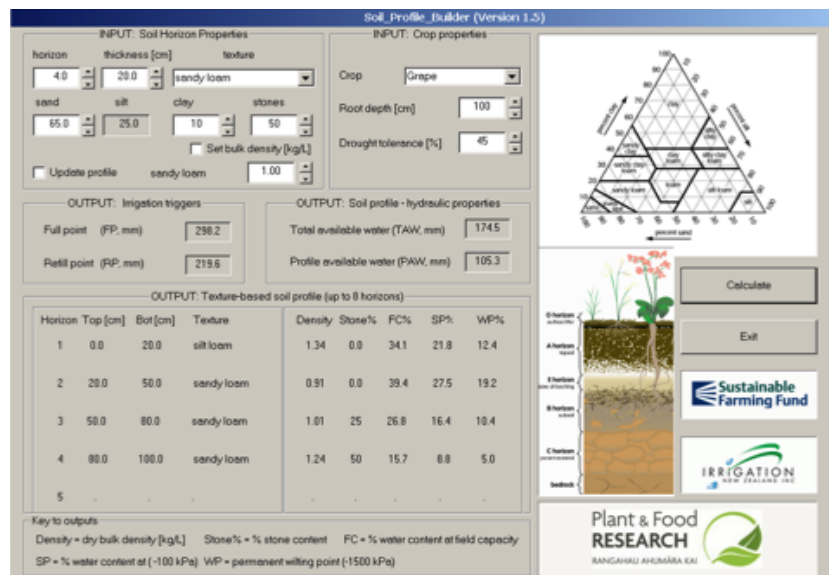


Soil Profile Builder software user guide

The *Soil Profile Builder* software is designed to help you establish your soils water holding characteristics – field capacity and stress point (how big the bucket is and at what point it need to be refilled) for irrigation. It uses data from the New Zealand Soils Database to determine appropriate physical and hydraulic properties for a range of soil textures. This information is worked out for each layer (horizon) that makes up your soil profile.

- The **soil inputs** are texture and stone content within each layer (horizon) of the soil profile.
- The **crop inputs** are the type, the root depth and the drought tolerance (stress point).
- The **outputs** give guideline values for the field capacity and stress point for irrigation, plus the total available water and the readily available water in the soil profile.

Inputs (which you can change) are ‘white’ boxes and outputs (the model predictions) are ‘grey’ boxes. All calculations are summed from the top to the bottom of the soil profile. Where soil moisture sensors are employed, the bottom of the profile should be set to the deepest measurement point. The soil profile builder screen is shown opposite.



The screenshot shows the 'Soil Profile Builder (Version 1.5)' interface. It is divided into several sections:

- INPUT: Soil Horizon Properties:** Includes fields for horizon number (4.0), thickness (20.0 cm), texture (sandy loam), and a breakdown of sand (65.0%), silt (25.0%), clay (10%), and stones (50%). There is a checkbox for 'Update profile' and a field for 'Set bulk density [kg/L]' (1.00).
- INPUT: Crop properties:** Includes 'Crop' (Grape), 'Root depth [cm]' (100), and 'Drought tolerance [%]' (45).
- OUTPUT: Irrigation triggers:** Shows 'Full point (FP, mm)' (298.2) and 'Refill point (RP, mm)' (219.5).
- OUTPUT: Soil profile - hydraulic properties:** Shows 'Total available water (TAW, mm)' (1745) and 'Profile available water (PAW, mm)' (105.3).
- OUTPUT: Texture-based soil profile (up to 8 horizons):** A table with 5 horizons, showing top and bottom depths, texture, density, stone content, field capacity (FC%), stress point (SP%), and wilting point (WP%).
- Visuals:** A soil texture triangle and a soil profile diagram showing horizons A, B, and C.
- Buttons:** 'Calculate' and 'Exit' buttons.
- Logos:** Sustainable Farming Fund, IRRIGATION NEW ZEALAND, and Plant & Food RESEARCH.

STEP 1: DEFINE THE SOIL TEXTURE

The soil profile can be defined by up to five horizons, or layers of a different texture. For each horizon, the user must enter the:

1. horizon number (e.g. 1, 2, 3, 4 or 5)
2. thickness/depth (e.g. 20 cm)
3. texture (e.g. sandy loam)
4. stone content by volume (e.g. 50%)

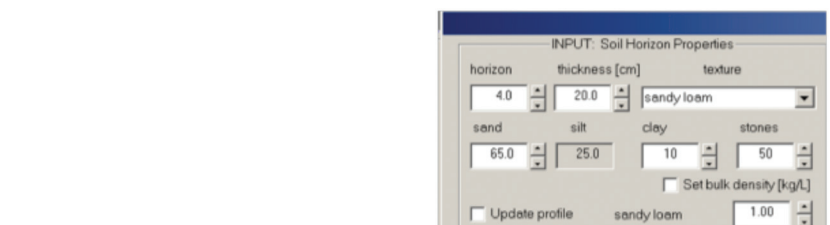
Soil texture is classified by the % of sand, silt and clay particles. Once the soil texture has been chosen, the software then assigns appropriate values for the sand, silt and clay fraction based on the USDA ‘soil texture triangle’. These fractions can be adjusted if the actual data is available.

