



# *¿La caracterización genómica ha mejorado la conservación de los recursos zoogenéticos?*

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Mendoza, 07 Octubre 2019

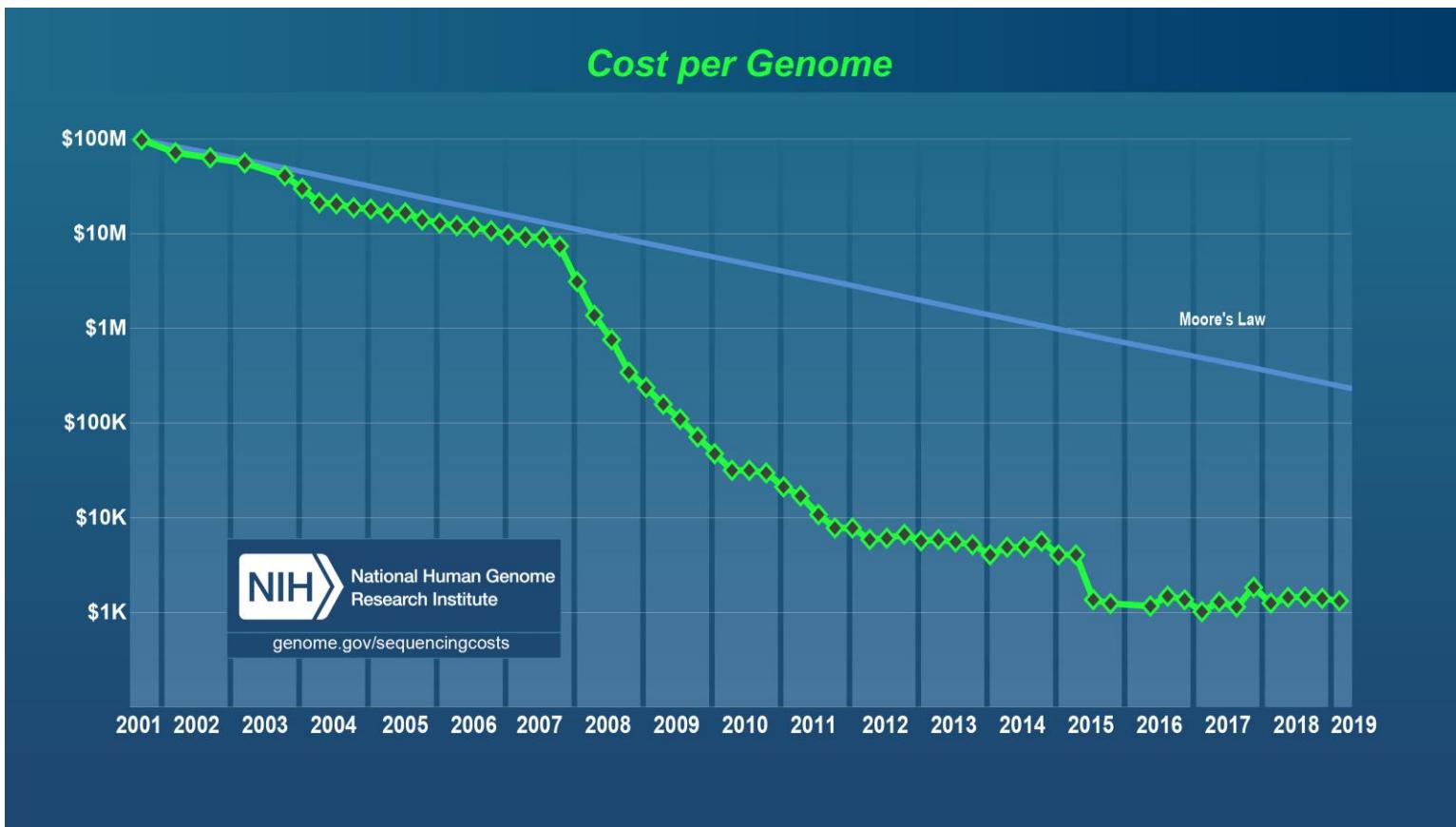


# *Does genomic improve animal genetic resources conservation?*



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# *Impact Next Sequence Generation*



# *Largest genomic databases*

	23andMe	CDCB/USDA
<b>Genotypes</b>	<b>&gt;5 million</b>	<b>&gt;3 million</b>
<b>Species</b>	<b>Human</b>	<b>Cattle</b>
<b>Countries</b>	<b>&gt;55</b>	<b>57</b>
<b>Genotyping cost</b>	<b>US\$69</b>	<b>US\$37–135</b>
<b>Delivery (weeks)</b>	<b>6–8</b>	<b>1–2</b>
<b>DNA generations</b>	<b>Few</b>	<b>&gt;10</b>
<b>EBV reliability</b>	<b>Low</b>	<b>High</b>

Reference: <http://genomemag.com/davies-23andme/#.VdY722zosY1>

Web sites: <https://www.23andme.com/>; <https://www.cdcb.us/>;  
[http://aipl.arsusda.gov/Main/site\\_main.htm](http://aipl.arsusda.gov/Main/site_main.htm)

Adapted from John B. Cole, USDA-ARS

# Dairy Cattle genotyping\*

<i>Country</i>	<i>Animals Genotyped</i>
USA	2,781,454
Canada	277,176
Italy	55,394
...	
Chile	13,895
Brazil	6,516
Argentina	4,273
Uruguay	228
Peru	156
<b>TOTAL</b>	<b>3,419,621</b>

# *Beef Cattle genotyping\**

<i>Ireland</i>	<i>Animals Genotyped</i>
Angus	169,617
Belgian Blue	57,070
Charolais	367,998
Hereford	95,132
Limousin	543,700
Simmental	124,326
Other Total	135,203
<b><i>TOTAL</i></b>	<b><i>1,493,046</i></b>

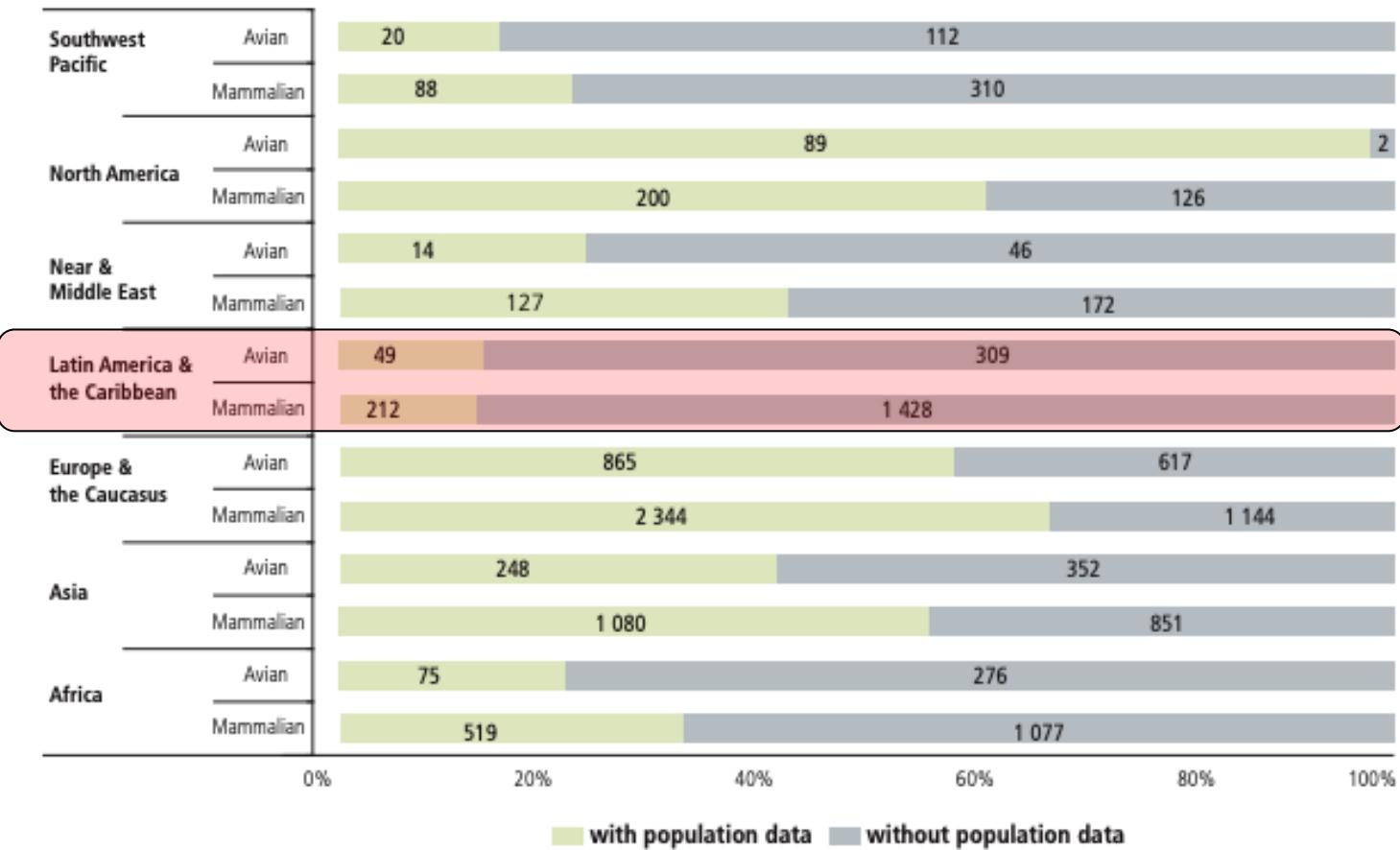
# SNP Chips Availability for AnGR:

SPECIES	NAME	NUMBER OF STANDARD SNPs	NUMBER OF CUSTOM SNPs	NUMBER OF SAMPLES	MANUFACTURER
Bos indicus	GGP Bos Indicus HD	74 K			Illumina
Bos taurus & indicus	GGP Bovine LD (v3 and v4)	26 K			Illumina
Bos taurus	Bovine LD genotyping beadchip	8 K	80 K	24, 96	Illumina
Bos taurus	Bovine SNP50 v3 DNA analysis beadchip	55 K		24	Illumina
Bos taurus	GGP Bovine 150K	134 K			Illumina
Bos taurus	Genome-wide BOS 1 Bovine array	640 K		96	Axiom
Bos taurus	Bovine HD DNA analysis kit	777 K		8	Illumina
Buffalo	Buffalo genotyping array	90 K		96	Axiom
Chicken	Illumina SNP BeadChip	54 K			Illumina
Chicken	Genome-wide chicken array	580 K		96	Axiom
Goat	International Goat Genome Consortium	60 K			Illumina
Pig	GGP Porcine LD	10 K			Illumina
Pig	Porcine SNP60 DNA analysis kit v2	65 K	25 K	24	Illumina
Pig	GGP Porcine HD	70 K			Illumina
Pig	Axiom® Porcine Genotyping Array (Axiom_PigHDv1)	660 K		96	Axiom
Ruminants	Bovine-ovine-caprine genotyping array	55 K, 55 K, 60 K		96	Axiom
Salmon	Salmon genotyping array	132 K		96	Axiom
Sheep	AgResearch OvineLD Imputation Tool	6 K			Illumina
Sheep	SheepLD	14 K			Illumina
Sheep	Ovine SNP50 DNA analysis kit	54 K		12	Illumina
Sheep	Ovine SNP 600 K BeadChip array	686 K			Illumina
Shrimp	Infinium ShrimpLD-24 Beadchip	6.4 K	80 K	24	Illumina
Trout	Trout genotyping array	58 K		96	Axiom

Source: Georges et al., 2018, Nature Reviews Genetics

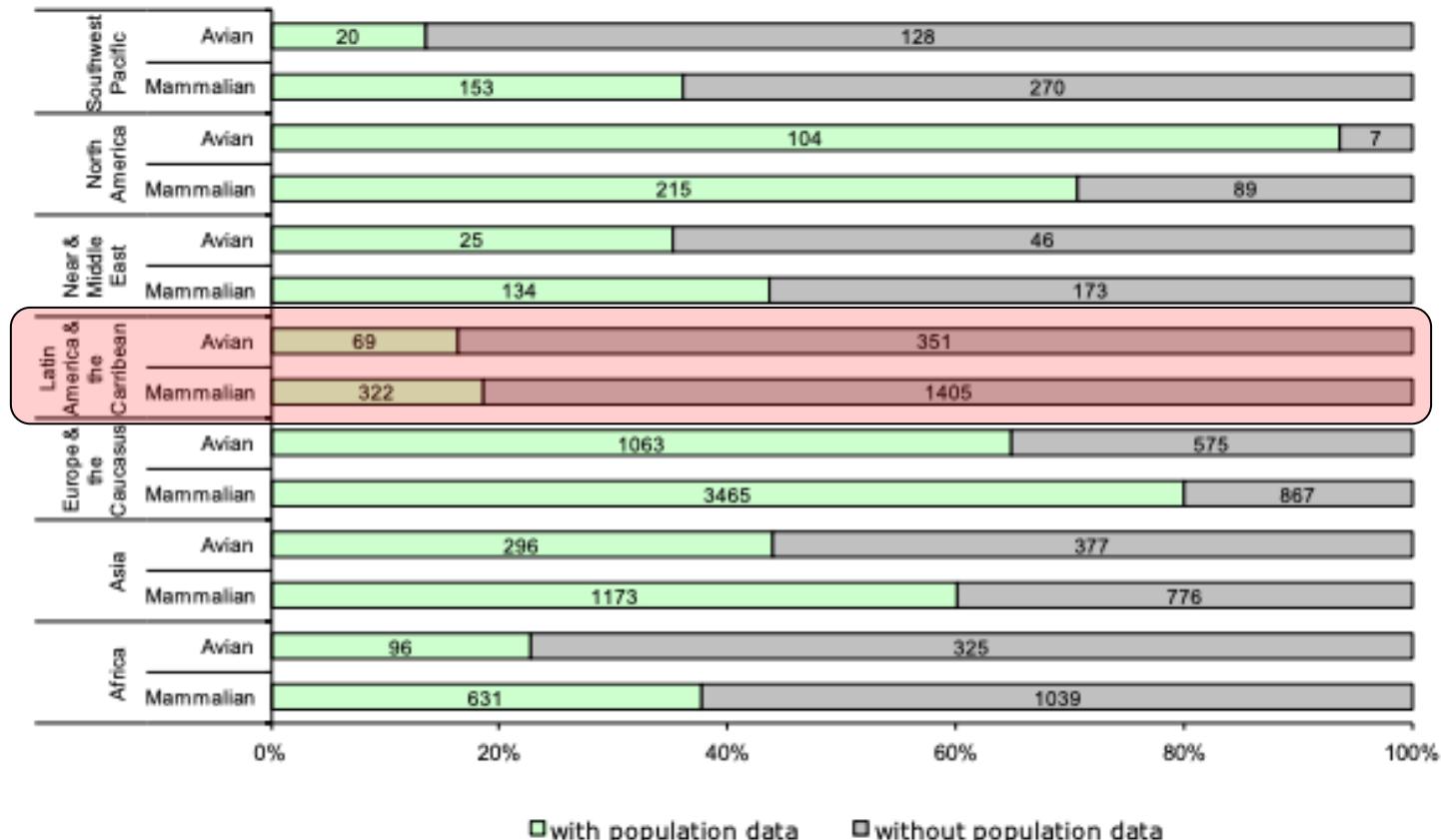
# *FAO: Proportion breeds with population data*

