Scientific contribution of INRA to pig Genetics

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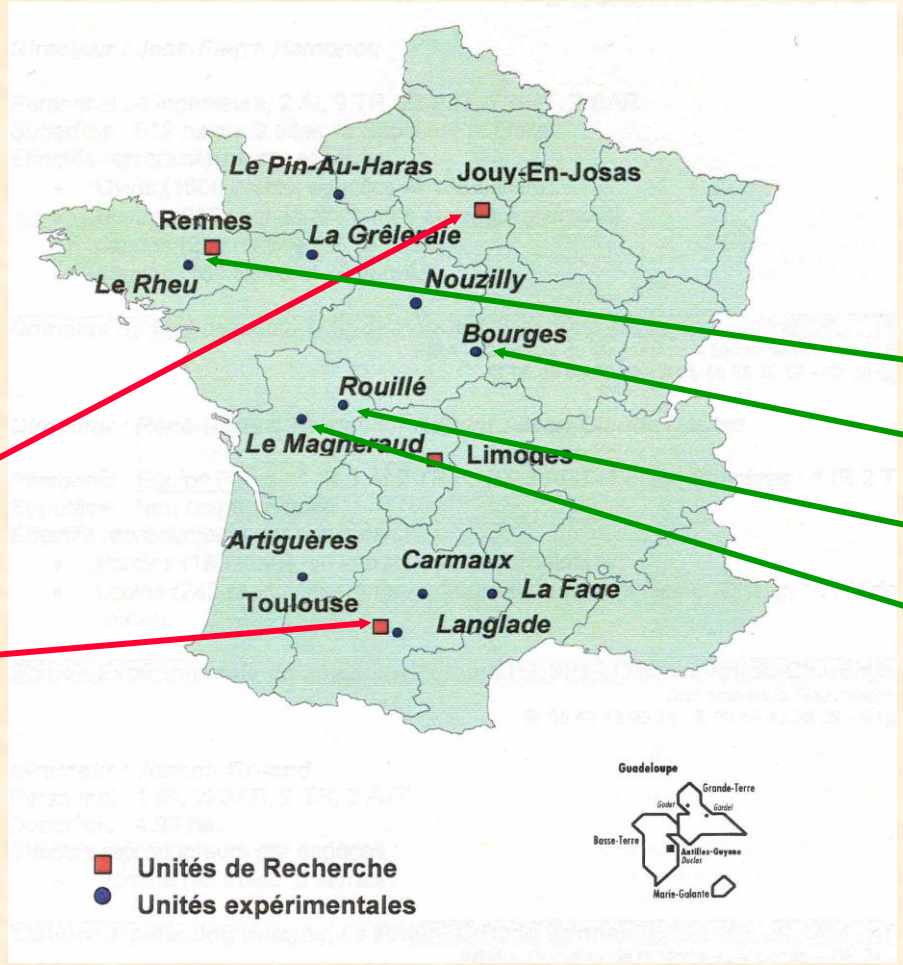
Pig genetics at INRA

