

VIGNERONS ET MAISONS



**INNOVATION IN THE VINE SECTOR: THE
CHAMPAGNE REGION INVENTS THE GRAPE
VARIETIES OF TOMORROW**

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FROM VINE DOMESTICATION TO THE EMERGENCE OF THE CHAMPAGNE REGION'S GRAPE VARIETIES

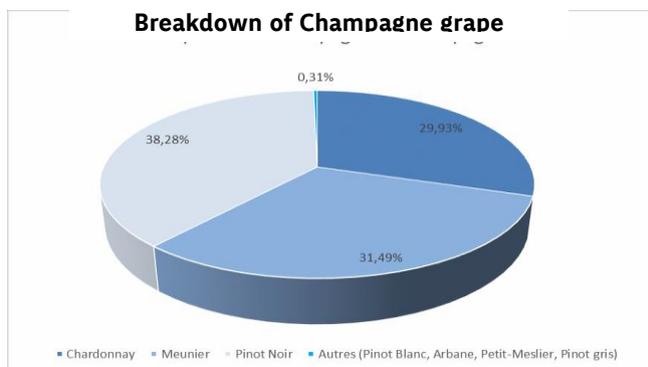
The origin of the vine species *Vitis* dates back more than 60 million years to the early Tertiary Era. At that time, primitive strains of vine were confined to the Northern hemisphere. In the Champagne region, a fossilised vine leaf dating from the Paleocene Age (60 million years ago) was found in the Sézanne area.

The Romans brought vine cultivation to Champagne between the 2nd and 3rd centuries of our era. The first ampelographic texts relating to the Champagne region date back to the 16th century. "La Maison Rustique" cites "Morillon, Pinot Aigret, Fromenteau or Pinot Gris and Gouais" among the best types of vine stock.

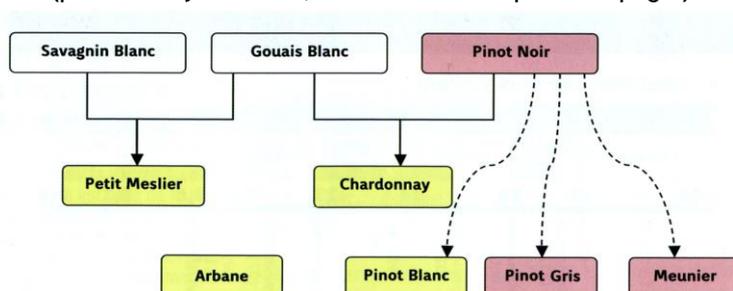
Meunier, Pinot Gris and Pinot Blanc are some mutations of Pinot Noir. Petit Meslier is the result of a cross between Gouais and Savagnin. The origin of the Arbane grape remains a mystery to this day.

For the most part, Champagne is produced from old grape varieties, along with one more recent arrival, Chardonnay, which has only been around for just over a century.

Currently, there are seven approved Champagne grape varieties: Pinot Noir, Meunier, Chardonnay, Arbane, Petit Meslier, Pinot Blanc and Pinot Gris.



Family tree of the seven approved Champagne grape varieties
(produced by the INRA, the IFV and Montpellier SupAgro)



A LONG TRADITION OF VINE HYBRIDISATION

Until the start of the 20th century, European vines were relatively isolated. With the advent of globalised trade and new methods of transporting goods, the region's grape varieties had to contend with new pests native to America. The arrival of powdery mildew in 1845, phylloxera in 1863 and downy mildew in 1875 devastated the European wine landscape, with grape varieties proving highly sensitive to these new pests.

It is against this dramatic context that the genius of the French hybrid teams will be measured. They plan to cross the European vine species (*Vitis vinifera*) with American species (*Vitis riparia*, *Vitis rupestris*, *Vitis berlandieri*, *Vitis labrusca* or *Muscadina rotundifolia*), some of which are resistant to powdery/downy mildew and phylloxera. The aim is to create new varieties combining these three types of resistance: this is the means by which direct producer hybrids (DPHs) are created. Famous hybrid breeders including Oberlin, Seyve-Villard, Seibel, Couderc and Baco all made their mark by giving their name to a wide range of hybrids. Though the quality of wine produced from these DPHs was subsequently found to be generally poor, they helped to ensure the sustainability of the French wine-growing tradition and around twenty hybrids are still registered in the official catalogue.

During the 20th century, chemistry came to the winegrowers' rescue with the rapid development of plant disease control products as the main strategy to protect vines against powdery and downy mildew. In the late 1990s, the consequences to public and environmental health resulting from systematic use of these disease control products led the French wine industry and public research sector to explore alternative solutions.