**2007**



# *FAO: Proportion breeds with population data*

**Figure 1. Proportion of national breed populations for which population figures have been reported**

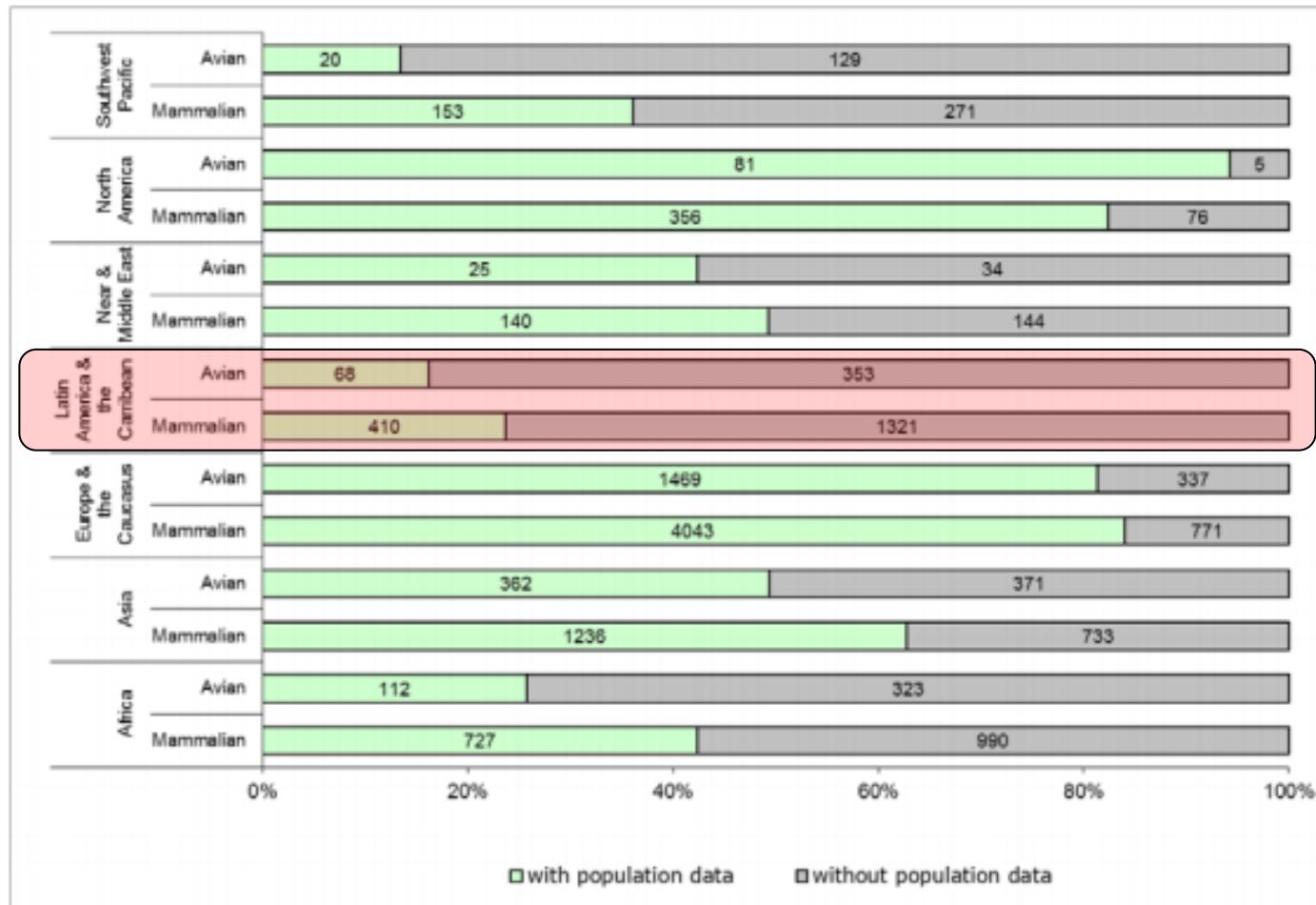


2013

Source: FAO, 2013, CGRFA-14/13/Inf.16 Rev.1

# *FAO: Proportion breeds with population data*

2019



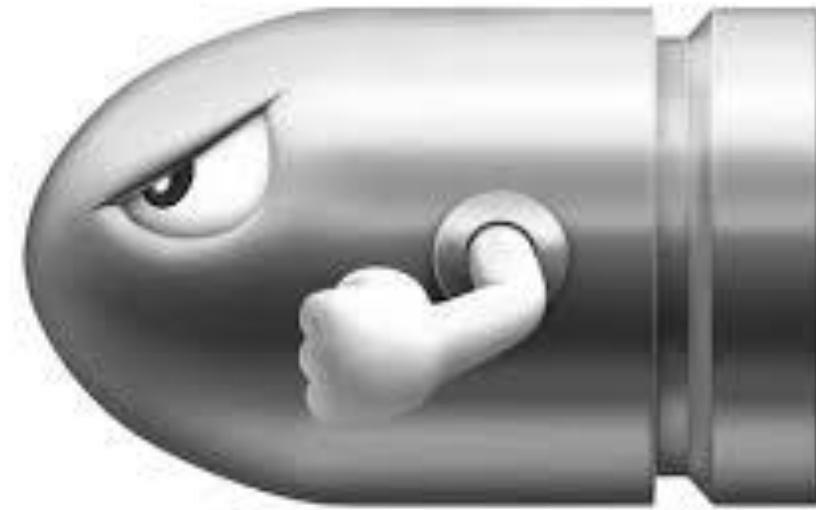
Source: FAO, 2019, CGRFA-17/19/11.2/Inf.4

# *Does genomic improve animal genetic resources conservation?*



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***Molecular Markers are not a  
silver bullet and can be very  
limited...***



***...unless phenotypes and samples  
be collected regularly!!!!***



# *Ex Situ Applications*



# Gene Banks

- Primary mechanism *Ex Situ* schemes;
- Established at least in more than 50 Countries;



# Embrapa Gene Bank, Brasília - DF



# Embrapa Gene Bank - 2019



<i>Specie</i>	<i>Semen/ Animals</i>	<i>Embryos/ Animals</i>	<i>DNA/ Animals</i>
<i>Cattle</i>	<b>63,290/ 190</b>	<b>251/ 39</b>	<b>464,807/ 3,221</b>
<i>Goats</i>	<b>7,630/ 107</b>	<b>26/ 4</b>	<b>175,288/ 1,230</b>
<i>Horses</i>	<b>1327/ 21</b>	<b>9/ 5</b>	<b>98,831/ 842</b>
<i>Sheep</i>	<b>21,398/ 129</b>	<b>163/ 35</b>	<b>378,190/ 5,017</b>
<i>Donkey</i>	<b>372/ 5</b>	-	<b>38,669/ 151</b>
<i>Pigs</i>	<b>535/ 14</b>	-	<b>44,182/ 655</b>
<i>Fish</i>	<b>2,958/ 137</b>	-	<b>13,616/ 359</b>
<i>Buffaloes</i>	-	-	<b>88,435/ 638</b>
<i>Chicken</i>	-	-	<b>15,906/ 188</b>
<i>Turtles</i>	-	-	<b>1,238/ 273</b>
<b>TOTAL</b>	<b>97,510/ 603</b>	<b>449/ 83</b>	<b>1,319,162/ 12,574</b>

