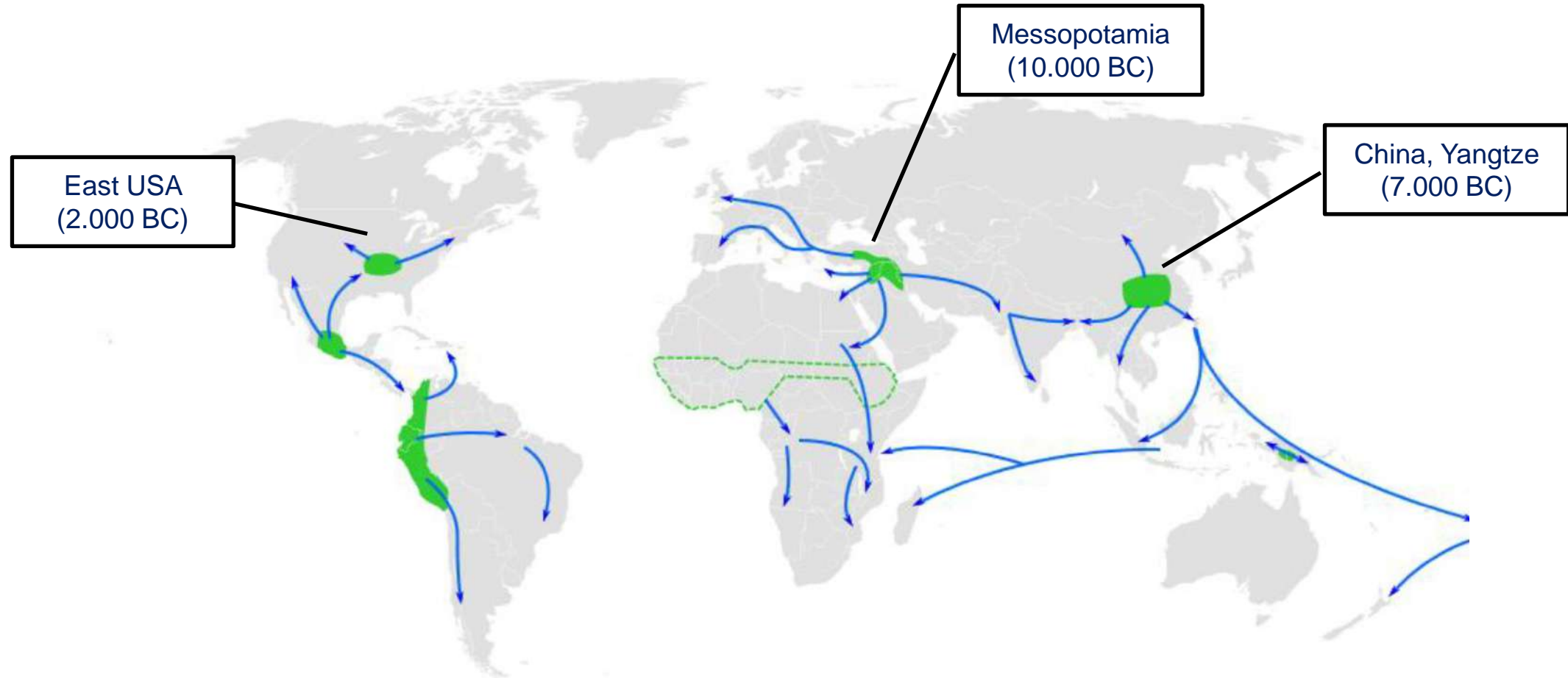




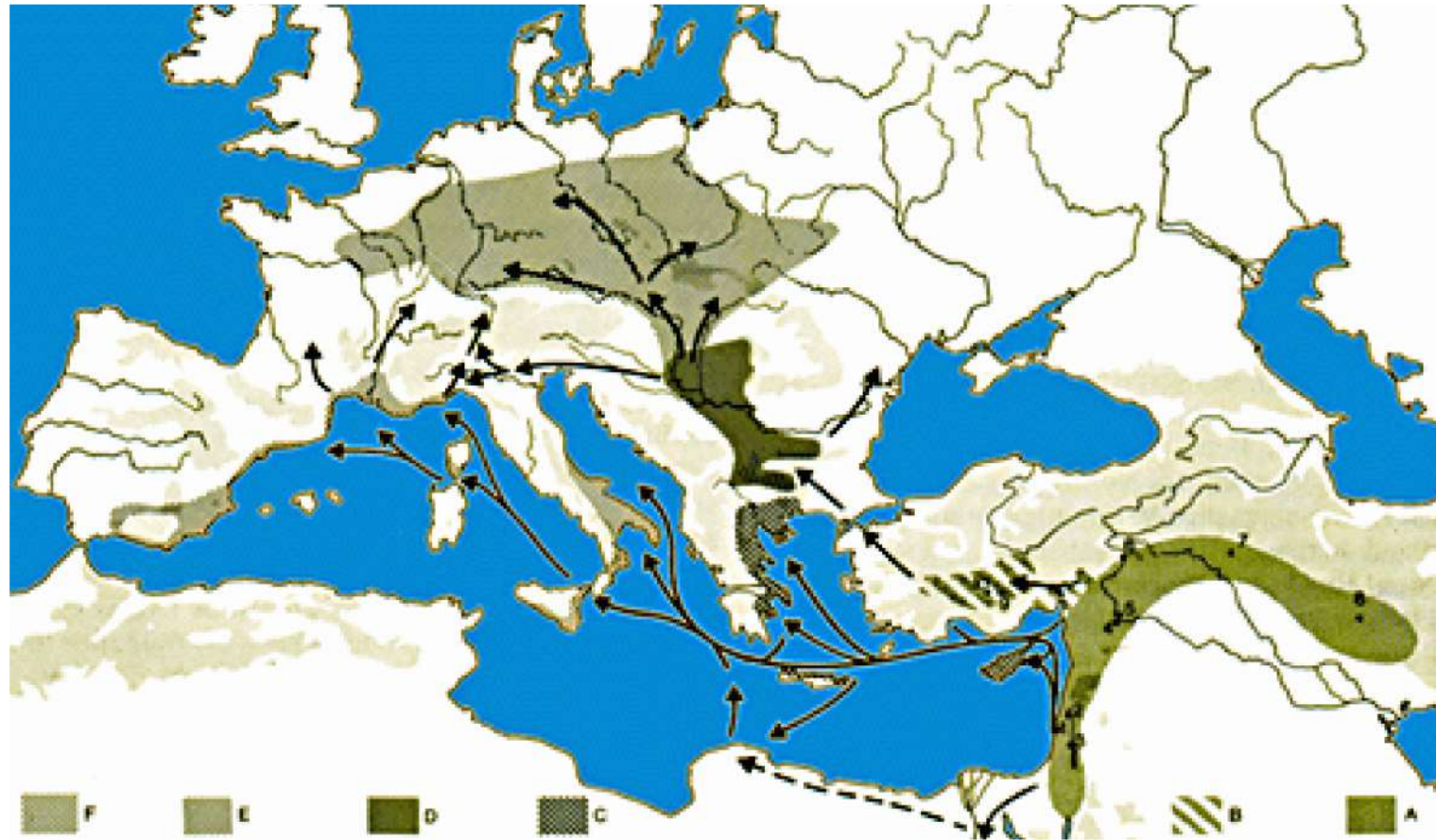
Exploiting the biodiversity: the case of indigenous breeds to produce traditional food products

*Prof. Notis Argiriou, University of the Aegean, Dept. Food Sciences and Nutrition
Deputy Director, CERTH | Institute of Applied Biosciences*

