

**Working Group on Biochemical and Molecular Techniques  
and DNA-Profiling in Particular**

**BMT/19/12**

**Nineteenth Session  
Alexandria, United States of America, September 23 to 25, 2020**

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**FRENCH STRATEGY FOR ACCESS TO MOLECULAR DATA & PROOF OF CONCEPT FOR  
COMBINING PHENOTYPE AND GENOTYPE**

*Document prepared by an expert from France*


*Disclaimer: this document does not represent UPOV policies or guidance*

The annex to this document contains a copy of a presentation on “French strategy for access to molecular data & proof of concept for combining phenotype and genotype”, prepared by an expert from France, to be made at the nineteenth session of the BMT.





[Annex follows]


**French strategy for access to molecular data  
&  
proof of concept for combining phenotype  
and genotype**

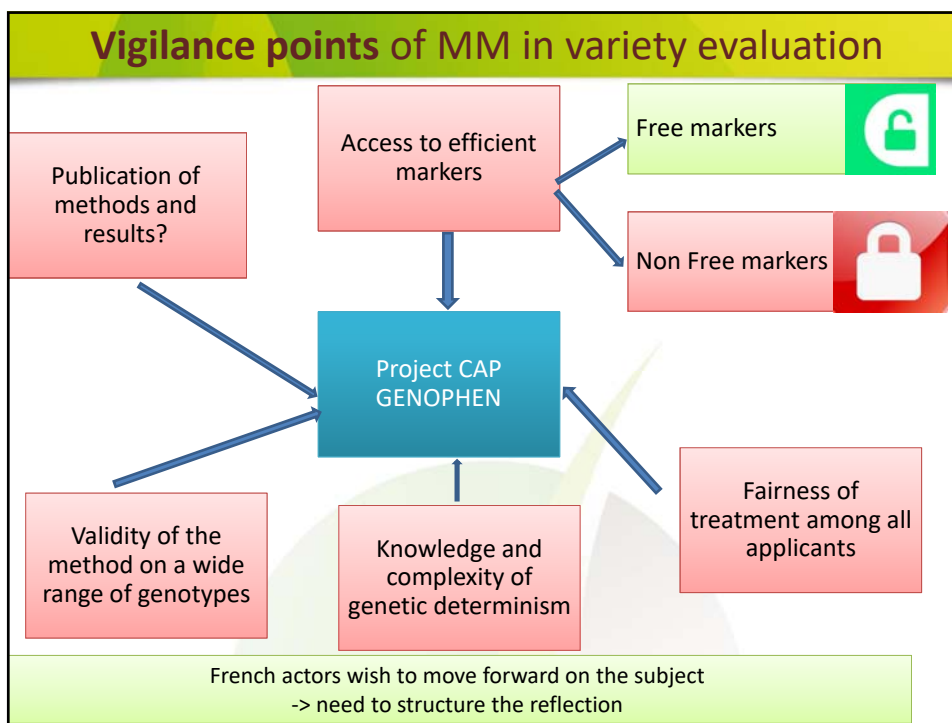
*Cadot Valérie, René Mathis, Bertoux Virginie*



**Benefits of Molecular Markers in variety evaluation**

- **DUS/VCU**
- Advantages of **Molecular Markers (MM)**, as a **complement to phenotyping** to evaluate traits of candidate varieties for DUS & VCU S (**Value for Cultivation, Use and Sustainability**) studies
  -  **nb assays in field**
  -  **costs of phenotyping**
  -  **faster and equally reliable results = efficiency**   
compensate experimental risk of field phenotyping,  
increased by climatic disturbances
  - Allow a better management of **resistance sustainability** with  
information on genes






Project CAP  
GENOPHEN (2019-20)




