AzoFert® : a decision support tool for fertiliser N advice based on a dynamic version of the predictive balance sheet method

C. Le Roux [2], F. Obriot [2], P. Dubrulle [1], J.M. Machet [1], N. Damay [2], R. Duval [3], S. Recous [1]




N-Pérennes : AzoFert® adaptation for perennial crops



J.Y. Cahurel[4], C. Le Roux [2]

[1] INRA - Unité d’agronomie de Laon-Reims-Mons, France
[2] Laboratoire d’Analyses et de Recherche de l’Aisne, France
[3] Institut Technique de la Betterave
[4]IFV, Institut Français de la Vigne et du Vin, Villefranche sur Saône, France

20th N Workshop – side event 27/06/2018

French History of Nitrogen Fertilisation

1969-2018: 50 years of N balance sheet method

1970 — 1980 — 1990 — 2000 — 2010 — 2018

1969: Publication of INRA method (INRA)

1978: Diffusion of N balance sheet method (ITCF)

1980: Hénin Report (agricultural impact of water pollution)

1990: Local adaptation of the method (Agricultural Chambers)

1990: 1st decision-support software Azobil (INRA, LDAR)

1990: 1st GIEC report

1991: Adoption of the Nitrates directive

2004: AzoFert® is born. Decision-support tool including dynamics simulation of soil N supplies (INRA, LDAR)

Since 2010: Developpment of dose calculation services (Agricultural Chambers etc…)

2012-2016: N-Pérennes project

2012: N Balance sheet registration in the regulation

ITCF: Institut Technique des Céréales et des Fourrages = Technical institut of cereals and fodders
INRA: Institut National de Recherche en Agronomie = National Institut of Agronomic Research
LDAR: Laboratoire Départemental d'Analyses et de Recherche = Departmental Laboratory of Analysis and Research

Source: Adapted from Meynard J-M. 2018. Colloque sur l'azote (AFA, Paris).

AzoFert® :
agronomical innovations

- Based on a complete mineral nitrogen balance sheet : all balance sheet inputs and outputs are taken into account
- Approach by a dynamic simulation of soil nitrogen supplies as well as nitrogen mineralisation of various organic sources: integration of climatic data
- Availability of fertiliser nitrogen is estimated with : simulation of gas losses and microbial immobilisation
- Adapted to a large number of annual crops : when nitrogen requirements and cycle of development are known

AzoFert® : balance sheet equation

$$Rf - Ri = (M'n + X + Ap + Fns + Fs + IR) -$$

N inputs

$$(Pf - Pi + Ix + Gx + Lx + Gs + Ls)$$

N outputs

Rf : soil mineral N at close of balance sheet,
Ri : soil mineral N at opening of balance sheet,
M'n : net mineralisation from humus **(Mh),** crop residues **(Mr),** organic products **(Ma),** catch crops **(Mci)** and meadow **(Mp)** residues,
X : amount of fertiliser N,
Ap : N wet deposition,
Fns : non symbiotic fixation,
Fs : symbiotic fixation,
Ir : N irrigation contribution

Pf : total N uptake by crop at close of balance sheet,
Pi : N uptake by crop at opening of balance sheet,
Ix : fertiliser N immobilised,
Gx : fertiliser N lost at gas,
Lx : fertiliser N lost by leaching,
Gs : soil inorganic N lost at gas,
Ls : soil mineral N lost by leaching between opening and close of balance sheet