# Embrapa Gene Bank Genotyping

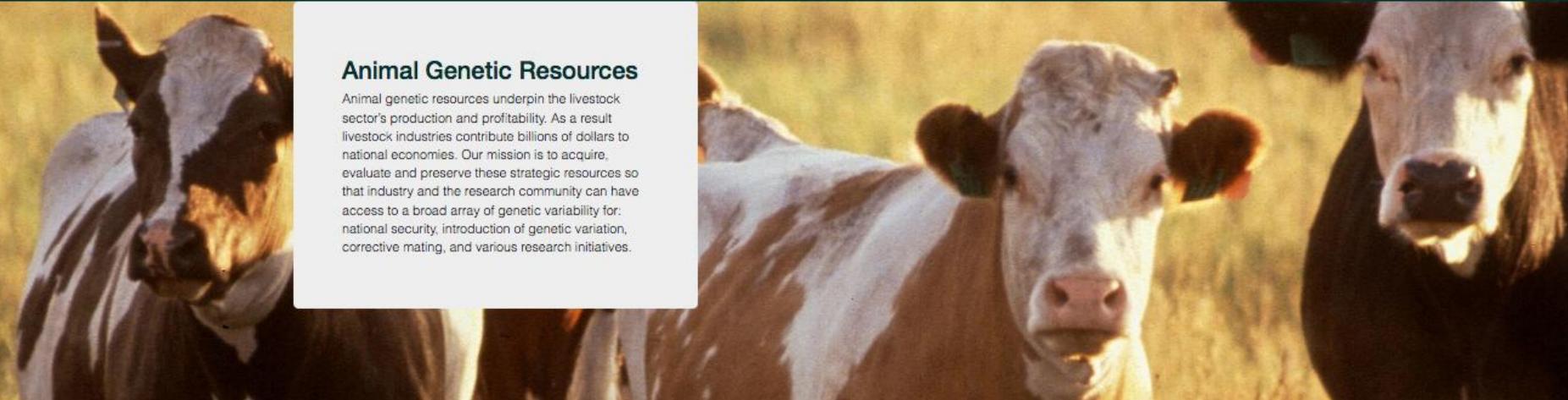
## 2019

<i>Specie</i>	<i>Animals (Semen)</i>	<i>% Genotyping/ Animals</i>	<i>SNP Chips</i>
Cattle	190	76% / 144	50,000/ 150,000
Goats	107	40% / 18	52,000
Horses	21	76% / 16	65,000
Sheep	129	69% / 89	54,000
Donkey	5	80% / 4	65,000
Pigs	14	71% / 10	60,000
Fish	137	56% / 77	Custom
<b>TOTAL</b>	<b>466</b>	<b>77% / 358</b>	

# Animal GRIN/ Alelo Animal



Information to Bring the World Together



**Product** for farmers, researchers and Institutions to access information about animal genetic resources and make breeding and conservation decisions and speed up exchange and management plans.

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### Genomic Data Submission & Request

#### Explore Genomic Data

Uses a drilldown format that allows you to see available genomic data by species, breed, line, and individual. You can also specify a specific SNP chip to filter results.

[GET STARTED](#)

#### Genomic Data Submission

Upload form to deposit genomic data

[GET STARTED](#)

#### Genomic Data Request Tool

Allows you to search for animals that meet your criteria and download associated genomic data

[GET STARTED](#)

#### Genomic Data Summary

Summary of available genomic data by chip and taxonomy; also provides a shortcut to download all animals for a specific chip or all animals from a breed

[GET STARTED](#)

# User Pages: Animals

**ANIMAL SEARCH**

SEARCH CRITERIA scrofa LINES PER PAGE 10 SEARCH

Search fields are Repository Number, Identifications, Taxonomy, and Breeder.

Hide/Show Advanced Search Options

RESULTS:

ID	REPOSITORY NUM	IDENTIFICATIONS	FULL TAXONOMY NAME	SEX	BREEDER	ACTIONS
306	347	388274003, JMF1 LARIAT 13-3, 2338	Suidae Sus scrofa Yorkshire	M	Jones and Moorman Farms	Upd   Del   Ped   Img   Obs   PPed
307	348	399324001, RHF1 GET SERIOUS 242-1, 2340	Suidae Sus scrofa Yorkshire	M	Richardson Farm	Upd   Del   Ped   Img   Obs   PPed
308	349	368039003, KK7 ACADIA PREMO 9401F 67-3, 8185	Suidae Sus scrofa Yorkshire	M	Kems Farms	Upd   Del   Ped   Img   Obs   PPed
309	350	365589004, JJ9 EXPLORER 51-4, 8816	Suidae Sus scrofa Yorkshire	M	IFFT Yorkshires	Upd   Del   Ped   Img   Obs   PPed
310	353	378075002, ECO CINCH 3-2	Suidae Sus scrofa Yorkshire	M	Earl Cain & Family	Upd   Del   Ped   Img   Obs   PPed
311	356	387704010, Hotmail, MSU1 STALLION 6-10, 8224	Suidae Sus scrofa Yorkshire	M	Michigan State University	Upd   Del   Ped   Img   Obs   PPed
312	357	385962010, Terminator, MSU0 HITMAN 45-10, 8222	Suidae Sus scrofa Yorkshire	M	Michigan State University	Upd   Del   Ped   Img   Obs   PPed
313	360	389792006, IGF1 BARNSTORMER 8-6, 2334	Suidae Sus scrofa Yorkshire	M	Isla Grande Farms	Upd   Del   Ped   Img   Obs   PPed
314	361	386254002, JJ10 MT HOOD 59-2, 2333	Suidae Sus scrofa Yorkshire	M	IFFT Yorkshires	Upd   Del   Ped   Img   Obs   Ped
355	417	378482005, NAY9 SATURN 503-5	Suidae Sus scrofa Yorkshire	M	Neher Acres	Upd   Del   Ped   Img   Obs   PPed

« Previous 1 2 3 4 5 6 7 8 9 ... 135 Next »

**CREATE NEW**

**PEDIGREE**

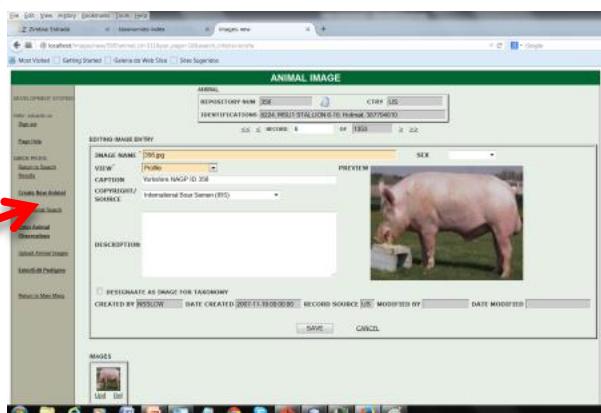
ANIMAL  
REPOSITORY NUM 356 CTRY US IDENTIFICATIONS 8224, MSU1 STALLION 6-10, Hotmail, 387704010 TAXONOMY Suidae Sus scrofa Yorkshire

SEARCH TAXONOMY  
SEARCH THE FULL TAXONOMY NAME(S) OR THE FORM SHOULD SEARCH FOR MATCHING ANIMALS IF DIFFERENT THAN THE TAXONOMY OF THE ANIMAL IN THE ANIMAL SECTION

Suidae Sus scrofa Yorkshire ADD

UPLOAD FILE FILE Browse No file selected UPLOAD FILE DELIMITER Please select UPLOAD FILE

PGGS 354063004 Registration Number more info PGGD 319819006 Registration Number more info PGGD 295319003 Registration Number more info PGGD 311670015 Registration Number more info PGGD 2485552 Registration Number more info PGGD 325700000 Registration Number more info



**UPDATE ANIMAL**

ANIMAL ID 311

REPOSITORY ANIMAL REPOSITORY NUM 356 COUNTRY US

**TAXONOMY**

FULL TAXONOMY NAME Suidae Sus scrofa Yorkshire COMMON Pg NAME

SEX M DATE OF BIRTH 01/23/2001 RECEIVED DATE 03/27/2002 GENOMIC INFORMATION AVAILABLE

ACTIVE • INACTIVE DATE INACTIVE REASON

**IDENTIFICATION**

SAMPLE IDENTIFICATION

RANK	IDENTIFICATION TYPE	IDENTIFICATION	IDENTIFICATION COUNTRY
1	Registration Number	387704010	Please select • DEL
2	Name	Hotmail	Please select • DEL
3	Name	MSU1 STALLION 6-10	Please select • DEL
4	Number	8224	Please select • DEL

