IWMI
International Water Management Institute

ITC Limited

Drought-Proofing Tool User Manual

Innovative water solutions for sustainable development

· Food · Climate · Growth

Contents

Acknowledgement

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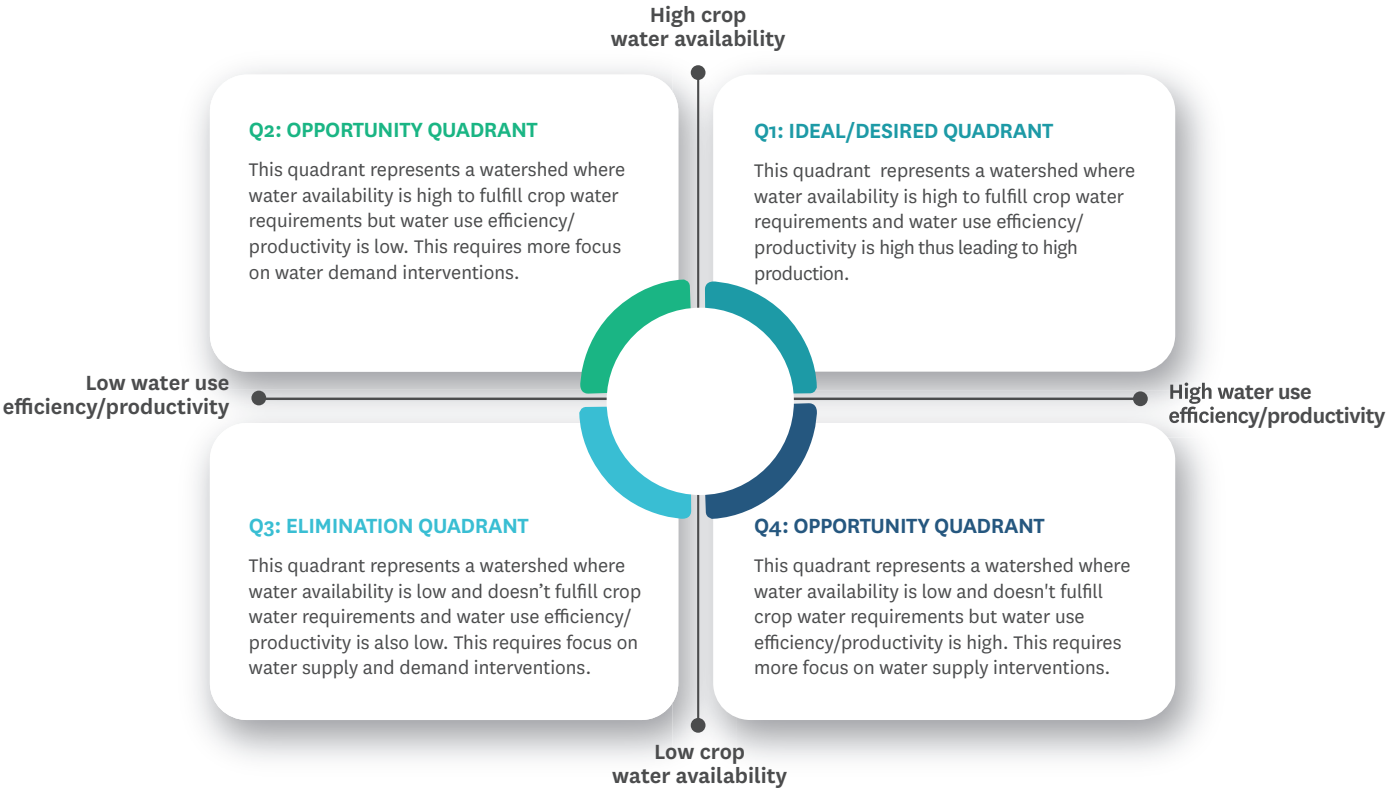
Introduction

Drought-proofing tool is developed to operationalize the Drought-proofing framework (Figure 1). In the framework, drought-proofing in a watershed is conceptualized as an interaction between water availability for crop and water productivity or use efficiency. In the framework, 'drought-proofing' is conceptualise as an interaction between water availability for crop (% of crop water need met) and how efficiently available water is used. Across a simple 2*2 plane, we can identify four distinct quadrants with water availability for crop on y-axis and crop water productivity on x –axis. Quadrant 1 is the ideal quadrant where water availability is sufficient to meet crop water needs and available water is used efficiently. In other quadrant, there must be focus on increasing water availability (quadrant 4) or water use efficiency (Quadrant 2) or both (Quadrant 3). By analysis where watershed crops lies in different rainfall years, user can identify the type and intensity of required interventions. Water availability can be increased with supply augmenting practices (storages, recharge and soil moisture conservation) whereas water use efficiency can be increased by increasing yield or reducing non-beneficial evaporation and increasing irrigation application efficiency.

Figure 1: Conceptual physical drought-proofing framework



With water as the key input to the drought proofing framework (Figure 1), a drought-proofing tool is developed to operationalize the framework. Water balance tool helps in site specific water balance, crop yield and crop requirement assessments.

The two key functions of the tool are as follows:

1. To assess water balance of study area under different conditions
2. To assess the impact of proposed land and water interventions on water balance for study area.

The water balance results from before and after the interventions are plotted in the same drought - proofing framework plot to monitor the change in crop yield and productivity. The tool is modeled in excel spread sheet with minimum input data requirements for simplifications. This user manual provides the step-by-step instructions on setting up and running the tool. This technical manual provides the methodological details and technical details of the backend processes.

Drought-Proofing Tool is developed in MS Excel + Visual Basic Editor (VBA) platform. The tool is composed of three sections: Input, Run Tool and Output. This user manual provides step-by-step instructions on how to navigate through the three sections as shown in Figure 2.

Figure 2: Drought tool layout

System Requirements

The ideal system requirements for the Drought-Proofing tool to run smoothly are (Recommended)

- Operating System: Windows XP and later versions (32 / 64 bit)
- Microsoft Excel: 2010 or later versions
- Disk space requirement: 12 Mb
- Memory requirement: 2 GB RAM (32 bit) or 4 GB (64 bit)

Minimum Requirements (The tool still runs with these system requirements with glitches in User Interface (Tabs), display & graphics, but the user will still be able to interpret results.

- Operation system: Windows XP, Windows 7 and later versions
- Microsoft Excel 2007 or later
- Disk space requirement: 12 Mb
- Memory requirement: 1 GB RAM

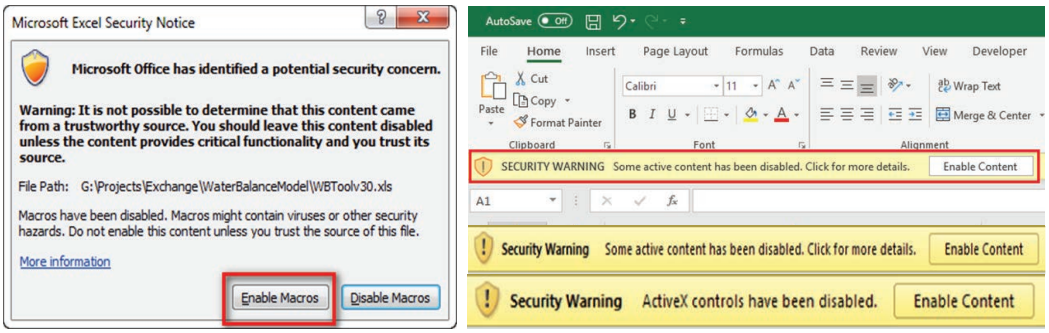
Setting up the Tool

Macro & ActiveX settings

Drought-Proofing Tool is developed on MS Excel + Visual Basic Editor (VBA) platform with macros doing all the computations process in the tool. It's pertinent to enable the macro setting in MS excel.

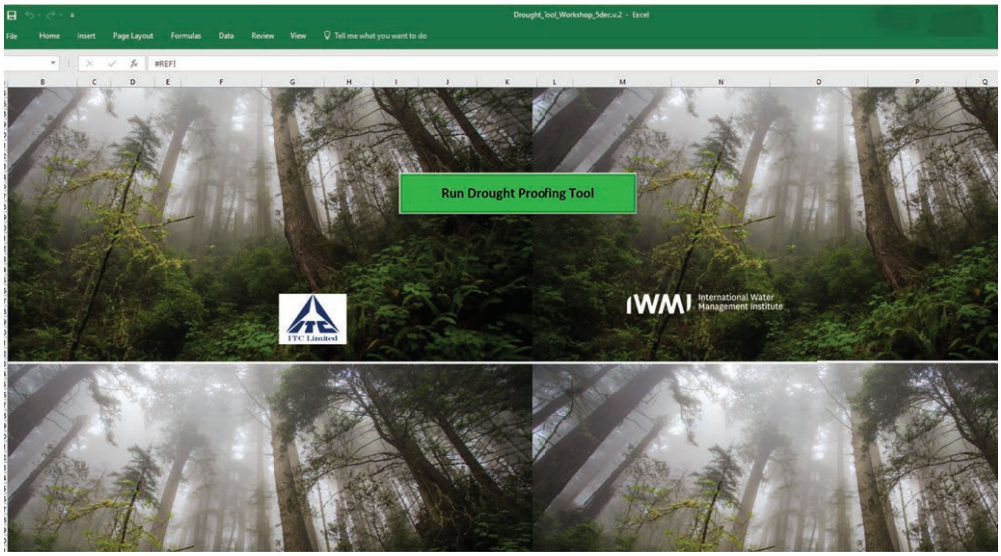
Default security settings of MS Excel may disable macros and external components from running, so the following warnings may appear when the tool is opened as shown below.

Figure 3: MS Excel – Warning messages



The security warning (Macros, ActiveX or Active content) appear because the drought tool uses all these features to run the tool which is normally not used in most of the excel files. Click on Enable content/ enable macros to support the full functioning of the drought-proofing tool. Once the macros & activeX components are enabled, drought tool is opened and front page of the tool appears as shown in Figure 4.

Figure 4: Drought Tool – Front Page



Opening the Interface

Once the tool is opened, activate the tool by clicking Run Drought Proofing Tool icon, master sheet will appear as shown in Figure 5. The master sheet acts as the main tab of the tool. Input, run tool and output section are accessed through this page.

Figure 5: Drought Tool – Mastersheet

Note: If the drought tool is run on older version of excel (i.e. 2003, 2007 or 2010) the layout and graphics may look slightly different.

Step 1: Land Use & Soil

The first step in running the tool is to start by entering the land use and soil data.

Click on Land & Soil icon to open the Land use and Soil tab (Figure 6).Following data (Table 1) is required and taken as input.

