Shaping diversity for on-farm organic plant breeding. *Case of wheat (and other cereals) in France*

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Our challenge:

1 - how to re-create diversified cultivars

2 - and how to exploit the remaining diversity from *ex-situ* conservation in a large scale

Estelle

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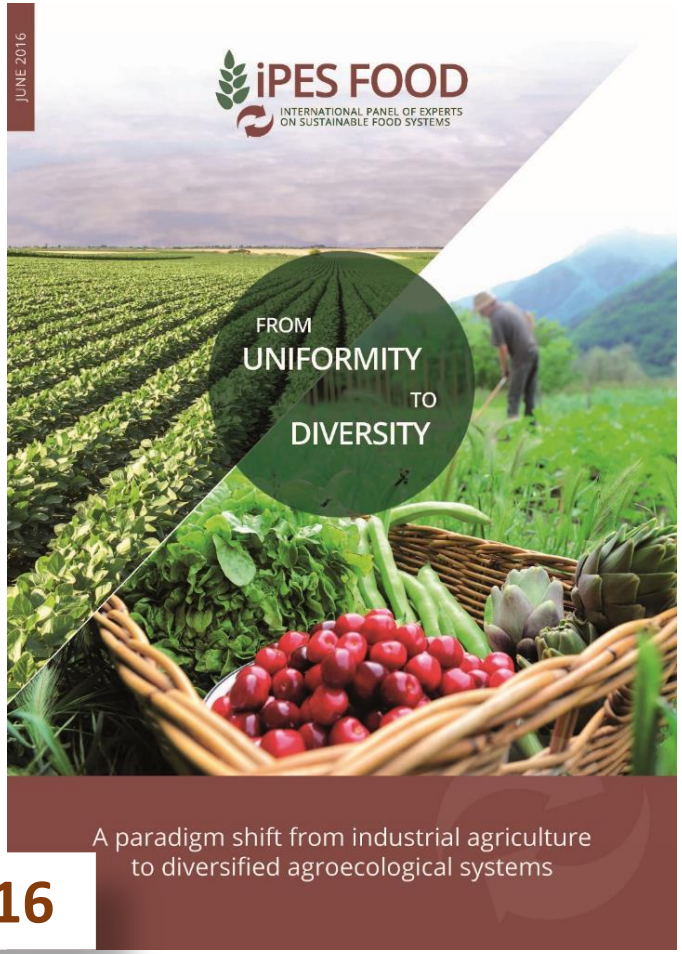
First hypothesis:
We need diversity for organic farming

From uniformity to diversity



Second hypothesis:
We need diversified cultivated plants

BUT

- Modern varieties are homogeneous

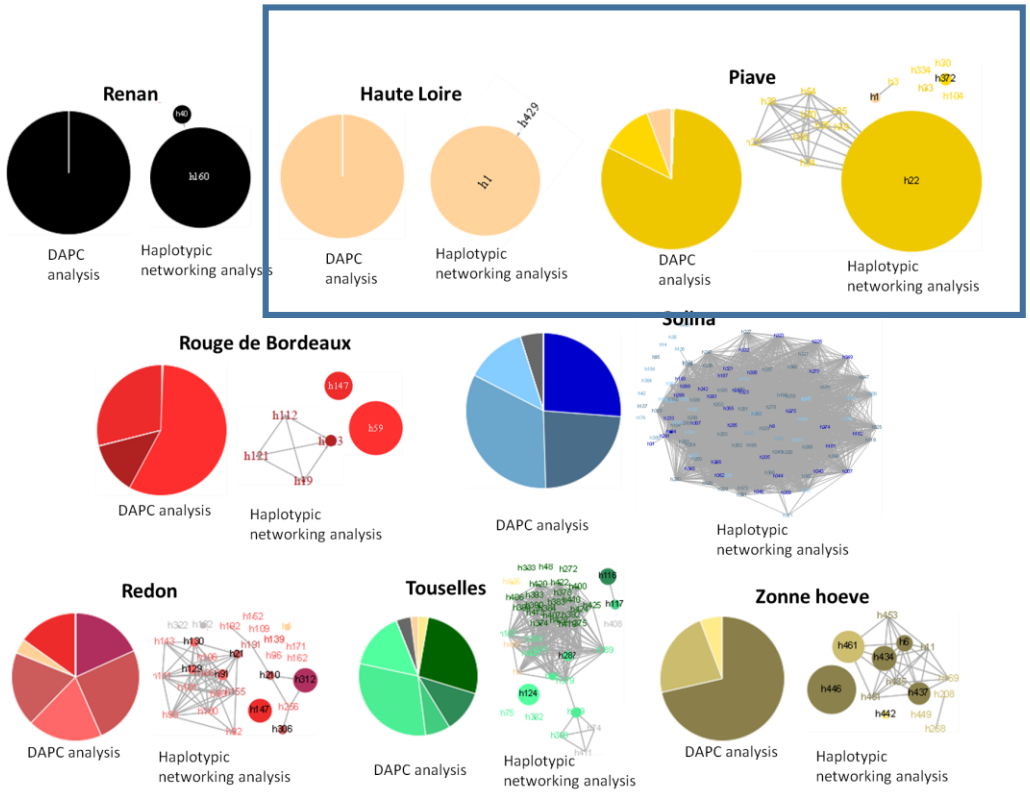
- And *ex situ* landraces have lost part of their intrinsic diversity

