



Food and Agriculture Organization of the United Nations



FAO Follow-up AquaCrop training

June 30, 2023

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



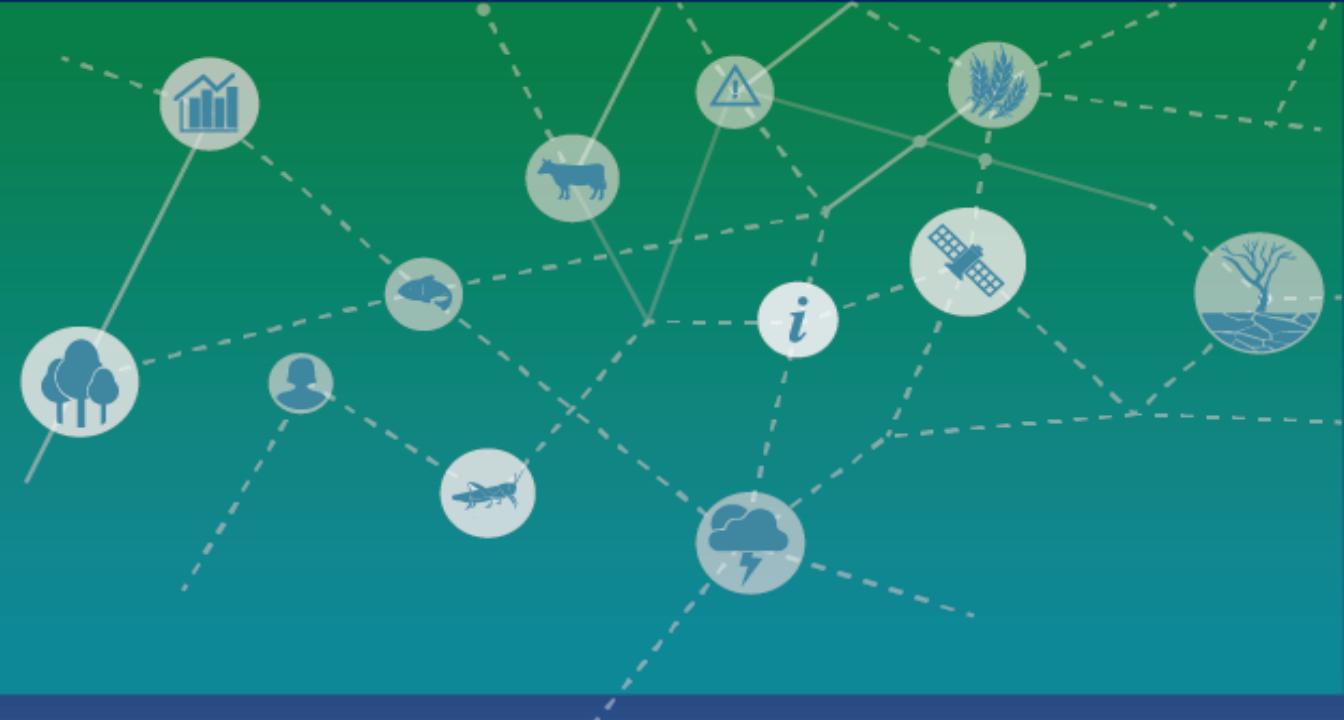
Workshop's agenda

30th June 2023 (4 h)

Content	Panelists
-Welcoming remarks	Ala Druta
-Introduction to AquaCrop crop water stress (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)	Jorge Alvar Andrea Setti Riccardo Soldan



**Food and Agriculture
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United Nations**



Introduction to AquaCrop crop water stress

June 30, 2023



Introduction content

- Water stress in AquaCrop
- Effect of water stress on harvest index
- Crop module and water stress tolerance

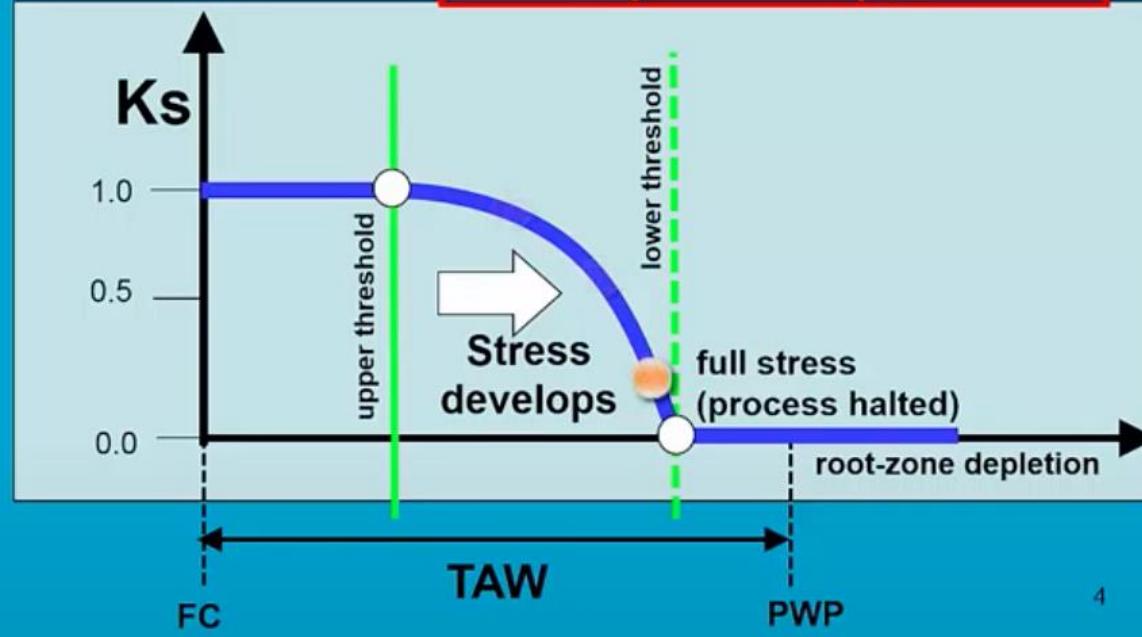
Water stress in AquaCrop

$$\text{CGC}_{\text{adj}} = K_{\text{s exp,w}} \text{ CGC}$$

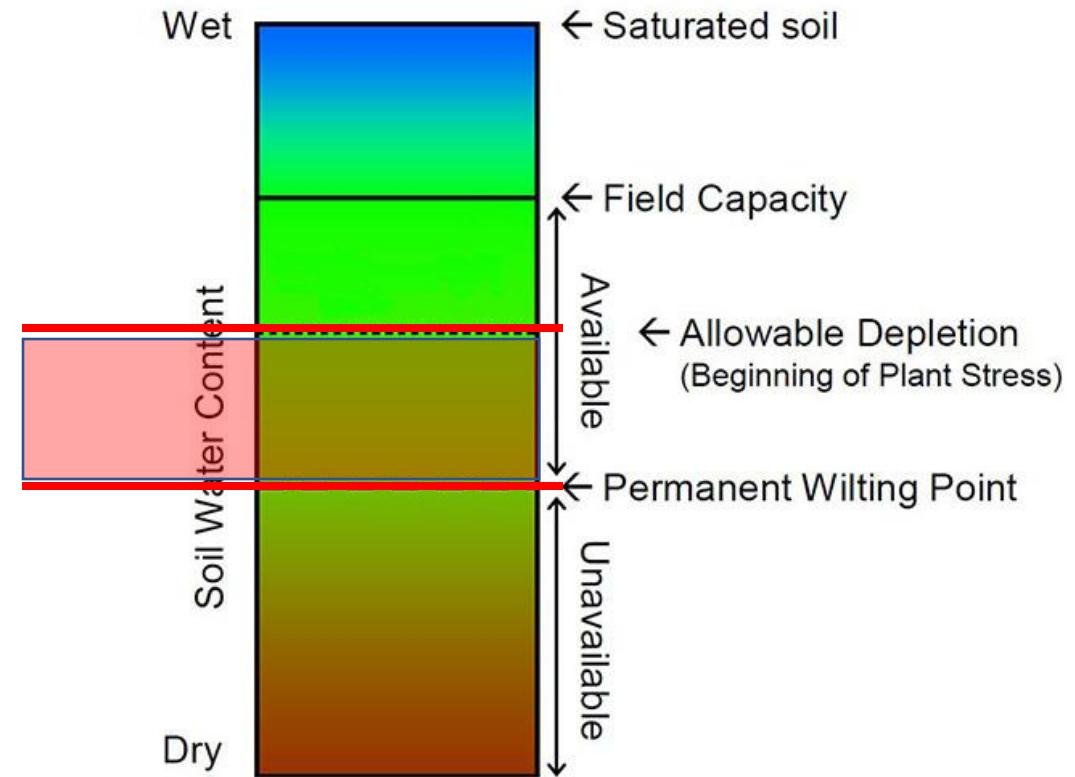
Soil water stress coefficient

K_s is a modifier which affects a target model parameter (e.g. Canopy Growth Coefficient which expresses the speed of canopy expansion)

$$\text{CGC}_{\text{adj}} = K_{\text{s exp,w}} \text{ CGC}$$

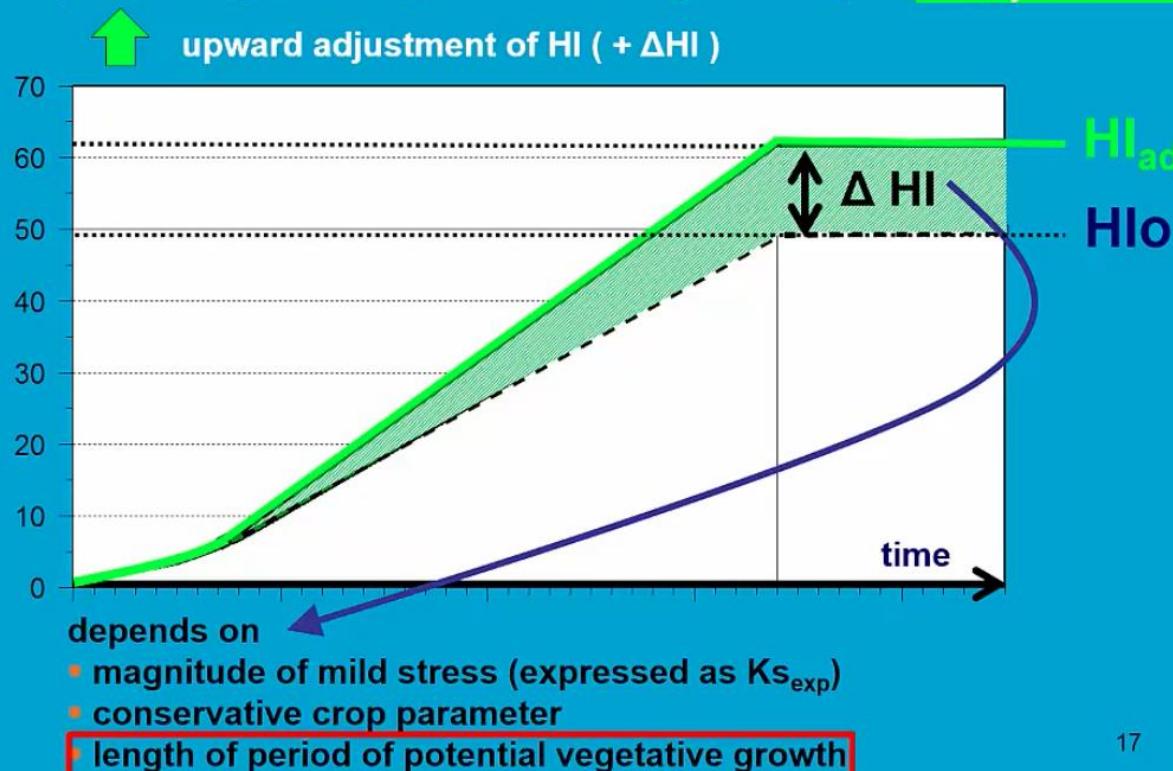


Soil Water Content

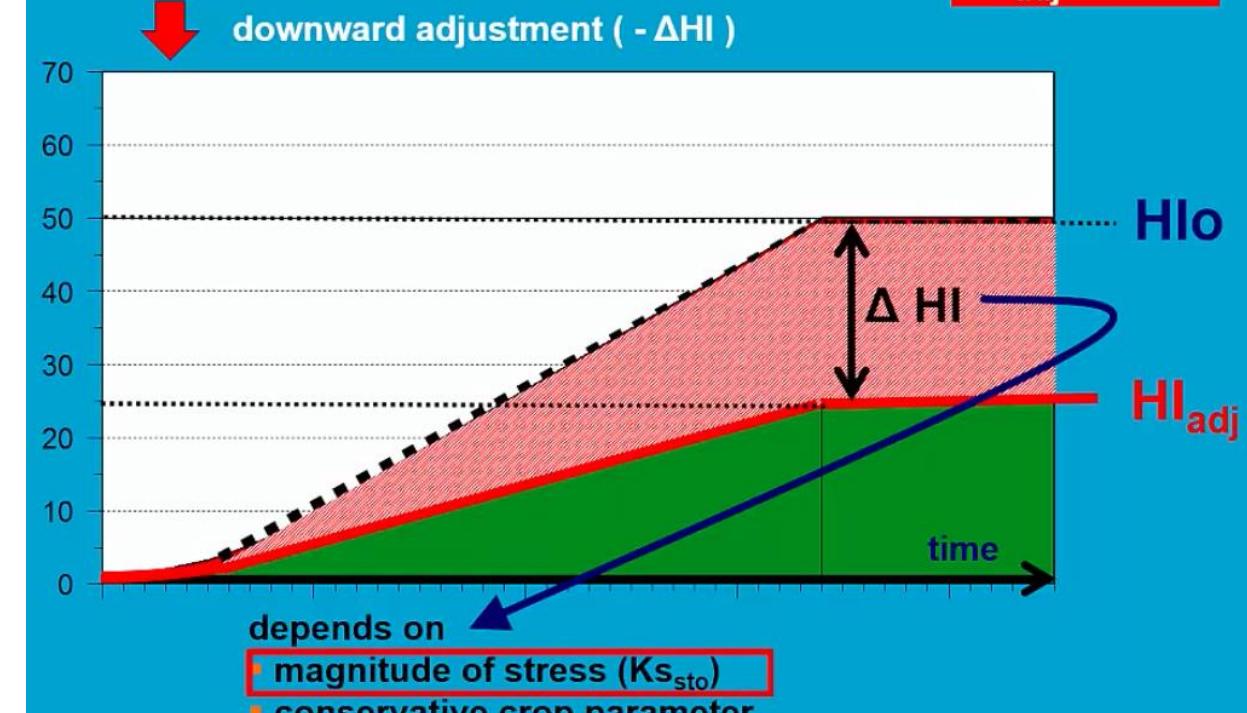


Effect of water stress on harvest index (yields)

- Water stress affecting leaf growth
(when vegetative growth is still possible)



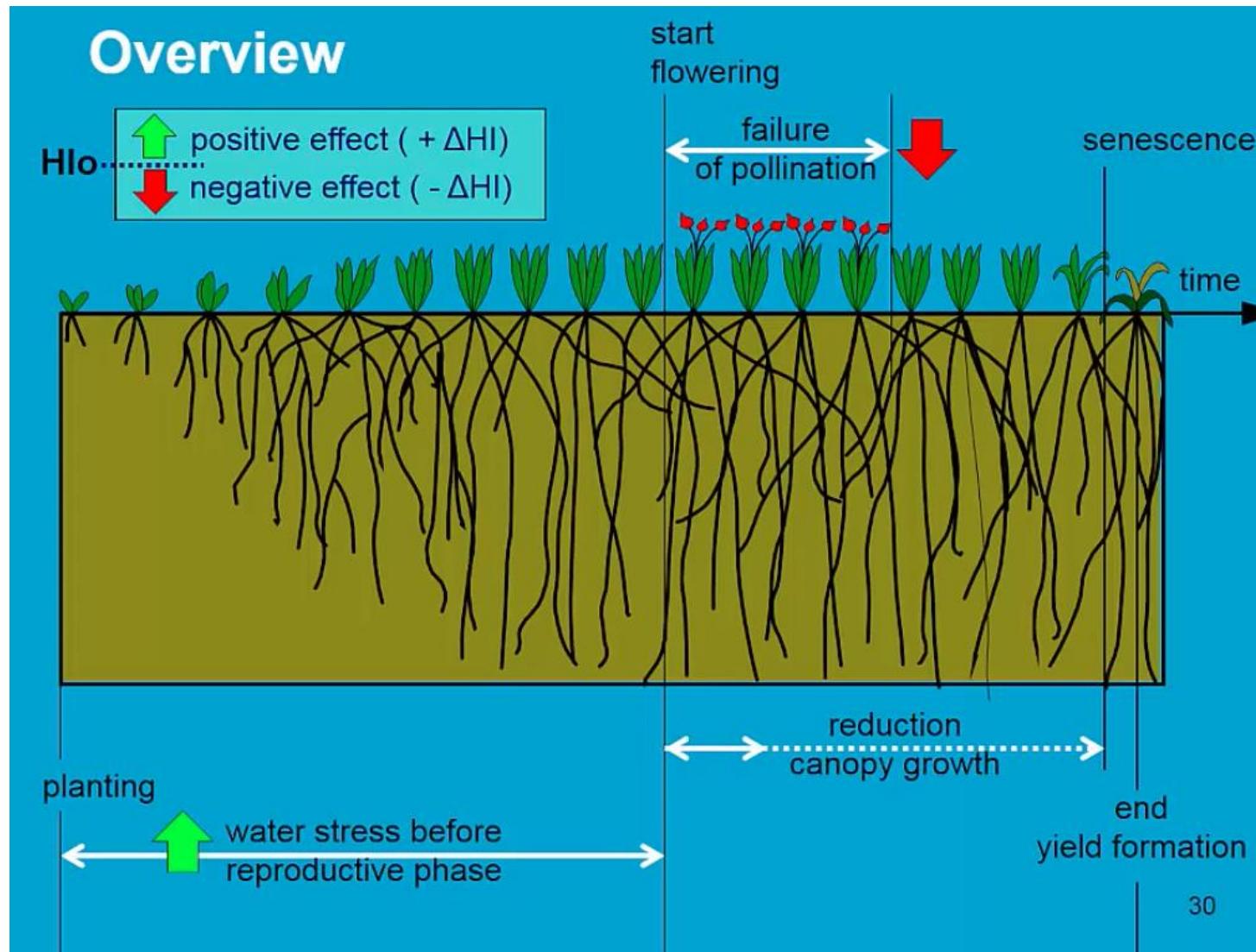
- Water stress affecting stomatal closure
(during yield formation)