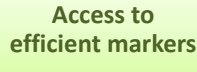
Project presentation

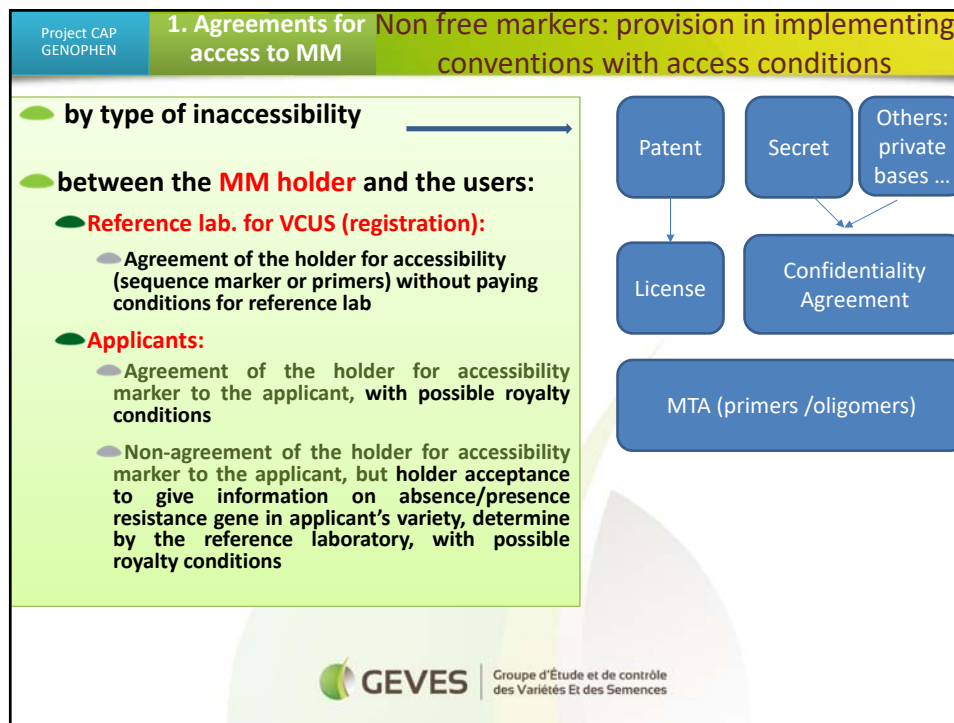
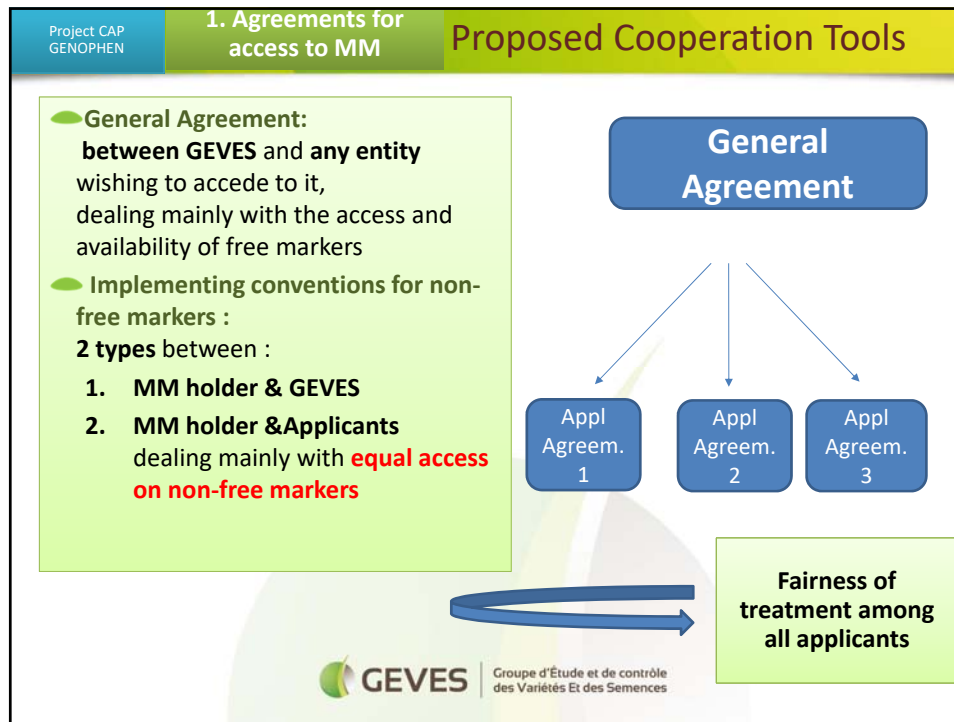
- **Aim:** define the main directives for the availability and implementation of markers for the registration of straw cereal varieties, in the framework of VCUS studies of resistance to pests and diseases
- **Partners:**

*French Seed Association*
- **Actions:**
  - **Action 1 :** Definition of the access requirements to molecular markers
  - **Action 2 :** Proof of concept of using molecular markers for Eye spot resistance assessment

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Project CAP GENOPHEN (2019-20)	Project results	
1	Agreements for giving access to Molecular Markers: - General agreement - implementing conventions	
2	List of selected traits & MM	
3	Scenario combining phenotyping and genotyping: <i>Eye spot case of study</i>	
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Project CAP GENOPHEN	1. Agreements for access to MM	Free vs. non-free markers definitions
<p>● Interest for an Examination Office, in certain cases, to have access to <b>non-free markers for reliable and efficient</b> variety evaluation</p>		
<b>Free markers</b>	<p>● Any genetic marker which is <b>not subject to any industrial property right or trade secret</b> and whose use is free, including the disclosure of information on the <b>primer sequence</b> and the <b>method for detecting</b> the said marker.</p>	
		
