

SABRE



CUTTING EDGE GENOMICS FOR SUSTAINABLE ANIMAL BREEDING

An Overview of SABRE

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Food Quality and Safety



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Outline

- Background
 - Sustainable livestock production
 - The scientific context
- Objectives
- Structure
- Delivery



EU Animal Production

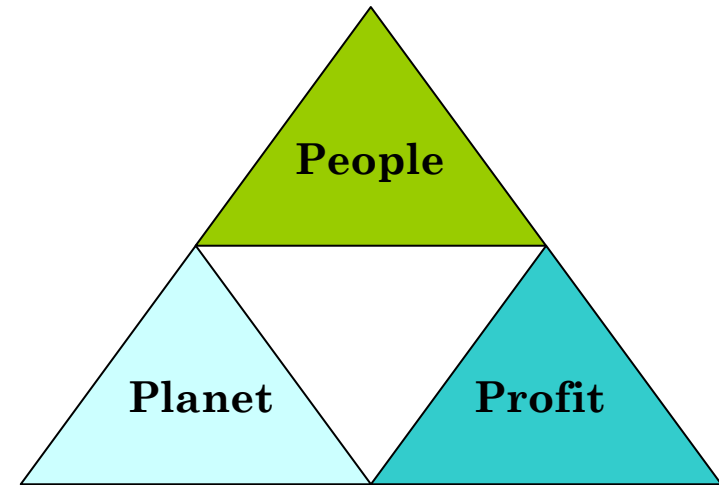
- 43 million tonnes of meat
- 147 million tonnes of milk
- 6.3 million tonnes of eggs
- 5.4 million tonnes of fish (EU-15)
- Total ex-farm value €132 billion
- **FABRE Technology Platform estimates the annual progress from breed improvement to be worth about €1.8 billion**



What Do We Mean by Sustainability?

‘Development that meets the needs of the present without compromising the ability of future generations to meet their own needs’

Brundtland’s definition of Sustainability, Report of the World Commission on Environment and Development, 1987



Sustainability Issues

- Animal Welfare
- Animal Health
- Environmental Footprint
 - Water
 - Greenhouse gases and ammonia
 - Odour nuisance
 - Landscape
- Biodiversity
- Zoonoses
- Profit
 - Cost of production
 - Value of output
 - Quality
 - Nutritional Value
 - Distinctiveness
 - Supply & Demand

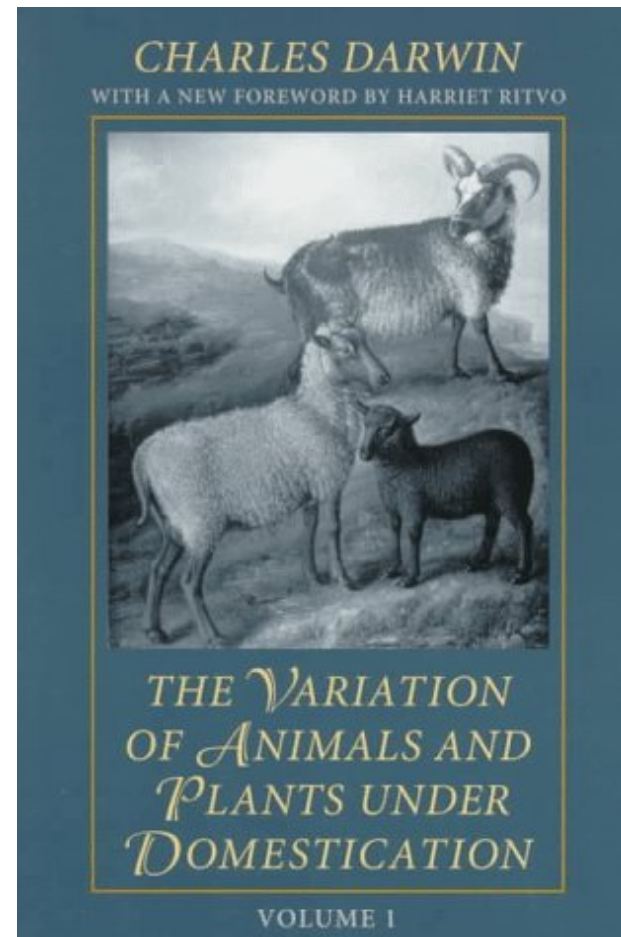


Global demand for animal products growing steadily



We Have Been Selecting for the Traits That Suit Human Needs Since Domestication

- Dog 13000BC
- Sheep 9000BC
- Pig 6000BC
- Cow 6000BC
- Chicken 3500BC
- Reindeer 1000BC
- Salmon 1970's
- Cod Now