ADD BREEDER NAME Michigan State University

**ANIMAL OBSERVATION**

ANIMAL REPOSITORY NUM 356 CTRY US IDENTIFICATIONS 8224, MSU1 STALLION 6-10, Hotmail, 387704010

NEW OBSERVATION ENTRY

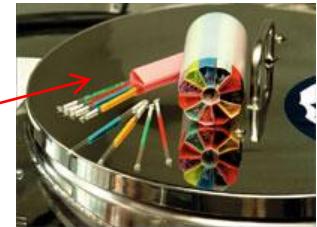
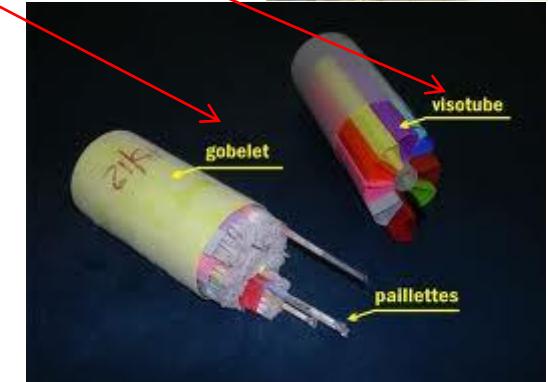
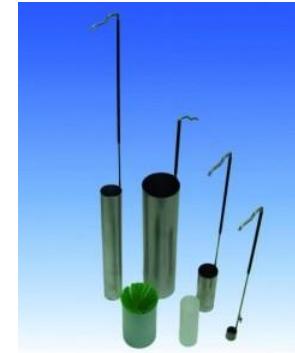
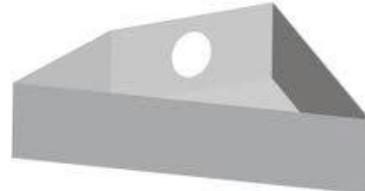
DESCRIPTOR \* Please select  
OBSERVATION VALUE \*  
DATE OBSERVED VARIABLE NAME INFORMATION SOURCE Select a source  
COMMENTS CREATED BY DATE CREATED RECORD SOURCE MODIFIED BY DATE MODIFIED  
SAVE CANCEL

**OBSERVATIONS**

ID	ANIMAL ID	DESCRIPTOR	VALUE	UNITS	DATE OBSERVED	QUALIFIER	INFO SOURCE	COMMENTS	ACTIONS
86	311	Cluster number	75		01/01/2009				Upd Del
87	311	Number born alive	14						Upd Del
88	311	21-day litter weight	58.5	kg					Upd Del
89	311	Backfat	12.19	mm					Upd Del

# User pages: Inventory (1)

LOCATION											
CONTAINER TYPE	TANK	PIE	CANISTER	GOBLET	VISOTUBE	BEG QTY	BEG UNIT COUNT	CUR QTY	CUR UNIT COUNT	STAGE	QUALITY
Visotube	1	D	1	A	1	27	1	27	1		<u>DEL UPD</u>
Visotube	1	D	1	A	2	36	1	36	1		<u>DEL UPD</u>
Visotube	1	D	1	A	3	25	1	25	1		<u>DEL UPD</u>
Visotube	1	D	1	A	4	40	1	40	1		<u>DEL UPD</u>
Visotube	1	D	1	A	5	22	1	22	1		<u>DEL UPD</u>
Visotube	1	D	1	A	6	46	1	46	1		<u>DEL UPD</u>
Visotube	1	D	1	A	7	39	1	39	1		<u>DEL UPD</u>
Visotube	1	D	1	A	8	35	1	35	1		<u>DEL UPD</u>
Visotube	1	D	1	A	9	27	1	27	1		<u>DEL UPD</u>



# User pages: Inventory (2)

## LOCATION

CONTAINER TYPE	ROOM	FREEZER	SHELF/TRAY	BOX	VIAL	BEG QTY	BEG UNIT COUNT	CUR QTY	CUR UNIT COUNT	STAGE	QUALITY	DEL UPD
Vial - Freezer	46	10	AR	1R	1	1	56	1	56			<a href="#">DEL</a> <a href="#">UPD</a>
Vial - Freezer	46	10	AR	1R	2	1	57	1	57			<a href="#">DEL</a> <a href="#">UPD</a>
Vial - Freezer	47	5	E	1	52	1	57	1	57			<a href="#">DEL</a> <a href="#">UPD</a>





# *In Vivo Applications*



# Morada Nova Sheep Breed

- Actual Problem: **annual culling** based on coat color and low pigmentation of muzzle and hooves has been estimated to reach up to 45%



ACCEPTED

NOT ACCEPTED

ACCEPTED

# Ovine 50k SNP Chip ( $N=61$ )

Embrapa

$Fst=10.78\%$

$Fst=9.23\%$

$Fst=2.93\%$

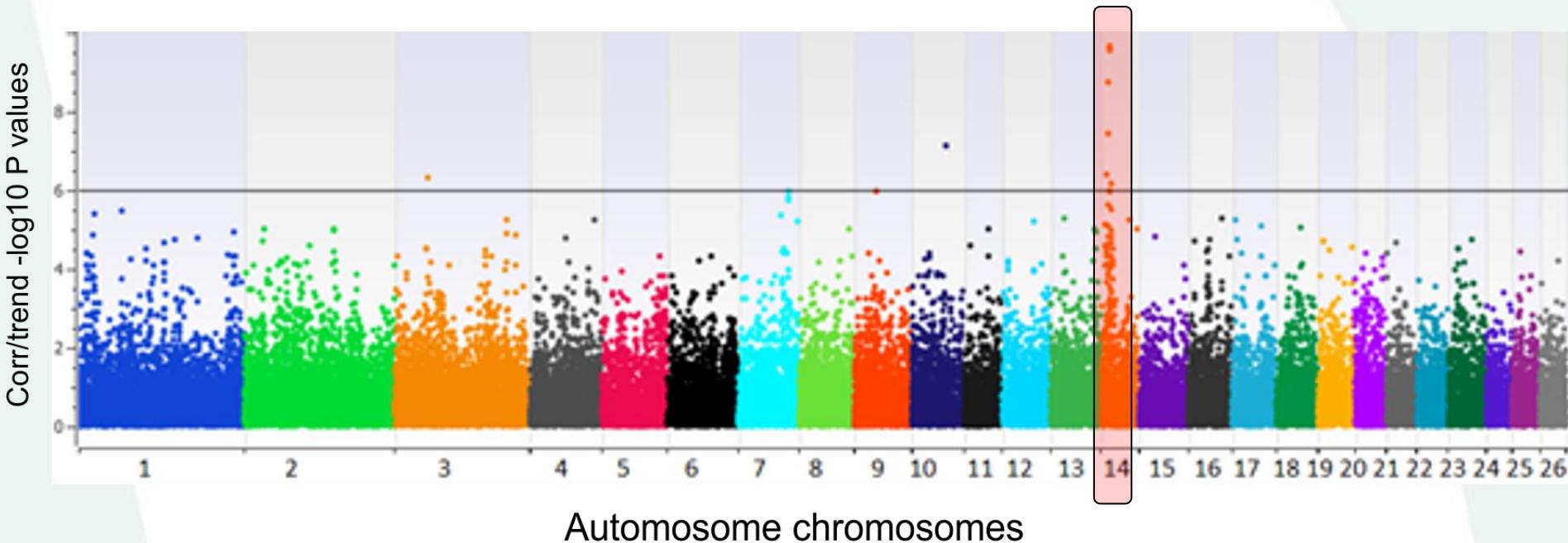


ACCEPTED

NOT ACCEPTED

ACCEPTED

# GWAS – Manhattan Plot



- Genome wide association study contrasting black and red/white coat colors;
- Chr 14: *MC1R* gene (melanocortin 1 receptor);
- SNP s26449 (closest one, Kijas et al., 2013);
- Results confirmed by Sanger resequencing of main exon;