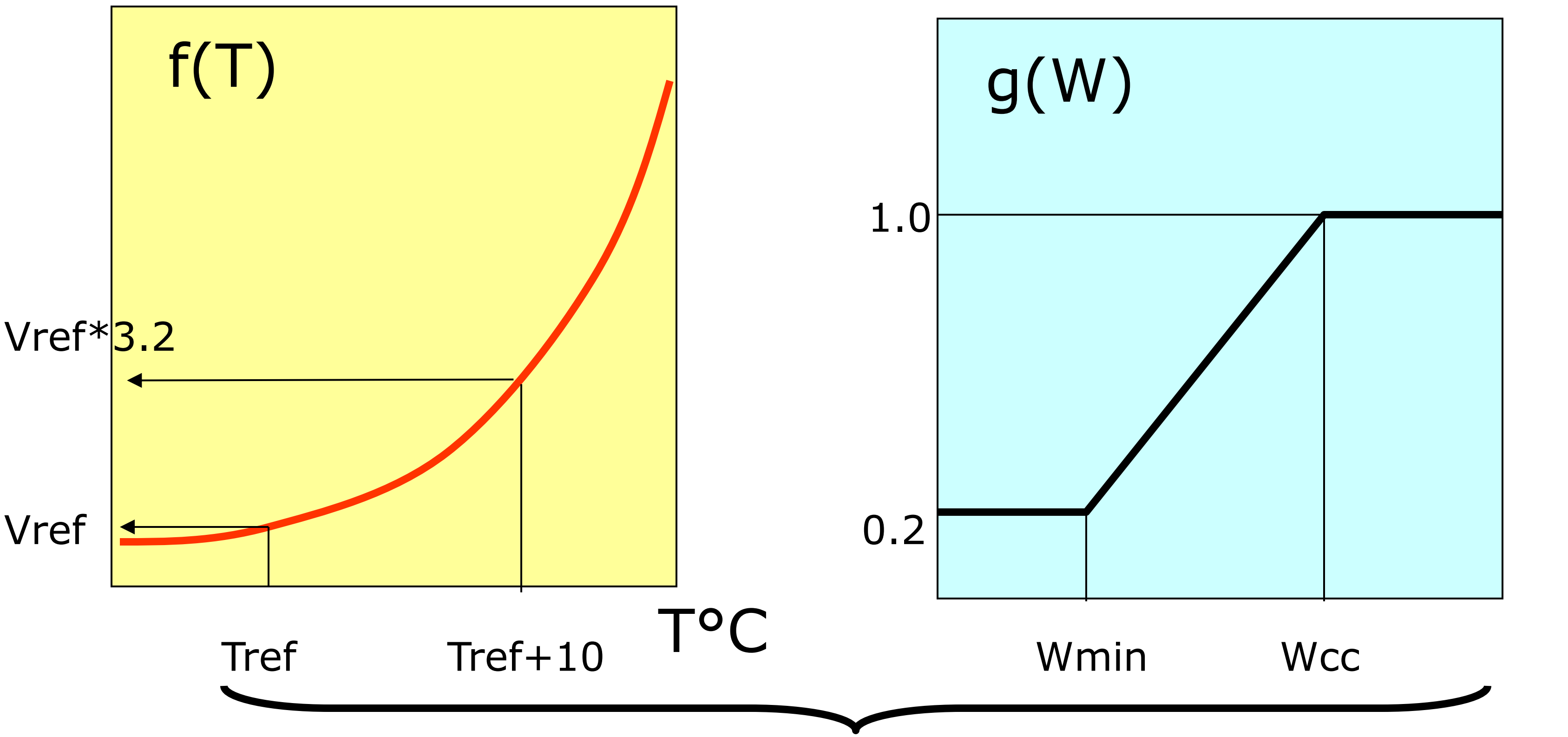
A dynamic simulation of soil N supplies

- Simulation of N supply during time from soil and various organic contributions :

  * crop residues
  * catch crops
  * organic products

→ Decomposition and mineralisation are expressed over time using « normalised time » integrating by decade the variations of temperature (T) and soil moisture (W)

Temperature (T) and soil moisture (W) functions



normalised day = f(T)*g(W)

