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An overview on the conservation programs of Animal Genetic Resources in Italy

Luca Buttazzoni

National Coordinator NFP AnGR of Italy

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National breeding programs for farm animals have been active in Italy since the end of WWII

50's and 60's of last Century → substitution of local with cosmopolitan breeds

70's → new interest in local, traditional breeds

National Breeders Associations → **Recognized Breed Societies**
[Today: Reg (EU) 2016/1012, art.2, par.5]
Italian Breeders Association (AIA) and 15 Regional Associations → **Third Party**
[Today: Reg (EU) 2016/1012, art.8, par.4]

The Ministry of Agriculture (MASAF) has long supported the cost of these programs by national funds
EU rules allow for such State aids *[Reg.(EU) 2022/2472, art.27, par.2]*
- Irreversible genetic improvement
- Preservation of AnGR

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The entire system is based on purebred animals

According to Reg.2016/1012, art.2, point 2:
'**breed**' means a population of animals sufficiently **uniform** to be considered distinct from other animals of the same species by one or more **groups of breeders** which have agreed to enter those animals in **breeding books** with details of their known ascendants for the purpose of reproducing their inherited characteristics by way of reproduction, exchange and selection within the framework of a **breeding programme**.

Some applications are just based on identity reasons, just to revive a local, traditional name

Alternative names (aliases) may be used: a breed has a unique official name, but it can be referred to by many other local names.

The method proved to be effective !

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Breeds at risk are listed in a periodically updated Ministerial decree (last March 2023)
Risk of genetic erosion is generally assessed by FAO criteria
Data are regularly recorded in DAD-IS

Specie	n.Breeds	n.Breeding females	min-Max Fem./breed	n.Herds	n.Breed Societies
Donkey	8	9,144	37 – 3,286	3,331	2
Cattle	20	42,988	43 – 7,097	3,003	7
Goats	33	36,335	4 – 6,618	989	1
Horses	23	17,500	13 – 3,518	10,023	3
Pigs	9	9,360	134 – 3,901	522	1
Poultry	38	4,858	2 – 900	151	1
Rabbits	5	141	2 – 96	20	1
Sheep	44	61,544	13 – 5,880	1,209	1
Total	180	181,870	2 – 7,097	≈ 19.248	17

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The European Green Deal influenced the CAP Program 2014-2022

The Italian Ministry then asked Breed Societies to strive for new objectives:
Animal welfare, GHG emissions, Reproductive efficiency and **biodiversity preservation**

In an effort to systematize selection activities, the National and Regional Governments agreed to co-fund a National Rural Development Plan aimed to deeply innovate Italian Breeding Programs of farm animals

Two specific measures were co-funded by national and EU funds:
10.2 : for the characterization and preservation of farm animal breeds and their genetic variability and for the improvements in the sustainability of commercial breeds;
16.2 : for the development of a unique open data base with phenotypic and genetic animal data.

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Measure 10.2 was divided in 9 sections:

- **Dairy cattle,**
- **Dual Purpose cattle,**
- **Beef cattle,**
- **Buffaloes,**
- **Horses and Donkeys,**
- **Sheep and Goats,**
- **Swine,**
- **Rabbits,**
- **Poultry**

Per each sector, only one application could be accepted

Measure 10.2 was run by partnerships with Universities and Research Institutes

To date, Swine and Rabbits have already completed their programs while the others are coming to an end by mid 2025

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	2018 -2021			2021 – 2023		
	Project	N.Benef.	N.Breeds	Project	N.Benef.	N.Breeds
Dairy cattle	LATTeco	2	3	LATTeco 2	1	3
Dual purpose	DUAL BREEDING	5	16	DUAL BREEDING 2	5	16
Beef cattle	I-Beef	3	14	I-Beef 2	3	16
Buffalo	-----	0	0	BIG	2	1
Horses	Equinbio	3	30	Equinbio 2	4	32
Sheep & Goat	CHEESR	1	11	Sheep & Goat	1	67
Swine	SUIS	1	10	SUIS 2	1	11
Rabbit	CUN-FU	1	33	CUN-FU 2	1	46
Poultry	TuBAvI	7	34	TuBAvI 2	6	21

