

# Old and New breeding goals and challenges



Felicity Vear  
*INRAE (retired)*

*Clermont-Ferrand / Toulouse, France*



- **Variety type**
- **Breeding goals**
  - **Not now priority for research**
  - **Always important**
  - **Cyclic importance**
  - **New / recent goals**

**Why? How?**



# Variety type

Hybrids / Open pollinated varieties



INRA6501

Peredovik

**Uniformity**

**Self fertility**

**Possibility of rapid innovation**

**Ease of maintenance of genetic resources**

# Goals now less important

Because breeding has been successful

## CMS

- No problem with PET1
- 72 (?) different CMS reported
- Good restorer genes
- Drought resistant ?



## Seed drop

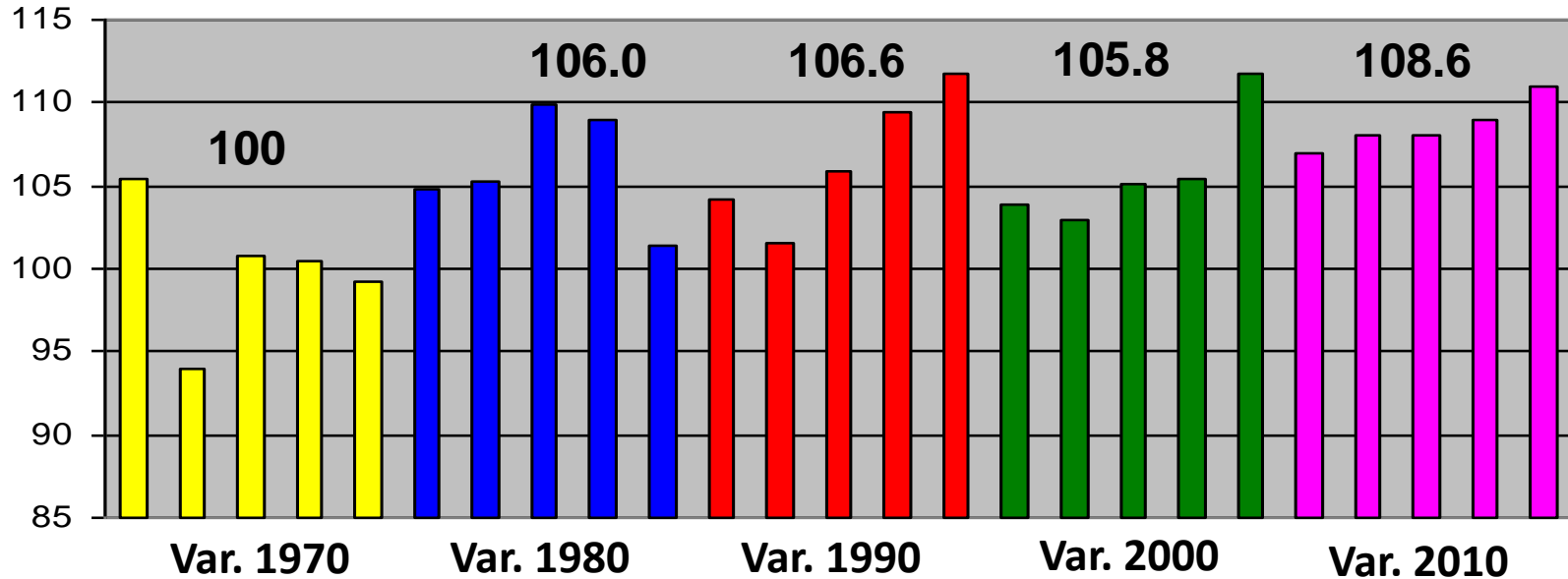
- Remained from wild *H.annuus*
- Eliminated by selection for yield at harvest <12% humidity