Prehistoric areas of agriculture and animal domestication

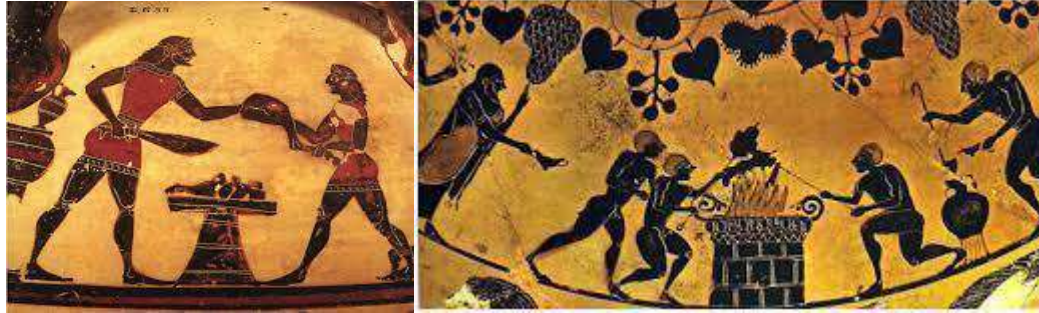


Animal domestication in Greece and Europe

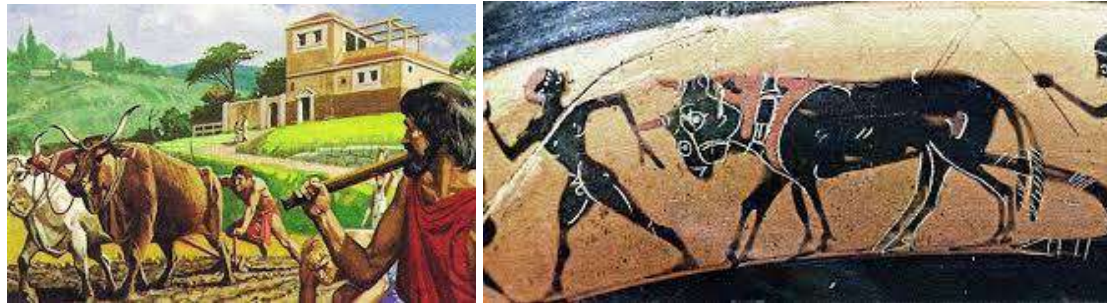


Animal uses in Greece – historical data

- Food



- Work



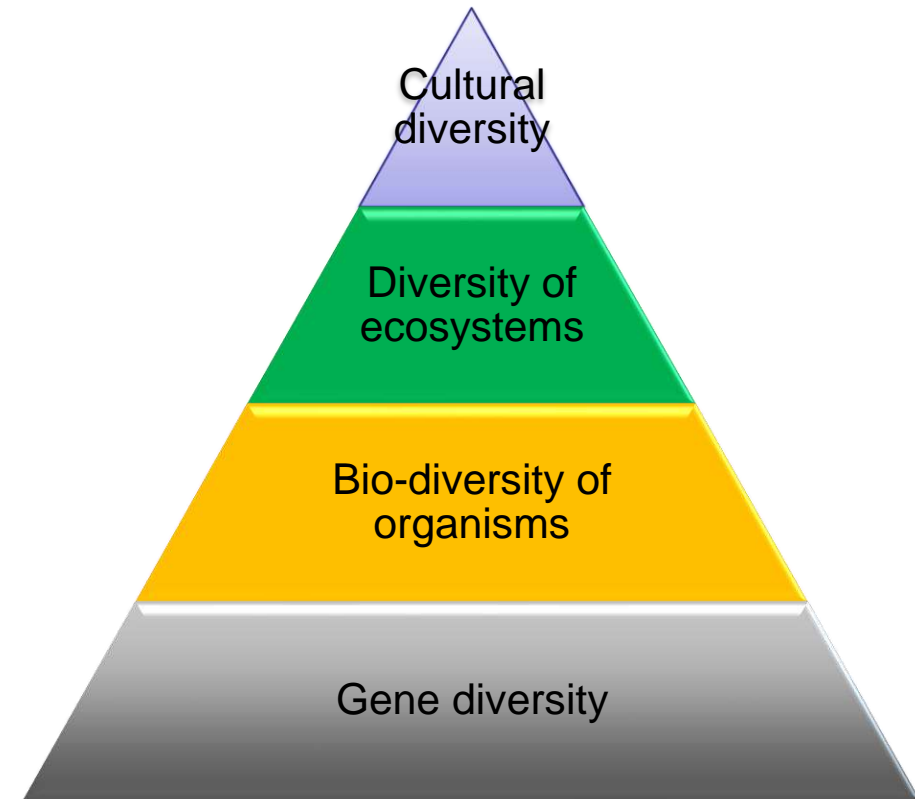
- Religion



Bio-diversity



- ❑ "biological diversity": variety and variability of life on Earth based on genetic differences
- ❑ "biodiversity of agro-ecosystems": variety of ecosystem diversity, the variety of species and ecological functions and processes that occur in different physical settings
- ❑ "biodiversity of culture": the historical process of accumulation of human stock, heritage, leading to the capability to use the biodiversity in a sustainable respect of the ecosystem



What happened the last 100 years in Greece

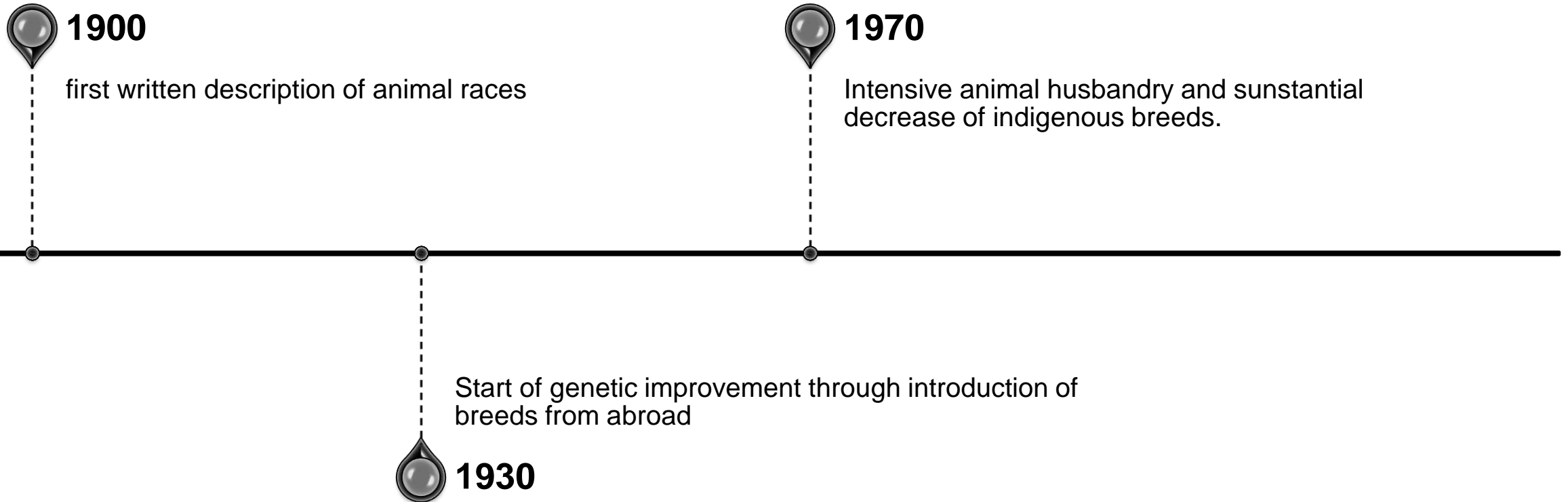
Autochthonous species were predominant till 50s

