

Guidelines for the use of the offline version of the NUTRISense SW (Uploaded in the web platform)

1. General Information

The NUTRISense software can calculate a new nutrient solution for a particular hydroponic crop and adapt it during cultivation after a chemical analysis of the drainage solution. The program automatically calculates the amount of fertilizer added to a specific volume of water to prepare the appropriate nutrient solution in each case (either new or adapted). For this to happen, some necessary information must be introduced into the program through the "GENERAL OPTIONS" sheet and the water chemical analysis for its preparation through the "WATER ANALYSIS" sheet. The necessary information to be entered into the program is described in detail in the next section ("Step-by-step guide to using the program")

2. A step-by-step guide to using the program

2.1 "User Information" tab.

The reference number and / or date are freely selected by the user according to the file organization system. Data entry for all "Information & Data" is optional. Failure to enter one or more pieces of information does not affect the calculations and the final result.

2.2 Enter data in the "Basic Options" tab.

Basic species

The plant species that will be irrigated with the specific nutrient solution. The selection is made from a default list of vegetable and flower plants grown in greenhouses.

Cultivation stage

Select one of the following alternatives:

Starter solution. In substrate crops, a "Starter solution" is chosen when prescribing a nutrient solution that moistens the substrate before planting the plants in it. Similarly, in crops in a hydroponics system, a "Starter solution" is chosen when calculating a recipe for a nutrient solution that fills the system's tanks or substrates before planting plants in it.

Vegetative stage. "Vegetative stage" is selected when the nutrient solution is intended for the initial stage of plant growth, from the day of transplantation until the day the plants begin to bear fruit in the first flowers.

Fruiting. In all fruiting vegetables other than tomatoes, we choose "Fruiting" if the nutrient solution is intended to be given to a crop that has already begun to bear fruit.

Season of the year

There are a total of five options. When the calculated nutrient solution is intended for a crop carried out in Spring or Autumn, there is one basic option ("Spring or Fall"). In this case, the standard nutrient solution that is considered excellent for that particular plant species does not undergo any corrective adaptation to climatic conditions. If the calculated nutrient solution is intended for summer cultivation, there are two options (Mild or Hot summer), so that nutrient solution to better adapt to local climatic conditions. When "Mild summer" or "Hot summer" is selected, the program automatically corrects the basic nutrient solution for Spring or Fall, reducing more or less, respectively, the concentrations of all the nutrients. Respectively, in the case of winter cultivation, the user can choose between "Mild" or "Cold" winter with the aim of again the best adaptation of nutrient solution in the prevailing weather conditions. When "Mild winter" or "Cold winter" is selected, the program automatically corrects the basic nutrient solution for Spring or Fall, increasing more or less, respectively, the concentrations of all the nutrients.

Coefficient of EC change

It is only used when calculating new nutrient solutions (for open or closed systems) and not for adapting nutrient solutions already applied in cultivation. Through the "Coefficient of EC change" option, the electrical conductivity of the calculated nutrient solution may be reduced or increased to levels greater or less than those selected by the program as pre-selected for the specific crop with a corresponding reduction or increase in the concentrations of all nutrients.

When its value is 1, there is no change in the EC and the concentrations of nutrient solution. When its value is lower than 1, the EC and the concentrations of nutrient solution are reduced while if they are higher than 1, the EC and the concentrations of nutrient solution are increased. The new EC values and nutrient solution concentrations are equal to the product of the factor on the default value given by NUTRISENSE. For example, suppose the EC value for pepper in the Vegetative stage is $2.2 \text{ dS}\cdot\text{m}^{-1}$, and the Coefficient of EC change is set at 0.92. In that case, the program will calculate a nutrient solution with EC equal to $2,024 \text{ dS}\cdot\text{m}^{-1}$ and correspondingly reduced nutrient concentrations. The Coefficient of EC change is recommended to be used with consideration only when the user has a specific reason to do so.

Information about concentrated stock solutions

For each concentrated stock solution, its volume and degree of concentration are defined (for example, how many times denser it is compared to the final nutrient solution administered to the plants through the drip solution).

Fertilizer options

For some nutrients, the user can choose which fertilizer to use. If he chooses a different fertilizer than the one pre-selected by the program, the user must specify the percentage of the specific nutrient in the fertilizer.

