



Reference Manual

AquaCrop Version 3.1plus

January 2011

Developed by

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with contributions of the AquaCrop Network

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Table of contents

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Acknowledgments

List of principal symbols

Chapter 1. FAO cropwater productivity model

to simulate yield response to water

1.1 From the Ky approach to AquaCrop	1-1
1.2 AquaCrop operation	1-5
1.2.1 Calculation scheme	1-5
1.2.2 Step 1 – simulation of the soil water balance	1-7
1.2.3 Step 2 – simulation of the green canopy development (CC).....	1-9
1.2.4 Step 3 – simulation of crop transpiration (Tr).....	1-11
1.2.5 Step 4 – simulation of the above-ground biomass (B).....	1-13
1.2.6 Step 5 – partitioning of biomass (B) into yield (Y).....	1-15
1.3 Input requirement.....	1-16
1.3.1 Weather data.....	1-16
1.3.2 Crop characteristics	1-17
1.3.3 Soil characteristics.....	1-18
1.3.4 Management practices	1-18
1.4 Application	1-19
References	1-19

Chapter 2. Users guide

Running AquaCrop

2.1 The AquaCrop environment	2-2
2.2 Main menu	2-3
2.3 Default settings at start.....	2-4
2.3.1 Selected input	2-4
2.3.2 Program settings	2-5
2.4 Selecting input files and undoing the selection	2-6
2.4.1 Selecting a file	2-6
2.4.2 Undo the selection	2-6
2.5 Displaying and updating input characteristics.....	2-7
2.5.1 Displaying input data	2-7
2.5.2 Updating input data	2-8
2.6 Creating input files	2-9
2.6.1 The save on disk command	2-9

2.6.2 The save as command	2-9
2.6.3 Create file	2-10
- Create new climate file	2-10
- Create new ETo, Rain or Temperature file	2-10
- Create new crop file.....	2-11
- Create new irrigation file.....	2-11
- Create new soil file.....	2-12
- Create new project file.....	2-12
2.7 To exit and close a menu	2-13

Menu reference

Hierarchical structure of the menus.....	2-14
Main menu - Environmental panel.....	2-14
- Climate	2-14
- Crop	2-14
- Management	2-15
- Soil.....	2-15
Main menu – Simulation panel	2-16
Main menu – Project panel.....	2-17
2.8 Climatic data	2-18
2.8.1 Minimum and maximum air temperature.....	2-18
2.8.2 Reference evapotranspiration (ETo)	2-19
2.8.3 Rainfall	2-19
2.8.4 Mean annual atmospheric CO ₂	2-20
2.8.5 Program settings	2-20
2.9 Crop characteristics	2-21
2.9.1 Description	2-23
- Display modes of crop parameters	2-23
- Type of edit fields (cells).....	2-23
- Protected files	2-23
2.9.2 Development	2-27
- Initial canopy cover	2-28
- Canopy development	2-29
- Flowering and yield formation (fruit/grain producing crops).....	2-32
- Root/Tuber formation (root/tuber crops).....	3-34
- Root deepening	2-35
- Temperatures for growing degree days (GDD)	2-38
2.9.3 Evapotranspiration	2-39
- Ke and Kcb coefficients	2-39
- Water extraction pattern	2-40
2.9.4 Production	2-42
- Crop water productivity normalized for ETo and CO ₂ (WP*)	2-42
- Performance under elevated atmospheric CO ₂ concentration	2-43
- Reference Harvest Index (HI ₀)	2-44
2.9.5 Water stress	2-47
- Canopy expansion, stomatal conductance and early canopy senescence ..	2-47
- Aeration stress	2-51
- Harvest Index	2-53
2.9.6 Fertility stress	2-59

