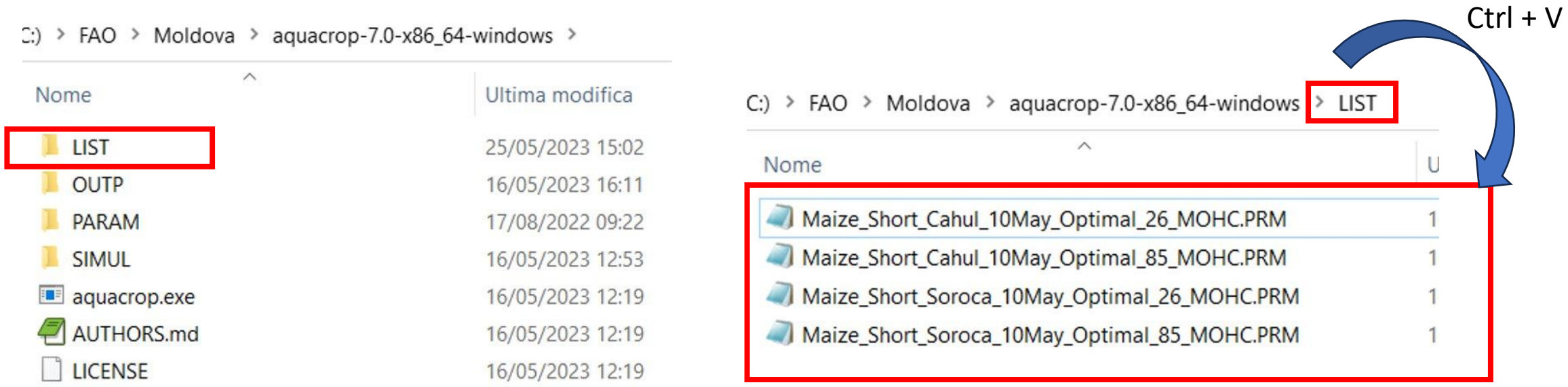
Ctrl + C





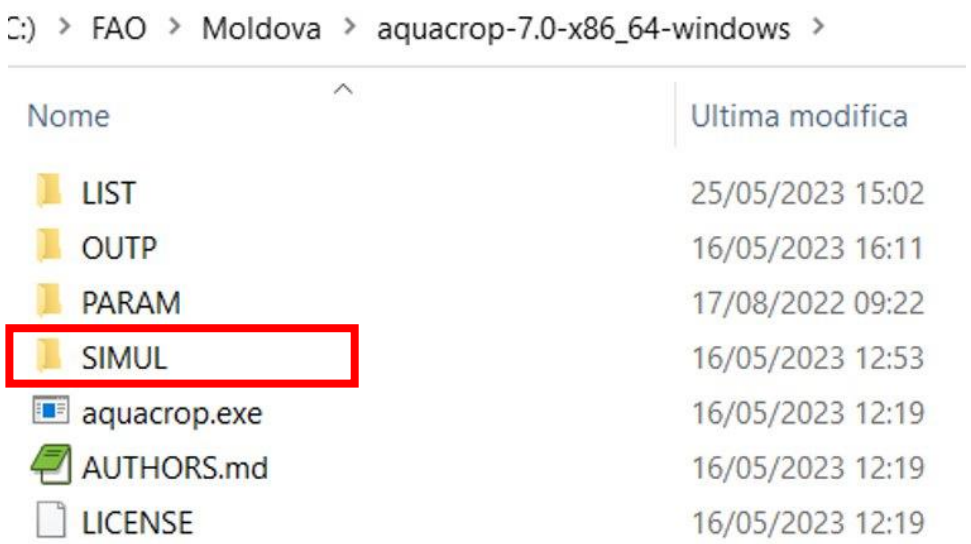
Plug-in data

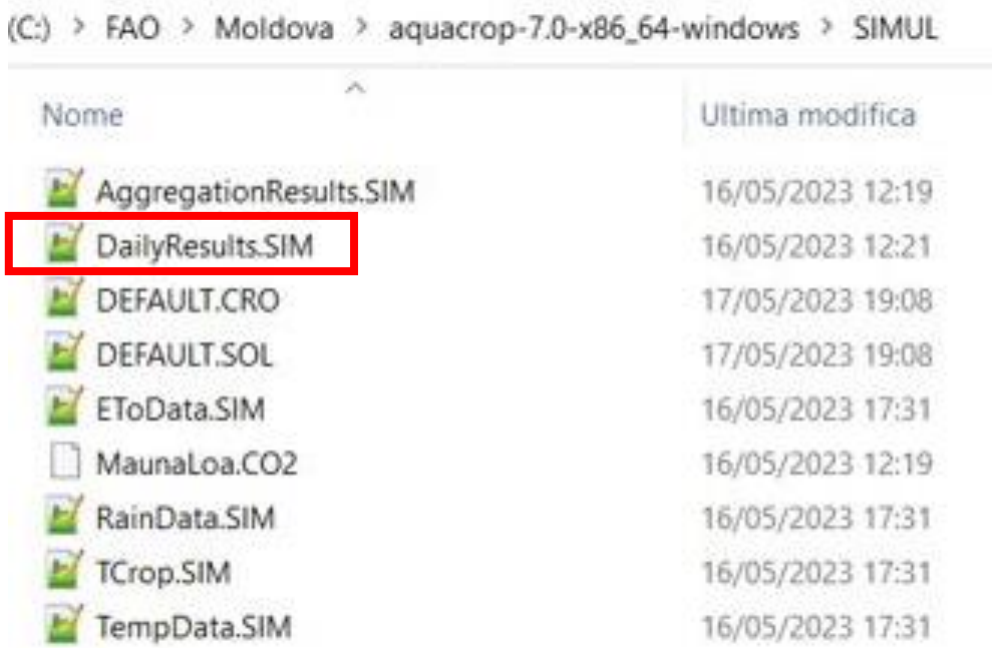
- Paste the .PRM files into the LIST folder of the Plug-in