# *How to improve In situ Conservation of Pantaneiro Cattle?*

- 51,843 SNP markers;
- Study performed by UFG

## Pantaneiro

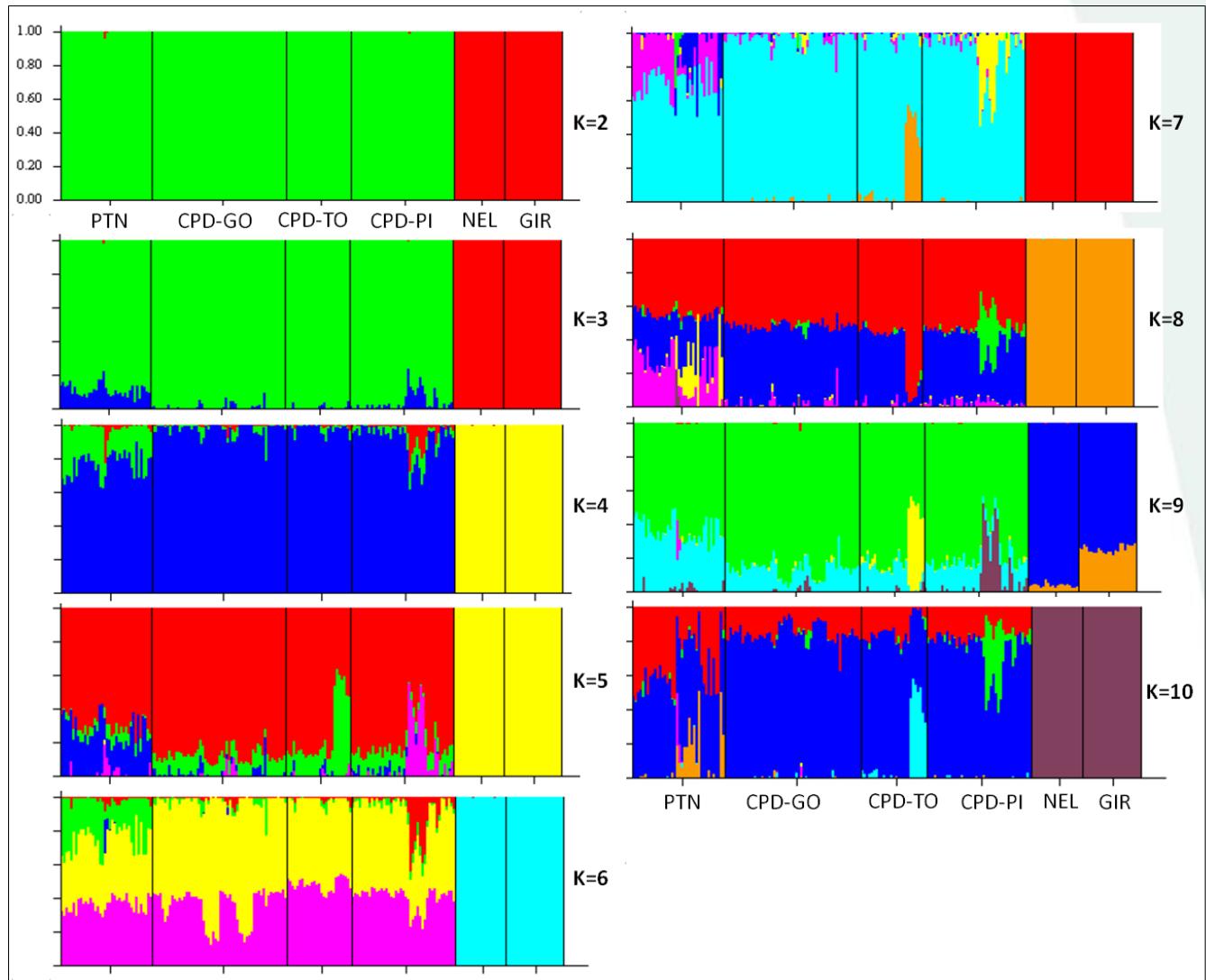


**Curraleiro Pé-Duro**

- Curraleiro- Pé-Duro (N=126)
- Pantaneiro (N=38)

# *How to improve In situ Conservation of Pantaneiro Cattle?*

- No apparent difference between the two breeds!!!



# *How to improve In situ Conservation of Pantaneiro Cattle?*

TABELA 2 – Diferença entre médias de distância genética entre grupos de genótipos Pantaneiros (PTN), Curraleiro Pé-Duro do Estado de Goiás (CPD-GO), Tocantins (CPD-TO), e Piauí (CPD-PI), formados a partir de quatro regiões geográficas

Comparação entre grupos	Diferença entre grupos	Intervalo de confiança	P
PTN x CPD-GO	-0,0012801	-0,0034030 0,0008428	ns
PTN x CPD-TO	-0,0067771	-0,0098253 -0,0037289	*
PTN x CPD-PI	-0,0008721	-0,0032179 0,0014738	ns
CPD-GO x CPD-TO	-0,0054970	-0,0082555 -0,0027384	*
CPDGO x CPD-PI	0,0004081	-0,0015468 0,0023629	ns
CPDTO x CPD-PI	0,0059050	0,0029714 0,0088386	*

\*P<0,05; ns=P>0,05

# *How to improve In situ Conservation of Pantaneiro Cattle?*



- **Curraleiro Pé-Duro:**
- **Official breed in Brazil since 2012;**
- **Semen commercialization;**
- **Low interest rates with governments loans;**



- **Pantaneiro:**
- **Very low number of breeders;**
- **Could be assigned as variety of  
Curraleiro Pé-Duro breed instead to  
formalize a new breed association;**



