
Animal Genetic Resources

Conservation-Breeding-Regulatory framework

GRIP course Uppsala – May 15, 2012

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Centre for Genetic Resources, the Netherlands

Introduce myself



- MSc – Wageningen University – Animal Breeding
- Head Animal Genetic Resources at Centre for Genetic Resources, the Netherlands
- Animal Sciences Group of Wageningen University and Research Centre
- Project development, program management, policy advice, international projects

Centre for Genetic Resources, the Netherlands

- Plant Genetic Resources
- Forest Genetic Resources
- **Animal Genetic Resources**



- Statutory research tasks for government/Ministry of Agriculture
- 5 year program
- Special unit/programme within Wageningen University and Research Centre
- www.cgn.wur.nl

Current activities CGN-Animal Genetic Resources

- *Ex situ* conservation
 - Gene bank semen (and embryo/oocyte) collections
- Support for *in situ* management
 - small populations of Dutch origin
 - minimising inbreeding rates
 - use of gene bank germplasm
- Policy advice
- National Focal Point
- Supportive research
 - Cryobiology and conservation genetics/genomics



Our team working on AnGR

Gene bank, Policy advice, Conservation/breeding, Research



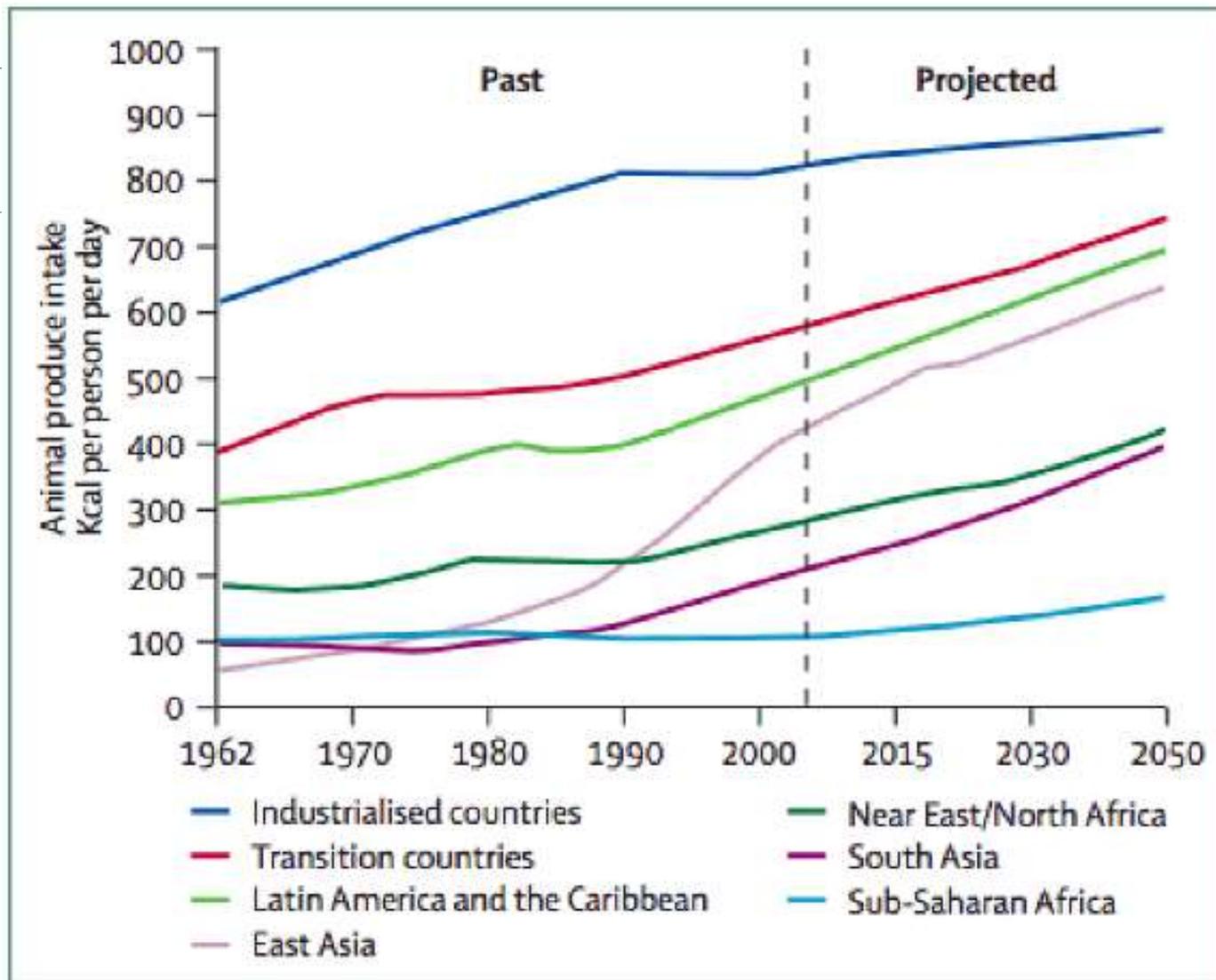
Presentation Outline

- Global perspective and state of AnGR
- Breeding principles - plants versus animals
- Conservation strategies
- Global exchange patterns of AnGR
- Policy and regulatory framework

Global perspective and state of AnGR

Global perspective - AnGR for sustainable food production

- Livestock play important roles in the production of food and for other purposes.
- The diversified use of livestock on average contributes to between 10% and 50% of the gross domestic product (GDP) of countries in the tropical developing world.
- About 70% of the world's rural poor depend on livestock for their livelihood (FAO, 2005a).
- Livestock, therefore, are of great socio-economic and cultural value in various societies around the world.



Trends in consumption of livestock products per person in different regions.
 Source: McMichael et al. (2007).

Global perspective - AnGR for sustainable food production (continued)

- Need for a livestock revolution in the developing world to double the current meat and milk consumption in these countries over the next 20 years.
- The potential of indigenous breeds in developing countries is often inadequately documented and inadequately utilized.
- Yet the most efficient way to sustain a breed is to continuously keep it commercially competitive or culturally viable.
- Important to implement sustainable breeding strategies and conservation strategies in the developing world

Biodiversity and Genetic diversity

- The Number, Variety and Variability of Living Organisms
- *Three levels: Genes, Species and Ecosystems*
- *Genetic diversity* represents the heritable variation within and between *populations* of organisms.
- The genetic diversity ultimately resides in the variations in the sequence of the four base pairs which, as components of nucleic acids, constitute the genetic code.
- New genetic variation arises in individuals by gene and chromosome mutations and, in organisms with sexual reproduction, is spread through the population by recombination.

Animal genetic resources: what to conserve?

Populations
Breeds



Semen
Embryos
Oocytes



DNA



Eco/production systems

Variation within and
between breeds

The definition of a breed (Woolliams and Toro, 2007)

In a study of the literature Woolliams and Toro (2007) concluded that the question “What is a breed?” is a simple question but difficult to answer. They found the following published definitions from a variety of groups, each relevant and pertinent to their particular stakeholders:

- i. *“Animals that, through selection and breeding, have come to resemble one another and pass those traits uniformly to their offspring.”*
- ii. *“A breed is a group of domestic cats (subspecies felis catus) that the governing body of (the Cat Fanciers Association) has agreed to recognize as such. A breed must have distinguishing features that set it apart from all other breeds.”*
- iii. *“A race or variety of men or other animals (or of plants), perpetuating its special or distinctive characteristics by inheritance.”*
- iv. *“Race, stock; strain; a line of descendants perpetuating particular hereditary qualities.”*
- v. *“Either a sub-specific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species, or a group for which geographical and/or cultural separation from phenotypically separate groups has led to acceptance of its separate identity.”*
- vi. *“A breed is a group of domestic animals, termed such by common consent of the breeders, ... a term which arose among breeders of livestock, created one might say, for their own use, and no one is warranted in assigning to this word a scientific definition and in calling the breeders wrong when they deviate from the formulated definition. It is their word and the breeders’ common usage is what we must accept as the correct definition.”*
- vii. *“A breed is a breed if enough people say it is.”*

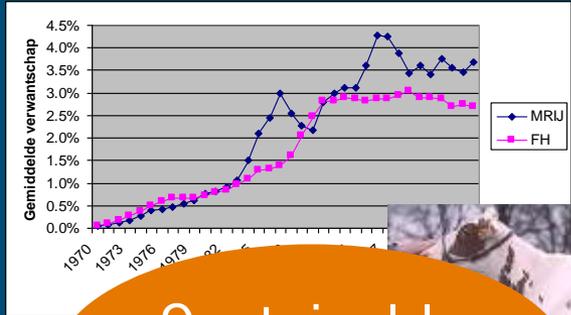
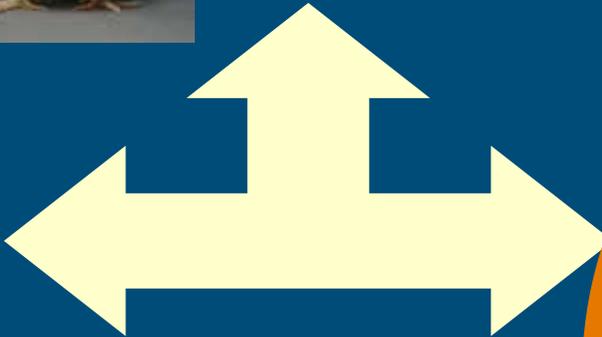
Continuing definition (v) (FAO, 2007), FAO argue that breed is very often a cultural term and should be respected as such, a perspective clearly articulated in definition (vi), and succinctly summarized in (vii).

Why genetic diversity/AnGR conservation important?



Global Food Security

Specific roles and functions
Cultural heritage



Sustainable Breeding

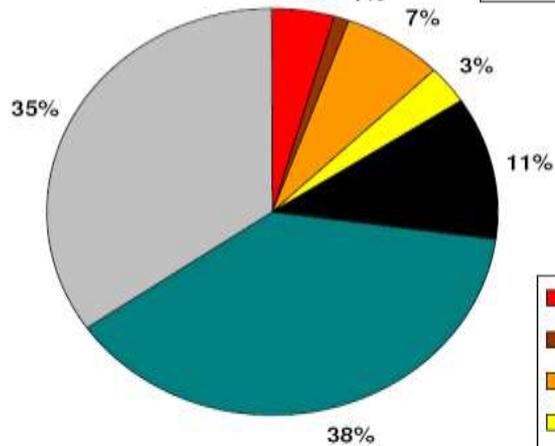
Use of Animal Genetic Resources: The Facts

- Global farm animal genetic diversity – between and within breed diversity – is under pressure
 - Globally 1/3 of breeds are categorized ‘at risk’
 - Many breeds have limited within-breed genetic diversity
- Major drivers of change
 - Globalization
 - Intensification
 - Horizontal and vertical integration
 - Decoupling of animal husbandry from surrounding natural environmental conditions
- AnGR (still) have many different functions and values
 - Crucial for future food security

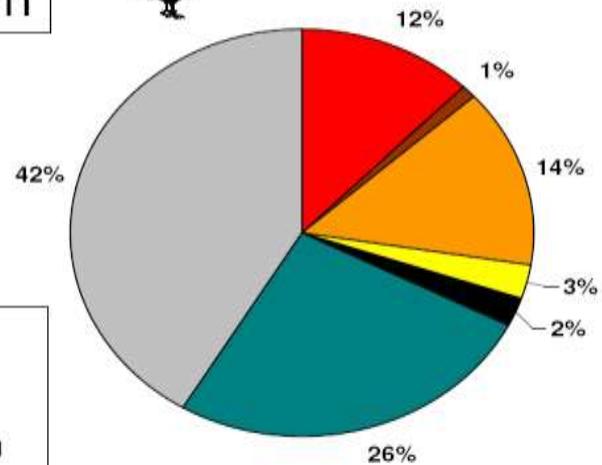


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Risk Status - the global picture



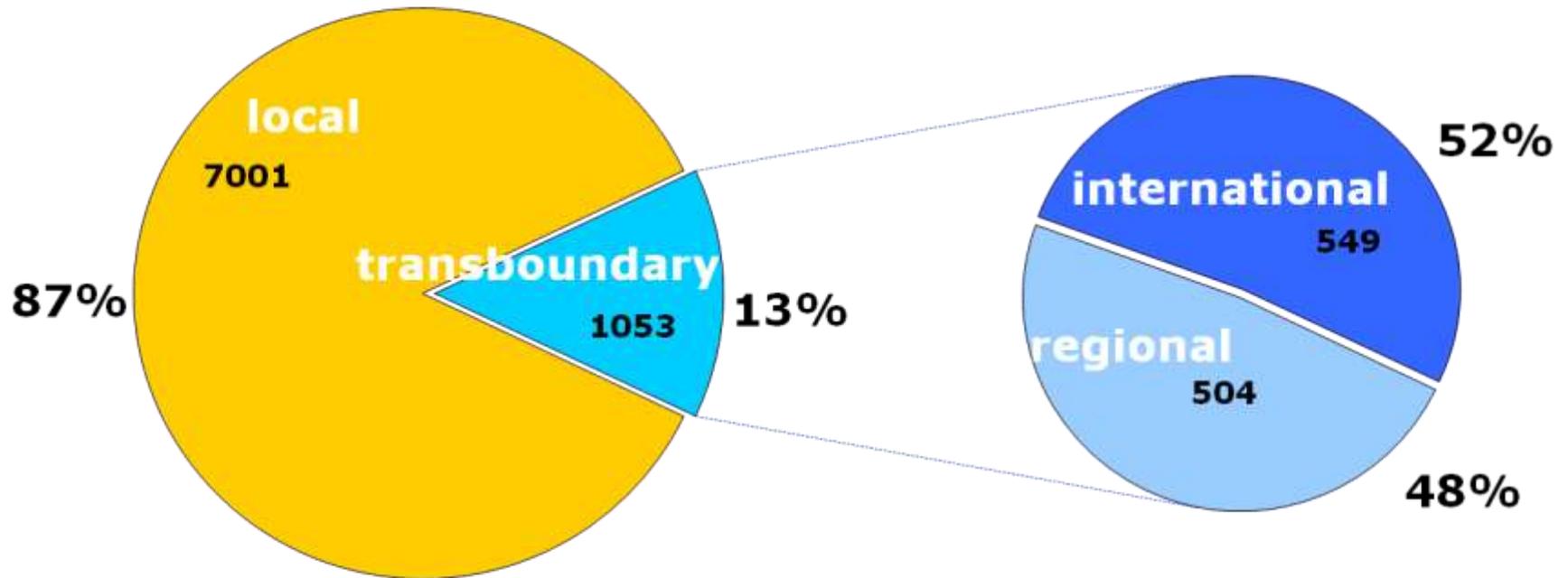
20% at risk
30% unknown



- critical
- critical-maintained
- endangered
- endangered-maintained
- extinct
- not at risk
- unknown