Research units

SGQA

LGC



Expérimental units

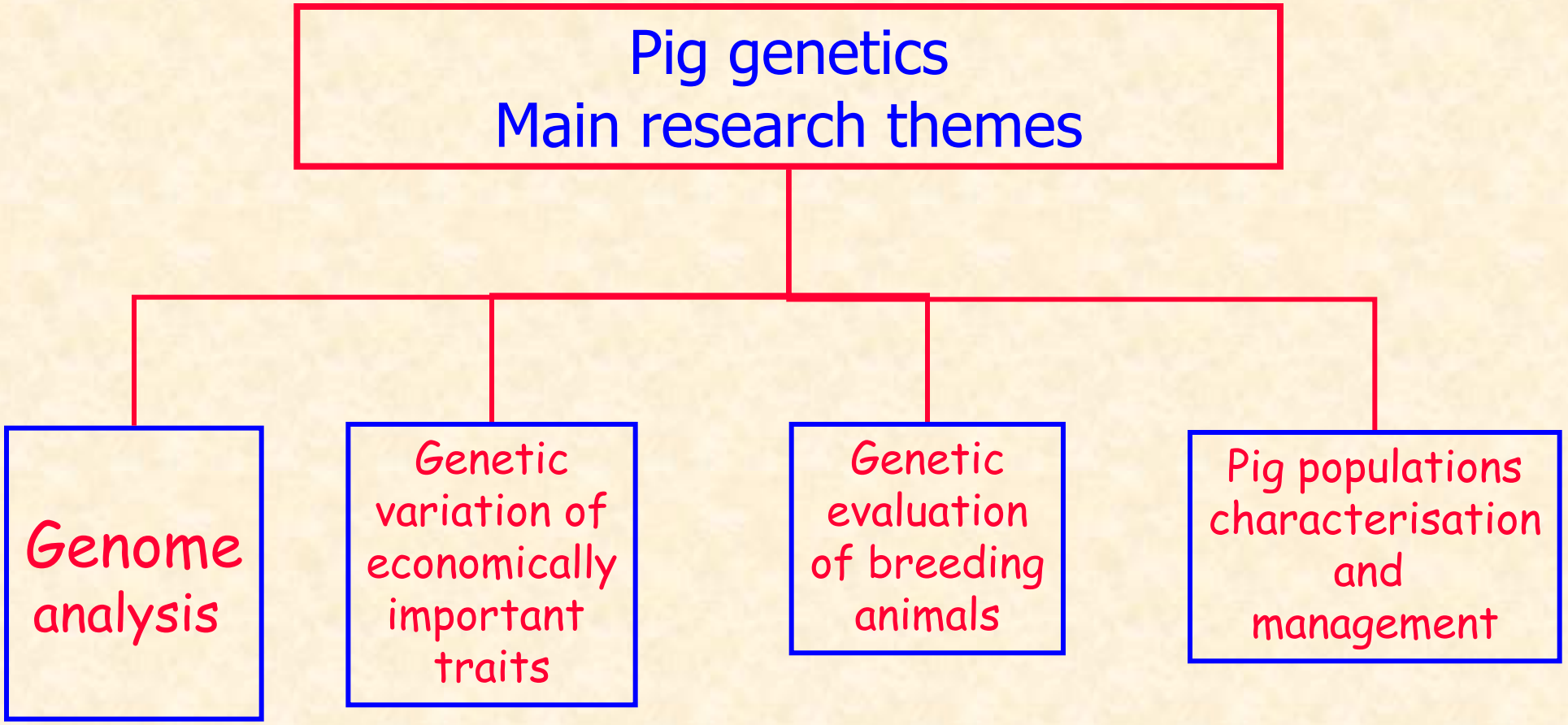
STP

UEP

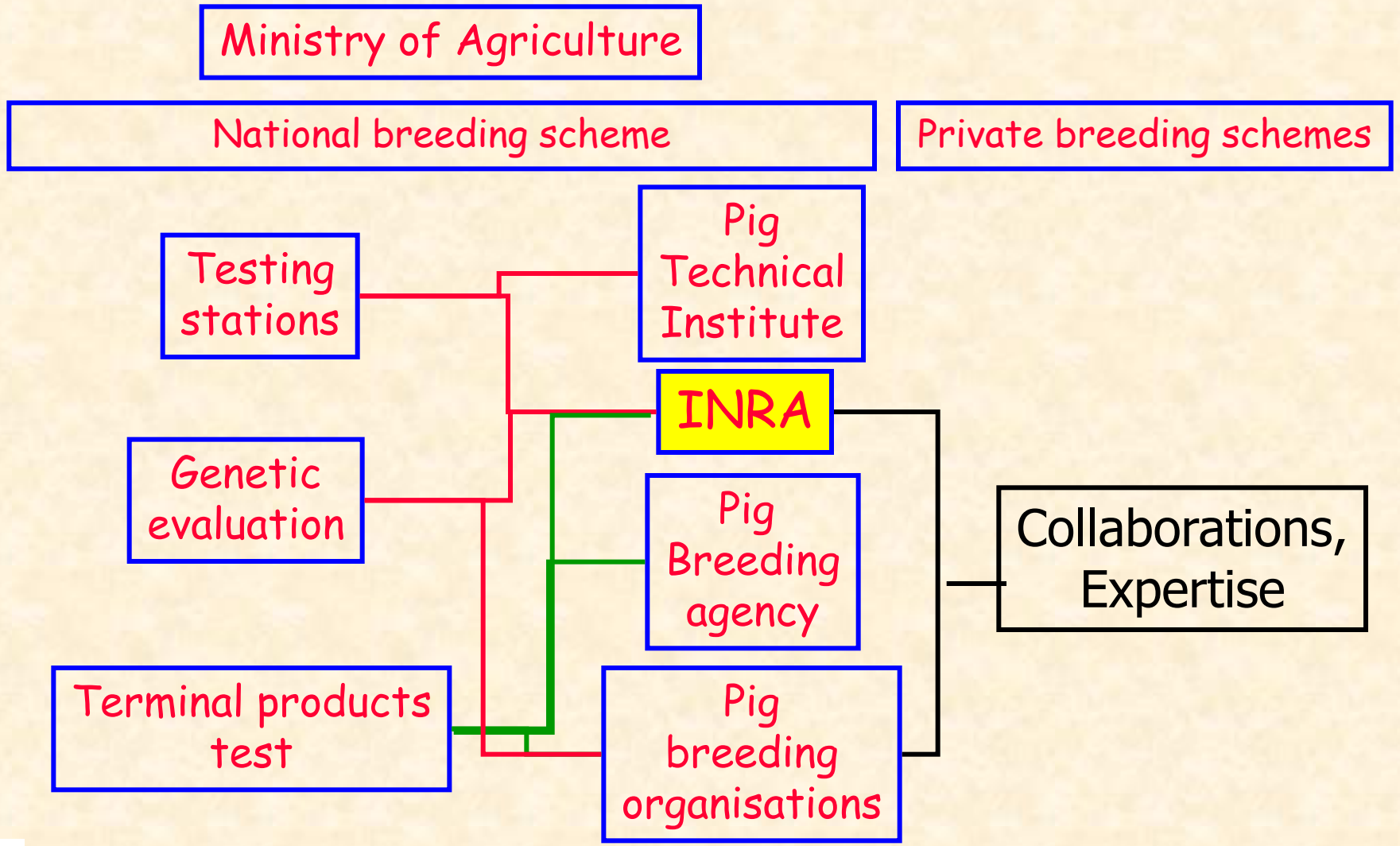
SESP

LMG

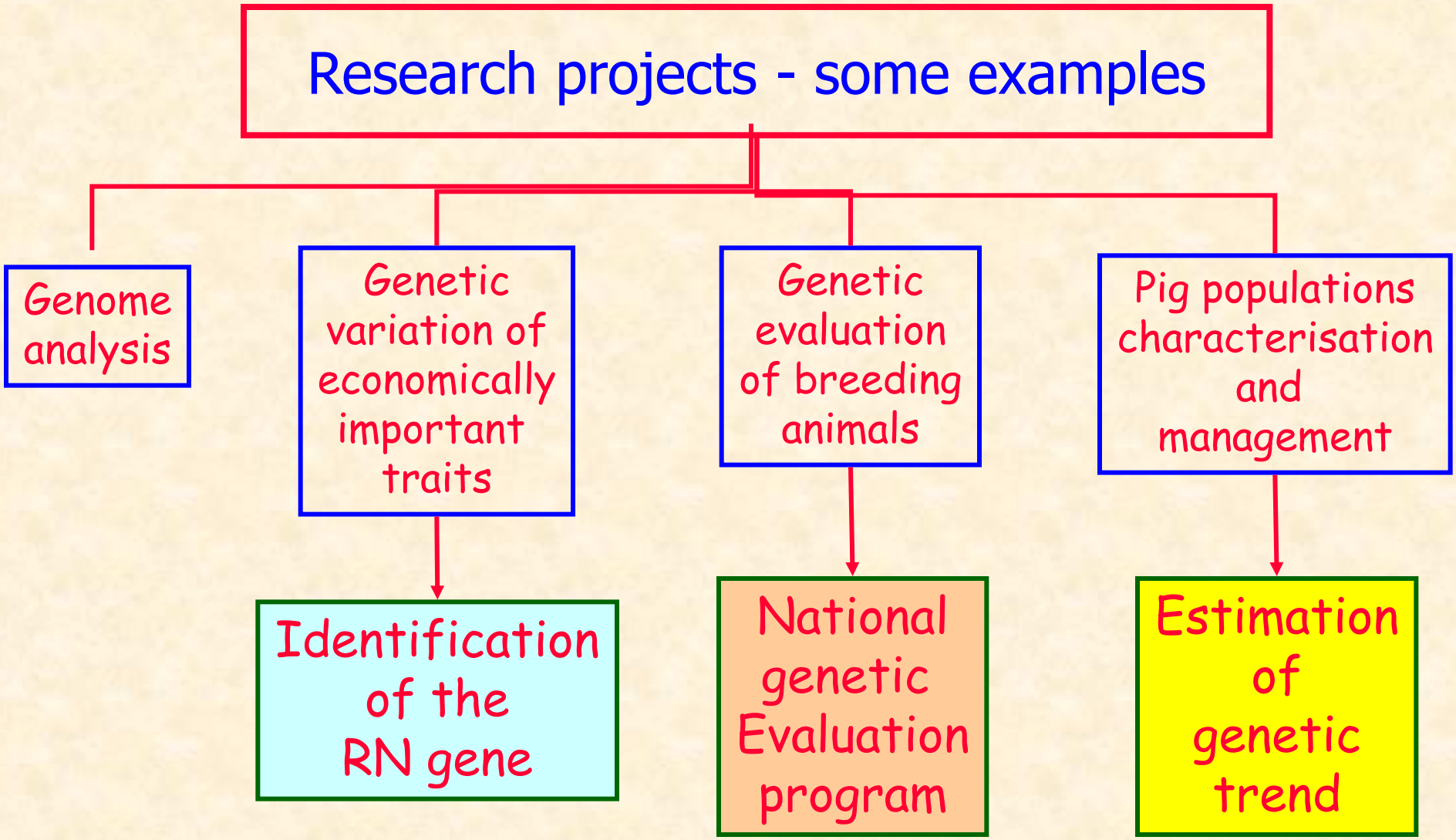
Pig genetics
Main research themes



Relationships between INRA and breeding organisations



Research projects - some examples



The RN gene

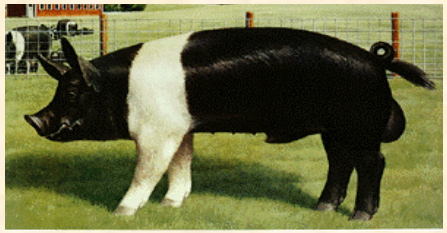
First results