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	Mandatory Actions in each program
1	Phenotypic Characterization (Authochtonus breeds only)
2	Genetic Characterization
3	Data editing and cross-check
4	New genetic and genomic tools for welfare, emission reduction and reproduction
5	Control of genetic diversity and inbreeding and on station data recording
6	Genetic distances among authochtonus breeds
7	Detection of innate and acquired genetic resistance to diseases
8	*In frigido* conservation of biological samples and germplasm
9	Mating schemes for small populations
10	Information, dissemination and diffusion of results

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PHENOTYPIC CHARACTERIZATION (Local Breeds Only)

Altogether 691.000 measures were taken on farm across all animal species:

Body measures relevant for the species
On field image analysis was used trying to simplify recording.

New phenotypes were collected on farm: locomotion score and temperament score in beef cattle, frayed fleece, nail hygiene in sheep, crushed piglets in pigs, ...

A large effort was produced to better describe rabbit and poultry breeds

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PHENOTYPIC CHARACTERIZATION

http://www.dualbreeding.com/it/razze/modicana

MODICANA, 31.12.2022:

162 bulls
4,264 cows
In 278 herds

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1) Coat color and distribution, shape of horns

Colore mantello	N°	%	Mantello distrib.	N°	%	Corna	N°	%
Bianco	0	0	Intero	1338	94.7	Assenti	50	3.5
Grigio	0	0	Pezzato	6	0.4	Portate in alto	1008	71.3
Nero	13	0.9	Spruzzato	0	0	Portate in avanti	185	13.1
Bruno Chiaro	5	0.4	Striscia Dorsale	69	4.9	Rivolte in basso	20	1.4
Bruno Scuro	3	0.2				Decornato	150	16.6
Castano	17	1.2						
Fromentino	183	12.9						
Rosso	838	59.3						
Rosso Mogano	0	0						

2) Body conformation

	N°	Media	Ds	Min.	Max.
Altezza al sacro (cm)	1413	150.0	8.4	130	170
Profondità addominale (cm)	1413	77.5	7.3	56	95
Lunghezza tronco (cm)	1413	82.3	5.9	70	110
Lunghezza groppa (cm)	1413	46.6	5.6	34	62
Larghezza groppa bisiliaca (cm)	1413	47.3	4.6	33	63
Larghezza groppa bisischiatica (cm)	1413	25.3	6.1	10	39
Inclinazione groppa (punteggio)	1413	6.4	1.1	1	9
Prof. mammaria (cm)	1413	12.4	7.3	-15	40
Lunghezza capezzoli anteriori (cm)	1413	9.6	3.2	3	25
BCS (punteggio)	1413	2.8	0.4	1.75	4.5
Muscolosità anteriore (punteggio)	1413	3.1	1.2	1	9
Muscolosità Posteriore (punteggio)	1413	3.1	1.3	1	9

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3) Defects of structure

	Difetto Assente		Difetto Lieve		Difetto Marcato	
	N°	%	N°	%	N°	%
Dorso Insellato	716	50.7	602	42.6	95	6.7
Dorso Arcuato	1380	97.7	33	2.3	0	0.0
Spalle Deboli	949	67.2	435	30.8	29	2.0
Garretti serrati posteriormente	1080	76.4	285	20.2	48	3.4
Unghia aperta	1013	71.7	330	23.4	70	5.0

4) Defects of udder

	Difetto Assente		Difetto Lieve		Difetto Marcato	
	N°	%	N°	%	N°	%
Capezzoli a imbuto	1009	71.4	293	20.7	111	7.9
Capezzoli non perpendicolari	1204	85.2	197	13.9	12	0.8
Capezzoli soprannumerari	884	62.6	439	31.1	90	6.4
Mammella spaccata tra i quarti	770	54.5	582	41.2	61	4.3
Piano inclinato	769	54.4	582	41.2	123	8.7

5) Temperament

	Non osservabile		Tranquillo		Nervoso	
	N°	%	N°	%	N°	%
Verso gli altri animali	917	64.9	489	34.6	7	0.5
Durante la mungitura	931	65.9	470	33.3	12	0.9
Verso l'uomo	830	58.7	524	37.1	59	4.2