Climatic data – Normalised time

- Climatic data for each decade : temperature, rainfall and evapotranspiration

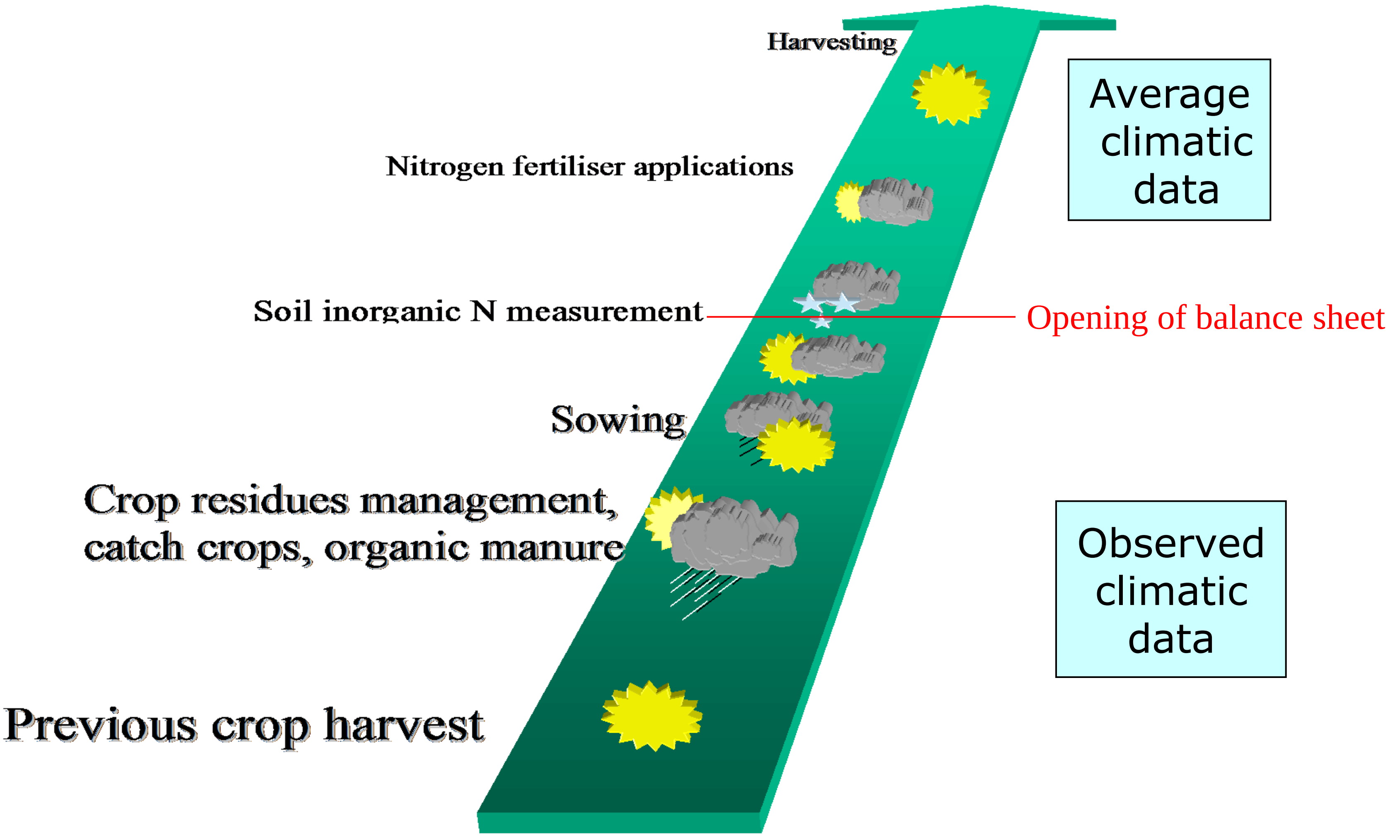
- Temperature reference : 15 °C, moisture reference : water field capacity

Example in Laon (France, Aisne) :

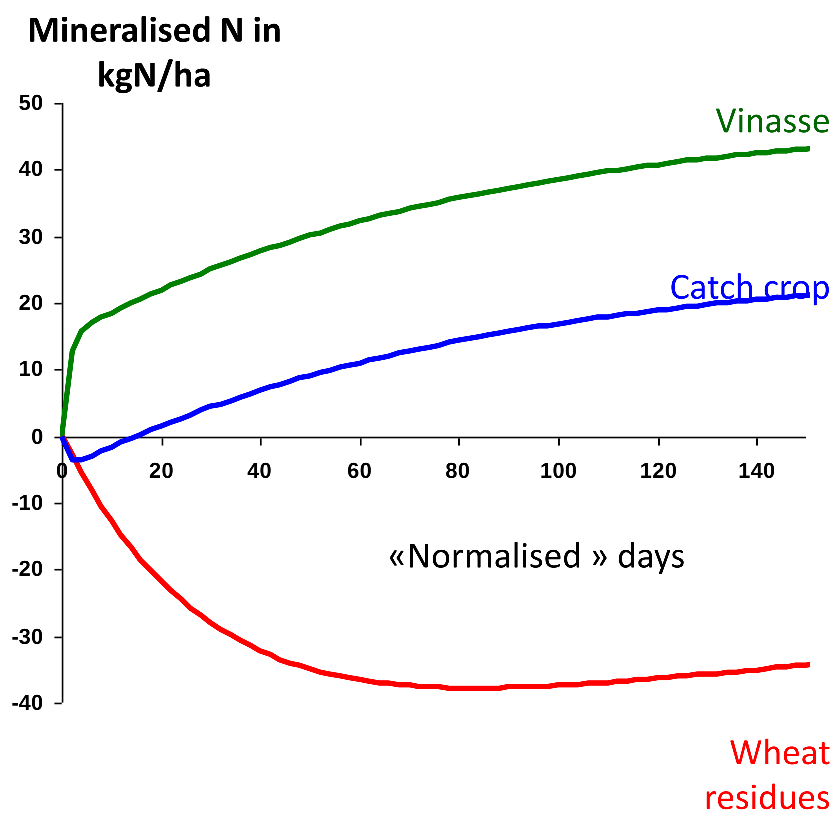
2nd decade of January : 2 normalised days