Figure 6: Land Use & Soil Tab

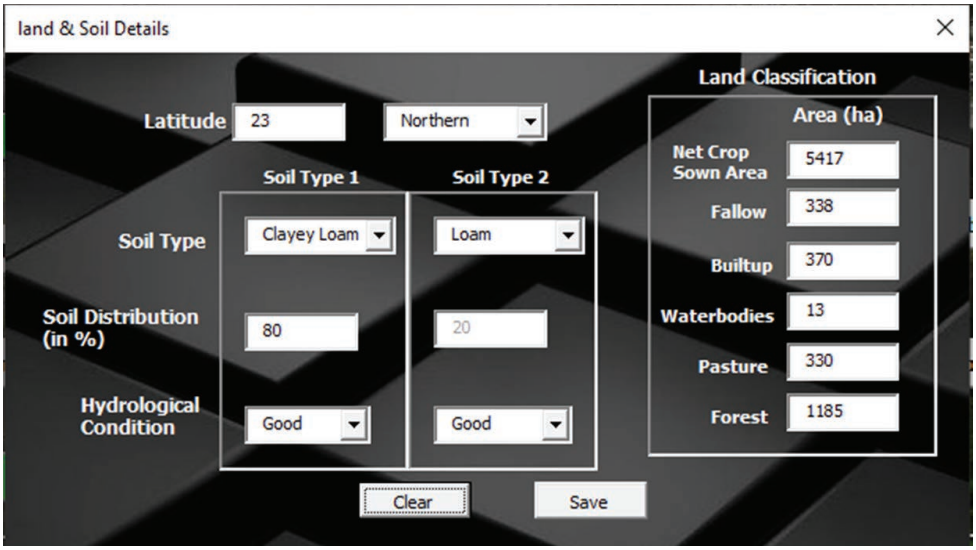


Table 1: Land Use & Soil data Requirements

Data Required	Explanation	Type	Options / Value Range
Soil Type	Soil types based on the soil texture, particle size and infiltration rate.	Drop down	Clay, Clayey Loam, Loam, Sand, Silty loam (User Can select upto 2 soil types)
Soil Distribution (in %)	Distribution of each soil type.	%	1 to 100%
Land Use Classification	Information on land use /land cover.	Float	Area in ha for agriculture, fallow, built-up, water bodies, pasture and forest
Latitude	North–South position of a point on the Earth's surface.	Float	0-50 For India (7 to 35)
		Drop down	Northern, Southern For India - Northern
Hydrological Condition for Soil type	Based on hydrological processes	Drop down	Good or Bad

The steps involved in entering the data in land use and soil tab are as follows:

Step 1.1: To start with the user inputs Latitude & Hemisphere details. For India, the Hemisphere is Northern.

Step 1.2: Soil Type is selected by clicking the drop down menu (Up to 2 Soil types). In case of only one soil type in the watershed, select the relevant soil in "Soil Type 1" drop down menu and in "Soil type 2" Select "NA" in the drop down menu. Once "NA" is selected in drop down menu, all soil distribution, soil depth and hydrological conditions are disabled.

Step 1.3: Enter soil distribution (%) of each soil which is the percent of area in the watershed covered by respective soil types. If there is only one soil present, value of 100% under soil distribution is entered in the "Soil Type 1" tab.

Step 1.4: Select hydrological condition for respective soil types. Hydrological conditions represent how good or bad the hydrological processes happen for that soil type.

Step 1.5: Enter Land Use Land Cover data in "Land Classification" section.

Step 1.6: Click icon to save the data entered. A popup window will appear confirming the land use and soil data is saved inside the tool

Note: In case of wrong details are entered, when Save icon is clicked, a warning tab will popup displaying the correct value ranges/suggestions to be entered. Click on "OK" in the popup window and proceed to re-enter correct values and Save click icon.

[1]Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff (USDA, 1986)

Step 2: Crop Details

The second step in running the tool is to start by entering the cropping pattern details.

Click on **Crop Pattern** icon to open the Crop details tab (Figure 7).

The Crop details tab consists of two sections, one is adding crop pattern details and second is adding new crop / updating existing crop parameters. Following cropping pattern data (Table 2) is required and taken as input.

Figure 7: Crop Details

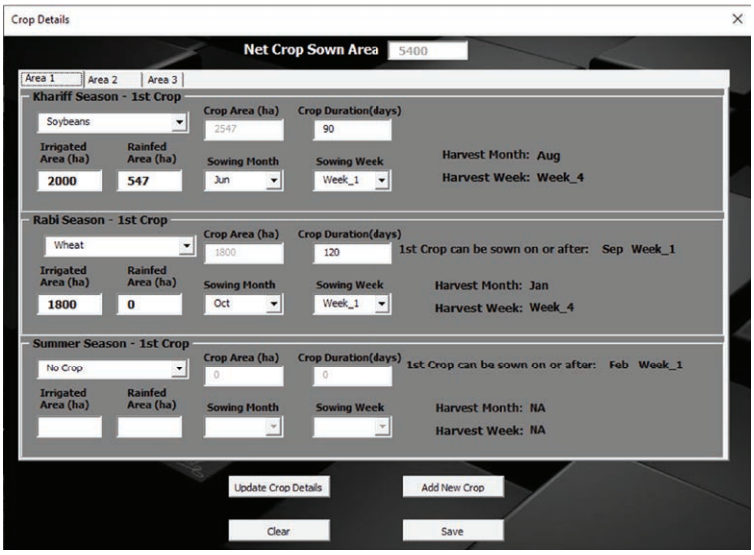


Table 2: Crop details data Requirements

Data Required/ Inbuilt	Explanation	Type	Options / Value Range
Crop Type (Maximum 9 crops)	Crop types inbuilt in tool	Drop down	18 Crop types inbuilt in tool (see **Annexure B**)
Crop Sown Area (in ha)	sum of irrigated and rainfed area	Float	(automatic)
Crop duration (days)	Crop growing days	Integer	Inbuilt in tool
Irrigated area (in ha)	Crop area which is irrigated	Float	-
Rainfed area (in ha)	Crop area which is rain-fed	Float	-
Crop Sowing Month & Week	-	Drop down	Crop Sowing Month & Week
Crop harvesting month & week	Crop harvesting month & week for each season displayed based on sowing date and crop duration	Text	Crop harvesting month & week (automatic)
Crop can be sown on or after	Suggestion for seasons crop sowing month & week depending on previous seasons harvesting month & week	Text	Suggestion for crop sowing month & week (automatic)

Adding cropping pattern details

The steps involved in entering the crop details tab are as follows:

The cropping pattern details have three tabs namely “Area 1”, “Area 2” and “Area 3”. Each area is a representation of unique area/plot in the watershed where crop is grown one another. For each area, multiple crops can (max 3) can be grown. However, at one time, only one crop can be grown in each area. Thus, at one time maximum of 3 crops and in total 9 crops can added.

Area 1	Area 2	Area 3
Crop 1 (Kharif)	Crop 1 (Kharif)	Crop 1 (Kharif)
crop 2 (Rabi)	crop 2 (Rabi)	crop 2 (Rabi)
Crop 3 (Summer)	Crop 3 (Summer)	Crop 3 (Summer)

Step 2.1: To start with the user selects crop type under Kharif, Rabi or summer season section by clicking the drop down menu.

Step 2.2: Enter Rain-fed & irrigated area for the selected crop. Maximum crop area in any of the seasons of "Area 1" should be equal to or less than the maximum area of "Kharif Season – 1st Crop". For Example, if Kharif season crop is Soyabean and the total area is 2547 ha, then Rabi season crop (wheat) area and summer season crop area should be less than 2547 ha.

Step 2.3: The tool shows standard crop growth duration for the respective crops. The user can modify the growth days based on site conditions if necessary

Step 2.4: Crop Sowing Month & Week is selected by clicking the corresponding drop down menu. For each area, crop sowing month and week for Rabi and summer season crop should be such that crops growing period don't overlap. Based on crop duration and sowing date, tools suggest the earliest sowing period on the Rabi and summer tabs. The suggested harvesting month and week includes a leeway of one week for land preparation.

Step 2.5: If there are more than 3 crops, the steps from 2.1 to 2.4 are to be followed for "Area 2" and "Area 3" also.

Step 2.6: Click "Save" icon to save the data entered. A popup window will appear confirming the cropping pattern is saved inside the tool.

Note: In case of wrong details are entered, when "save' icon is clicked, a warning tab will popup displaying the correct value ranges/suggestions to be entered. Click on "OK" in the popup window and proceed to re-enter correct values and click "save" icon.

Note: The sum area of all the crops in Kharif or Rabi or summer season should not be greater than the net sown area.

Add New Crop / Update Existing crop details

The tool is inbuilt with 18 major crops grown in India. The inbuilt crop details are attached in Annexure B. The Crop details inbuilt inside the tool are given in Table 3. User can edit or add new crop details by following the steps outline below.

Table 3: Crop details inbuilt in tool

Details	Explanation	Type	Type / Value Range (See Annexure B & C)
Price (INR /tonne)	Selling price per tonne.	Integer	Depends on crop type
Potential yield (tonne/ha)	Potential yield of a crop per hectare	Float	Depends on crop type
Maximum root depth (m)	Maximum depth of root	Float	0.3 to 0.1 m (Avg: 0.65m) Depends on crop type
Yield response factor (Ky)	Ky represents the effect of reduction in evapotranspiration on yield losses.	Float	Classifications inbuilt in tool (0.2 to 1.15)
Cover type and seed	Row crops, small grains or closed seed[2]	Drop down	Row crops, small grains or closed seed
Crop Treatment	Crop treatment represents the mechanical practices used for crop growth	Drop down	Contoured, straight row, terraced or combination of treatment
Crop growth duration (days)	Total growth duration (total number of days from sowing to harvesting date)	Integer	Growth days depend on crop type.
Depletion factor	Depletion factor is the fraction of total available water that a crop can extract from the root zone without suffering water stress	Float	0.5
Crop growth stage distribution	Ratio of four crop growth stage days (Initial, development, mid & late)	Float	in ratio (depends on crop type)
Crop Coefficients (Kc)	Kc represents of the ratio of crop evapotranspiration (ETa) to reference evapotranspiration (ETo).	Float	(0.2 to 1.5) each stage will have a different Kc value. (Depends on crop type)

[2]Row crops are field crops planted in rows far enough apart that most of the soil surface is directly exposed to rainfall.
Small grain is planted in rows close enough that the soil surface is not directly exposed to rainfall.
Close-seeded are crops either planted in close rows or broadcasted. This kind of cover usually protects the soil throughout the year.

Click on Update Crop Details icon to open the update existing crop detail tab (Figure 9) or click on Add New Crop icon to open the add new crop details tab (Figure 8).