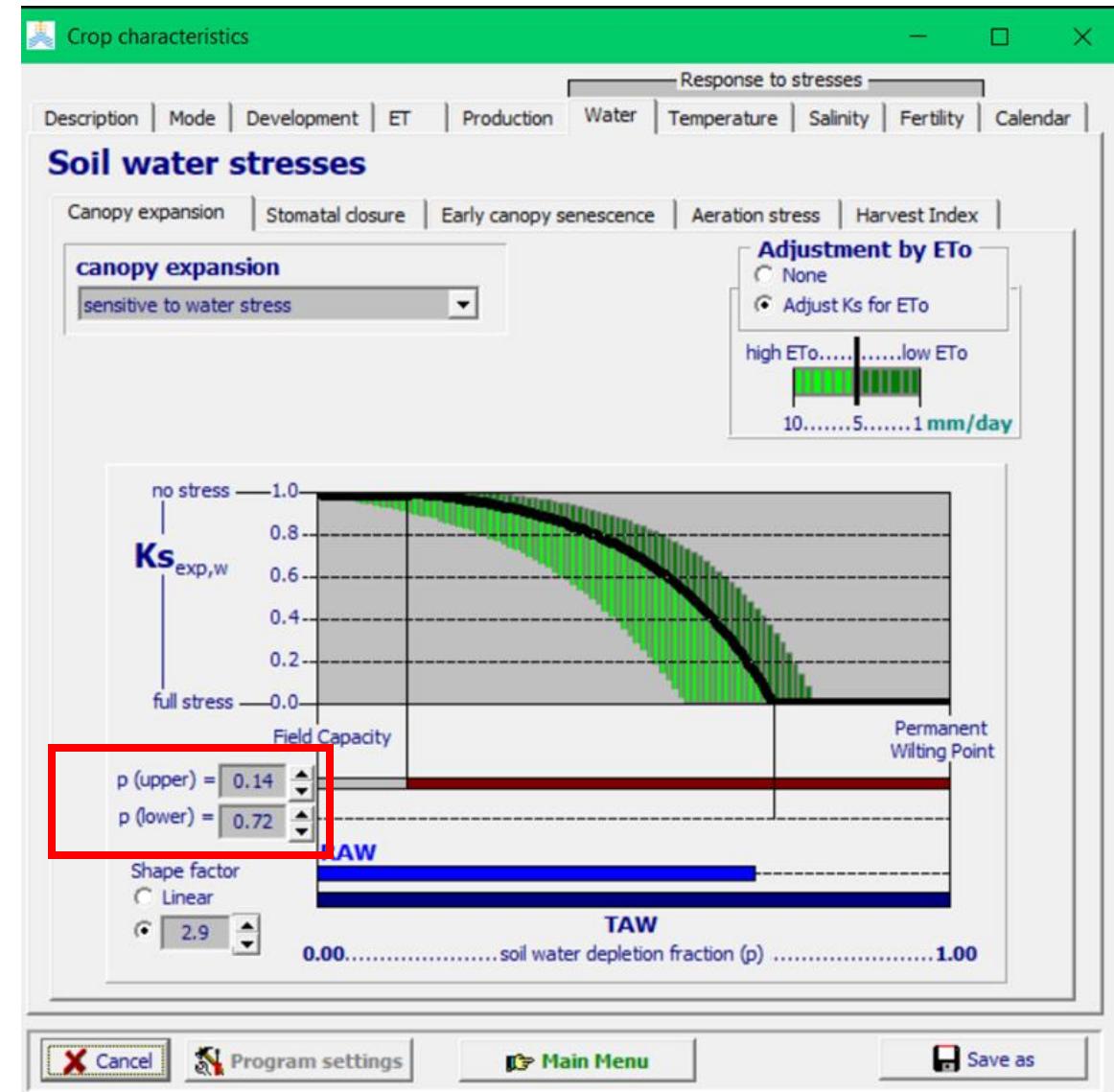
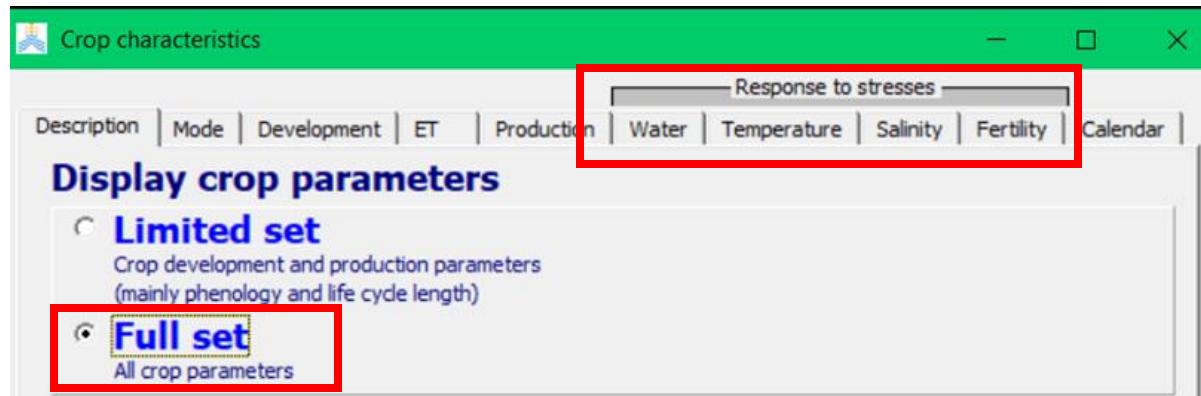
Mild and moderate stress during vegetative growth: up to + 20% Hi

Mild and moderate stress during yield formation: up to - 40% Hi

Effect of water stress overview



Crop module and water tolerance thresholds



* TAW – total available water
RAW – ready available water

Crop module and water tolerance thresholds

Crop characteristics

Response to stresses

Description | Mode | Development | ET | Production | Water | Temperature | Salinity | Fertility | Calendar

Soil water stresses

Canopy expansion | Stomatal closure | Early canopy senescence | Aeration stress | Harvest Index

canopy expansion
sensitive to water stress

Adjustment by ETo
 None
 Adjust Ks for ETo
high ETo.....low ETo
10.....5.....1 mm/day

Ks_{exp,w}
no stress — 1.0
0.8
0.6
0.4
0.2
full stress — 0.0

TAW
Field Capacity | Permanent Wilting Point

p (upper) = 0.14
p (lower) = 0.72

Shape factor
 Linear
 2.9

soil water depletion fraction (p) 0.00.....1.00

Cancel **Program settings** **Main Menu** **Save as**

Crop characteristics

Response to stresses

Description | Mode | Development | ET | Production | Water | Temperature | Salinity | Fertility | Calendar

Soil water stresses

Canopy expansion | Stomatal closure | Early canopy senescence | Aeration stress | Harvest Index

canopy expansion
tolerant to water stress

Adjustment by ETo
 None
 Adjust Ks for ETo
high ETo.....low ETo
10.....5.....1 mm/day

Ks_{exp,w}
no stress — 1.0
0.8
0.6
0.4
0.2
full stress — 0.0

TAW
Field Capacity | Permanent Wilting Point

p (upper) = 0.30
p (lower) = 0.65

Shape factor
 Linear
 2.9

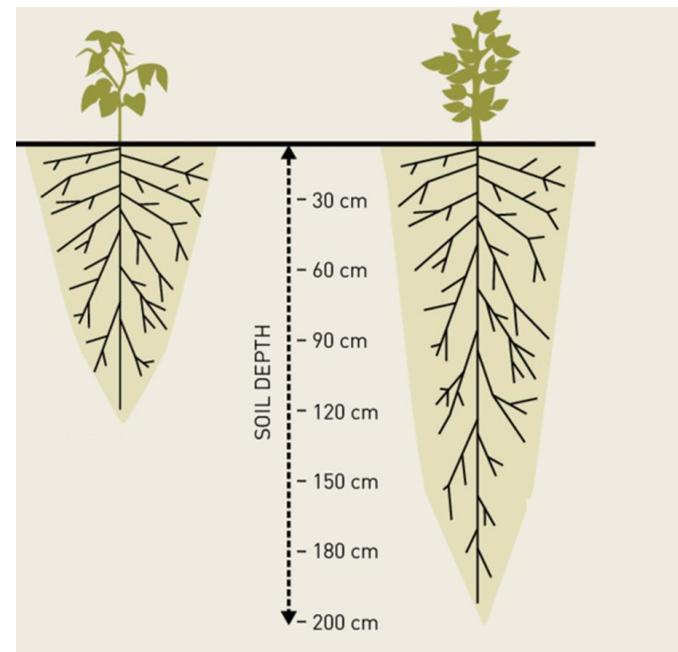
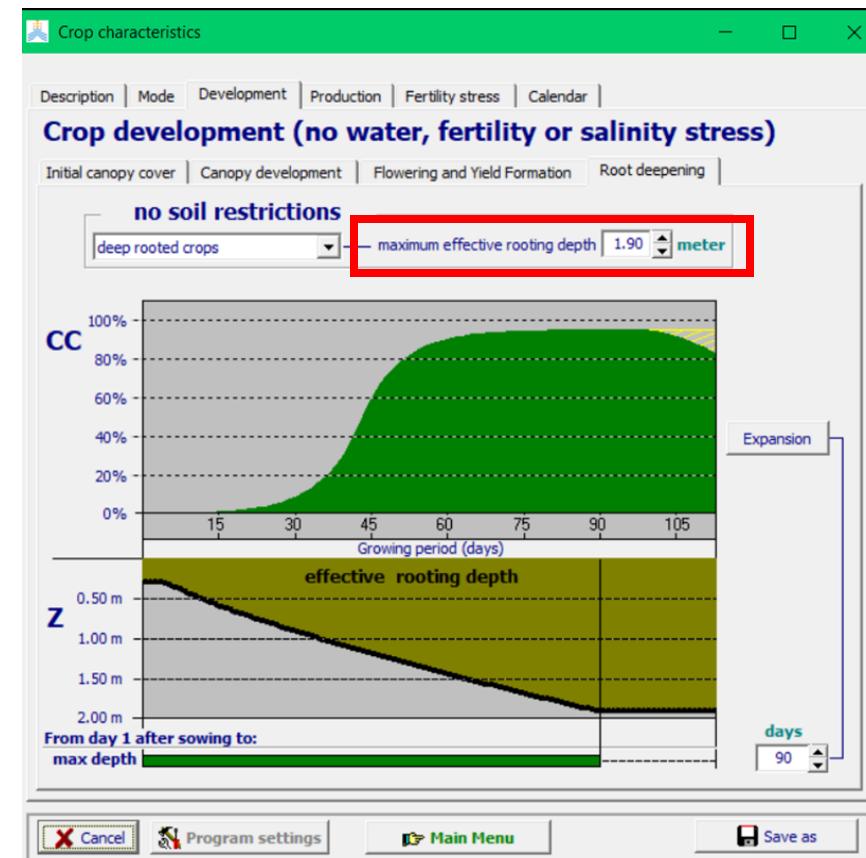
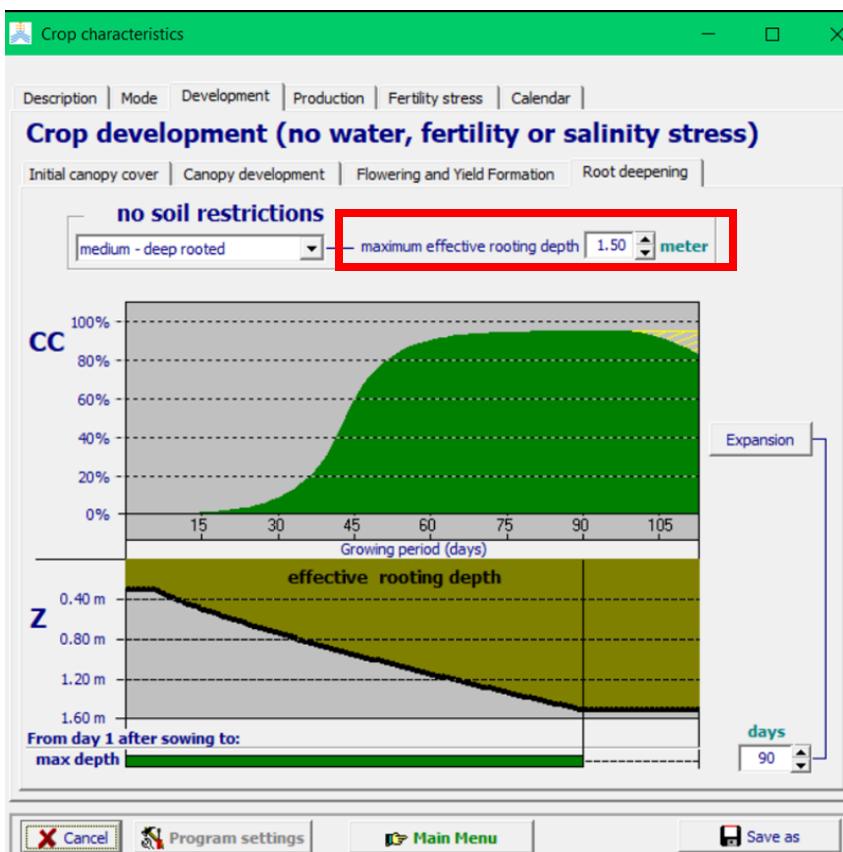
soil water depletion fraction (p) 0.00.....1.00

Cancel **Program settings** **Main Menu** **Save as**

Crop module and water tolerance

Alternative options to increase crop tolerance to water stress

- Timing of flowering
- Timing to reach the maximum canopy cover
- Root depth
- Etc..





Food and Agriculture Organization of the United Nations



Tutorial: how to make project files

June 30, 2023



Objective

Objective: run AquaCrop to see the effect of future climate projection on two rainfed maize varieties with different water stress tolerance, under two emission scenarios (RCPs), in Cahul.

- GCM: MOHC
- RCPs: 2.6 and 8.5
- Crop varieties: Standard (Maize medium-rooted 150cm) and improved (deep-rooted 190cm).
- Locations: Cahul

Experimental design

Locations	Cahul
GCM	MOHC
RCPs	2.6 8.5
Management	Optimal
Crop (mazie)	Standard Improved

4 Project files

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

Maize_Standard_Cahul_10May_Optimal_26_MOHC
Maize_Standard_Cahul_10May_Optimal_85_MOHC
Maize_Improved_Cahul_10May_Optimal_26_MOHC
Maize_Improved_Cahul_10May_Optimal_85_MOHC

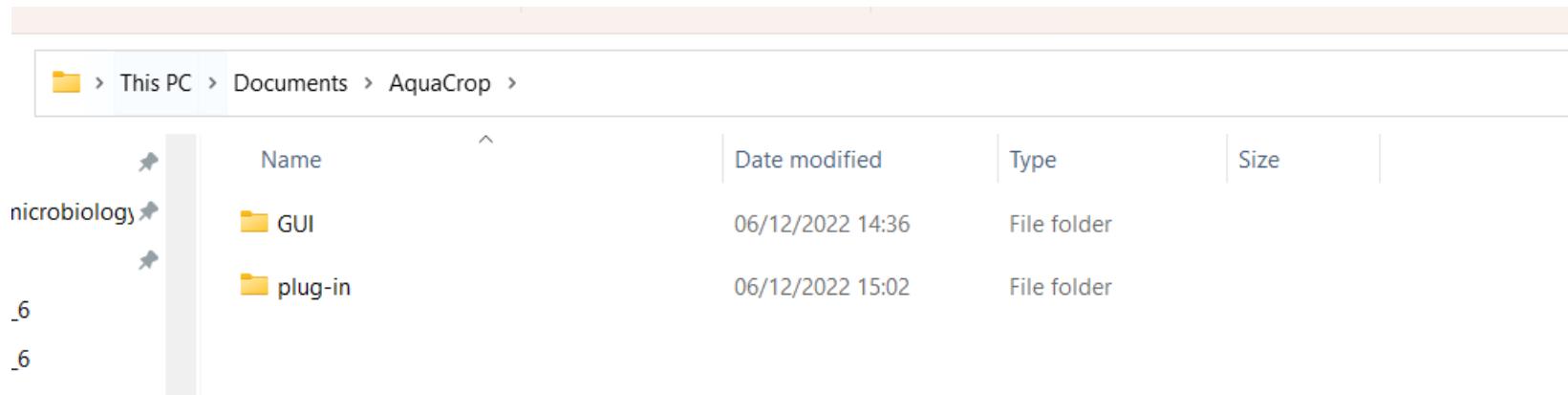


Instruction

- The link to all the **SLIDES** presented in this workshop can be found at: <https://github.com/Risk-Team/Moldova-workshop> under "Follow-up workshop: June 30th"
- The link to the **DATA** used in this workshop can be found at: https://www.dropbox.com/sh/1tvn0bs252tj7mi/AAAE4keAW4Z6-y05F3_uSuwa?dl=0

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

The screenshot shows a Windows File Explorer window with the following directory path: This PC > Desktop > Moldova-workshop-main > Moldova-workshop-main. The contents of the folder are listed in a table:

Name	Date modified	Type	Size
slides	07/12/2022 16:07	File folder	
.gitignore	07/12/2022 16:07	GITIGNORE File	1 KB
README.md	07/12/2022 16:07	MD File	9 KB

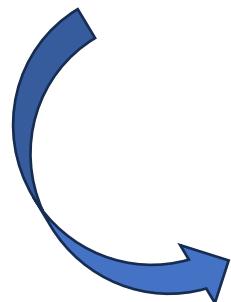
- Where your AquaCrop installations should be

The screenshot shows a Windows File Explorer window with the following directory path: This PC > Documents > AquaCrop. The contents of the folder are listed in a table:

Name	Date modified	Type	Size
GUI	06/12/2022 14:36	File folder	
plug-in	06/12/2022 15:02	File folder	

In case you do not have AquaCrop installed

- *To run the plugin the text file named "DailyResults.SIM" is needed to be in the "SIMUL" folder of the plugin. Download and paste [this file](#).



C:\ > FAO > Moldova > aquacrop-7.0-x86_64-windows >			
Nome	Ultima modifica	Tipo	Dimensione
LIST	17/05/2023 19:08	Cartella di file	
OUTP	16/05/2023 16:11	Cartella di file	
PARAM	17/08/2022 09:22	Cartella di file	
SIMUL	16/05/2023 12:53	Cartella di file	
aquacrop.exe	16/05/2023 12:19	Applicazione	1.740 KB
AUTHORS.md	16/05/2023 12:19	File MD	1 KB
LICENSE	16/05/2023 12:19	File	2 KB

Upload of the files

Go to the GUI downloaded folder and **remove all the content** of your personal “DATA” folder.

Follow the shown path:

Nome	Ultima modifica
1 aquacrop-7.0-x86_64-windows	16/05/2023 12:19
1 GUI_AC7	18/05/2023 11:28

... > FAO > Moldova > GUI_AC7 >

Nome	Ultima modifica
2 AquaCropV70No17082022	17/05/2023 17:37

3	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

In case you would like to reinitialize the AquaCrop default data you can find it in the “Data with default AquaCrop files” folder.

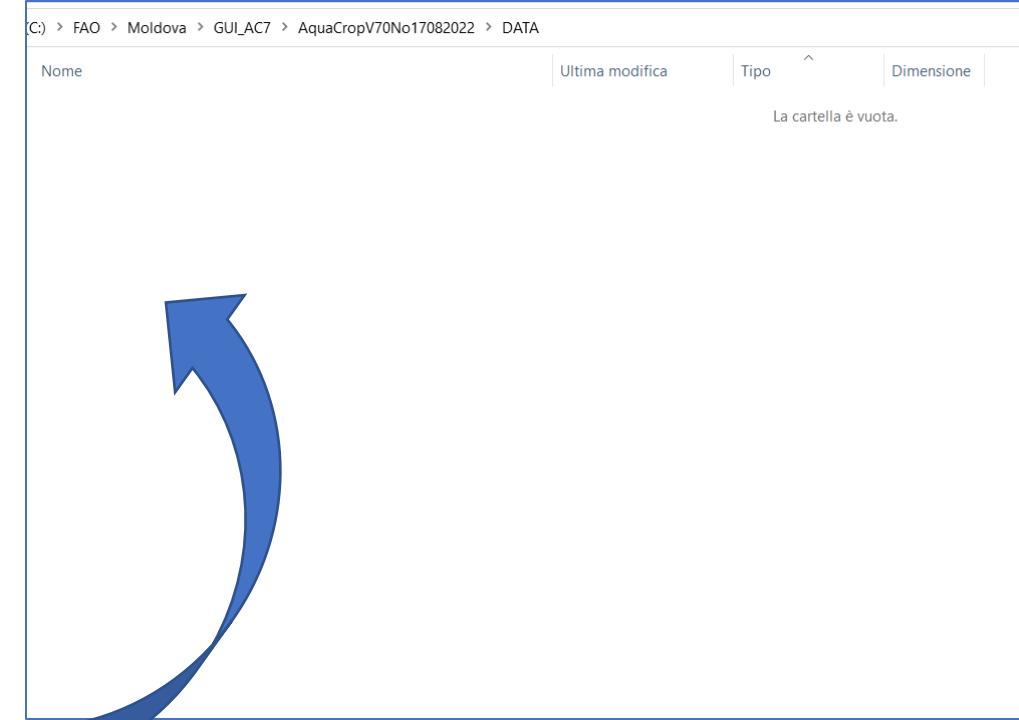
Upload of the files

Copy and paste the DATA folder content to your personal DATA folder.