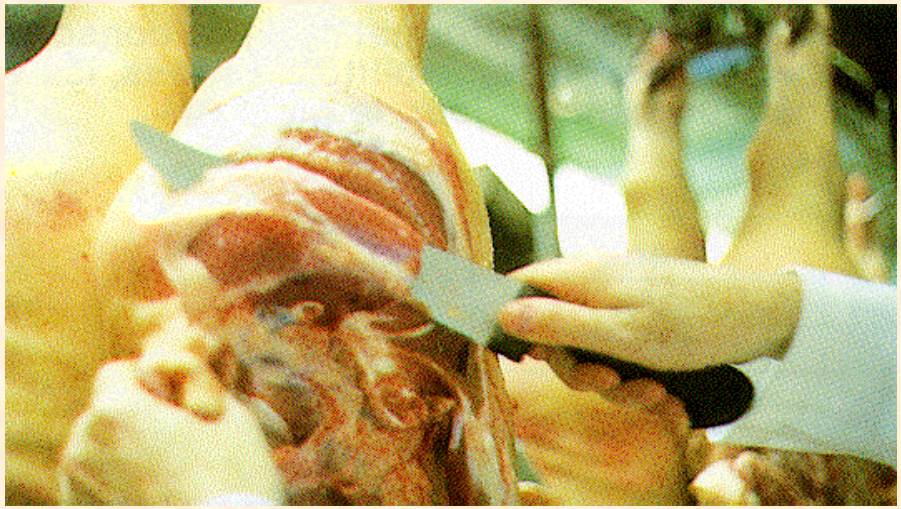
Laconie sire line

Piétrain

Large White

Hampshire



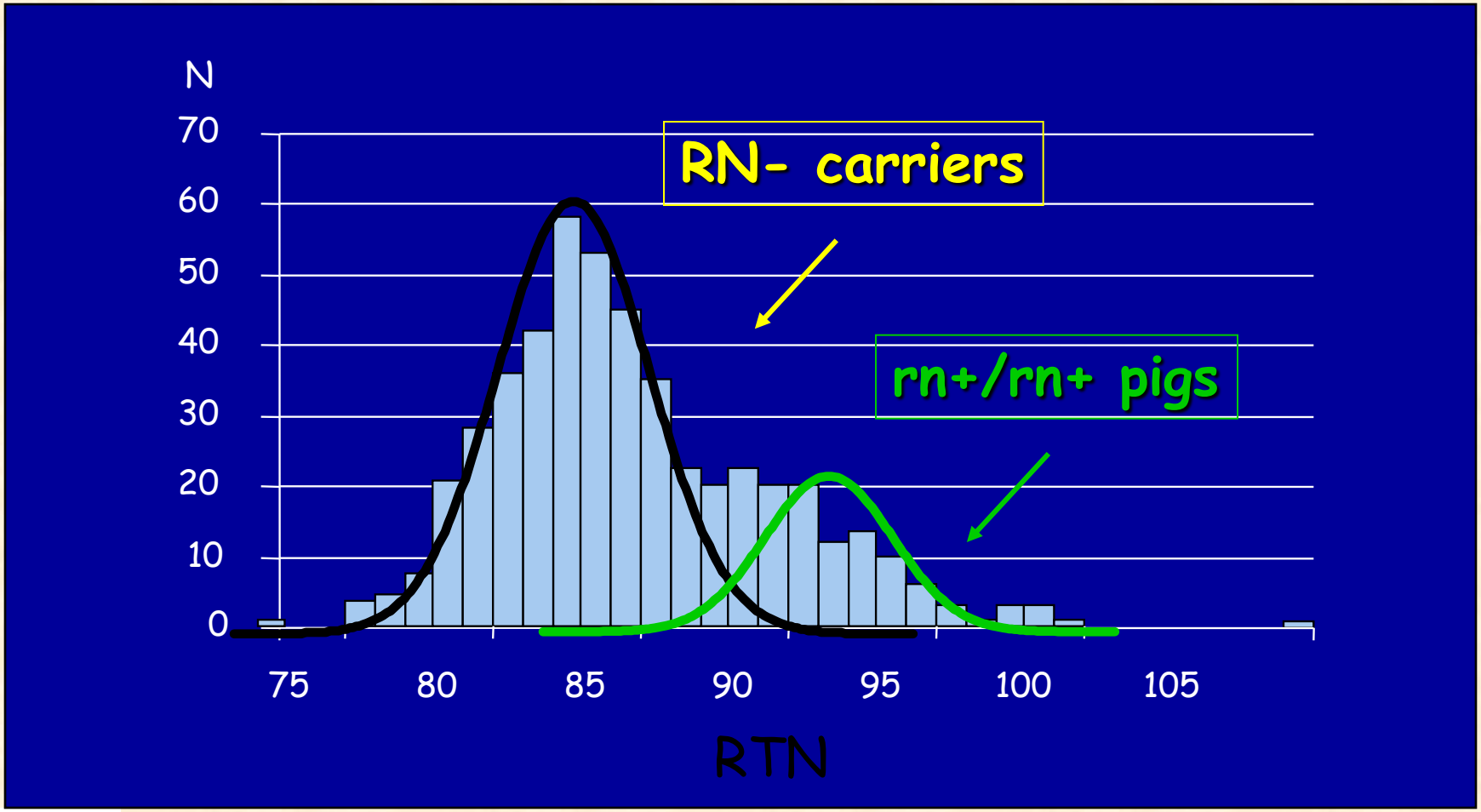


$$RTN = \frac{\text{Cooked weight}}{\text{Fresh weight}}$$

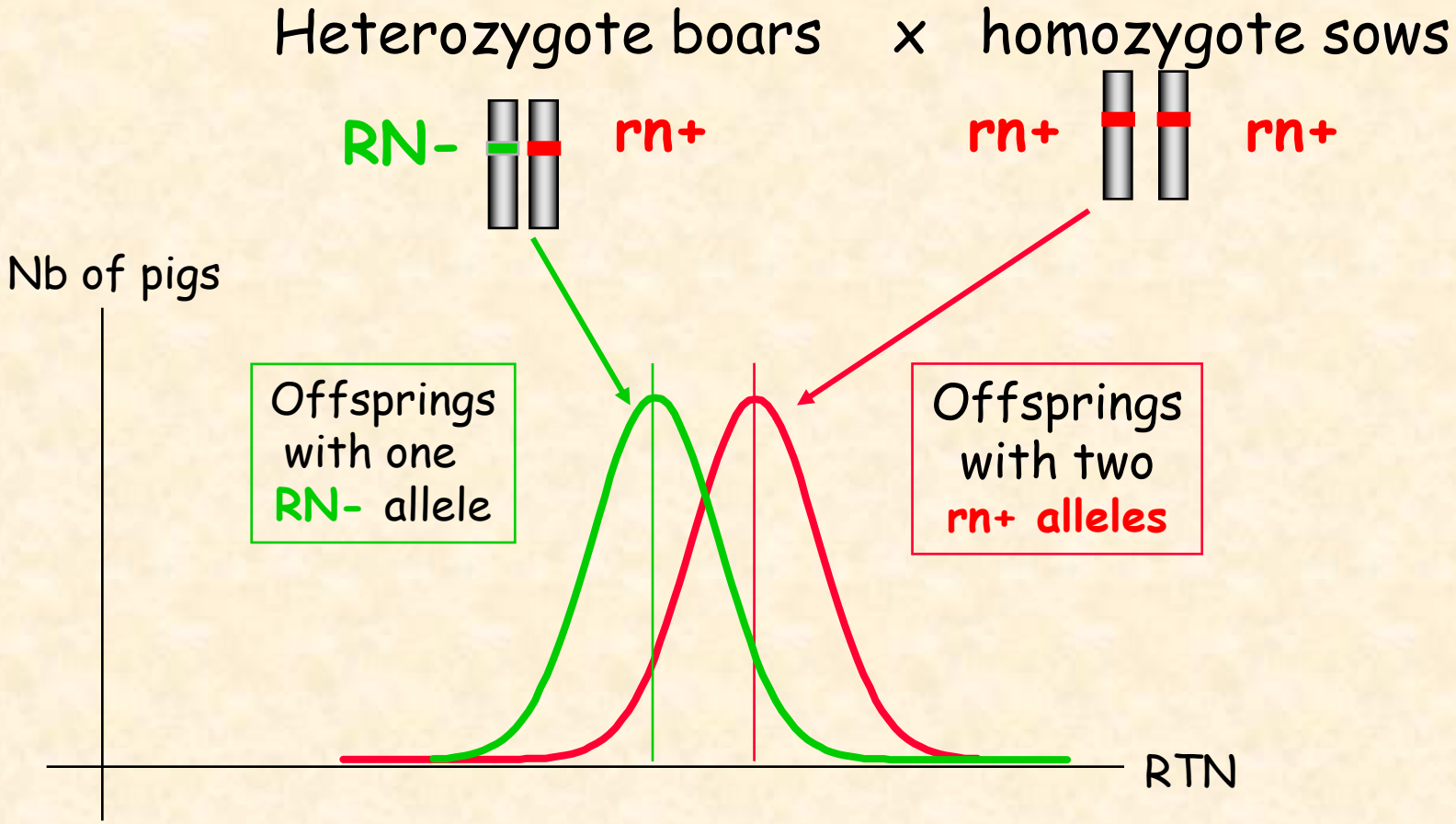
« Paris ham » cooking yield

Distribution of RTN in the Laconie line

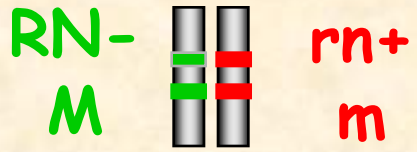
Segregation analysis



Experimental confirmation of RN gene segregation