Target values for K, Ca, Mg and N

The desired composition of a nutrient solution is determined by defining target concentrations for all the nutrients contained in it, except for the four mentioned above (K, Ca, Mg, N). For these nutrients, NUTRISENSE provides two alternatives. These options are as follows:

Target values for K, Ca, Mg. The two alternatives provided by NUTRISENSE are the following:

- The values of K, Ca and Mg in nutrient solution are determined indirectly, by defining a target K: Ca: Mg ratio (mmol / mmol) which is combined with a target EC in nutrient solution.
- The values of K, Ca and Mg in nutrient solution are directly defined as their target K, Ca and Mg concentrations (mmol / L).

Target values for NO₃-N. The two alternatives provided by NUTRISense are the following:

- The values for NO₃-N are determined indirectly, by defining a target total-N/K ratio, N:K (mmol/mmol).
- The values for NO₃-N are directly defined as their target NO₃ concentration (mmol / L).

Target values for NH₄-N. The two alternatives provided by NUTRISense are the following:

- The values for NH₄-N are determined indirectly, by defining a target NH₄-N/(NO₃ + NH₄) ratio (mmol/mmol).
- The values for NH₄-N are directly defined as their target NH₄-N concentration (mmol / L).

Users must be aware that they do not have to specify the target proportions or concentrations for the nutrients K, Ca, Mg and N (or for any other) as they are contained in the program libraries (or are automatically calculated by the program in case adaptation of nutrient solution). It's just that the software user, through the above options, determines how the calculations will be done automatically by the program. Usually, both ways give almost the same result. In rare cases, the result is not the same because when calculations are made based on desired proportions, the emphasis is placed on the desired EC, while when they are based on target concentrations, the emphasis is placed on the final concentrations of nutrients. Therefore, when for some reason some of the default values contained in the software libraries cannot be applied in terms of the composition of the nutrient solution being prepared (eg water contains more calcium than what is considered excellent for one type of plant) then the two calculation methods (with proportions or concentrations) follow a different approach. Therefore, they do not give exactly the same result.

% pure fertilizer in the commercial product

The commercial preparations of acids used to regulate pH (nitric acid, phosphoric acid, sulfuric acid) are not pure acids but their concentrated solutions (they also contain water). Therefore, it is necessary to introduce to NUTRISense the percentage of pure fertilizer in the commercial product to correctly calculate the quantities that must be added to the water during the preparation of concentrated solutions.

It is noted that the use of sulfuric acid is extremely rare. Also included in the same data entry section is Si fertilizer (if used, as its use is optional). In particular, when the user wishes to prepare a nutrient solution with silicon, he must enter in the program the content of pure silicon (Si) in the commercial preparation that he intends to use. The contents of the acids and silicon in the commercial products usually are indicated on their labels.

Number of Tanks

The most common practice in hydroponic crops is the preparation of two concentrated stock solutions. One of the two (A) contains calcium fertilizers and does not contain sulfate and phosphate fertilizers. The second one contains sulfate and phosphate fertilizers and does not contain calcium fertilizers.

In addition to these two tanks, there is a third one that contains stock solution of acid to regulate pH (usually nitric acid). If the calculated recipe is to be applied using two stock solutions of fertilizers plus a stock solution of acid, the user chooses "2+ACID".

However, some more advanced fertigation units can operate with many stock solution fertilizers (at least 5 plus a container of acidic stock solution) to facilitate nutrient solution change without the need to prepare new stock solutions. In this case the user selects the number of tanks and the program calculates the recipe not in the form of kilograms of fertilizers for a specific volume of the stock solution but in the form of a percentage injection ratio of the specific stock solution in irrigation water during the automatic preparation of the nutrient solution. In this case, in the software of the fertigation unit, not only the desired EC and pH values are introduced in the calculated nutrient solution but also the percentage ratios of infusion of the available concentrated solutions calculated by NUTRISSENSE.

When selecting several stock solutions of 5 + 1 or greater, the quantities of fertilizers placed in each tank are set by default to NUTRISSENSE.

Define requested service

Here the user is asked to specify the type of system he wants to have with the specific application of NUTRISSENSE. This option depends on the selection made above for the growing stage. If at the stage of cultivation, the user has chosen a "Starter solution", then the user has two alternatives for the type of service. The first option is "Starter NS", while the second one is "User's options - Starter NS".

