What does animal breeding industry expect from biotechnology developments ?

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UNCEIA

UNCEIA WWW.UNCEIA.fr

- **National Union of the French AI companies**
- **Represents the sector towards National and International bodies, officials Ministry of Agriculture, INRA and professionals: FGE, Technical Institutes.**

UNCEIA is member of EFFAB (European Forum for Animal Breeders), represents the interests of the industry at COPA- COGECA, ICAR, IETS

- **Provides services to its members: legal, social, genetics, reproduction, sanitary, educational issues.**
- **Develop research programmes in genomics and biotechnologies of reproduction (MAS, AGENAE projects), in partnership with research institutes**
- **40 employees, Turn Over 6 millions Euros.**

Outlook

- _What are we talking about?
  - *What is breeding ?*
  - *What is the breeding industry, how it works?*
- _History of biotechnologies in breeding industry
- _Current and possible use of biotechnologies in breeding programmes
  - *Reproduction: dissemination of genetic progress*
  - *Evaluation and selection: creation of genetic progress*
- _Access to gene resources.
- _Conclusion

What is breeding?

- **Breeding refers to animal populations (herds, breeds) and not to individuals**
- **Two dependent processes:**

Reproduction: ***organisation of replacement of breeding animals of herds with improved progeny, by natural mating, by AI, by ET: dissemination of genetic progress***

Evaluation and selection: ***definition of traits of economic importance, setting up breeding goal, recording of data to evaluate traits, genetic evaluation, selection programmes: creation of genetic progress***

Breeding programmes are based on:

- **Records on animals for traits of economic relevance**

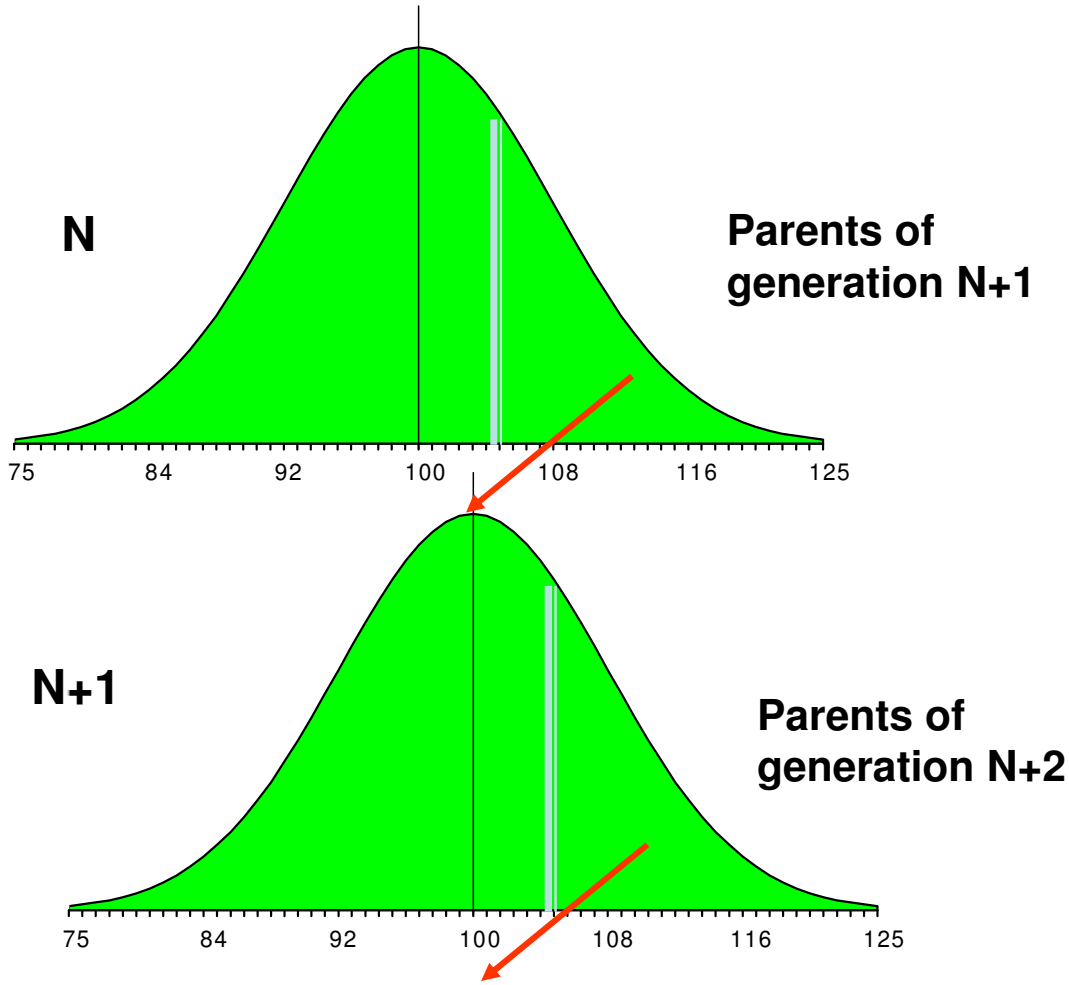
  Recorded traits are simple and synthetic: weights and volumes , measurements, dates, observations, counting, %...for milk production, fat protein contents, mastitis, fertility, carcass weight, growth capacity, feed efficiency, muscle development, scoring etc