Looking for a linked genetic marker



Heterozygote sire
RN-M / rn+ m

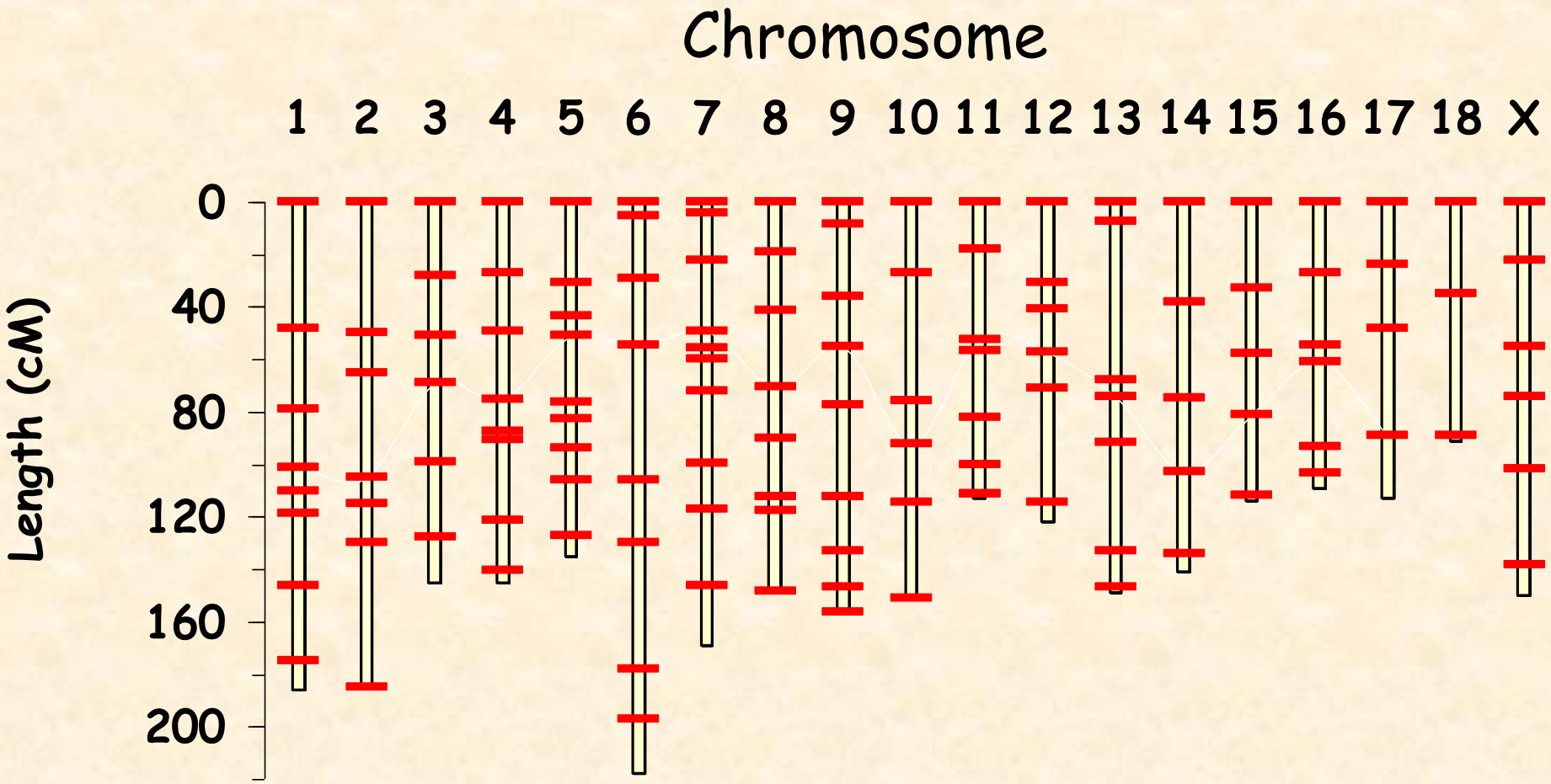
Nb of pigs

Offsprings with M (and thus RN-) allele

Offsprings with m (and thus rn+) allele

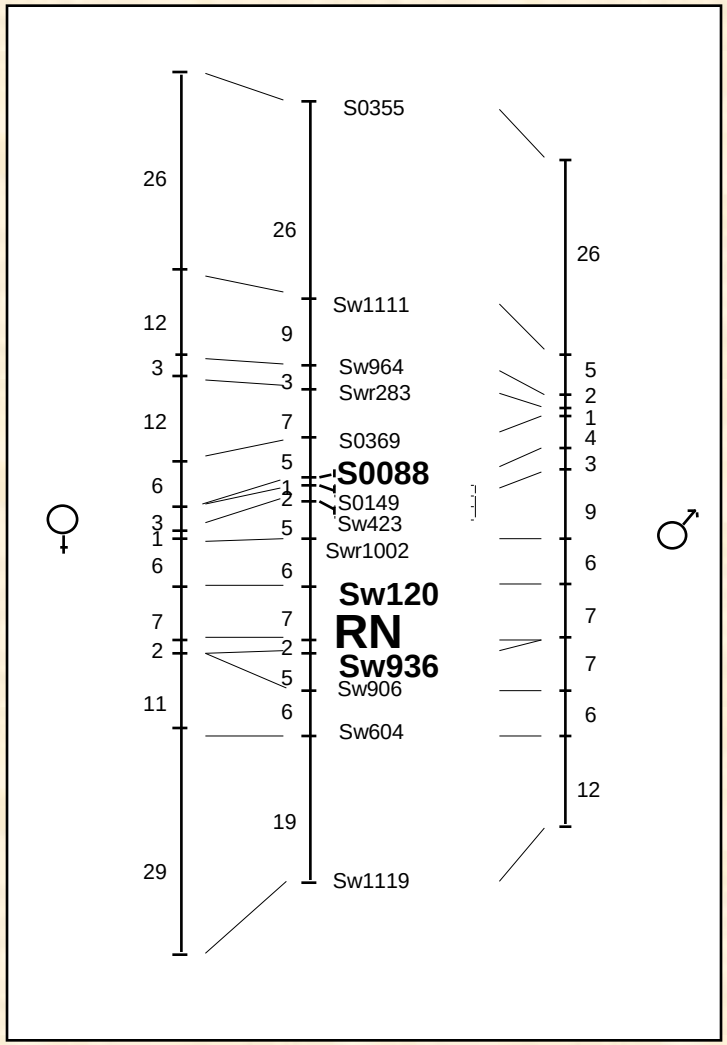
RTN

Panel of genetic markers



Genetic mapping of the RN gene

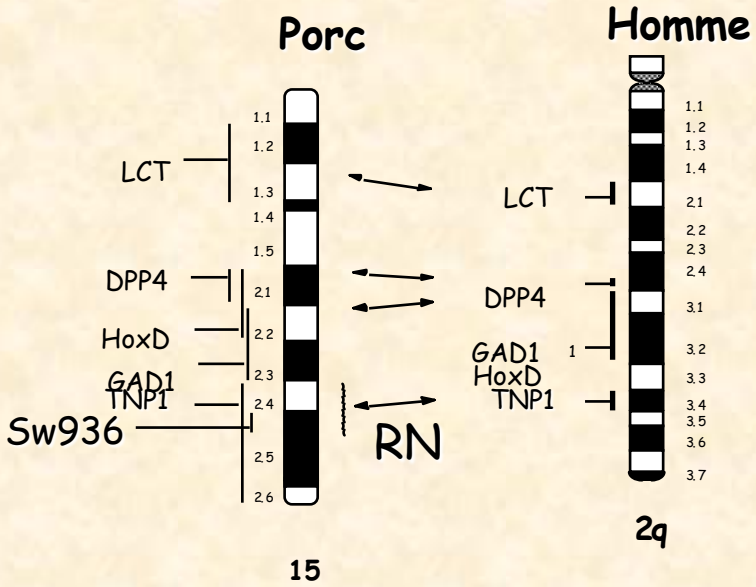
- Production of expérimental families