Figure 9 : Update Crop details

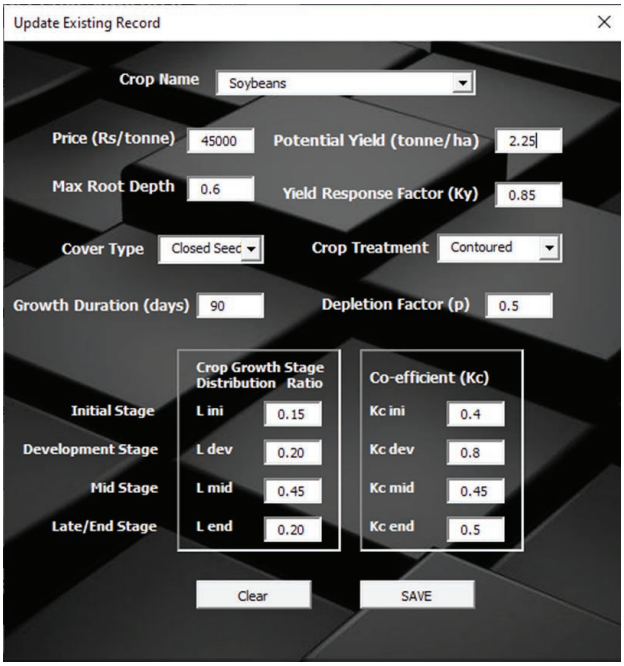
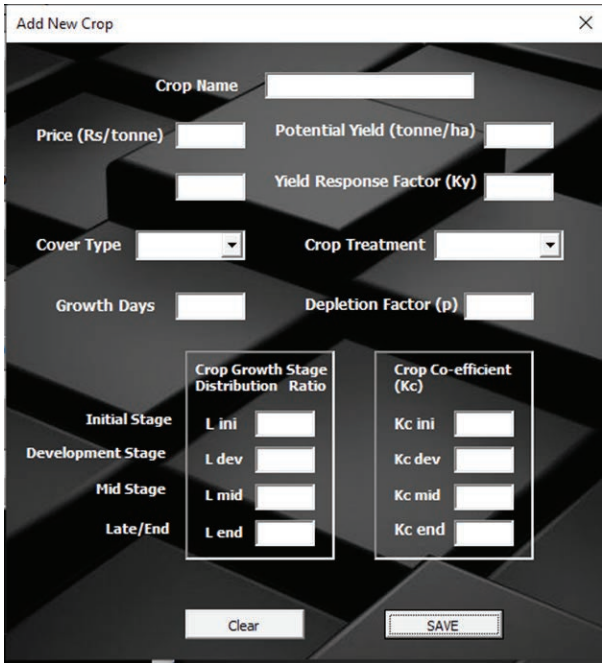


Figure 8 : Add new Crop details



The steps to modify the existing crop parameters or add new crop and its parameters are as follows,

Step 1: To modify inbuilt crop parameters, click on the crop name drop **down** menu (Figure 9) to select one of the crop name inbuilt in the tool. All the Crop parameters are displayed. To add new crop, add the crop name in crop name text box (Figure 8).

The steps for updating existing crop details and adding new crops is the same. Only in adding new crop, user must enter the crop name (figure 9).

Note: Refer Annexure B and Annexure C for updating or adding new crop parameters to tool.

Step 2: Modify the price (INR/tonne) in update crop details (Figure 9) or enter new price relevant to the new crop (Figure 8).

Step 3: Modify the potential yield (tonne/ha) in update crop details (Figure 9) or enter new potential yield (tonne/ha) relevant to the new crop (Figure 8)

Step 4: Modify the maximum root depth (m) in update crop details (Figure 9) or enter new maximum root depth (m) relevant to the new crop (Figure 8).

Step 5: Modify the cover type and crop treatment in update crop details (Figure 9) or enter select cover type and crop treatment relevant for the new crop (Figure 8).

Step 6: Modify the crop growth duration (days) in update crop details (Figure 9) or enter new crop growth duration (days) relevant to the new crop (Figure 8).

Step 7: Modify the depletion factor in update crop details (Figure 9) or enter new depletion factor relevant to the new crop (Figure 8).

Step 8: Modify the crop growth stage distribution ratio in update crop details (Figure 9) or enter new crop growth stage distribution ratio relevant to the new crop (Figure 8).

Crop growth stage distribution ratio represents how the total crop growth days are distributed across crop growth stages (Initial, development, mid and late stage). For example, if the total crop growth days is 120 days and 25% (i.e. 30 days) of the crop days is in initial stage then Lini becomes 0.25, similarly if the development stage is 30% (i.e. 36 days) then Ldev becomes 0.3. The same principle applies to mid and late stage. Sum of all development stage should be equal to 1 (i.e. Lini+ Ldev + Lmid + Lend =1)

Step 9: Modify the crop coefficients (Kc) for each crop growth stage in update crop details (Figure 9) or enter new crop coefficients (Kc) for each crop growth stage relevant to the new crop (Figure 8).

Step 10: Click "Save" icon to save the data entered. A popup window will appear confirming the data is saved inside the tool.

Note: In case of wrong details are entered, when "save" icon is clicked, a warning tab will popup displaying the correct value ranges/suggestions to be entered. Click on "OK" in the popup window and proceed to re-enter correct values and click "save" icon.

Step 3: Rainfall & Temperature

The third step in running the tool is to start by entering the rainfall and temperature data.

Click on Rainfall & Temperature icon to open the Rainfall and temperature tab. (Figure 10). Rainfall and temperature data is stored in an external excel file in each format. Format of excel sheet is distributed with the tool. The rainfall and temperature data must be pre-prepared in a separate excel before running the tool. Daily rainfall for 20 years (mm) and monthly mean, minimum and maximum temperature (°C) is entered in the excel file. The excel template is provided along with the tool.

Note: The rainfall and temperature excel file layout must not be changed (i.e. modifying, adding or deleting new rows or columns in excel file).

Figure 10: Rainfall and Temperature.

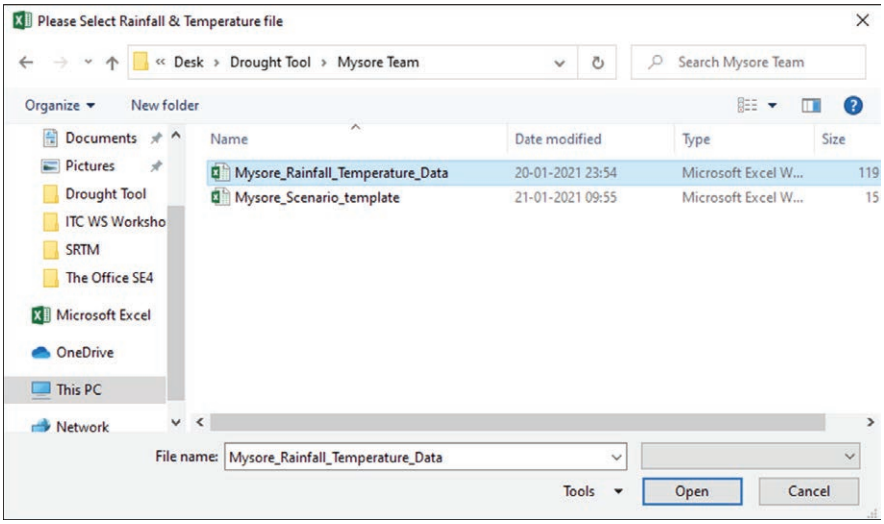


Table 4: Rainfall & Temperature

Details	Explanation	Type	Type / Value Range
Rainfall & Temperature data	20 years' daily rainfall (mm)	Float	-
	20 years' monthly mean, minimum and maximum temperature (°C)	Float	-

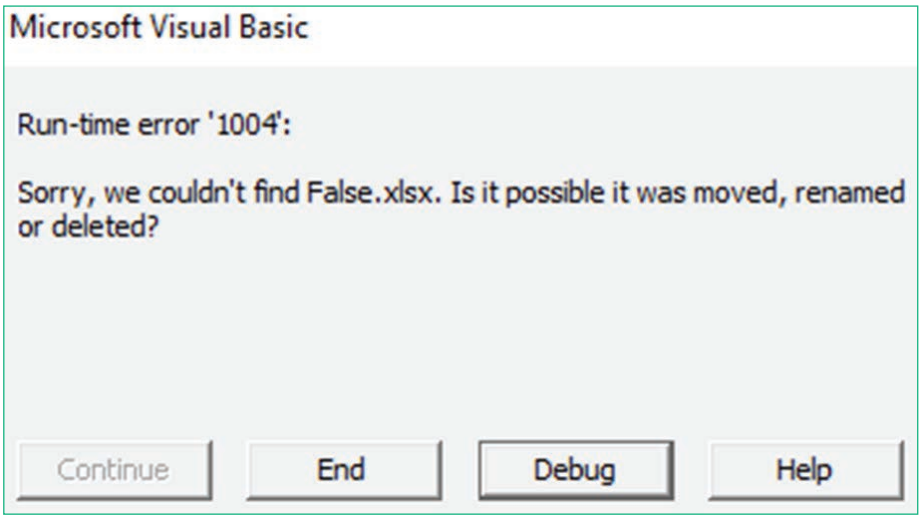
- **Step 3.1:** In the tab, go to the pre-prepared excel file location and select excel file containing daily rainfall and monthly temperature data.
- **Step 3.2:** Click on "open" to import the data from pre-prepared file to the tool. A popup window will appear confirming the data is saved inside the tool.

Note: Only the file containing the rainfall and temperature data should be select. Name the pre-prepared file always under same formation ("Location name"Rainfall_Temperature_Data").

Note: When the "cancel" or "X" button is clicked, the data is not imported into tool, and a popup window showing error message will be displayed as shown in Figure 11.

- Click on "End' in the popup window to close the error message.

Figure 11: Rainfall and Temperature error message.

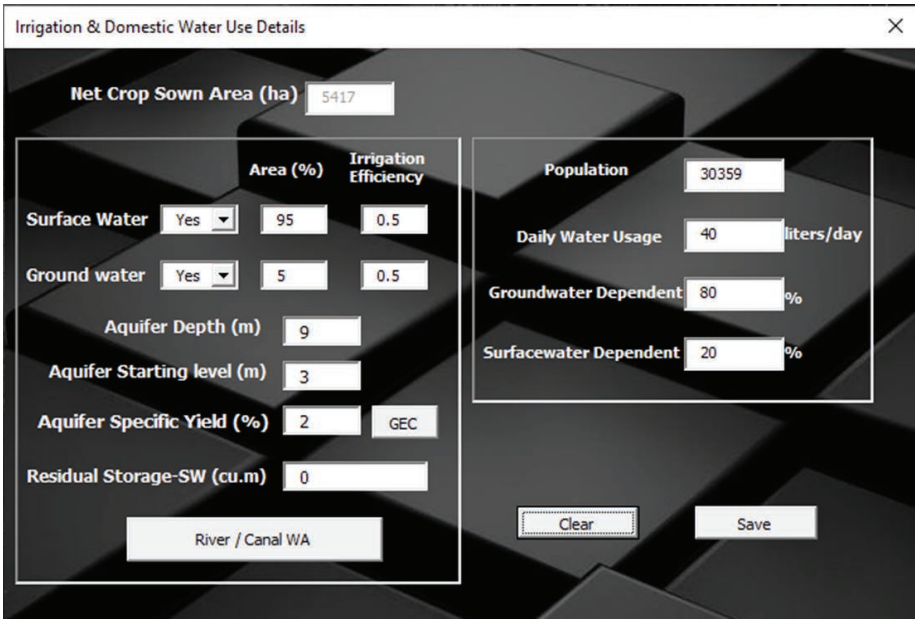


The error message does not have any implication on the tool simulation. Error message is displayed due to external file not being selected. Proceed to step 3.1 and 3.2 to import the correct external rainfall and temperature data into the tool.

Step 4: Irrigation & Domestic

The fourth step in running the tool is to start by entering the irrigation and domestic data. Click on Irrigation & Domestic icon to open the irrigation and domestic tab. (Figure 12).