Substituted by imported more productive races

Extensive livestock converted to intensive



Historical milestones



List of Sheep and Goat breeds in Greece

Species	Breed	Population
Sheep	Agriniou	In danger of extinction
	Anogeion	threatened
	Argos	in danger of extinction
	Asterousiou	threatened
	Drama	threatened
	Zakinthos	threatened
	Thrakis	in danger of extinction
	Ikaria	in danger of extinction
	Kalaritiko	threatened
	Karagouniko	no risk
	Karistou	no risk
	Katafygiou	in danger of extinction
	Katsika	threatened
	Kefalinias	in danger of extinction
	Kimis	in danger

Species	Breed	Population
Goat	Lesvou	no risk
	Lefkimis	in danger of extinction
	Boutsko	no risk
	Pilioritiko	threatened
	Roumoukiou	in danger of extinction
	Sarakatsaniko	in danger of extinction
	Serron	threatened
	Skopelou	threatened
	Sfakion	no risk
	Florinas	threatened
	Frizarta	no risk
	Chalkidikis	in danger of extinction
	Chios	no risk
	Eghoria	no risk
	Skopelou	in danger

Why autochthonous breeds?

The indigenous Greek breeds present unique characteristics such as:

- Resistance to adverse environments
- Possibility of utilizing poor, barren areas - pastures
- Disease resistance
- Ability to survive with limited food and water
- Production of products, mainly milk and meat, with unique quality characteristics

OF GREAT ECONOMIC IMPORTANCE

Measures for the preservation of indigenous Greek breeds

Study of their physiological and productive properties

Genetic certification of breeds

Control of yields and implementation of genetic improvement programs

Improving conditions and / or changing their productive breeding system

Utilization of quality products and their connection with the appropriate markets

Establishment of conservation and conservation of rare breeds, depending on the risk of their extinction

ΟΡΓΕΙΤΙΚΗ ΑΣΙΑ ΑΝΑ 100g
AVERAGE NUTRITIONAL VALUE PER 100g

ΕΝΕΡΓΙΑ / ENERGY	273kJ (65.6)	ΛΙΠΗ / FAT	1.5g
ΠΡΟΤΕΙΝΕΣ / PROTEINS	14.8g	ΕΣΤΗΝ ΟΡΓΩΣΗΝ ΕΣΤΗΡΩΣΙΑ / OF WHICH SATURATED	0.6g
ΥΔΑΤΑΝΘΡΑΚΕΣ / CARBOHYDRATES	43.7g	ΨΑΤΕΣ / SUGAR	26.7g
ΕΣΤΗΝ ΟΡΓΩΣΗΝ ΣΑΚΧΑΡΩΝ / OF WHICH SUGARS	16.1g	ΝΑΤΡΙΟ / SODIUM	0.74g
ΕΣΤΗΝ ΟΡΓΩΣΗΝ ΑΜΥΔΩΝ / OF WHICH STARCH	27.6g	ΑΣΗΤΙ / SALT EQUIVALENT	1.89g
ΒΙΤΑΜΙΝΕΣ / VITAMINS			
	% ΕΝΕΡΓ. / % RDA*		% ΕΝΕΡΓ. / % RDA*
ΒΙΤΑΜΙΝΗ Β1 / THIAMIN	15.9mg — 31%	ΦΩΛΙΚΟ ΟΞΥ / FOLIC ACID	200µg — 100%
ΒΙΤΑΜΙΝΗ Β2 / VITAMIN B2	1.7mg — 33%	ΒΙΤΑΜΙΝΗ Β12 / VITAMIN B12	0.9µg — 36%
ΡΙΒΟΦΛΑΒΙΝΗ (B2) / RIBOFLAVIN (B2)	1.4mg — 28%	ΒΙΤΑΜΙΝΗ D / VITAMIN D	4.3µg — 86%
ΘΙΑΜΙΝΗ (B1) / THIAMIN (B1)	1.2mg — 24%	ΒΙΤΑΜΙΝΗ Ε / VITAMIN E	2.4mg — 24%
ΜΕΤΑΛΛΑ / MINERAL			
	% ΕΝΕΡΓ. / % RDA*		% ΕΝΕΡΓ. / % RDA*
ΑΛΕΣΤΙΟ / CALCIUM	340mg — 47%	ΜΑΓΝΗΣΙΟ / MAGNESIUM	230mg — 77%
ΣΙΣΗΡΟΣ / IRON	7mg — 50%	ΠΟΤΑΣΙΟΣ / POTASSIUM	7mg — 43%
ΦΩΣΦΟΡΟΣ / PHOSPHORUS	640mg — 80%		

* % ΕΝΕΡΓ. ΣΥΜΒΟΛΙΣΜΟΣ / SYMBOLIC REPRESENTATION / * % ENER. RECOMMENDED DAILY ALLOWANCE.
ΚΑΤΩ ΤΟ ΠΑΚΕΤΟ ΠΑΡΙΣΤΕΙ ΕΞΕΡΓΑΣΙΑ 12 ΜΕΡΩΝ / THIS PACKAGE CONTAINS APPROX. 12 SERVINGS



The authenticity and the identity of a food product is part of its existence

CREATING THE IDENTITY

Traceability and Identity

Nutritonal value

Place of poduction

Method of production

Historical link

Traceability

- Genetic and biochemical profile



How to chart and exploit the biodiversity with examples

INTRODUCTION TO GENETICS AND GENOMICS

What gives variation?

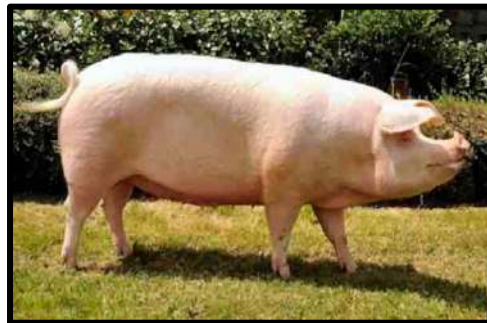
- Individuals of the same species have similar characteristics, but they are rarely identical.
- Genetic variation gives unique traits to an individual.

Differences
in the DNA
sequence



Phenotype

Height
Shape
Color
etc.



Productive

Yield
Composition
Reproduction
etc.

What gives variation?

- Genetic variation within family members.
- Way of inheritance.



**Differences
in the DNA
sequence**

Phenotype

Height
Shape
Color
etc.

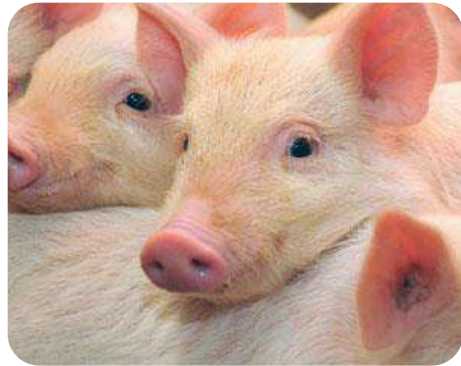
Productive

Yield
Composition
Reproduction
etc.