Looking at landraces diversity

Modern variety and *ex situ* conserved landraces

In situ conserved landraces

Mixtures

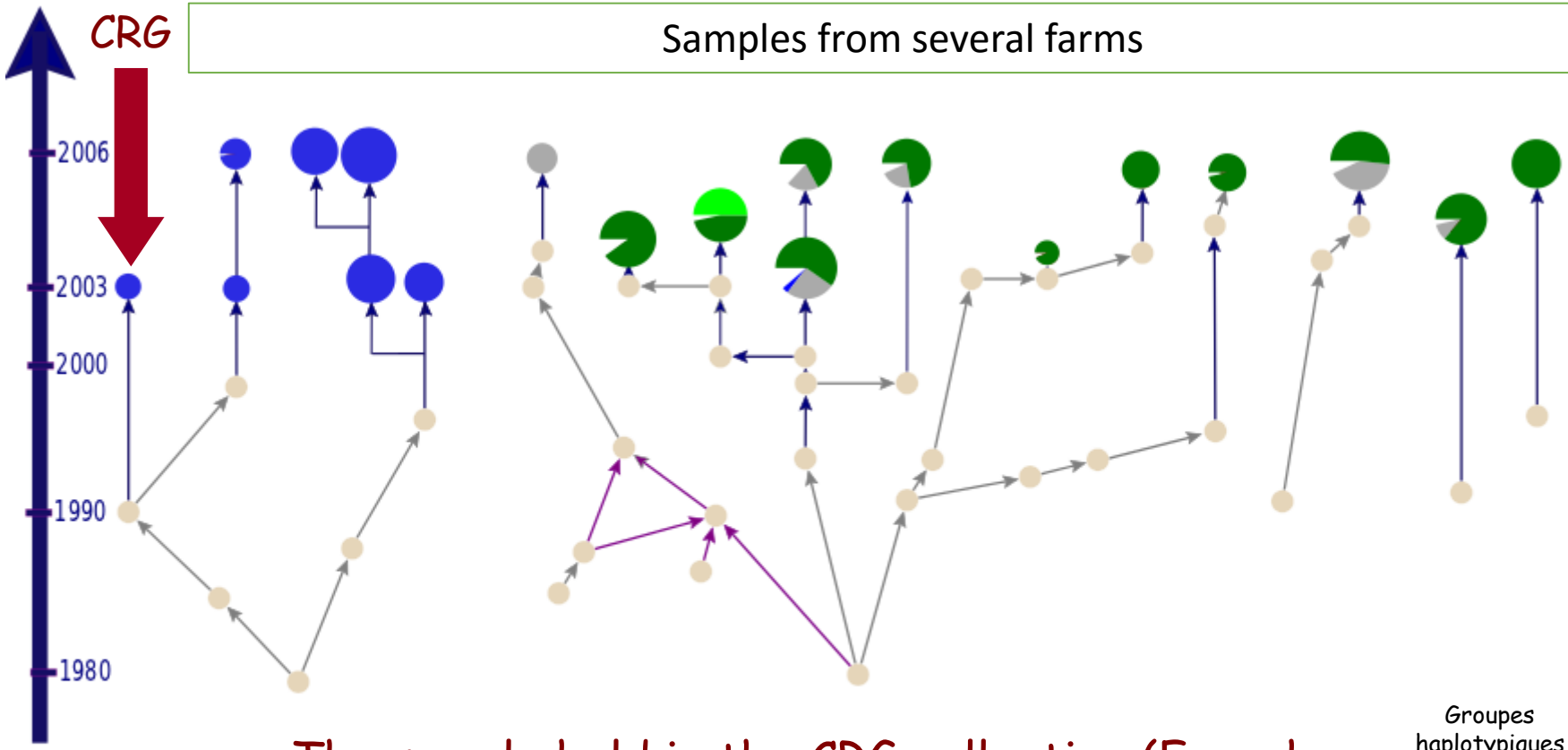


Ex situ conserved landraces have lost their intrinsic diversity: their look like modern varieties

Fine genetic structure obtained by DAPC and haplotypic network analysis for each farmer's variety. The colors represent the various groups defined by DAPC analysis. In haplotypic network analysis, two haplotypes are connected if they are different from each other at ≤ 15 loci.