<b>Non Free markers</b>	<p>● Any genetic marker which is the <b>subject</b> of an <b>industrial property right or business secret</b> and whose disclosure of the method for detecting it and/or use of the primer sequence requires the prior <b>agreement of the holder of the marker</b>.</p>	
		
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Project CAP GENOPHEN

**1. Agreements for access to MM**

**Which accessibility for non-free markers?**

Extraction of implementing conventions for non-free markers

Information provided by the MM holder	Reference lab (for registration purposes)	All applicants	
		Access agreement	No access agreement
Information on Nucleotide sequences of markers	X		
Information on Nucleotide sequences of primers	X	X (option)	
Product : Primers (oligomers) provided by the holder	X	X	
Method/Protocol	X	X	

This tables reflects the position agreed by the CAP-GENOPHEN partners as stated in the implementing conventions

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Project CAP GENOPHEN

**1. Agreements for access to MM**

**Markers accessibility for the applicants**

For what purpose?

Breeding

VCU (Registration)

Who's doing the molecular marker analysis?

Applicants

Services provided by official lab or service contractory labs

Official lab or service contractor labs

Case 1 : Access of primers to all applicants


Case 2 : No access of primers to applicants


For who?

For all applicants

Fairness of treatment among all applicants

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Project CAP GENOPHEN	1. Agreements for access to MM	Publication of methods and results ?
<p><b>DUS with UPOV Models :</b></p> <ul style="list-style-type: none"> <li>Among the three models using molecular techniques, this work is close to the model 1 (<i>characteristic-specific MM</i>)</li> <li>This an example of MM providing a partial information on the characteristic</li> <li>The final result on the characteristic comes from a combination of MM test and phenotyping</li> </ul> <p><b>VCUS:</b></p> <ul style="list-style-type: none"> <li><b>Case of resistance to pests:</b> Interest in publishing information related to the resistance strategy used, for sustainable management of resistance (collective management of resistance genes: phoma; yellow rust; downy mildew &amp; powdery mildew /vine...).</li> <li>Public interest.</li> <li>Keys for reading and interpretation to be provided.</li> </ul>		
 <span style="font-size: small;">Groupe d'Etude et de contrôle des Variétés Et des Semences</span>		

Project CAP GENOPHEN	1. Agreements for access to MM	Publication of MM adapted to the use												
Users	Content Results	Comments												
1. Commissions VCU / CTPS (National listing)	<b>Information on all applications :</b> <b>raw data + resistance cotation (1 Sens. à 9 Rés.) + presence/absence gene</b> <table border="1" style="font-size: x-small; margin: 5px auto;"> <tr> <td>Variété</td> <td>Piétin ver.</td> <td>Pch1-SNP</td> </tr> <tr> <td>A</td> <td>2</td> <td>Abs Pch1</td> </tr> <tr> <td>C</td> <td>4</td> <td>Abs Pch1</td> </tr> <tr> <td></td> <td>7</td> <td>Pch1</td> </tr> </table>	Variété	Piétin ver.	Pch1-SNP	A	2	Abs Pch1	C	4	Abs Pch1		7	Pch1	Validated by CAP-GENOPHEN partners & Commissions CTPS
Variété	Piétin ver.	Pch1-SNP												
A	2	Abs Pch1												
C	4	Abs Pch1												
	7	Pch1												
2. Applicants	<b>Information to applicants only his own cultivars:</b> <b>resistance cotation (1 Sens. à 9 Rés.) + presence/absence gene</b>	Validated by CAP-GENOPHEN partners & Commissions CTPS												
3. Continuum registration -Post registration	Marker genotyping information and interpretation (absence/presence of genes)	to be discussed and validated in CAP-PHENOGEN												
4. External users	Resistance rating, with general indication resulting from the combination of phenotyping and MM tests	Validated by CAP-GENOPHEN partners but to be finalized in CAP PHENOGEN												
		<b>Consensus framework to be finalized in CAP PHENOGEN on the communication of MM with a specific content related to the targeted user</b>												