2.9.7 Calibration for soil fertility	2-60
- Soil fertility stress and decline coefficients	2-60
- Calibration process	2-61
2.9.8 Temperature stress	2-65
- Biomass production	2-65
- Pollination	2-66
2.9.9 Calendar	2-67
2.9.10 Program settings	2-68
2.10 Start of the growing cycle	2-69
2.10.1 Specified date	2-69
2.10.2 Generate onset	2-69
2.11 Irrigation management	2-71
2.11.1 No irrigation (rainfed cropping)	2-71
2.11.2 Determination of net irrigation water requirement	2-71
2.11.3 Irrigation schedule (specified events)	2-72
2.11.4 Generation of irrigation schedules	2-73
2.11.5 Irrigation method	2-75
2.12 Field management	2-76
2.12.1 Soil fertility	2-76
2.12.2 Mulches	2-78
2.12.3 Field surface practices	2-79
2.12.4 Program settings	2-80
2.13 Soil profile characteristics	2-81
2.13.1 Soil horizons and their physical characteristics	2-81
- Soil water content at saturation, field capacity and permanent wilting point	2-81
- Saturated hydraulic conductivity (K_{sat})	2-82
- Total Available soil Water (TAW) and drainage coefficient (τ)	2-82
2.13.2 Indicative values for soil physical characteristics	2-82
2.13.3 Characteristics of the soil surface layer	2-84
2.13.4 Restrictive soil layer	2-85
2.13.5 Program settings	2-86
2.14 Simulation period	2-87
2.15 Initial conditions	2-88
2.15.1 Initial soil water content	2-88
2.15.2 Water between soil bunds	2-89
2.15.3 Program settings	2-89
- Soil compartments	2-89
- Settings at start of the simulation run	2-89
2.16 Off season conditions	2-90
2.16.1 Mulches in the off-season	2-90
2.16.2 Irrigation events in the off-season	2-91
2.17 Project characteristics	2-92
2.17.1 Single run and multiple run projects	2-93
2.17.2 Selecting and creating a project	2-94
- Selecting a project	2-94
- Creating a project	2-94
2.17.3 Updating project characteristics	2-98
2.18 Simulation run	2-99

2.18.1 Display of simulation results	2-99
- Climate-Crop-Soil water sheet	2-99
- Sheet with selected parameter	2-100
- Soil water profile sheet.....	2-101
- Soil water balance sheet	2-101
- Production sheet	2-102
- Total Run sheet.....	2-103
- Simulated environment sheet	2-105
2.18.2 Numerical output	2-106
2.18.3 Output files	2-107
- Daily results.....	2-107
- Seasonal results	2-107

Input/Output and program settings Files

2.19 Input files	2-110
2.19.1 Climate file (*.CLI).....	2-110
2.19.2 Temperature (*.TMP), ETo (*.ETo) and Rainfall (*.PLU) files	2-111
2.19.3 CO2 file (*.CO2).....	2-112
2.19.4 Crop file (*.CRO).....	2-113
2.19.5 Irrigation file (*.IRR)	2-113
2.19.6 Field management file (*.MAN).....	2-113
2.19.7 Soil file (*.SOL).....	2-113
2.19.8 File with initial conditions file (*.SW0).....	2-113
2.19.9 File with off-season conditions (*.OFF)	2-113
2.19.10 Single run Project file (*.PRO)	2-113
2.19.11 Multiple run Project file (*.PRM).....	2-113
2.20 Files with program settings	2-114
2.21 Output files	2-115
2.21.1 Crop development and production	2-115
2.21.2 Soil water balance	2-116
2.21.3 Soil water content (profile and root zone).....	2-117
2.21.4 Soil water content (compartments)	2-117
2.21.5 Net irrigation requirement.....	2-118
2.21.6 Seasonal output	2-119

Chapter 3. Calculation Procedures

3.1 The root zone as a reservoir	3-2
3.1.1 Incoming and outgoing water fluxes.....	3-2
3.1.2 Stored soil water and root zone depletion	3-3
- Stored soil water expressed as a equivalent depth	3-3
- Root zone depletion.....	3-3
- Total Available soil Water (TAW).....	3-4
3.2 Stresses	3-5
3.2.1 Stress response functions	3-5