Genomics in livestock - DNA

In livestock genomic selection has led to

- Decreased generation intervals
- Accurate breeding value for young animals at birth
- Selection of production traits without impacting other desired traits



Genomics in livestock - DNA

Greek sheep and goat breeds



In Europe 7% of caprine breeds have disappeared and many more are at the verge of extinction

Disappearance may result in loss of traits that are essential for adaptation:

- resistance to various diseases
- ability to graze on poor pastures

Conservation of autochthonous breeds and strengthen local communities and products



Genomics in livestock - DNA

Aims

- Genetic characterization of Greek breeds
- Development of a genomic database mostly for small ruminants that can be used to improve the adapted germplasm

Breeders

- Improve productive and reproductive performances
- Select disease-resistant genotypes
- Help producers to reduce breeding costs through GS and AI

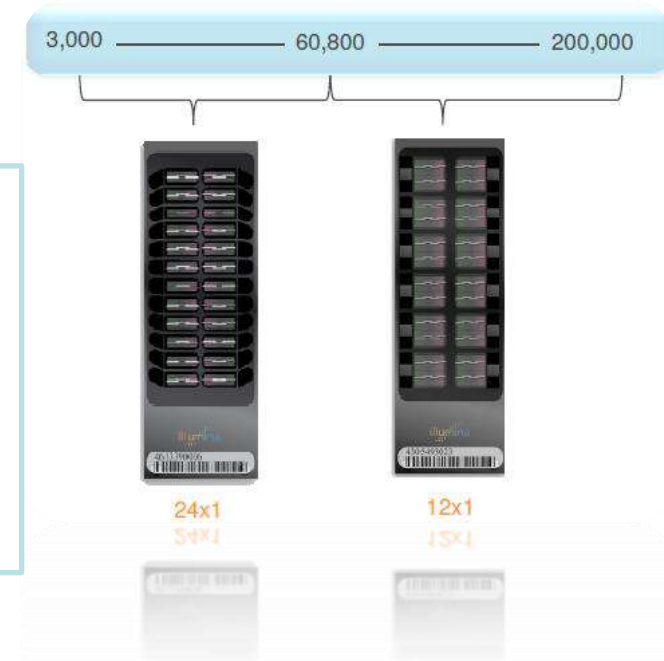
Consumers

- Increase food safety for consumers
- Help consumers' deception

Genomics in livestock - DNA

Genotyping microarrays

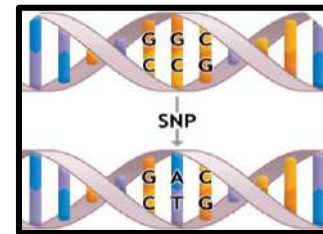
- Study up to 1,000,000 markers (SNPs / indels) for any species
- Focused, high-throughput genotyping applications



DNA



DNA Analysis



SNP detection



Selection

Genomics in livestock - DNA

Genotyping microarrays

Animal	#Markers
Ovine (LD)	5,409
Ovine (HD)	54,241
BovineHD	777,962
Bovine	54,609
Porcine	62,163
Goat	53,347
Chicken	57,636
Feline	62,897
Equine	65,157
Rainbow Trout, Deer, Turkey, Salmon ...	

Sheep breeds



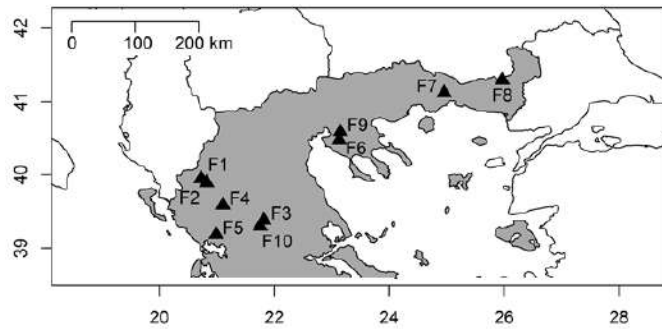
Goat breeds



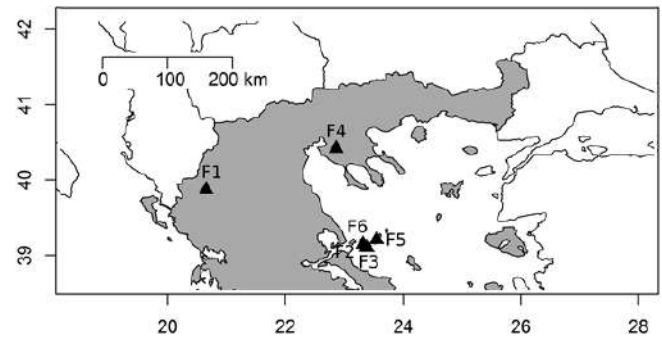
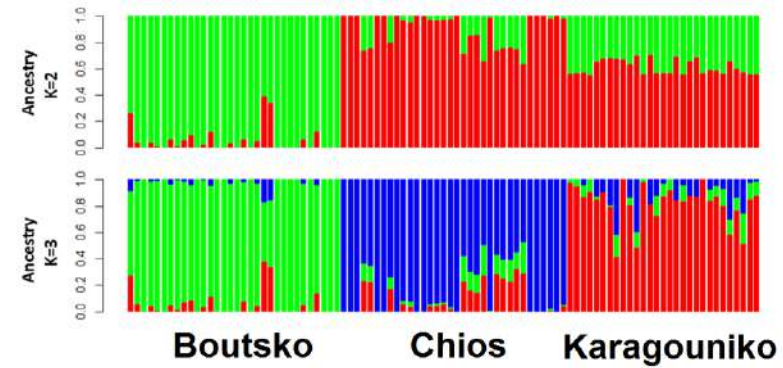
Genomics in livestock - DNA