Johns Hopkins University Press

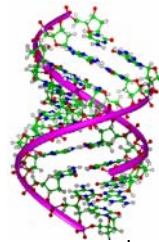


A Chronology



1800s
Formation
of herdbooks

1906
"Genetics"

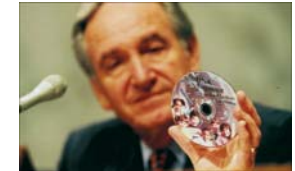


1953
Watson and
Crick



1977
DNA
sequenced

1991
'Halothane'
gene test



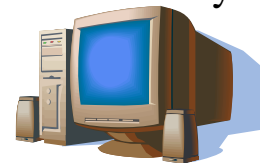
2003
Human
Genome
sequenced

1865/6
Mendel



1920s and 30s
Fisher, Lush
and others
Population
genetics

1970s +
Advances in
quantitative
analysis



2004
Chicken
genome
sequenced



Very Significant Progress

Species	Trait	Indicative Performance		
		1960s	Present	% Change
Pigs	Pigs weaned /sow/year	14	21	50
	Lean %	40	55	37
	Kg lean meat/tonne feed	85	170	100
Broiler chickens	Days to 2 Kg	100	40	60
	Feed conversion ratio	3.0	1.7	43
Layer hens	Eggs per year	230	300	30
	Eggs/tonne feed	5000	9000	80
Dairy cows	Milk/cow/lactation (Kg)	6000	10000	67



Modified from van der Steen, Prall and Plastow, 2005 J. Anim Sci 83

Selective Breeding is a Powerful Tool



Photo courtesy of Roslin Institute



Breeders Now Have More Balanced Breeding Goals

- Traditional breeding goals

- Growth
- Yield
- Efficiency
- (Quality)

- Current and near future breeding goals

- Growth
- Yield
- Efficiency
- Fertility
- Fitness
- Food quality
- Food safety
- Disease resistance
- Welfare
- Robustness
- Behaviour
- Managing diversity

A role for genomics




Priority 5 – Food Quality and Safety 3rd Call - Area T5.4.6 of *'delivering safer, healthier nutritious, functional and varied foodstuffs'*

- First Consortium meeting May 2004
- Outline submission October 2004
- Full submission February 2005
- Selection for funding June 2005
- Project start date 1 April 2006
- End date 31 March 2010



SABRE

CUTTING EDGE GENOMICS FOR SUSTAINABLE
ANIMAL BREEDING



Project Rationale

New Genomic Tools

- Genome sequence
- SNP panels
- Affordable high-throughput genotyping
- Expression arrays
- Improved bioinformatics

Breeding for Sustainability Goals

Food Quality

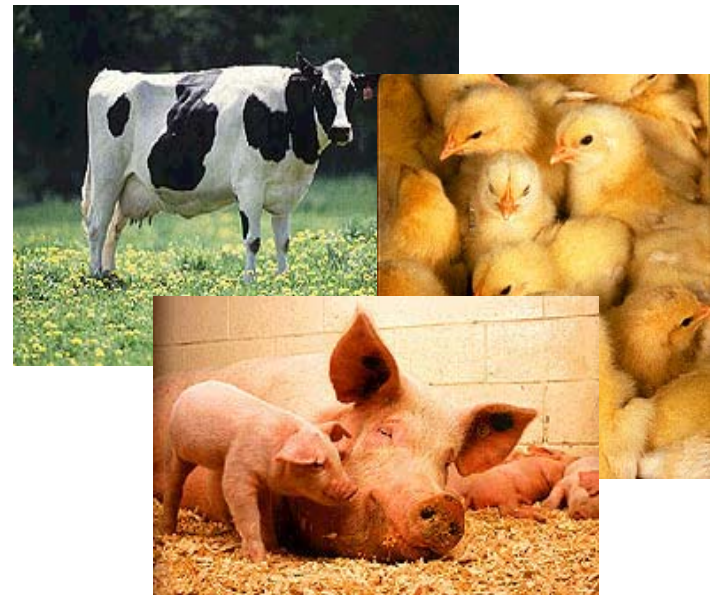
Economic Sustainability

Food Safety

Environmental Sustainability

Animal Well-being

Biodiversity



High-Level Objectives

To provide the fundamental knowledge of the genomics and epigenetics of animal health, food safety and food quality traits of livestock species, together with the necessary selection technologies, such that breeders can re-focus animal breeding and production towards more sustainable, environmentally friendly, low input systems that deliver safe and high quality foods.