- Linear shape	3-5
- Convex and concave shapes	3-6
- Logistic shape.....	3-6
3.2.2 Soil water stress.....	3-7
3.2.3 Air temperature stress.....	3-8
3.2.4 Soil fertility stress.....	3-9
3.3 Growing Degree Days	3-11
3.3.1 Method 1	3-11
3.3.2 Method 2	3-11
3.3.3 Method 3	3-12
3.4 Green canopy cover for optimal conditions.....	3-13
3.4.1 Green canopy cover throughout the crop cycle.....	3-13
3.4.2 Canopy development.....	3-14
3.4.3 Germination and initial canopy cover at 90% crop emergence	3-15
3.4.4 Maximum canopy cover (CC _x)	3-15
3.4.5 Green canopy cover decline	3-15
3.4.6 Green canopy cover for forage crops	3-16
3.5 Green canopy cover for stress conditions	3-17
3.5.1 Period of potential vegetative growth	3-18
3.5.2 Adjustment of canopy growth coefficient due to water stress	3-19
3.5.3 Early canopy senescence under severe water stress conditions	3-21
3.5.4 Canopy development when transpiration is inhibited.....	3-23
3.5.5 Canopy development under limited soil fertility.....	3-23
3.6 Effective rooting depth	3-25
3.6.1 Effective rooting depth at planting (Z _n)	3-26
3.6.2 Expansion of the root zone in a well watered soil.....	3-26
3.6.3 Rooting depth for Forage crops.....	3-27
3.6.4 Expansion of the root zone when the crop is water stressed.....	3-27
3.6.5 Expansion of the root zone in a shallow soil.....	3-29
3.7 Soil water balance	3-30
3.7.1 Time -depth grid.....	3-30
3.7.2 Calculation scheme	3-31
3.7.3 Redistribution and drainage subroutine.....	3-32
- Drainage function.....	3-32
- Drainage characteristic τ (tau).....	3-32
- Calculation procedure	3-34
3.7.4 Runoff subroutine.....	3-36
3.7.5 Infiltration subroutine.....	3-37
3.7.6 Capillary rise	3-38
3.7.7 Processing of 10-day and monthly climatic data	3-39
- Daily climatic data	3-39
- Estimation of surface runoff.....	3-40
- Estimation of effective rainfall and deep percolation	3-40
- Estimation of soil evaporation.....	3-42
3.8 Salt balance.....	3-43

3.9 Soil evaporation.....	3-44
3.9.1 A two stage calculation method	3-45
- Stage I - energy limiting stage.....	3-45
- Stage II - falling rate stage	3-45
3.9.2 Readily Evaporable Water (REW).....	3-45
3.9.3 Soil evaporation coefficient for wet soil surface (K_e)	3-46
3.9.4 Adjustment of K_e for withered canopy, mulches and partial wetting by irrigation	3-48
- Sheltering effect of withered canopy cover.....	3-48
- Adjustment for mulches	3-49
- Adjustment for partial wetting by irrigation	3-49
- Adjustment for mulches and partial wetting by irrigation	3-49
3.9.5 Evaporation reduction coefficient (K_r)	3-50
3.9.6 Calculation of soil evaporation (E)	3-51
- Energy limiting stage (Stage I).....	3-51
- Falling rate stage (Stage II)	3-51
3.10 Crop transpiration	3-53
3.10.1 Crop transpiration coefficient (K_{cb})	3-54
3.10.2 Coefficient for maximum crop transpiration (K_{cb_x}).....	3-55
3.10.3 Adjustment of K_{cb_x} for ageing and senescence	3-55
- Adjustment of K_{cb_x} for ageing effects.....	3-55
- Adjustment of K_{cb_x} once senescence is triggered	3-56
3.10.4 Soil water stress coefficient (K_s)	3-57
- Water stress coefficient for stomatal closure ($K_{s_{sto}}$)	3-57
- Water stress coefficient for deficient aeration conditions	3-58
3.10.5 Soil water extraction.....	3-60
- Calculation procedure	3-60
- Maximum root extraction (S_x) and the total extraction rate ($\sum S_x dz$).....	3-61
3.10.6 Feedback mechanism of transpiration on canopy development.....	3-62
3.11 Above-ground biomass	3-63
3.11.1 Normalized crop water productivity (WP^*)	3-64
- Normalization for atmospheric CO_2	3-64
- Normalization for the climate	3-64
- Classes for C3 and C4 crops	3-64
3.11.2 Adjustment of WP^* for atmospheric CO_2 , type of products synthesized, and soil fertility	3-65
- Adjustment of WP^* for atmospheric CO_2 (f_{CO_2})	3-65
- Adjustment of WP^* for type of products synthesized (f_{yield}).....	3-67
- Adjustment of WP^* for soil fertility (K_{SWP}).....	3-68
- Adjustment of WP^* for atmospheric CO_2 , type of products synthesized and soil fertility	3-69
3.11.3 Air temperature stress coefficient for biomass production	3-70
3.11.4 Above ground biomass production between cuttings	3-70
3.12 Partition of biomass into yield part (yield formation)	3-71
3.12.1 Reference Harvest Index (HI_0).....	3-72
3.12.2 Building up of Harvest Index.....	3-72
- Building up of Harvest Index for leafy vegetable crops	3-72