With this in mind, in the 2000s, the Institut National de la Recherche Agronomique (INRA) embarked on an innovative varietal creation programme. Known as the ResDur programme, its objective is to foster the development of a sustainable, more environmentally friendly approach to wine-growing. It is seeking to create vine varieties with effective, long-lasting disease resistance, bringing excellent cultivation capacities to the vine and optimal taste and flavour to the wine. Though the basic principle is an old one (cross-hybridisation), the early sorting techniques utilised, which include marker-assisted selection (MAS), are innovative.

The Champagne region joined this ResDur programme in 2010. The first series of vine varieties, planted in an experimental vineyard in 2011 and 2012, is currently being evaluated and planting of a second series is underway. These varieties are assessed on a number of criteria – phenology, agronomic performance, yield components and wine quality – but they have not been selected to fulfil the requirements of a particular type of wine.

VARIETAL INNOVATION IN THE CHAMPAGNE REGION:

The flowers from a Chardonnay cluster are castrated by hand:



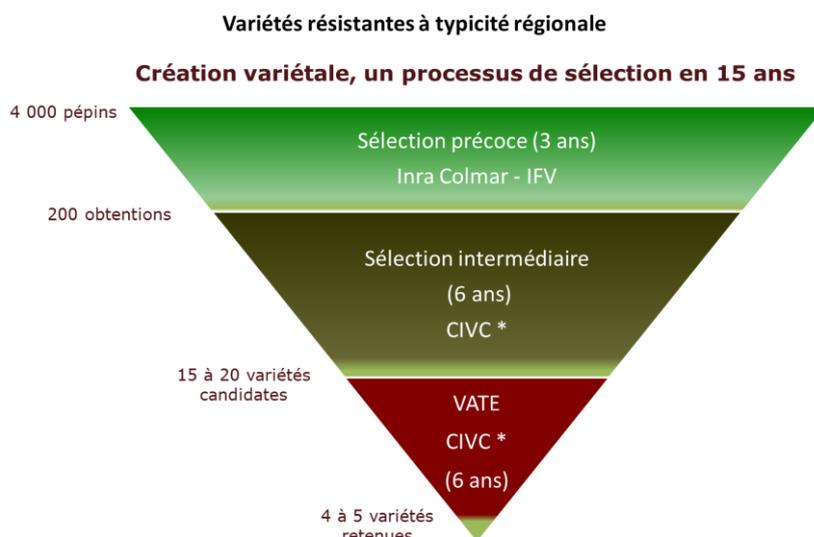
They are then fertilised using pollen from a resistant vine variety and the future grape cluster is protected until harvesting :



Seedlings grown from the grape seeds are sorted using marker-assisted selection tools to retain only those that have acquired the desired genes:



SELECTION PROCESS



Stage 1: Early selection (3 years) helps retain only those seedlings containing the desired resistance genes.

4,000 grape seeds will be sown for germination. Once the seedlings develop, they will be sorted by genotyping (marker-assisted selection) using DNA from one of their leaves. Only seedlings with the required resistance genes will be retained.

Stage 2: Intermediate selection (6 years) in situ in the Comité Champagne's experimental vineyard.

200 plants – evaluation based on 5 vines of each variety.

This stage helps verify resistance effectiveness, behaviour when exposed to other pathogens, degree of precocity and the main growth and flavour characteristics.

Stage 3: Agronomic, Technological and Environmental Value tests (ATEV) (6 years)

15 to 20 varieties – evaluation based on a minimum of 90 vines of each variety, grafted onto 2 rootstocks at a minimum of 2 sites.

A crucial stage intended to study resistance durability and precisely establish the cultivation and technological capacities of each variety, compared with control varieties.

Stage 4: Once the varieties have been chosen (4 or 5 probably), administrative measures will be taken to register them in the French catalogue of vine varieties, and finally in the Champagne AOC specifications.

KEY QUESTIONS ABOUT VARIETAL INNOVATION

Why is the Champagne region embarking on a programme of varietal innovation? What benefits will this bring for the sector and for consumers?

This research programme aims to meet two key objectives: environmental protection and long-term adaptation to climate change. The goal is to create new grape varieties that are resistant to major vine diseases, adapted to the changing climate and of a very high quality, while retaining the distinctive characteristics of Champagne wines.

The project will reap a number of potential benefits:

- reduced use of vine protection products, leading to improved environmental protection.
- a wider range of climate change adaptation options, with a particular focus on the long term, combined with changes in vine growing and winemaking practices.