- Analysis of **microsatellite** markers
- RN is mapped on chromosome **15** between Sw120 and Sw936 at **2cM** from **Sw936**



Positional cloning of RN gene (1996-2000)

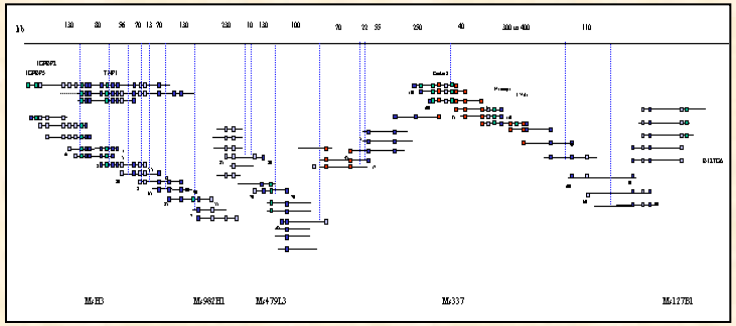
- Physical assignment of RN gene in pigs
- Comparative mapping (with human genome)

15 q2.5



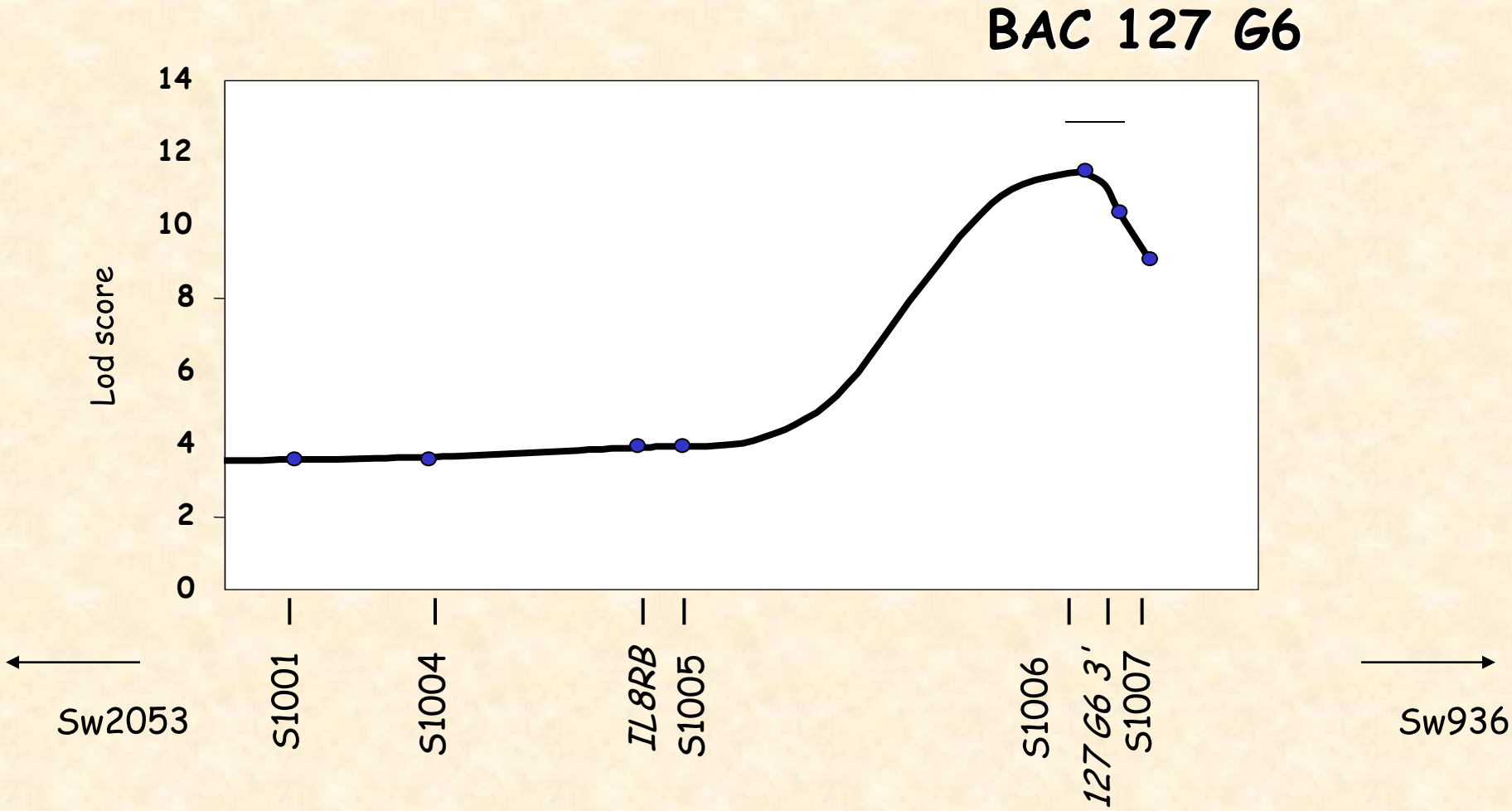
Positional cloning of RN gene (1996-2000)