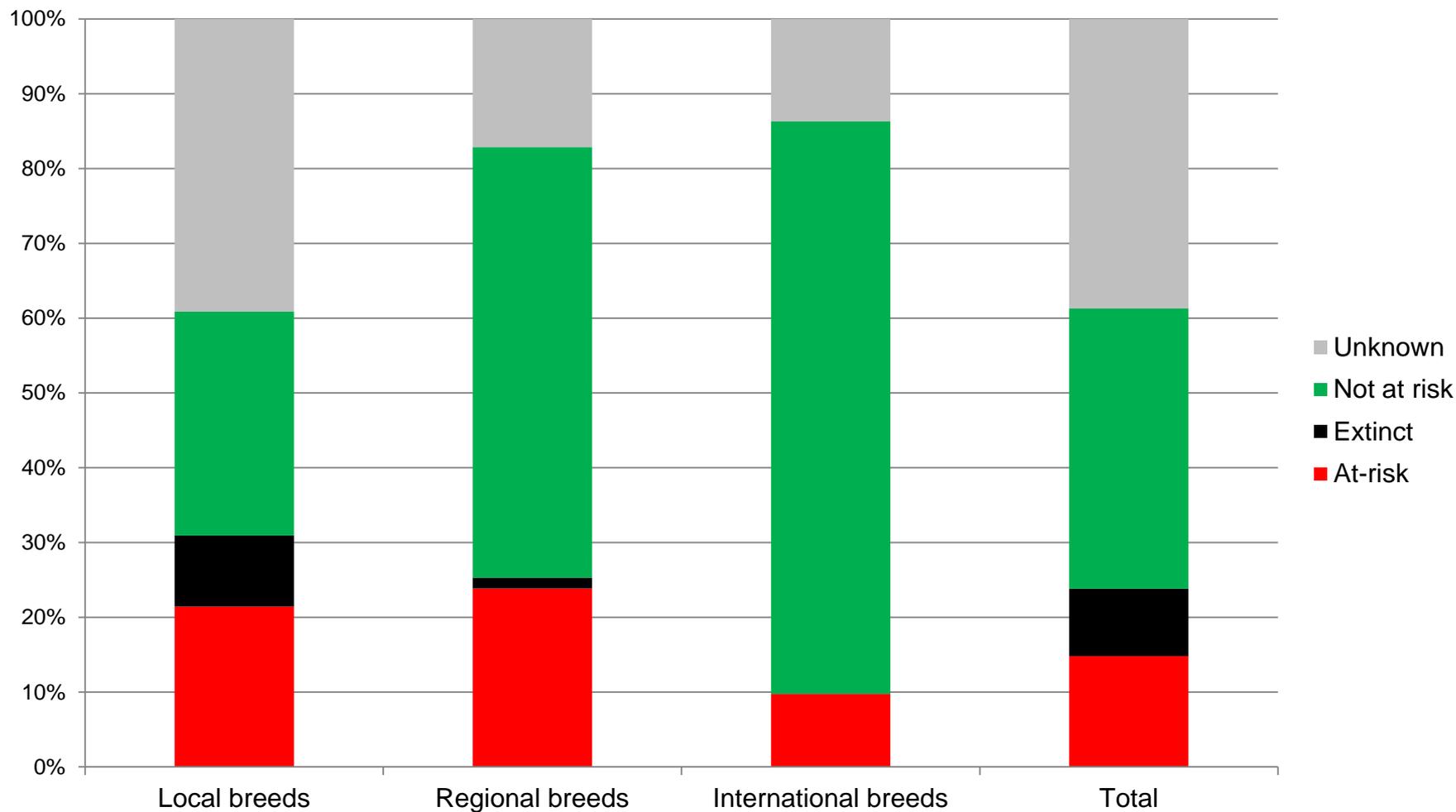
Breed diversity and threats

8054 breeds reported, of which 631 are extinct



FAO, 2010

Risk status of local & transboundary breeds

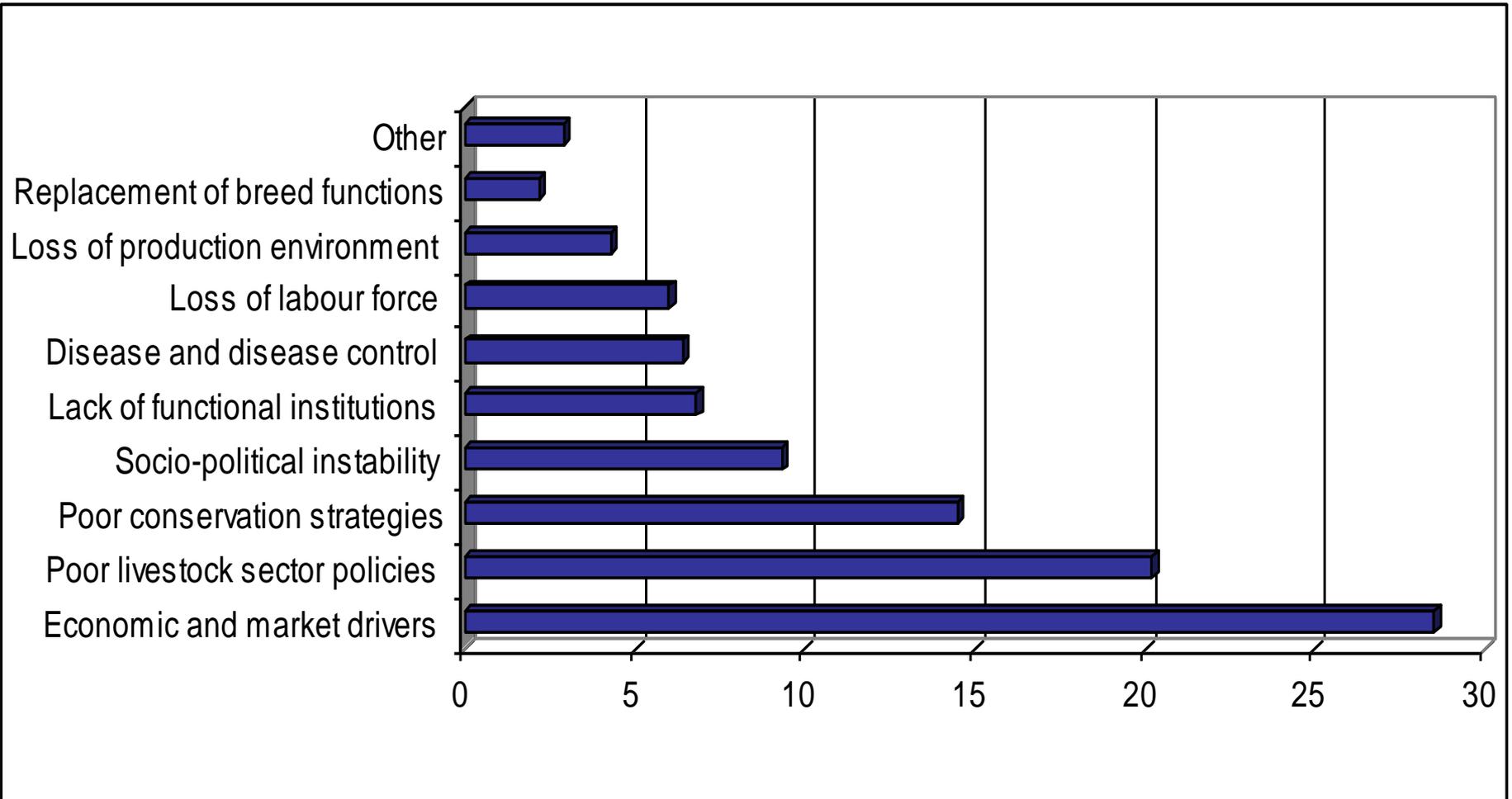


(DAD-IS 2010)

Endangerment criteria

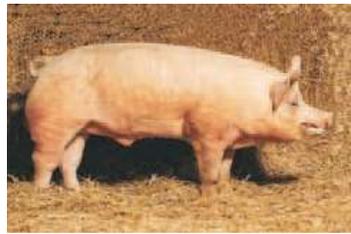
<i>Species category^b</i>	<i>Endangerment Category</i>	Demographic criteria Number of breeding females ^a current or expected in 10 years						and or	Genetic criteria Inbreeding rate / generation		
		<100	<300	≥100 < 1 000	≥300 < 3 000	≥ 1 000 < 2 000	≥ 3 000 < 6 000		>3%	>1% ≤3%	>0.5% ≤1%
<i>High reproduction capacity</i>	<i>Critical</i> <i>Endangered</i> <i>Vulnerable</i>	■		■		■			■	■	■
<i>Low reproduction capacity</i>	<i>Critical</i> <i>Endangered</i> <i>Vulnerable</i>		■		■		■		■	■	■

Main threats to breed diversity



Example - The Netherlands

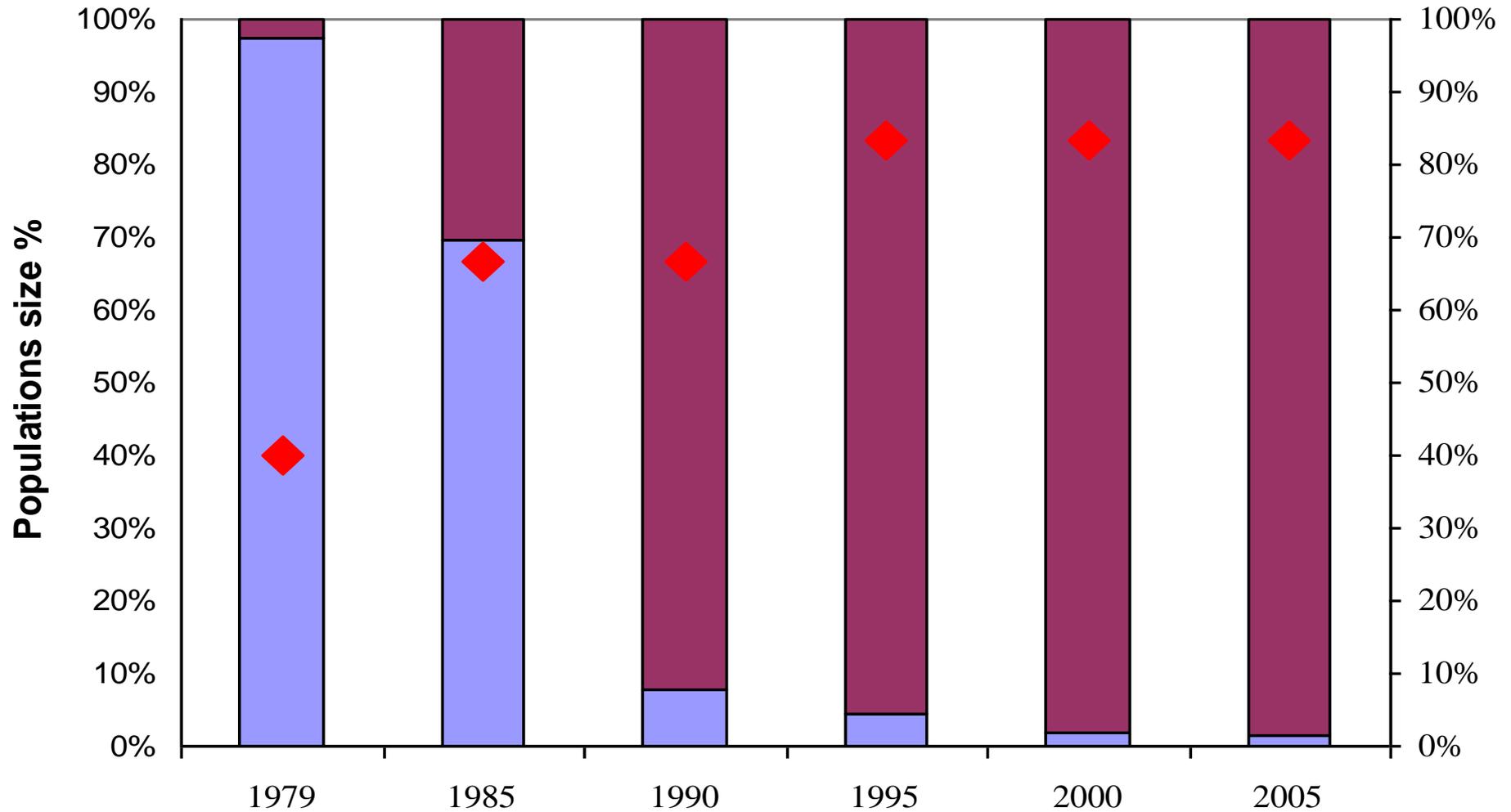
- World leading breeding companies (CRV, TOPIGS, Hendrix Genetics)



- Many native breeds became rare breeds

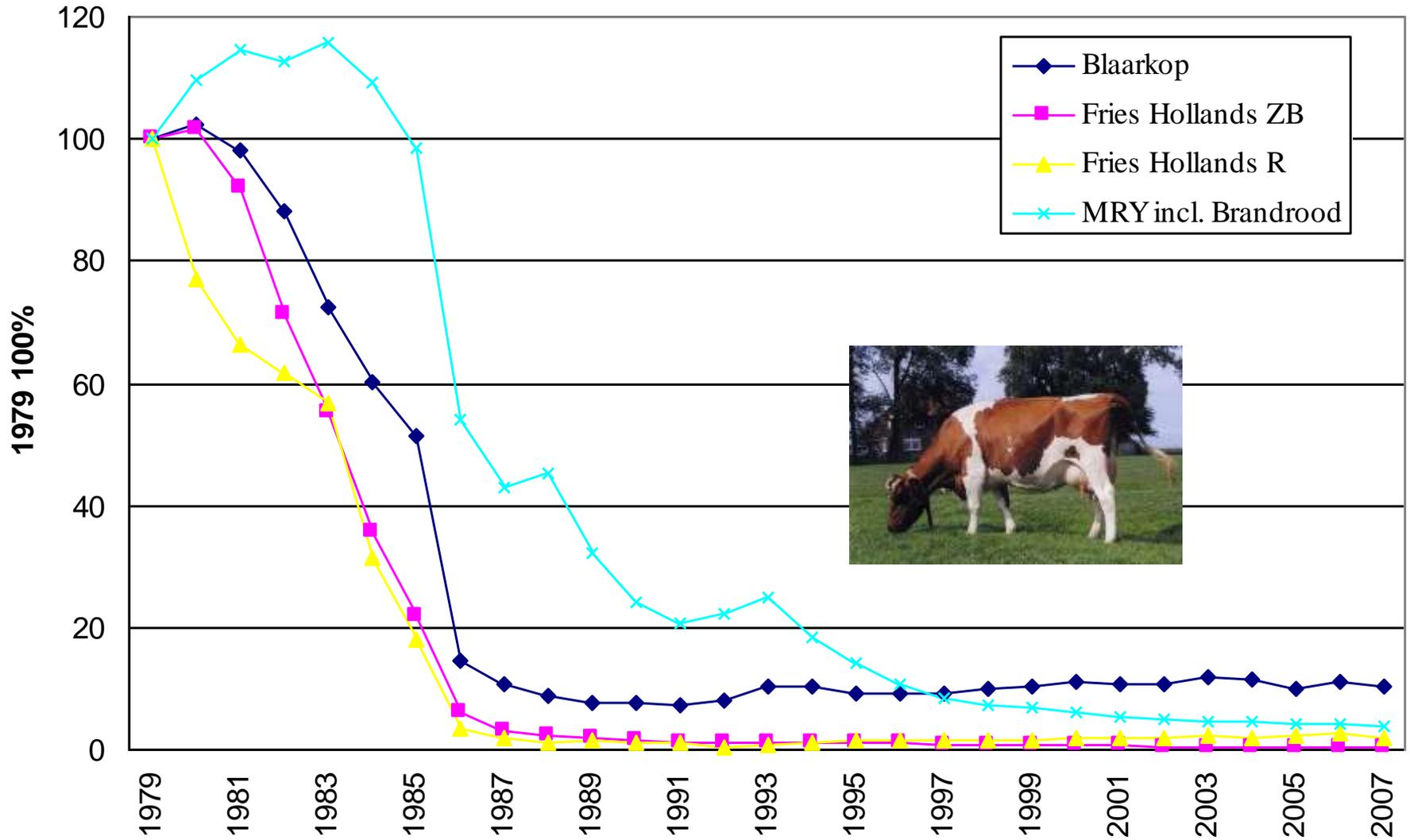


Cattle, The Netherlands



- non-native breed population
- native breed population
- ◆ Proportion of endangered native breeds (right scale)

% change in population size 1979 - 2007

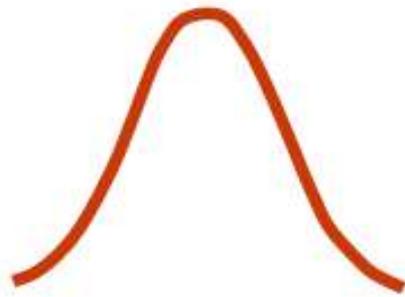


Animal Breeding principles - Plants vs Animals

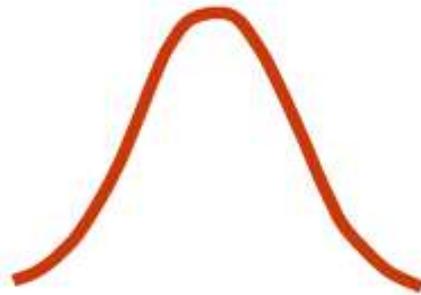


Genetic component in variation is usually 20-30 % of the visible one and in each generation new mutations contribute .1% new variation – **enough variation for changes and for compensating side effects**