# Goals now less important

Because breeding has been successful

## Oil content



## High oleic

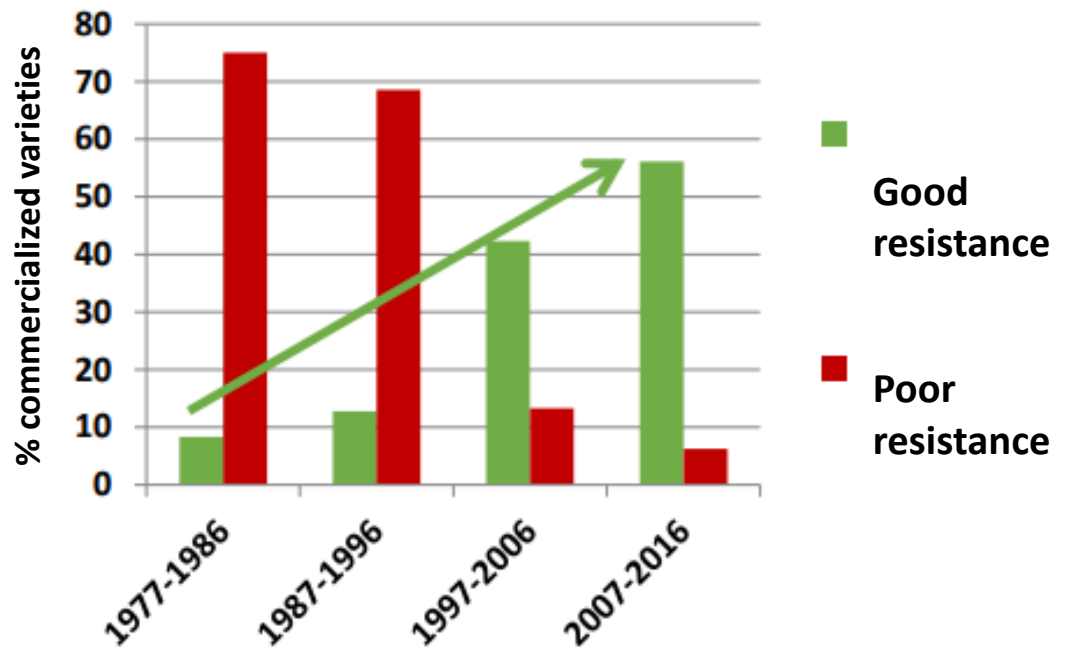
Soldatov's mutation , now 80-95%, yields etc close to  
« conventional » varieties

(Low saturates, high stearic, other fatty acids ??)

# Goals now less important

Because breeding has been successful

Phomopsis (in Europe)



Use of Phomopsis resistant varieties in France (Mestries , pers.com)

- **Goals now less important**

- **Because of agricultural / climate changes**

## **Disease resistance**

- **Botrytis**



## **Sclerotinia**



## **Phoma (in France ?)**



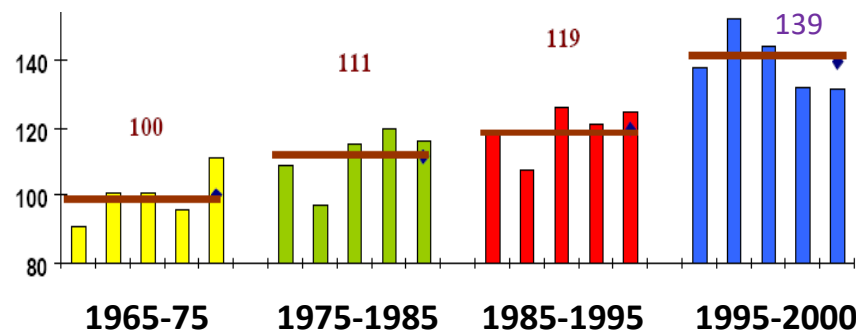
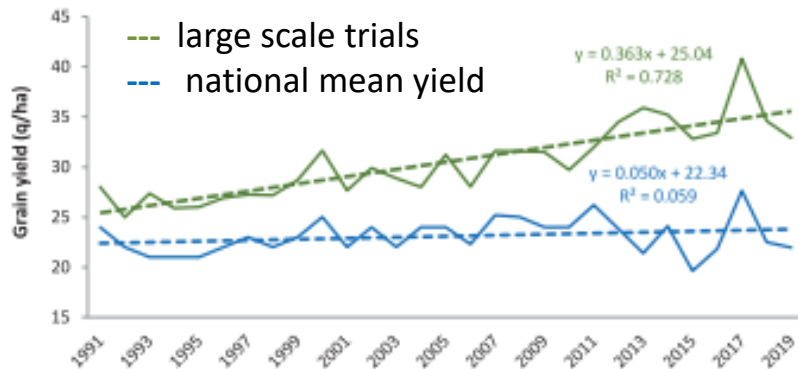
**Breeding:  
Susceptible material  
eliminated**