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CONTROL OF GENETIC DIVERSITY AND INBREEDING AND ON STATION DATA RECORDING

The legal definition of "breed" does not consider genomic characterizations:
However, once the breed is recognized, genomic characterizations are essential

- to better define the breed
- to define genetic distances from other breeds and then priorities in conservation strategies

Genetic Diversity was determined in a variety of approaches:

Observed Omozygosity (Ho), expected heterozygosity (He), minimum allele frequency (MAF), Pedigree (F) and genomic inbreeding (Fhom)

ROH were used to estimate old and recent inbreeding in many species;

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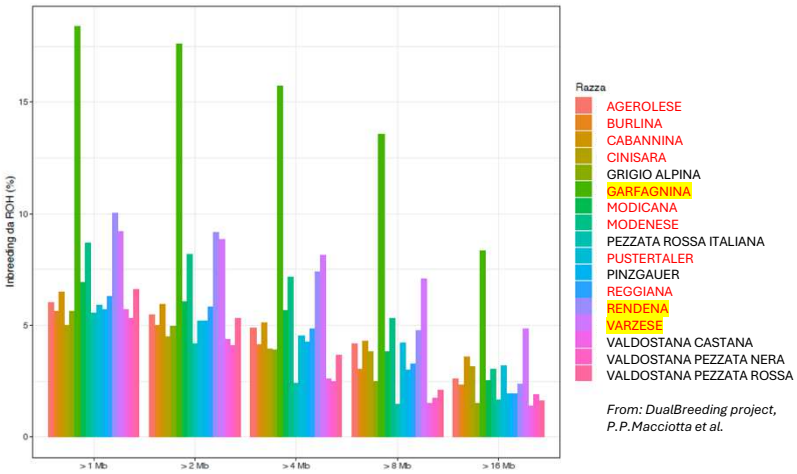
CONTROL OF GENETIC DIVERSITY AND INBREEDING

Dual purpose cattle
ROH Inbreeding as ROH length increases



From: DualBreeding project, P.P.Macciotta et al.

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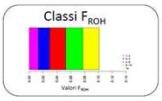
CONTROL OF GENETIC DIVERSITY AND INBREEDING

FRISA VALTELLINESE

F_{ROH} medio 0.10
H_e Attesa 0.38
H_o Osservata 0.38

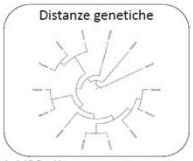
N° allevamenti 92
N° soggetti 2174

Classi F_{ROH}



Distribuzione allevamenti

Distanze genetiche

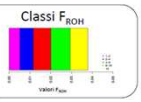


NICASTRESE

F_{ROH} medio 0.038
H_e Attesa 0.414
H_o Osservata 0.408

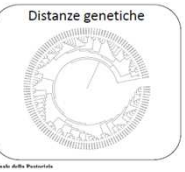
N° allevamenti 73
N° soggetti 5684

Classi F_{ROH}



Distribuzione allevamenti

Distanze genetiche



Genetic characterization of two sheep local breed

From: Sheep & Goat project. P.Crepaldi et al.

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GENETIC DISTANCES AMONG AUTHOCHTONOUS BREEDS

Different approaches were taken to estimate genetic distances, all based on SNP Panel data:

- Principal Component Analysis;
- Multi Dimesional Scaling (MDS);
- Reynold; Nei; Rogers and Edwards genetic distances.

Also, Population structures were analyzed by ADMIXTURE

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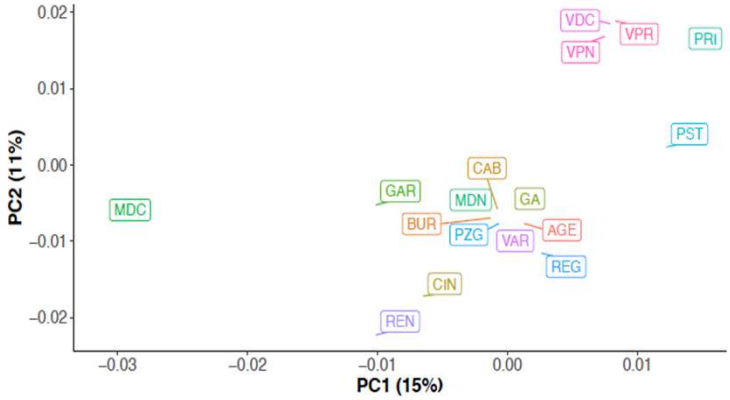
GENETIC DISTANCES AMONG AUTHOCHTONOUS BREEDS



