



**INRA**  
SCIENCE & IMPACT

## **Genetics and genomics RTDI contributing to the needs of the forest-based sector**

*François Lefèvre, Inra URFM, Avignon*  
*francois.lefevre@avignon.inra.fr*



# Preliminaries

Genetics is not only genomics

At least 3 dimensions of innovation in genetics and genomics :

- (1) innovation in molecular bio-technology
- (2) innovation in related applied mathematics
- (3) innovation in the strategies to integrate these novelties in decision and management processes

(1) and (2) are going very fast, probably faster than (3)

# What genetics and genomics RTDI will do

- increase considerably the precision of the genetic characterisation and, therefore, the efficiency of breeding and conservation programmes
- progressively extend our genetic management capacity from a limited number of model species to any forest tree species
- help understand and manage evolutionary processes to improve sustainable forest management in the long term

# What genetics and genomics RTDI will NOT do

- simplify the complexity of biology or eliminate uncertainty
- make the development of a clever new genotype faster than the development of a clever new machine or new process

# Genetics and genomics RTDI outcome

- better knowledge of the global genetic diversity (« neutral ») and organisation of the genomes
- direct access to targetted genes (« adaptive »), their functions and expression patterns  
=> integrates with functional ecology
- knowledge on the evolutionary processes and drivers (drift, bottleneck, admixture, hybridisation, dispersal, selection...) at different time scale (ancient, current)  
=> integrates with ecology and forest management

# Needs of the forest-based sector

To improve the provision of timber and non-timber forest products in a sustainable way, in the context of climate change, global change, and related uncertainties,

adaptive (innovative) forest management is required, combining :

1) short-term perspective : rationalize the exploitation of current genetic resources, speed-up the selection process thus allowing faster turnover of selected material

2) long-term perspective : a dynamic view allowing for flexibility to cope with uncertainties

# Needs of the forest-based sector

To improve the provision of timber and non-timber forest products in a sustainable way, in the context of climate change, global change, and related uncertainties,

adaptive (innovative) forest management is required, combining :

1) short-term perspective : rationalize the exploitation of current genetic resources, speed-up the selection process thus allowing faster turnover of selected material

=> contribution of genetics / genomics RTDI to selection *sensu stricto*

2) long-term perspective : a dynamic view allowing for flexibility to cope with uncertainties

=> contribution of genetics / genomics RTDI to breeding, conservation and use of genetic resources, natural regeneration systems

# Contribution of genetics and genomics RTDI to : breeding programmes

Breeding = short-term genetic gain & long-term response to selection

From selection to marker-aided selection and to genomic selection, the extended genetic knowledge will contribute to :

- more accurate estimation of genetic parameters and breeding values (kinship estimates)
- optimized phenotyping strategy and shorter selection process
- increased selection intensity on targetted genes while raising-up non-target diversity
- better exploitation of non-additive effects
- better characterization and management of GxE



# Contribution of genetics and genomics RTDI to : genetic resources (FGR) conservation and use

FGR conservation = component of sustainable forest management and biodiversity conservation

The extended genetic knowledge will contribute to :

- standard genetic characterisation of global and targetted diversity in conserved or candidate FGR
- rationalized *ex situ* conservation (core-collections)
- monitoring dynamic conservation *in situ* or *ex situ*
- localisation and prospecting of targetted diversity
- optimized and faster introgression of interesting genes (genome sectors) in elite gene pool

# Contribution of genetics and genomics RTDI to : natural regeneration systems

Evolution-oriented forestry = a new concept of adaptive management systems fostering local evolution while conserving genetic diversity.

The extended genetic knowledge will contribute to :

- characterisation of the genetic diversity and its organisation to define evolutionary objectives and related forestry practice
- monitoring the impact of practices on the drivers of genetic changes (drift, mating system, selection)
- rationalized genetic enrichment of the local resource by introduction of a limited amount of selected material
- marker assisted selective thinning

# To increase impact of genetics and genomics RTDI

Keep on with the 3 dimensions of innovation :

- (1) innovation in molecular bio-technology
- (2) innovation in related applied mathematics
- (3) innovation in the strategies to integrate these novelties in decision and management processes

automatization, reduction of costs, analytical pipelines

spread access to these innovations in the scientific community,  
diversify studied species

computing resources become an issue

support interdisciplinary integration and training to develop (3)

# Some general references

Ekblom & Galindo (2011) Applications of next generation sequencing in molecular ecology of non-model organisms. *Heredity* 107:1-15

Neale & Kremer (2011) Forest tree genomics: growing resources and applications. *Nature Review Genetics* 12:111-122

Rockman (2012) The QTN program and the alleles that matter for evolution: all that's gold does not glitter. *Evolution* 66:1–17

Lefèvre et al. (2013) Considering evolutionary processes in adaptive forestry. *Annals of Forest Science* DOI 10.1007/s13595-013-0272-1