Plug-in

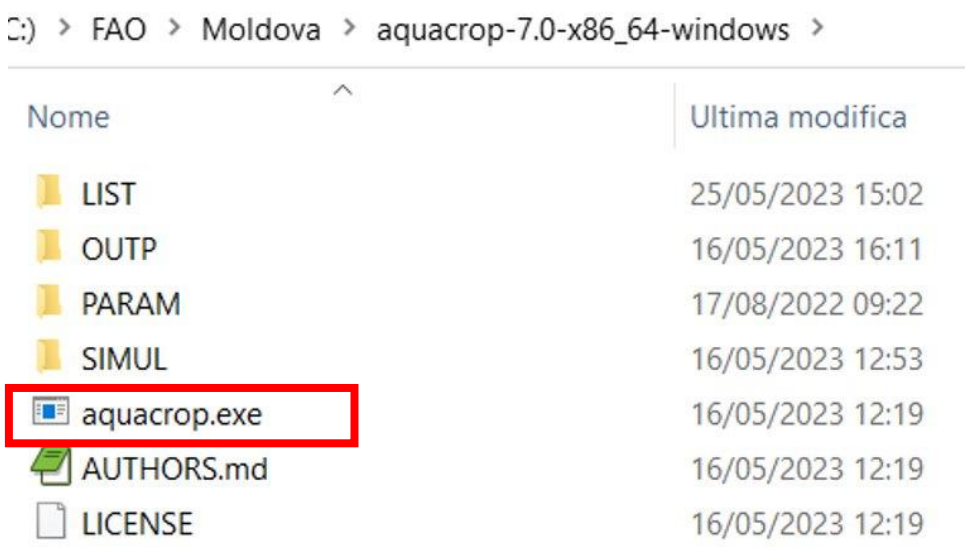
- *To run the plugin the text file DailyResults.SIM is needed to be in the “SIMUL” folder of the plugin.