Thomas M, Demeulenaere E, Dawson, JC, Khan A-R, Galic N, Jouanne-Pin S, Remoue C, Bonneuil C & I Goldringer (2012) On-farm dynamic management of genetic diversity: the impact of seed diffusions and seed saving practices on a population-variety of bread wheat. Evolutionary Applications 5(8): 779-795

Genetic structure of several accessions of Rouge de Bordeaux, a French landrace



The sample held in the CRG collection (French wheat genebank) represents only a subset of the diversity of the Rouge de Bordeaux

Groupes haplotypiques

lot de graine
diffusion
reproduction
mélange

0,03 - 0,90

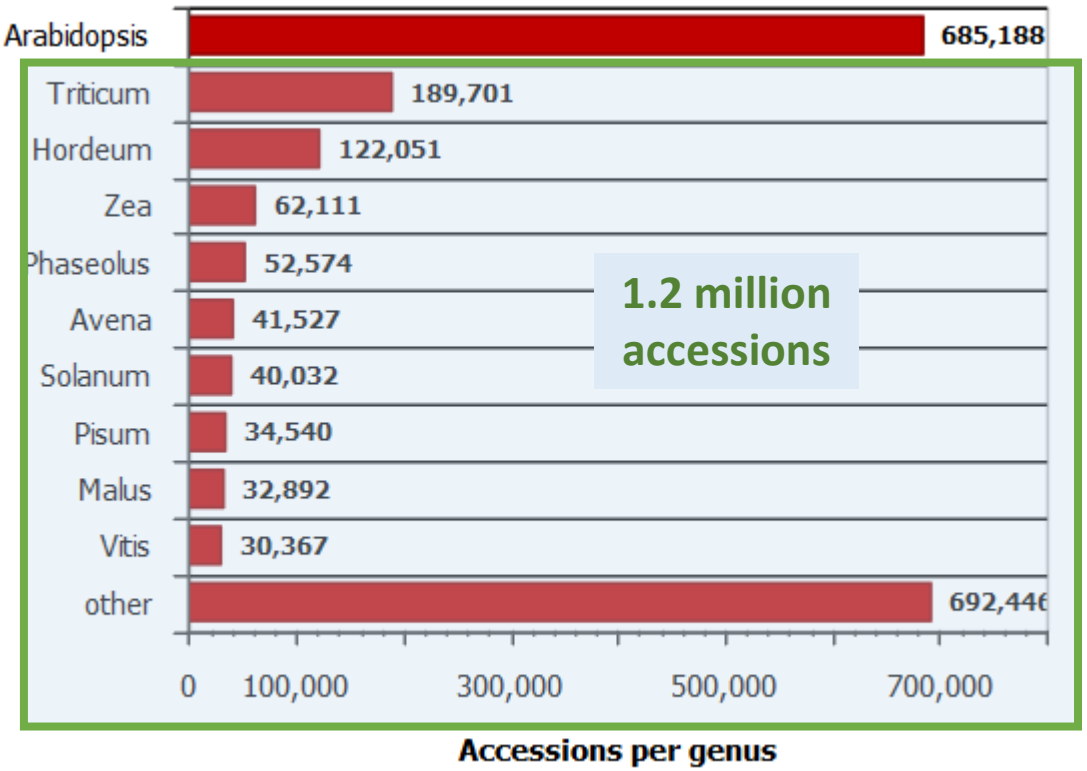
Diversité haplotypique non-biaisée de Nei (1978)