The Big Picture

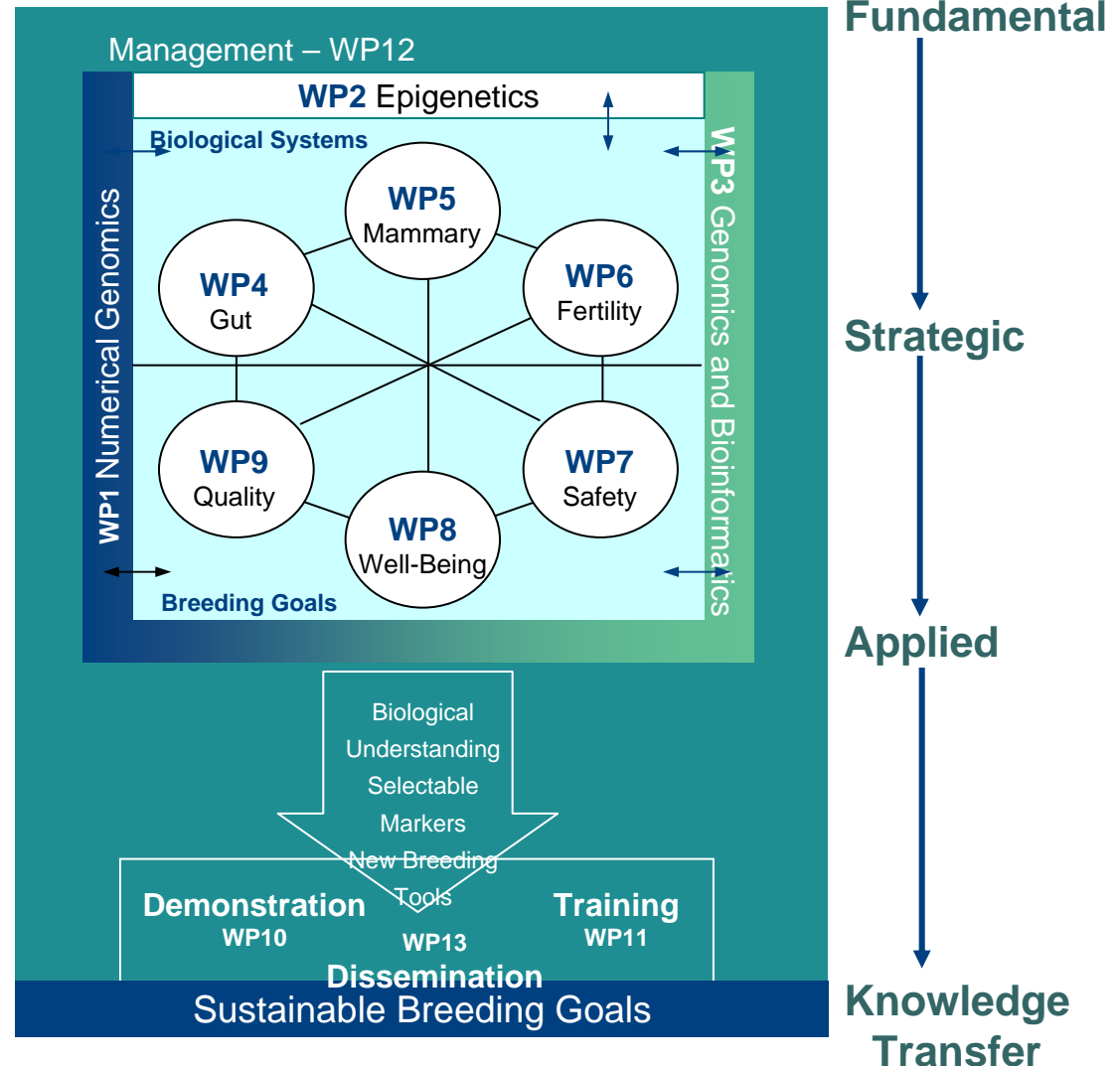
4-year project

33 partners
from 14 countries

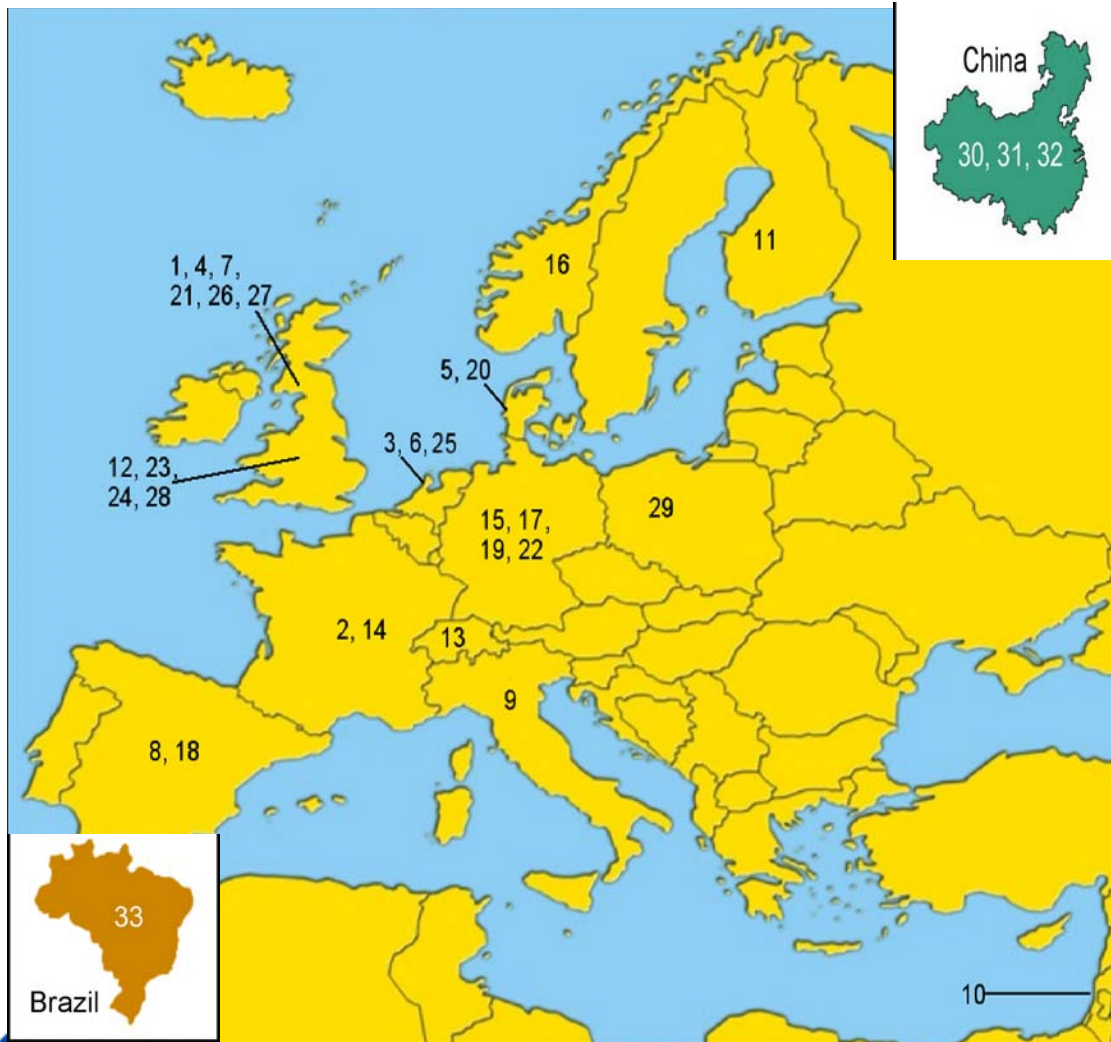
€13.9m grant
Total value > €23m

205 person years
of effort

Main Species:
Cattle
Pigs
Poultry



33 Partners from 14 Countries



Participants:

1. Genesis Faraday Partnership
2. Institut National de la Recherche Agronomique
3. ID-Lelystad
4. Roslin Institute
5. Danish Institute of Agricultural Sciences
6. Wageningen University
7. Argentix Ltd
8. Cordoba University
9. Parco Tecnologico Padano
10. Agricultural Research Organization, The Volcani Center
11. MTT Agrifood Research Finland
12. Genus plc
13. University of Berne
14. CNRS-UPR
15. Research Institute for the Biology of Farm Animals, FBN-Dummerstorf
16. Agricultural University of Norway
17. University of Bonn
18. Institut De Recerca I Tecnologia Agroalimentaries
19. Lohmann Tierzucht
20. The Royal Veterinary and Agricultural University
21. University of Glasgow
22. University of Munich
23. Cogent Ltd
24. Sanger Institute
25. Institute for Pig Genetics
26. BioBest Ltd
27. Scottish Agricultural College
28. Institute for Animal Health
29. University of Medical Sciences Poznan
30. JiangXi Agricultural University
31. Zhejiang University
32. China Agricultural University
33. Universidade Federal De Viscosa