Here you can find the DATA folder content

(C:) > FAO > Moldova > GUI_AC7 > AquaCropV70No17082022 > DATA				
Nome	Ultima modifica	Tipo	Dimensione	
10May.CAL	20/04/2023 15:28	File CAL	1 KB	
Cahul_MOHC-HadGEM2-ES_rcp26.CLI	11/11/2022 17:12	File CLI	1 KB	
Cahul_MOHC-HadGEM2-ES_rcp85.CLI	11/11/2022 17:12	File CLI	1 KB	
Soroca_MOHC-HadGEM2-ES_rcp26.CLI	11/11/2022 17:12	File CLI	1 KB	
Soroca_MOHC-HadGEM2-ES_rcp85.CLI	11/11/2022 17:12	File CLI	1 KB	
RCP2-6.CO2	21/10/2022 16:02	File CO2	3 KB	
RCP4-5.CO2	21/10/2022 16:02	File CO2	3 KB	
RCP6-0.CO2	21/10/2022 16:02	File CO2	3 KB	
RCP8-5.CO2	21/10/2022 16:02	File CO2	3 KB	
SSP1_1.9.CO2	21/10/2022 16:02	File CO2	2 KB	
SSP1_2.6.CO2	21/10/2022 16:02	File CO2	2 KB	
SSP2_4.5.CO2	21/10/2022 16:02	File CO2	2 KB	
SSP3_7.0.CO2	21/10/2022 16:02	File CO2	2 KB	
SSP5_8.5.CO2	21/10/2022 16:02	File CO2	2 KB	
Maize-short.CRO	03/05/2023 16:31	File CRO	7 KB	
Optimal.MAN	16/05/2023 14:48	File MAN	2 KB	
Cahul_MOHC-HadGEM2-ES_rcp26.PLU	11/11/2022 17:12	File PLU	510 KB	
Cahul_MOHC-HadGEM2-ES_rcp85.PLU	11/11/2022 17:12	File PLU	510 KB	
Soroca_MOHC-HadGEM2-ES_rcp26.PLU	11/11/2022 17:12	File PLU	510 KB	
Soroca_MOHC-HadGEM2-ES_rcp85.PLU	11/11/2022 17:12	File PLU	510 KB	
North_South.SOL	27/10/2022 15:04	File SOL	1 KB	
Cahul_MOHC-HadGEM2-ES_rcp26.TNX	11/11/2022 17:12	File TNX	935 KB	
Cahul_MOHC-HadGEM2-ES_rcp85.TNX	11/11/2022 17:12	File TNX	935 KB	
Soroca_MOHC-HadGEM2-ES_rcp26.TNX	11/11/2022 17:12	File TNX	935 KB	
Soroca_MOHC-HadGEM2-ES_rcp85.TNX	11/11/2022 17:12	File TNX	935 KB	
Cahul_MOHC-HadGEM2-ES_rcp26.ETO	11/11/2022 17:12	WPS Spreadsheets...	510 KB	
Cahul_MOHC-HadGEM2-ES_rcp85.ETO	11/11/2022 17:12	WPS Spreadsheets...	510 KB	

Personal DATA folder

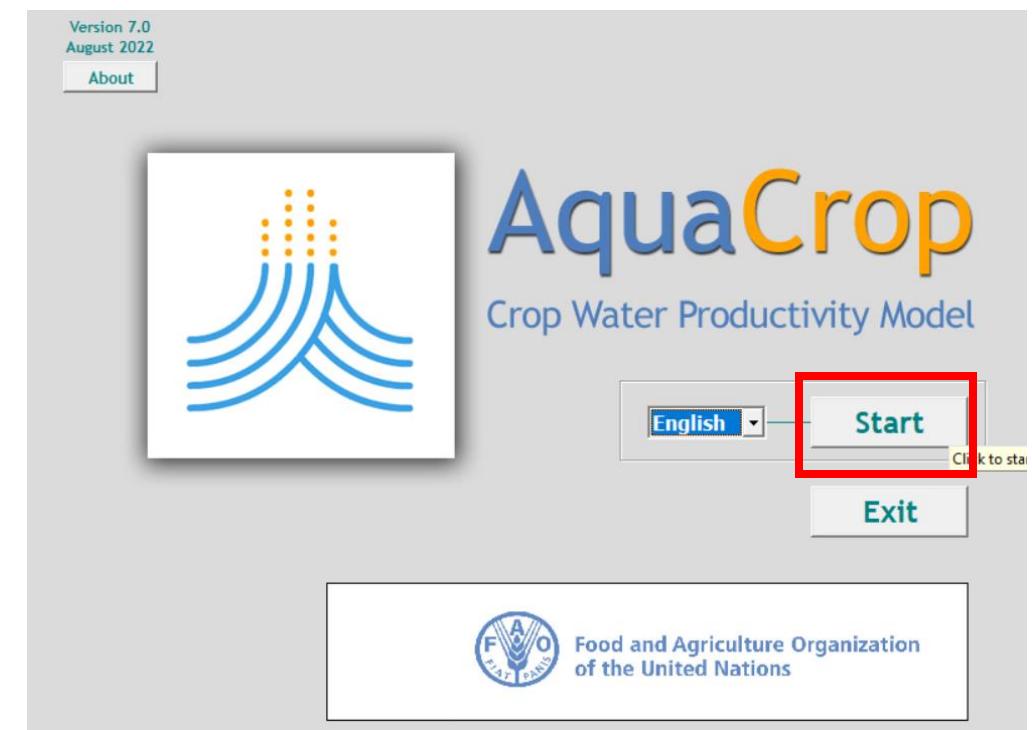


Open AquaCrop

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

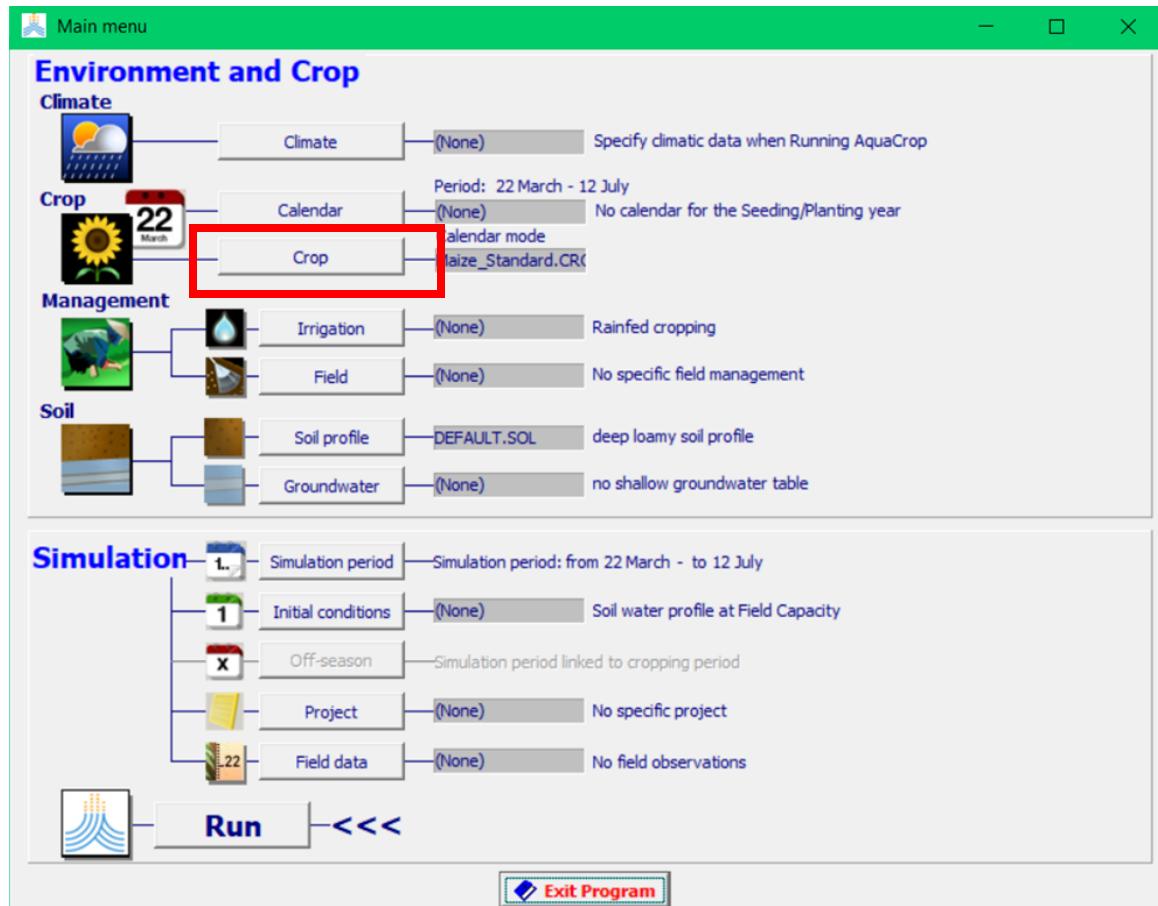
DATA	17/05/2023 17:27
IMPORT	20/04/2023 11:06
OBS	20/04/2023 11:06
OUTP	20/04/2023 11:06
SIMUL	17/05/2023 17:27
_DEISREG.ISR	20/04/2023 11:06
ISREG32.DLL	20/04/2023 11:06
AquaCrop.exe	20/04/2023 11:06
AquaCrop.ico	20/04/2023 11:06
DelsL1.isu	20/04/2023 11:06

2. Select language and press Start

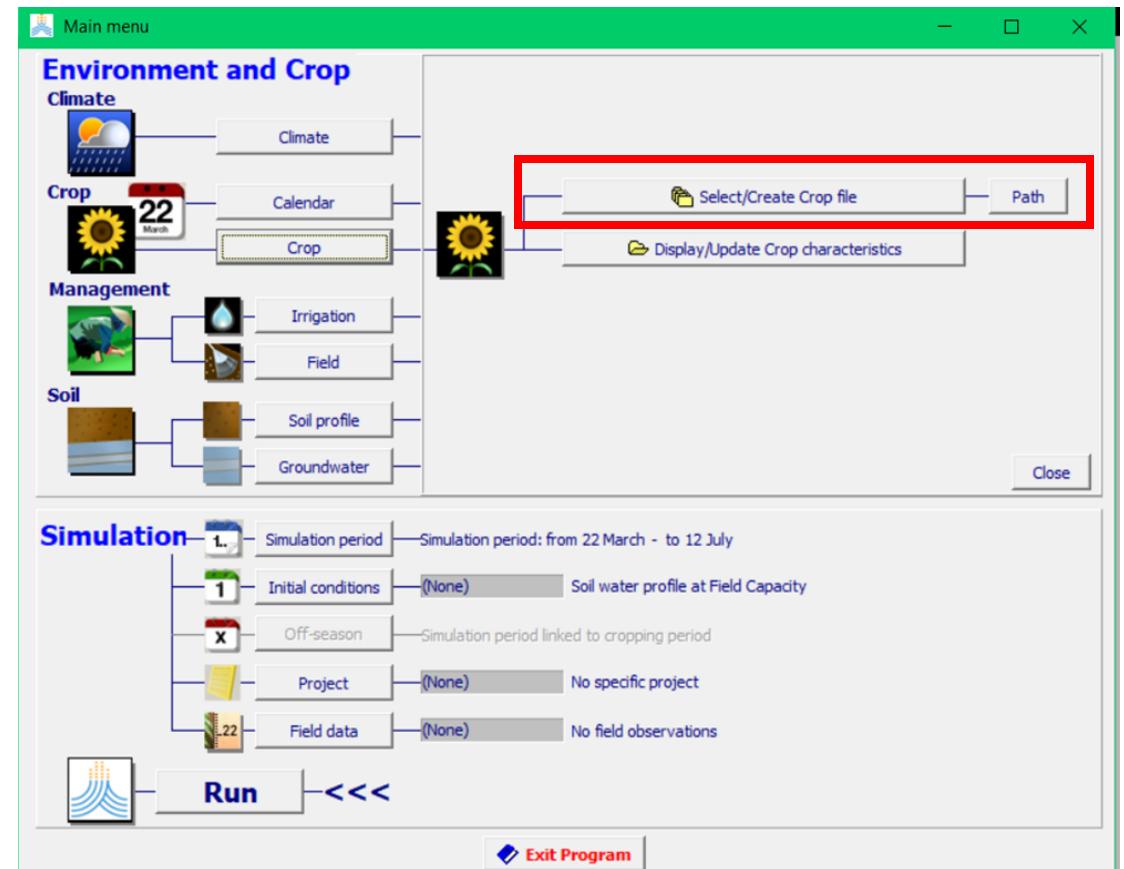


Creation of the crop file

Go to crop module

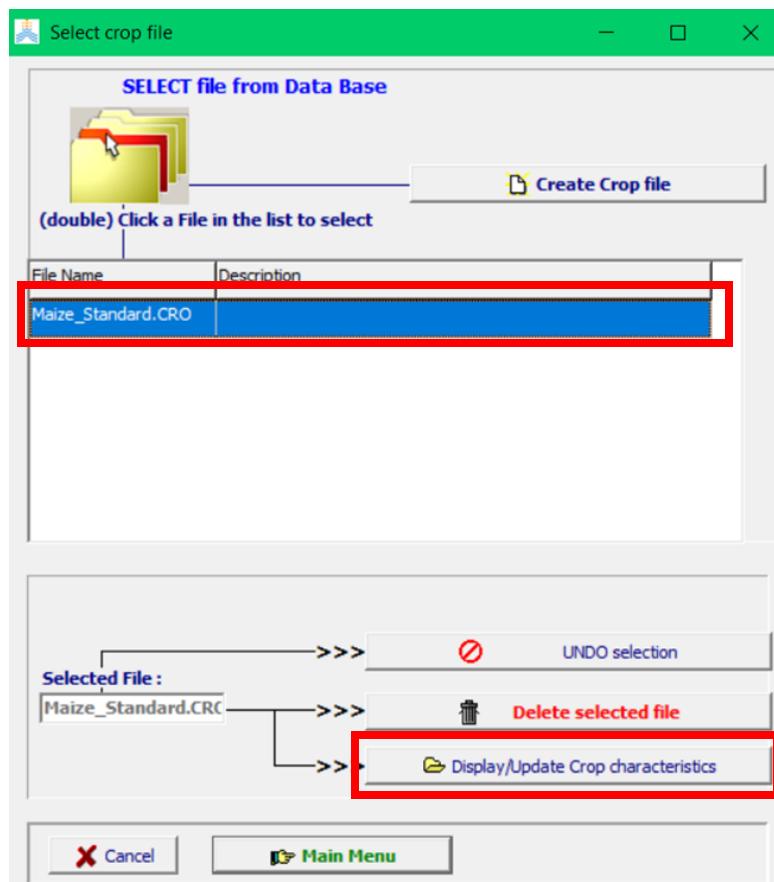


Click on Select/Create Crop file

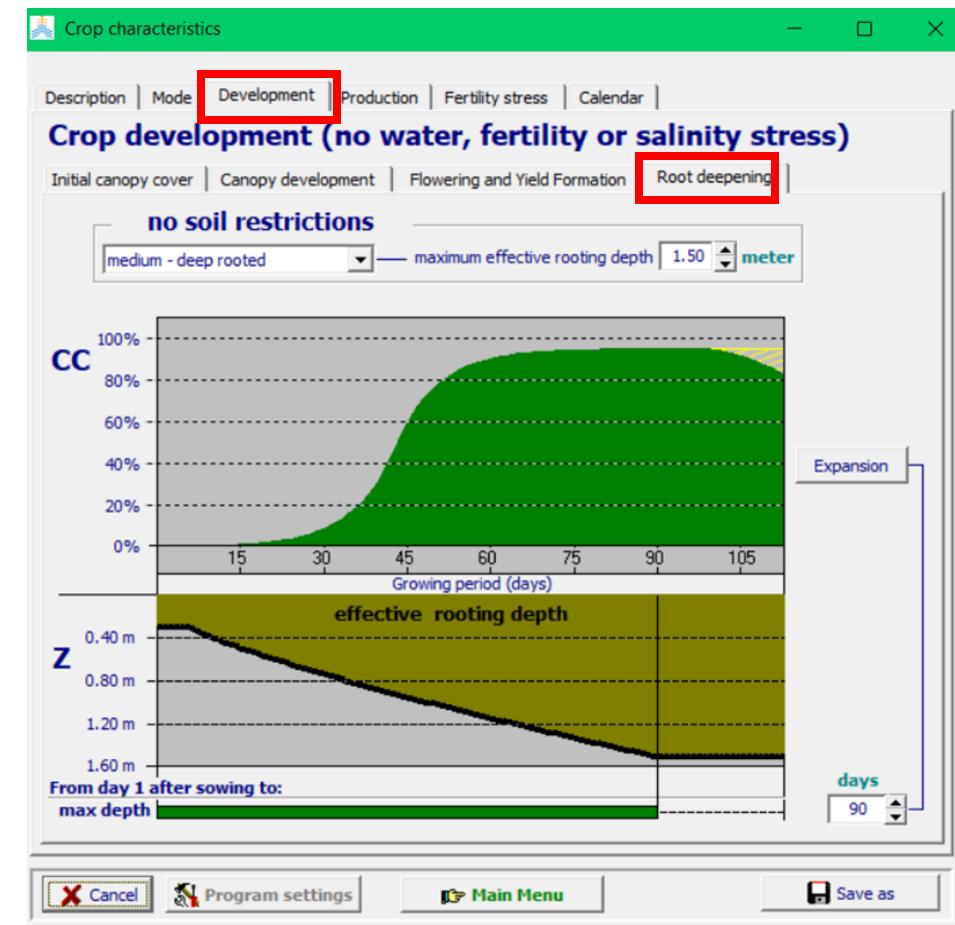


Creation of the crop file

- Select the crop file to be modified
- Click on Display/Update Crop characteristics

