FROM AZOFERT® TO N-PERENNES :
DYNAMIC DECISION SUPPORT TOOL FOR FERTILISER
N RECOMMENDATION FROM ANNUAL TO PERENNIAL CROPS

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Introduction

- A rigorous management of nitrogen (N) for crops is necessary (**Figure 1**).

- In 2005, AzoFert® software, a dynamic method, replaced Azobil based on a static balance sheet method (Machet et al., 1990).

- Unlike annual crops, **perennial crops accumulate reserves**, especially N, during their vegetative cycle in different compartments of the plant, store them during the winter phase in their perennial parts (trunk, roots...) and remobilize at the start of the plant next cycle (Jordan et al. 2009).

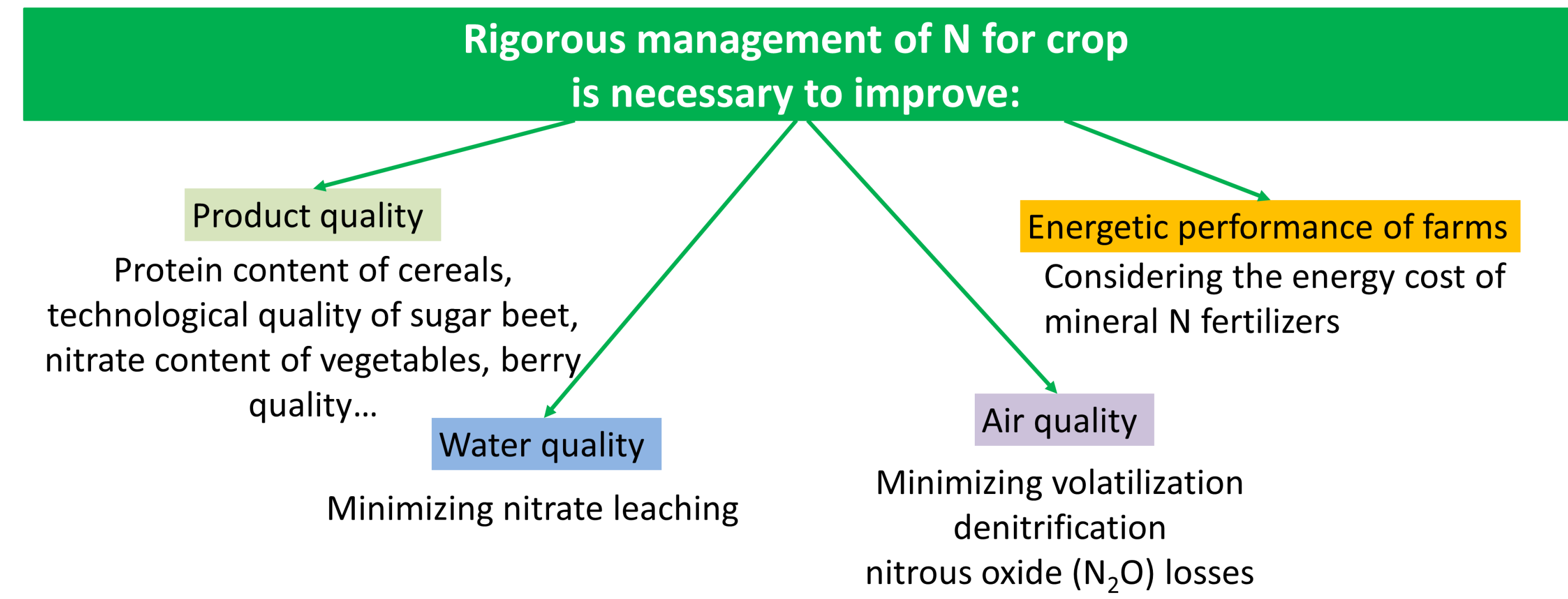- <u>**Aim:**</u> To present a new paradigm used for vine-growing system based on AzoFert® model.