Underpinning Science

- **WP1 Numerical Genomics**
 - Tools for dissecting complex traits
 - Combining QTL and gene expression results
 - Tools for marker-assisted, gene-assisted and genomic selection
 - Data analysis with other WP
- **WP2 Epigenetics**
 - Global epigenetic modifications and variability of phenotype
 - Characterisation of imprinted QTL loci
 - Late foetal growth and epigenetic contribution
 - Chromatin organisation and nuclear differentiation
- **WP3 Genomics and Bioinformatics**
 - High quality-sequence and annotation of 2 target pig chromosomes
 - SNP mining, validation and information
 - Generate Linkage Disequilibrium and gene conservation maps
 - Develop ontologies of phenotypes
 - Supply pathway data to annotate transcriptomics results



Biological Systems

- **WP4 Gut health and functionality (chicken and pigs)**
 - Analysis of response variation (bacteria and parasites)
 - QTL and fine mapping on resource populations
 - Integration of data
 - Genetic variation
- **WP5 Mammary Function (dairy cows)**
 - Refinement of mastitis QTL
 - Expression studies of challenged animals
 - SNP associations
- **WP6 Fertility and Reproduction (dairy cattle and sheep)**
 - Transcriptome analysis of neuro-endocrine regulation
 - Transcriptome analysis of ovarian follicles and of preimplantation embryos
 - Identification of SNPs
 - Identification of a segregating QTL on BTA7
 - Association studies to validate selected SNPs
 - Phenotype ontology of reproductive functions



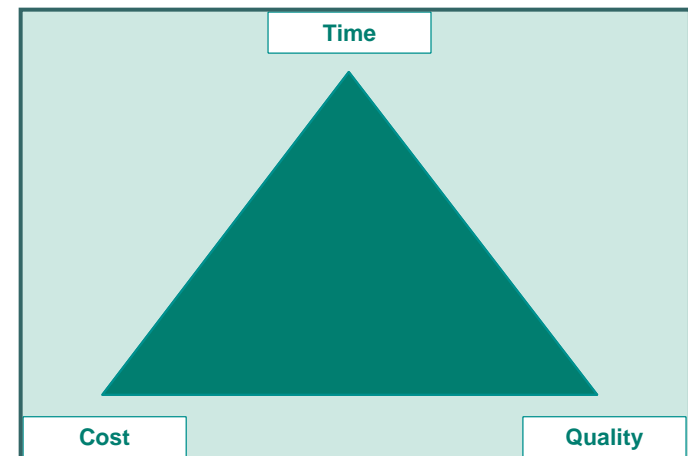
Breeding Goals

- **WP7 Product Safety (eggshell quality)**
 - Fine mapping of QTL in resource populations
 - SNP genotyping of potential QTL in a commercial population
 - Gene expression studies in extreme QTL populations
- **WP8 Animal Well-Being (pigs and poultry)**
 - Investigation of molecular mechanisms influencing adrenal sensitivity to ACTH
 - Behavioural reactivity and meat quality, relationship to gene expression pattern in pigs
- **WP9 Product Quality (boar taint)**
 - Genome-wide QTL/association study
 - Transcriptome analysis using cDNA-microarray analysis
 - Proteome analysis using quantitative LC/LC- MS/MS analyses
 - Fine-mapping of candidate regions, integration of genome, proteome and transcriptome data
 - Confirmation of selected SNPs in large-scale study