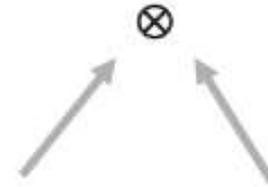
production animals



parent stock



lots of variation



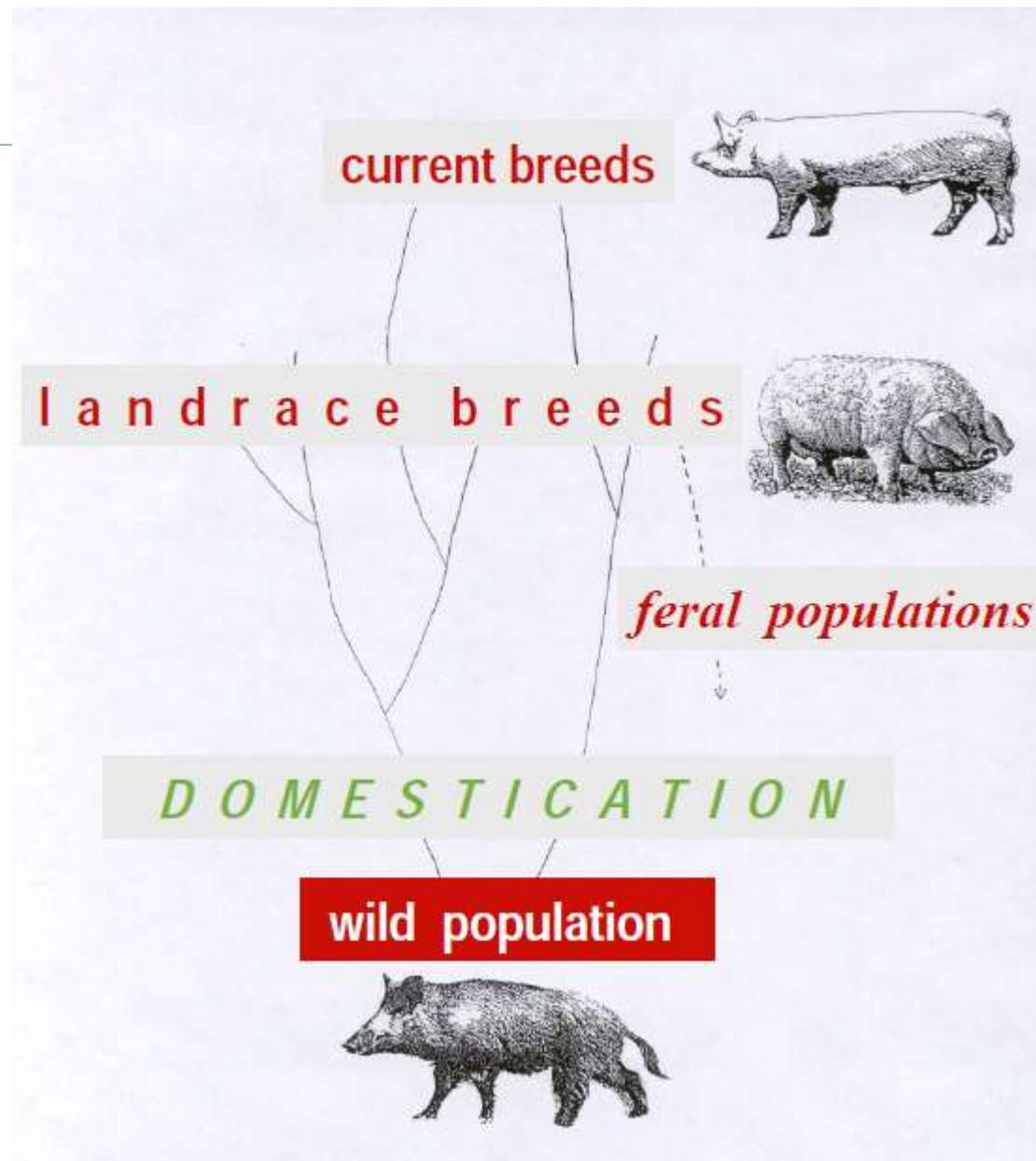
crossing
(poultry, pigs)



lots of variation

→ genetic variation is in production animals owned by farmers

Breed Development

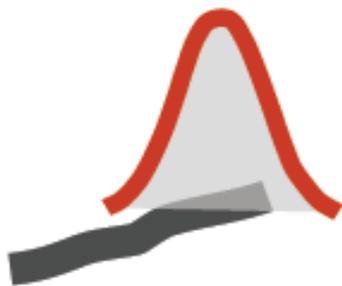


genetic progress
over generations

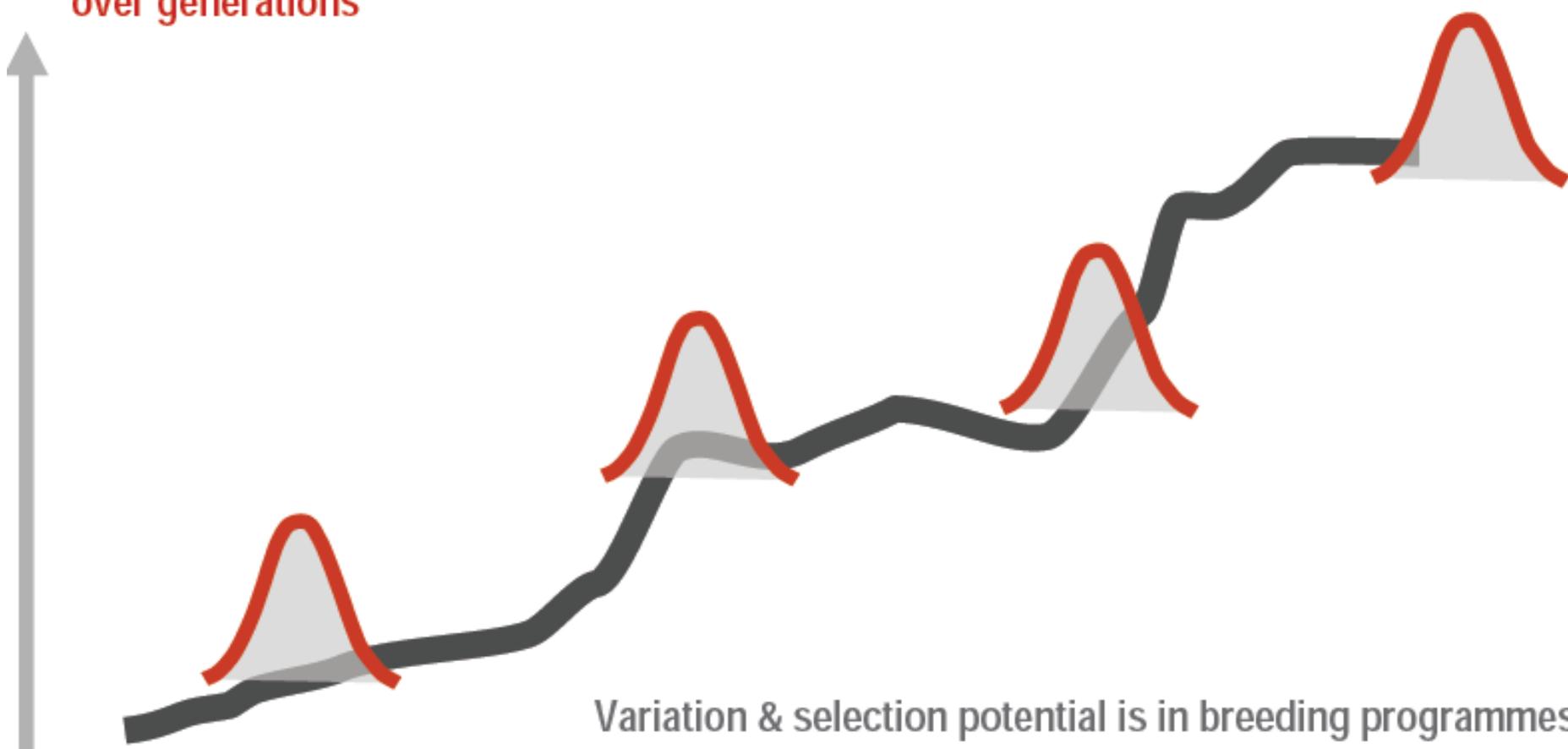


breed improvement

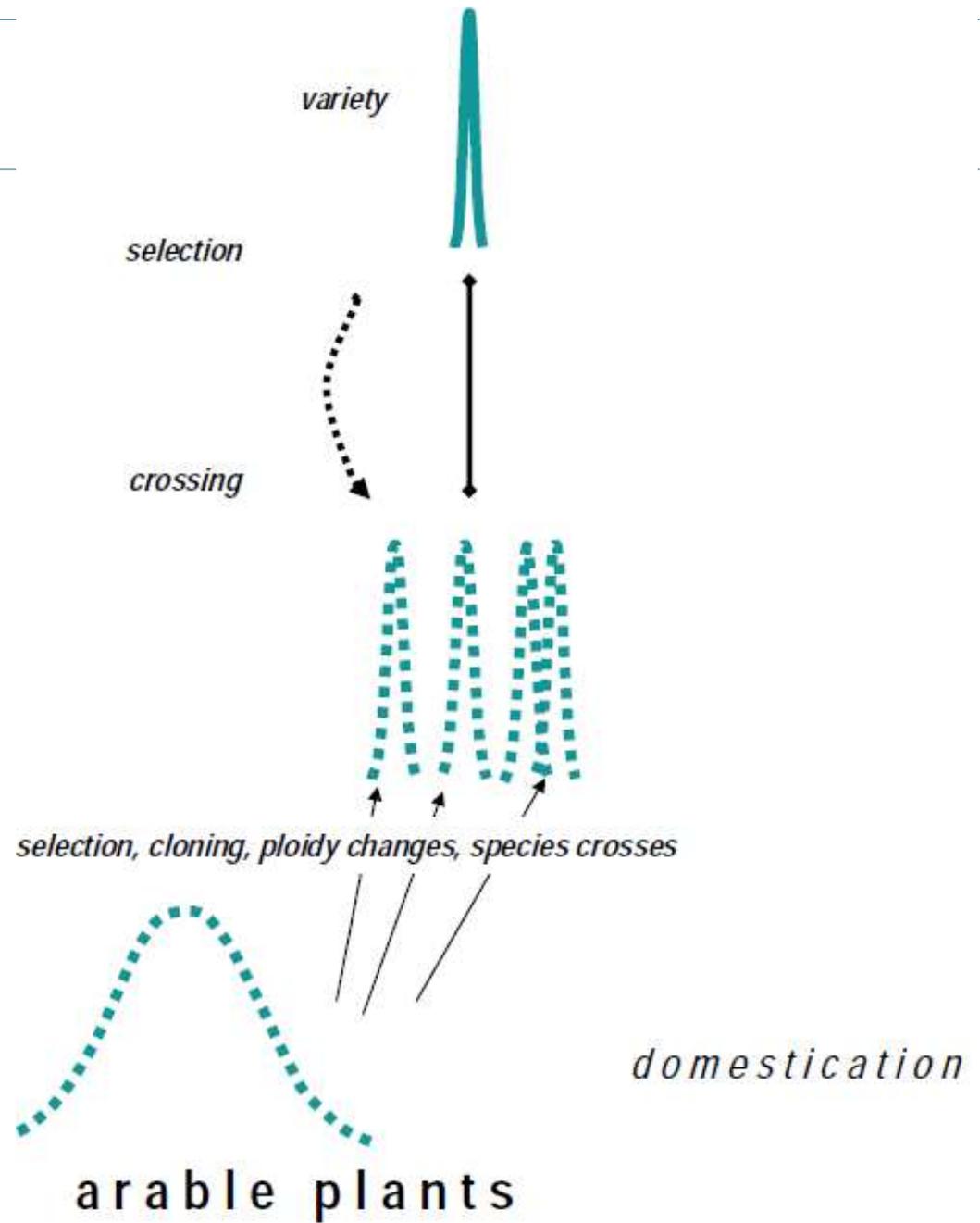
data collection - genetic ranking - selection - mating

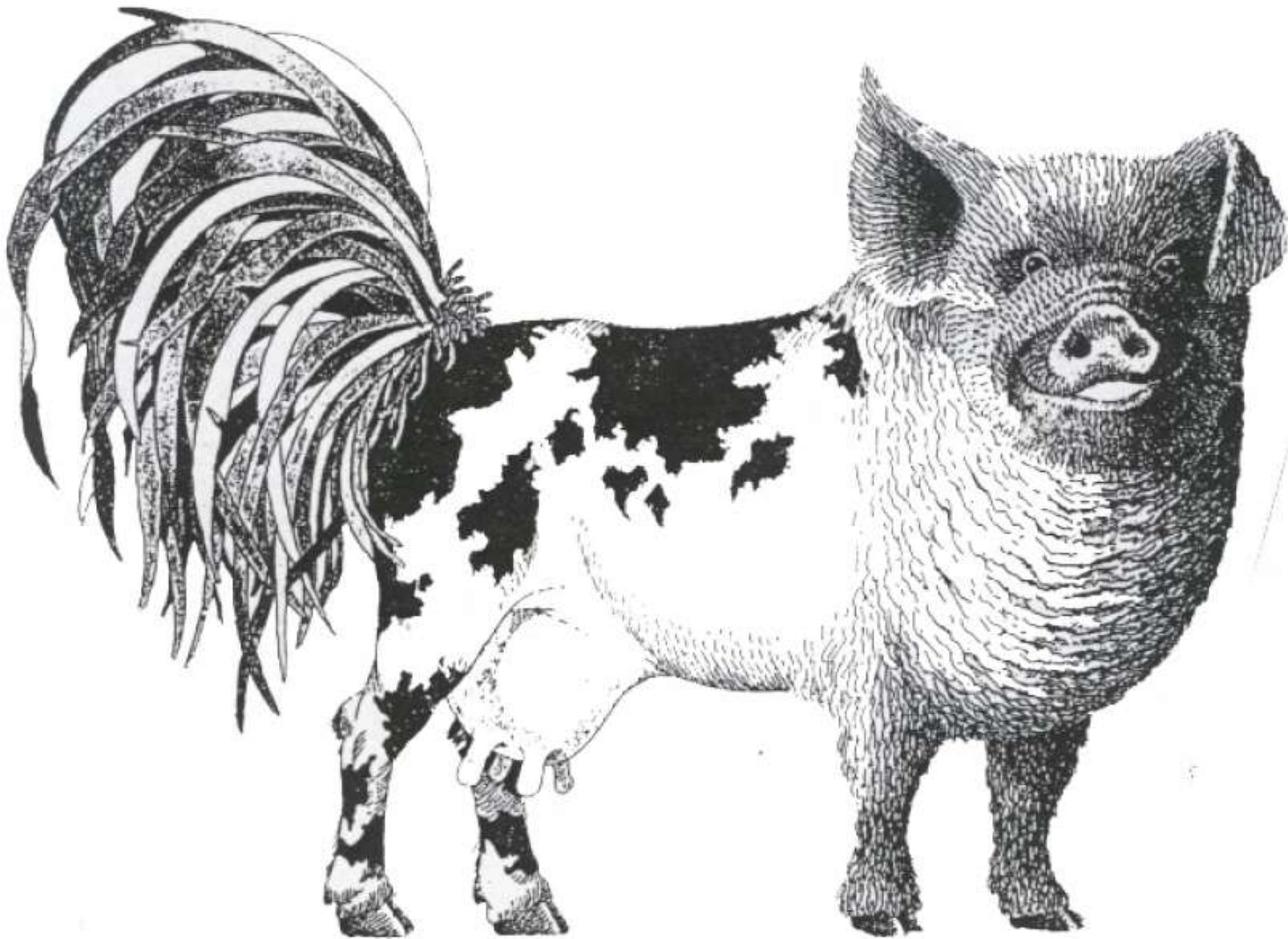


genetic progress
over generations



Variation & selection potential is in breeding programmes
success is based on operations within population





p l a n t s

- **variation stored in gene bank lines**
- **access to public gene banks via multilateral agreement**

a n i m a l s

- **variation on farms and breeding schemes**
- **need for sustainable use of variation**