Rigorous management of N for crop is necessary to improve:

Product quality
Protein content of cereals, technological quality of sugar beet, nitrate content of vegetables, berry quality…

Water quality
Minimizing nitrate leaching

Energetic performance of farms
Considering the energy cost of mineral N fertilizers

Air quality
Minimizing volatilization denitrification nitrous oxide (N_2O) losses

Figure 1. Importance of a rigorous management of N for crops

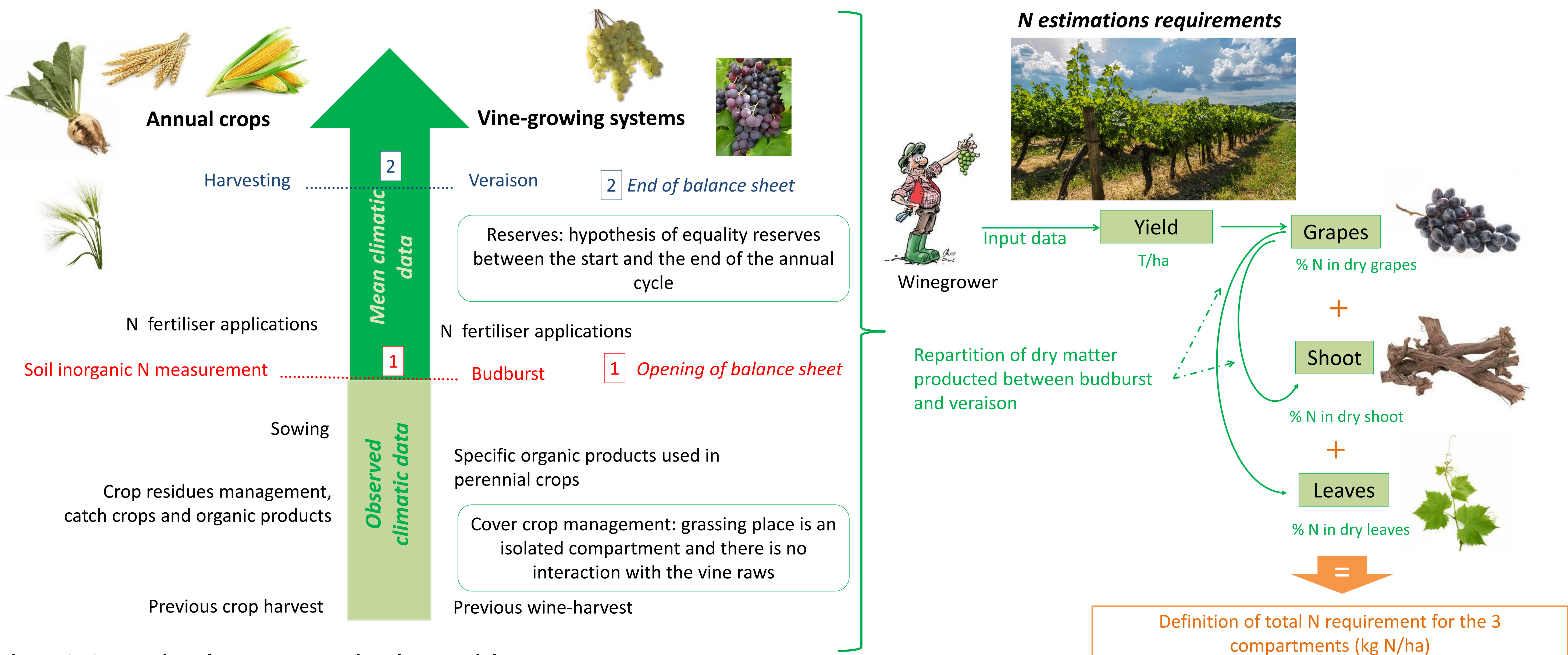## Parameters adaptation to perennial crops (N-PERENNES project)

Annual crops

Vine-growing systems

2 | Harvesting .... Veraison | 2 *End of balance sheet*

Mean climatic data

Reserves: hypothesis of equality reserves between the start and the end of the annual cycle

N fertiliser applications

N fertiliser applications

Soil inorganic N measurement | 1 | Budburst | 1 *Opening of balance sheet*

Sowing

Observed climatic data

Specific organic products used in perennial crops

Crop residues management, catch crops and organic products

Cover crop management: grassing place is an isolated compartment and there is no interaction with the vine raws

Previous crop harvest | Previous wine-harvest

Figure 2. Comparison between annual and perennial crops

N estimations requirements

Winegrower

Input data → Yield T/ha → Grapes
% N in dry grapes
+
Shoot
% N in dry shoot
+
Leaves
% N in dry leaves
=

Repartition of dry matter produced between budburst and veraison

Definition of total N requirement for the 3 compartments (kg N/ha)

A dynamic simulation of soil N supplies

- A dynamic approach, according to climatic conditions (temperature, rainfalls, evapotranspiration) is used to simulate N supplies from the soil and different organic sources (crop residues, catch crops, organic products).