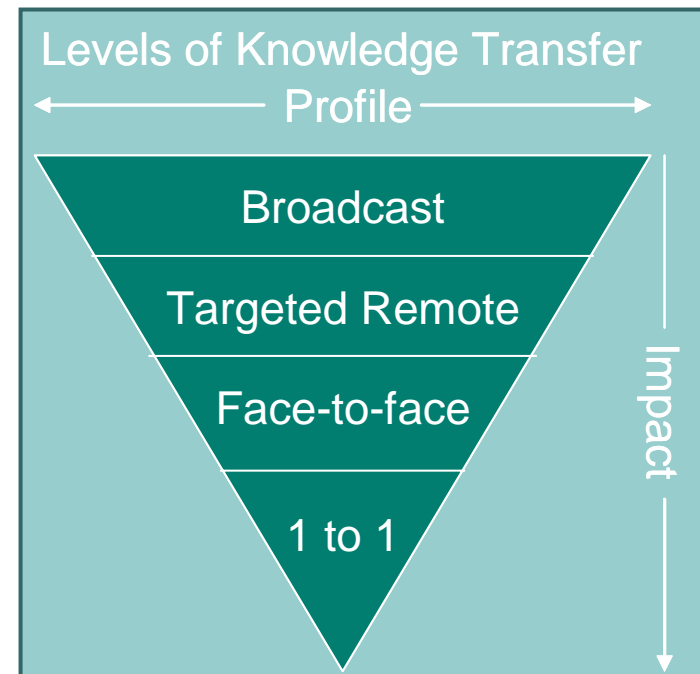
Knowledge Transfer

- **WP10 Demonstration**
 - Genomic selection in action
 - Allele frequencies, biodiversity and production systems
 - Impact of selection on Mucin4 SNP
 - Technology Translation with end-users
- **WP11 Training**
 - Transfer of knowledge within the IP
 - Genomics training including new Member States and INCO Countries
 - Training industry to use the new selection tools delivered
 - Provision of Early Stage Training
- **WP12 Management**
 - Monitoring and reporting
 - Finances, IPR, Ethics, Risk management
 - Gender Action Plan
 - Public Engagement Plan
- **WP13 Dissemination**



WP13 Dissemination

- **Broadcast**
 - Publications
 - Press events and articles
 - www.sabre-eu.eu
- **Targeted remote communication**
 - Newsletter
- **Face-to-face technology interaction**
 - Demonstration
 - Training and workshops
 - Annual conference
- **One-to-one technology translation**



Impact on Many Aspect of Sustainability

Impact of Work Packages by Aspects of the Call * = some impact ** = major impact		Aspects of the call T5.4.6.3									
		Fundamental Genomics	Re-focus animal breeding	Food Quality	Food Safety	Animal Welfare	Environmental impact	Reduced Inputs	Competitiveness	Biodiversity	INCO target Countries
WP1	Numerical Genomics	*	**	*	*	*	*	*	*	*	*
WP2	Epigenetics	**	*	*	*	*	*	*	*	*	
WP3	Bioinformatics	**	*	*	*	*	*	*	*	**	*
WP4	Gut	*	*		**	**	**	**	**	*	*
WP5	Mammary	*	**	*		*	*	*	**	*	
WP6	Fertility – Cows	*	**			*	**	*	**	*	
WP7	Safety – Eggs		*	*	**		*	*	**	*	
WP8	Well-being	*	**	*	*	**			*	*	*
WP9	Quality - Taint		*	**		**	**	**	**		**
WP10	Demonstration		**	*		*	**	*	**	**	*
WP11	Training	*	**	*	*	*	*	*	**	*	*
WP12	Management	*	*	*	*	*	*	*	*	*	*
WP13	Dissemination	*	**	*	*	*	*	*	**	*	*



Deliverables

- **BASIC** - Fundamental biological knowledge related to structural genomics, epigenetics, functional genomics, transcriptomics and metabolomics and improved theory of operational genomics and genetics
- **STRATEGIC** - Identified genomic regions and pathways relevant to traits. Synthesis of knowledge on relationships between traits and how to balance selection objectives into sustainable strategies
- **APPLIED** - New selectable genetic markers or identified causative polymorphisms and new statistical breeding tools