In both cases, the program calculates a nutrient solution for wetting the substrate or filling the tanks in substrate-free crops (hydroculture). The only difference between them is that with the "User's options - Starter NS" option the program displays the tab "User's options", through which the user can enter their own desired values for any of the features of the nutrient solution instead of the default (standard) values given by NUTRISSENSE.

When "Vegetative stage", "Fruiting", "Fruiting 1", "Fruiting 2" or "Fruiting 3" has been selected as the cultivation stage, the user has eight alternatives for the type of service:

Open system – standard NS: When this option is selected, NUTRISSENSE calculates automatically a nutrient solution for the chosen already crop species, cultivation stage and season of the year when cultivated in an open hydroponic system. The user cannot modify any characteristics of the NS calculated by NUTRISSENSE.

a) Open system – standard NS: When this option is selected, NUTRISSENSE calculates automatically a nutrient solution for the chosen already crop species, cultivation stage and season of the year when cultivated in an open hydroponic system. The user cannot modify any characteristics of the NS calculated by NUTRISSENSE.

b) Closed system – standard NS: When this option is selected, NUTRISSENSE calculates automatically a nutrient solution for the chosen already crop species, cultivation stage and season of the year when cultivated in a closed hydroponic system. The user cannot modify any characteristics of the NS calculated by NUTRISSENSE.

c) Open system – Adjusting the NS: When this option is selected, NUTRISSENSE adjusts the composition of the currently applied nutrient solution (to be defined in a new appearing tab named "Current NS formula") based on the composition of the drainage solution as determined through a recent chemical

analysis. This option is selected when the NS is applied in an open hydroponic system. The user cannot modify any characteristics of the NS calculated by NUTRISSENSE.

d) Closed system – Adjusting the NS: The same as (c) but the NS to be adjusted is destined for a closed hydroponic system. The user cannot modify any characteristics of the NS calculated by NUTRISSENSE.

e) User's options - Open system: The same as (a), but the user can modify one or more characteristics of the NS calculated by NUTRISSENSE through the entry panel "User's options".

f) User's options – Closed System: The same as (b) but the user can modify one or more characteristics of the NS calculated by NUTRISSENSE through the entry panel "User's options".

g) User's options - Open system - Adjusting the NS: The same as (c) but the user can modify one or more characteristics of the NS calculated by NUTRISSENSE through the entry panel "User's options".

h) User's options – Closed System - Adjusting the NS: The same as (d) but the user can modify one or more characteristics of the NS calculated by NUTRISSENSE through the entry panel "User's options".

Of the eight options above, four apply for open hydroponic cultivation and the remaining four for indoor hydroponic cultivation. When the user selects one of the options for closed hydroponic systems, NUTRISSENSE asks some additional questions that need to be answered by the user.

The first option is if in the fertigation head is connected before or after the drainage solution mixer.

The second question refers to the desired Drainage percentage, which the user must select.

The third question refers to the most recent Electrical conductivity (EC) of the drainage solution (dS/m) measured in the effluent solution.

2.3 Enter data in the "Water analysis" tab.

The nutrient concentrations in the irrigation water used to prepare the nutrient solution are introduced.

2.4 Enter data in the "Drainage solution composition" tab.

This tab only appears when the Nutrient solution type is a "User's options - Adjusting the NS " either in open or closed hydroponic system. The concentrations of nutrients in the draining solution are introduced from a recent analysis in a reliable chemical laboratory. Concentrations are given in mmol /L.

2.5 Enter data in the "User's options" tab.

This tab only appears when the type of service selected in the "General Options" tab also contains the term "User Options". This tab allows the user to enter their own desired values for any of the features of the nutrient solution instead of the default (standard) values given by NUTRISSENSE.

User options can be given either as desired nutrient concentrations or as desired ratios with each other (K: Ca: Mg, total-N / K, NH₄-N / total-N). The program implements user options provided that they are feasible, which is not often the case. If any of the user's options regarding a desired feature of the nutrient solution are not feasible, NUTRISSENSE calculates the most similarly possible price for that particular feature.

2.6 Calculate NS Formula

When the user completes the data entry in all tabs, he selects "Calculate NS Formula" to receive the recipe of the desired nutrient solution.