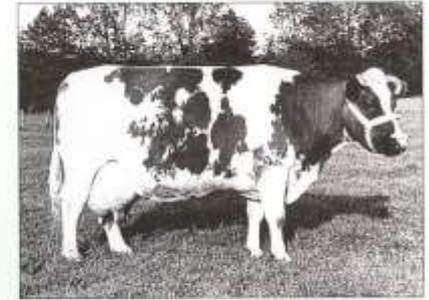
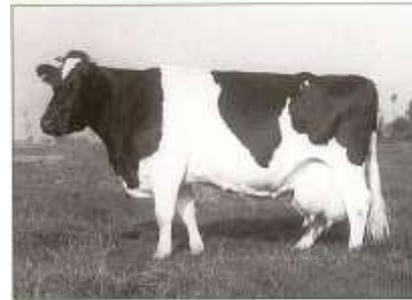
Animal Breeding

- “Optimal exploitation of the biological variation of species, under given constraints of reproductive capacity, using appropriate breeding value estimation tools.”
(Ollivier, 2000)
- Aim: To use between and within breed genetic diversity
- Application of reproductive techniques

Breeding goal and selection

- Breeding is long term work
- Small, incremental steps
- Breeding goal is thinking for the future

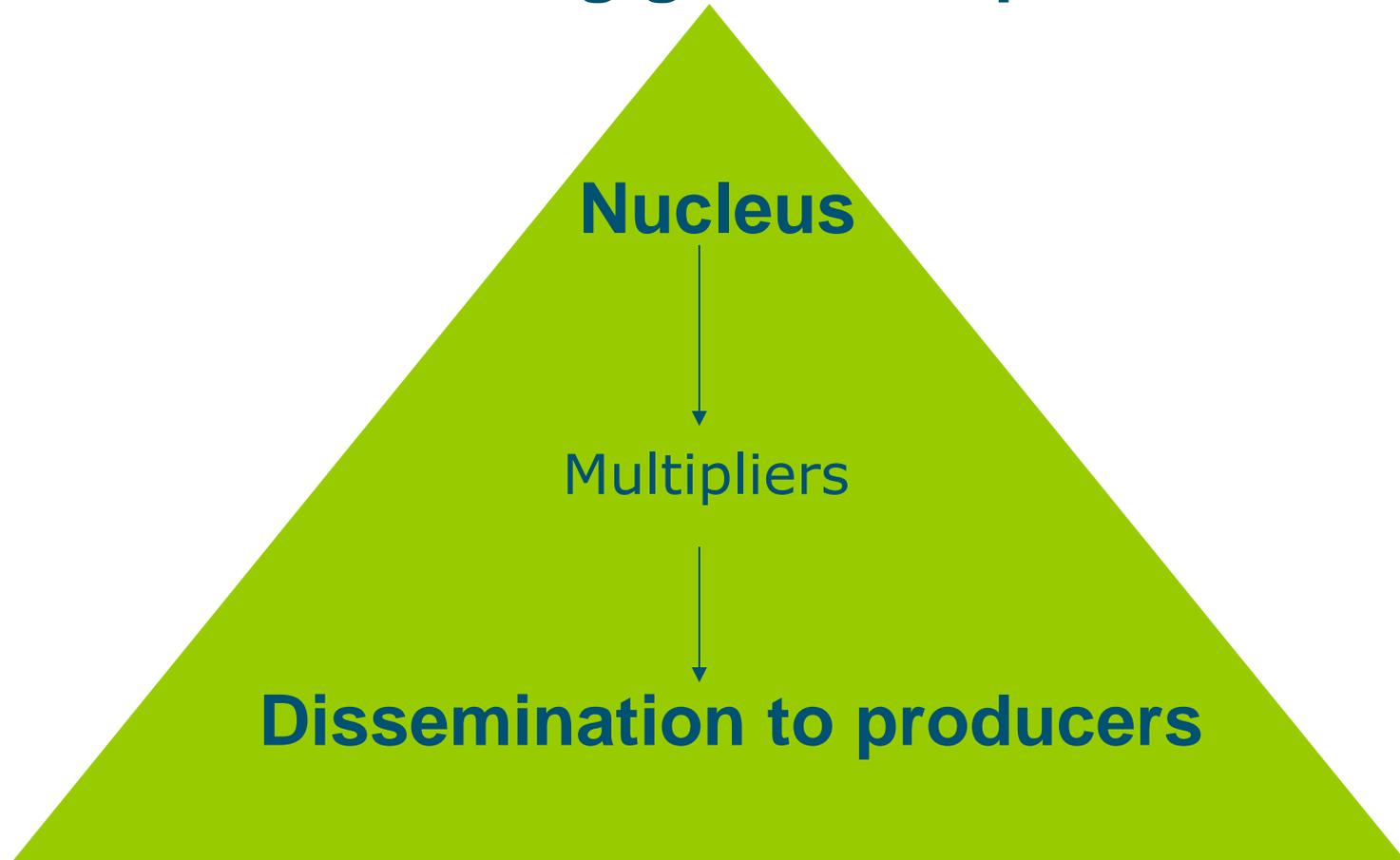
Cows from the 1950's in the Netherlands



Linksboven: Jeltje 30 (vader Frans Adema 257 van Groenhoven), kampioene NRS-jubileumkeuring 1949 Den Bosch
Rechtsboven: Kaatje 5 (vader Prins), als 13-jarige kampioene NRS-jubileumkeuring Den Bosch 1959
Hiernaast: Klaartje (vader Reinder van Alma), kampioene NRS-jubileumkeuring Den Bosch 1954 en moeder van kampioen Knaap.

Breeding schemes

Generating genetic improvement



Genetic progress (within populations)

$$\Delta G = \frac{\begin{array}{l} \text{Accuracy of selection} \\ \text{Intensity of selection} \\ \text{Genetic variance} \end{array}}{\text{Generation interval}}$$

Generation interval

Parameters to evaluate scheme:

ΔG = rate of genetic change

ΔF = rate of inbreeding

Breeding goal and selection - State of art

1950: Phenotypic performance

1960: Daughter yield deviations from progeny test

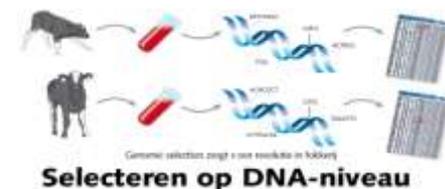
1970: Phenotypic performance and pedigree information to produce breeding values bulls (BLUP: Best Linear Unbiased Prediction)

1980: BLUP national scale and animal models



1990: Use of DNA markers
More health, longevity, fertility and robustness traits in BLUP

2000: Whole Genome Selection – “Genomic selection”



Big changes in animal breeding industry!

Genomic testing of bulls tipped to gains

By WAIWAI TIMMO - Waikato Times | Tuesday, 23 May 2007

LIC is working on genetic testing for bulls, which it dubs the "biggest development in genetics since the invention of artificial insemination".

Genomic selection means bulls could be tested for their breeding value with blood tests soon after birth rather than waiting for them to mature, mate and produce



EURIBRID FIRST TO USE GENOMIC SELECTION COMMERCIALY



FIRST COMMERCIAL USE OF GENOMIC SELECTION

20,000 GENETIC MARKERS USED



Euribrid and "Selection" of DNA markers for animals for the basic application

Genomic traits of animals markers to very difficult the like. breeding value the information the genes breeding value

manager of Euribrid's Breeding Research Centre, "Through genomic selection, ge

Use of DNA markers

At birth know the difference:

- Addison (sire: Mountain)

+2224 kg milk

-0.87 % fat

-0.28 % protein

- Slogan (sire: Mountain)

-15 kg milk

0.17 % fat

0.11 % protein

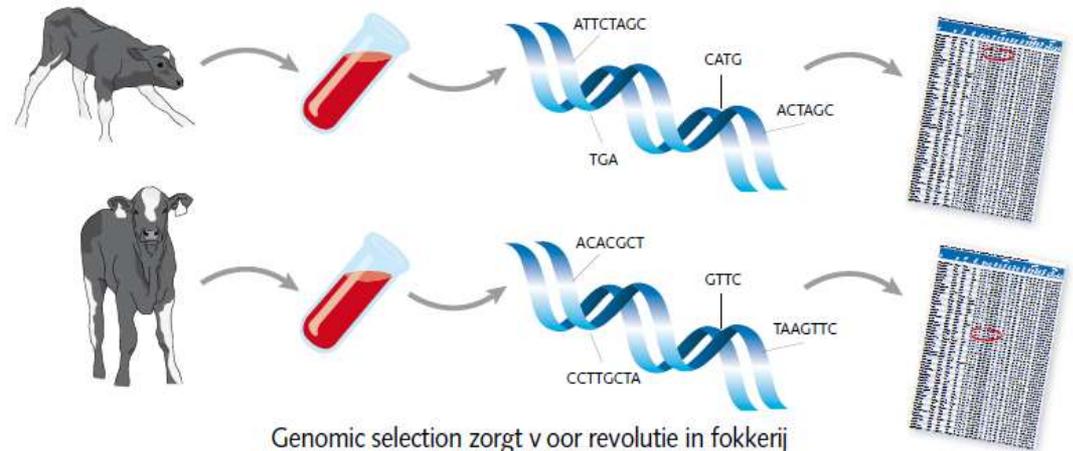


(Slide courtesy HG)

Animal Breeding &
Genomics Centre

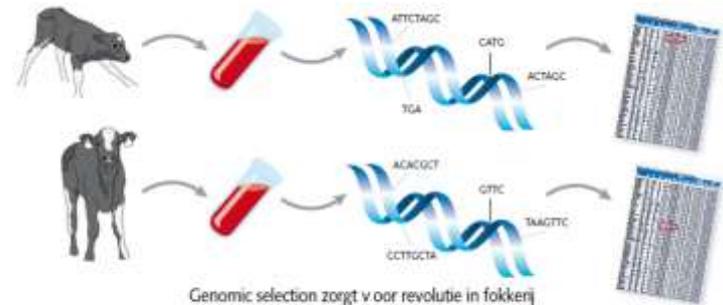
Benefits of genomic selection

- Increased accuracy
- Ability to overcome age and sex limitations
- Allows estimation of relationships where pedigrees are not recorded
- Direct link between genetic evaluation and the genome
- Better opportunity to select for traits with unfavourable genetic correlation



Selecteren op DNA-niveau

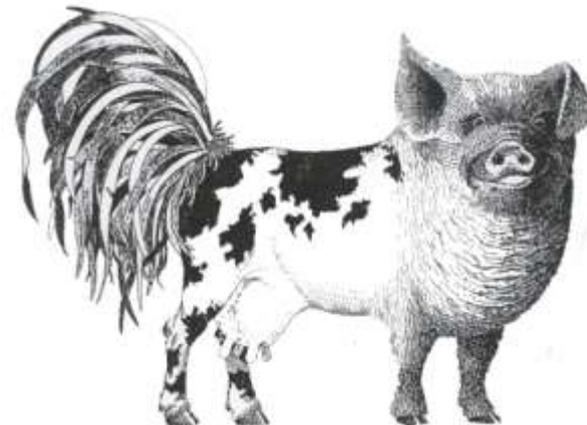
- Animal Breeding / Use of DNA markers / Genomic Selection



Selecteren op DNA-niveau

≠

- Genetic Modification

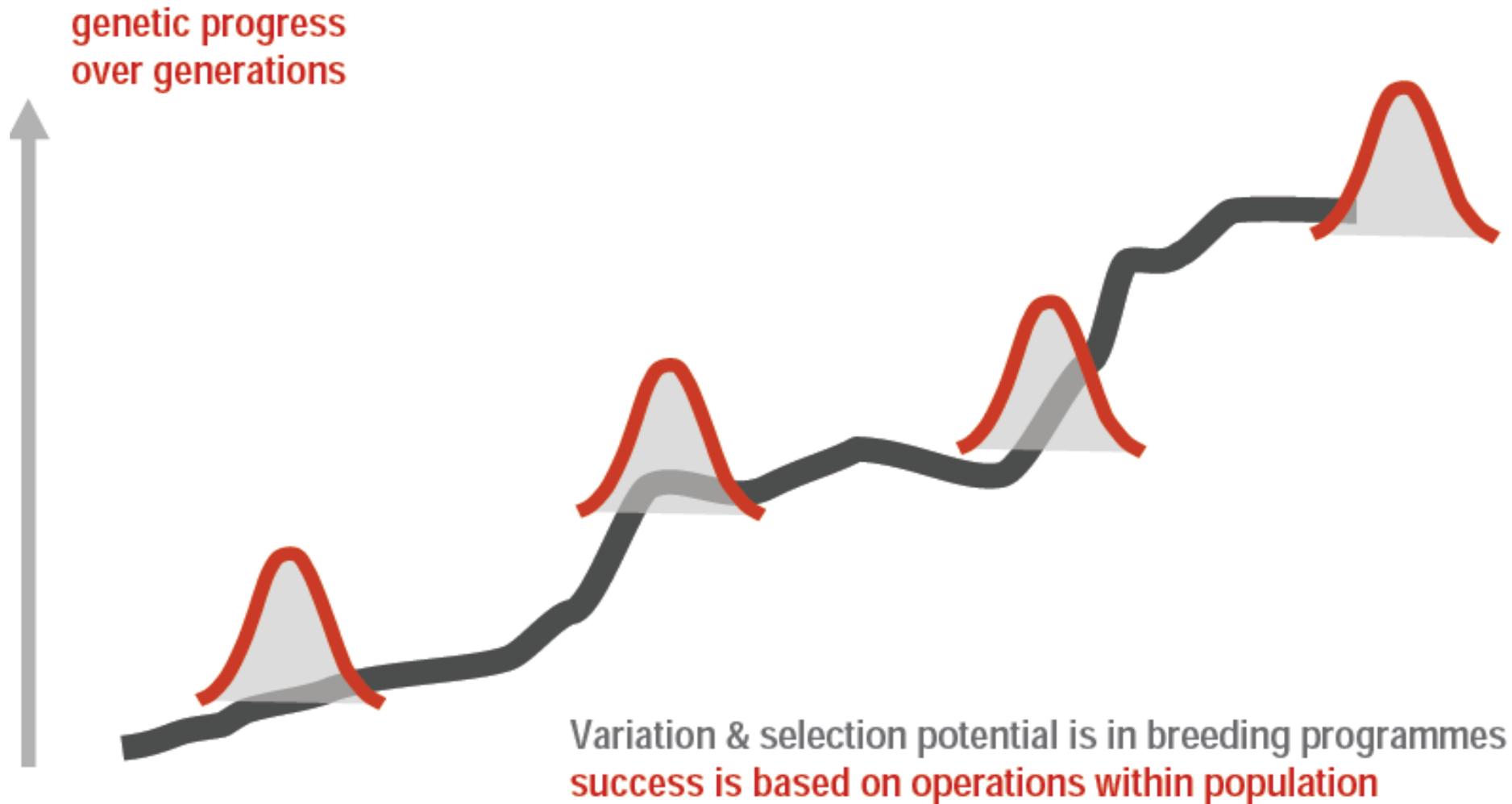


Genomic selection for all breeds?

And in all (developed and developing) countries?