☞ **physical map** of the RN chromosomal région (contig of **BAC clones**)



Cloning of 2.4 billions letters

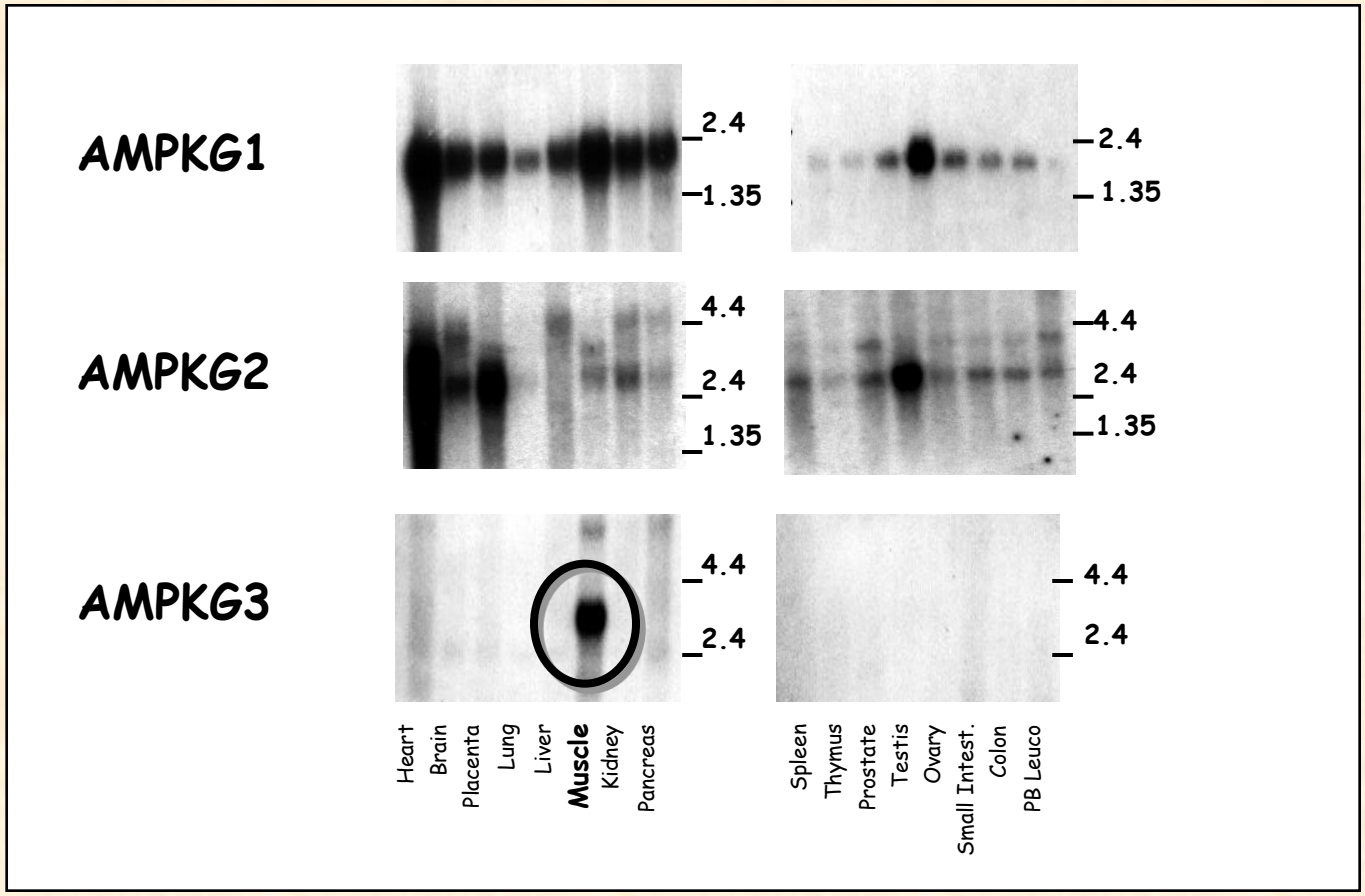
Linkage disequilibrium mapping



Séquencing of BAC 127 G6 clone

- The sequence (130.000 lettres) of the **BAC clone** containing the nearest markers has been determined
- The sequences of 3 genes have been identified

AMPKG3 is specifically expressed in muscle



Northern blot with human ARNm

Identification of a candidate mutation

- Séquencing of the gene on: rn+/rn+ pigs
  RN-/RN-

- Identification of a candidate mutation

R 200 Q

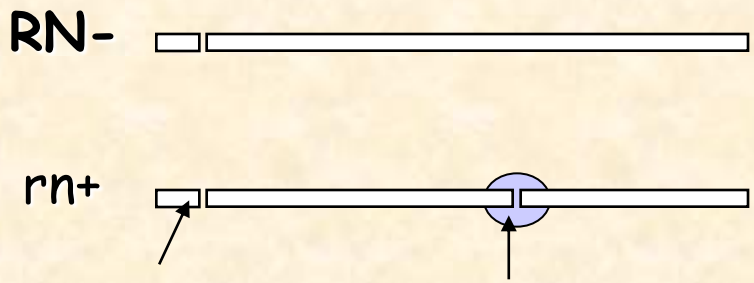
The R200Q mutation is associated with RN-

Breed	no	RN	AMPKG3
Hampshire (Sweden)	60	++	R - R
Hampshire (Sweden)	87	[-]	R - Q
Hampshire (Sweden)	40	[-]	Q - Q
Hampshire synthetic line	103	++	R - R
Hampshire synthetic line	91	[-]	R - Q
Hampshire synthetic line	18	[-]	Q - Q
Piétrain	75	++	R - R
Duroc & synthetic lines	160	++	R - R
Large White	72	++	R - R
Landrace	83	++	R - R
Meishan	8	++	R - R
Wild boar	8	++	R - R
Other breeds	70	++	R - R