How will the new varieties be obtained?

These new varieties will be obtained by hybridisation. This is just what mankind has been doing for thousands of years: crossing two varieties to try to produce one that combines the best features of both parent plants. Modern techniques make it possible to sort the varieties obtained faster and more effectively.

What are genetic markers? How are they used and how can useful genes be identified?

Genetic markers provide information about the genotype of an individual species; they are small segments of DNA occurring near a gene of agronomic or technological interest (disease resistance for example) in the plant's DNA.

For every generation produced from a such a cross, the markers selected and used in the laboratory help detect with precision the presence or absence of the desired gene(s) being sought in the young vines undergoing selection. They can be used throughout an experiment and can be observed on any organ and at any stage of the plant's development (the same genetic information is contained in all of the plant's cells).

Compared with traditional selection methods, marker-assisted selection proves:

- faster (just a few days of laboratory analyses are enough to diagnose the presence or absence of desired genes in the young vines undergoing selection);
- more precise (the presence or absence of the desired gene is reliably detected);
- non-destructive as only a very small quantity of plant material is required for the analysis to be performed (1 cm² of leaf for example);
- not subject to environmental influences.

How are they different from GM plants?

A plant is said to be “genetically modified” if one or more foreign genes are artificially inserted into its genome (genetic engineering technology). Hybridisation exploits the plants’ natural reproductive mechanism and the accompanying genetic variation. The progeny of the cross are screened for the desired characteristic.

Will the distinctive characteristics of Champagne wines be altered?

Every experimentation phase provides for tasting both at the various winemaking stages and over a number of years. Each new variety is compared to an existing Champagne grape variety, such as Chardonnay for example. The decision as to whether a variety is characteristic or not, and whether to include it in the mix of vine varieties planted will be made by Champagne professionals. If this is the case, a request will be made to INAO, the French National Institute for Product Origin and Quality, for its inclusion in the Champagne appellation’s specifications.

What is the difference between direct producer hybrids (DPHs) and the new varieties of the future?

Previously, there was a very significant proportion of American vine species in the genome of DPHs: though these offered a high level of resistance, they also contained unacceptable quality defects present in the American species. The new varieties of the future will be obtained after several backcrossing cycles. This means a substantial proportion of their genome will be derived from *Vitis vinifera*, which should instill characteristics close to our current grape varieties but with, in addition, a high level of resistance to downy and powdery mildew.

Which grape varieties will be used for the crosses?

The parent plants of these future varieties will comprise:

- Champagne grape varieties,
- varieties emerging from the ResDur programme undertaken by the French Agronomy Research Institute (INRA) or varieties obtained by the French Vine and Wine Institute (IFV). These are non-genetically modified varieties that will provide disease resistance.

Will the new grape varieties be very different from current ones?

Even though their genetic makeup will ultimately have changed very little, will the new hybrids be able to keep the same names as the original grape variety (Chardonnay, Pinot Noir etc.)?

Each new variety will contain around 95% of the gene pool of *Vitis vinifera* and 50% of the genetic makeup of a specific Champagne variety, but it is not possible to say that the genetic makeup will ultimately remain little changed. This will depend on the variety.

The new grape varieties will be unique and different. During the various experimentation and selection phases, it will be possible to steer the choice in the direction of one variety rather than another. The new varieties will indeed be hybrids derived from Chardonnay, Pinot Noir or Meunier but from the moment a new variety is produced, it will be given a different unique name.

Confronted with these new varieties, won't diseases simply mutate in order to adapt and cause problems again in a few years' time?

The risk of circumventing disease resistance has been taken into account. Every new variety selected must combine at least two genes that are resistant to powdery and downy mildew which, according to experts, minimises the risk of circumvention very significantly.

As has been observed previously, Champagne grape varieties have mutated in the past. Isn't it therefore possible these new varieties could mutate in turn, gradually becoming unsuited to Champagne wines?

Mutations can certainly occur, as has been seen in the past following selective pressure in the environment. These mutations will help to enhance biodiversity by producing new clones or new varieties that may or may not be suited to the Champagne region.

What is the benefit of using genetic markers for selection?

They make it possible to undertake early sorting, saving both time and space.

In the 19th century, it took 3-4 years before a plant's sensitivity or resistance to downy or powdery mildew could be evaluated. This would have involved observation of around 2,000 seedlings over a 3-year period (50% of the 4,000 seeds are expected to germinate).

Today, at the 4-leaf stage (2 months after germination), plants that do not carry the desired resistance genes may be eliminated, which reduces the number of specimens to be observed to 200.