- Building up of Harvest Index for root/tuber crops.....	3-73
- Building up of Harvest Index for fruit/grain producing crops	3-74
3.12.3 Adjustment of HI_0 for inadequate photosynthesis.....	3-75
3.12.4 Adjustment of HI_0 for water stress before the start of yield formation	3-76
3.12.5 Adjustment of HI_0 for failure of pollination (only for fruit/grain producing crops)	3-79
- Flowering	3-79
- Failure of pollination.....	3-79
3.12.6 Adjustment of HI_0 for water stress during yield formation.....	3-83
- Upward adjustment of HI_0	3-83
- Downward adjustment of HI_0	3-85
- Combined effect on HI_0	3-86
3.12.7 Total effect of water and temperature stress on the Harvest Index	3-87
3.13 Schematic outline of the model operation	3-89
References	3-90

Chapter 4. Calibration guidance

Annexes

I. Crop parameters

I.1 Cotton

I.2 Maize

I.3 Potato

I.4 Paddy rice

I.5 Quinoa

I.6 Soybean

I.7 Sugar Beet

I.8 Wheat

II. Indicative values for lengths of crop development stages

List of principal symbols

Symbol	Description	Unit
B	dry (above ground) biomass	Mg ha ⁻¹
CC	Green Canopy Cover	m ² m ⁻²
CC*	Green Canopy Cover adjusted for micro advection	m ² m ⁻²
cc ₀	Canopy size of the average seedling at 90% emergence	cm ²
CC ₀	Canopy Cover at 90% emergence	m ² m ⁻²
CC _x	Maximum green Canopy Cover	m ² m ⁻²
CDC	Canopy Decline Coefficient	d ⁻¹ or °C-d ⁻¹
CGC	Canopy Growth Coefficient	d ⁻¹ or °C-d ⁻¹
CN _{II}	Curve Number for antecedent moisture class II	-
CR	Capillary Rise	mm d ⁻¹
Dr	Root zone depletion	mm
DP	Deep percolation	mm d ⁻¹
E	Soil evaporation	mm d ⁻¹
E _x	Soil evaporation in Stage I (wet soil surface)	mm d ⁻¹
ECe _n	Electrical conductivity of the saturated soil-paste extract: lower threshold (at which soil salinity stress starts to occur)	dS m ⁻¹
ECe _x	Electrical conductivity of the saturated soil-paste extract: upper threshold (at which soil salinity stress has reached its maximum effect)	dS m ⁻¹
EC _w	Electrical conductivity of the irrigation water	dS m ⁻¹
ET	Evapotranspiration (soil water evaporation and crop transpiration)	mm d ⁻¹
ET ₀	Reference crop evapotranspiration (evaporating power of the atmosphere)	mm d ⁻¹
f	Adjustment factor	-
f _{age}	Reduction coefficient describing the effect of ageing, nitrogen deficiency, etc. on the crop transpiration coefficient	d ⁻¹
f _{sen}	Reduction coefficient describing the effect of canopy senescence on the crop transpiration coefficient	-
f _{yield}	Reduction coefficient describing the effect of the products synthesized during yield formation on the normalized water productivity	-
FC	Field Capacity	
GDD	Growing Degree Days	°C-d
HI	Harvest Index	%
HI ₀	Reference Harvest Index	%
I	Irrigation	mm d ⁻¹
K _{sat}	Saturated hydraulic conductivity	mm d ⁻¹
Kcb	Crop transpiration coefficient	-
Kcb _x	Crop transpiration coefficient when complete canopy cover (CC = 1) but prior to senescence	-
Ke	Soil evaporation coefficient for fully wet soil surface	-
Ke _x	Soil evaporation coefficient for fully wet and non-shaded soil surface	-

