

DECIDUOUS: a user-friendly tool to support fruit tree choice for agroforestry

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Abstract

For various reasons (climate accidents, economic resilience, wind/sun protection...), more and more farmers in France are interested in introducing trees in their agricultural systems, especially with current French financial support for plantations. Many of them (market gardeners but also breeders or arable growers) are willing to plant fruit trees to increase farm incomes better than timber species, but do not have any experience or knowledge about fruit growing, especially in regions where there are no fruit advisors. They might also have no possibility to spray trees.

In this context, we initiated in 2021 a web-based decision tool designed to guide users for adequate fruit species and rootstock, according to plot conditions (soil, climate) and to farmer's project (time availability, design). Lists of cultivars adapted to low-input systems are also provided.

The tool is designed under Shinyapp and so far adapted to French conditions. From 2024, the tool will be enlarged and displayed in other EU countries in the frame of the Digital project.

Keywords: agroforestry, fruit trees, alley-cropping, decision tool

Context

Fruit agroforestry appears to be a relevant option for farmers interested in diversifying their system for various purposes. Livestock farmers may be interested in shelter and protection against birds of prey for animals, while vegetable farmers may be interested in fruit production, and also other services provided by trees in the cropping system. In Europe, there are more and more successful examples of fruit tree planting in arable, market gardening and grassland, but also examples of failure due to inappropriate choice of fruit trees by farmers, for a number of reasons. The first one is that these farmers generally do not have specific knowledge of fruit growing, and don't have fruit advisors in many regions where fruit production is not a main production. Farmers therefore don't know the most determining criteria for selecting fruit trees (species, rootstocks, cultivars). In some cases, farmers depend on the availability of nursery stock, and this available material might not always be adapted to farmer and plot constraints.

From agroforestry advisors' point of view, the needs and expectations coming from interested farmers were redundant.

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Material & Methods

In this context, we started to think in 2021 about an online decision tree to help fruit tree choice for agroforestry systems specifically. We started this tool for six main fruit species (apple, pear, plum, peach, apricot, cherry).

The tool was supported by the French national agroforestry network, called RMT Agroforesteries³.

In 2021, we worked with a group of 4 students from an agricultural school based in Montpellier, France. The objective was to think about the tool architecture, content, database, ergonomics. Students also met fruit experts in France to discuss about the main criteria to be considered in the algorithm, about the ones to be discarded for different reasons (secondary, hard to consider for modeling...). The last remaining criteria, less than 10 in total, were then weighted by experts according to their importance for the algorithm programming.

In a second step, these criteria have been presented to a wider audience, including organic farmers and advisors, in order to ask them for their own weighting. This additional step gave us a more representative sorting of criteria selected.

Results

The criteria considered in the DECIDUOUS decision tool were dealing with:

- Soil characteristics (pH, depth, hydromorphic level, Calcium level)
- Climatic conditions and late frost risk
- But also specific questions like time availability for farmers for each season, tree height expected for agroforestry system...

Criteria and associated scores have been gathered into a 'expert matrix', and the decision tool has been built under R-Shiny interface for a user-friendly and 'funny' approach.

The algorithm is based on a weighting system that matches the characteristics of the fruit tree species with the criteria entered by the user. The algorithm calculates a total score, which is the weighted sum of the criteria according to (i) the user inputs and (ii) the importance of each criterion ranked by the experts:

$$Total\ score = \sum_{i=1}^n w_i S_i$$

where w_i is the weight of criterion i and S_i is the score of criterion i .

Finally, the R-Shiny tool returns a list of possible choices, according to the answers given by the user, with a relative scoring table, and colors depending on the correspondence with entry data (figure 1). A list of low-susceptible cultivars is also proposed for each species, and various regions of France. Most of farmers won't have time/space to spray for tree protection, that's why the most adapted to low-input systems have to be proposed.