# *Ex situ and In Vivo Applications*



# Genetic Diversity of Gene Banks: *Pantaneiro cattle genetic group*

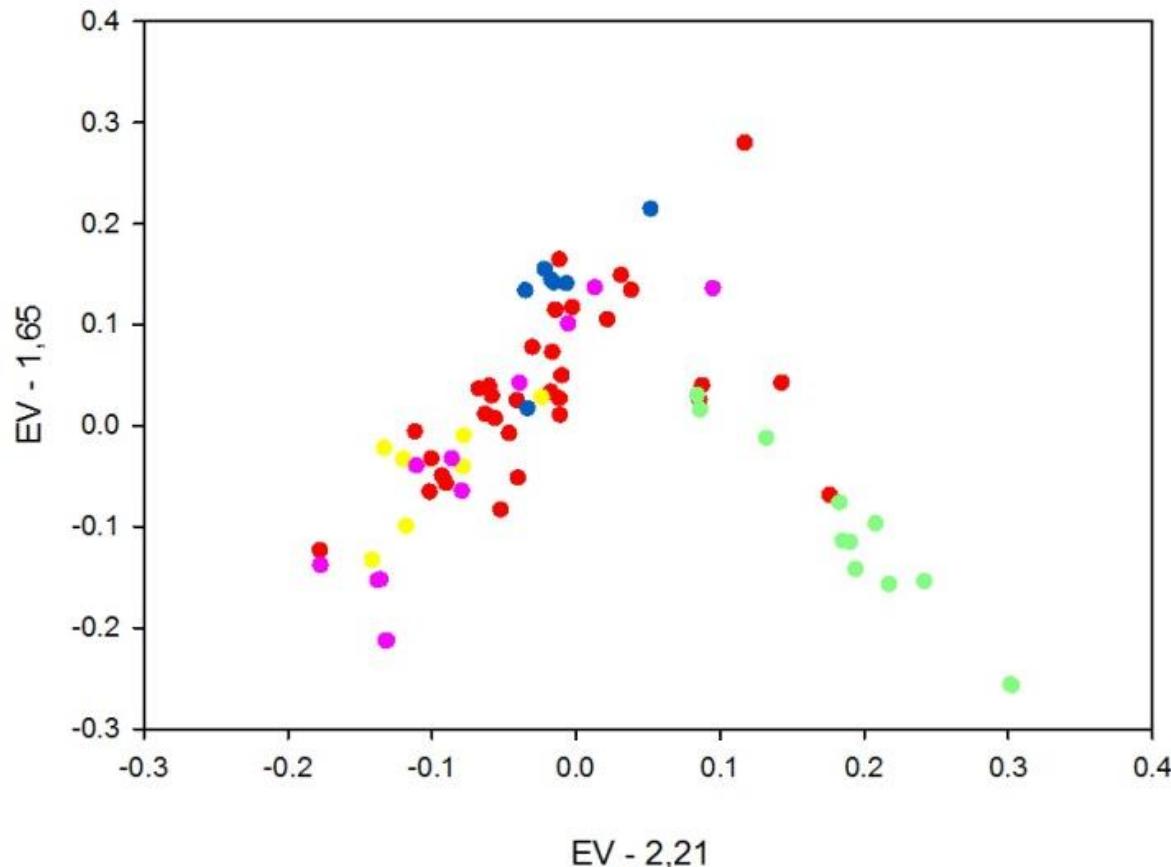
- Gene Bank samples, N = 37
- In situ samples, N = 35
- Genotypes obtained from different groups/projects!
- QC: Call rate markers > 0.85, MAF > 0.05, X and Y chromosome, Number of alleles > 2;
- Total SNPs – 32,982; LD:  $r^2 > 0.50$ ;
  - **Total number of SNPs = 12,756**



# *Genetic Diversity of Gene Banks: Pantaneiro cattle genetic group*

Embrapa

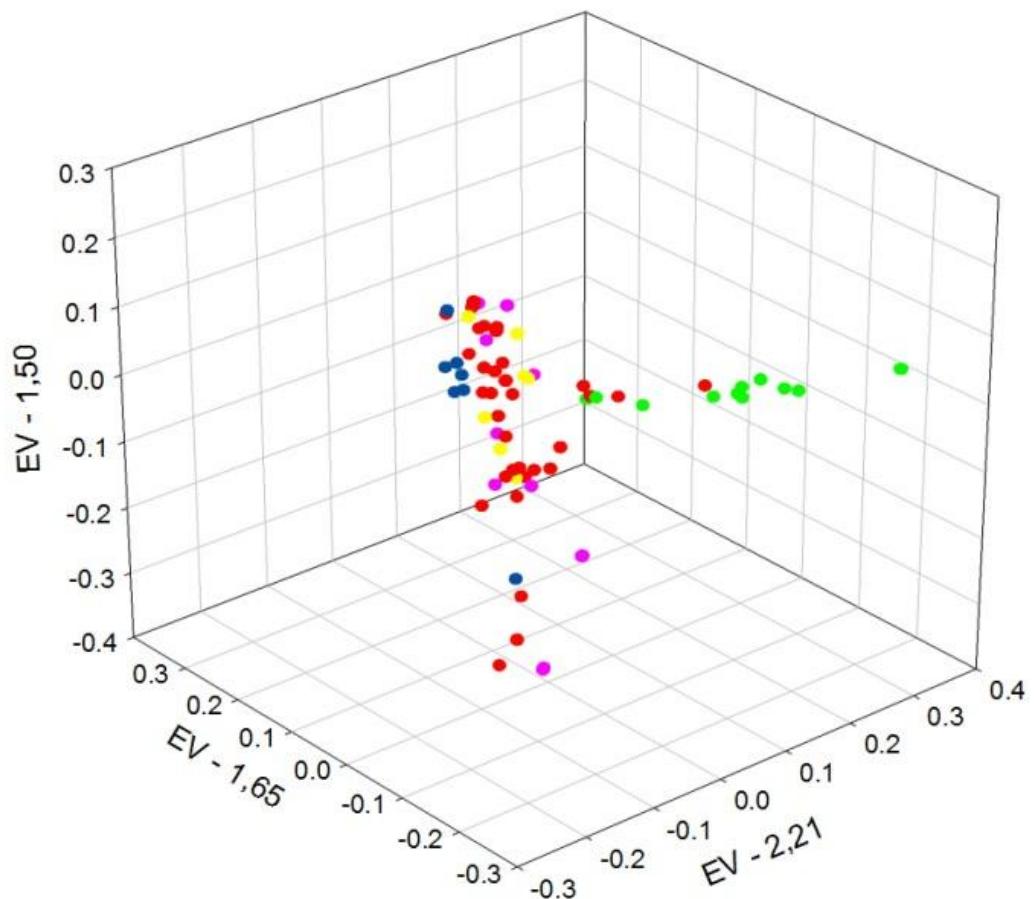
Principal Componet Analysis - Pantaneiro - 12K



- Pantaneiro - BBGA
- Pantaneiro I
- Pantaneiro IV
- Pantaneiro II
- Pantaneiro III



## Principal Component Analysis - Pantaneiro - 12K



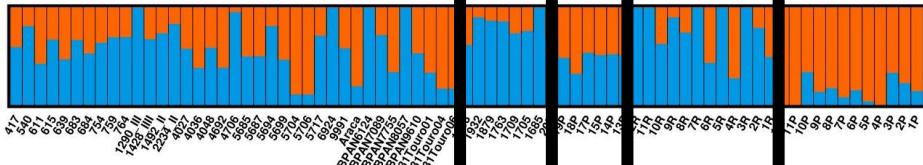
- Pantaneiro - BBGA
- Pantaneiro I
- Pantaneiro II
- Pantaneiro III
- Pantaneiro IV

# *Genetic Diversity of Gene Banks: Pantaneiro cattle genetic group*

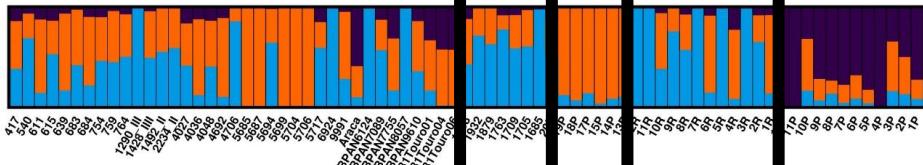
Embrapa

K=2

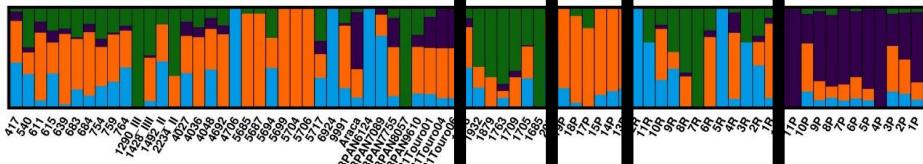
BBGA



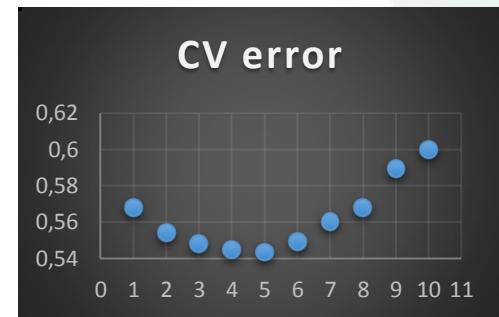
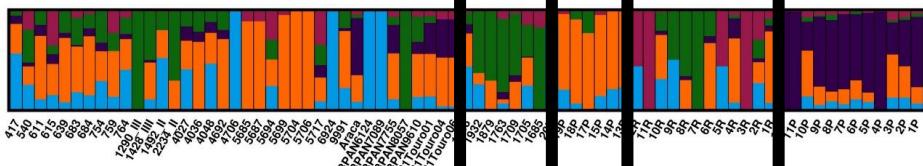
K=3