- **Large database to calculate genetic evaluations**
- **Use of genetic variability intra breed**
- **Collective management of decision process at any step, from selection to gene distribution**

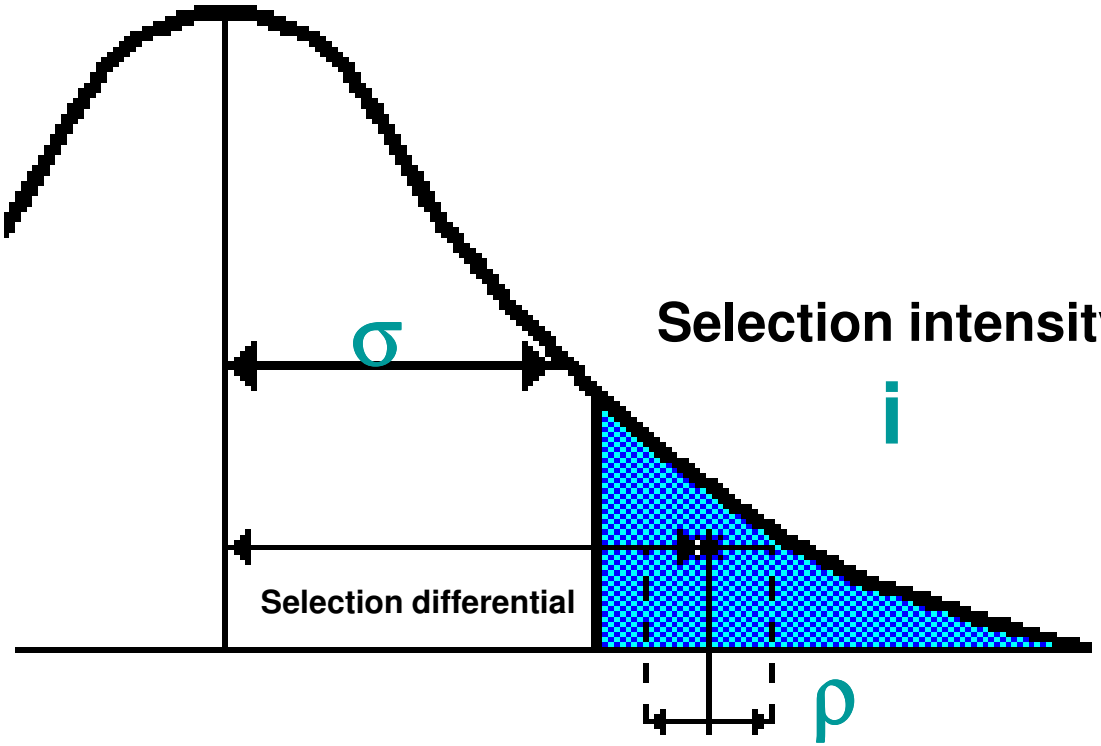
Breeding programmes, remarks :

- **Most selected traits are chosen for the benefit of farmers, that should make a living of animal production**
- **In Europe, breeding programmes are mostly run by farmers' owned organisations, AI co-operatives, breeding organisations in ruminant and partly in pig breeding.**
- **New technologies are mostly implemented through the channels of these organisations (AI, ET, IVF,MAS…) and are combined within the breeding programmes**