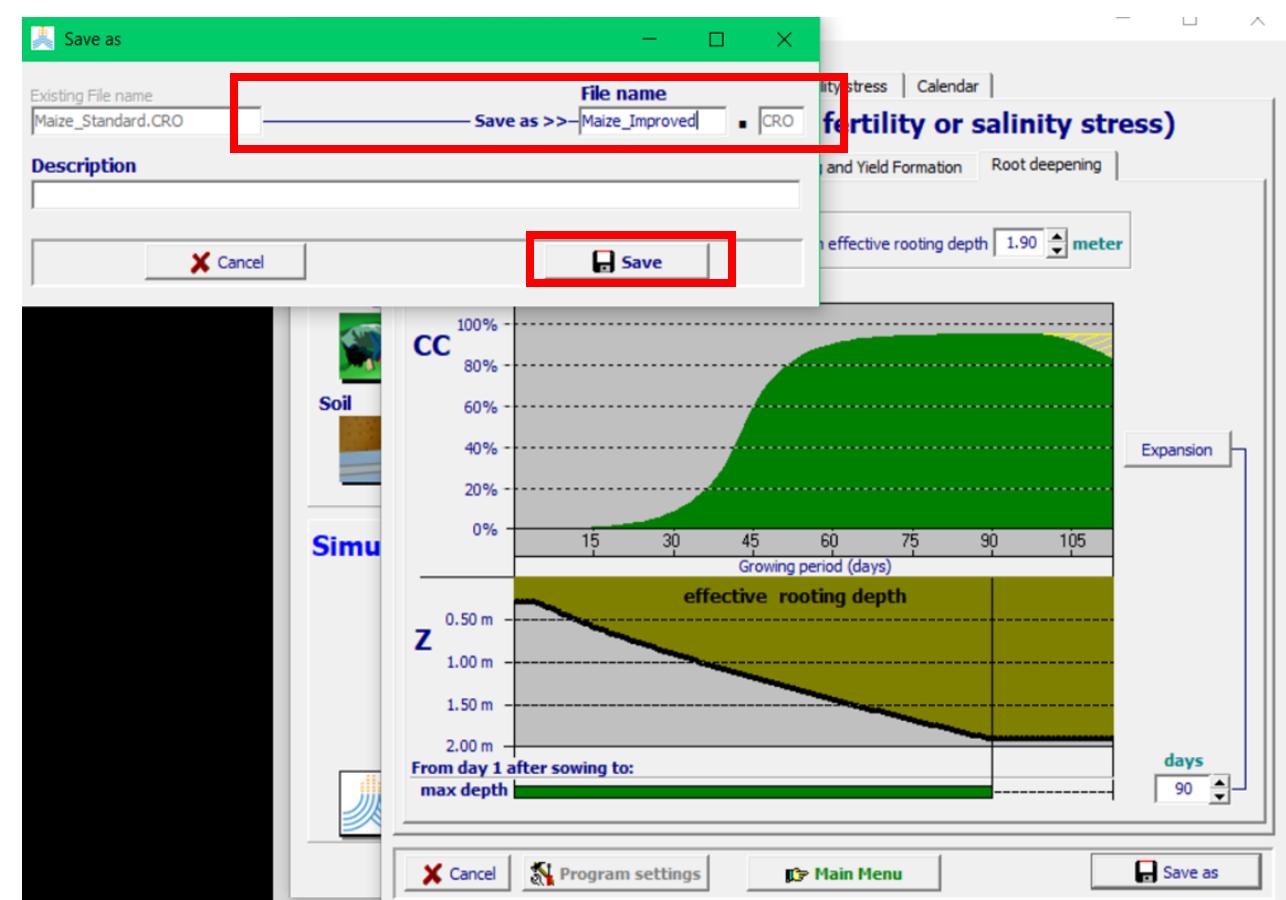
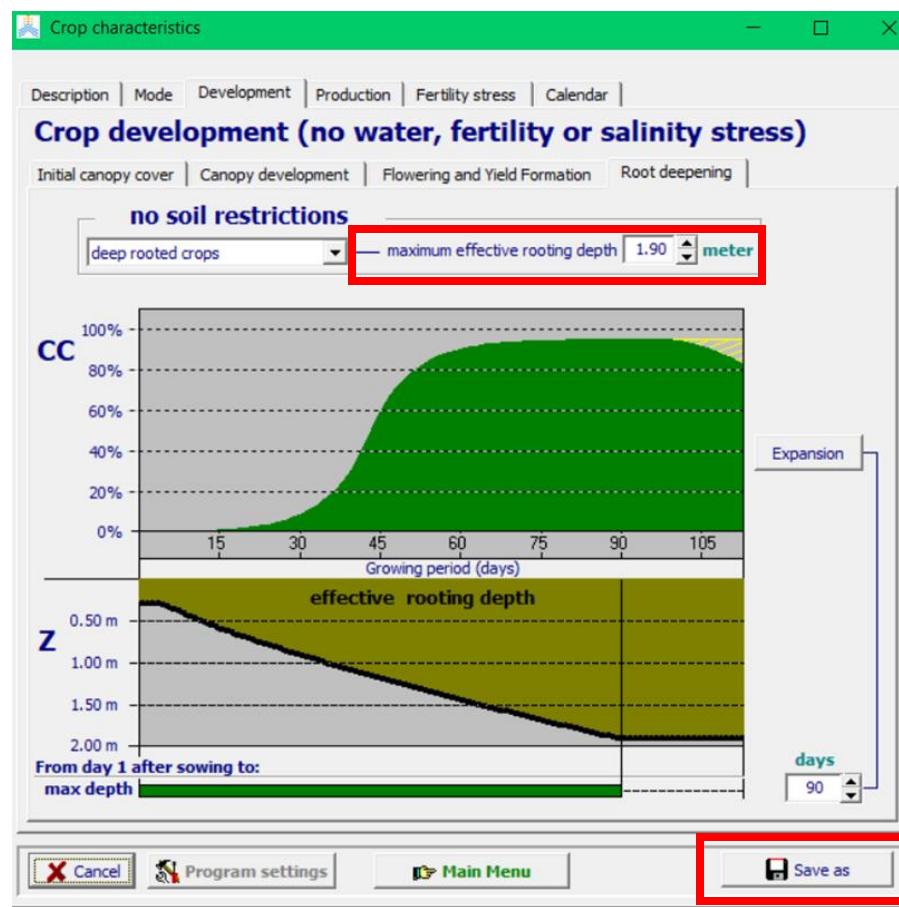


- Select the "Development" sub-module
- Click on "Root deepening"



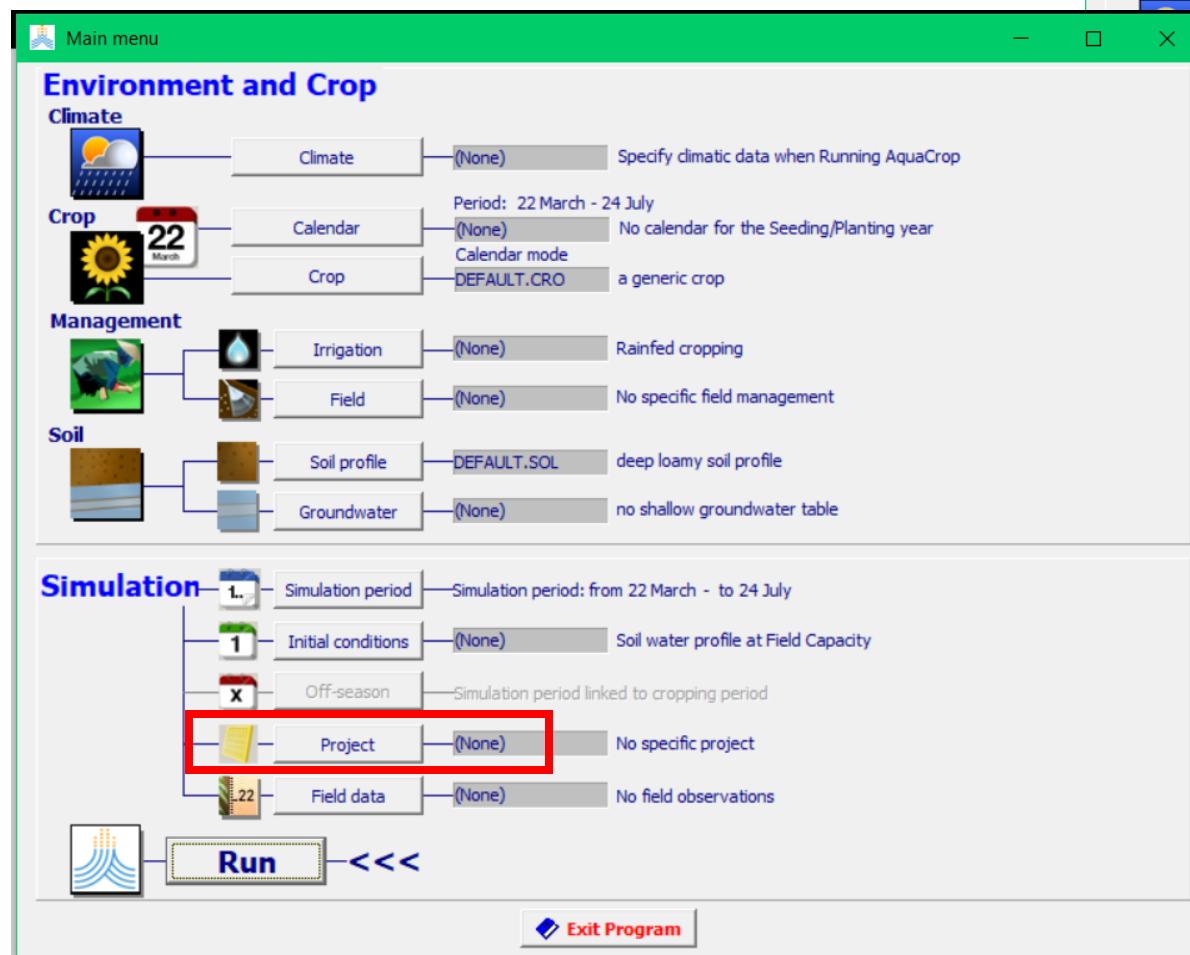
Creation of the crop file

- Bring the "Maximum effective rooting depth" up to 1.90 meters using the upper arrow.
- Select "Save as"

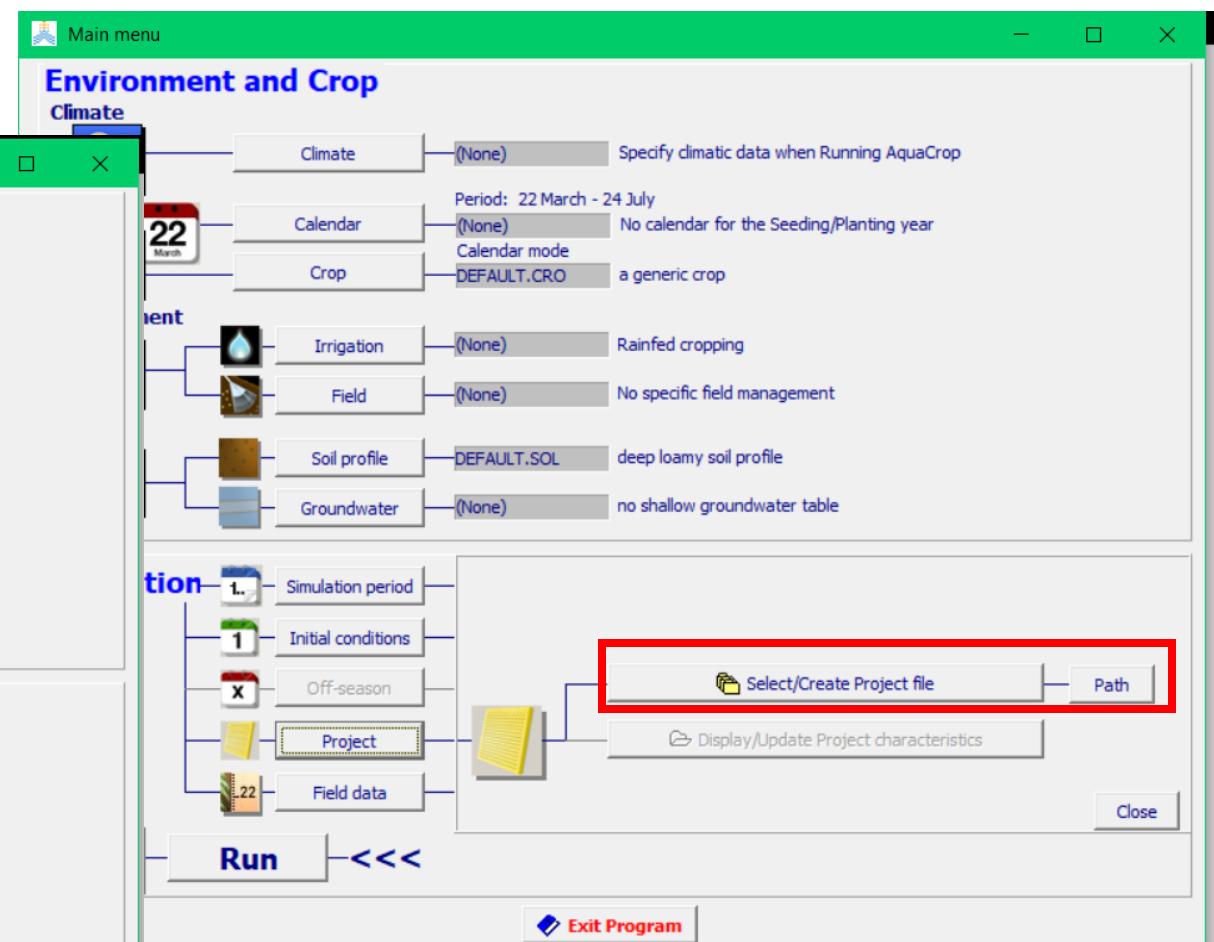


Creation of the project files (.PRM)

Press the “Project” button to create the project file

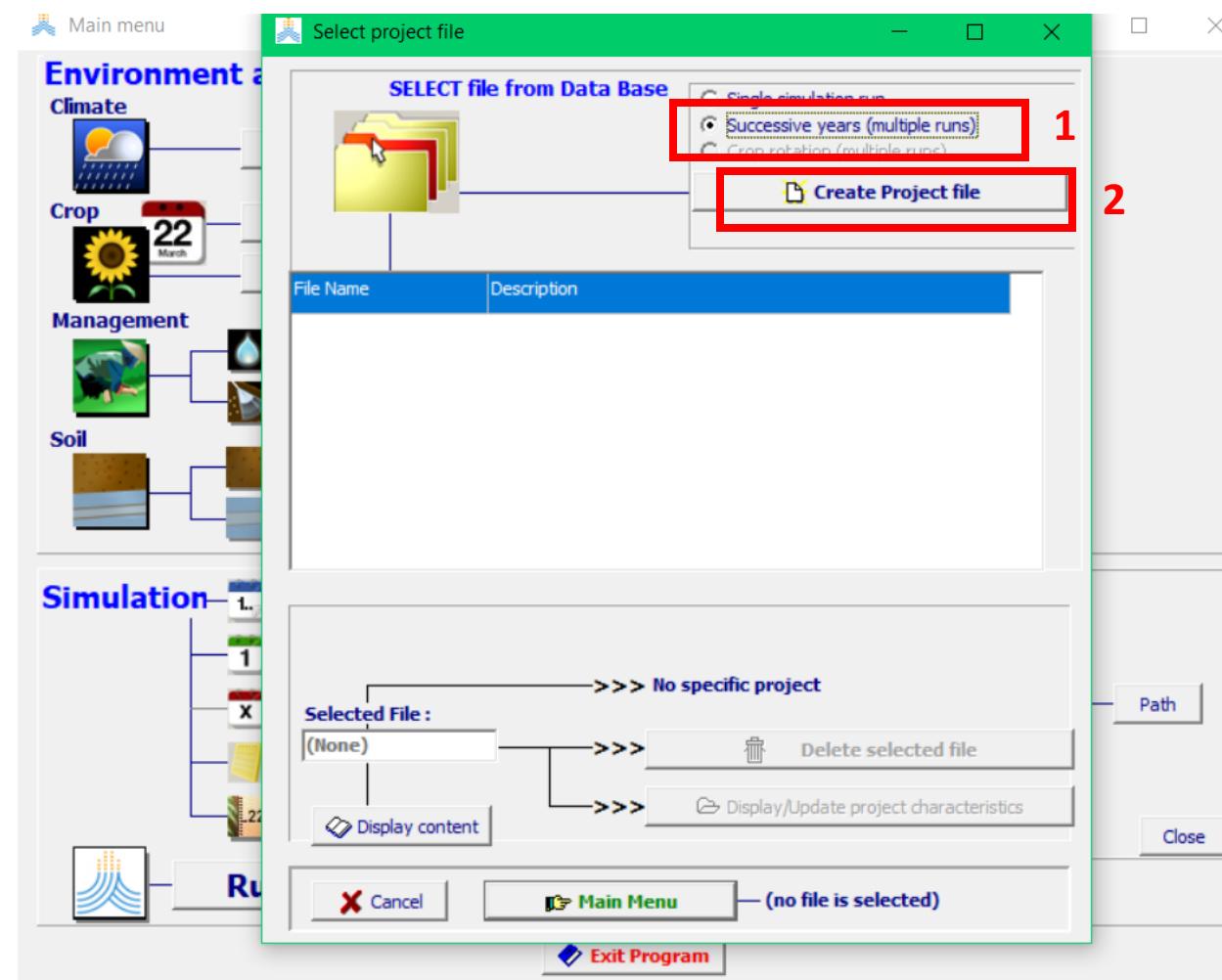


Click on “Select/Create Project file”



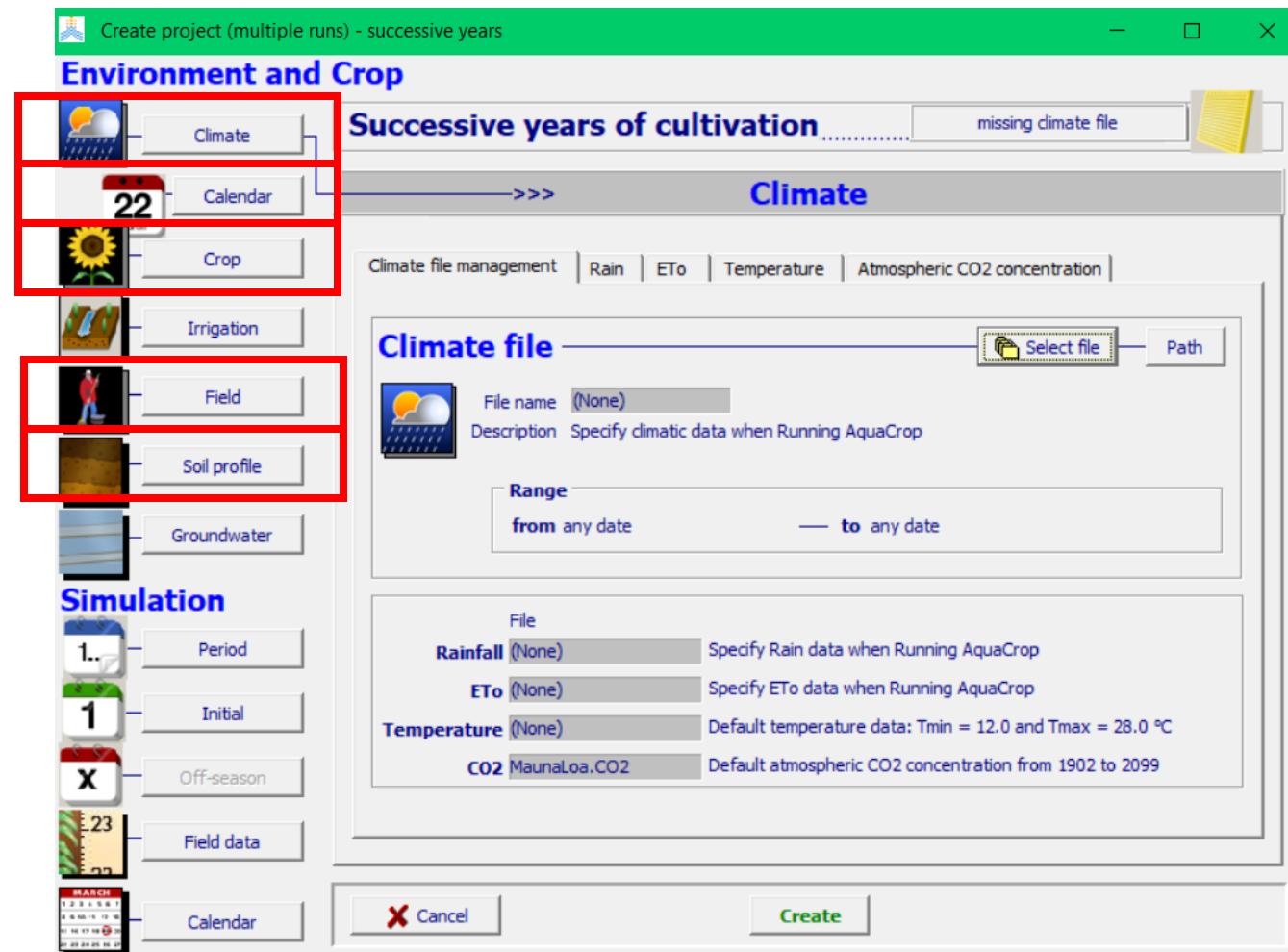
Creation of the project files (.PRM)