Development of a diagnostic test

PCR amplification

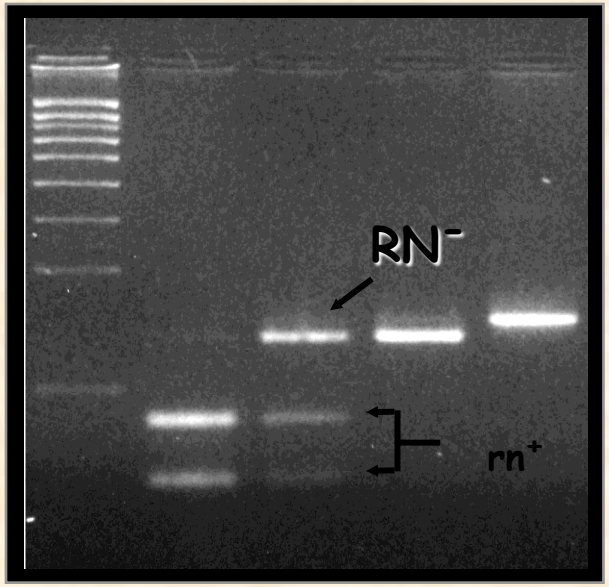
Enzyme digestion



Primer control site

Diagnostic site

Uncut control



rn^+ RN^- RN^-

rn^+ rn^+ RN^-

Genetic evaluation of pigs

INRA Département of Animal Genetics

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Genetic evaluation of pigs

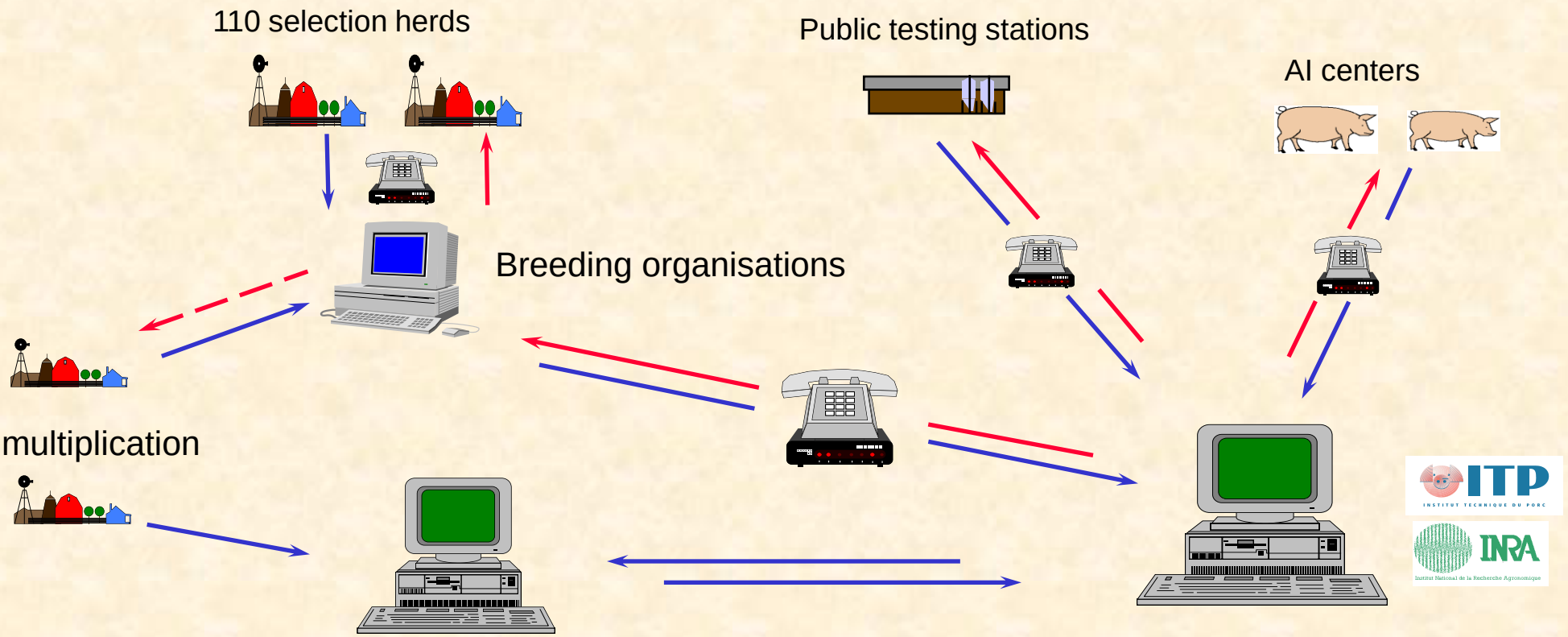
« BLUP – animal model » genetic evaluation

- performances have to be centralised
  - pedigrees

- Information has to be transmitted quickly

- High frequency of genetic evaluations
  - National genetic evaluation every month
  - Within - herd evaluation

Genetic information flow

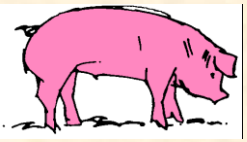


Département of Animal Genetics

Genetic evaluation
Production traits

On-farm test

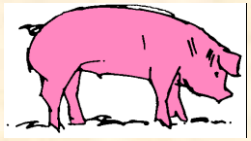
Male and female
candidates to selection



Age at 100 kg (A100)
Backfat thickness at 100 kg
(BF100)
(Loin depth)
(Meat quality)

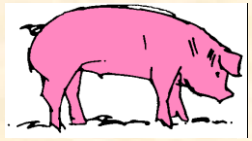
Station test

Young candidate boars (until 1996)

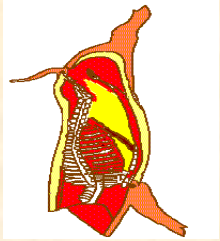


Average daily gain (ADG)
Backfat thickness (ABF)
Food conversion ratio (FCR)

Slaughtered sibs (since 1997)



Average daily gain
Food conversion ratio



Dressing % (DP)
Muscle content (MC)
Meat quality index (MQI)

Genetic parameters

Large White

	ADG1	ABF	FCR	ADG2	DP	MC	MQI	A100	BF100
ADG 1	**0.30**	0.27	0.02	0.89	-0.25	-0.22	0.11	-0.65	0.22
ABF	0.25	**0.73**	0.74	-0.11	0.20	-0.79	0.23	0.05	0.85
FCR	0.01	0.40	**0.41**	-0.36	0.07	-0.78	0.22	0.16	0.55
ADG 2	0.27	-0.05	-0.41	**0.30**	-0.31	0.12	0.07	-0.80	-0.06
DP	-0.09	0.11	0.10	-0.09	**0.40**	-0.02	-0.10	0.30	-0.03
MC	-0.10	-0.54	-0.47	-0.03	0.02	**0.63**	-0.22	0.01	-0.85
MQI	0.03	0.09	0.08	0.00	-0.04	-0.07	**0.21**	0.00	0.13
A100								**0.19**	-0.09
BF100									**0.42**