Genotyping microarrays

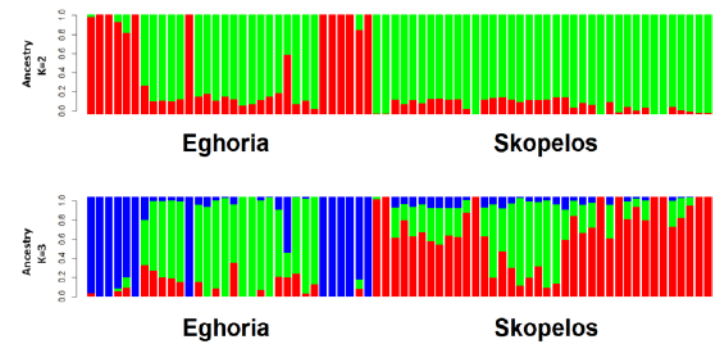
Population structure using ~40,000 SNPs



Sheep

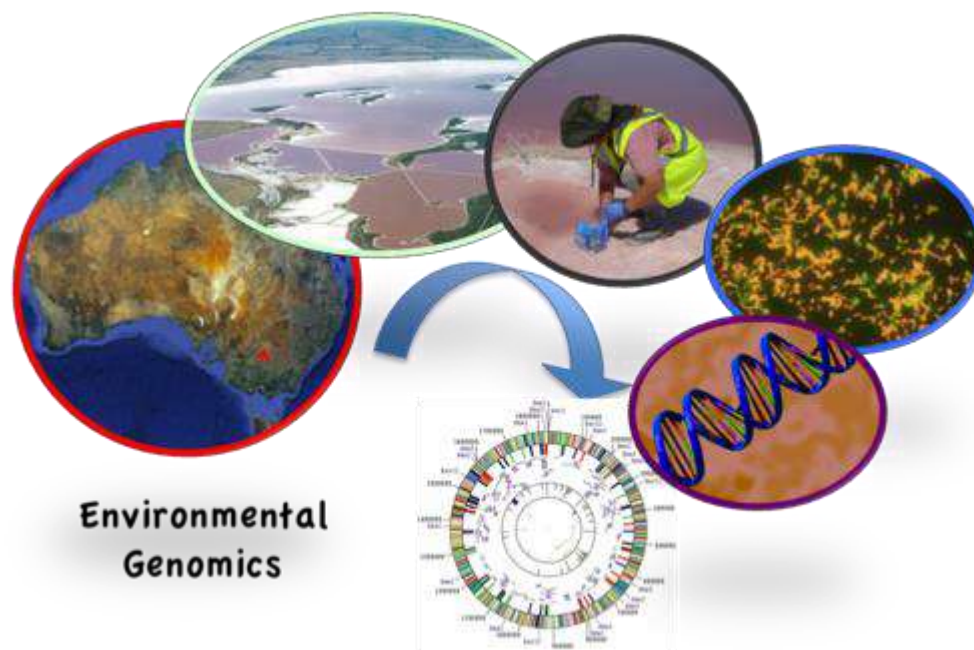


Goats



Michailidou et al., 2018

Metagenomics



Environmental Genomics



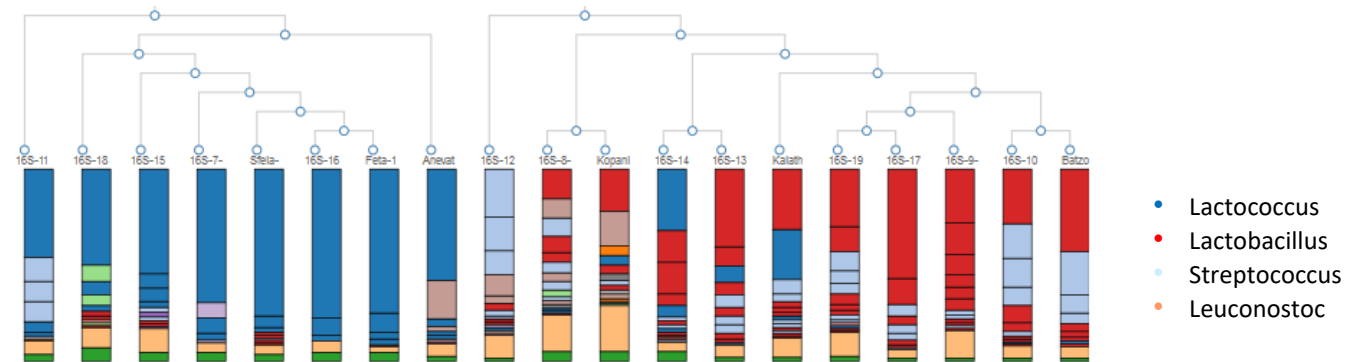
Metagenomic analysis of PDO Greek cheeses

PDO Cheese

- Create a microbial identity of cheeses.
- Identify desirable (probiotic) bacteria
- Protect the added value of the product
- Protect investments.



- ✓ Sphela
- ✓ Batsos
- ✓ Kalathaki
- ✓ Kopanisti
- ✓ Feta
- ✓ Anevato





How to render rural areas sustainable

CREATE ADDED VALUE FOR THE PRODUCTS

Premium food products

350 Euro / Kg



Kobe beef

9.000 Euro / melon



Yubari melon

The Greek black pig example

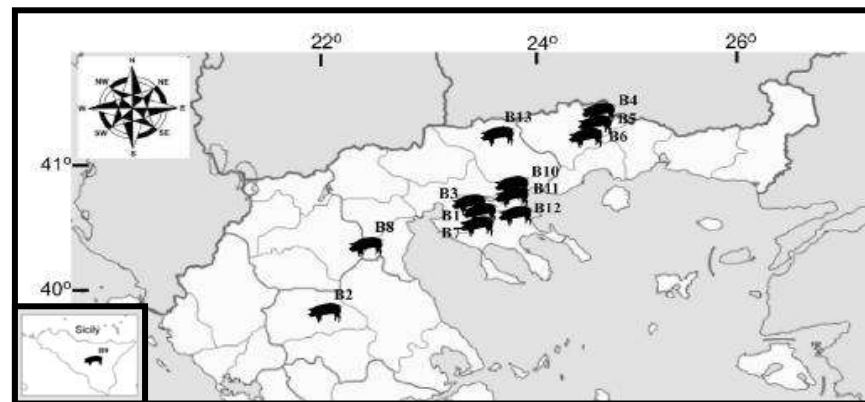
Actions
and
practices to
manage
populations
at risk

- Create purebred nuclei
- Improve rations (additives such as olive pulp)
- Develop recipes and standardize final product offered to the consumer with a standard quality, quantity and a strong brand name



The Greek black pig example

- An ancient Greek pig breed (Mediterranean pig)

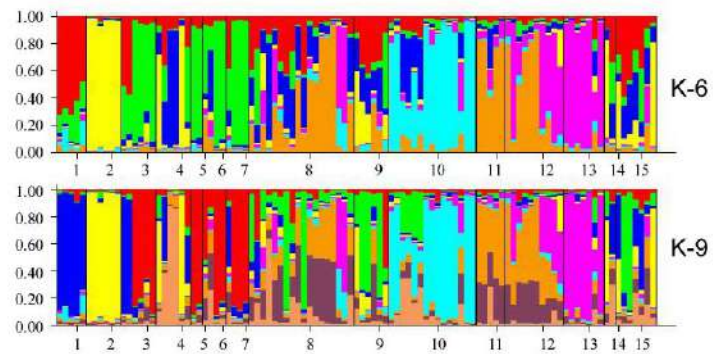


Recordings of purebreds
Study of genetic diversity

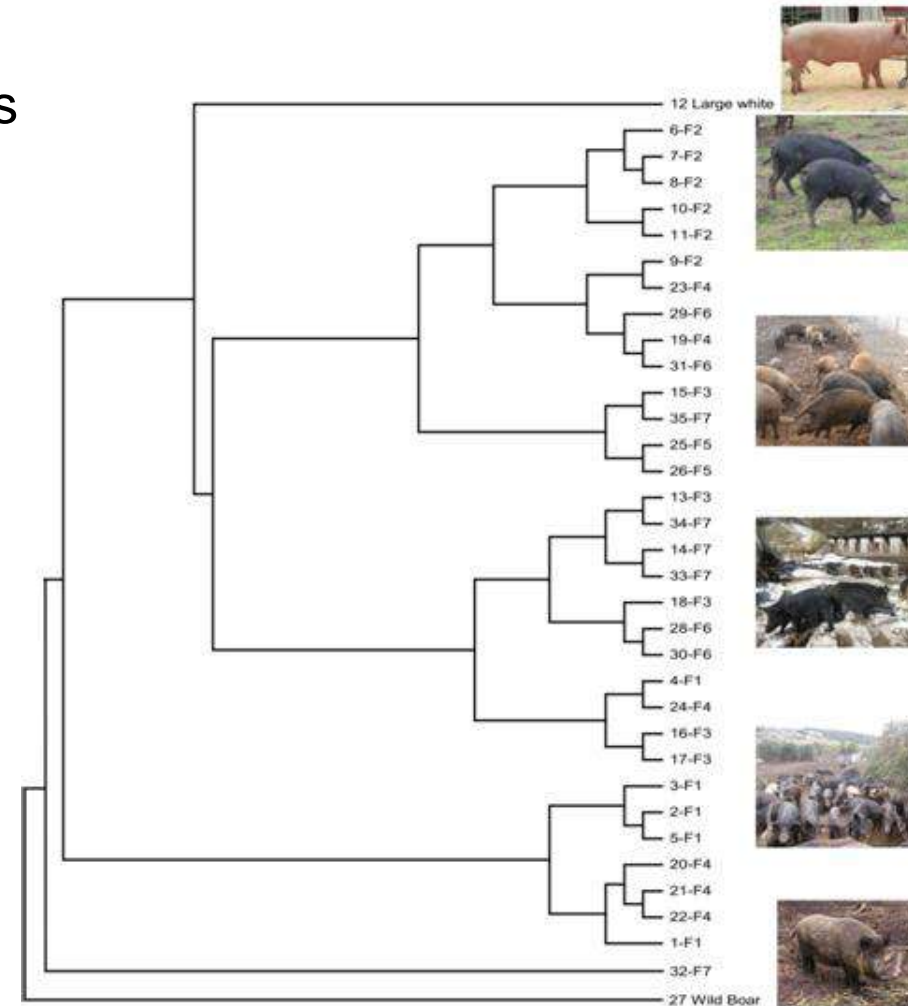
Supported by MED 2007-2013 - "Animal Breeding: Quality Biodiversity Innovation Competitiveness (QUBIC)" (#1G-MED08-395).