K=4



K=5



# *Genetic Diversity of Gene Banks: Pantaneiro cattle genetic group*

População	Ho	He	FIS
BBGA	0.34	0.33	-0.004
Pantaneiro I	0.37	0.33	-0.02
Pantaneiro II	0.39	0.37	-0.04
Pantaneiro III	0.35	0.34	-0.01
<b>Pantaneiro IV</b>	<b>0.37</b>	<b>0.35</b>	<b>-0.04</b>



## $F_{ST}$ MATRIX

	BBGA	Pantaneiro I	Pantaneiro II	Pantaneiro III	Pantaneiro IV
BBGA	0				
Pantaneiro I	0.0141*	0			
Pantaneiro II	0.01477*	0.04984*	0		
Pantaneiro III	0.00885	0.01254	0.03899*	0	
Pantaneiro IV	0.052*	0.08026*	0.07385*	0.06891*	0

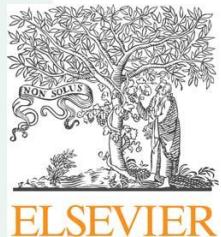
\*Significativo P-value < 0.05

# Potential Directions

- We should increase knowledge about our breeds and their **PHENOTYPES!!**;
- Develop/ Adapt, implement and integrate Genetic Resources Information Systems for **whole genome sequence** data;
- Increase studies to support national and foreign policies;

# One of our sources...

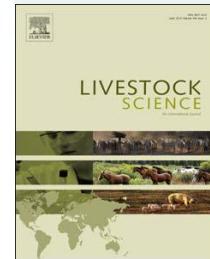
Livestock Science 193 (2016) 32–38



Contents lists available at [ScienceDirect](#)

Livestock Science

journal homepage: [www.elsevier.com/locate/livsci](http://www.elsevier.com/locate/livsci)



Conservation of animal genetic resources – A new tact

Samuel Rezende Paiva<sup>a</sup>, Concepta M. McManus<sup>b</sup>, Harvey Blackburn<sup>c,\*</sup>



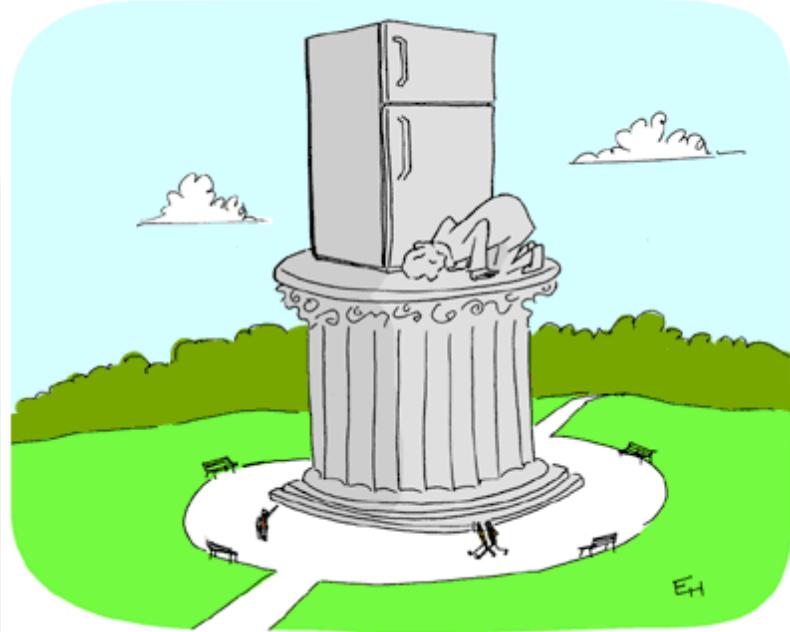
<sup>a</sup> Embrapa (Brazilian Agricultural Research Corporation), Secretaria de Relações Internacionais (Secretariat of International Affairs), Embrapa Labex US Program, Brasília, DF, Brazil

<sup>b</sup> Universidade de Brasília, INCT Pecuária, Faculdade de Agronomia e Medicina Veterinária, Brasília, DF, Brazil

<sup>c</sup> USDA/ARS/National Animal Germplasm Program, Fort Collins, USA

**Livestock Science 193:32-38 (2016)**

**Monument to the Lost Sample**



***Let's avoid this  
Monument!!!***

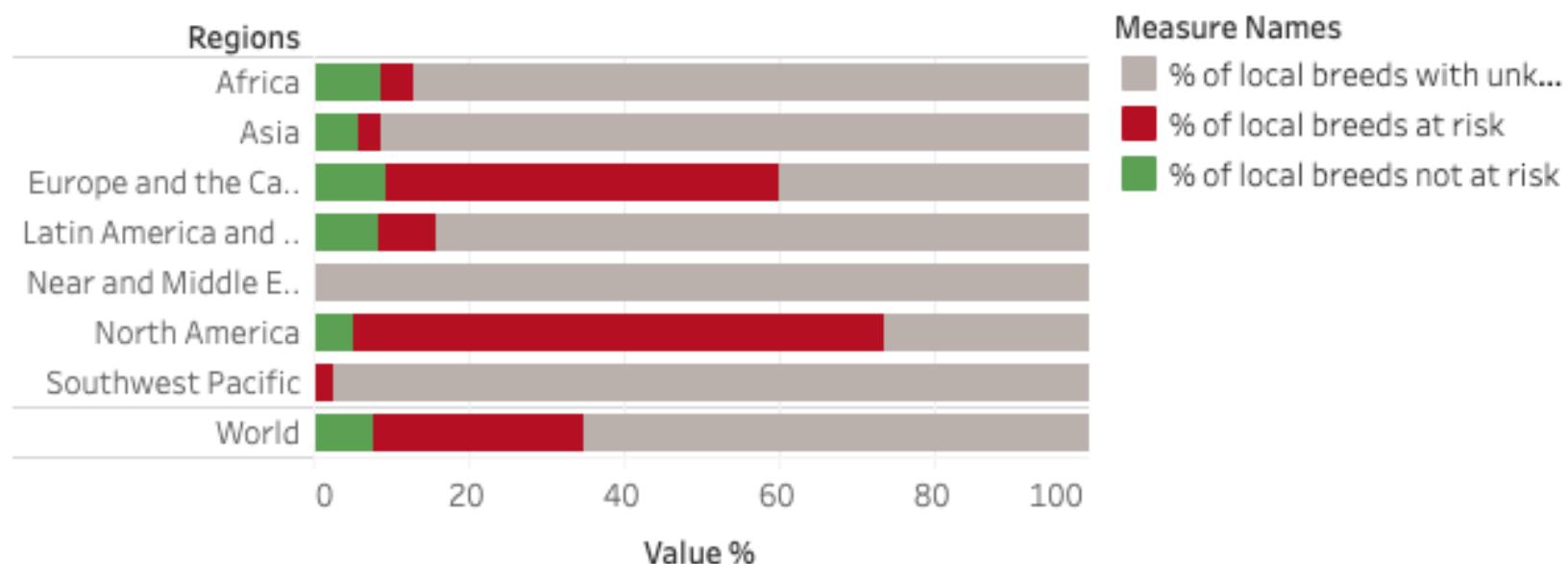
*samuel.paiva@embrapa.br*



MINISTÉRIO DA  
AGRICULTURA, PECUÁRIA  
E ABASTECIMENTO



## ***SDG indicator 2.5.2: Proportion of local breeds, classified as being at risk, not-at-risk or of unknown level of risk of extinction, the***



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