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)

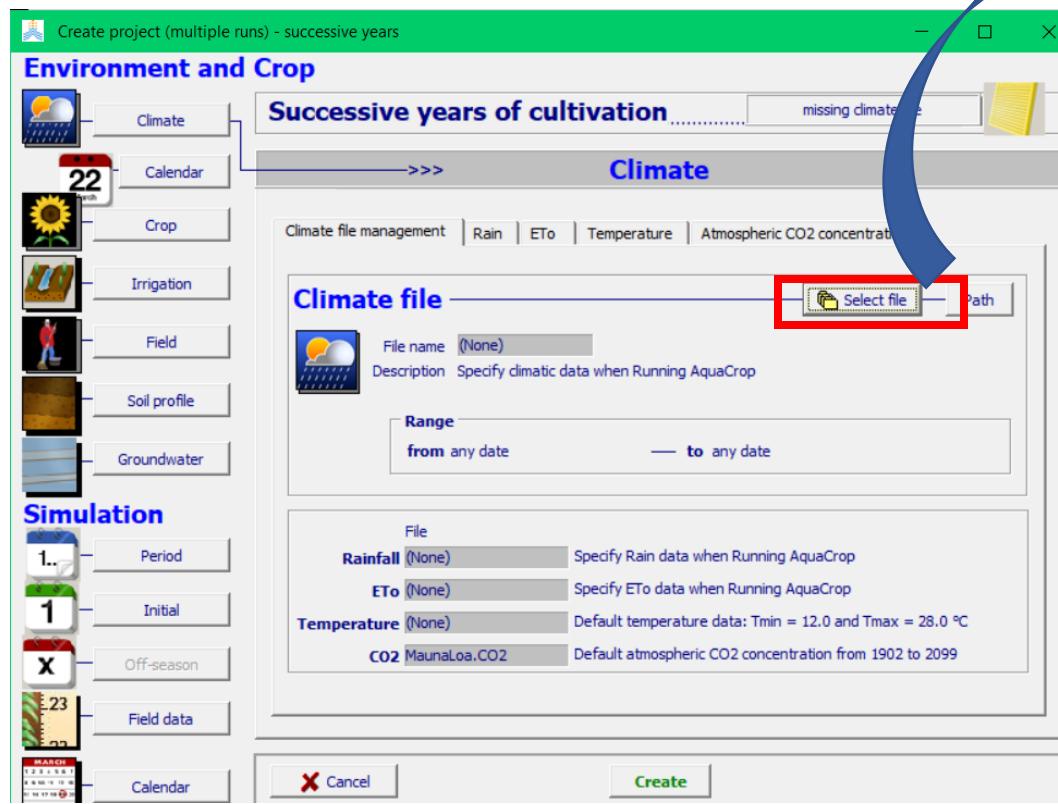
One by one, we will go through each of the highlighted components of the menu and select the correct files to create the PRM file.



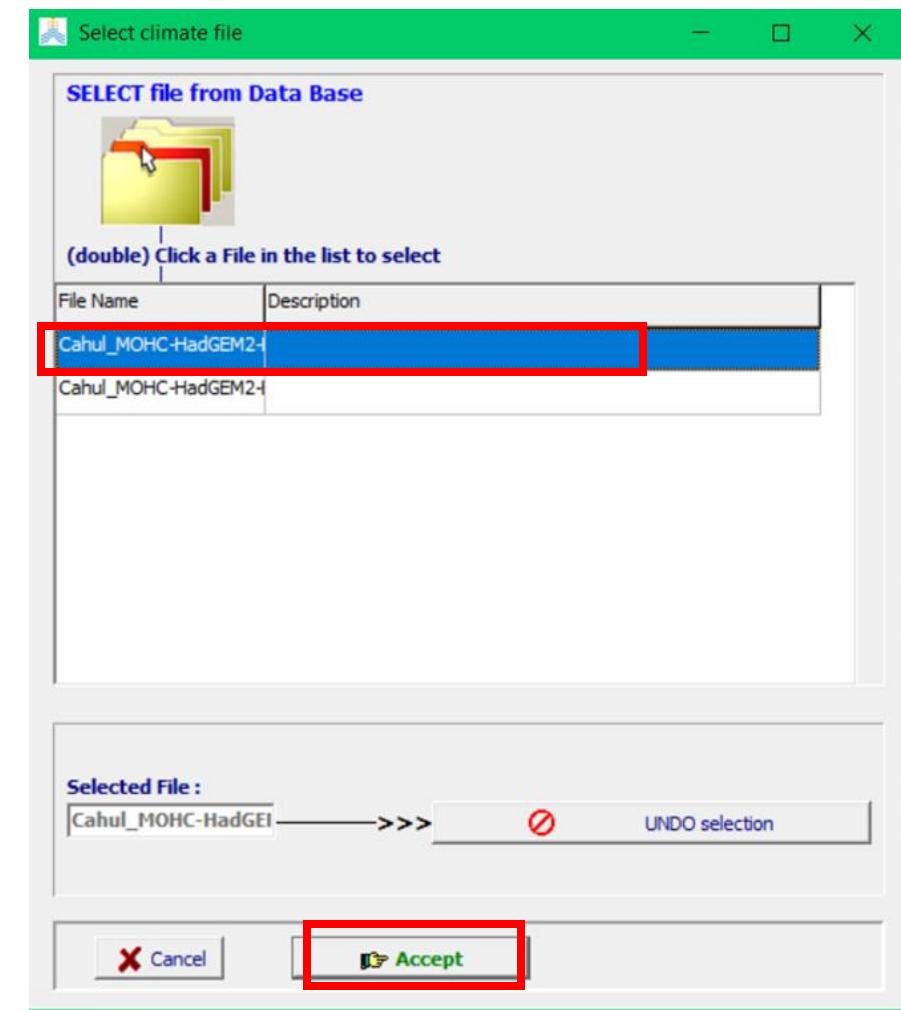
Climate module

1. Climate file

Press "Select file"



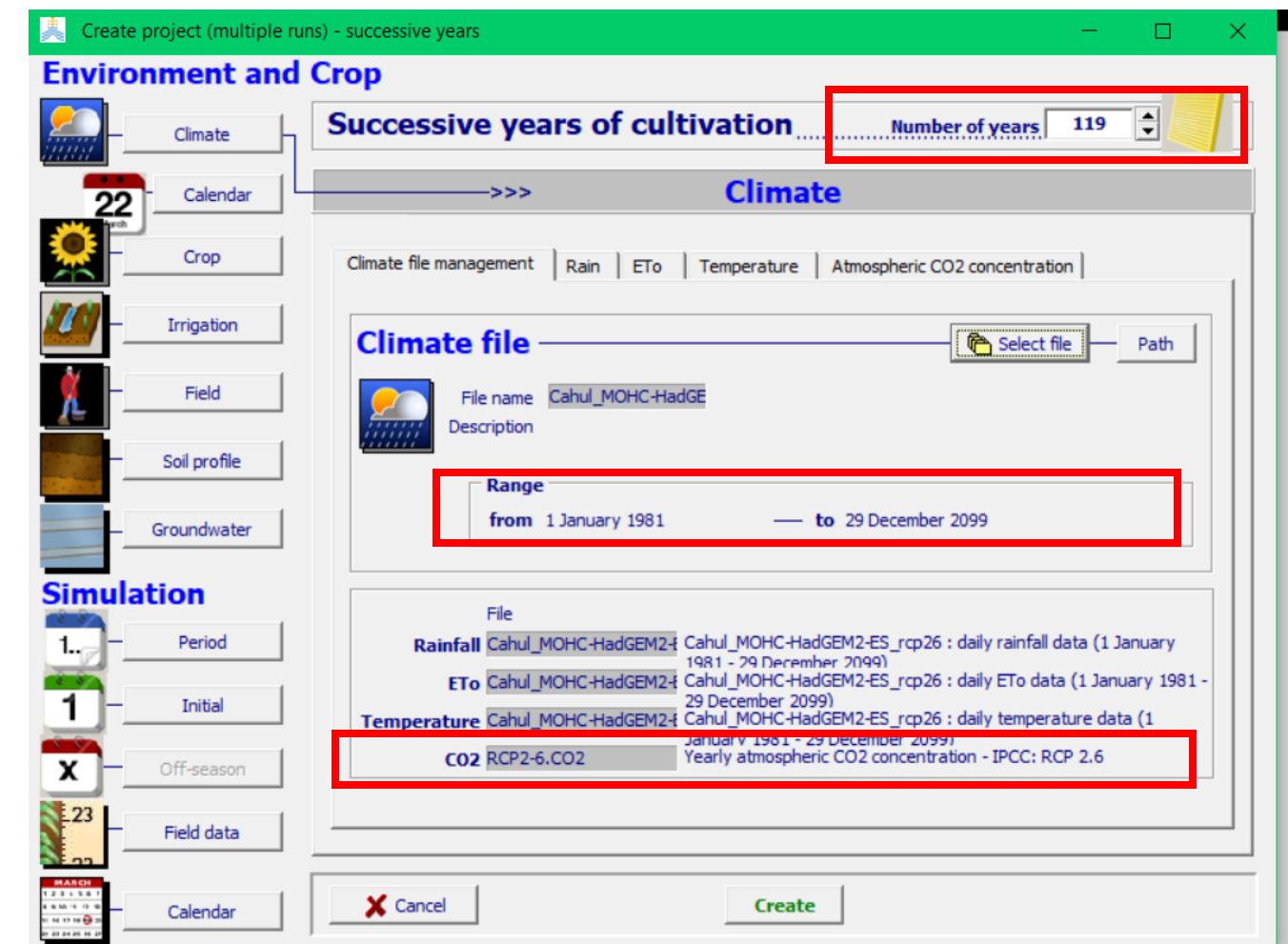
Select the first file "Cahul_MOHC-HadGEM2-"
Press the "Accept" button



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)

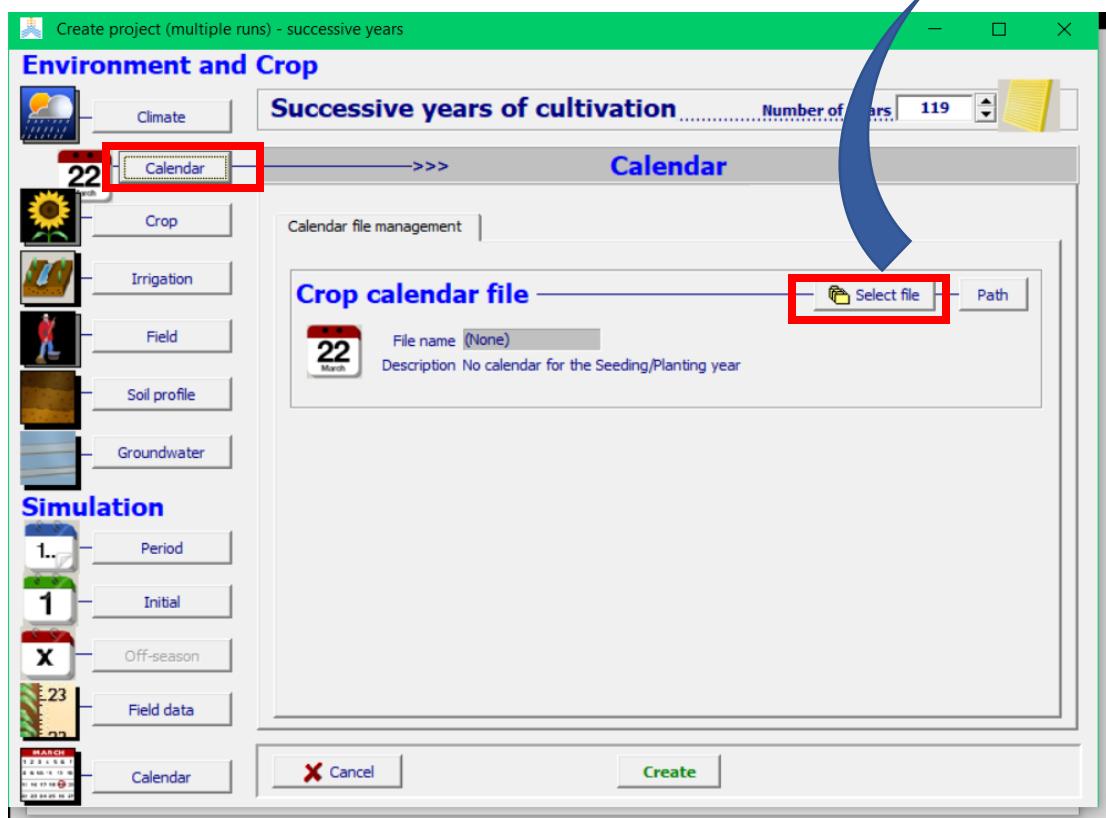


Calendar module

2. Calendar file

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

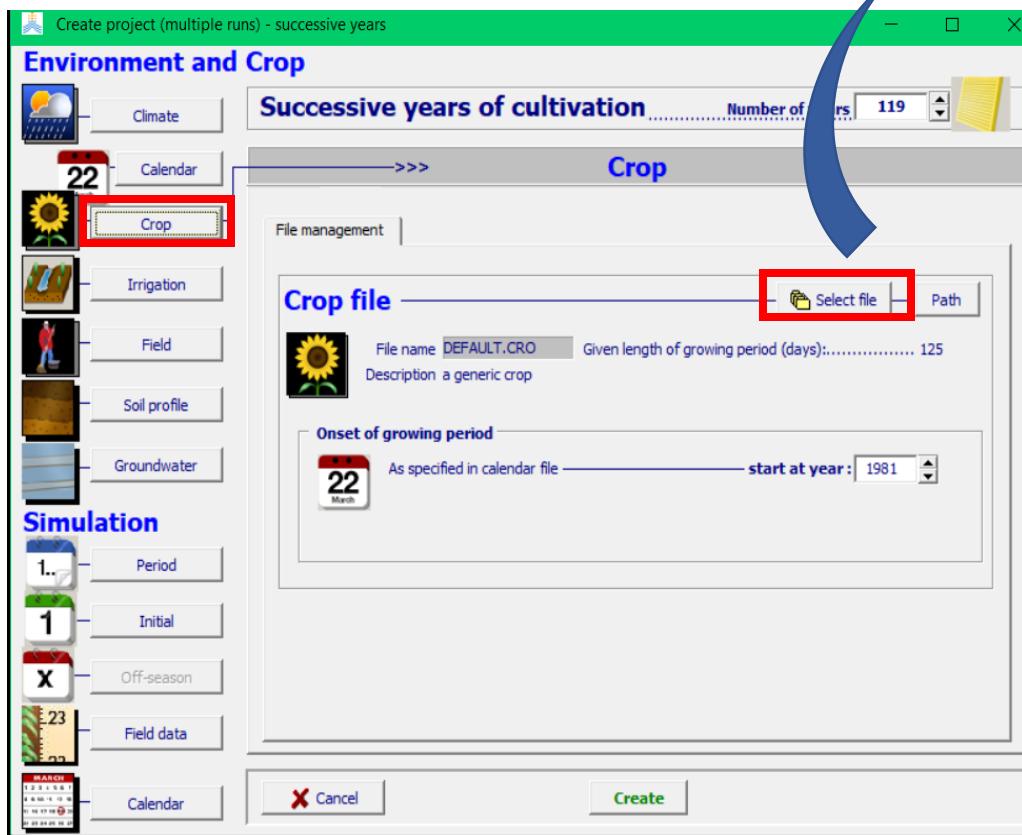
Press “Select file”



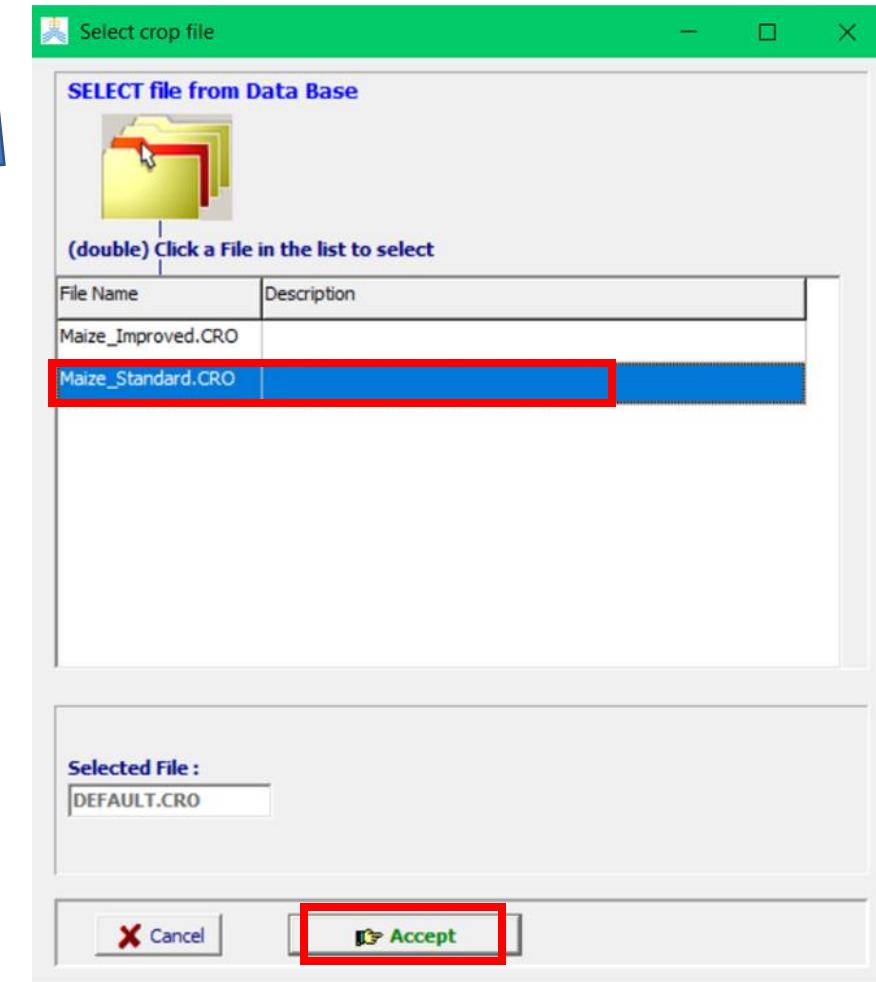
Crop module

3. Crop file

Press “Select file”