If the soil’s bulk density is known, then a measured value can be entered, otherwise a default value (e.g. the national average value) will be assigned by clicking on the check box.

Clicking on the ‘Update profile’ check box retrieves the appropriate physical and hydraulic properties for a given soil texture and depth. This process must be followed for each soil horizon.

The left hand panel describes an example soil texture profile: in this example 20 cm of silt loam sits on top of 80 cm of sandy loam. The stone content increases beyond a depth of 50 cm.

The right panel shows the soil’s bulk density, stone content and volumetric water content at Field Capacity (FC), Stress Point (SP) and wilting point (WP). The SP is defined by the water content at a water potential of -1.0 bar.



This close-up shows the input fields for a single horizon: horizon 4.0, thickness 20.0 cm, texture sandy loam, sand 65.0%, silt 25.0%, clay 10%, stones 50%, and bulk density 1.00 kg/L.

OUTPUT: Texture-based soil profile (up to 8 horizons)

Horizon	Top [cm]	Bot [cm]	Texture	Density	Stone%	FC%	SP%	WP%
1	0.0	20.0	silt loam	1.34	0.0	34.1	21.8	12.4
2	20.0	50.0	sandy loam	0.91	0.0	39.4	27.5	19.2
3	50.0	80.0	sandy loam	1.01	25	26.8	16.4	10.4
4	80.0	100.0	sandy loam	1.24	50	15.7	8.8	5.0
5

Methods to estimate stone content and bulk density can be found in most standard soil text books.

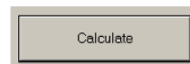
Soil water availability refers to the capacity of a soil to retain water that is available to the plants. Following heavy rain or irrigation the soil (which is saturated) drains quickly until field capacity is reached. The plant then uptakes water for transpiration and soil losses water by evaporation reducing soil moisture until a point is reached where the plants can extract no more water. This point is referred to as the permanent wilting point (the plant dies). The total plant available water, TAW (mm), is the difference between FC and WP. However, for each crop there is an intermediate point between FC and WP, where the plant shows the first sign of water stress (the point at which production/ quality is compromised). This is referred to as the stress point, SP (mm), where $SP = (1-p)*TAW$, p being the drought tolerance. These values are crop-dependent and also include the root depth. In general the default 'Drought tolerance' value is 50%

STEP 2: CHOOSE THE CROP

The next step is to select the crop type. Typical (default) values for the root depth and the drought tolerance have been adopted from the FAO-56 paper on crop water requirements (Allen et al, 1998) which can be downloaded from the link provided on the CropIRLog web page (www.kimberly.uidaho.edu/ref-et/fao56.pdf). Here the drought tolerance, p, represents the fraction of TAW that each crop can extract from a given root-zone depth. These can be changed if you have site specific data.

STEP 3: CALCULATE THE IRRIGATION SET POINTS

Once the soil profile and crop type are entered, you then click on the calculate button to generate values for the irrigation set points.



STEP 4: INTERPRETATION OF THE OUTPUTS

Two outputs are generated by the software: the irrigation trigger points and the plant available water.

- Figure 9 shows the full point and refill point for a given soil profile depth and crop type. These numbers are required inputs for the CropIRLog software. In this example the calculations are integrated (i.e. summed up) from the soil surface to the bottom of the soil profile (i.e. 0.0 to 100 cm). We assume that grapes can extract 45% of the total available water from their root-zone depth (i.e. 100 cm) before they begin to exhibit symptoms of water stress. Other set points can be deduced by changing the drought tolerance (e.g. from 45% to 60%) or the root depth (e.g. 100 cm to 50 cm) to reflect growers preference to impose more water stress late in the season, or to reflect shallower roots on younger vines.
- Figure 10 shows plant available water within the soil profile. The total available water is the amount of water held in the soil profile between field capacity and wilting point. The readily available water is the amount of water held in the soil profile between field capacity and stress point. In this example the total available water in the top 1.0 m is 174.5 mm, and the grapes should be able to extract about 70 mm from the root-zone before any signs of water stress occur.

In some cases it could be necessary to set the soil profile depth to be greater than the root depth. One example would be when soil moisture monitoring extends to 100 cm yet the crop roots only extend to a depth of 50 cm. In that case the irrigation trigger points would reflect expected values obtained by soil moisture monitoring.

INPUT: Crop properties	
Crop	Grape
Root depth [cm]	100
Drought tolerance [%]	45

OUTPUT: Irrigation triggers	
Full point (FP, mm)	298.2
Refill point (RP, mm)	219.6

OUTPUT: Soil profile - hydraulic properties	
Total available water (TAW, mm)	174.5
Profile available water (PAW, mm)	105.3