**What will be the  
future impact of these  
diseases?**

# Goals always important

## Seed Yield

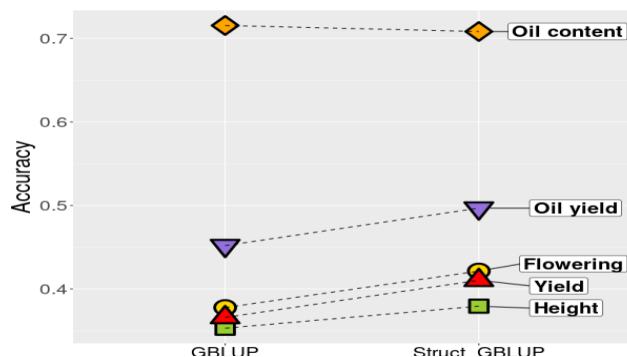
## Genetic gain



(Terres Inovia – Promosol)

## New Tools

### Genomic selection



(Mangin et al, 2020)

### Automatic phenotyping



(Blanchet et al, 2017)



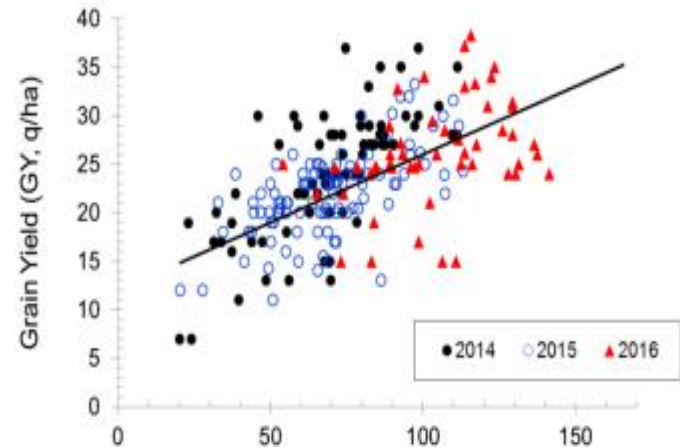
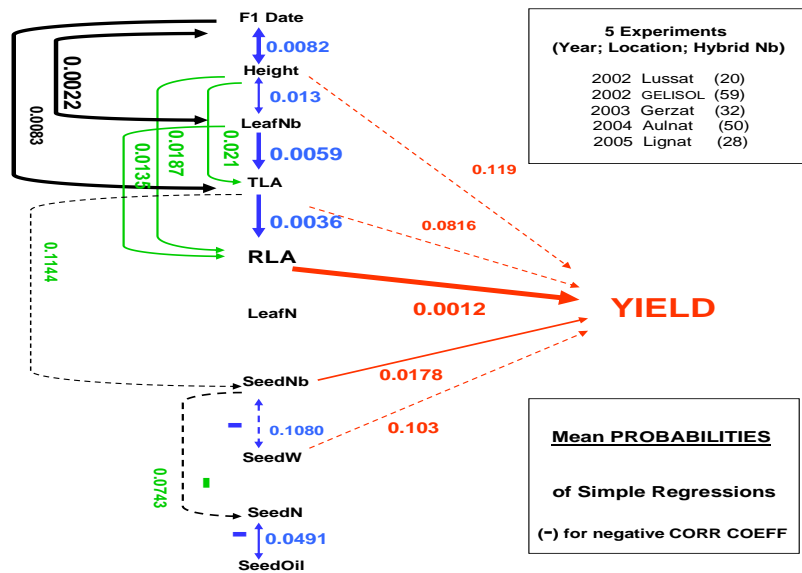
# Goals always important

## Seed Yield

### New Tools:

Modeling : help to predict performance from a few trials taking into account environmental conditions and management (Casadebaig et al,2016)

## Confirmation of the importance of leaf area duration



Leaf area duration (days) measured by satellite reflectance (Debaeke et al, 2020)

Residual leaf area measured by hand (Triboi et al, 2006)

# Goals always important

## Drought Resistance

Since spread from chernozems in eastern Europe

### *Helianthus argophyllus*



Not much success in breeding

### Cultivated sunflower

Improved measurements

Association mapping

Genomic selection

(Langlade et al, 2022)

**Will resistance or escape be most important?**

**Will breeding or management be most important?**

# Goals of cyclic importance

## Protein content and Hullability



Interest in comparison with soybean, pea, other crops...