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

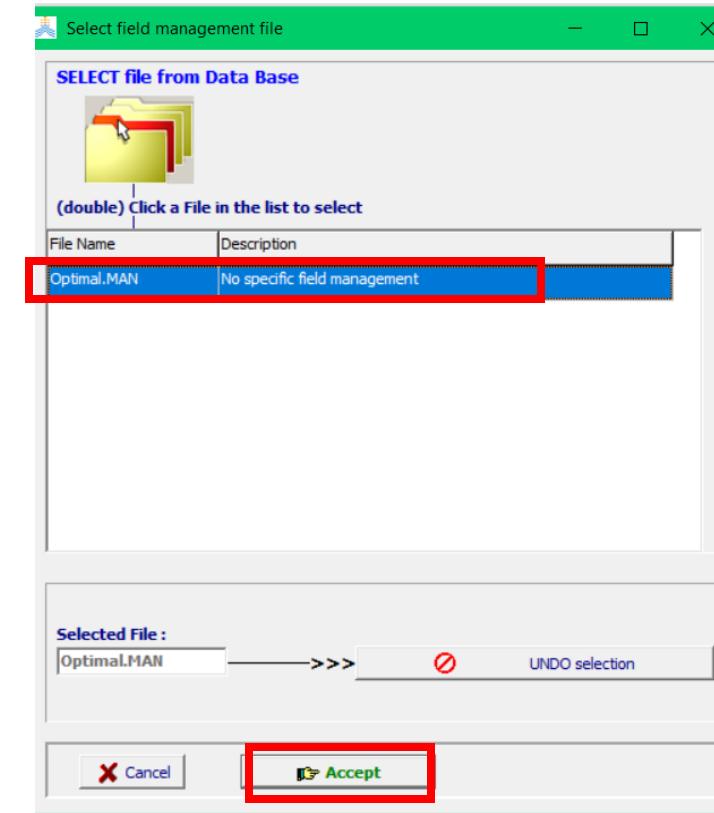
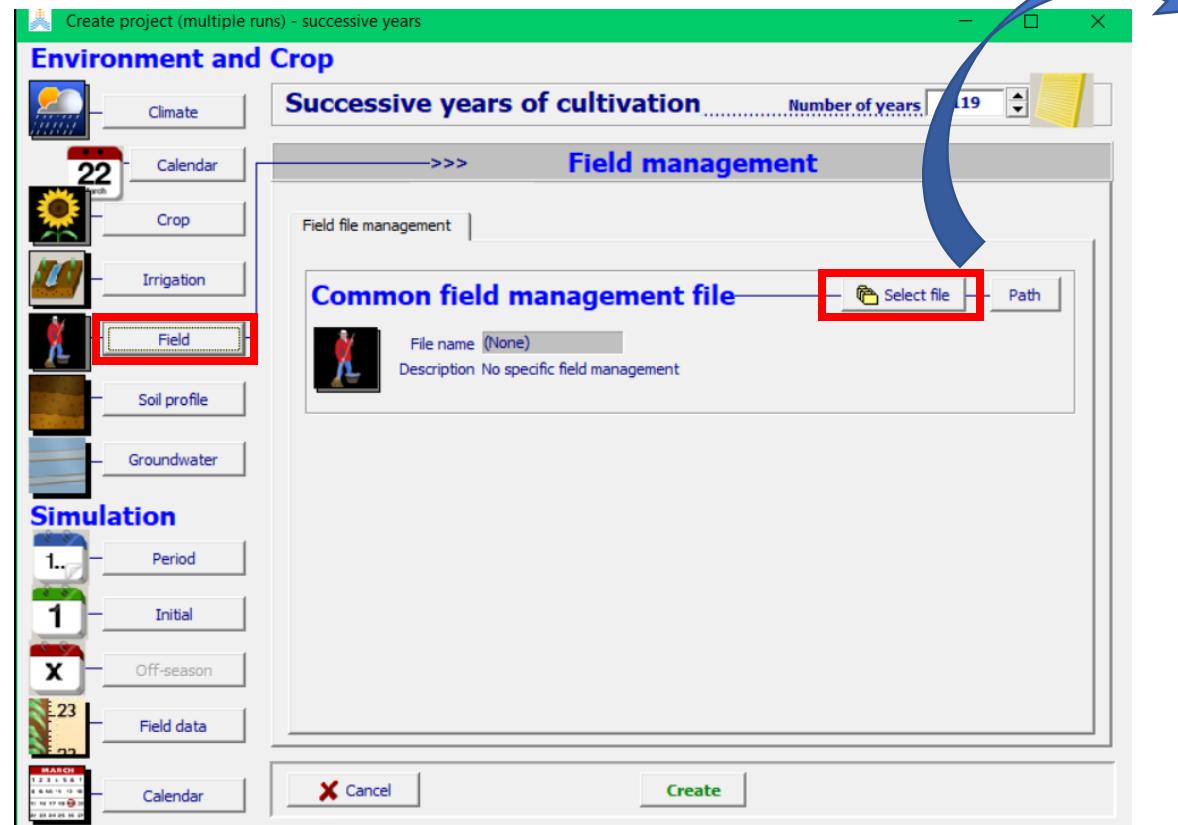


Field module

4. Field management file

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

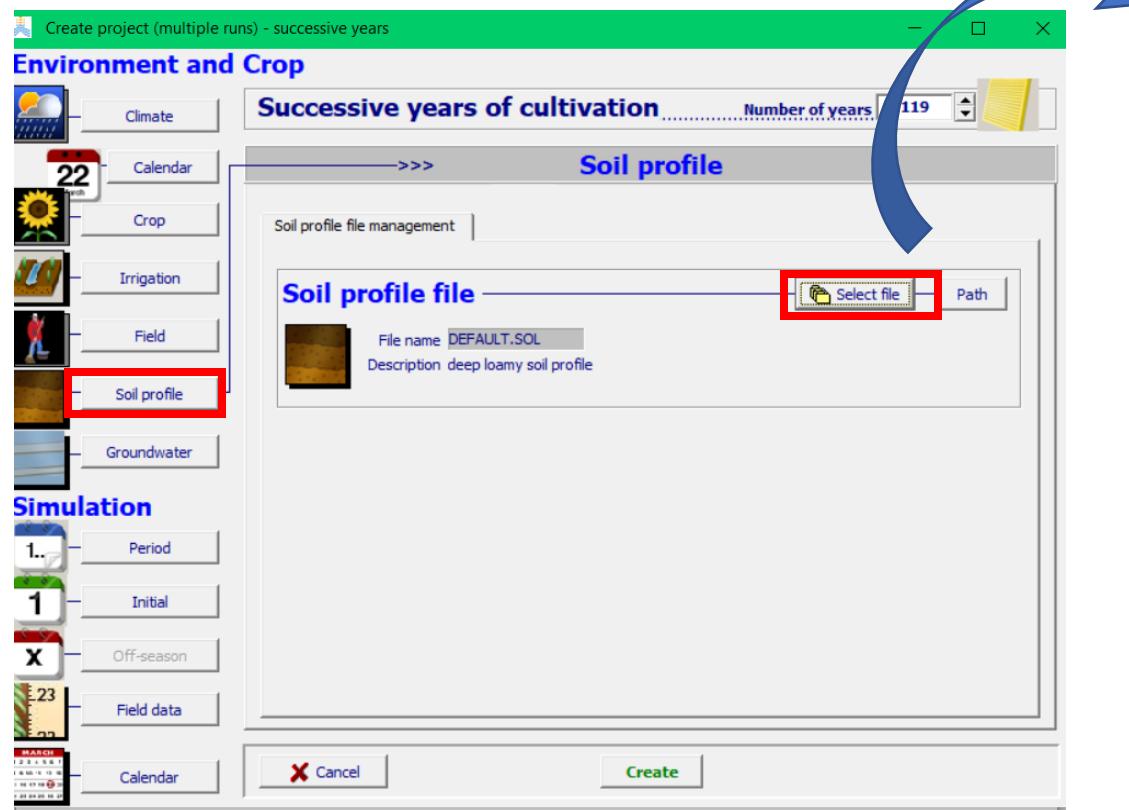
Press “Select file”



Soil module

5. Soil file

Press “Select file”

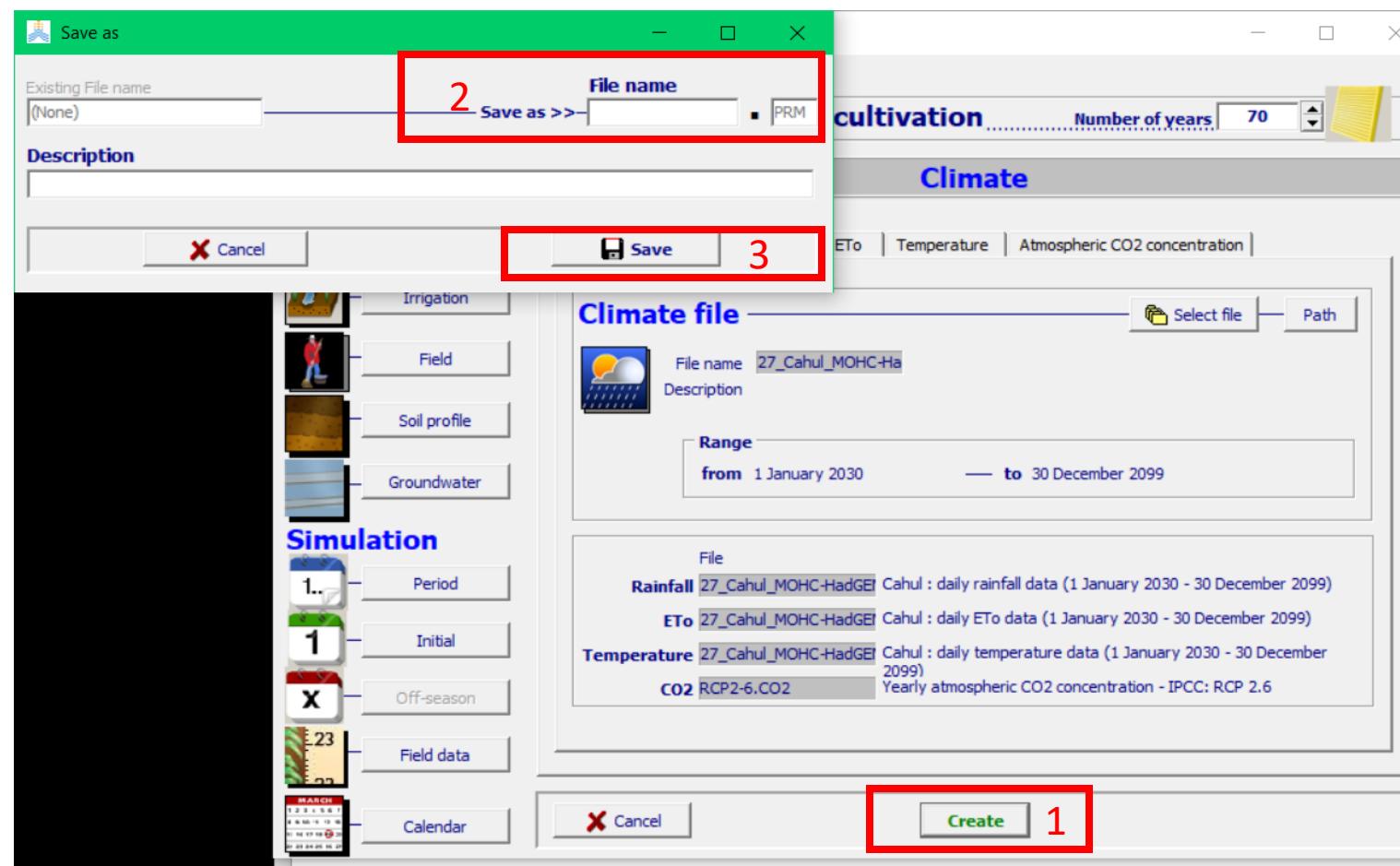


Select the file “North_South”
Press the “Accept” button



Saving project files (.PRM)

1. Press “CREATE”
2. Fill the “File name” with the name: **Maize_Standard_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

Variables scheme

Maize_Standard_Cahul_10May_Optimal_26_MOHC X

Maize_Standard_Cahul_10May_Optmal_85_MOHC Step →

Change the Climate file to Cahul RCP 8.5

Maize_Improved_Cahul_10May_Optimal_26_MOHC Step →

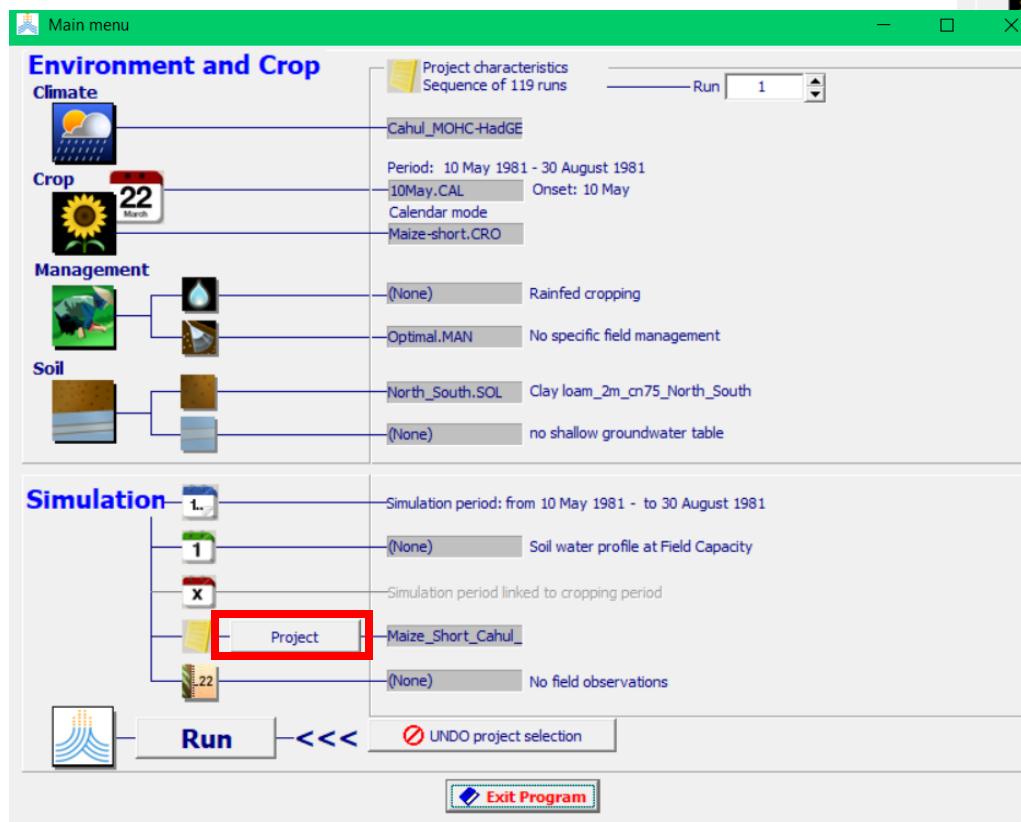
Change the crop file to Improved (variety)

Maize_Improved_Cahul_10May_Optimal_85_MOHC Step →

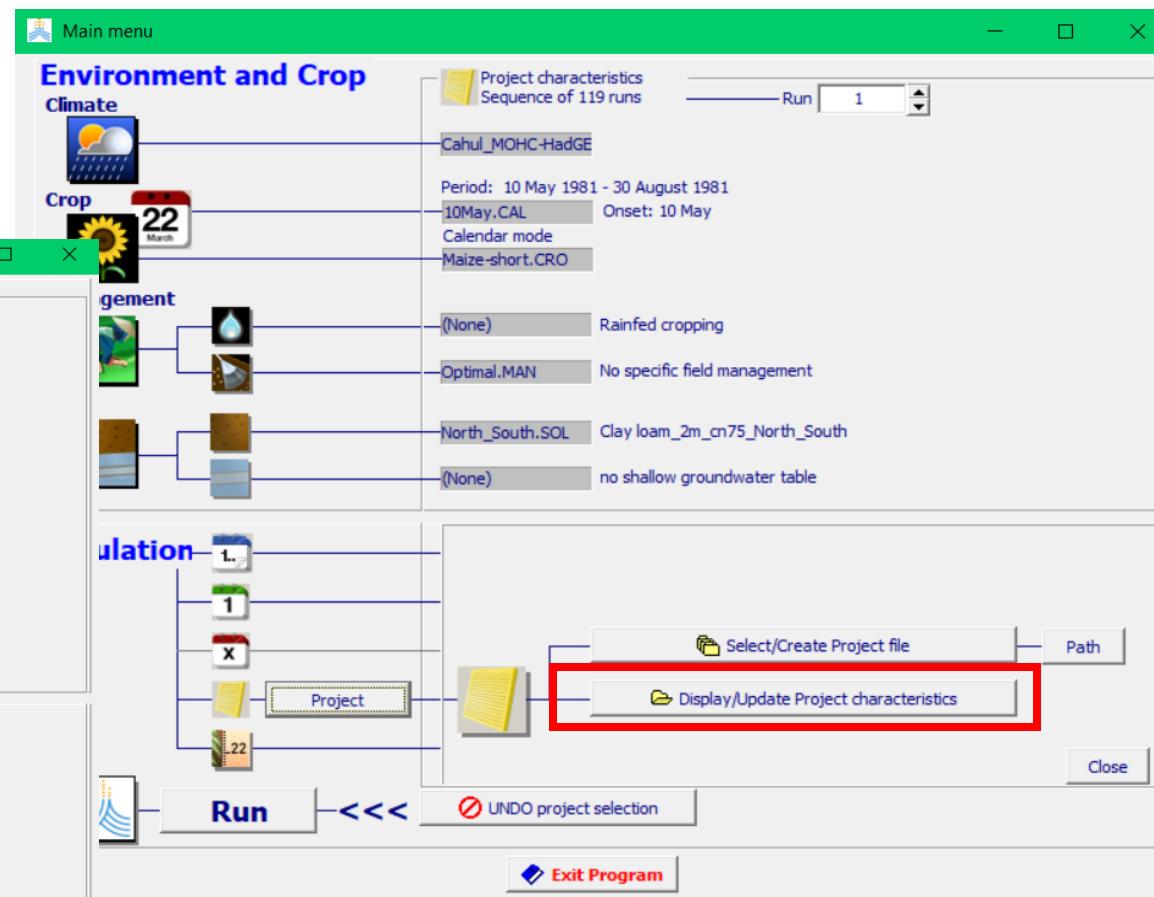
Change the crop file to Improved (variety)

Creation of new project files (.PRM)