Figure 12: Irrigation & Domestic details



Data requirements and value range for irrigation and domestic tab is given below (Table 5)

Table 5: Irrigation & Domestic data requirements

Data Required	Explanation	Type	Type / Value Rang
Surface (SW) dependent	Area irrigated by Surface water (%).	Drown down Float	0-100 % (Yes & if irrigated crop is dependent on SW)
Groundwater (GW)	Area irrigated byground water (%).	Drop down Float	0-100 % (Yes & if irrigated crop is dependent on GW)

Irrigation efficiency for SW & GW	Irrigation efficiency of farmer baseline method (flood irrigation)	Float	0.3 to 1
Residual Storage – Surface Water (cu.m)	Residual storage -SW is the volume of water available left for irrigation in surface storage (Ponds, tanks, reservoir, etc.) at the end of normal year	Integer	-
Aquifer Depth (m)	Total Depth of the aquifer	Float	
Aquifer Starting Level (m)	Water level in the aquifer from the bottom of aquifer at the start of season.	Float	- (value should be ≤ aquifer depth)
Aquifer Specific Yield (%)	Specific yield of the aquifer expressed in percentage. Recommended values for different aquifer types is available in tab.	Float	1-100%
Monthly water availability from river/canal	Monthly water availability from rivers/canals to meet the irrigation demand	Integer	-
Population	Total population of the watershed	Integer	-
Daily Water Usage (liters/day/person)	Daily water used per person for domestic purpose.	Float	50 to 140
Domestic Water Dependency (Surface or Groundwater dependent) %	Percentage dependency on SW or GW to meet domestic water requirements	Integer	1 – 100%

The steps involved in entering the irrigation and domestic details are as follows,

Step 4.1: Irrigation type is selected by clicking the drop down menu and select Yes or No. If the irrigation type is selected "No", then Area (%), and irrigation efficiency text box are disabled

Step 4.2: Enter the percentage of area dependent on surface or groundwater.

Step 4.3: Enter the irrigation efficiency for corresponding irrigation source.

Step 4.4: Enter the aquifer depth in meters.

Step 4.5: Enter aquifer starting level in meters. Aquifer starting level is the water level in the aquifer measured from bottom of the aquifer to the present water level.

Step 4.6: Enter specific yield of the aquifer in percentage. Aquifer specific yield is the volume of water released (%) from storage by an unconfined aquifer per unit surface area of aquifer per unit decline of the water table. Clicking GEC on will display recommended specific yield values for different aquifer types. Values are recommended based on Groundwater Estimation Committee report (GEC) by CGWB, GoI.

Step 4.7: Enter the volume of surface water residual storage in cu.m. Residual storage-SW is the volume of water available from all the surface structures (dams, ponds, lakes, etc) for irrigation at the end of year in normal rainfall years. If all storages go dry at the end of years, please enter 0.

Step 4.8: Click on River/Canal WA to enter the monthly water availability from rivers/canals as shown in Figure 13. In case of no inflows from rivers/canals, the tabs can be left empty.

Step 4.9: Enter the population data in nos.

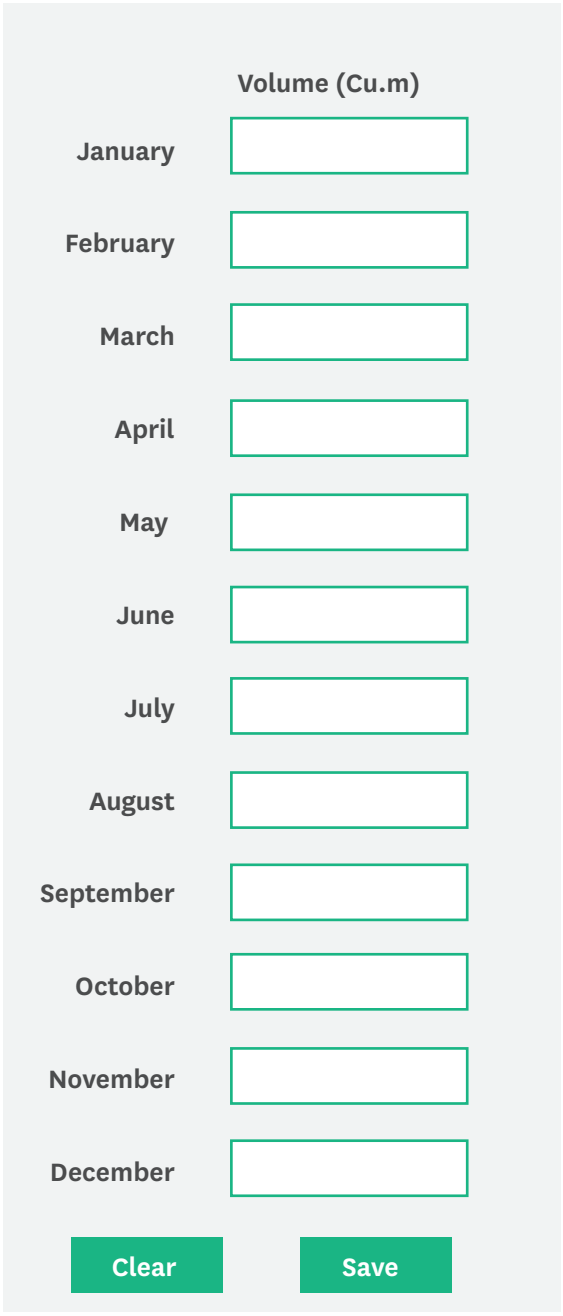
Step 4.10: Enter the per capita daily domestic water consumption (liters/day/person)

Step 4.11: Enter the percentage dependency on surface and groundwater for domestic water requirements.

Step 4.12: Click "Save" icon to save the data entered. A popup window will appear confirming the data is saved inside the tool.

Note: In case of wrong details are entered, when "save" icon is clicked, a warning tab will popup displaying the correct value ranges/suggestions to be entered. Click on "OK" in the popup window and proceed to re-enter correct values and click "save" icon.

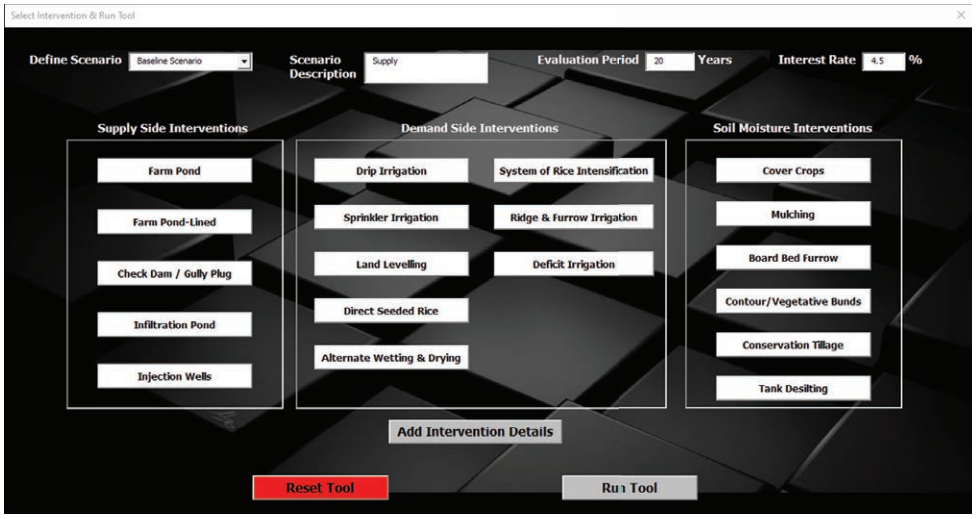
Figure 13: River/Canal



Step 5: Run Tool

Once all the input data is entered in tool, proceed to **Run Tool** click on icon. Under run tool, different scenarios with different interventions are created for simulation. Select scenarios &run tool tab will be displayed as shown in Figure 14.

Figure 14: Select Scenarios & Run Tool

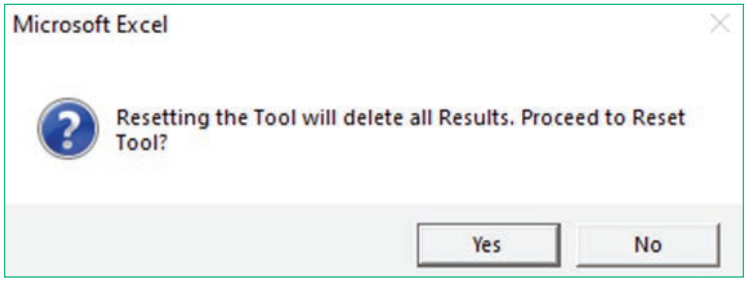


The steps involved in selecting scenarios & run tool are as follows,

Step 5.1: Before selecting scenarios and adding interventions, if the user is using the tool for the first time, click on **Reset Tool** icon to reset the tool. Resetting the tool will delete all the results and intervention details created by the previous user.

Note: Resetting the tool will not delete all the input details, only intervention details and results will be deleted. A popup window will appear to confirm reset tool (Figure 15), click on Yes to confirm reset tool or click on No to cancel resetting tool.

Figure 15: Reset Tool.



A popup window displaying the confirmation of resetting tool will appear. Click on “OK”

Step 5.2: Select the scenario from the define scenario drop down menu. The tool is currently limited to running 9 different scenarios. To begin with, select the “Baseline Scenario” in the dropdown menu.

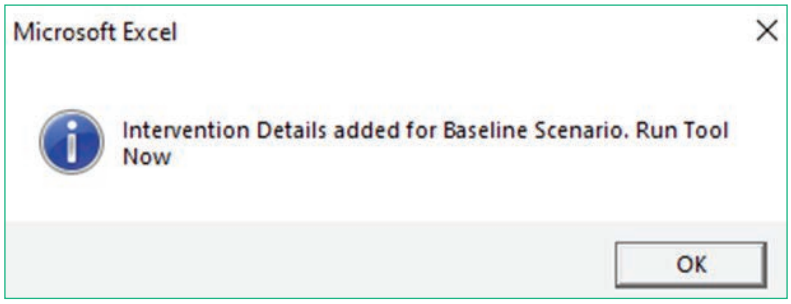
Note: Baseline scenario is selected first to run the tool without adding any interventions. The results of the baseline scenario will be set as the benchmark for other scenarios (Scenario 1 to 8) to compare with to measure the impact of interventions.

Step 5.3: Enter the description of the scenario, for “Baseline Scenario”, the description can be entered as “No Intervention”, since no interventions is considered.

Step 5.4: Enter the interest rate (%) and evaluation period can be left as 20 years. This is used for the cost benefit analysis of scenarios.

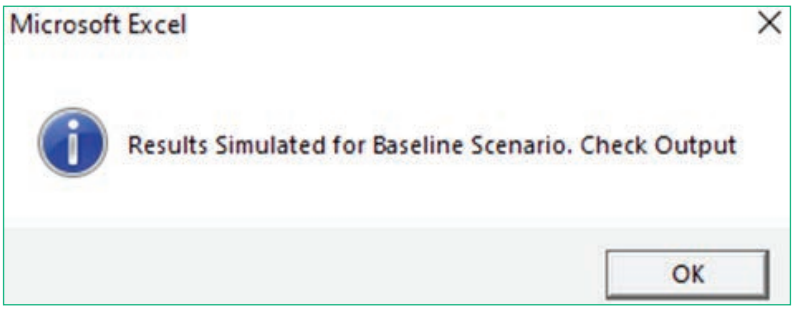
Step 5.5: Click on icon **Add Intervention Details** to save the all the details for “Baseline Scenario”. A popup window will appear confirming the data is saved in the tool as shown in Figure 16. Click on OK and proceed to run tool.

Figure 16: Add Interventions



Step 5.6: Click on Run Tool to run the tool for baseline scenario (i.e. without any interventions). The computational process takes around 30 to 60 seconds. Once the computation is done, a popup window will appear to complete the computational process (Figure 17). Click OK and proceed to check results.