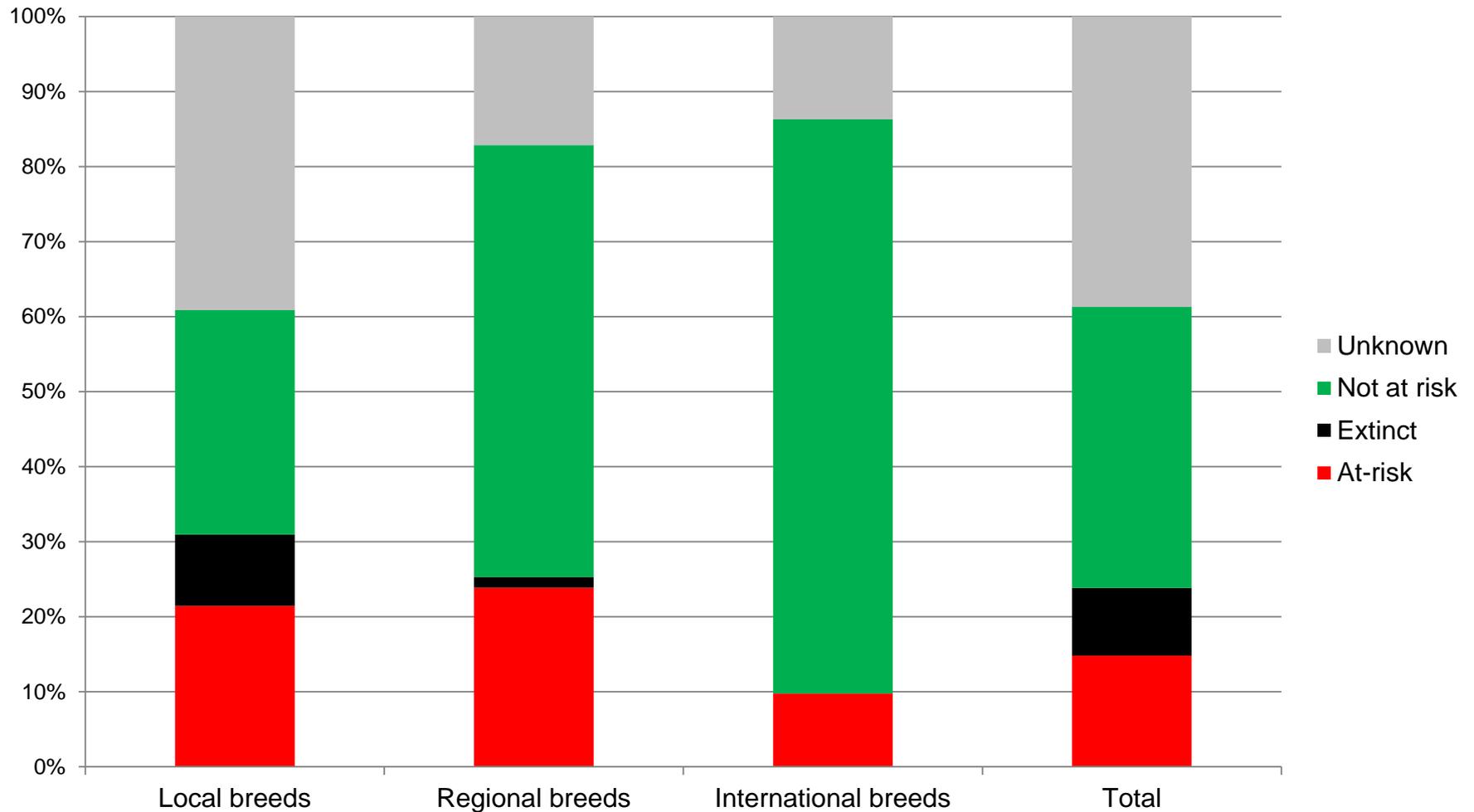
- Extensive validation of association between genotypes and phenotypes needed (“training sets”)
- ‘You can’t manage what you do not measure’: GS cannot be used if accurate performance records are not available.
- Only genotyping without phenotyping and efficient data analysis will be wasteful expenditure.

Key principle of animal breeding remains



Conservation strategies

Risk status of local & transboundary breeds



(DAD-IS 2010)

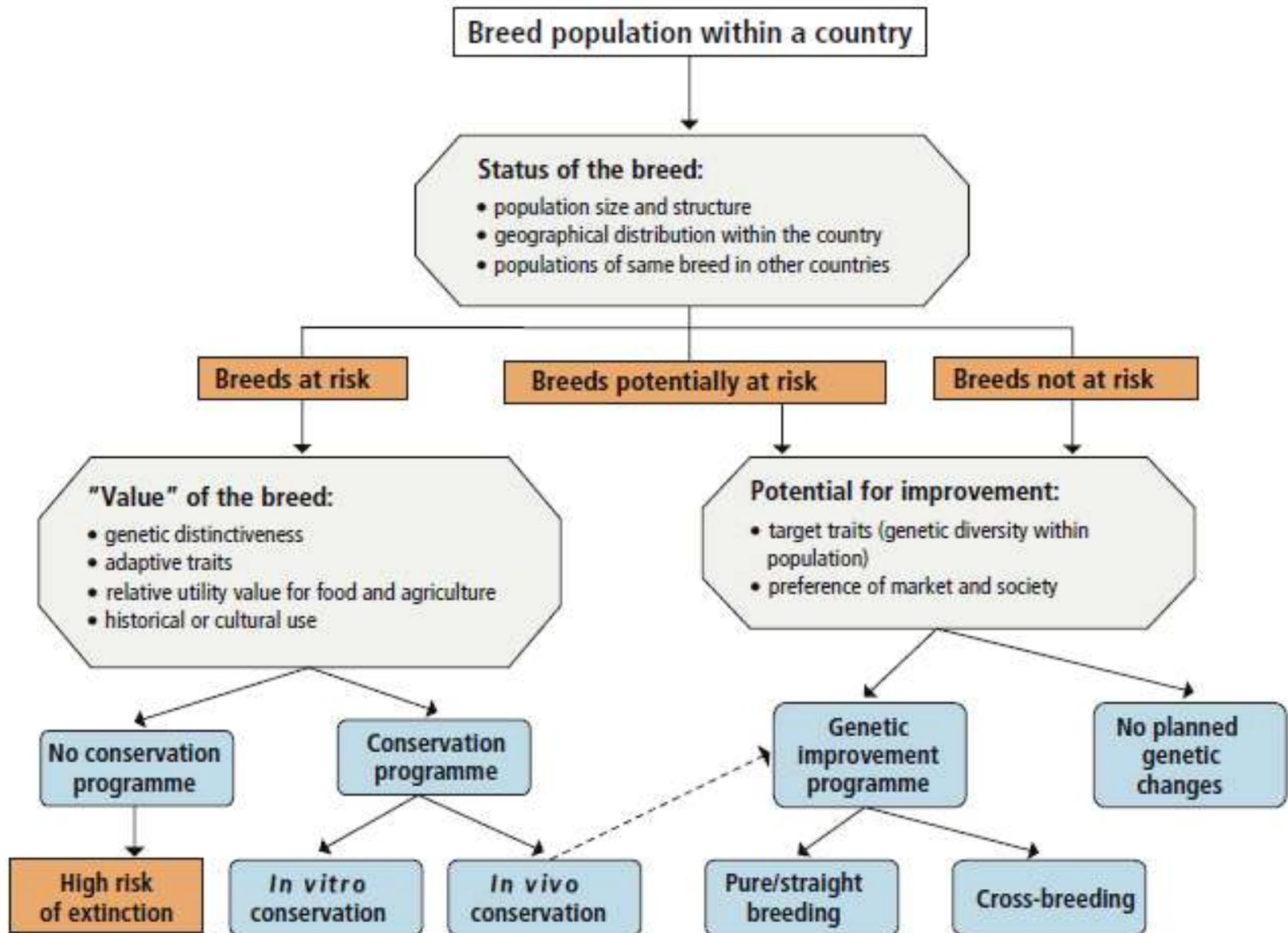


Table 1.1. Conservation techniques and objectives, adapted from Gandini and Oldenbroek (2007).

Objective	Technique		
	Cryoconservation	<i>Ex situ – in vivo</i>	<i>In situ</i>
Flexibility of the genetic system, as			
<ul style="list-style-type: none"> • Insurance for changes in production conditions 	Yes	Yes	Yes
<ul style="list-style-type: none"> • Safeguard against diseases, disasters, etc. 	Yes	No	No
<ul style="list-style-type: none"> • Opportunities for research 	Yes	Yes	Yes
Genetic factors			
<ul style="list-style-type: none"> • Continued breed evolution / genetic adaptation 	No	Poor	Yes
<ul style="list-style-type: none"> • Increase knowledge of breed characteristics 	Poor	Poor	Yes
<ul style="list-style-type: none"> • Exposure to genetic drift 	No	Yes	Yes
Sustainable utilisation of rural areas			
<ul style="list-style-type: none"> • Opportunities for rural development 	No	Poor	Yes
<ul style="list-style-type: none"> • Maintenance of agro-ecosystem diversity 	No	Poor	Yes
<ul style="list-style-type: none"> • Conservation of rural cultural diversity 	No	Poor	Yes



Long term cryo-storage – Is it possible?

- Cryopreservation: “suspended animation” in liquid nitrogen ($-196\text{ }^{\circ}\text{C}$)
- All chemical and physical processes arrested
- Only Cosmic background radiation is a theoretical source of DNA damage.
- This is estimated to become relevant only after several thousands of years (Mazur, 1985)
- Consequently: Storage is safe for several thousands of years, possibly longer



Purposes of AnGR gene banks

- Preserve the present wealth of genetic diversity → Secure it for future generations
- Recreate lost breeds or breeding lines
- As back-up in case genetic problems would occur.
- To allow development of new lines or breeds.
- Support *in situ* conservation

A powerful tool in prevention of inbreeding and genetic drift in small populations (Meuwissen 1999 Sonesson et al 2002).



Choice of cell type

Depends on goal(s) of gene bank

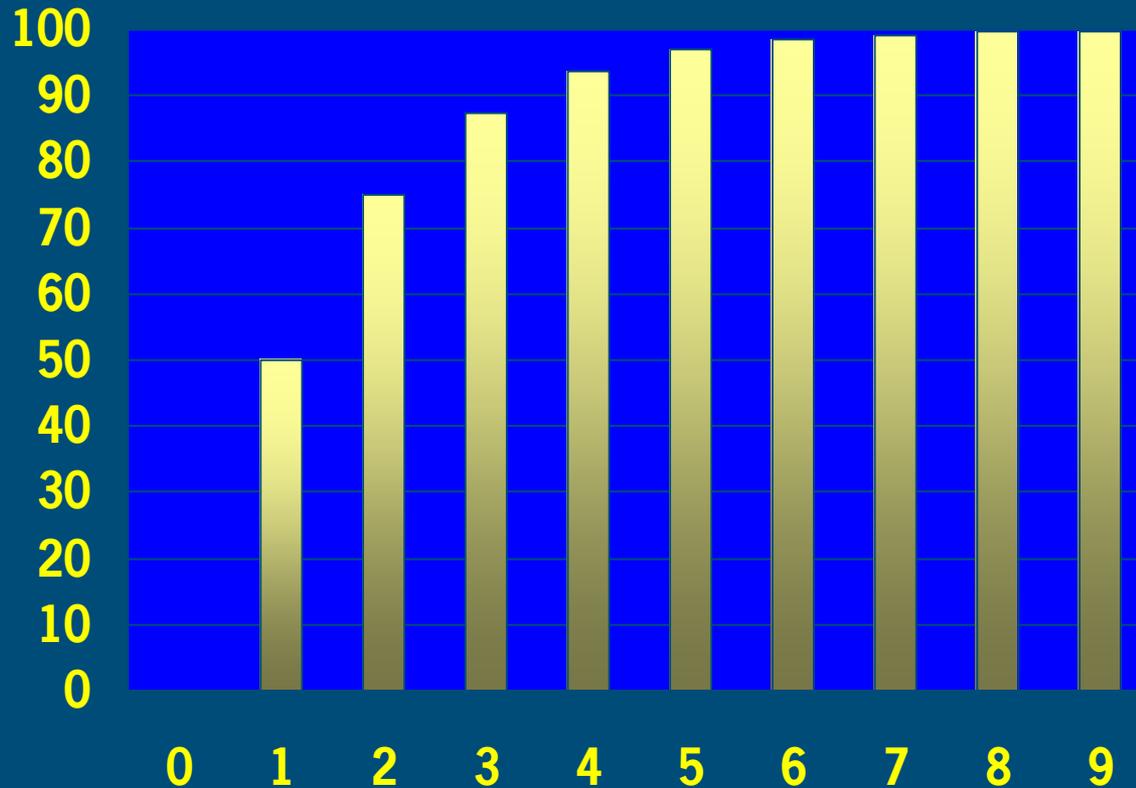
- Long time storage, no updates or regular use
- Medium-term storage, but with regular exchange with *in situ* populations. E.g. semen used to support breeding schemes.

Semen and embryos can be updated regularly and be readily used in the field.

In the Netherlands

- Using semen
- Starting with embryos (endangered cattle breeds)
- Beginning to consider somatic cells
- DNA

Reconstitution of lost breeds with cryopreserved semen & backcrossing



Percentage of the original breed in subsequent generations of the backcross

Semen cryopreservation feasible for all species?

Chicken example

- Research had to be done
 - Development of new freezing media and protocol
 - Insemination experiment
- Use of new medium resulted in adequate freezing and insemination results



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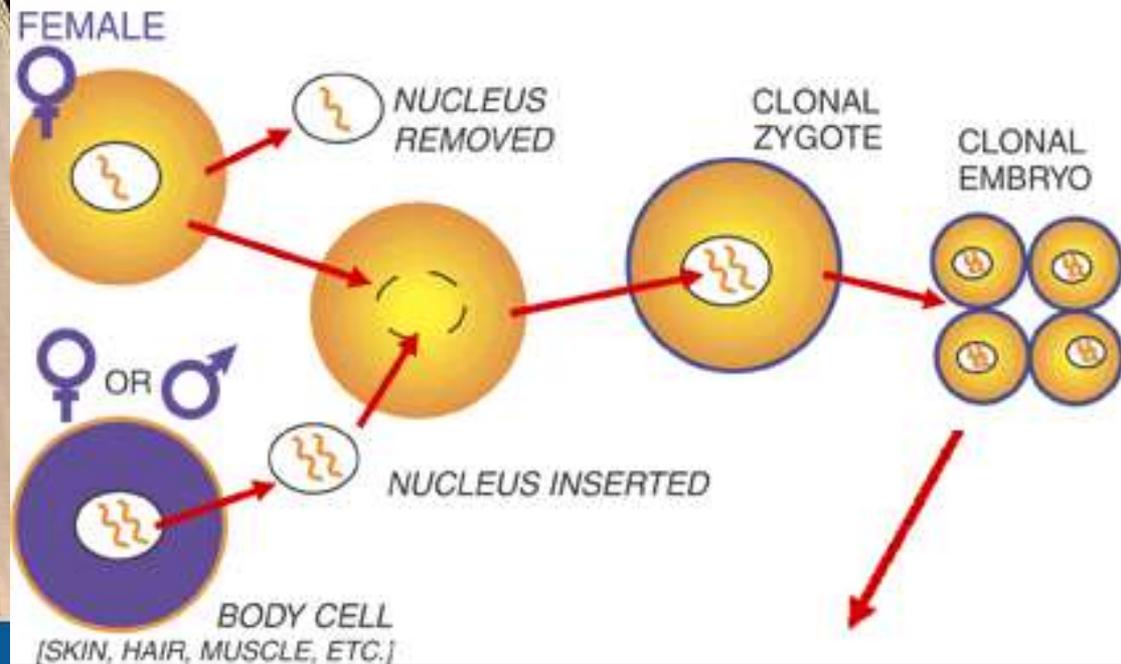
Somatic cells → Reproductive cloning

Collection

Maturation



PPL Therapeutics' five healthy female piglets, Millie, Christa, Alexis, Carrel and Dotcom, born on 5 March 2000, as a result of nuclear transfer (cloning) using adult cells.