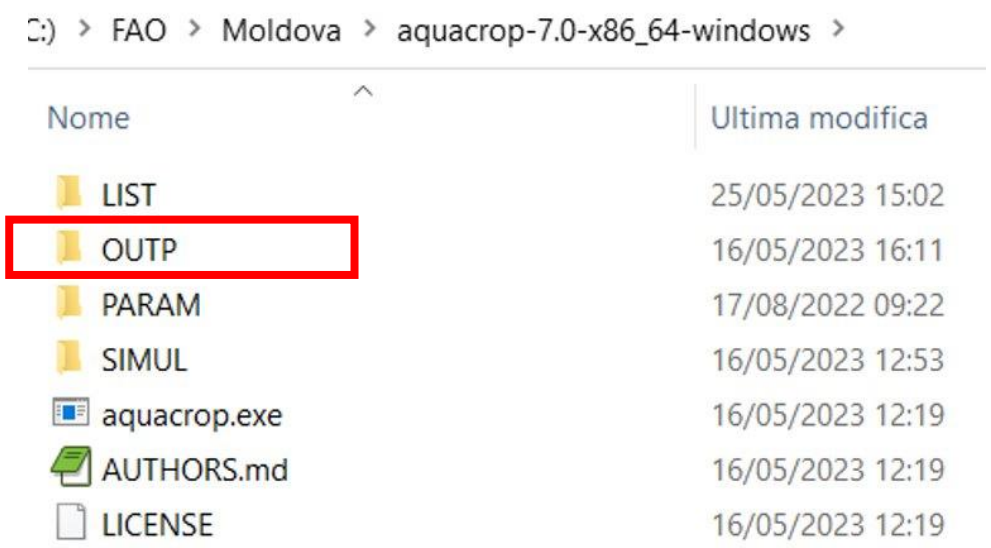
Plug-in

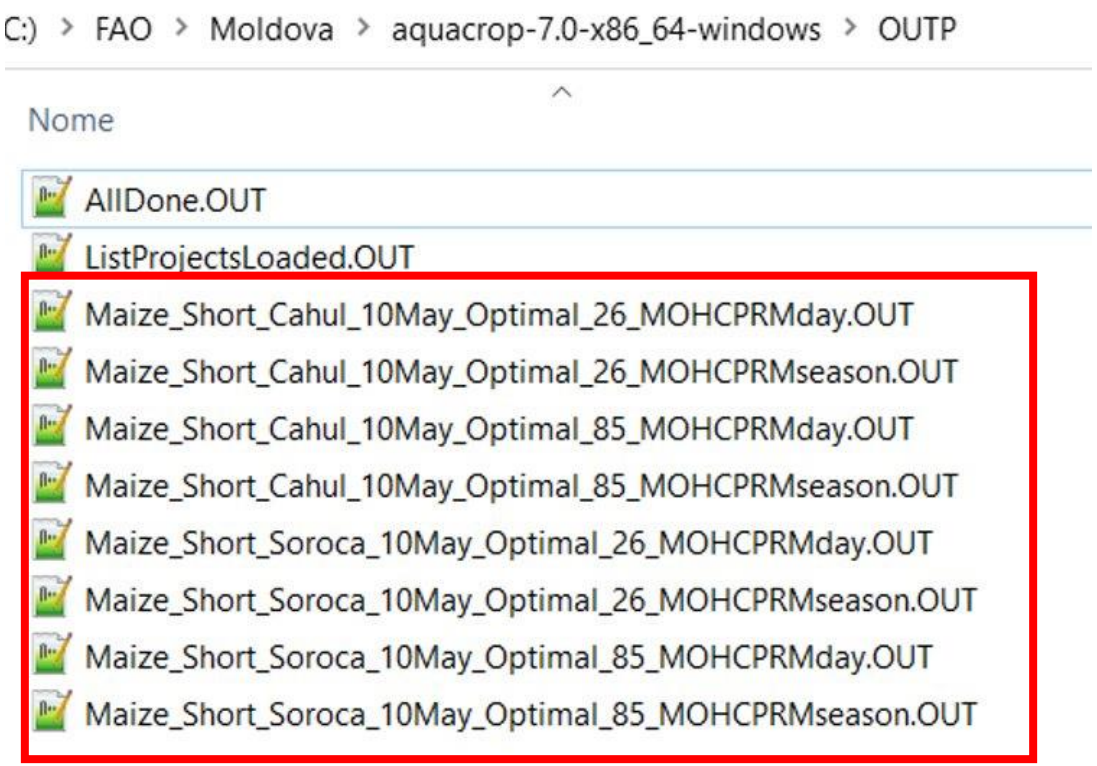
- Run the plug-in by double-clicking on aquacrop.exe