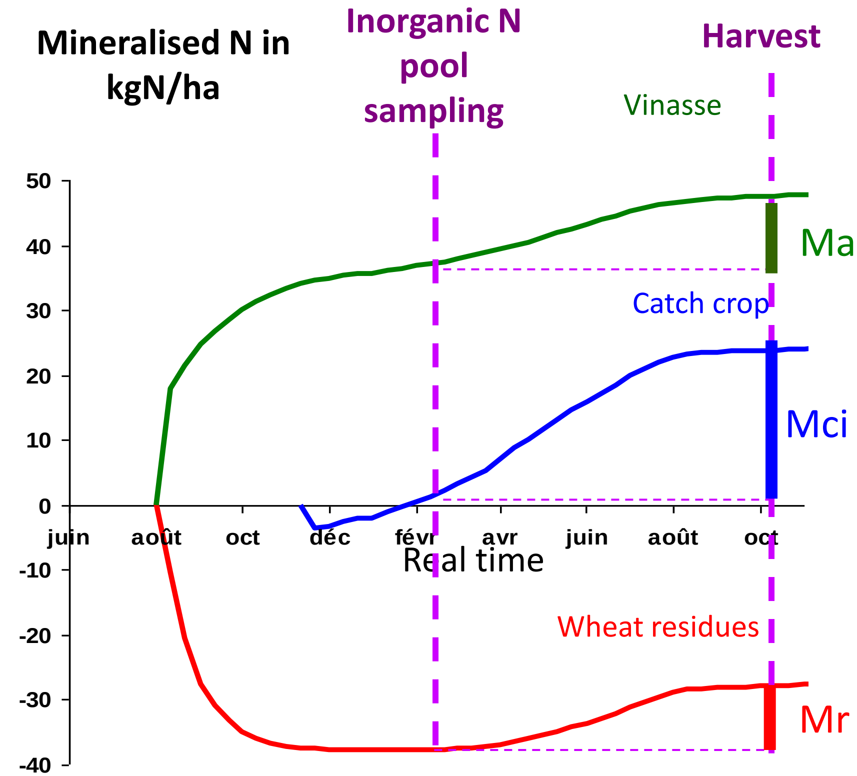
1st decade of July : 16 normalised days

Dynamic approach of nitrogen supply



N mineralisation of various organic sources





Ma: Organic products N supply

Mci: Cacth crops N supply

Mr: Crop residues N supply

N-Pérennes : AzoFert® adaptation for perennial crops

- Currently no tool available for perennial crops
- Project originating from RMT Fertilisation & Environment (RMT F&E), funded by CASDAR (French Ministry of Agriculture)
- Prototype for vines and apple-trees

Specificity of perennial crops

	Vine-growing systems	Fruit-growing systems
Opening balance sheet	Budburst	Flowering
End of balance sheet	Veraison	Start of yellowing leaves
Cover crop management	Hypothesis: cover crop place is an isolated compartment and there is no interaction with the vine or fruit-growing systems	
Estimations of N requirements	Definition of N repartition on different compartments of vine established from literature	Apple trees: 80 + 0.6 x yield Peach trees: 90 + 1.3 x yield
Reserves	Hypothesis of equality reserves between the start and the end of the annual cycle	Taken into account in the previous relation
Leaves on soil	Taken into account of the % of leaves returned in the plot	
Vigor	Not considered. We have to take it in the finish recommendation	
Planting density	Integrated indirectly in the calculation on the specific surface area	
Canopy management	Not considered	

Future enhancements for N'Pérennes

- Take into account organic fertilizers for recommendation (organic agriculture)
- Make a driver tool, especially for fruit-growing systems
- Integrate peach-tree besides vine and apple-tree
- Finalize the tool