Figure 17: Computation confirmation message



Step 5.7: Click on the define scenarios drop down menu again and select “Scenario 1”. Scenario 1 can be allocated for combination of interventions.

Step 5.8: Enter the description of the scenario, for “Scenario 1”, the description can be entered as “Supply + demand side interventions”, it depends on the type of interventions the user is selecting.

Step 5.9: Interest rate (%) and evaluation period can be same as the baseline scenario.

Step 5.10: Select relevant intervention from supply side, demand side or soil moisture interventions. Clicking on any intervention will display intervention tab which will allow the user to enter the relevant intervention information.

Note: Refer Annexure D for comprehensive details on interventions.

Sample interventions layout and user inputs are as shown in Figure 18, Figure 19 and Figure 20.

Step 5.11: Repeat step 5.5 and step 5.6 for all the scenarios after adding relevant interventions

Figure 18: Supply side intervention

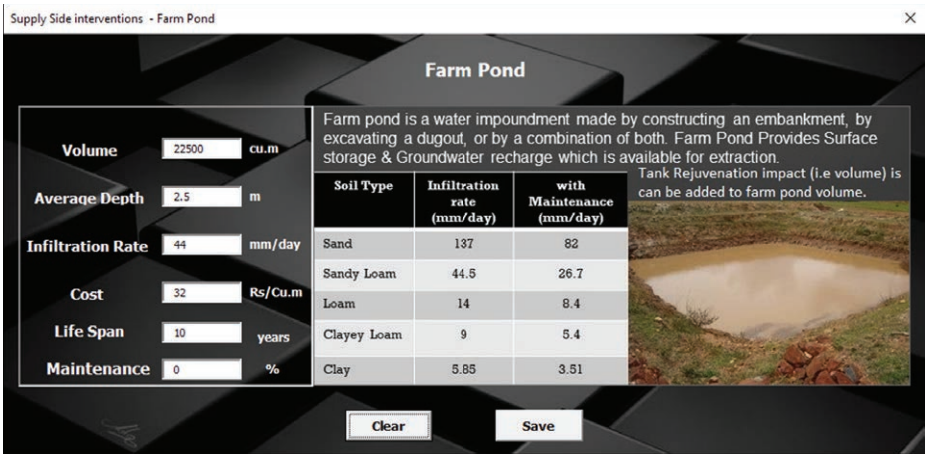


Figure 19: Demand side Intervention

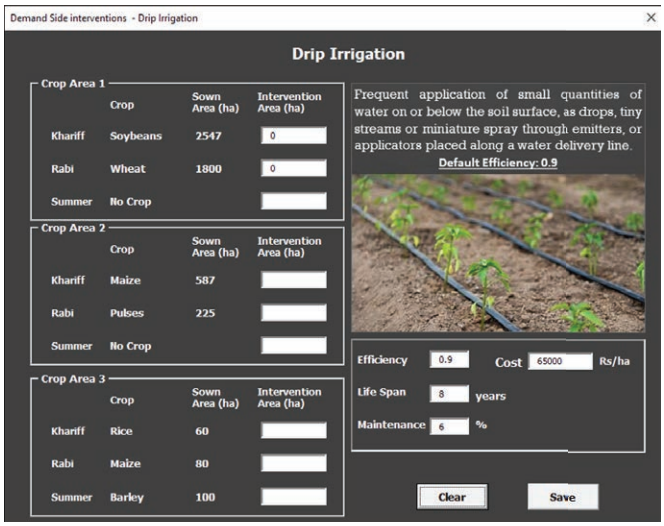


Figure 20: Soil moisture Intervention

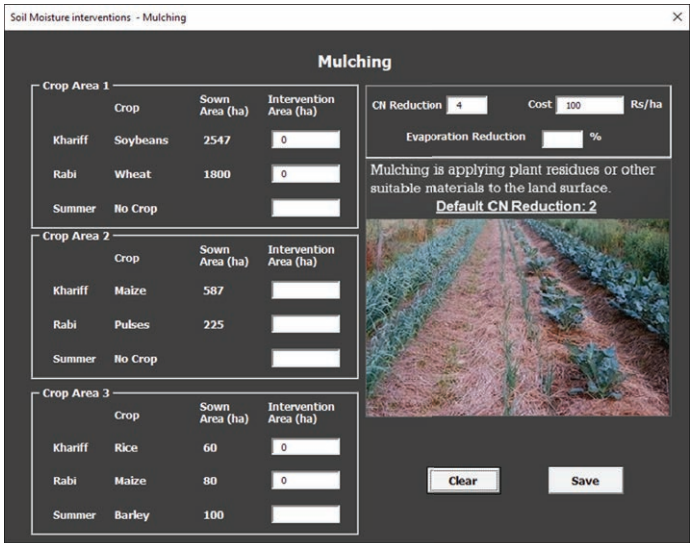


Table 6: Supply side interventions

Intervention	User Input	Type	Explanation	Value Range (Refer Annexure D)
Farm pond, Farm pond (Lined), Check dam / Gully Plug, Infiltration Ponds	Volume (cu.m)	Float	Total volume of water added due to interventions.	-
	Average Depth (m)	Float	Average depth of each structure	1 to 3 m
	Infiltration Rate (mm/day)	Float	Infiltration rate of water stored in the structures. Rate depends on the soil type.	Infiltration rate for various soil types and conditions is provided in each intervention tab.
	Cost (INR/cu.m)	Integer	Cost incurred per unit volume of water to implement the intervention	-
	Life Span (years)	Float	Life span of interventions	-
	Maintenance (%)	Float	Yearly Maintenance cost. (% of the overall investment)	0 to 100%

Intervention	User Input	Type	Explanation	Value Range (Refer Annexure D)
Injection / recharge wells	Recharge Volume (cu.m/day/unit)	Float	Recharge Volume/ capacity of each unit per day.	-
	Total Numbers or unit.	Float	Total number of structures planned.	-
	Cost per unit (INR/unit)	Integer	Total cost per injection/recharge wells	-
	Life Span (years)	Float	Life span of interventions	-
	Maintenance (%)	Float	Yearly Maintenance cost. (% of overall investment)	0 to 100%

Table 7: Demand side interventions

Intervention	User Input	Type	Explanation	Value Range (Refer Annexure D)
Drip Irrigation / Sprinkler Irrigation [Crop Specific]	Crop wise Area covered (ha)	Float	Intervention area for each crop	-
	Efficiency (η)	Float	Irrigation efficiency of each interventions.	Drip – 0.9 Sprinkler – 0.75
	Cost (INR/ha)	Integer	Cost incurred per hectare to implement the intervention	-
	Life Span (years)	Float	Life span of interventions	-
	Maintenance (%)	Float	Yearly Maintenance cost. (% of overall investment)	0 to 100%

Intervention	User Input	Type	Explanation	Value Range (Refer Annexure D)
Land Levelling	Crop wise Area covered (ha)	Float	Intervention area for each crop	0 to 100%
	Water Saved (%)	Integer	Water saved due to the intervention	25 to 30%
	Cost (INR/ha)	Integer	Cost incurred per hectare to implement the intervention	-
	Life Span (years)	Float	Life span of interventions	-
	Maintenance (%)	Float	Yearly Maintenance cost. (% of overall investment)	0 to 100%
Direct Seeded Rice (DSR), Alternate Wetting & Drying (AWD), System of Rice Intensification (SRI), Ridge & Furrow Irrigation (RFI) and Deficit Irrigation (DI)	Crop wise Area covered (ha)	Float	Intervention area for each crop	-
	Cost (INR/ha)	Integer	Cost incurred per hectare to implement the intervention	-
	Water Saved (%)	Integer	Water saved due to the intervention	DSR – 12 to 35% AWD –25% SRI – 50% RFI – 20 to 30% DI – 30%

Table 8: Soil Moisture interventions

Intervention	User Input	Type	Explanation	Value Range (Refer Annexure D)
Cover Crops, Mulching, Conservation Tillage [Crop Specific]	Crop wise Area covered (ha)	Float	Intervention area for each crop	-
	CN Reduction	Integer	CN reduction of each interventions. (i.e reduction in runoff)	Cover crops – 2 Mulching – 2
	Evaporation Reduction (%)	Integer	Reduction in evaporation due to intervention	Cover Crops – Mulching –
	Cost (INR/ha)	Integer	Cost incurred per hectare to implement the intervention	-
Tank Desilting [All Crops]	Crop wise Area covered (ha)	Float	Intervention area for each crop	-
	CN Reduction	Integer	CN reduction of each interventions. (i.e reduction in runoff)	2
	Evaporation Reduction (%)	Integer	Reduction in evaporation due to intervention	-
	Cost (INR/ha)	Integer	Cost incurred per hectare to implement the intervention	-
	Maintenance (%)	Float	Yearly Maintenance cost. (% of overall investment)	0 to 100%

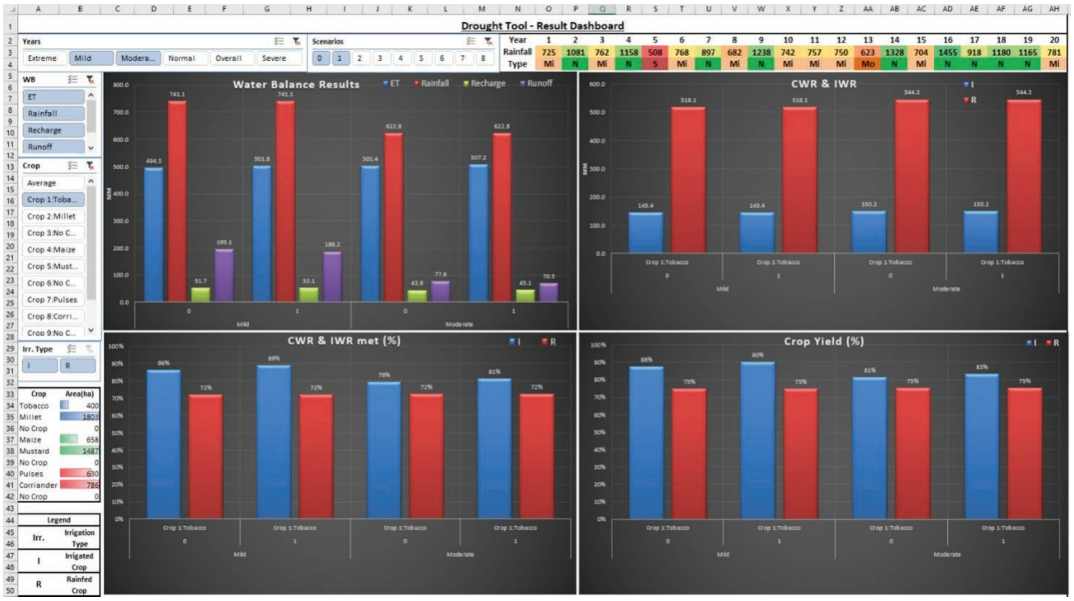
Intervention	User Input	Type	Explanation	Value Range (Refer Annexure D)
Contour/ Vegetative bunds [All Crops]	Crop wise Area covered (ha)	Float	Intervention area for each crop	-
	CN Reduction	Integer	CN reduction of each interventions. (i.e reduction in runoff)	Bunds – 3 C.Tillage – 3
	Life Span (years)	Float	Life span of interventions	-
	Cost (INR/ha)	Integer	Cost incurred per hectare to implement the intervention	-
	Maintenance (%)	Float	Yearly Maintenance cost. (% of overall investment)	0 to 100%
Broad Bed Furrows (BBF) [All Crops]	Crop wise Area covered (ha)	Float	Intervention area for each crop	-
	CN Reduction	Integer	CN reduction. (i.e reduction in runoff)	BBF – 3
	Efficiency (η)	Float	Irrigation efficiency of BBF	-
	Life Span (years)	Float	Life span of interventions	-
	Cost (INR/ha)	Integer	Cost incurred per hectare to implement the intervention	-
	Maintenance (%)	Float	Yearly Maintenance cost. (% of overall investment)	0 to 100%

Step 6: Dashboard and Detailed Results

Dashboard

Once all the user has added and ran all the scenarios, results for all the scenarios can be viewed by clicking on the Dashboard icon in the output section of the Master sheet. Result dashboard will be displayed as shown in the Figure 21.