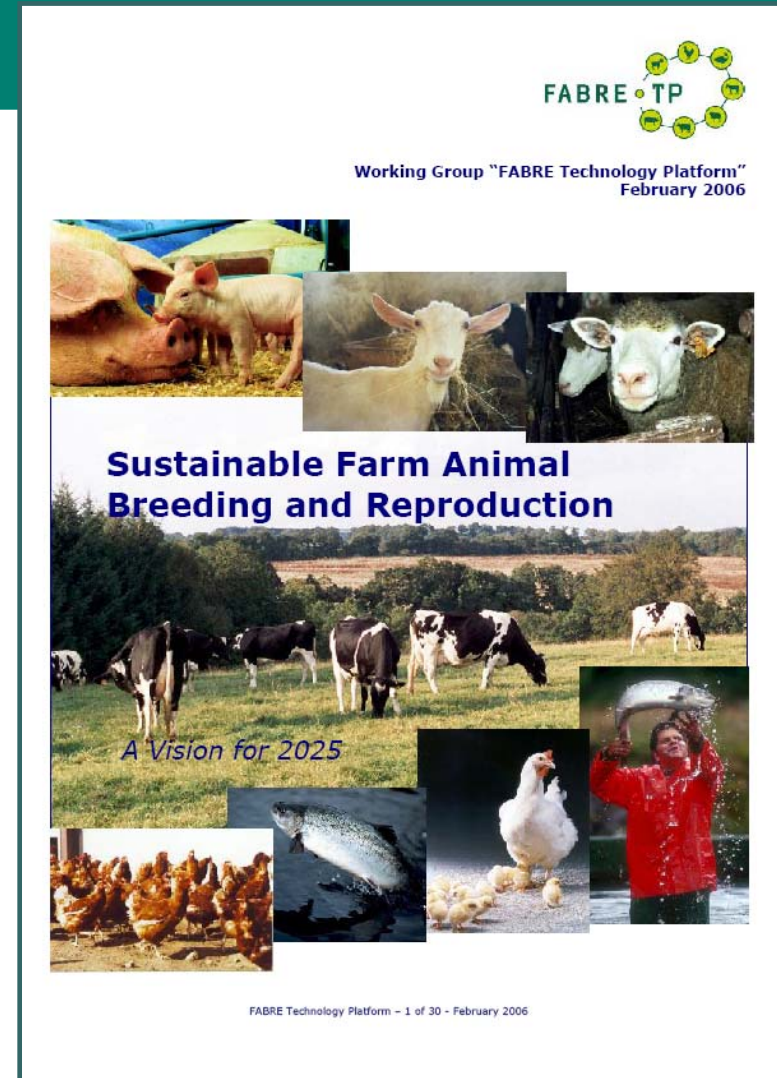
Practical Illustrations of Potential Deliverables

Output Level	Time Horizon	Illustrative Benefit	Potential Value
Basic	> 5 Year	10% fewer mastitis cases would mean better animal welfare and less use of antibiotics	€163m/yr
Strategic	2-5 Years	10% reduction in zoonotic infection of humans from pigs and poultry would mean reduced employment and healthcare costs	€445m/yr
Applied	<2 years	A genetic solution to boar taint with 50% uptake would mean 50 million fewer pigs per year castrated. Improved welfare and reduced environmental footprint	€171m/yr