1. Press “Project” button

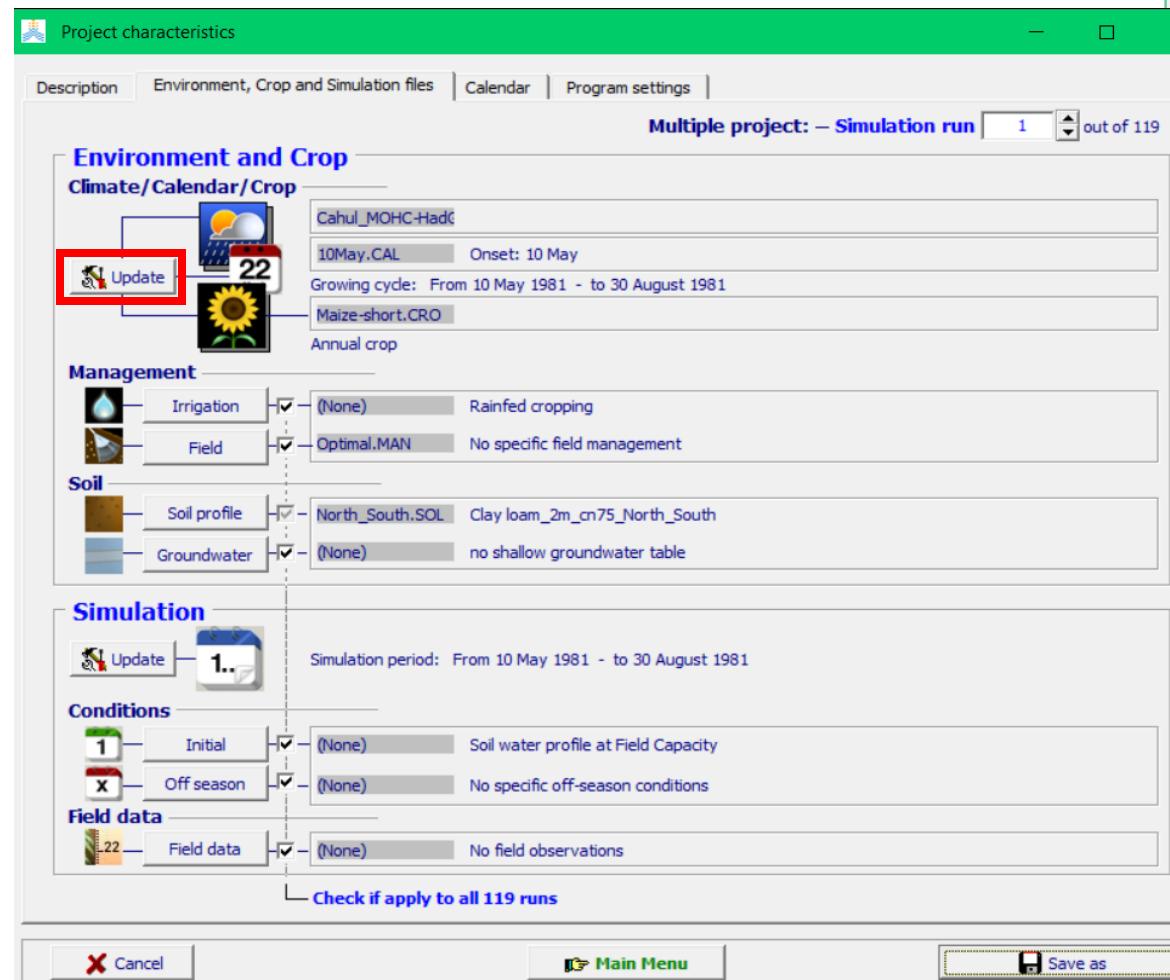


2. Select Display/Update Project characteristics

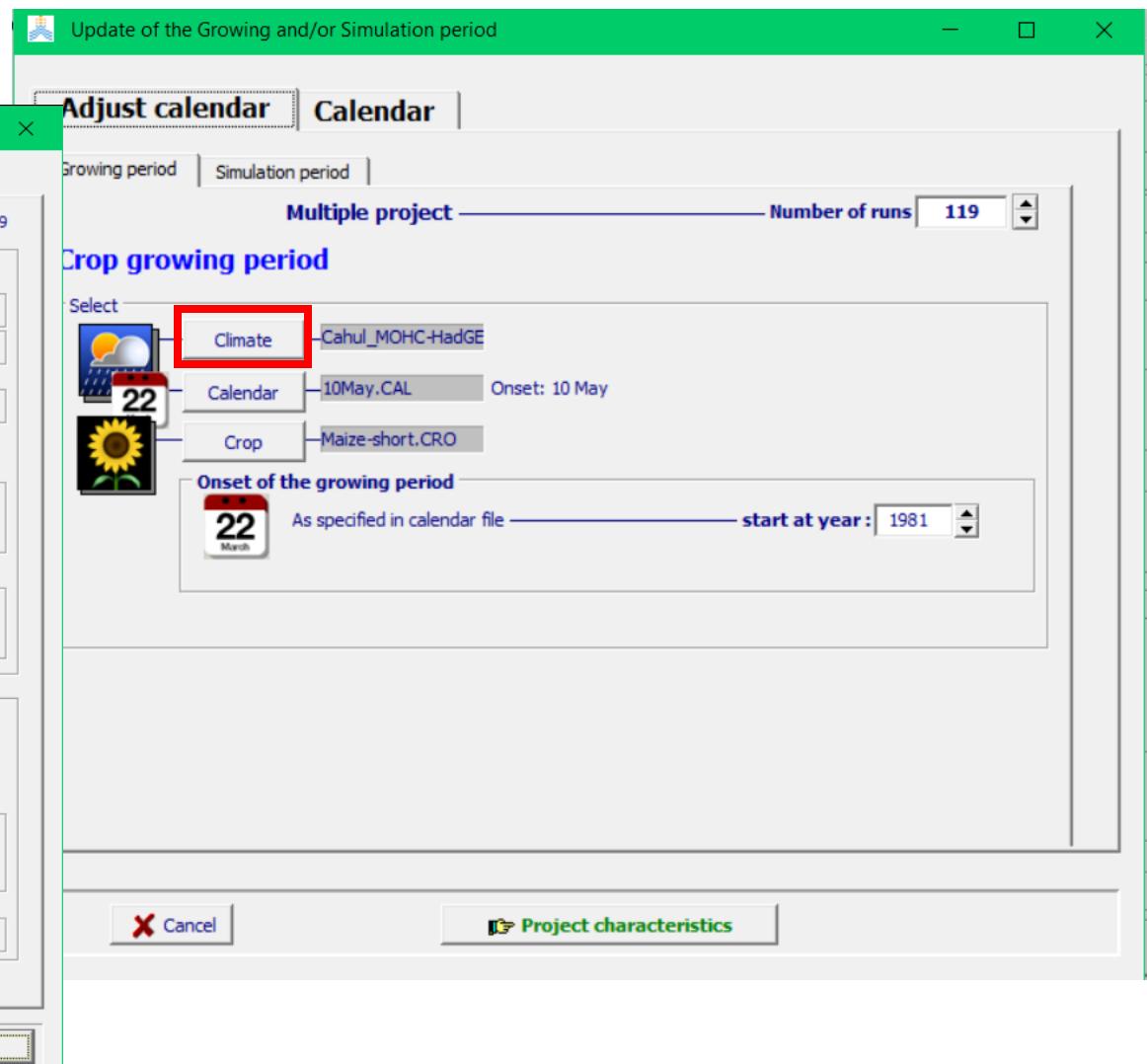


Creation of new project files (.PRM)

3. Press “Update” button

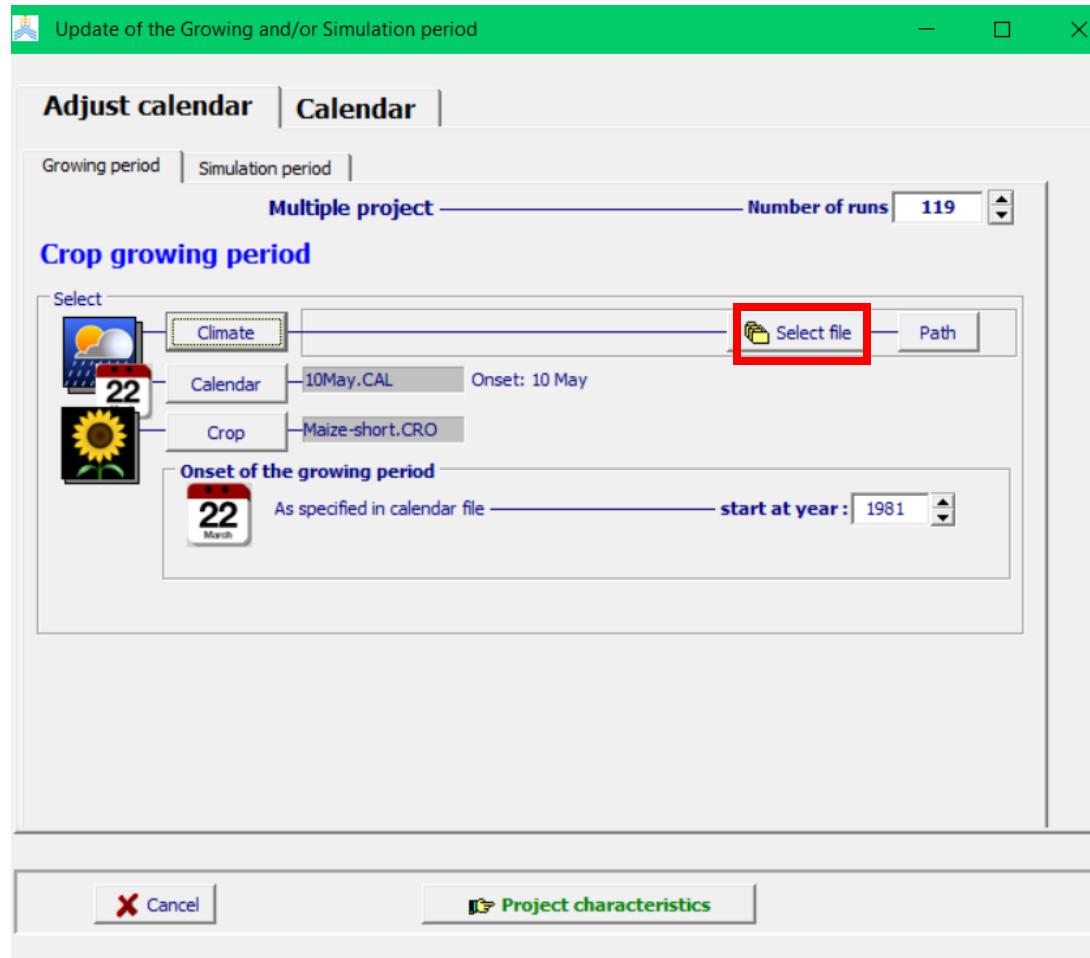


4. Click on Climate

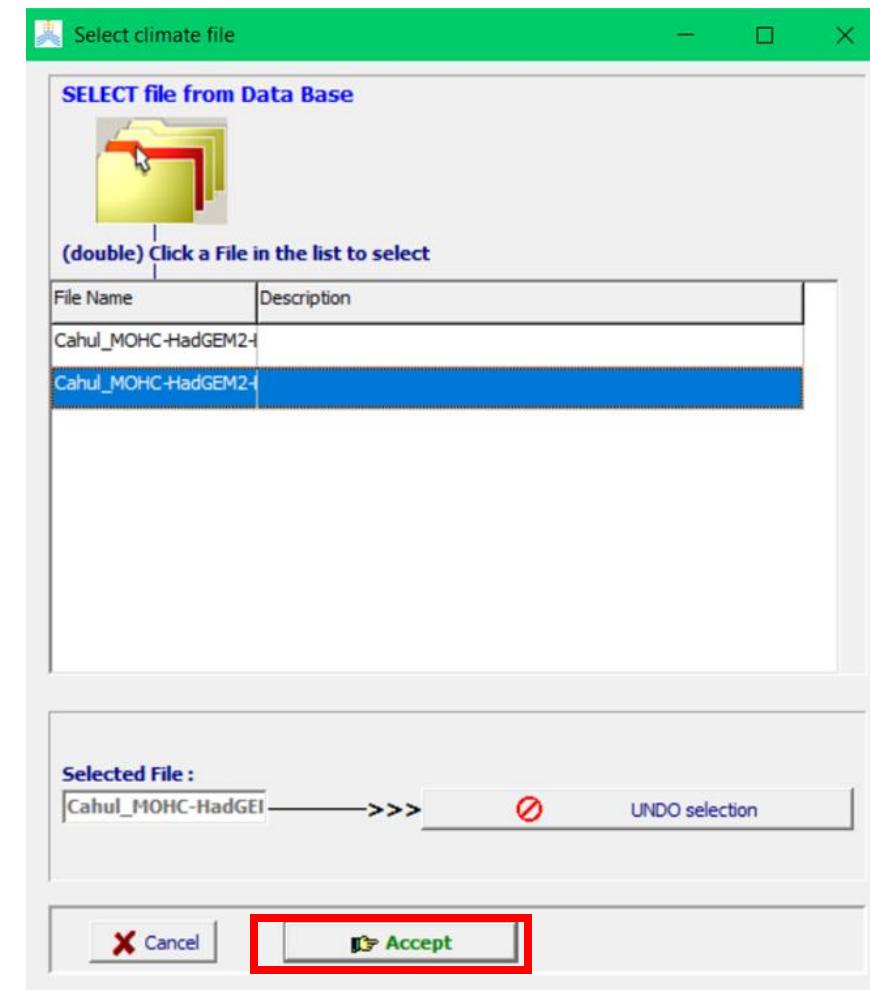


Creation of new project files (.PRM)

5. Click on “Select file”

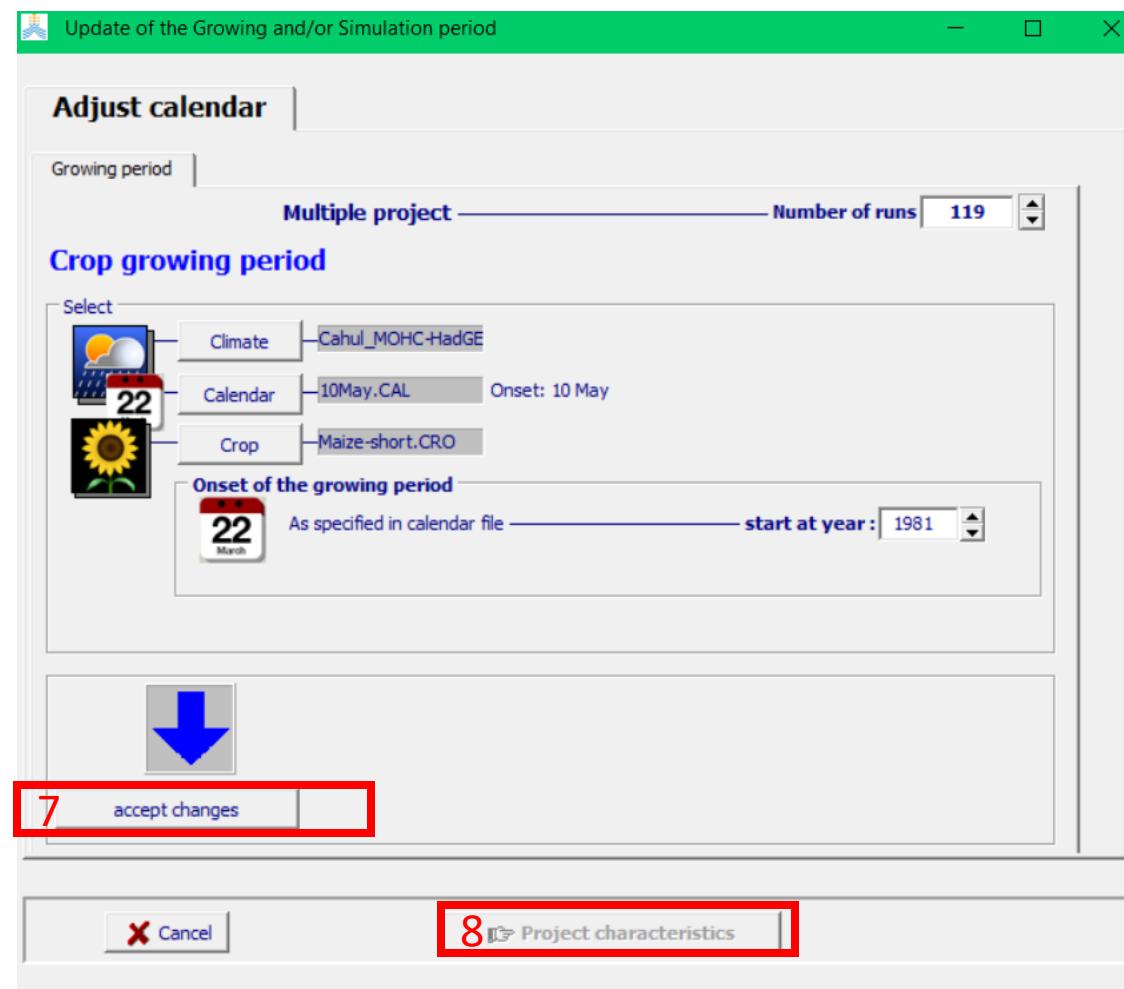


6. Select the second file “Cahul_MOHC-HadGEM2-”



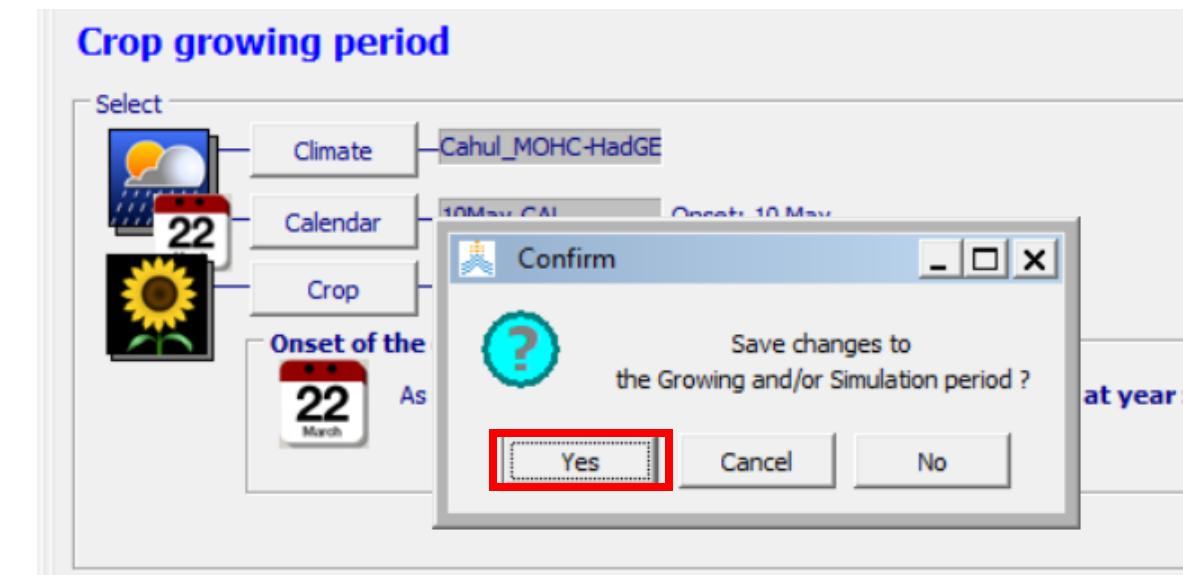
Creation of new project files (.PRM)