AGE: AGEROLESE
BUR: BURLINA
CAB: CABANNINA
CIN: CINISARA
GA : GRIGIO ALPINA
GAR: GARFAGNINA
MDC: MODICANA
MDN: MODENESE
PRI: PEZZATA ROSSA ITALIANA
PST: PUSTERTALER
PZG: PINZGAUER
REG: REGGIANA
REN: RENDENA
VAR: VARZESE
VDC: VALDOSTANA CASTANA
VPN: VALDOSTANA PEZZATA NERA
VPR: VALDOSTANA PEZZATA ROSSA

From: DualBreeding project, P.P.Macciotta et al.

Dual Purpose Cattle: Principal Components from the matrix of molecular markers

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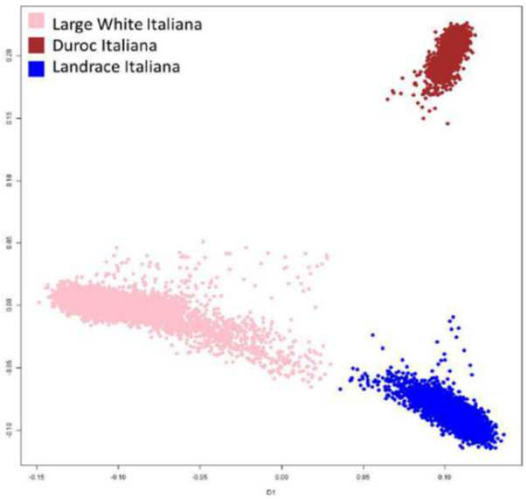
GENETIC DISTANCES AMONG AUTHOCHTONOUS BREEDS



Swine: Multi Dimensional Scaling

From: SUIS project, L.Fontanesi et al.

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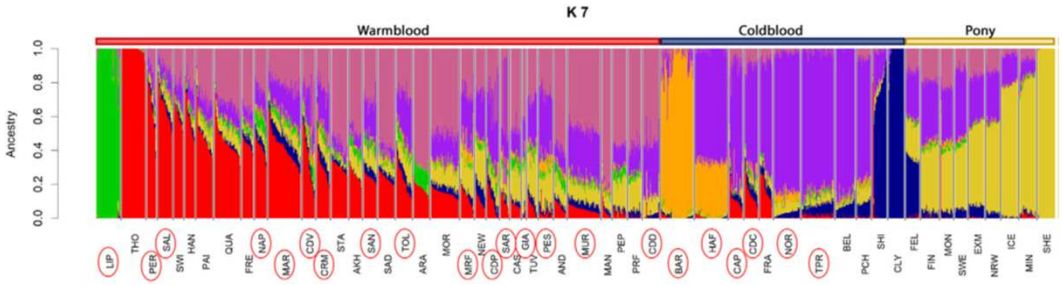
GENETIC DISTANCES AMONG AUTHOCHTONOUS BREEDS



Admixture plot at K = 7 from the International dataset. On the top of the graph, color bars indicate groups of breed types: warmblood breeds are marked in red, coldblood breeds in blue and ponies in yellow

S.Capomaccio, M.Ablondi, D.Colombi, C.Sartori, A.Giontella, K.Cappelli, E.Mancin, V.Asti, R.Mantovani, A.Sabbioni, M.Silvestrelli; Exploring the Italian equine gene pool via high-throughput genotyping; Frontiers in genetics, 23.01.2023, DOI: 10.3389