Plug-in

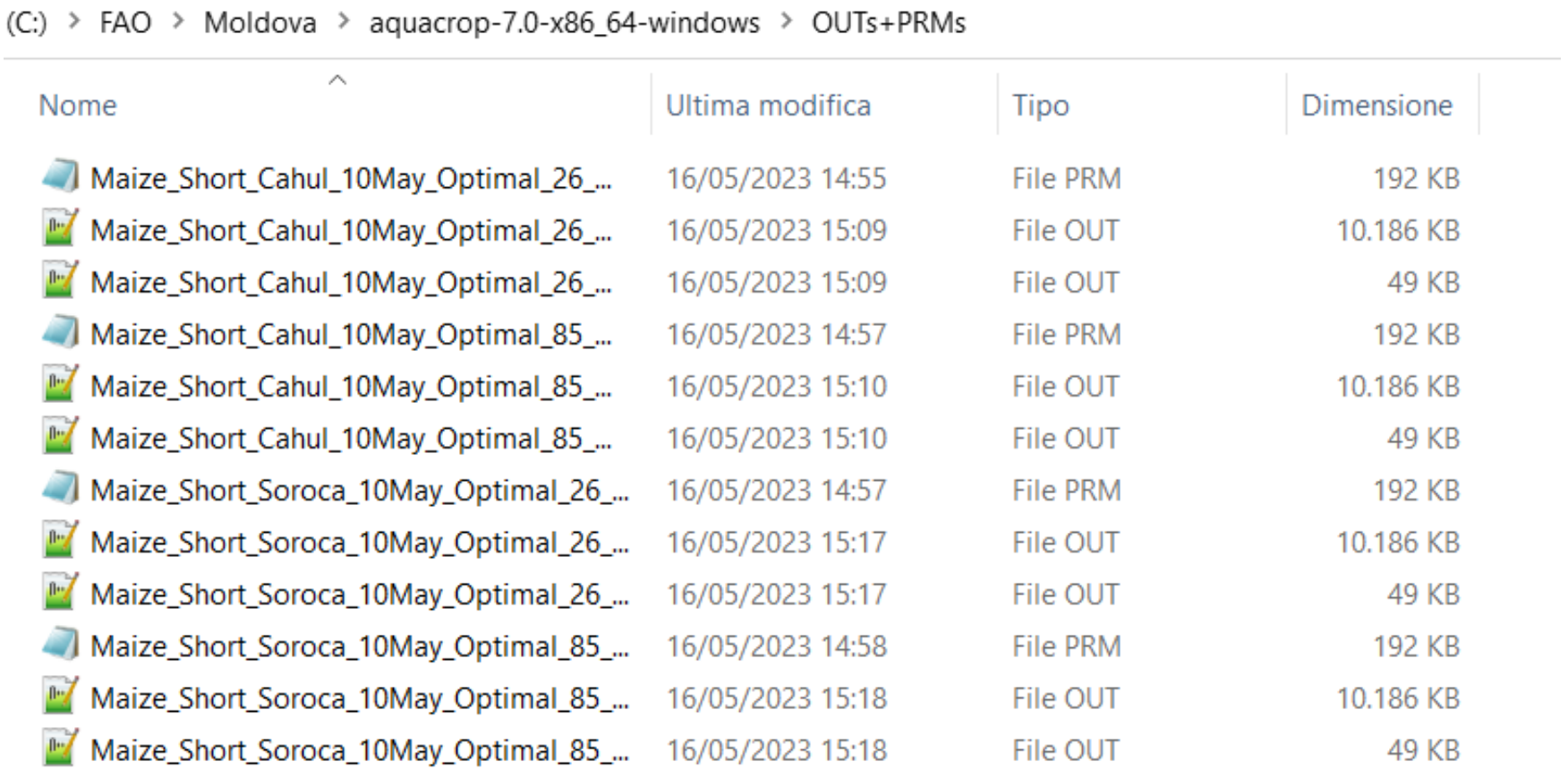
- After the plug-in worked, you will find the .OUT files (daily and seasonal) in the OUTP folder





Plug-in

Create a new folder and copy and paste the PRMs and OUTs data.



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Simulation Scheme

May 30, 2022

Food and Agriculture Organization of the United Nations

Simulation scheme

Maize, tomato, green pea, sunflower

Varieties (x1)	Locations (x3)	Sowing dates (x3)	Management (x2)	RCPs (x2)	GCMs (x3)
	Soroca	Calibrated/validated	Optimum	2.6	MOHC-HadGEM2-ES
	Chisinau	15 days before	Non-optimum		NCC-NorESM1-M
				8.5	
	Cahul	15 days later			MPI-M-MPI-ESM-LR

Total project files: 108 **files**
Name file: Crop_Variety_Location_Sowingdate_Management_RCP_GCM
Time frames: 2010-2039 (near-term); 2040-2071 (mid-term); 2070-2099 (long-term)
Outputs: Yield; CWP; abiotic stresses (canopy expansion; stomatal closure)

Wheat

Varieties (x1)	Locations (x1)	Sowing dates (x3)	Management (x2)	RCPs (x2)	GCMs (x3)
		Calibrated/validated	Optimum	2.6	MOHC-HadGEM2-ES
	National	15 days before	Non-optimum	8.5	NCC-NorESM1-M
		15 days later			MPI-M-MPI-ESM-LR

Total project files: 36 **files**
Name file:
Wheat_Variety_Location_Sowingdate_Management_RCP_GCM
Time frames: 2010-2039 (near-term); 2040-2071 (mid-term); 2070-2099 (long-term)
Outputs: Yield; CWP; abiotic stresses (canopy expansion; stomatal closure)

Thank you!

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andrea.setti@fao.org