Proteins for

Animal feed or

Human food?

Frequent negative correlations

Protein / oil

positive correlations

Hullability / % hull

Need for partial or complete hulling?

Will there be different varieties for oil and for protein ?

# Goals of cyclic importance

## Exploitation of crop residues

### Sunflower stems good source of isolation



(ENSIACET, Toulouse )

- Replacement of plastic by bio materials
- Secondary harvest

How much can be removed from field?

Should there be breeding for this use?

# Goals of cyclic importance

## Resistance to diseases with pathogen races

### Downy mildew



- Almost world wide
- Many resistance genes in wild *H. annuus*
- Are all really different?
- Good differentials, need to up-date

### Orobanche



- Recent spread, not Americas
- Resistance genes quite rare
- Lacking for the most virulent races
- Differentials still needed

# Goals of cyclic importance

## Resistance to diseases with pathogen races

### Downy mildew

- Resistance mechanisms not well known
- No PI gene sequenced
- Races distinguished by markers /sequences

(Mestries et al, 2022)

### Orobanche

- Resistance mechanisms well identified
- Resistance gene (Or) sequenced
- Markers for races not yet available

(Munos et al, 2022)

**Will genomic sequences of the pathogen make it possible to identify new races?**

**Will genomic sequences of sunflower make it possible to identify the « strongest » resistance genes?**

# Goals of cyclic importance (in France)

Resistance to diseases with pathogen races ??

## Verticillium



(Debaeke et al, 2020)

**Problem for some varieties**

**Why more in Argentina , USA?**

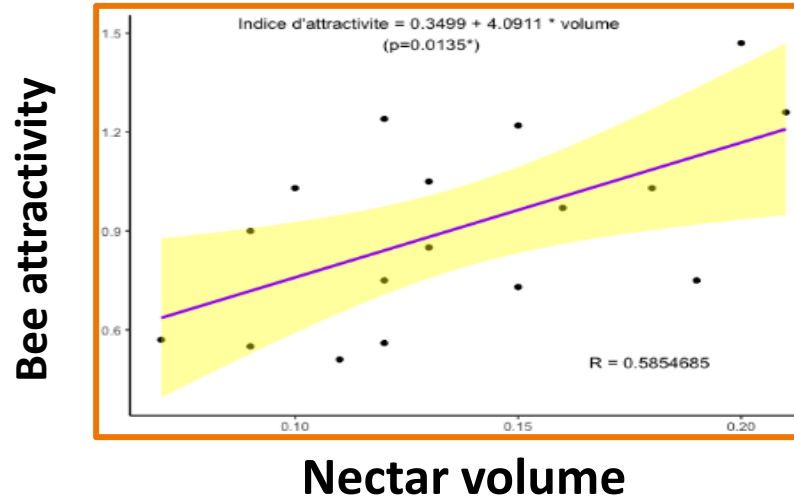
**Why cyclic problem in France?      Climate, Sunflower genotype??**