Genetic progress



Components of genetic progress



1. By generation

$$\Delta G = i \times r \times s$$

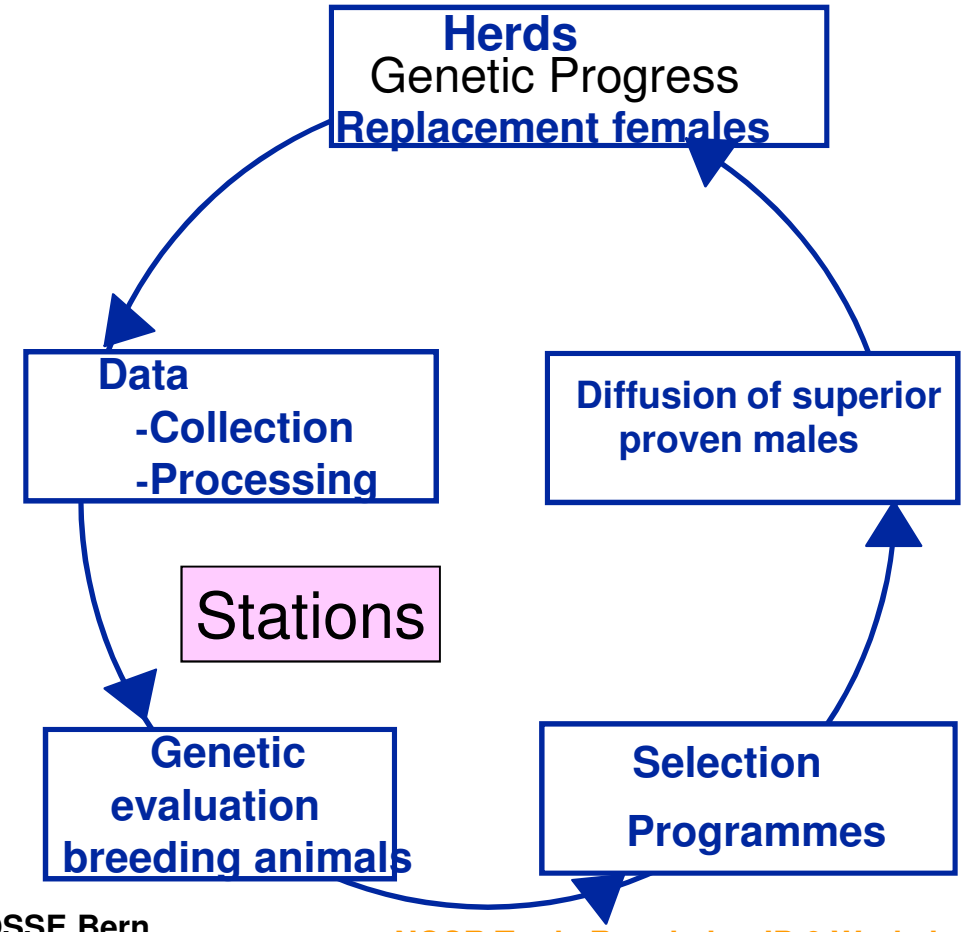
2. By year

$$\Delta G_a = (i \times r \times s) / T$$

T : Generation interval

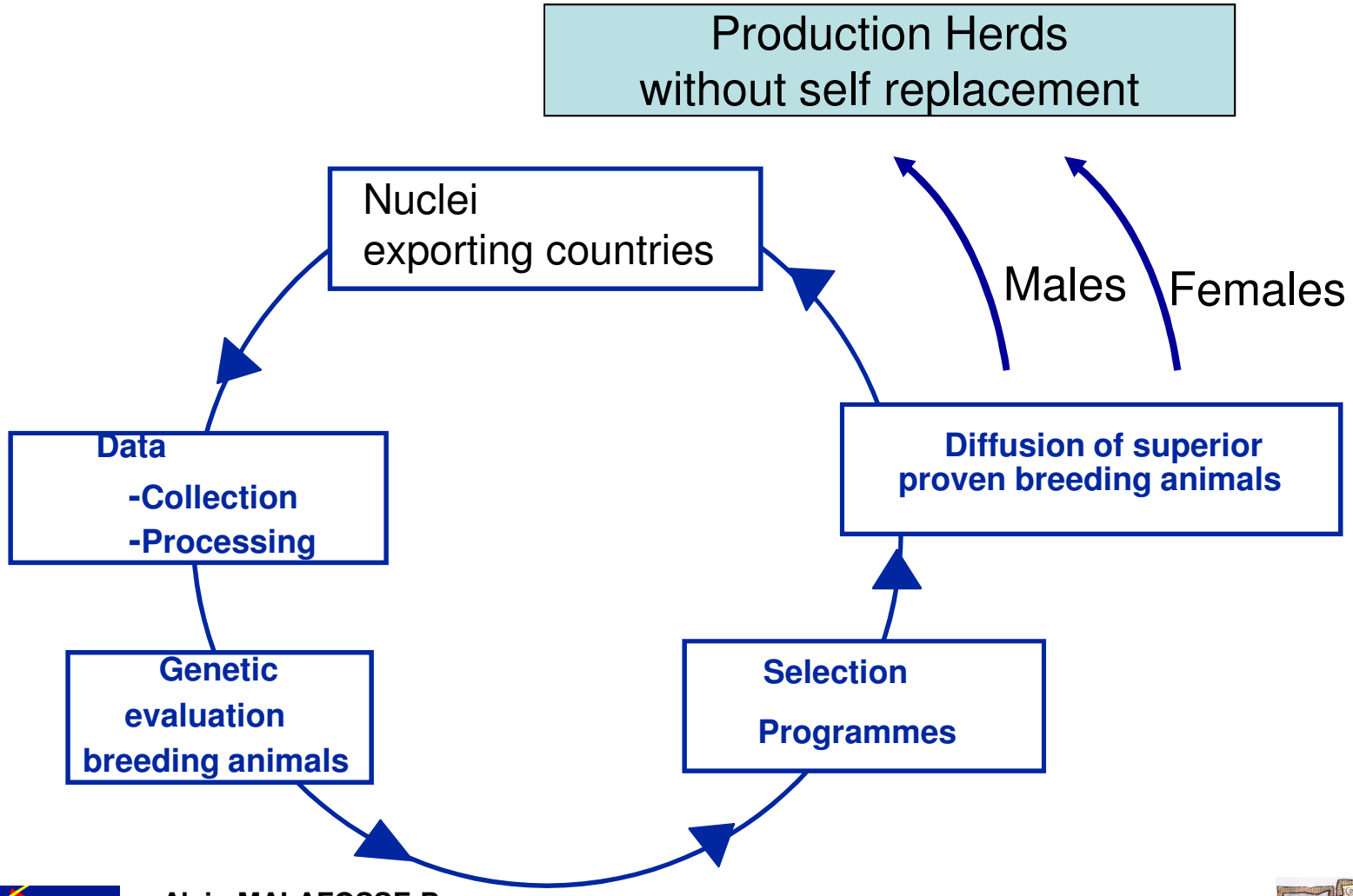
CREATION/DIFFUSION of GENETIC PROGRESS

Herd self replacement: ruminants



CREATION/DIFFUSION of GENETIC PROGRESS

Without self replacement :pigs-poultry importation, cross breeding



Short history of biotechnologies

in animal breeding (cattle) -1

Date	Technology	Use of technology
Late 30 ties	**Artificial Insemination**	**Reproduction**
Mid 60 ties	**Semen freezing**	**Progeny testing Semen exchanges**
70 ties	**Embryo transfer in vivo**	**Reproduction + Management of nucleus**
80 ties	**In vitro fertilisation**	**id**
1987	**Sexed semen:Johnson publication**	**Choice of sex calves by farmers**
05/07/1996	**Somatic cell cloning: Dolly**	**Multiplication of genomes**

Revolution !!

Short history of biotechnologies

in animal breeding (cattle) -2

Date	Technology	Use of technology
90 ties	**PCR patent**	**Development of molecular markers : microsat, mapping of genomes**
	Molecular genetics	**First programmes for QTL detection**
	Molecular genetics	**Detection of genes of interest and defects**
2001	**Marker assisted selection 1**	**Improvement of Selection programmes**
2008	**Marker assisted selection 2**	**Improvement of Selection programmes**
2008	**Genomic selection**	**Improvement of Selection programmes**

Revolution !!