The Greek black pig example

- Genetic relatedness of individuals



ADMIXTURE analysis



Michailidou et al., 2014

The Greek black pig example

Creation of high quality meat products



100 €/Kg



Genetic selection of animals, DNA traceability of the final product



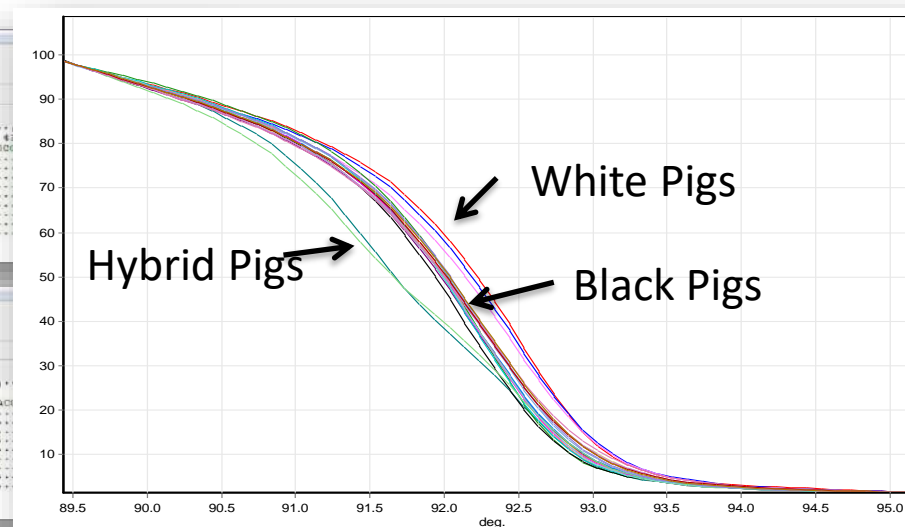
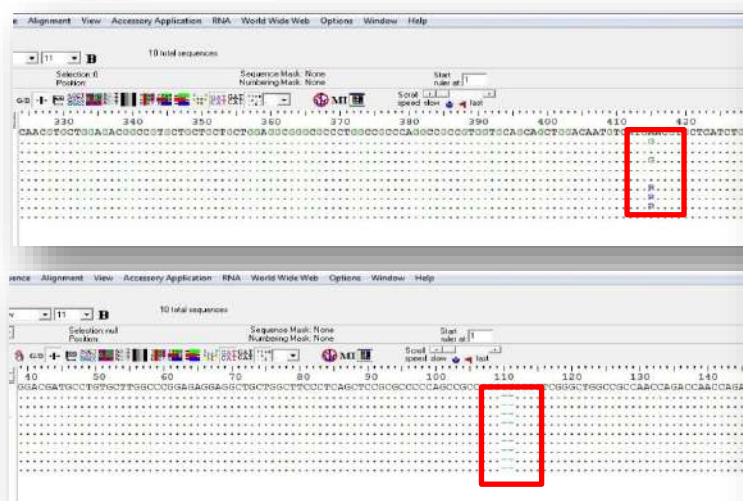
San Daniele