**Are there races, with specific recognition (effectors ?)**

**Possible control by biofumigation?**

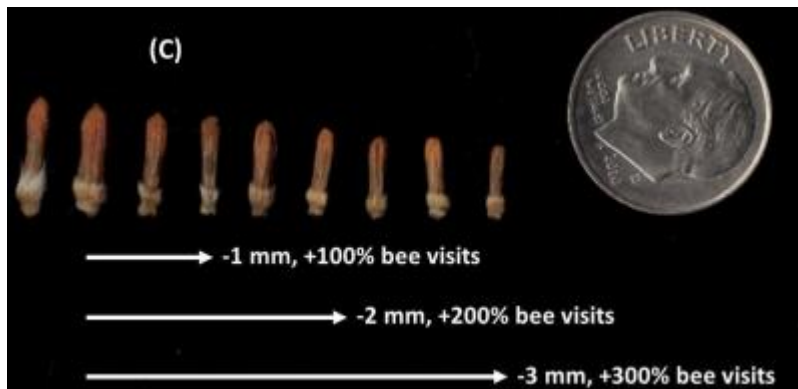
# Goals of cyclic importance

**Pollinators, Bees**  
**Improved yield,**  
**Honey production**  
**Environment**



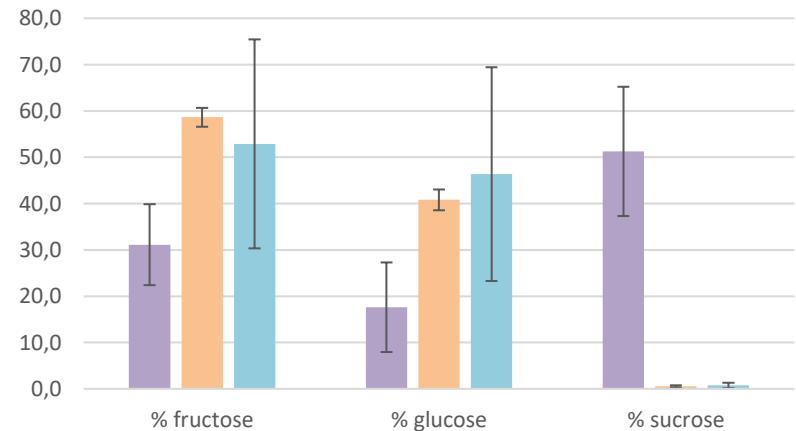
(Catrice et al, pers.com)

## Corolla length



(Prasifka 2015)

## Sucrose production



(Catrice et al, pers.com)



# New / recent goals

## Herbicide resistance

Appreciated by farmers, Herbicide tolerant varieties widely used

How much resistance will be developed by weeds?

How important will organic sunflowers become?

(France about 10% in 2021)

Are there other ways to reduce weed problems?

Rapid seedling growth to cover soil?

Mixed cropping ? Mechanical hoeing?

Can breeding provide any new answers?

# New / Recent goals

## Reduction of Bird damage

- Always a problem, especially for small areas of sunflower
- At emergence and at harvest: perhaps different solutions



(Terres Inovia, 2020)

**Would regular germination and fast seedling growth help?**  
**Would rapid dry-down help at harvest?**

# New / Recent goals

## Cold resistance / Seedling vigour

**1990s:** Winter crop trials in Morocco and Spain : good results

**Now:** Permit early sowing (drought or heat escape)

Or give rapid and uniform emergence

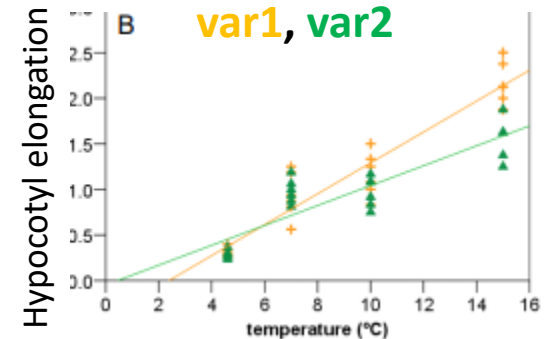


reduce weeds, bird damage?

but : seedling vigour = earliness

lack of vigour = root growth??

Genetic differences for chlorophyll,  
osmotic potential, base temperature for  
germination, hypocotyl elongation



(Alline,2009)

**Better knowledge of physiology of  
germination and seedling growth  
could help several breeding goals**



## New / recent goals??

### Possible changes in ideotype

#### Dwarfs



Not a success, poor seed set

#### Branching



Only useful for biomass /  
intercropping/ornamental?

**Do any *Helianthus* spp have interesting structuration?**

**Would require a very large breeding effort**

# Conclusions

- **Most goals long-term or cyclic**
  - **yield,**
  - **drought and disease resistance,**
  - **insect pollinator attractivity**
  - **relative importance oil / protein**
- **A few characters for which breeding has been successful, but must be maintained**
  - **CMS,**
  - **oil quantity and quality**



# Conclusions



**New characters not really new but before it was difficult to obtain significant results**

- cold resistance,**
- seedling and young plant growth,**
- bird « resistance »**

**Will new tools (models, aerial photography, automatised phenotyping, genomics...) make possible significant advances in breeding concerning these goals?**



## I would like to thank

- All my colleagues at INRAE, Toulouse (LIPM and AGIR) and Terres Inovia
- Promosol (now Seleopro) and colleagues in the firms that collaborate with INRAE
- ISA

for their comments,  
for use of their figures in this presentation,  
for making it possible for me to follow progress in  
sunflower research in the last six years