Results from PhD of Matthieu Thomas, INRA Le Moulon

New diversified cultivars should be created

The EU catalogues comprise more than 23,000 varieties of agricultural species and more than 21,000 varieties of vegetable species, and 12,500 fruit varieties

The **European Search Catalogue for Plant Genetic Resources** (EURISCO) provides information about 1.9 million accessions of crop plants and their wild relatives, preserved ex situ by almost 400 institutes. It is based on a network of National Inventories of 43 member countries and represents an important effort for the preservation of world's agrobiological diversity by providing information about the large **genetic diversity kept** by the collaborating institutions



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Finding seeds for the future

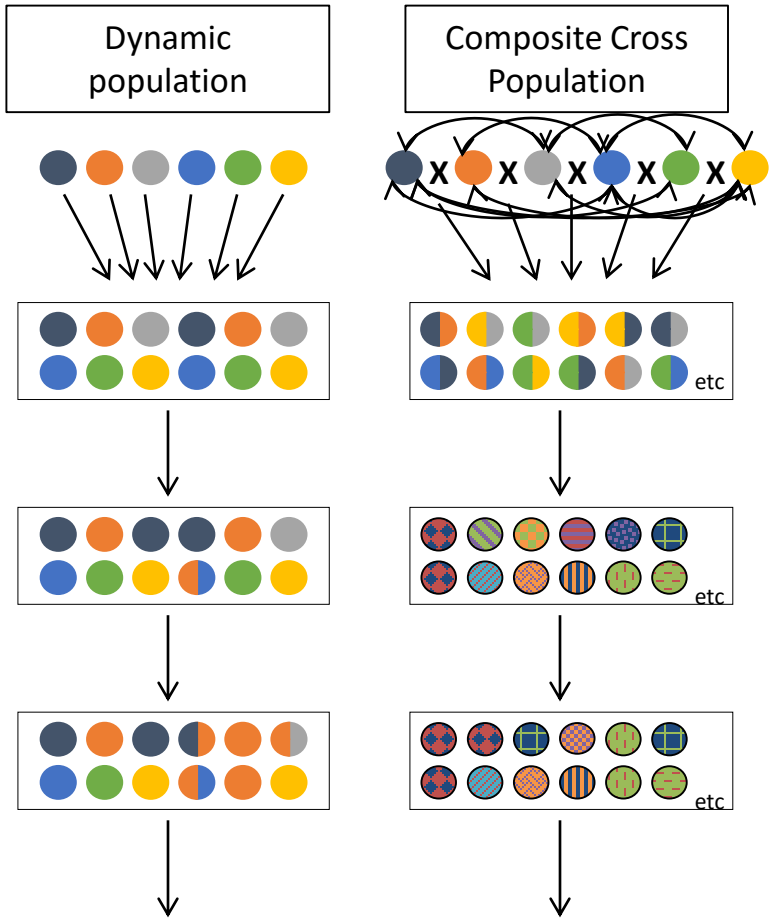
1 – Exploring and comparing breeding methods for diversity

Buckwheat

Bread wheat

Two strategies

	Bread wheat	Buckwheat
Parents	French landraces from a gene bank	European commercial varieties and landraces from a gene bank
	2013	*2015*
	2014 One farm	*2016* One farm
	2015 Two then several farms	*2017* Two the several farms



First results (bread wheat)

- In 2018, a farmer realized a selection in both populations in one place and 2 bakers did the same in another location.
- Each year, phenotypic characteristics and yield components are observed on all the populations (10 populations from 2019)

The human selection mainly determine crop traits (phenotypic characteristics and yield components), then the location and finally the breeding strategy.