³ <https://rmt-agroforesteries.fr/>

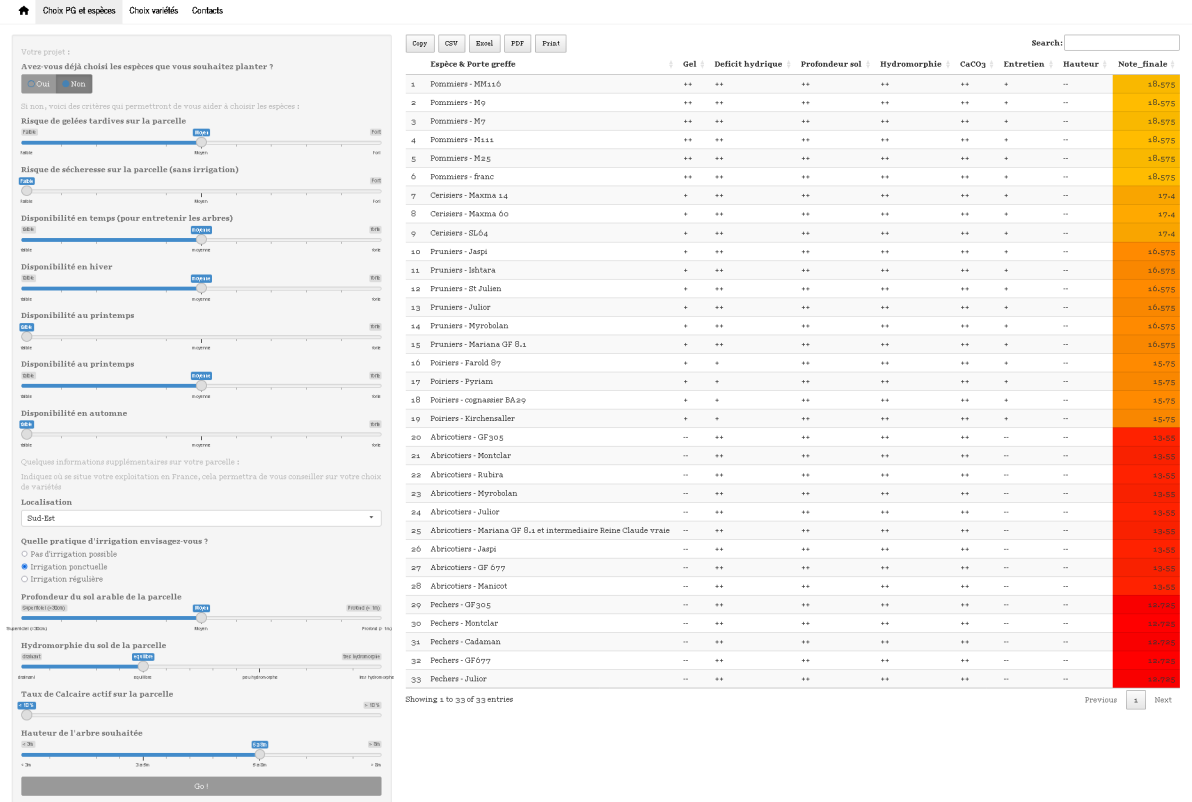


Figure 1: overview of the results table (right part) after data entry by user (left part). Version Dec 2023.

The final but most decisive part of the work was to ensure that results given by the tool are robust enough for end users in order to avoid wrong recommendations. To do this, experts were asked to run simulations with the tool and observe results with their knowledge. In some cases, the algorithm formula and matrix had to be modified to improve the tool results.

Perspectives

The tool is expected to be finalized for the French context and 6 main fruit species in February 2024. It will afterwards be implemented :

- In other EU countries with specific national data, in the frame of the Horizon Europe DIGITAF project (www.digitaf.eu) ;
- With other minor fruit species for the french situation.

This tool should be used for a first approach of tree choice, but the final decision shall be discussed to some extent with other skilled people such as fruit growers, nurserers, advisors.