~ 20 Euros/Kg



Pata Negra Bellota

~ 150 Euros/Kg

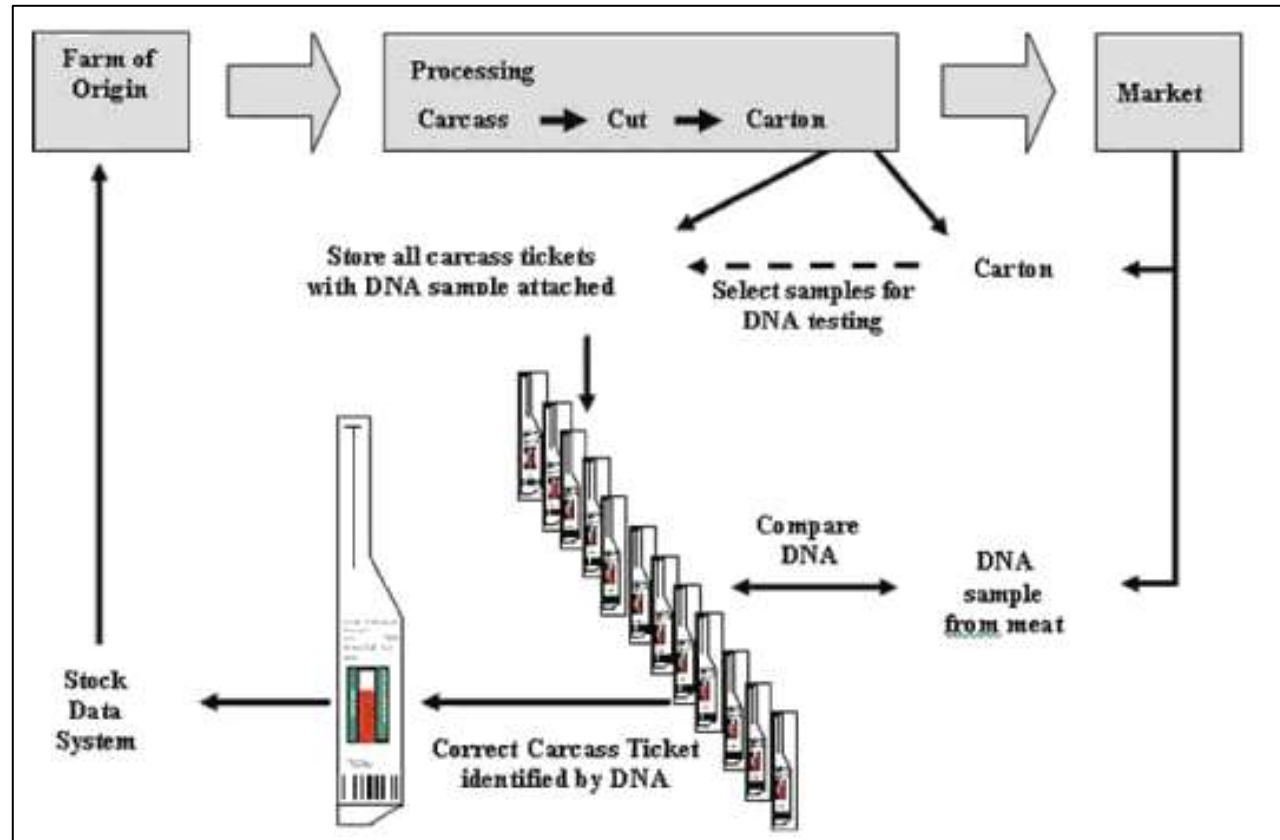


Greek Black Pig sausages
From 8 to 25 Euros/Kg



Greek Black Pig salami
From 18 to 45 Euros/Kg
100 Euros/Kg on shelf

DNA Traceability



Case study: dairy products





Autochthonous Domestic Animals in Greece



Approx. 10 millions Goats and Sheep in Greece

SNP Microarrays

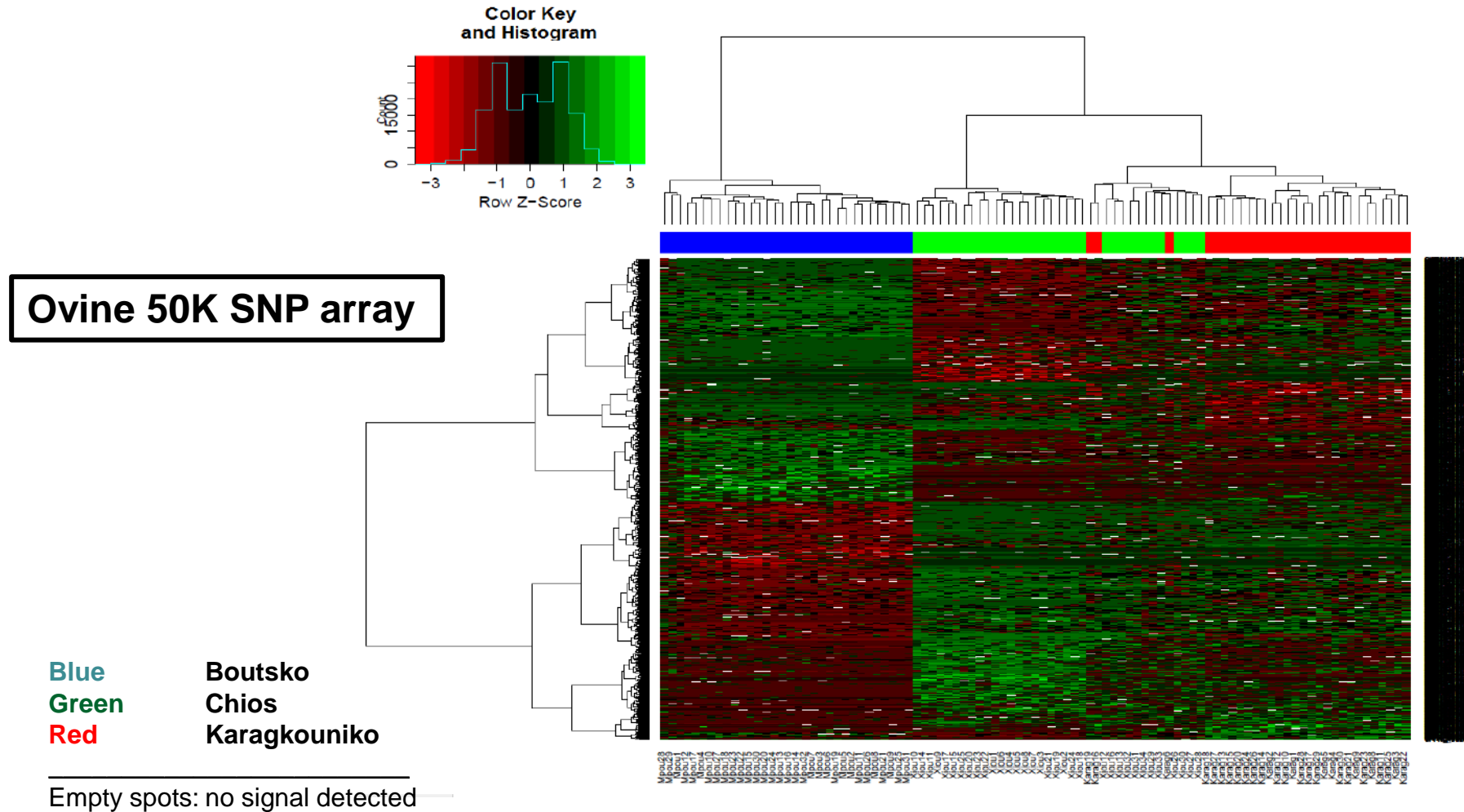


Bovine and Ovine Genotyping BeadChip

- The BovineLD BeadChip enables accurate genotyping to understand the impact of genetics on milk production, reproduction, health
- 80,000 custom markers for bovine
- 42,000 custom markers for ovine

New varieties and animal races

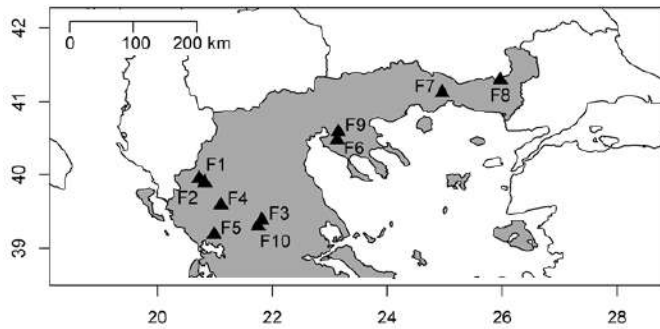
SNPs arrays of Greek sheep breeds



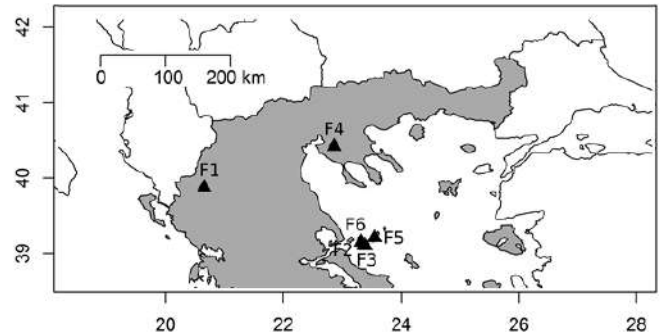
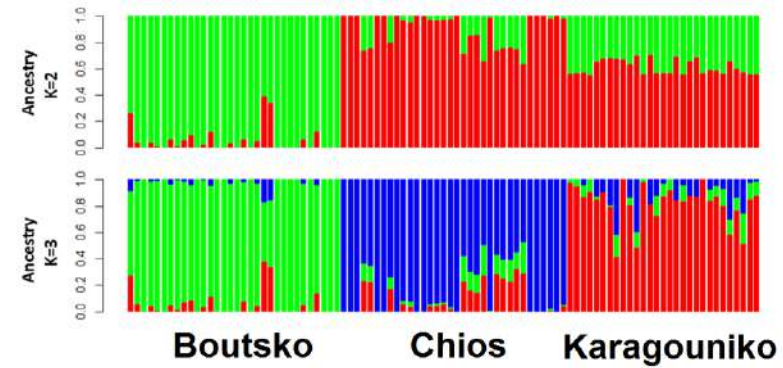
Genomics in livestock - DNA