Thawing

Culture/reprogramming

Culture

Transplantation

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Sampling strategies from genetic point of view

Decision-making at three levels:

- Which species?
- **Breeds to be included
(prioritization of breeds)**
- **Sampling of individuals within selected breeds**

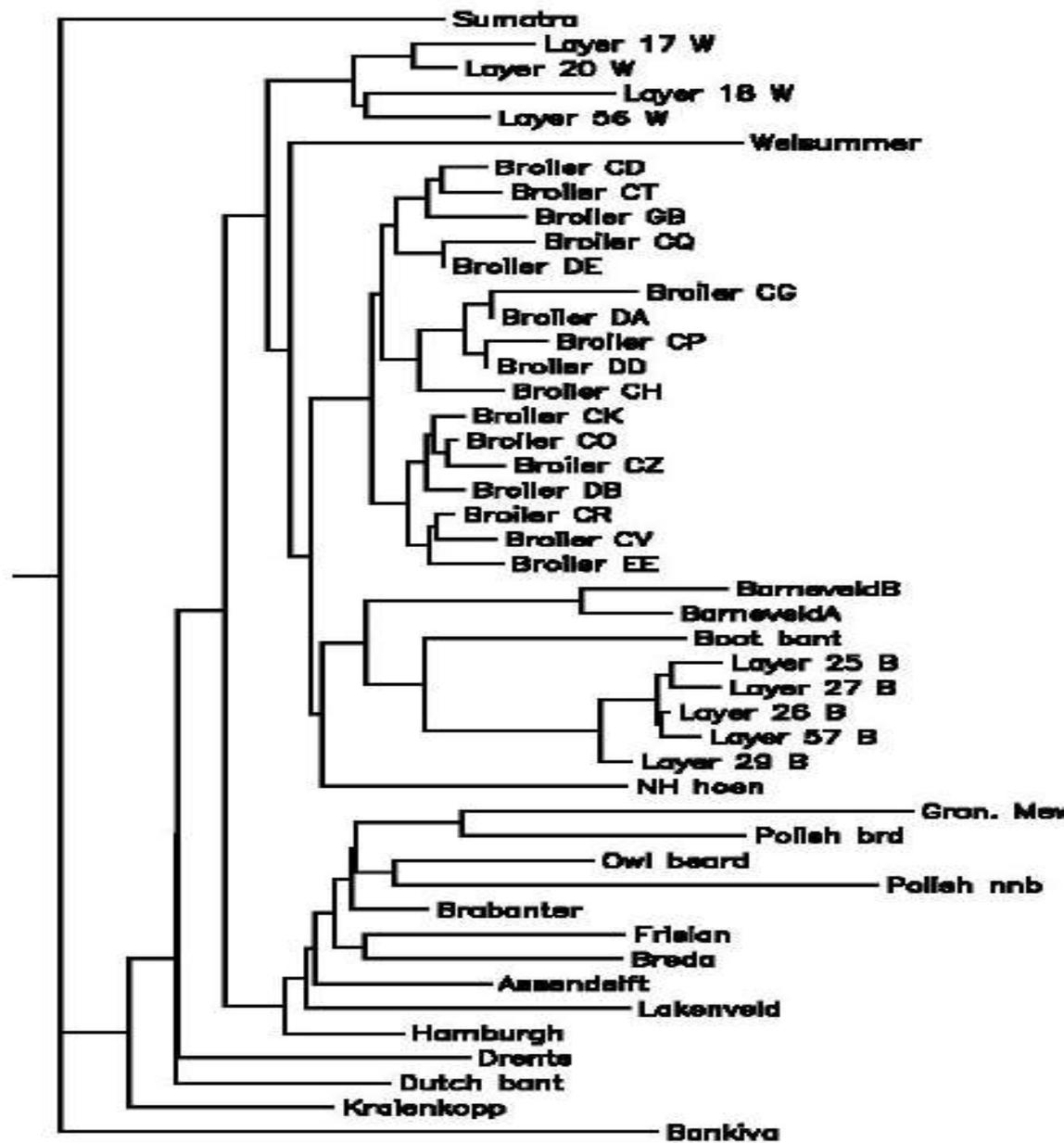
Prioritising breeds from a genetic point of view

Total genetic diversity of a group of breeds

- Contribution of a single breed to the total diversity of the group of breeds
- Contribution to the between-breed diversity
- Contribution to the within-breed diversity

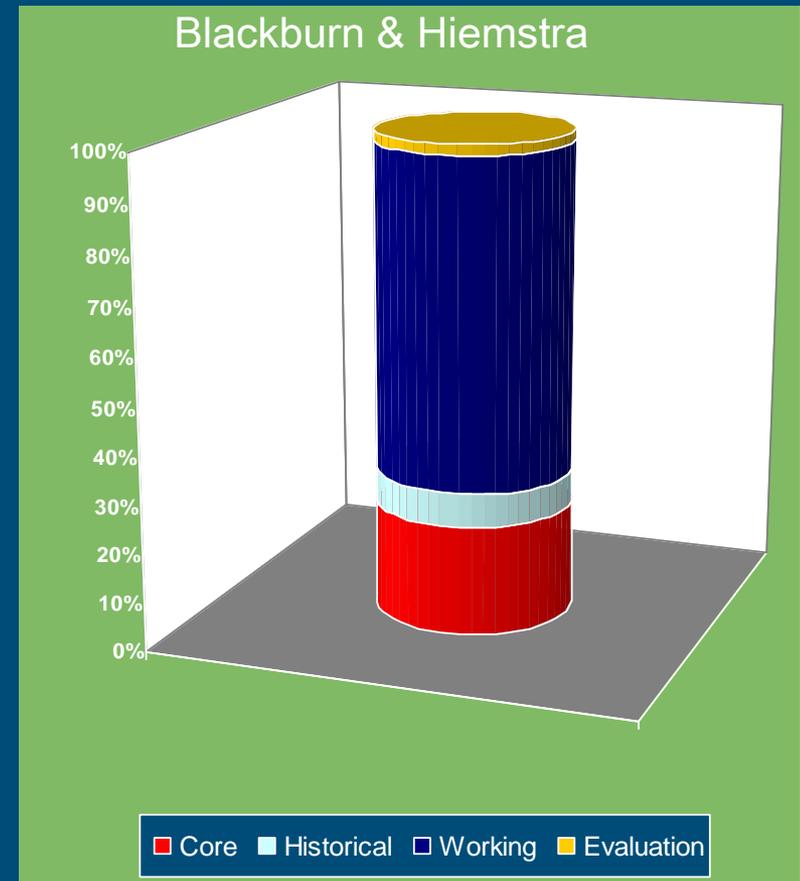
Breed prioritization

Marker Estimated Kinships

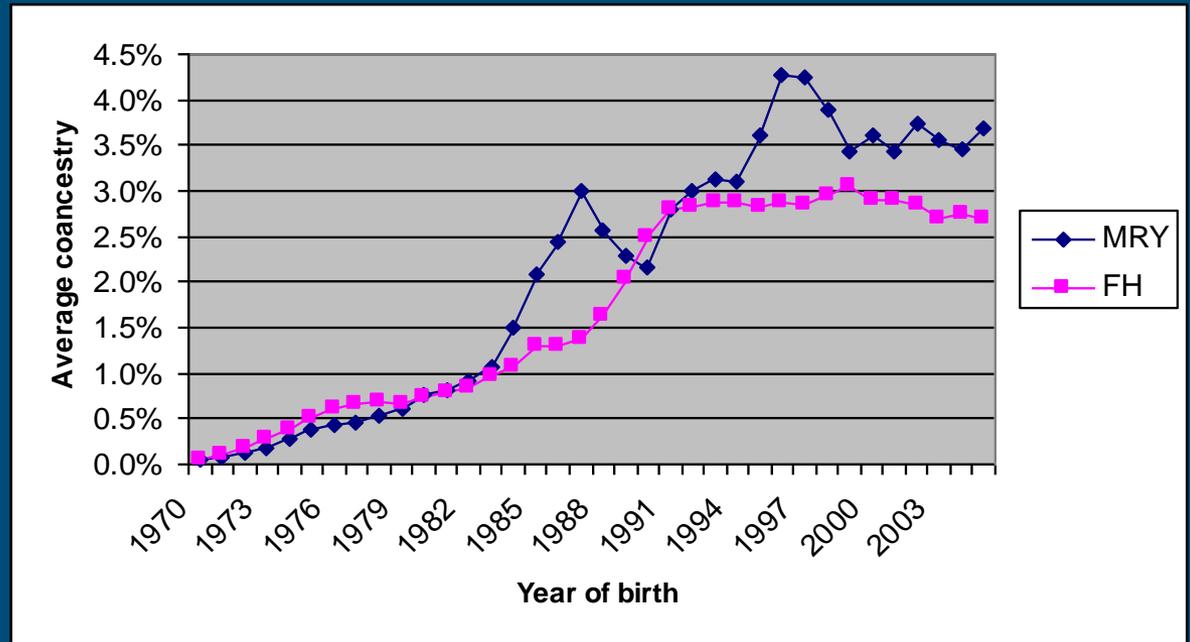


Core collection

- Long term storage. May potentially be used in a critical situation.
- Broad sampling ($N_e = 50$) in order to capture the breadth of genetic diversity of a breed
- Preferably more samples than needed to reconstitute the breed.
- The Core Collection may or may not be static. It can be updated to insure the genetics are of utility.



Importance of monitoring of within breed diversity



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Cryo-aided breeding schemes (example NL)

Wageningen UR - Wageningen UR - Centrum voor Genetische Bronnen Nederland - Windows Internet Explorer

http://137.224.129.202/cryo/zoeken_genenbank_alles_nl.jsp?species=cattle&breed=Fries%20Roodbont



WAGENINGEN UR
for quality of life

Onderwijs Onderzoek Publicaties Nieuws & Agenda Over Wageningen UR Werken

wageningen ur (home) > centrum voor genetische bronnen nederland

CGN Dierlijke Genetische Bronnen

Alle donoren van diersoort **cattle** en ras **Fries Roodbont**.

Naam	Ras	Diersoort
BERTUS	Fries Roodbont	cattle
BROEKSTER KEI	Fries Roodbont	cattle
CITATION LEON	Fries Roodbont	cattle
De Vennen Petero	Fries Roodbont	cattle
DOEDE	Fries Roodbont	cattle
FOLKERT	Fries Roodbont	cattle
GERBEN	Fries Roodbont	cattle
GRATAMA WISNOAS	Fries Roodbont	cattle
Grietjes Blijdorp	Fries Roodbont	cattle
HESSEL	Fries Roodbont	cattle
ROOSJE VAN BIJDORP 11	Fries Roodbont	cattle
ROOSJES BLIJDORP 9	Fries Roodbont	cattle
SJOARDA S ALLE	Fries Roodbont	cattle
SJOARDA S EEUWE	Fries Roodbont	cattle
SIBBENNE'S IODBIT	Fries Roodbont	cattle

Centrum voor Genetische Bronnen Nederland

- Nieuws & Agenda
- CGN Algemene informatie
- CGN Dierlijke Genetische Bronnen
- CGN Genetische Bronnen Bomen
- CGN Plantaardige Genetische Bronnen
- Feedback

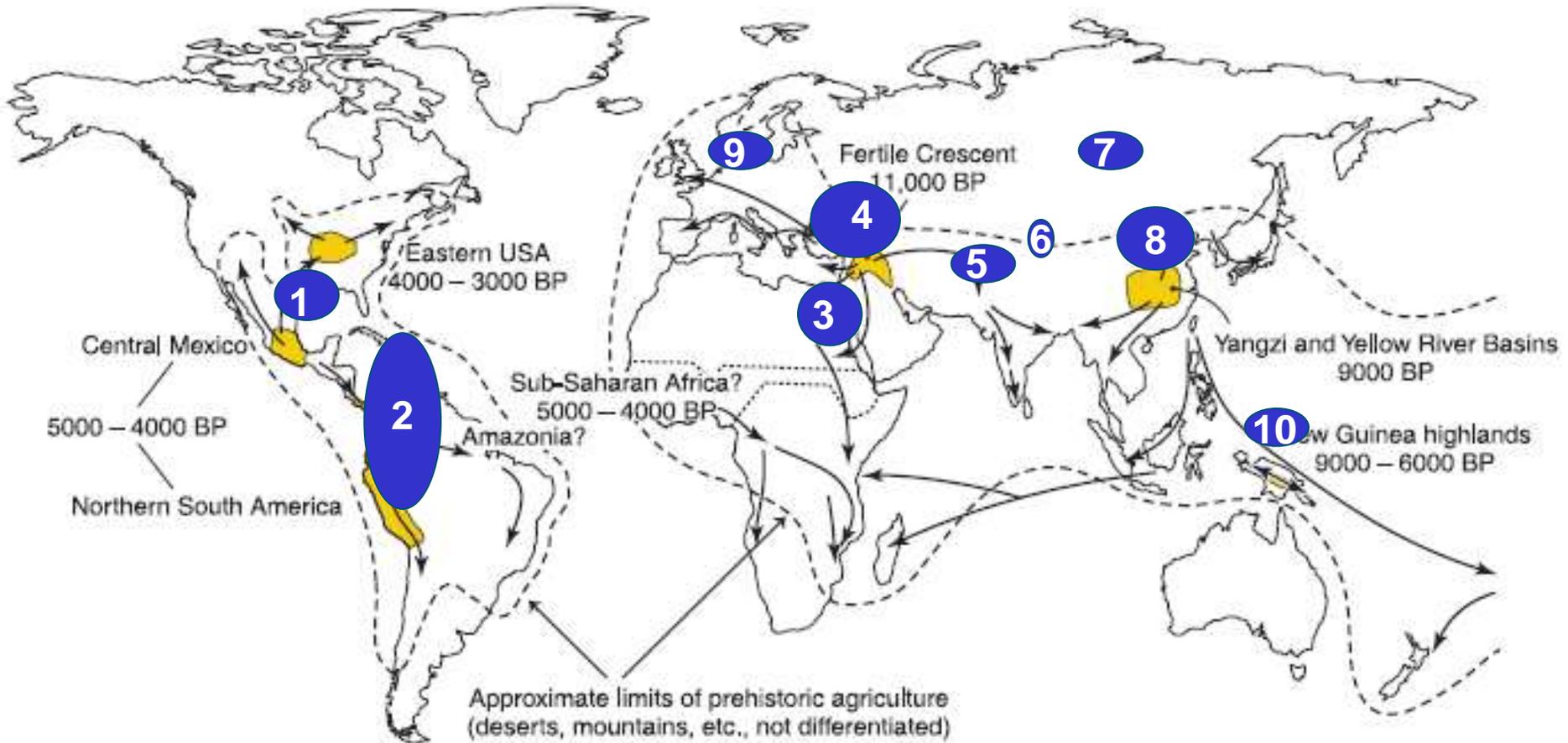
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Dutch Friesian Red and White

- < 400 breeding females
- > 40 bulls in gene bank

Global exchange patterns of AnGR

Centers of domestication and historic exchange



1: Turkey

3. Cattle, donkey

4. Cattle, sheep, goats, pigs

6: Yak

7: Horse

2: Guinea Pigs, Llama, Alpaca

5. Cattle, goats, chicken

8: pigs, chicken

9/10: Pigs

Hanotte 2005

Factors influencing gene flow

Historical

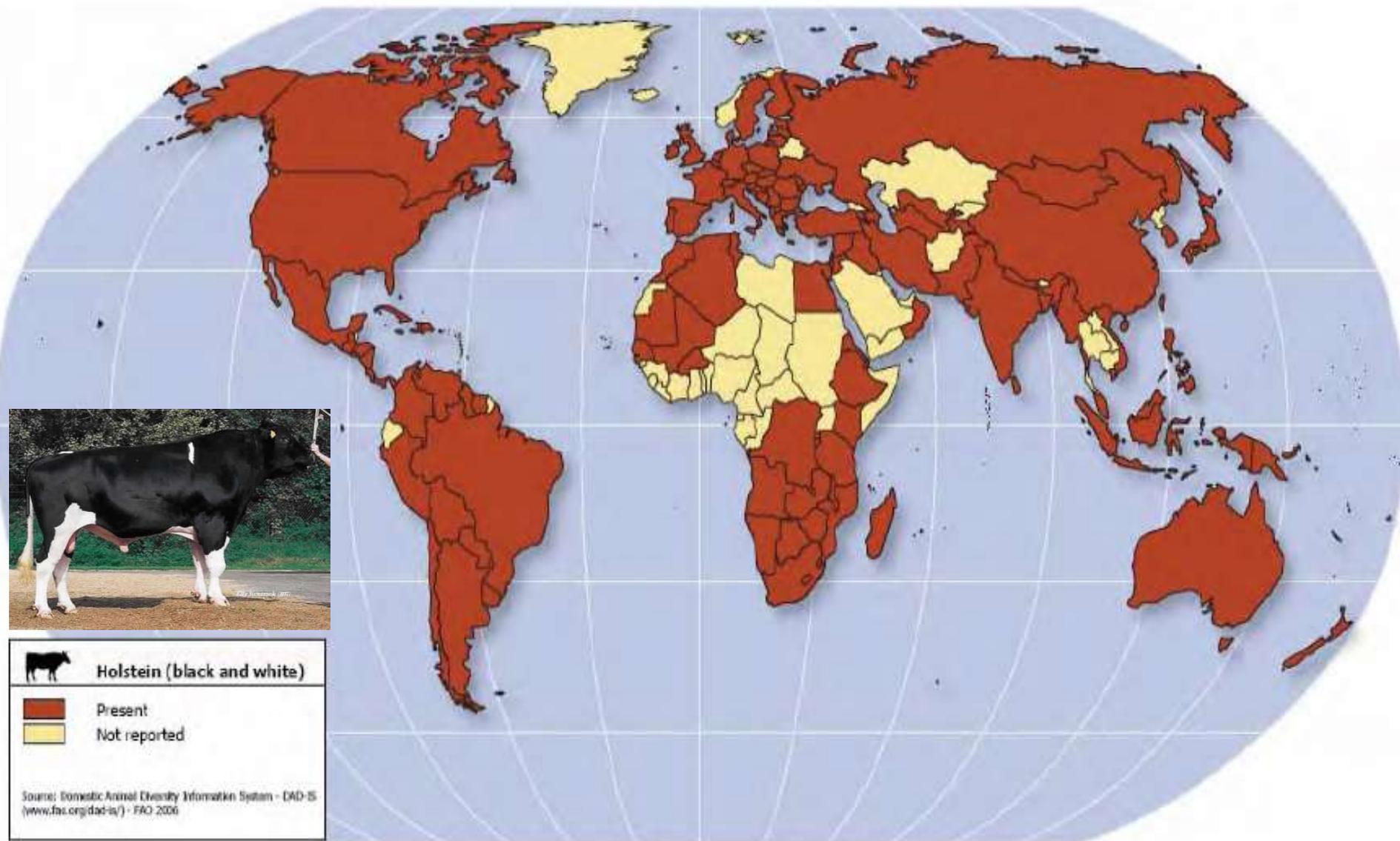
- Human migration
- War and conquest
- Breed formation