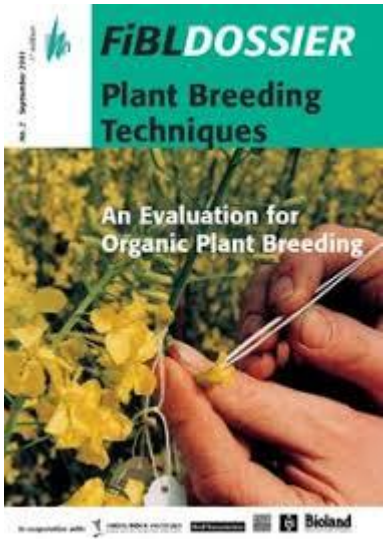
The selection of the farmer and the bakers have conserved the overall diversity even if they have fostered some chosen traits

2 – Creation of diversified crops: the concept of "Diversified Oriented Populations" (DOP)

- Mainly based on a large number of *ex-situ* accessions
- **DOP is a "personalized" mixture of several accessions with one or several common phenotypic traits requested by a farmer**
- The objective is to provide a basic diversified population to the farmers,
  - supposed to represent a huge potential of adaptation, but targeted on some characteristics,
  - in order to speed the breeding process and to facilitate the adoption by farmers

First step: looking for accessions

- **Studying the history of the** species cultivation, uses, and specifically plant breeding (to be coherent with **organic principles**)
  - e.g. artificial mutagenesis begun in the 70s



- **Listing the diversity** available in the gene banks
- **Choosing** accessions to collect diversified origins and **gathering accessions**

Step 2: multiplication and observations

all the accessions individually for 2 years at least in order to:

- to check the observations
- and to amplify the seed amount

Step 3: creation and distribution of DOP

- **Creating diversified and personalized populations** (or DOP) according to the farmers' requests
- **Distributing and ensuring a follow-up** of the evolution of the populations on the farms

  Evaluation of the relevance of the methodology through farmers' satisfaction

  and *in situ* observation of the populations

Example of Rivet wheat

- Durum wheat from the Northern European areas, suitable for cool and humid conditions

Example on Rivet wheat

- We started this experience in 2016 with rivet wheat (a demand from several farmers among the different seed associations of the farmers' seeds network (RSP - Réseau Semences Paysannes) in France)
- Multiplication and observation of:
  - 197 accessions for 2 years (2017 and 2018)
  - 25 traits observed
  - and DOP were distributed in 2018 (just after harvest) and 2019 with remaining seeds.

Dans le cadre du projet

197 accessions commandées

2016-2018: Multiplication and observation of 25 traits

First distribution in 2018

Total observed: 197

- 157 accessions have been included into 29 personalized populations
- The populations were established according 1 to 4 traits requested by the farmers
- Each personalized populations included 3 to 77 accessions
- 44 farmers have participated and each personalized population has been provided to at least two farmers
- 15 accessions did not find their place in a personalized population, creating the “orphan population”

Conclusion

- In 2019, we got new demands, increasing this list.
- First information about the behavior of the DOP in 2018: globally the farmers observed that the populations corresponded to the characteristics requested, so it is a first encouraging result.
- Farmers would like to get bigger quantities of seed at the beginnings: they received 20 to 200 gr.

  and it is quite difficult for some of them to start from so few seeds
- They wish to try with other crops: alfafa, oat and spelt; we have already begun the multiplication phase.

Our challenge

To find the means

- For initial multiplication to provide enough seeds
- For on farm observation to better evaluate the methods

21 – 27 September 2020

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