Figure 21: Dashboard layout



The dashboard consists of key results relevant to the drought proofing framework. The results in the dashboard are as follows:

1. **Plot 1:** Water Balance Results (Rainfall, Runoff, ET & recharge)
2. **Plot 2:** Crop Water Requirement (CWR) & Irrigation Water Requirement (IWR) – in mm
3. **Plot 3:** Crop Water Requirement met (CWR met) – in %
4. **Plot 4:** Crop Yield – in %
5. **Plot 5:** Drought Proofing Result – in %
6. **Plot 6:** Benefit Cost Ratio
7. **Plot 7:** Drought Plots – CWR met & Efficiency

Table 9: Dashboard Results

Plot	Results	Unit	Explanation
Plot 1	Water Balance Results	mm	Gives the water balance of watershed (Rainfall, Runoff, ET & recharge) for different drought years and scenarios.
Plot 2	Crop Water Requirement & Irrigation Water Requirement	mm	Plot depicts how much total water required for the crop growth and how much irrigated water is required under different drought years.
Plot 3	Crop Water Requirement Met	%	Crop water requirement met results for rain-fed area and irrigated area separately. The percentages represent how much of the CWR & IWR is met.
Plot 4	Crop Yield	%	Crop yield plot represents how much percentage of potential crop yield is attained for rain-fed area and irrigated area separately under different drought years and scenarios.
Plot 5	Drought Proofing Results	%	Drought-Proofing results is the overall weighted average of all crops and all drought years. The plot shows the drought-proofness of each scenario.
Plot 6	Benefit Cost Ratio (BCR)	Investment & Benefits	Overall investment (Cost of all interventions), benefits (monetary benefits due to increase in Crores /decrease in crop yield) and BCR results of different scenario types.
Plot 7	Drought Plots – CWR met & Efficiency	CWR met - % Efficiency - 0 to 1	Plot 7 is applicable only for irrigated crops. The points in the plots represent a crops position in drought quadrant.

Note 1: All the results (Plot 1 to Plot 7) are simulated for 20 years and 9 scenarios.

Note 2: The results are then categorized and aggregated based on the drought type and scenarios. The drought types are normal, mild, moderate, severe and extreme. The drought types are determined based on the Standardised precipitation index (SPI values) which is widely used for drought classification. For example, in the 20-year rainfall period, if the rainfall for 7 years is classified under mild drought category, all the results of 7 mild drought years are averaged into a single result in the dashboard plots. Same categorization is applied for other drought types also.

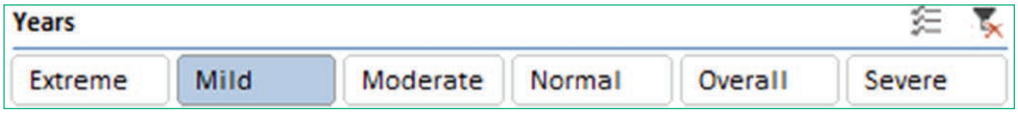
Note 3: In the 20-yearrainfall period, if a drought type doesn't occur, then results of the non-occurring drought type will not be categorized into the dashboard results. Clicking on that non-occurring drought type will show empty results in the plots.

Steps for viewing the result plots are as follows:

Step 1: Select the drought type in the year's classification tab shown in Figure 22. Clicking on a drought year will show the selected drought year results in the plots (Plot 1 to Plot 7). To select multiple drought types in the tab, hold Ctrl key in the keyboard and use the mouse pointer to click other drought types.

Note: Overall button in the drought type displays the average results for 20 years.

Figure 22: Drought Classification tab



Step 2: Select the Scenario in the scenario classification tab shown in Figure 23. Clicking on a scenario will show the selected scenario's results in the plots (Plot 1 to Plot 7). To select multiple scenarios in the tab, hold Ctrl key in the keyboard and use the mouse pointer to click multiple scenario numbers.

Note: 0 represents "Baseline Scenario", 1 represents "Scenario 1", etc.

Figure 23: Scenario types

Step 3: Step 3 is relevant for only Plot 1 (i.e. Water Balance (WB) results). Select the water balance parameter in the WB tab (Figure 24) to view that parameter in Plot 1. To select multiple scenarios in the tab, hold Ctrl key in the keyboard and use the mouse pointer to click multiple Water balance parameters.

Figure 24: Water balance components

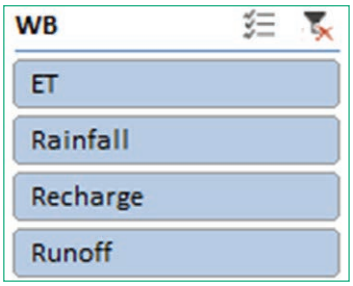
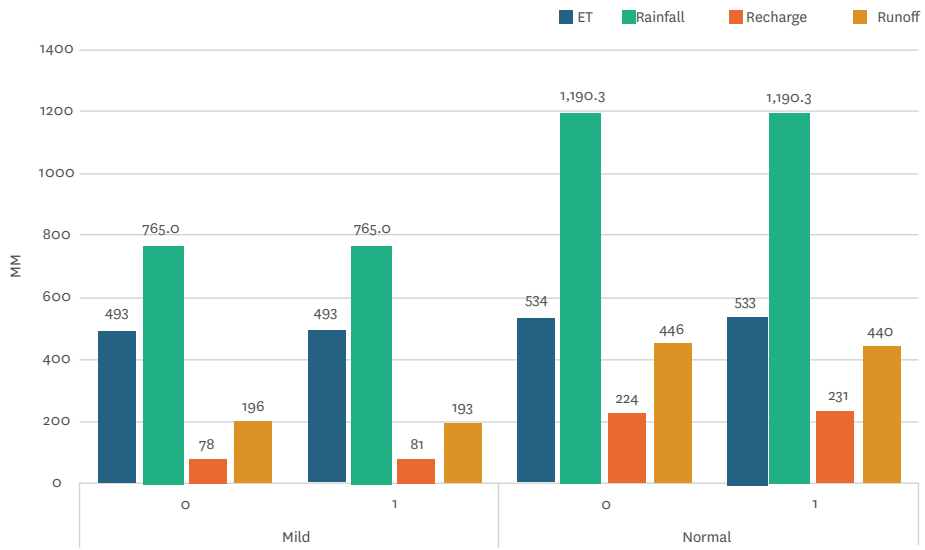


Figure 25 shows the water balance results for different drought years and scenarios. This plot help to understand the impact of interventions on water balance. Plot 1 compares different drought years and scenarios.

Figure 25: Water Balance Results



Step 4: In addition to drought types and scenarios, Plot 2 (CWR & IWR), 3 (CWR met) and 4 (Crop Yield) can be viewed for different crops and irrigation type. User can select the crop type (Figure 26) and crop "Irrigation Type" tab (Figure 27). All results can be viewed simultaneously or separately. However, clarity of plots will be compromised if all results are viewed simultaneously.

Figure 26: Crop Types

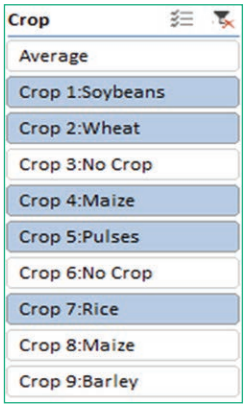
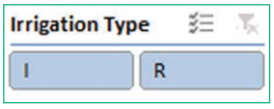
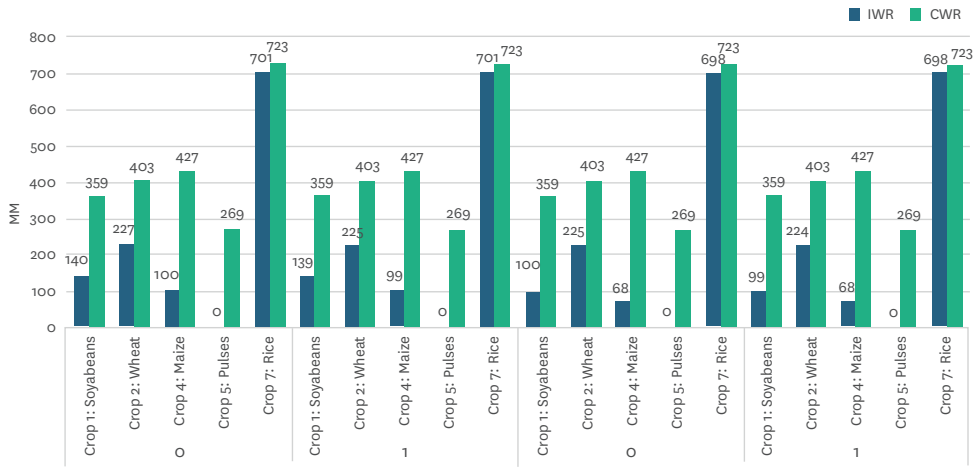


Figure 27: Irrigation Type



Plot 2: Crop Water Requirement (CWR) & Irrigated water Requirement (IWR) – Figure 28 shows the CWR & IWR for a crop under different drought years and scenarios. This plot help to understand the total water required for the crop growth and how much irrigated water is required under different drought years.