Short history of biotechnologies

in animal breeding -summary

- **Improving of herd efficiency**

  - adaptation of gene make-up to economic conditions

  - new tools for breeding management (to save time,work, simplification)

- **Biotechnologies aim at :**

  - offer new services to farmers

  - offer new products

- **Biotechnologies improve efficiency of selection programmes.**

Reproduction and dissemination of genetic progress

- **To get more progeny from superior animals:**
  - *Artificial insemination*
  - *Embryo production and transfer (ET)*
  - *Cloning*
- **To choose sex of the progeny**
  - *Embryo sexing*
  - *Sperm sexing (flow cytometry)*

Artificial insemination

- **First biotechnology in animal breeding:**
  - *Implemented in any species and any type of production*
  - *Efficient, easy to implement, cheap*
  - *Vehicle of genetic progress and improving health status*

- **First tool to create genetic progress:**
  - *Planned mating to breed parents for the next generation*
  - *Progeny test and development of selection programmes*

  semen exchange

Embryo production and transfer

- **Improving female prolificacy in cattle:**
  - *5 embryos/ flush = 2.5 calves (may be repeated)*
  - *Efficiency improved by IVF (less reproduction disorders)*
  - *Instead of 1 calf/ cow/year : several scores by year*

- **To create genetic progress:**
  - *Management of nuclei to produce next generation*
  - *Improving selection intensity on dam sires*
  - *Reducing generation interval (bulls or dams from very young dams)*
  - *Improving of exchanges of genomes between countries instead of trading living animals*

- **Connexion with molecular techniques:**
  - *Embryo sexing: very accurate, good pregnancy rates*
  - *Genotyping for simple genes (gene of interest, genes defects) or for Markers Assisted Selection (early step selection)*

SCNT* Cloning: current and possible usage

- **No practical benefit at the moment**
  - **not currently applied in regular breeding programmes of production animals in EU**
- **Important options for the future**
  - **animal breeding and production take place in a global environment with an increasing role of biotechnologies**
  - **EU cannot afford to become detached from the further development**
  - **when animal cloning would be forbidden as technology support tool for animal breeding and production now, this will have an important signal function and serious consequences**
    - **Research and innovation**
    - **Competitiveness animal breeding and production Europe**

**** Somatic Cell Nuclear Transfer***

SCNT Cloning - Potential Applications

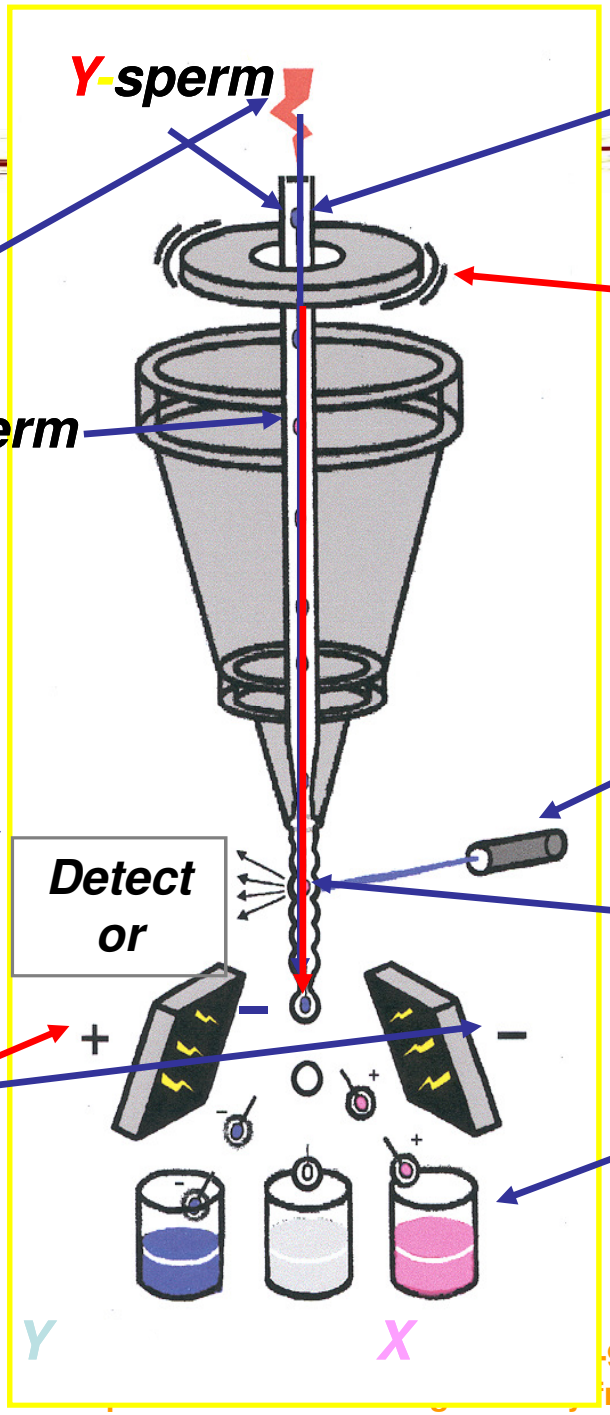
- **Research** – improving knowledge of biology
- **Insurance** – safeguarding valuable animals
- **Conservation** – increasing animal numbers
- **Biosecurity** – international trade in genetics
- **Dissemination** of improved genetics
- Niche roles in **breed improvement**