➔ Increase diversity



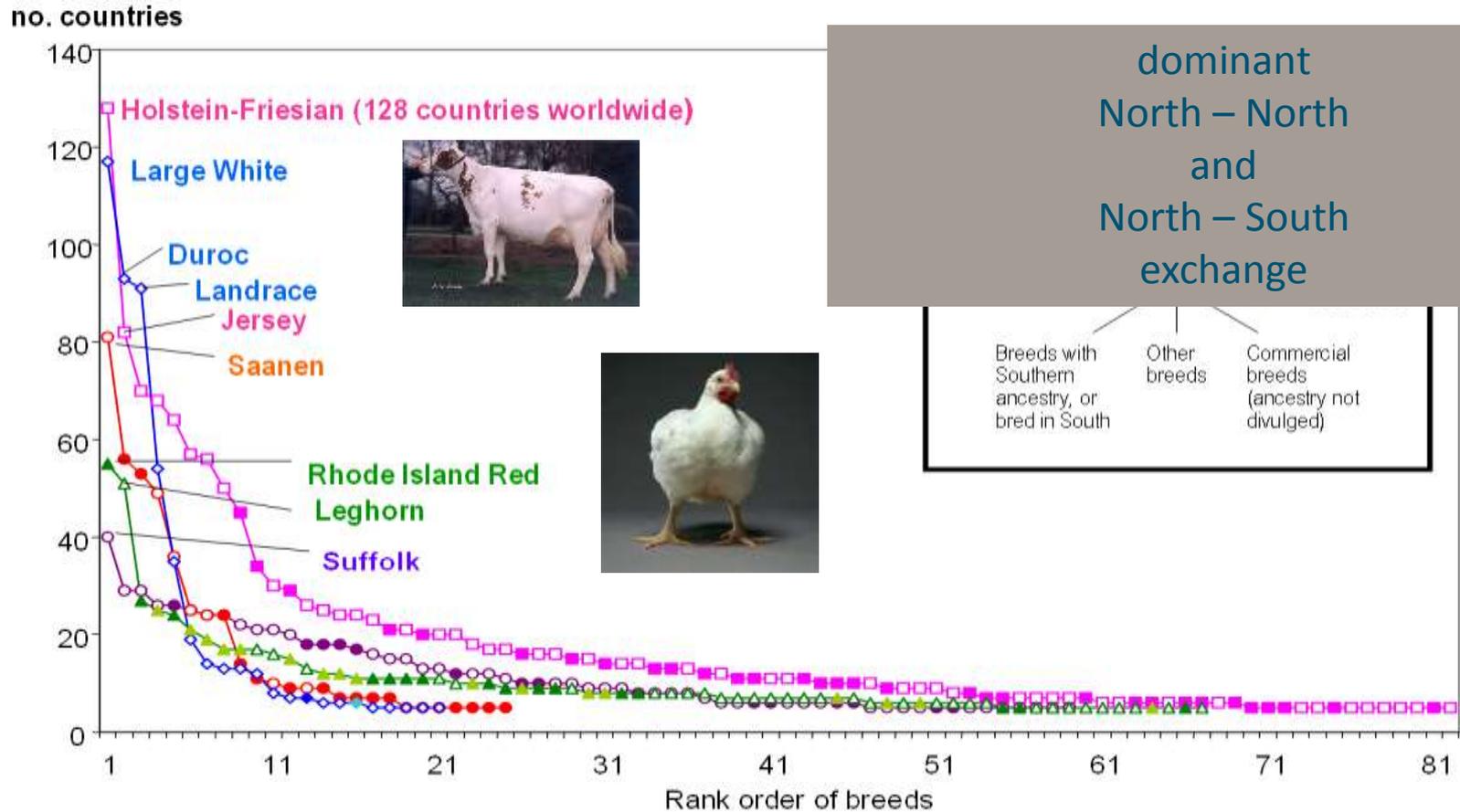
Diego Rivera's *La Conquista*

Lots of exchange between countries → international breeds

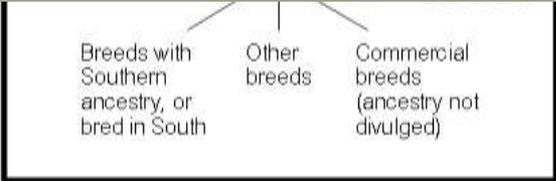


Distribution of internationalised breeds within the five major species

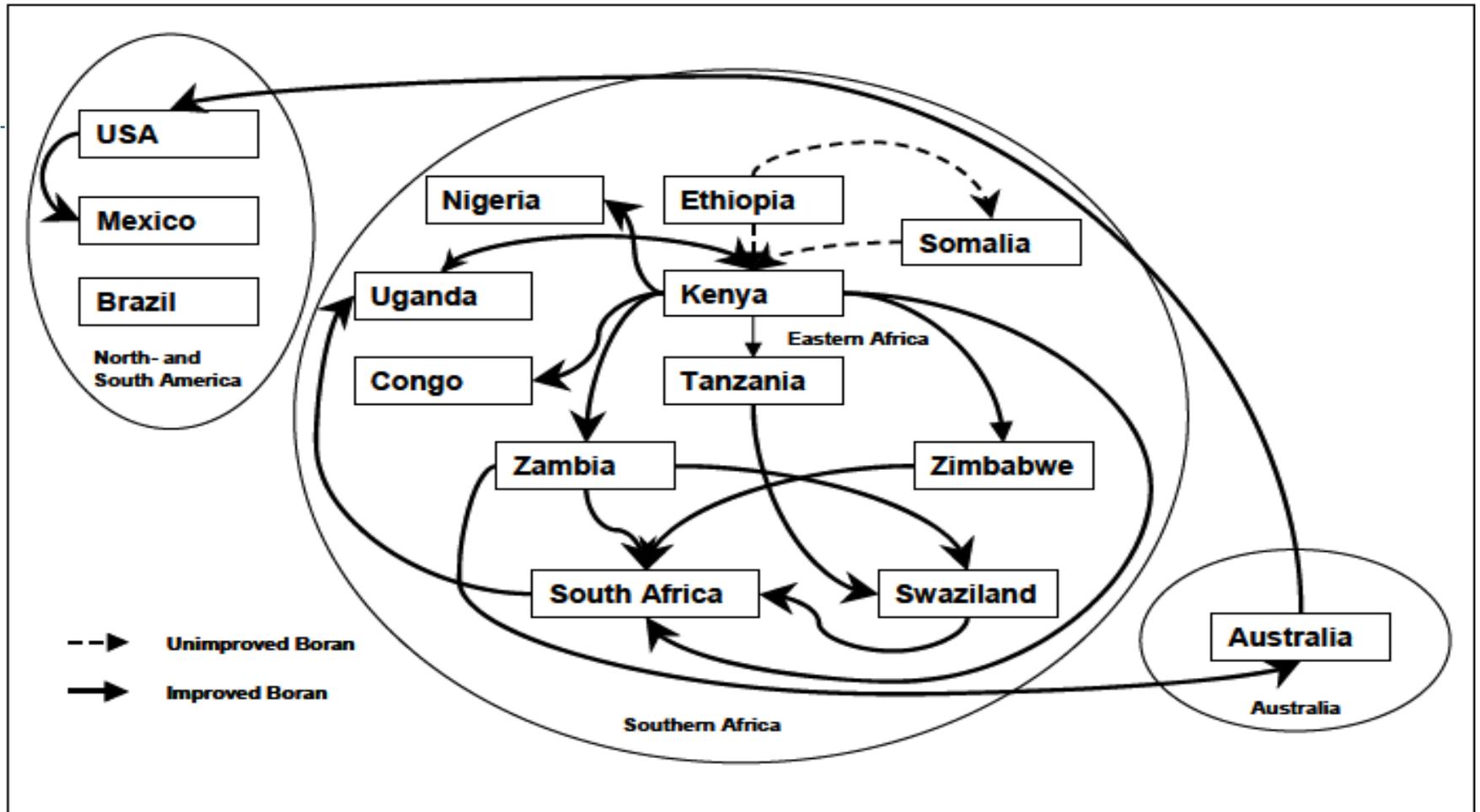
(Breeds in ≥ 5 countries, each breed is presented with a point, the top few breeds of each species are named)



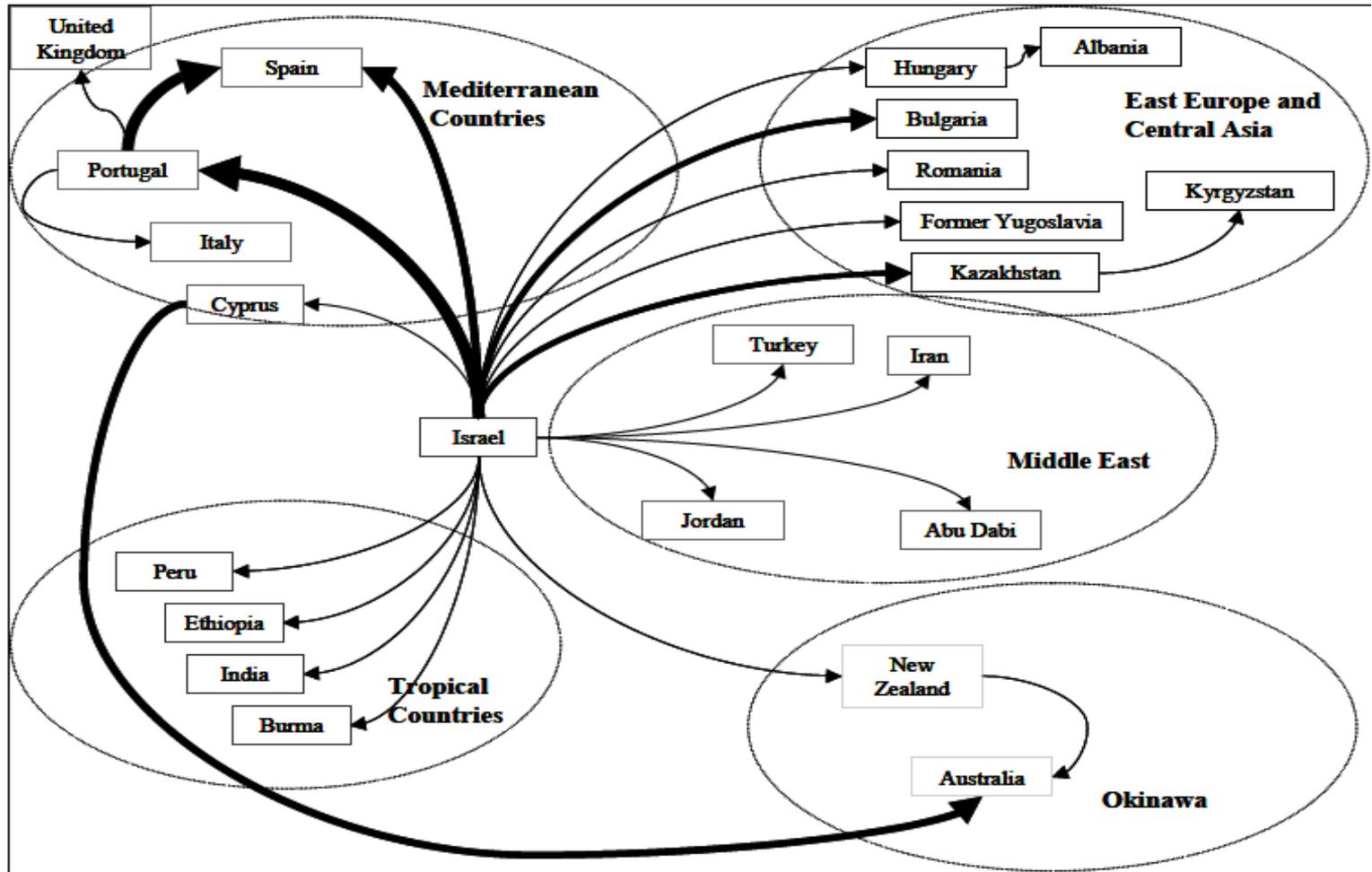
dominant
North – North
and
North – South
exchange



Worldwide transfers of Unimproved and Improved Boran cattle breeding material from Eastern and Southern Africa



World wide gene flow of the Improved Awassi and Assaf breeds of sheep from Israel



ZEBU BREEDS RAISED IN BRAZIL

- ❑ The zebu breeds originally introduced in Brazil are: Gyr, Guzerat, Nellore and Sindhi;
- ❑ Tabapuã and Indubrazil were formed in Brazil, through crossbreeding.

Breed	Registered animals (2006)	
	Number	Percentage
Gyr	7,853	3.86
Guzerat	6,647	3.27
Nellore	171,813	84.53
Sindhi	669	0.33
Indubrazil	940	0.46
Tabapuã	7,571	3.74
Brahman*	7,751	3.81
TOTAL	203,240	100.00

* Recent introduction



Source:
Arthur Mariante, 2010



NELLORE

- ❑ Nelore originates from Indian Zebu-type Ongole cattle, one of the last Indian breeds to attract interest of Brazilian breeders;
- ❑ Initial lack of interest of the breeders was due, particularly, to the shape of the ears, which were not thought to be standard among zebu breeds at the time;
- ❑ Brazil started to buy from India in the early 1900s
- ❑ 2005: some 85% of Brazil's 190 million cattle, had Nelore blood
- ❑ High adaptability to the tropical climate, together with its strong defense instinct and excellent calf survival
- ❑ In 2009, 2.6 million doses of Nelore semen have been sold in Brazil.
- ❑ Ongole population has greatly declined in its original range in coastal Andhra Pradesh (and is qualitatively inferior to Nelore)

Source:

Mathias, E. & Mundy, P. 2005

Arthur Mariante, 2010



- ❑ The Gyr breed arrived in Brazil in 1911;
- ❑ Only in the 40's the breed became more popular;
- ❑ New imports occurred in the 1960's with emphasis on milk production, originating a line called Dairy Gyr, whose numbers are increasing rapidly;
- ❑ Interest in animals or semen from this breed has been growing, not only in Brazil but also in other tropical countries;
- ❑ Around 500,000 Gyr semen doses are sold per year;
- ❑ Polled Gyr was formed using a local breed with Iberian origin, called National Polled.