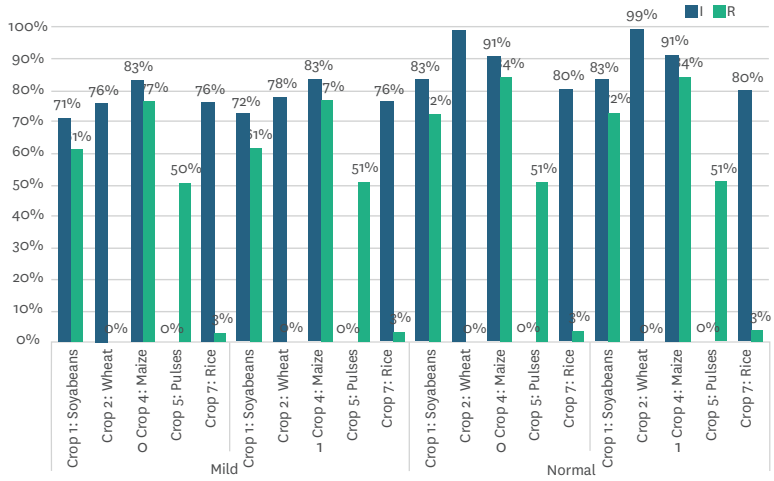
Figure 28: CWR and IWR



drought years

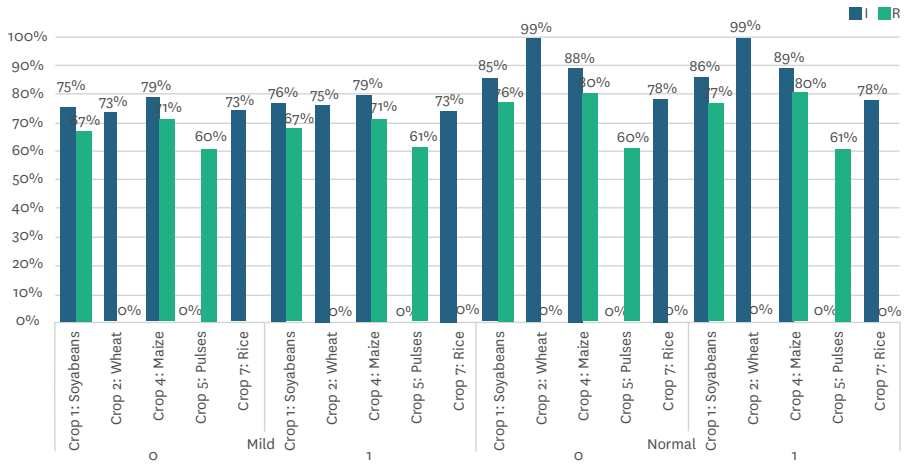
Plot 3: Crop Water Requirement met (CWRmet) – Figure 29 shows the crop water requirement met for rain-fed area and irrigated area separately. The results are in %. The percentages represent how much of the CWR is being met. For example, if the CWR of rice is 700mm and CWRmet is 90% the CWRmet is 630mm (90% of 700mm).This plot helps the user to understand how the CWRmet varies across different drought years and scenarios. I stands for irrigated and R stands for rain-fed.

Figure 29: CWR met



Plot 4: Crop Yield – Figure 30 represents the crop yield in %. The results indicate the percentage of potential crop yield is obtained. For example, if the potential yield of rice is 3.5 tonne/ha and the crop yield (%) is 70%, then the actual yield is 2.45 tonne/ha (70% of 3.5 tonnes/ha). This plot helps the user to understand how the crop yield varies across different drought years and scenarios.

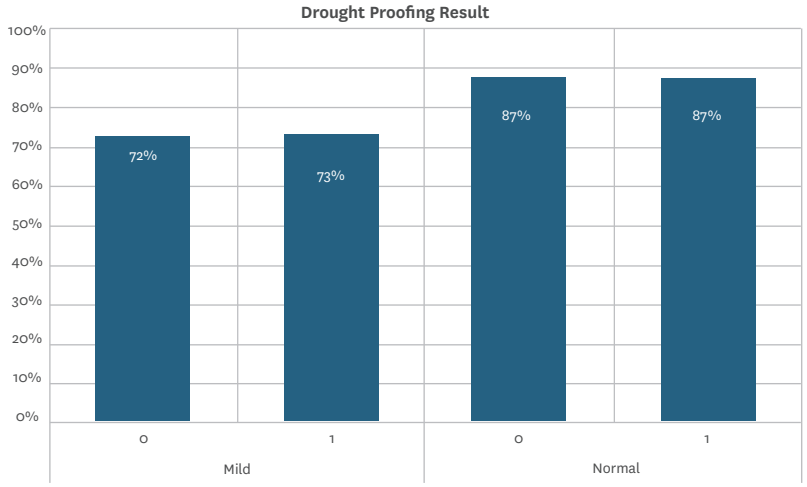
Figure 30: Crop Yield



Note: Plot 5 (Drought-Proofing Results) and Plot 6 (Benefit-Cost ratio) display the overall results of different drought and scenario types.

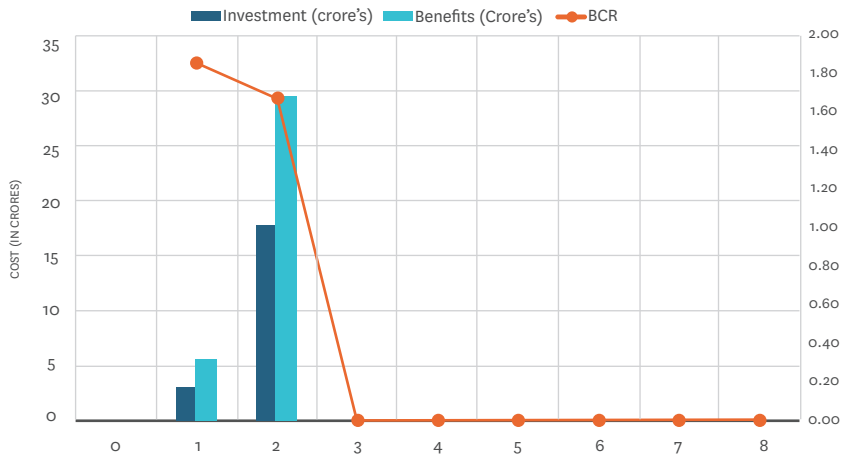
Plot 5: Drought-Proofing Results – Figure 31represents how much the watershed area is drought proofed under different drought years and scenarios. Drought-proofing results are expressed in %. Drought-proofing results are basically the weighted average of all crop yields. A watershed is said to be drought-proofed, if the Drought-proofing results are 80% and above (i.e. Weighted average crop yield is 80% and above). This plot helps the user to understand how the watershed is drought proofed under different drought years and scenarios.

Figure 31: Drought-proofing Results



Plot 6: Benefits - Cost Analysis – Figure 32 shows the investments, benefits and Benefit-Cost ratio for different scenarios. The benefit-cost analysis for 20-year period is displayed in the plot. This plot helps the user to understand how much investment and benefits vary across different scenarios.

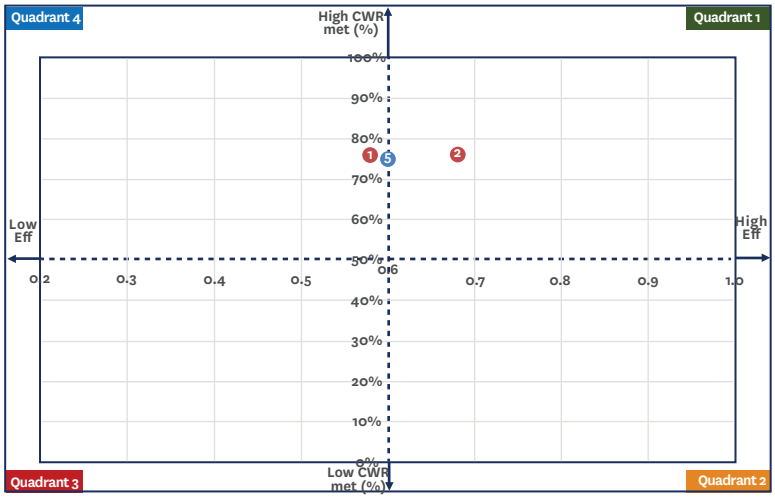
Figure 32: Benefit-Cost Analysis



Plot 7: Drought Plot – Figure 33 displays the drought quadrants which displays the CWRmet and efficiency of irrigation. Plot 7 is applicable only for irrigated crops. Depending on the position of a crop in the plot the interventions are determined.

- Quadrant 1 is the desired location where the crop has high crop CWR met and high efficiency.
- In quadrant 2 crop ha low CWRmet and high efficiency, which means the interventions need to be focused on increasing the CWRmet.
- In quadrant 3, crop has low CWRmet and low efficiency, which means the interventions need to be focused on increasing the CWR men and In quadrant 4, crop has high CWRmet but low efficiency, which means the interventions need to be focussed on increasing the efficiency.

Figure 33: Drought Quadrants



To create the plot, enter the any of the Crop Water Requirement met (CWR met) & efficiency (eff) values from Figure 34 into the tab shown in Figure 35. The values entered (CWR met & eff) entered in the tabs will be displayed in the drought quadrant plot (Plot 7). The drought quadrant plot is intentionally limited to only eight data point to view the results clearly in the plot 7.

Figure 34: CWRmet & Efficiency results

	Soybeans		Wheat		No Crop		Maize		Pulses		No Crop		Rice		Maize		Barley	
	CWR m	Eff	CWR m	Eff	CWR m	Eff	CWR m	Eff	CWR m	Eff	CWR m	Eff	CWR m	Eff	CWR m	Eff	CWR m	Eff
0	75%	0.58	83%	0.58	-	-	86%	0.58	-	-	-	-	77.38%	0.66	94%	0.58	67%	0.58
S1	76%	0.58	85%	0.58	-	-	86%	0.58	-	-	-	-	77.52%	0.66	94%	0.58	69%	0.58
S2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: The CWR met and efficiency details displayed in Figure 34 is the average of 20 years for different crop types. Step 5 and Plot 7 is relevant only for irrigated area.

Figure 35: Drought quadrant input tab

Point	CWRm	Eff	Point	CWRm	Eff
1	76%	0.58	5	75%	0.60
2	76%	0.68	6		
3			7		
4			8		

Other results

The dashboard only shows the consolidated results of different drought years and scenario types. To view the detailed results for 20 years, click on any of the relevant excel sheet tabs (Figure 36).

Figure 36: Detailed Results tab

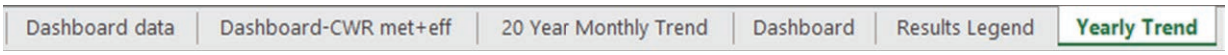


Table 10: Other results

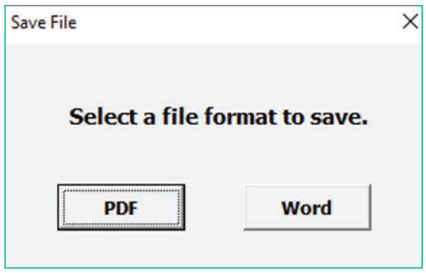
Tab Name	Results
Yearly Trend	Yearly trend graph of water balance results, end of season storage (Groundwater & Surface water) for different scenarios. This tab helps the users to understand the yearly variability in results during different years under different scenarios.
20 year Monthly Trend	Monthly trend graphs of water balance results. This tab helps the users to understand the monthly variability in results during different years under different scenarios.
Dashboard-CWR met +eff	Detailed results of crop yield, CWR met (irrigated Area) and efficiency which can be used in plot 7 •20 year results of CWR met (irrigated area) and efficiency of all crops under different scenarios
Dashboard data	Detailed results of all the Plots (Plot 1 to Plot 7). The results in the plots are categorized and aggregated based on the drought type and scenarios. Dashboard data-3 shows the results of detailed results

- 20 year results of water balance under different scenarios
- 20 year results of CWR and CWR met for rain-fed & irrigated area under different scenarios
- 20 year results of efficiency of irrigated crops under different scenarios.
- 20 year results of crop yield for rain-fed & irrigated area under different scenarios
- Drought proofing results for 20 years under different scenarios.
- End of season storage (GW & SW) for 20 years under different scenarios.
- Investment, benefits and BCR under different scenarios

Step 7: Generating Report

The final step in running the tool is to generate and export the results. The document can be exported either in .PDF or .doc format. Click on icon to generate report. A popup window will appear (Figure 37), click on the desirable format, then choose the destination folder to save the file. The save file can be used to prepare DPRs and proposals.

Figure 37: Save File option



Data Preparation

Before running the tool, it beneficial that all the data required for running the tool is entered in the data template document, to document the input parameters. The documentation of the input parameters will help in preparing the DPR's & proposals. **Annexure A** has the data collection template.