Project CAP GENOPHEN		1. Agreements for access to MM				2. List of selected traits & MM				
Caractère d'intérêt	Espèce	Gène/QTL	Dispo. Marqueur	Nb. Marqueur	Marqueur Dispo. Projet	Type Marqueur	Origine Marqueur	Accessibilité	Convention	Validé par Arvalis
Piétin-verse	Blé tendre	<i>Pch1</i>	OUI	11	1	SNP	Référence Bibliographique	Libre	Cadre	OK
Mosaïque SBGMV	Blé tendre	<i>Sbm1</i>	oui	1	1	SNP	Arvalis	Non-libre	Application	OK
Mosaïque SBWMV	Blé tendre	<i>Sbwm1</i>	OUI	2	1	SNP	Référence Bibliographique	Libre	Cadre	OK
Mosaïque WSSMV	Blé tendre	<i>QTL 2D</i>	OUI	1	1	SNP	Référence Bibliographique	Libre	Cadre	OK
<b>Cécidomyies</b>	<b>Blé tendre</b>	<b><i>Sm1</i></b>	<b>OUI</b>	<b>14</b>	<b>0</b>	<b>SNP</b>	<b>Référence Bibliographique</b>	<b>Non Libre</b>	<b>Protégé brevet</b>	-
Mosaïque BaYMV-BaMMV	Orge	<i>rym4</i>	OUI	4	1	SNP	Arvalis	Non-libre	Application	OK
Mosaïque BaYMV-BaMMV	Orge	<i>rym5</i>	OUI	4	1	SNP	Arvalis	Non-libre	Application	OK
JNO BYDV	Orge	<i>Ryd2/Yd2</i>	OUI	3	1	SNP	Arvalis	Non-libre	Application	OK

→ Choice of simple genetic determinism : Yellow rust excluded  
 → Agreed list (GEVES/Arvalis, INRAE & UFS) which includes free or non free markers for registration purposes  
 → 7 couples host/pathogen/genes  
 → One couple excluded because of patent

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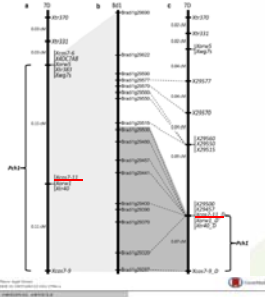
Project CAP GENOPHEN		1. Agreements for access to MM				2. List of selected traits & MM				
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## Eye spot : markers of resistance gene *Pch1*

### Common wheat

◇ 2 markers SNP :

- From FSOV project 2010
- From bibliography



Free marker: X-cos7-11D (General agreement)

	Génotype Non <i>Pch1</i>	Génotype Hétéroz. <i>Pch1</i>	Génotype <i>Pch1</i>
Résistant	5	13	81
Sensible	374	3	3

→ Genotyped marker on 430 common wheat varieties with a diagnostic value of 98%.

→ Markers classify 98% of varieties according to the rule: « Présence of *Pch1*gène *Pch1* → Note ≥ 5 »

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Project CAP GENOPHEN	1. Agreements for access to MM	2. List of selected traits & MM	3. Scenario combining phenotyping & genotyping
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Validated scenario combining phenotyping & MM

- Yr1: on all applications :  
phenotyping in field with 2 trials + monogenic marker *Pch1*
- Yr2: according to the **New decision rules for national listing below:**

Year 1			Year 2	
Phenotyp. cotation (1: S to 9: R)	Marker Pch1 (absent/het./present)	Decision rules	Phenotyp. cotation (1: S to 9: R)	Decision rules
<=4	Present (very rare)	on going in Yr2	Cot. Yr1 & Yr 2. <=4	S
	absent/ heter.	S	Cot.Yr1 & Yr 2.>=5	R (Bonus)
5	Present	R (bonus)	Cot. Yr1 & Yr 2. <=4	S
	absent/ heter.	on going in Yr2	Cot.Yr1 & Yr 2.>=5	R (bonus)
>=6	Present	R (bonus)		
	absent/ heter.			

Efficiency of combining phenotyping & MM for cultivar resistance assessment :

- Reduction of nb trials to implant in field in Yr2,
- Faster confirmation of resistance
- Adapted to a large range of genetic background

## NEW PROJECT AS A FOLLOW UP: CAP-PHENOGEN (2020-2023)

- **Aim:** Proof of concept of the interest of molecular marking as a complement to phenotyping to characterize varietal resistance to pests in common cereals, in the framework of VCUS studies
- **Models host/pathogens/genes:**  
7 couples host/pathogens on Common wheat & Barley
- **Partners:**
- **Expert :**

Bundessortenamt

*French Seed Association*
- **Actions**
  1. **Marker validation** : robustness, comparison with phenotyping data, validation of the molecular tool, with a finalized protocol
  2. **Ability to implement combined phenotyping and genotyping scenarios**
  3. **Valorization of information on identified resistance genes** :  
Define existing brakes to communicate known resistance genes to users

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## Conclusion- discussion

- Advantages of combining phenotyping and genotyping
- Definition of free/non free markers
- Legal frame for giving access to non free markers, with **fairness of treatment among all applicants**
- Publication topics to be finalized with a specific content related to the targeted user

**THANK YOU FOR YOU ATTENTION**