As cloning technology has significantly improved during recent years, the global use of SCNT cloning for farm animals may appear earlier than we can foresee now

Semen sexing

- To improve management of herd replacement
- To improve genetic pogress at herd level
- State of the art:
  - Sexed semen straw production:7/hour (2mil cells)
  - Waste 85% of sperm cells
  - Units contain about 90% of X sperm
  - Pregnancy rate on heifers:30% lower
- Interesting in the current situation of:
  - Lack of heifers and low prices for bull calves
  - Good milk price
  - Reasonable technical performances

SX MoFlo®



Computer

Deflection of Charged droplets

Hoechst 33342 Stained sperm

~90,000/sec

UV Laser

X sperm 4% More DNA

3 containers

Molecular genetics: practical use

- To improve quality of records thanks to markers:
  - Identification, traceability, parentages
- To eradicate gene defects
  - BLAD, CVM, Mule foot, PrP (scrappy), halothan...
- To genotype for simple genes of interest
  - Kaseïne-Kappa,Alpha S1,DGAT1,GrH,Mh,RN…
  - Color

Molecular genetics and genetic evaluation

- **Association of genome area controlling selected traits with markers (high density of SNP)**
- **Calculation of markers effects on these area (Quantitative Trait Loci) or the whole genome (Genomic selection)**
- **Calculation of early EBV* with good accuracy (combining makers effect + rest of genome)**