Project Equinbio 2

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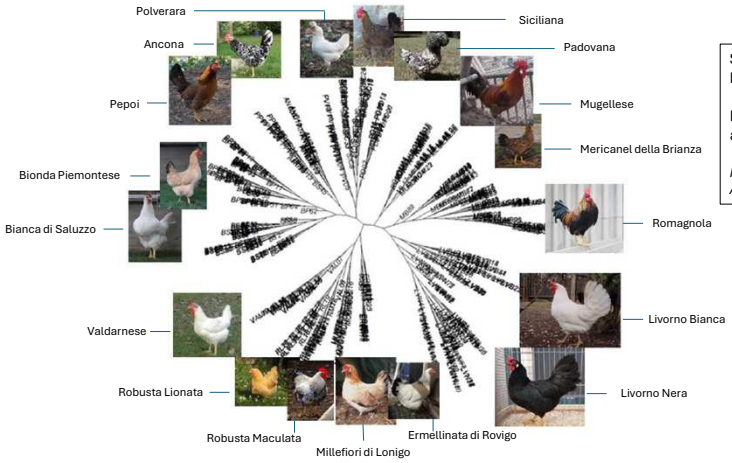
GENETIC DISTANCES AMONG AUTHOCHTONOUS BREEDS



Shared alleles distances based on microsatellites.

Probabilistic breed assignement error < 1 %

From: TuBAvl project A.Schiavone et al.

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DETECTION OF INNATE AND ACQUIRED GENETIC RESISTANCE TO DISEASES

Cytokines (CXCL8, IL26, and IFN-γ) and CD4 limphocytes have been investigated as mastitis markers in Simmental cattle

Data on frequency of many markers associated to diseases have been collected across breeds.
The less common were:

- Mutation in exon 6 of gene ATP2A1 in beef (associated to *Congenital Pseudo-myotonia*)
- SMARCA4 (BRG1) and WNT7A in buffalo (associated to *transverse hemimelia*)
- Frameshift mutation in FA2H gene (associated to *congenital ichthyosis* in Chianina cattle)
- G>A mutation in the KDM2B gene (associated to *Paunch Calf syndrome* in Romagnola cattle)
- Variants of TMEM154 gene in sheep (improved resistance to *Visna-Maedi virus*)
- MUC4 and MARC0090899 in pigs (improved resistance to *Enteritis*)
- WUR gene in pigs (improved resistance to *Porcine Respiratory Reproductive Syndrome* - PRRS)
- KIT gene in rabbits (associated to *megacolon* in piebald coated breeds)
- SNP in KIT gene in Cinta Senese pigs (associated to white belted coat)
- MSRB3 gene in rabbits (associated to ear and dental diseases)

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MATING SCHEMES FOR SMALL POPULATION

Most of the breeds at risk undergo mating programs just aimed to maintain genetic diversity:
Matings are suggested to breeders and services are provided to get males or semen

A special case is the State Stud of Lipizzan Horses, kept in genetic segregations since 1900.
The Stud is part of the multinational UNESCO ICH element: «Lipizzaner Horse Breeding Traditions»

Some small breed also undergo selection schemes, based on Optimal Contribution Selection (OCS) or in closed nucleus. We will see Saturday an example of the latter for the «Massese» sheep breed

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HOW TO SUPPORT TRADITIONAL BREEDS ?

There is nothing wrong in intensive breeding:
it efficiently produces nutritive food minimizing environmental impact per unit of products

However, the logic of intensive breeding is:
Genetic Improvement → Higher yield → More inputs → Higher yield

The preservation of local breeds need different economic scenarios:
The most immediate choice is to provide public support to «*in situ*» conservation
Regional RDP funds provide for such support in Italy

Today in Italy over 70 % of people live in the cities.
Their perception of «landscape», «nature» and «farm animals» has largely changed

- They consider «natural» the forests, and no longer the agricultural landscape;
- Pastoralism is seriously hindered by predators (wolves);
- Traditional systems are no longer economically sustainable.

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THE FUTURE ?

In general, the NRDP, measure 10.2, technically went very well and yielded al expected outputs

Most importantly, today Italian breeders are much more aware of the need to improve environmental and ethical sustainability of animal farming.

Also preservation of traditional breeds is nowadays recognized as an important goal by the public.

However, National and Regional Governments decided not to propose a similar NRDP in the new CAP programming.

Hopefully, in the future Italian Animal Breeding will return to be supported by farmers contributions and national funds.

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