- Decomposition and mineralisation are expressed over time using normalised time, based on temperature (T) and soil moisture (W) functions.

$$\text{Normalised time}_{(day\ i,\ day\ j)} = \Sigma_{i,j}\ f(T) \times g(W)$$

Concentrated vinasses
Catch crops
Rape residues
Normalised days
Mineralised N (kg/ha)

Soil inorganic N measurement
Harvesting
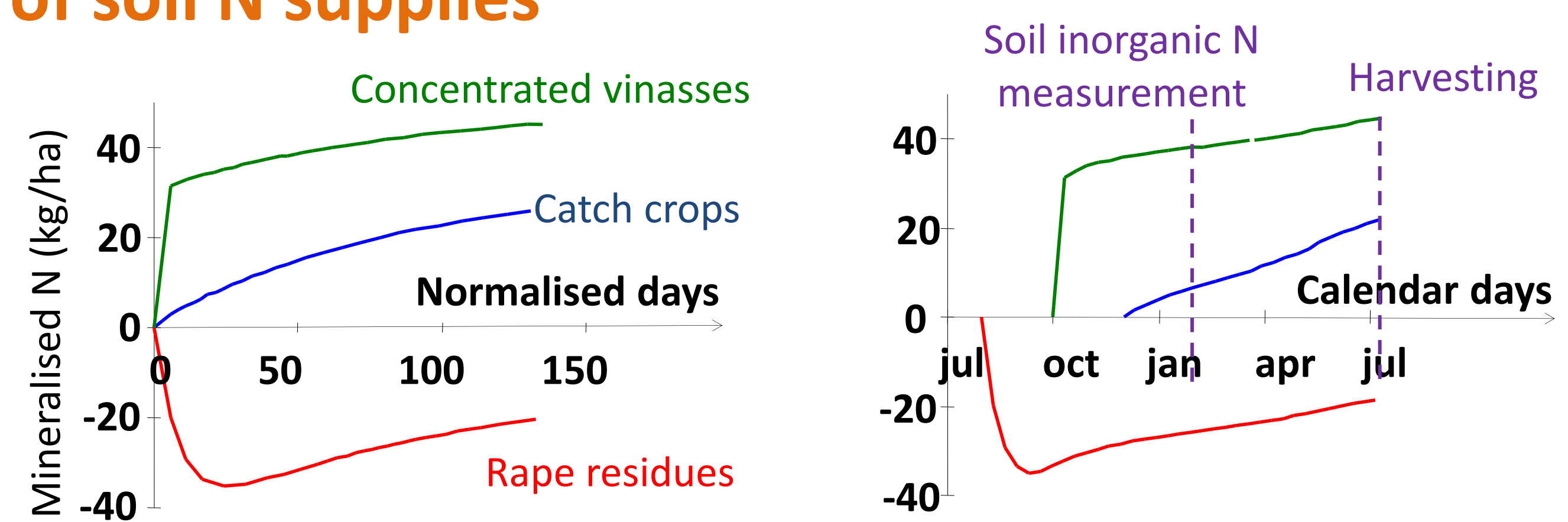Calendar days
jul oct jan apr jul
Rape residues

Figure 3. N mineralisation of different organic sources in normalised days (left side) translated in calendar days (right side)

Conclusions

- The recent scientific knowledge of C and N cycles are integrated in several models → AzoFert® model **was created to integrate recently acquired knowledge into a more simplistic tool.**

- AzoFert® is a model **in constant evolution** and it has been implemented as a **teaching tool** in "N'EDU" project.

- In this new paradigm for perennial crops, **vigor and canopy management were not considered**.

- This concept for perennial crops is a prototype. Improvements need to be done to extend the use.

✓ Machet J.M., Dubrulle P., Damay N., Duval R., Julien J.L., Recous S., 2017. A dynamic decision-making tool for calculating the optimal rates of N application for 40 annual crops while minimising the residual level of mineral N at harvest. Agronomy, 7, 73; doi:10.3390/agronomy7040073.
✓ Machet J.M., Dubrulle P., Louis P., 1990. Azobil® : A computer program for fertiliser N recommendations based on a predictive balance sheet method. In proceedings of the 1st congress of the European Society of Agronomy, Paris, France, European Society of Agronomy: Colmar, France.
✓ Jordan M.-O., Wendler R., Millard P., 2009. The effect of autumn N supply on the architecture of young peach (Prunus persica L.) trees. Trees 23, 235-245.
✓ Cahurel et al. 2017. N-PÉRENNES, un outil de raisonnement de la fertilisation azotée en cultures pérennes : application à la vigne et à certains arbres fruitiers. COMIFER-GEMAS conference in Nantes.