**** Estimated Breeding Value***

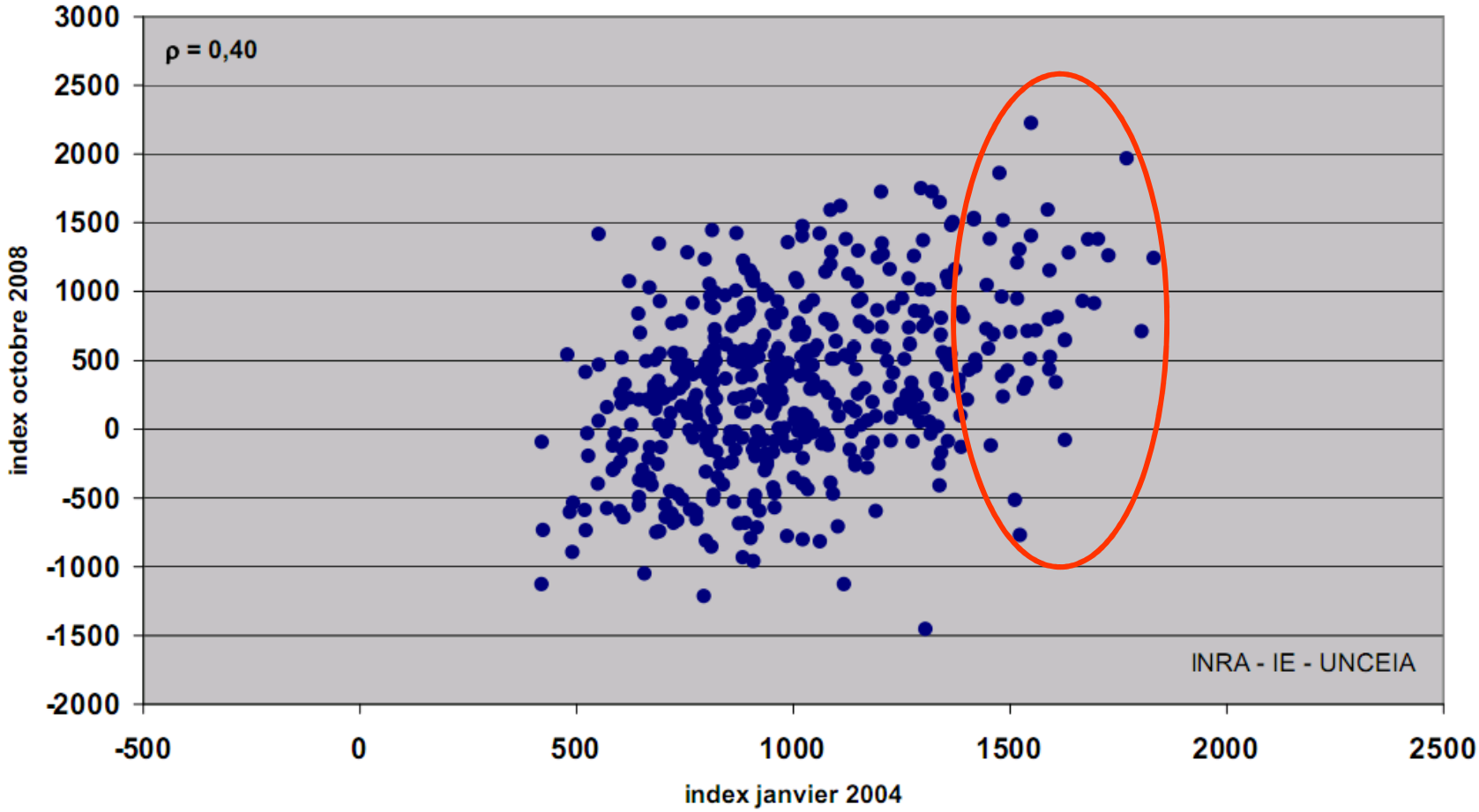
Consequences 1- on genetic evaluation

- Selection of candidates at very early stage
- Female may get an accurate EBV
- Need a continuous assessment of markers effect: genetic evaluation on farm or station is still necessary, but questions on progeny test
- Homogenous reliability between traits
- New traits* are easy to take into account