Arthur Mariante, 2010



RECENT EXCHANGE AGREEMENTS BRAZIL INDIA

- ❑ After the last ban that forbid the importation of zebu cattle from India in 1962, Brazil and India re-started the discussion about Animal Genetic Resource exchange in 1998.
- ❑ Recently, Brazil and India signed two Agreements:
 - ❖ Agreement to import embryos from India
 - ❖ Agreement to export semen from Brazil

Source:
Arthur Mariante, 2010

Rare examples on successful introgression of exotic genotypes to main stream breeds

e.g. Meishan pig breed

South – North

Exchange



Photo: Keith Weller / Nebraska

el
reproductive trait to Western bro

ssbred animals
brids

ysiological regulation

Use of wild species almost negligible

Taihu introgression into western pig genotypes

Source
Pieter Knap,
2010

- Stable market since mid-1990s:
- ~ 100.000 replacement females per year in Europe + north America
- ... i.e. < 1.5 % of the total market volume
- ... with 12½ % penetration of the exotic genotype
- Huge R&D expense, mainly due to low carcass revenue from byproducts
- Significant contributions to science (reproductive physiology)
- Commercial disaster



Genex Meishan
The new generation female

(Click image for a larger version)



AnGR – Exchange – in summary

- Exchange has been and will be important for breed and livestock sector development
- Limited detailed information about global gene flow
 - Exchange between developed countries is dominant
 - Increasing North-South flow
 - Substantial South-South flows, but not very well documented
 - South-North flow very limited
- Veterinary standards/laws are the most relevant barriers
- Not-sustainable introductions of Northern breeds in South
- Demand for Southern genes to the North is currently limited

Future scenario's?

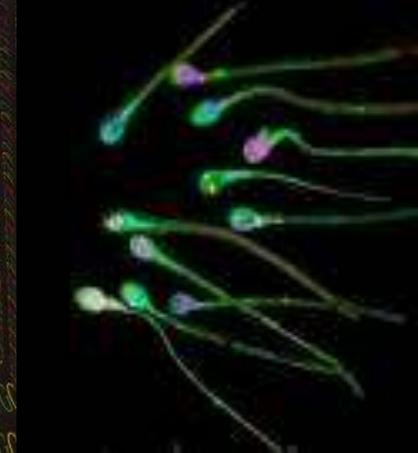
Future will be different ?!

Future developments may (further) change AnGR exchange patterns, and the relationships between stakeholder groups may become increasingly unbalanced

Biotechnology



PPL Therapeutics' five healthy female piglets, Millie, Christa, Alexis, Carrel and Dotcom, born on 5 March 2000, as a result of nuclear transfer (cloning) using adult cells.



Emerging diseases and climate change

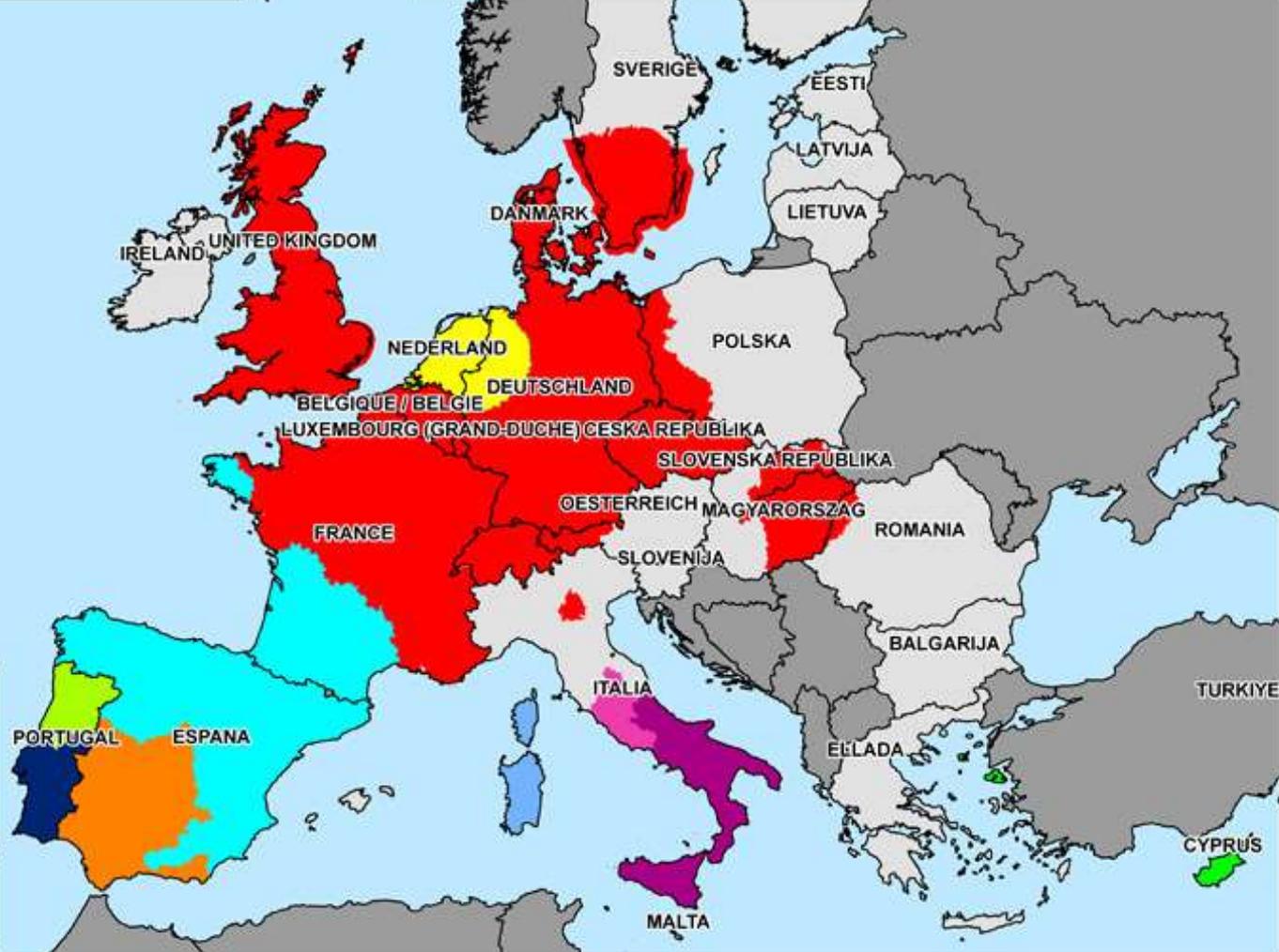
Bluetongue

Restricted zones* as of 19 November 2008

This map includes information on the bluetongue virus serotypes circulating in each restricted zone, which permits, for the purposes of Articles 7 and 8 of Regulation No 1266/2007, the identification of the restricted zones demarcated in different Member States where the same bluetongue virus serotypes are circulating.

Zone (serotypes)

- A (2,4,9,16)
- B (2,16)
- D (16)
- F (8)
- G (1,2,4,16)
- I (4,1)
- J (1)
- K (1,8)
- L (8,6)
- S (1,4,8)



* as defined in Article 2 (d) of Commission Regulation No 1266/2007: geographic areas where surveillance and/or protection zones have been demarcated by the Member States in accordance with Article 8 of Council Directive 2000/75/EC.

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AnGR Policy and Regulatory Framework

Interlaken, 7 Sep 2007

Accepted FAO documents on AnGR set goals for inventories, sustainable use, conservation and capacity building.

The latter encourages reviewing ABS issues



COMMISSION ON
GENETIC RESOURCES

FAO Global Plan of Action AnGR (2007)

- Characterization + monitoring
 - Sustainable use
 - Conservation
 - Capacity building
- Funding strategy



International legal framework for exchange, use and conservation of AnGR

- CBD – Nagoya protocol – Access and Benefit Sharing
- WTO – TRIPS – Patents
- WTO – SPS – Veterinary standards

“Currently, the exchange of AnGR is mainly regulated by the transfer of private ownership, and is particularly influenced by zoo-sanitary regulations”

CBD



Rio, 1992

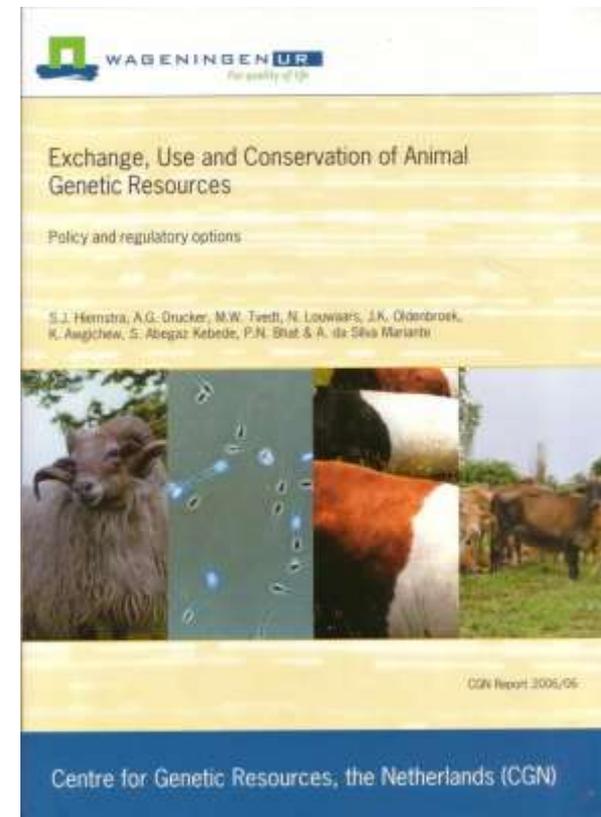
- Biodiversity, agrobiodiversity, including genetic resources for food and agriculture
- Promoting conservation and sustainable use of biodiversity
- Access to genetic resources and the fair and equitable sharing of benefits arising from their utilization (ABS)
- National responsibility and national sovereignty
- 'Benefit sharing' is important issue

Animal Genetic Resources: Policy issues?

- How to halt further genetic erosion and promote sustainable breeding and use?
- Is there a need to further regulate exchange?
- How to balance different systems of rights, e.g.
 - sovereign rights of nations
 - intellectual property rights
 - communal rights / rights of livestock keepers

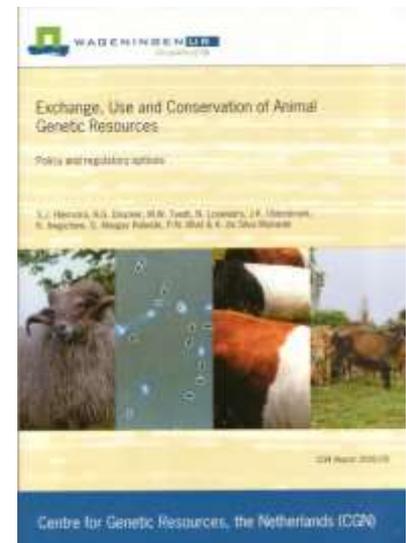
Conclusions Hiemstra et al. (2006): Exchange

- Currently, the negative impact of introduction of high-output breeds (N-S) may be more relevant than South-North movements
- Need for (voluntary) instruments to guide *responsible exchange* of AnGR, globally
 - Genetic impact assessment
 - Model (standard) MTA
 - Guidelines or 'codes of good practice'



Conclusion Hiemstra et al. (2006): Conservation

- Urgent need to place due emphasis on the conservation and sustainable use of AnGR at the national level, supported by regional and global cooperation
 - Raise awareness among citizens, consumers, policy makers and livestock sector stakeholders
 - *In situ* conservation initiatives, in particular strengthening of breeding and marketing of local breeds
 - *Ex situ* conservation programs
 - Monitoring of status and trends



Rationale for the PGR Treaty applying this rationale to AnGR

PGR Treaty	Relevance of arguments for AnGR sector
Need to conserve PGR	Very relevant
Need to sustainably use PGR	Very relevant
Need to address ABS	Arrangements for ABS appear adequate
Existence of international/regional gene banks for PGR before the CBD	Lack of international/regional gene banks for AnGR
Ex-situ collections in public domain	No, generally private ownership of AnGR
Need to ensure access to these ex-situ collections	Limited needs so far
Need to support maintenance of gene banks and PGR conservation activities in developing countries	Yes, obligation of developed countries under the CBD so far limited use of genetics from developing countries

The Nagoya Protocol on Access and Benefit-Sharing

Wageningen – ABS-AnGR-Workshop (2010)

- What makes Animal Genetic Resources special ?
 - How does the exchange of Animal Genetic Resources work ?
 - Which measures on ABS are needed to conserve and promote the sustainable use of AnGR ?
- 60 participants: all stakeholder groups, all global regions represented
- Collaboration with FAO, funded by Dutch, Norwegian and Swiss governments

Main characteristics of AnGR (Wageningen, 2010)

- Between and within breed diversity is under threat
- Conservation by utilization is important strategy, conservation is relatively expensive and complex
- Selection programmes are incremental and make use of within and between breed variation
- Limited flows of AnGR from “South” to “North” (however, there is exchange for research purposes)
- Flows of improved breeding material from “North” to “South” are dominant → sustainability issues
- AnGR hardly in the public domain (private ownership)

ABS-AnGR Workshop

suggestions/outcomes

- Expectations of developing countries regarding benefit sharing for AnGR may not be realistic
- Alternative measures are needed to raise funds for conservation purposes
- FAO Global Plan of Action is proper framework to promote conservation and sustainable use of AnGR
- Negotiating a specific legally binding international Treaty for AnGR should not be a first choice
- Need to develop voluntary instruments (guidelines, model material transfer agreement, etc.)
- North-South collaboration → Capacity building

Table 1: Distinctive features of genetic resources for food and agriculture		WG AnGR⁹	WG FGR¹⁰	WG PGR¹¹
A. The role of GRFA for food security	A.1 GRFA are an integral part of agricultural and food production systems and play an essential role for achieving food security and the sustainable development of the food and agriculture sector.		-	+
	A.2 Plant, animal, invertebrate and micro-organism GRFA form an interdependent network of genetic diversity in agricultural ecosystems.		-	
B. The role of human management	B.1 The existence of most GRFA is closely linked to human activity and many GRFA can be regarded as human-modified forms of genetic resources.			
	B.2 The maintenance and evolution of many GRFA depend on continued human intervention, and their sustainable utilization in research, development and production is an important instrument to ensure conservation.	+		
C. International exchange and interdependence	C.1 Historically, GRFA have been widely exchanged across communities, countries and regions over often long periods of time, and a relevant part of the genetic diversity used in food and agriculture today is of exotic origin.	+		+
	C.2 Countries are interdependent with regard to GRFA and act both as providers of some GRFA and as recipients of others.		-	
	C.3 The international exchange of GRFA is essential to the functioning of the sector, and its importance is likely to increase in future.	+	-	+
D. The nature of the innovation process	D.1 The innovation process for GRFA is usually of incremental nature and the result of contributions made by many different people, including indigenous and local communities, farmers, researchers and breeders, in different places and at different points in time.	+	-	+
	D.2 Many GRFA products are not developed out of an individual genetic resource, but with the contributions of several GRFA at different stages in the innovation process.			+
	D.3 Most products developed with the use of GRFA can in turn be used as genetic resources for further research and development, which makes it difficult to draw a clear line between providers and recipients of GRFA.		-	+
	D.4 Many agricultural products reach the market place in a form in which they may be used both as biological resources and as genetic resources.	-	-	

Table 1: Distinctive features of genetic resources for food and agriculture

		WG AnGR ⁹	WG FGR ¹⁰	WG PGR ¹¹
E. Holders and users of GRFA	E.1 GRFA are held and used by a broad range of very diverse stakeholders. There are distinct communities of providers and users with respect to the different subsectors of GRFA.	+		+
	E.2 The different stakeholders managing and using GRFA are interdependent.		-	
	E.3 A significant amount of GRFA is privately held.	+		
	E.4 An important part of GRFA is held and can be accessed <i>ex situ</i> .	-		
	E.5 An important part of GRFA is conserved <i>in situ</i> and on farm under different financial, technical and legal conditions.	+	+	
F. GRFA exchange practices	F.1 The exchange of GRFA takes place in the context of customary practices and existing communities of providers and users.	+	+	+
	F.2 An extensive transfer of genetic material between different stakeholders along the value chain occurs in research and development.	+		
G. Benefits generated with the use of GRFA	G.1 While the overall benefits of GRFA are very high, it is difficult to estimate at the time of the transaction the expected benefits of an individual sample of GRFA.			+
	G.2 The use of GRFA may also generate important non-monetary benefits.		+	
	G.3 The use of GRFA may lead to external effects going far beyond the individual provider and recipient.		+	



Thank you for your attention and contributions



Thanks to colleagues to contribute slides

Centre for Genetic Resources, the Netherlands