A vision for 2025

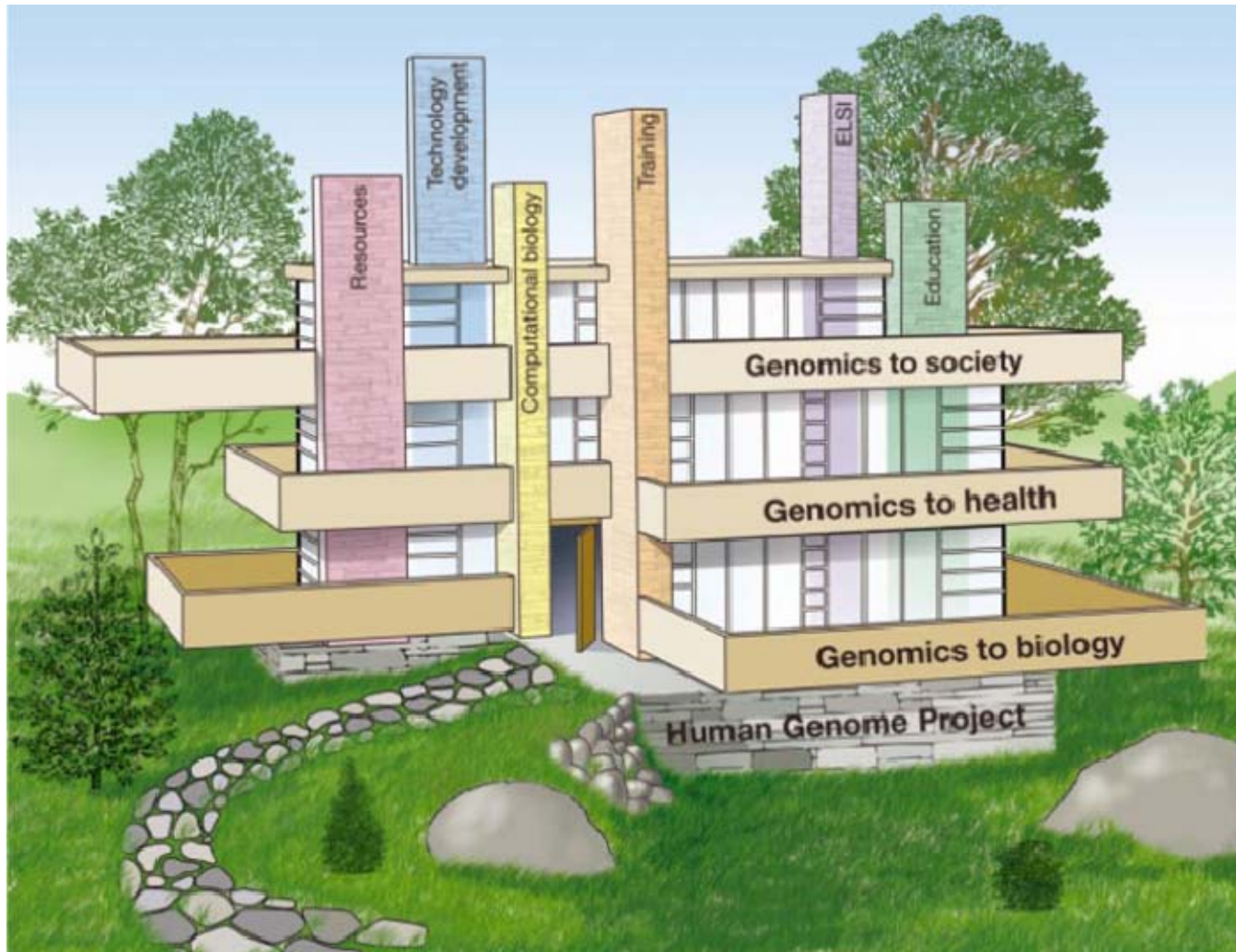
- Safe and Healthy Food
- Robust, Adapted Healthy Animals
- Balanced Breeding and Biodiversity
- Social Responsibility
- A Competitive Europe
- A Distinctive Europe
- A Diversity of Benefits



www.fabretp.org



Francis Collins' 2004 Nature Paper

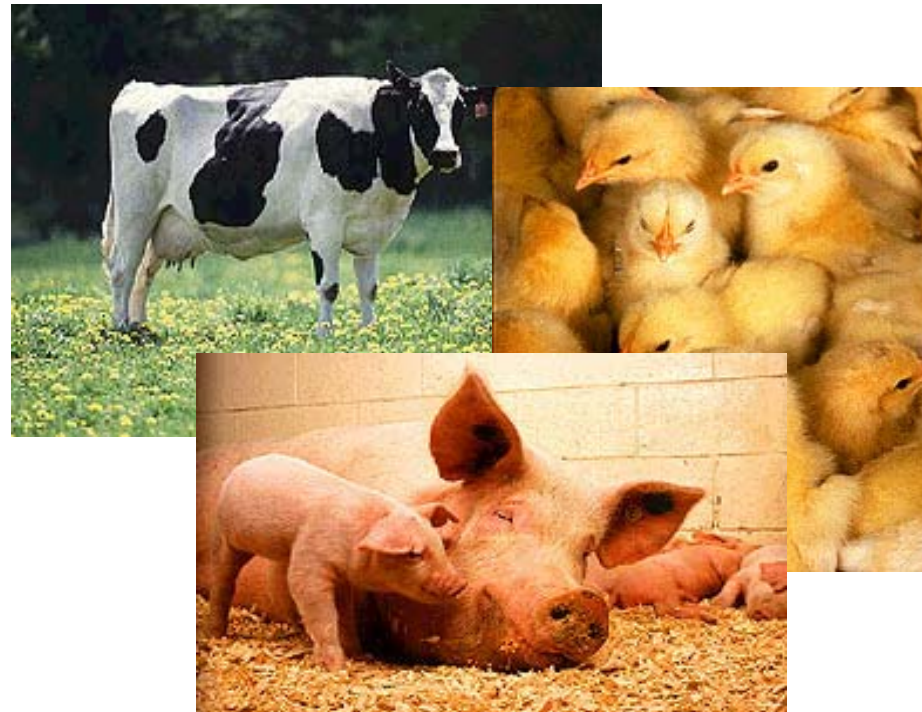


Acknowledgments

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Thank You for Your Attention



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