K _r	Evaporation reduction coefficient	-
K _{S_{aer}}	Water stress coefficient for water logging (aeration stress)	-
K _{S_b}	Cold stress coefficient for biomass production	-
K _{S_{CCx}}	Soil fertility stress coefficient for maximum Canopy Cover	-
K _{S_{exp,f}}	Soil fertility stress coefficient for canopy expansion	-
K _{S_{exp,w}}	Water stress coefficient for canopy expansion	-
K _{S_{pol,c}}	Cold stress coefficient for pollination	-
K _{S_{pol,h}}	Heat stress coefficient for pollination	-
K _{S_{pol,w}}	Water stress coefficient for pollination	-
K _{S_{salt}}	Soil salinity stress coefficient	-
K _{S_{sen}}	Water stress coefficient for canopy senescence	-
K _{S_{sto}}	Water stress coefficient for stomatal closure	-
K _{S_{WP}}	Soil fertility stress coefficient for Water Productivity	-
p _{exp, lower}	Fraction of TAW at which CGC becomes 0	-
p _{exp, upper}	Fraction of TAW at which CGC starts to be reduced	-
p _{pol}	Fraction of TAW at which pollination starts to fail	-
p _{sen}	Fraction of TAW at which early canopy senescence is triggered	-
p _{sto}	Fraction of TAW at which stomata start to close	-
P	Precipitation	mm.d ⁻¹
PWP	Permanent Wilting Point	
RAW	Readily Available soil Water in the root zone	mm
REW	Readily Evaporable Water	mm
RO	Surface runoff	mm.d ⁻¹
S	Root extraction term	m ³ .m ⁻³ .d ⁻¹
S _x	Maximum root extraction term	m ³ .m ⁻³ .d ⁻¹
t	Time	GDD or d
T	Air temperature	°C
T _{avg}	Average air temperature	°C
T _{base}	Base temperature (below which crop development does not progress)	°C
T _n	Daily minimum air temperature	°C
T _{upper}	Upper temperature (above which crop development no longer increases with an increase in air temperature)	°C
T _x	Daily maximum air temperature	°C
Tr	Crop transpiration	mm.d ⁻¹
Tr _x	Maximum crop transpiration (for a well watered crop)	mm.d ⁻¹
TAW	Total Available soil Water (between FC and PWP) in the root zone	mm
Wr	Soil water content of the root zone expressed as an equivalent depth	mm
WP	Crop water productivity	Mg ha ⁻¹ mm
WP*	Crop water productivity normalized for ET _o and air CO ₂ concentration	Mg ha ⁻¹
Z _{e,surf}	Evaporating soil surface layer	m
Z _{e,top}	Top soil layer from which water flows to the evaporating surface layer	m
Z	Effective rooting depth	m

Z_n	Minimum effective rooting depth	m
Z_x	Maximum effective rooting depth	m
z	Soil compartment (depth layer)	m
θ	Volumetric soil water content	$m^3 \cdot m^{-3}$
$\theta_{\text{air dry}}$	Soil water content when air dry	$m^3 \cdot m^{-3}$
θ_{FC}	Soil water content at FC	$m^3 \cdot m^{-3}$
θ_{PWP}	Soil water content at PWP	$m^3 \cdot m^{-3}$
θ_{sat}	Soil water content at soil saturation	$m^3 \cdot m^{-3}$
τ	Drainage coefficient	-