Annexure B has list of all the crop details inbuilt in the tool.

Annexure C has links to crop parameter databases.

Annexure A: Data Template

Input Section	Description	Data
	Soil Type 1:	
	Soil Type 2:	
	Soil Type 1 distribution (in %):	
	Soil Type 1 distribution (in %):	
	Soil type 1 depth (m) :	
	Soil type 2 depth (m):	
Land & Soil Details	Land Use Classification (in ha):	Agriculture
		Fallow
		Built-up
		Water bodies
		Pasture
		Forest
	Hemisphere (N/S):	
	Latitude:	
	Hydrological Condition for Soil type 1: (Good/Bad)	
	Hydrological Condition for Soil type 1: (Good/Bad)	
Rainfall & Temperature	20 year's daily rainfall (mm)	 Rainfall_Temperature_Data.xlsx
	20 year's monthly mean, minimum and maximum temperature in oC	
	Irrigation Dependency on Surface Water: (Yes/No)	
	Irrigation Dependency on Surface Water: (%)	
	Irrigation Dependency on Groundwater: (Yes/No)	
	Irrigation Dependency on Groundwater: (%)	

Irrigation & Domestic Use	Irrigation efficiency for Surface Water (0.3 to 1)
	Irrigation efficiency for Groundwater (0.3 to 1)
	Residual Storage – Surface Water: (cu.m)
	Aquifer Depth (m)
	Aquifer Starting level (m)
	Aquifer Specific Yield (%)
	Monthly water availability from river/canal: (cu.m)
	Population: (Nos)
	Daily Water Usage: (50 to 140 liters/day/person)
	Domestic Water Dependency on Surface water (%):
	Domestic Water Dependency on Groundwater (%):

Cropping pattern details

Area	Crop	Crop Name	Rain-fed Area (ha)	Irrigated Area (ha)	Sowing month	Sowing Week	Growth Duration
Area 1	Crop 1: Kharif						
	Crop 2: Rabi						
	Crop 3: Summer						
Area 2	Crop 1: Kharif						
	Crop 2: Rabi						
	Crop 3: Summer						
Area 3	Crop 1: Kharif						
	Crop 2: Rabi						
	Crop 3: Summer						

Annexure B:
Inbuilt Crop details (Data source: GCWM, 2008)

Crops	Total Growth Days	Initial stage ratio	Development stage ratio	Mid stage ratios	End stage ratio	Initial stage days	Mid stage days	Mid stage days	End stage days
No Crop	0	0.00	0.00	0.00	0.00	0	0	0	0
Wheat	120	0.15	0.25	0.40	0.20	18	30	48	24
Maize	100	0.17	0.28	0.33	0.22	17	28	33	22
Rice	90	0.30	0.20	0.30	0.20	27	18	27	18
Barley	120	0.15	0.25	0.40	0.20	18	30	48	24
Rye	210	0.10	0.60	0.20	0.10	21	126	42	21
Millet	90	0.14	0.22	0.40	0.24	13	20	36	22
Sorghum	125	0.15	0.28	0.33	0.24	19	35	41	30
Pulses	95	0.16	0.26	0.37	0.21	15	25	35	20
Soybeans	90	0.15	0.20	0.45	0.20	14	18	41	18
Sunflower	120	0.19	0.27	0.35	0.19	23	32	42	23
Tobacco	120	0.18	0.27	0.27	0.27	22	33	33	33
Potato	110	0.20	0.25	0.35	0.20	22	28	39	22
Cassava	150	0.10	0.20	0.43	0.27	15	30	65	41
Sugarcane	110	0.08	0.17	0.39	0.36	9	18	43	40
Sugar beets	95	0.20	0.25	0.35	0.20	19	24	33	19
Mustard	110	0.30	0.25	0.30	0.15	33	28	33	17
Groundnuts	150	0.22	0.28	0.30	0.20	33	42	45	30
Cotton	195	0.17	0.33	0.25	0.25	33	64	49	49

Other Crop details(Data source: GCWM, 2008)

Crops	Price	Yield (INR/tonne)	kc_ini (tonne/ha)	kc_dev	kc_mid	kc_end	Ky Values	Min root depth	Max root Depth	Depletion fraction - p
No Crop	0	0	0	0	0	0	0	0	0	0
Wheat	25000	4.5	0.4	0.8	1.2	0.75	1.1	0.05	1.25	0.55
Maize	22500	2.8	0.5	0.85	1.2	0.95	1.25	0.05	1	0.55
Rice	29000	3.4	1.15	1.5	1.3	1.05	1.11	0.05	0.51	0.31
Barley	14500	3	0.4	0.8	1.2	0.75	1	0.05	1	0.55
Rye	22000	4.5	0.95	1	1.05	1	1.1	0.05	1.25	0.55
Millet	35000	0.6	0.51	0.78	0.87	0.5	1.2	0.05	1	0.55
Sorghum	50000	2.5	0.4	0.75	1.15	0.5	0.9	0.05	1	0.55
Pulses	34000	0.44	0.45	0.75	1.15	0.6	0.8	0.05	1.2	0.5
Soybeans	45000	2.25	0.4	0.8	1.15	0.45	0.85	0.05	1	0.5
Sunflower	76000	1.1	0.4	0.8	1.2	0.4	0.95	0.05	0.8	0.45
Tobacco	140000	0.9	0.4	0.8	1.2	0.8	0.9	0.05	0.8	0.4
Potato	25000	22	0.5	0.8	1.2	0.7	0.85	0.05	0.4	0.35
Cassava	25000	25	0.3	0.45	0.8	0.3	0.95	0.05	0.6	0.35
Sugarcane	150000	90	0.5	1	1.3	0.6	1.2	0.05	1.2	0.65
Sugar beets	75000	70	0.5	0.85	1.2	0.7	1	0.05	0.7	0.55
Mustard	25000	2	0.35	0.6	1.15	0.35	1.1	0.05	1	0.6
Groundnuts	35000	2.7	0.5	0.8	1.1	0.55	0.7	0.05	0.5	0.5
Cotton	50000	0.5	0.35	0.35	1.15	0.7	0.85	0.05	1	0.65

Crop Cover and treatment type

Crops	Cover Type	Treatment Type
No Crop	NA	NA
Wheat	Small Grains	Straight Row
Maize	Row Crops	Straight Row
Rice	Row Crops	Straight Row
Barley	Small Grains	Straight Row
Rye	Small Grains	Straight Row
Millet	Small Grains	Contoured
Sorghum	Small Grains	Straight Row
Pulses	Closed Seed or Broadcast legumes	Contoured
Soybeans	Closed Seed or Broadcast legumes	Contoured
Sunflower	Row Crops	Straight Row
Tobacco	Row Crops	Straight Row
Potato	Row Crops	Straight Row
Cassava	Row Crops	Straight Row
Sugarcane	Row Crops	Straight Row
Sugar beets	Row Crops	Straight Row
Mustard	Row Crops	Straight Row
Groundnuts	Row Crops	Straight Row
Cotton	Row Crops	Straight Row

Annexure C: Input data sources

	Impact on physical process	Where in database	Database Link	Reference
CN number	Runoff (Q)	USDA (Table 2.2a)	USDA, 1986	(USDA, 1972)
Hydrological Soil Group	CN number	USDA (Appendix A)	USDA,	(USDA, 1972)
Crop Cover Type	CN number	USDA (Table 2.2a)	USDA, 1986	(USDA, 1972)
Rainfall and Temperature	Reference Evapotranspiration (ETo) and Runoff (Q)	IMD, Pune	IMD 1, Pune IMD 2, Pune	(IMD, n.d.)
Crop coefficient values (Kc)	Crop Evapotranspiration (ETc)	GCWM (Table 2) or FAO (Table 12)	GCWM, 2008 FAO, Paper-56	
Different stage duration	Crop Evapotranspiration (ETc)	GCWM (Table 2) or FAO (Table 11)	GCWM, 2008 or FAO, Paper-56	(Stefan Siebert, 2008) (FAO, 1998)
Yield response factor (Ky)	Crop Yield	FAO (Table 1)	FAO, Ky function FAO, Paper-66	(FAO, 2012)
Infiltration	Recharge	FAO (Table 7)	FAO, Manual-5	(FAO)
Rooting depth	Soil Moisture	GCWM (Table 2) or FAO (Table 22)	GCWM, 2008 or FAO, Paper-56	(Stefan Siebert, 2008) (FAO, 1998)
Crop Depletion Factor	Soil Moisture	GCWM (Table 2) or FAO (Table 22)	GCWM, 2008 or FAO, Paper-56	(Stefan Siebert, 2008) (FAO, 1998)
Crop Yield	Crop Yield	Agriculture Statistics (2018), Ministry of Agriculture & Farmers welfare, India	MoAFW, 2018	(MoAFW, 2018)
Aquifer Specific Yield (Sy)	Aquifer Capacity	GEC, Report (2015)	GEC, 2015	(MoWRRDGR, 2015)

Annexure D: Intervention data sources

Intervention	Value Range	Database	Database Link	Reference
Drip Irrigation [Crop Specific]	Default Efficiency (η)of 90% 4 (or) Irrigation Management, TNAU.	FAO, Annexure 1, Training manual-	FAO, Manual-4 TNAU	(FAO, 1989) (TNAU, n.d.)
Sprinkler [Crop Specific]	Default Efficiency (η) of 75% 4 (or) Irrigation Management, TNAU.	FAO, Annexure 1, Training manual-	FAO, Manual-4 TNAU	(FAO, 1989) (TNAU, n.d.)
Land levelling [All Crops]	Default irrigation water saved (25 to 30%)	Land levelling, Cultivation Practices, TNAU	TNAU	(TNAU, n.d.)
Direct Seeded Rice (DSR) [Rice specific]	Default irrigation water saved (12 to 35%)	DSR-Advance in Agronomy, IRRI	IRRI-CSISA	(IRRI, 2011)
Alternate Wetting and Drying (AWD) [Rice Specific]	Default irrigation water saved (25%)	TNAU, IRRI – (AWD in Philippine Rice Production- Feasibility Study for clean development mechanism	IRRI-TNAU	(Joel D.L.C. Siopongco, 2013)
System of Rice Intensification (SRI) [Crop Specific]	Default irrigation water saved (50%)	Expert System for Paddy, Rice ecosystem, TNAU (or) SRI Practices, CFIAD	TNAU CFIAD, Cornell	(TNAU, n.d.)
Ridge and Furrow Irrigation [Crop Specific]	Default irrigation water saved (20 to 30%)	Water Management Technology Options for Non-Rice Crops, TNAU	TNAU	(TNAU, n.d.)

Intervention	Value Range	Database	Database Link	Reference
Deficit Irrigation [Crop Specific]	Default irrigation water saved (30%)	Expert System for Paddy, Water management, TNAU	TNAU	(TNAU, n.d.)
Farm Pond, Check dams, infiltration ponds, Injection wells-Infiltration value	Depends on soil type and maintenance	Infiltration Rate – Manual on Infiltration ponds design WDOE, 2003)	WSDOT, 2003	(Massman, 2003)
Cover Crops, Mulching, Conservation tillage, Tank desilting, Bunds, BBF	CN reduction value (-2 to -3)	Representation of agricultural conservation practices with SWAT	Purdue, 2007	(Mazdak Arabi, Jane R. Frankenberger, Bernie A. Engel, Jeff G. Arnold, 2007

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