7. Press “Accept changes” button



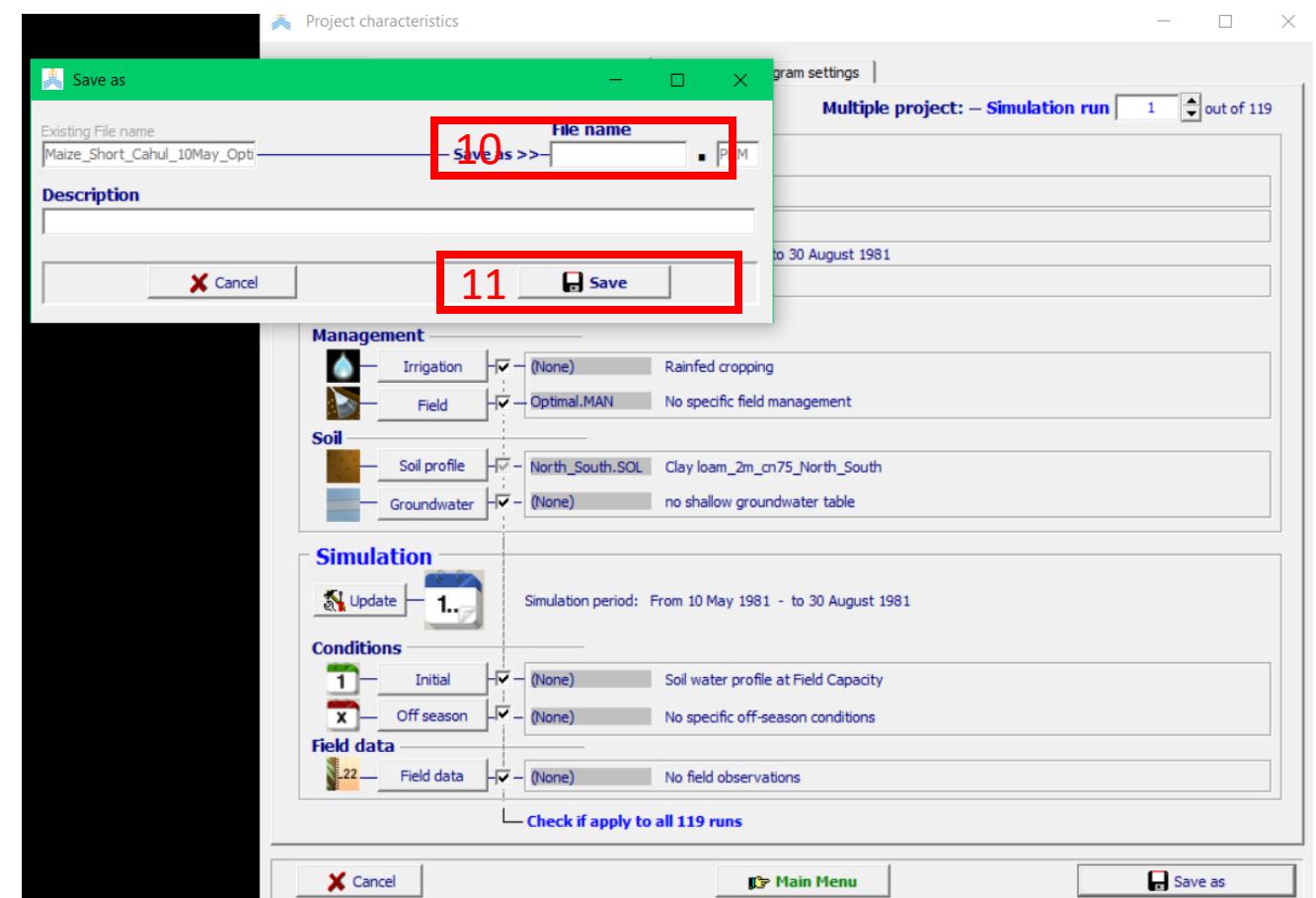
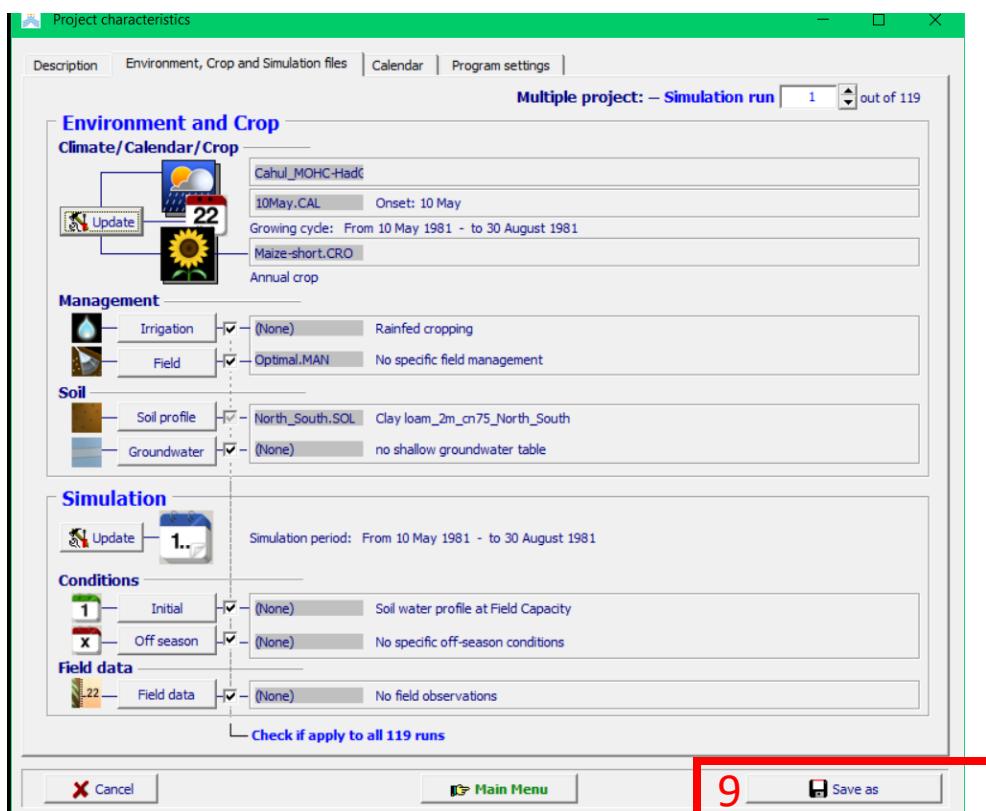
8. Click on “Project Characteristics” to go back on the main project page

9. Select "Yes"



Creation of new project files (.PRM)

9. Press “Save as” button
10. Fill the “File name” with: Maize_Standard_Cahul_10May_Optimal_85_MOHC
11. Press the “Save” button



Creation of new project files (.PRM)

Variables scheme

Maize_Standard_Cahul_10May_Optimal_26_MOHC X

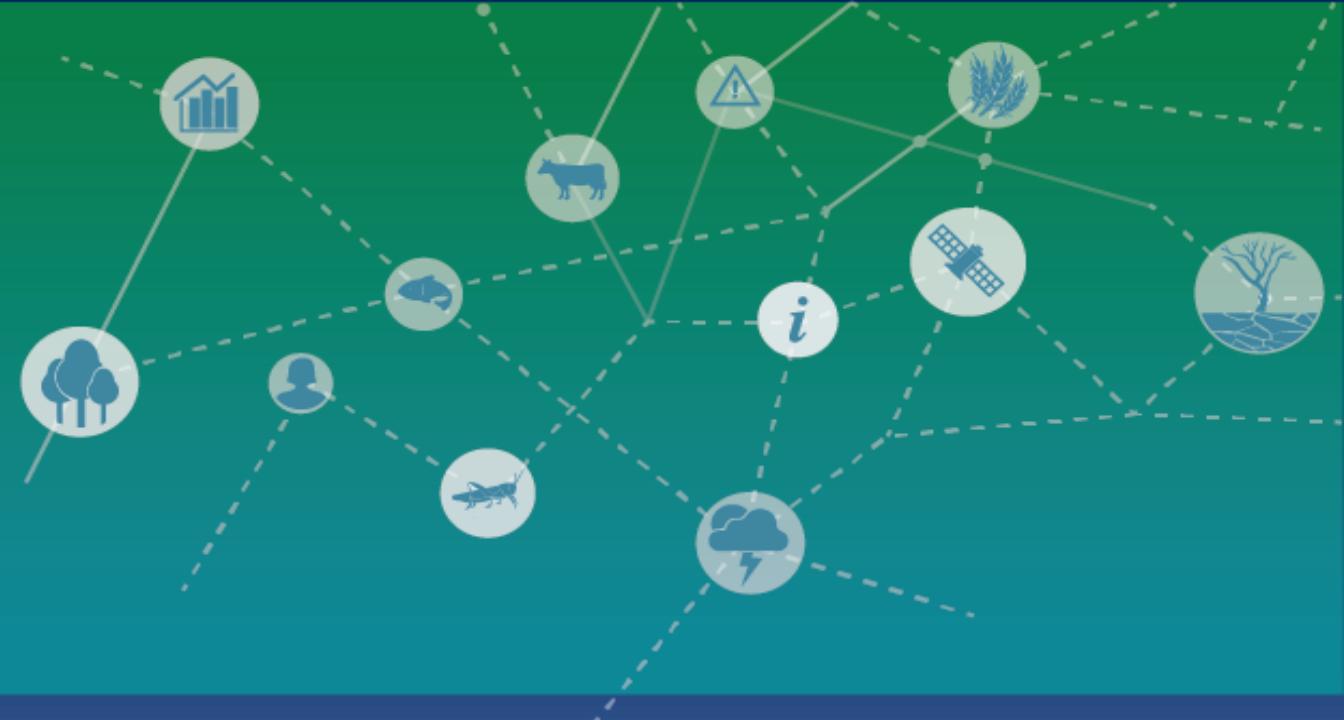
Maize_Standard_Cahul_10May_Optimal_85_MOHC X

Maize_Improved_Cahul_10May_Optimal_26_MOHC Step → Change the crop file to Improved (variety)

Maize_Improved_Cahul_10May_Optimal_85_MOHC Step → Change the crop file to Improved (variety)



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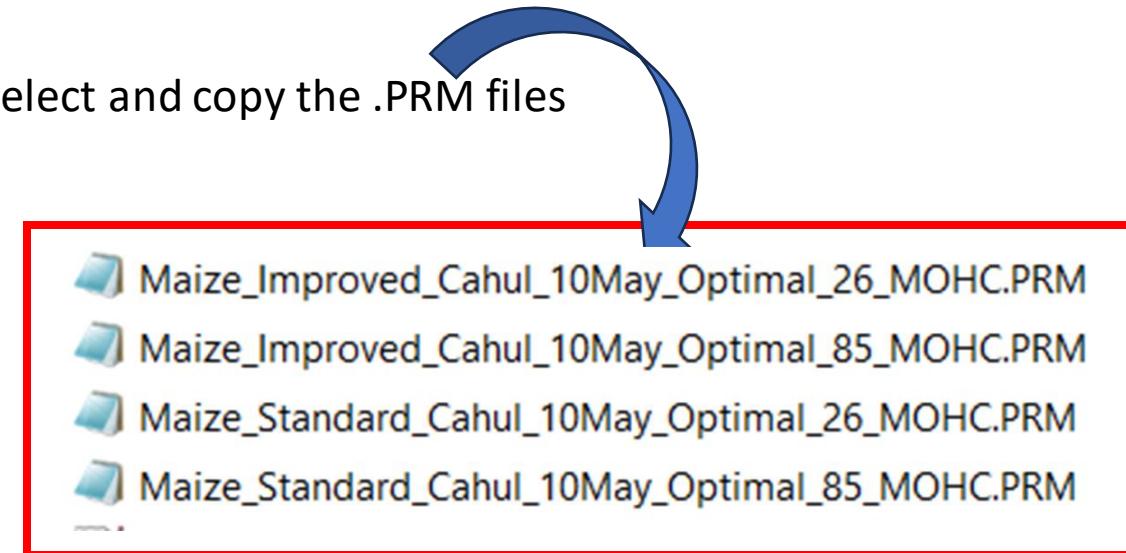
AquaCrop Plugin

June 30, 2023

Plug-in data

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

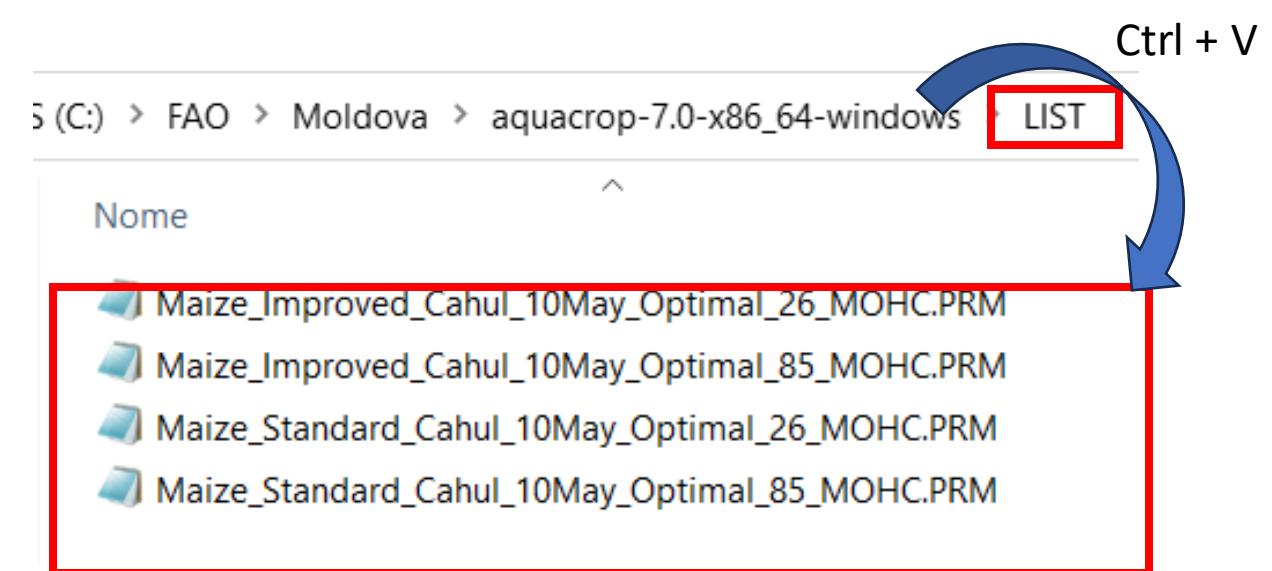
(C:) > FAO > Moldova > GUI_AC7 > AquaCropV70No17082022 >	
Nome	Ultima modifica
DATA	25/05/2023 14:59
IMPORT	20/04/2023 11:06
OBS	20/04/2023 11:06
OUTP	20/04/2023 11:06
SIMUL	17/05/2023 19:37
_DEISREG.ISR	20/04/2023 11:06
_ISREG32.DLL	20/04/2023 11:06
AquaCrop.exe	20/04/2023 11:06
AquaCrop.ico	20/04/2023 11:06
DelsL1.isu	20/04/2023 11:06



Plug-in data

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

C:\ > FAO > Moldova > aquacrop-7.0-x86_64-windows >	
Nome	Ultima modifica
LIST	25/05/2023 15:02
OUTP	16/05/2023 16:11
PARAM	17/08/2022 09:22
SIMUL	16/05/2023 12:53
aquacrop.exe	16/05/2023 12:19
AUTHORS.md	16/05/2023 12:19
LICENSE	16/05/2023 12:19



Plug-in

- *To run the plugin the text file DailyResults.SIM is needed to be in the “SIMUL” folder of the plugin. You can find it [Here](#)

C:\ > FAO > Moldova > aquacrop-7.0-x86_64-windows >	
Nome	Ultima modifica
LIST	25/05/2023 15:02
OUTP	16/05/2023 16:11
PARAM	17/08/2022 09:22
SIMUL	16/05/2023 12:53
aquacrop.exe	16/05/2023 12:19
AUTHORS.md	16/05/2023 12:19
LICENSE	16/05/2023 12:19

(C:\ > FAO > Moldova > aquacrop-7.0-x86_64-windows > SIMUL	
Nome	Ultima modifica
AggregationResults.SIM	16/05/2023 12:19
DailyResults.SIM	16/05/2023 12:21
DEFAULT.CRO	17/05/2023 19:08
DEFAULT.SOL	17/05/2023 19:08
EToData.SIM	16/05/2023 17:31
MaunaLoa.CO2	16/05/2023 12:19
RainData.SIM	16/05/2023 17:31
TCrop.SIM	16/05/2023 17:31
TempData.SIM	16/05/2023 17:31

- Run the plug-in by double-clicking on aquacrop.exe (for 4 project files it will take approximately 3 minutes)

C:\ > FAO > Moldova > aquacrop-7.0-x86_64-windows >	
Nome	Ultima modifica
LIST	25/05/2023 15:02
OUTP	16/05/2023 16:11
PARAM	17/08/2022 09:22
SIMUL	16/05/2023 12:53
aquacrop.exe	16/05/2023 12:19
AUTHORS.md	16/05/2023 12:19
LICENSE	16/05/2023 12:19

Plug-in

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

C:\ > FAO > Moldova > aquacrop-7.0-x86_64-windows >	
Nome	Ultima modifica
LIST	25/05/2023 15:02
OUTP	16/05/2023 16:11
PARAM	17/08/2022 09:22
SIMUL	16/05/2023 12:53
aquacrop.exe	16/05/2023 12:19
AUTHORS.md	16/05/2023 12:19
LICENSE	16/05/2023 12:19

(C:) > FAO > Moldova > aquacrop-7.0-x86_64-windows > OUTP

Nome
AllDone.OUT
ListProjectsLoaded.OUT
Maize_Improved_Cahul_10May_Optimal_26_MOHCPRMday.OUT
Maize_Improved_Cahul_10May_Optimal_26_MOHCPRMseason.OUT
Maize_Improved_Cahul_10May_Optimal_85_MOHCPRMday.OUT
Maize_Improved_Cahul_10May_Optimal_85_MOHCPRMseason.OUT
Maize_Standard_Cahul_10May_Optimal_26_MOHCPRMday.OUT
Maize_Standard_Cahul_10May_Optimal_26_MOHCPRMseason.OUT
Maize_Standard_Cahul_10May_Optimal_85_MOHCPRMday.OUT
Maize_Standard_Cahul_10May_Optimal_85_MOHCPRMseason.OUT

Plug-in

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

C:\ > FAO > Moldova > aquacrop-7.0-x86_64-windows > OUTs+PRMs

Nome	Ultima modifica	Tipo
Maize_Improved_Cahul_10May_Optimal...	26/06/2023 11:02	File PRM
Maize_Improved_Cahul_10May_Optimal...	26/06/2023 11:07	File OUT
Maize_Improved_Cahul_10May_Optimal...	26/06/2023 11:07	File OUT
Maize_Improved_Cahul_10May_Optimal...	26/06/2023 11:03	File PRM
Maize_Improved_Cahul_10May_Optimal...	26/06/2023 11:08	File OUT
Maize_Improved_Cahul_10May_Optimal...	26/06/2023 11:08	File OUT
Maize_Standard_Cahul_10May_Optimal_2...	26/06/2023 10:57	File PRM
Maize_Standard_Cahul_10May_Optimal_2...	26/06/2023 11:09	File OUT
Maize_Standard_Cahul_10May_Optimal_2...	26/06/2023 11:09	File OUT
Maize_Standard_Cahul_10May_Optimal_8...	26/06/2023 11:02	File PRM
Maize_Standard_Cahul_10May_Optimal_8...	26/06/2023 11:10	File OUT
Maize_Standard_Cahul_10May_Optimal_8...	26/06/2023 11:10	File OUT

[Here](#) you can find the the PRMs and OUTs files ready to be uploaded on AquaCrop Plotter.

[Here](#) is the link to the AquaCrop plotter platform.

Thank you!

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