* For instance on longevity…

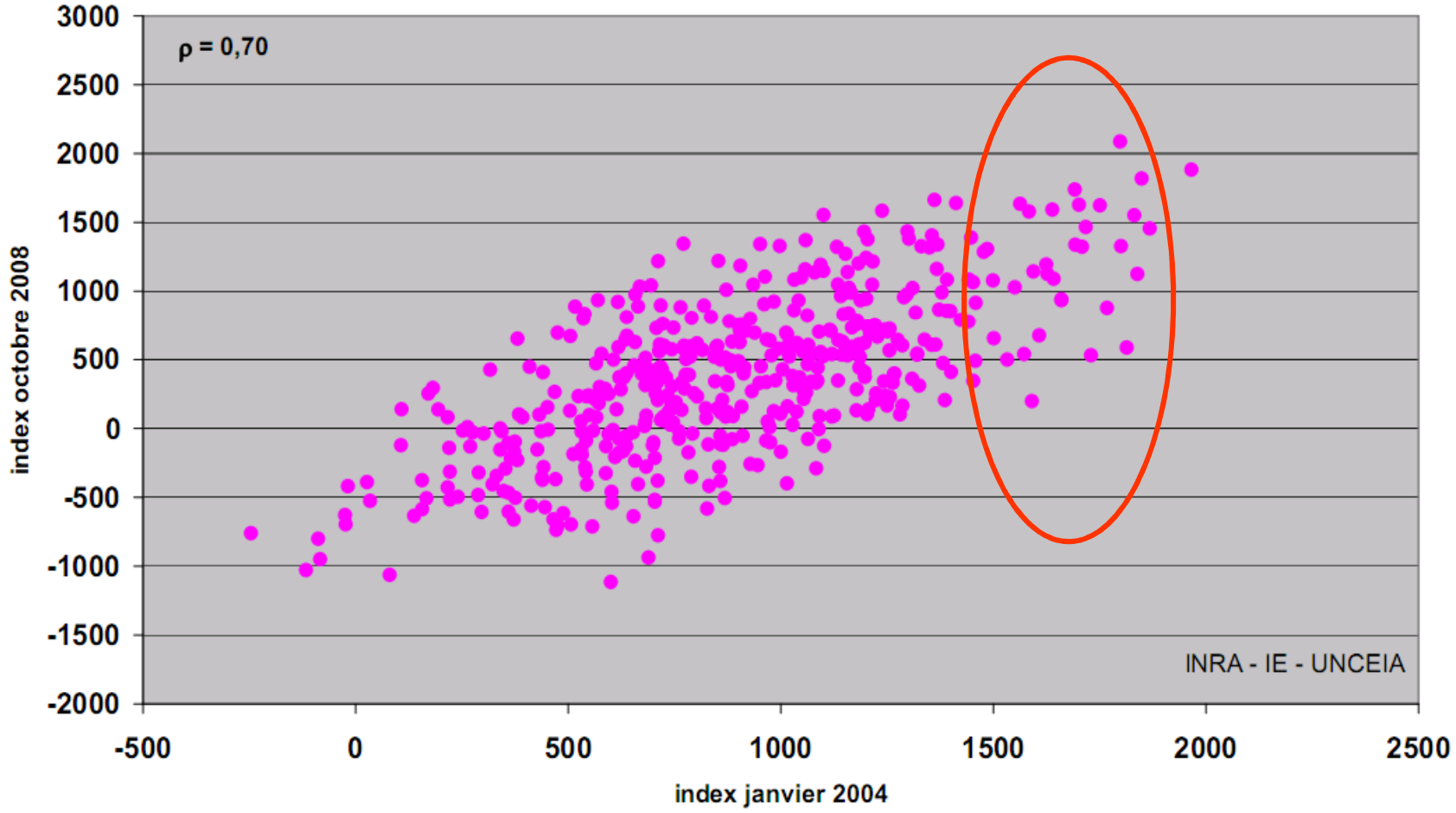
EBV Milk Holstein without markers

Reliability of EBV 2004 < 0,30



EBV Milk Holstein with markers

Reliability of EBV 2004 > 0,50



Consequences 2- on structures

- **Need to test many young candidates but test capacity is no more at stake**

- **Early EBV: possibility of use young bulls without PT**
  - ***Reducing of costs***

- **Huge changes to be expected in:**
  - **Programme structures (access to MG EBV system)**
  - **Semen diffusion-production**
  - **Import x export**

Access to gene resources

- **Ruminants: Biology: one calf per year**
  - **Obligatory involvement of many + global exchange**
  - **"Free" access to the best animals, at least to their semen or embryos**
  - **Sense of collective property of genetics**
- **Pigs-poultry: Biology: more offspring**
  - **Use of hybrid vigour + closed breeding populations**
  - **Access via "membership cooperative" or company**
    - **Pigs: via the cooperative or private company**
    - **Poultry: via private company**

May biotechnologies change these principles?

French tentative to define animal property right(1994)

- **Identified risk: jeopardising the collective traditional breeding by biotechnology providers**
  - **Patent law allows to patent genes if they are changed**
  - **GM Animals and their progeny may be patented**
  - **Breeds and their names are not protected in Europe**

Possible items for discussion

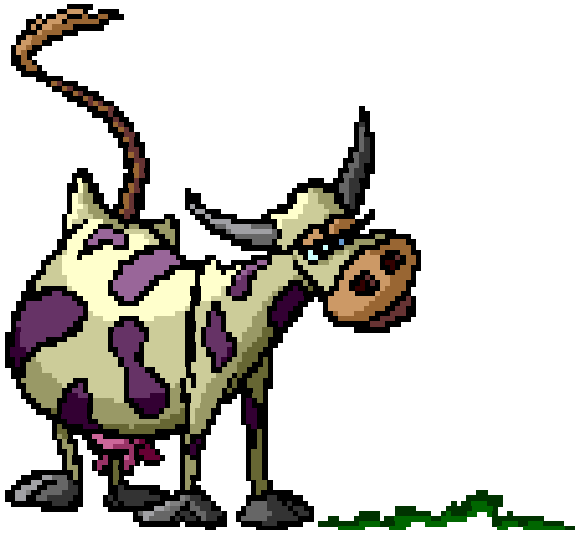
- **Animal property right (analogy with plant breeders right)**
- **Protection of Animal Selected Populations (selected by the owner of the property right, complementary to patents**
- **Right to control the use of breeding animals and of the genetic material.**

Could be an input to discuss at the EU level (biotechnology directive)

Conclusion

- **The breeding industry relays on biotechnologies to develop and to progress**
- ***It's goal is to improve animal farming operations, in simplifying farmers work and in bringing genetic progress***
- **The implementation of biotechnologies is profitable in economical terms but the first payee is the farmer**
- ***Research is essential to improve or to develop new biotechnologies***
- ***Public transparency and discussion are important***
- **Investments, mastering of research projects, intellectual property rights, maintaining knowhow, transparency, dialogue and capacity of assessing offers on the market are at stake for breeding industry**

Thank you for your attention…



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