Genotyping microarrays

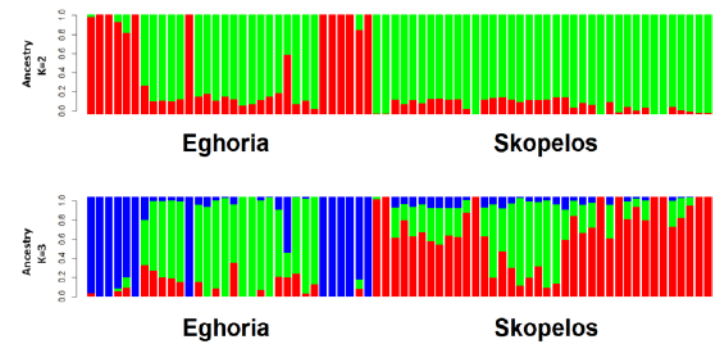
Population structure using ~40,000 SNPs



Sheep



Goats



Michailidou et al., 2018

Genomics in livestock - DNA

Genotyping microarrays

Validated purebreds → validated products



Protection of PDO and PGI products

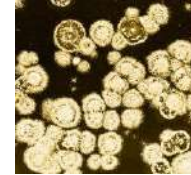


Greek dairy products from autochthonous breeds and microbes

Food Product



Biodiversity



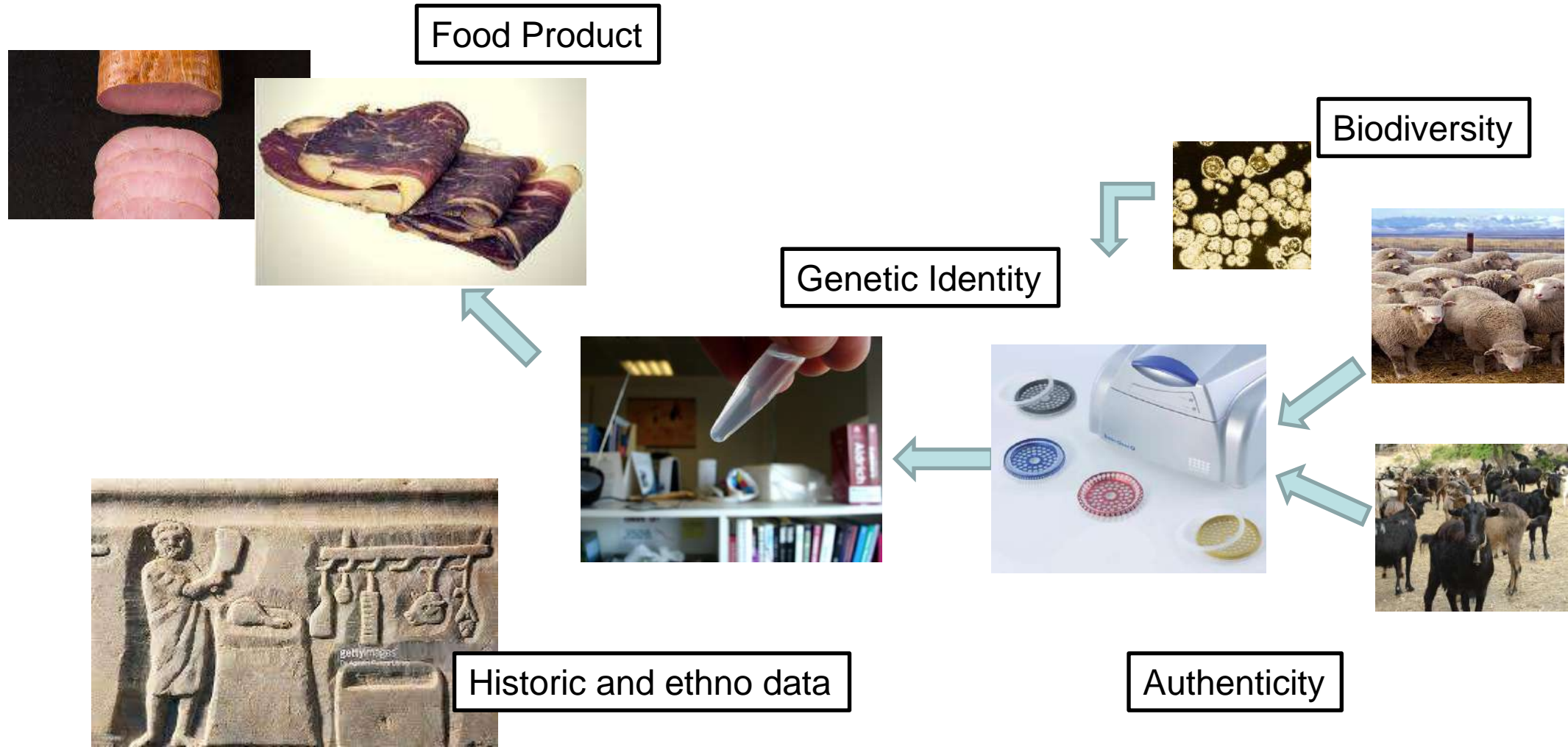
Genetic Identity



Historic and ethno data

Authenticity

But also Greek cured meat products from autochthonous breeds and microbes



Economic importance: considerations

The emergence of the economic importance of a race leads to its self-preservation.

Lack of knowledge of the properties of the breed - products produced

Breeding in unsuitable environmental breeding conditions - breeding system

Genetic improvement of the breed

Low prices of products produced

Absence of producer organizations - low self-esteem

Economic importance: considerations

The dramatic changes in our economy and society, combined with the escalating climate change, may force us to adjust our livestock systems in the near future.

In addition, the public's attention to issues such as environmental management, the welfare of farmed animals, the origin - properties of the food it consumes will be decisive for what animals and how we raise them

In this context, the value of indigenous Greek tribes is likely to increase, as several examples in the past show.

With this perspective - the challenge of rescuing the domestic genetic potential is today, both necessary and urgent

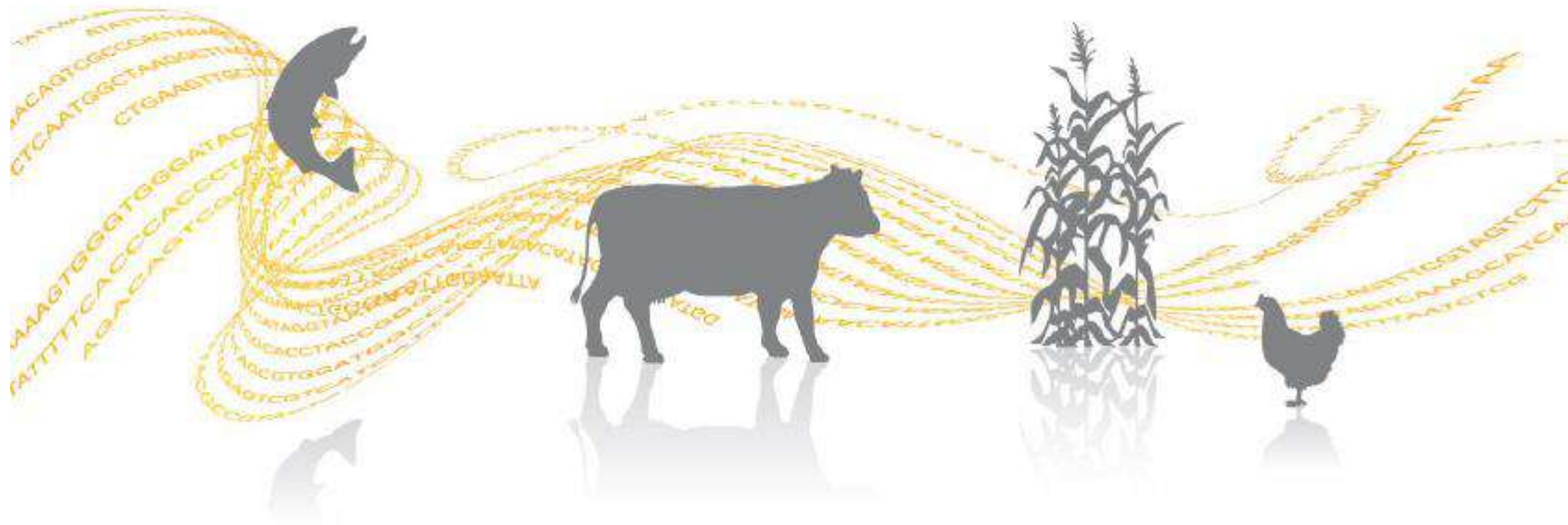
Conclusions

Indigenous breeds have an economic value

To be conserved must produce products or services

Products should have an identity

Tradition and new technologies should be joined for a back to the future approach



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