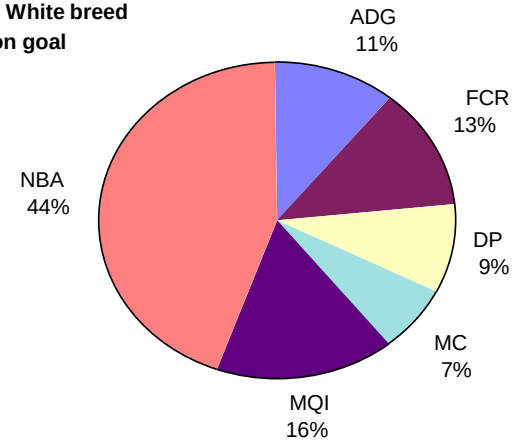
On the diagonal : heritabilities

Above diagonal : genetic correlations

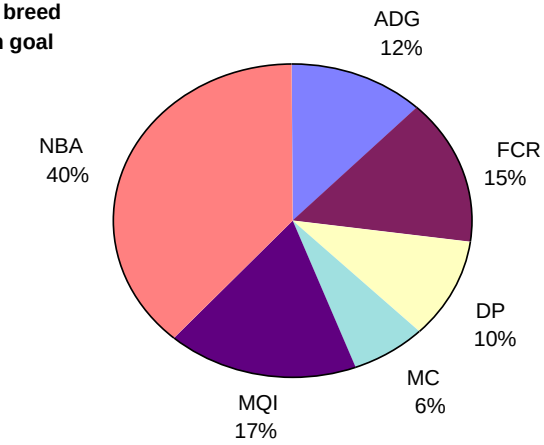
Below diagonal : phenotypic correlations

Selection goals (until 2002)

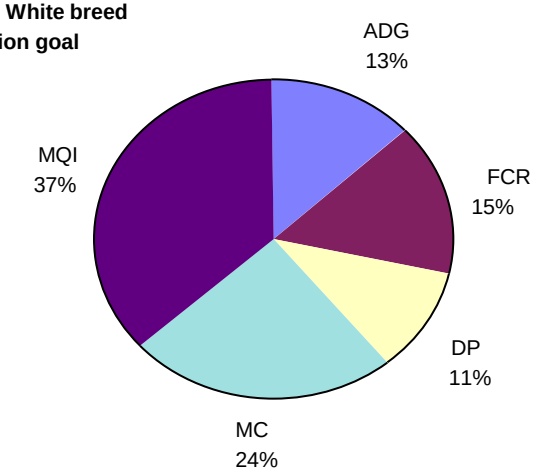
Female Large White breed
Selection goal



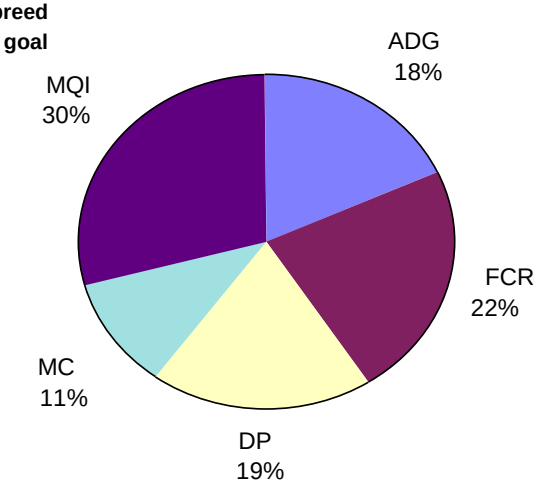
Landrace breed
Selection goal



Male Large White breed
Selection goal



Piétrain breed
Selection goal



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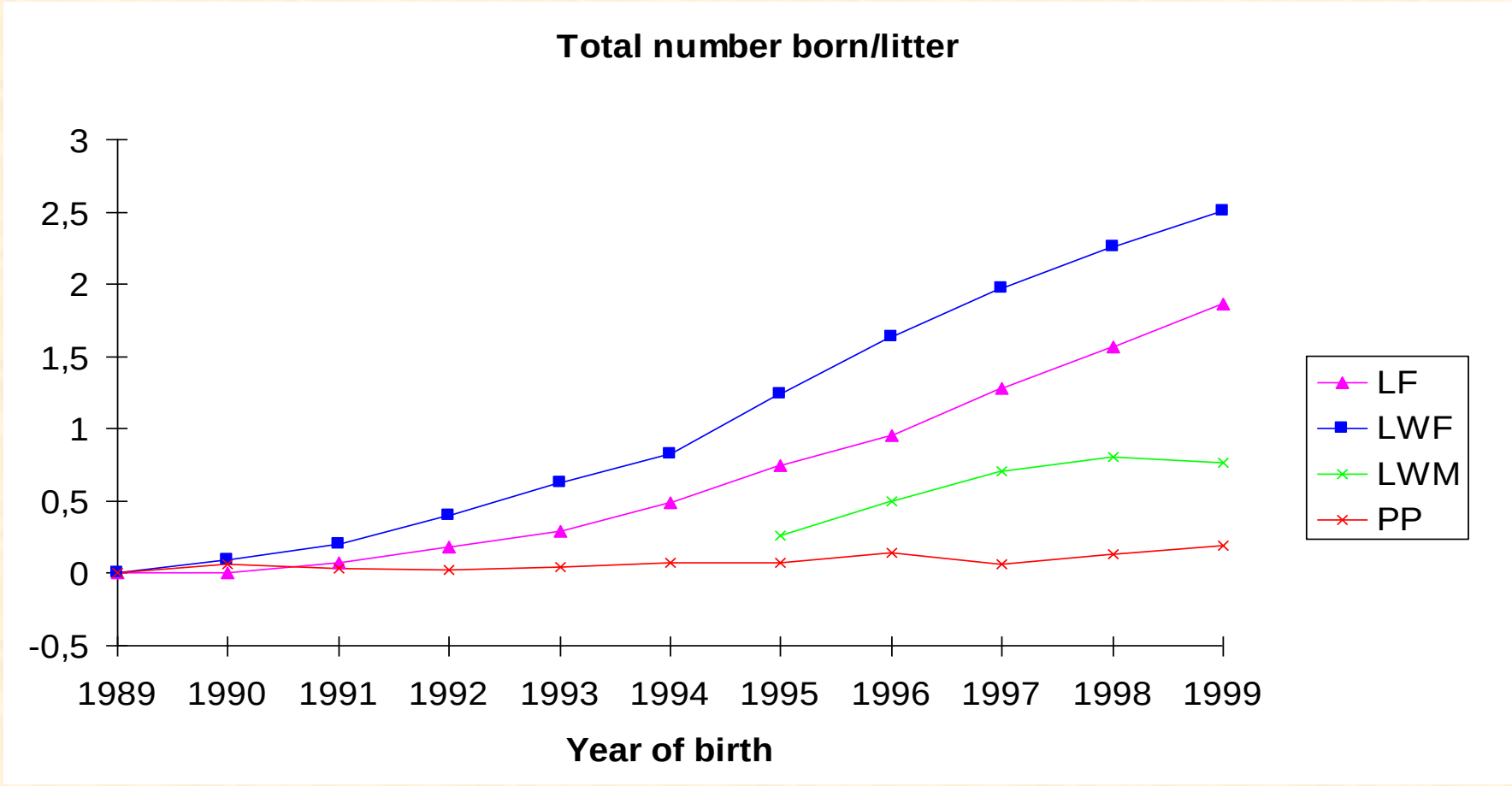
Estimating genetic trend from genetic evaluation results

Estimated genetic trends : main French breeds



Estimation of realised genetic trend using frozen semen

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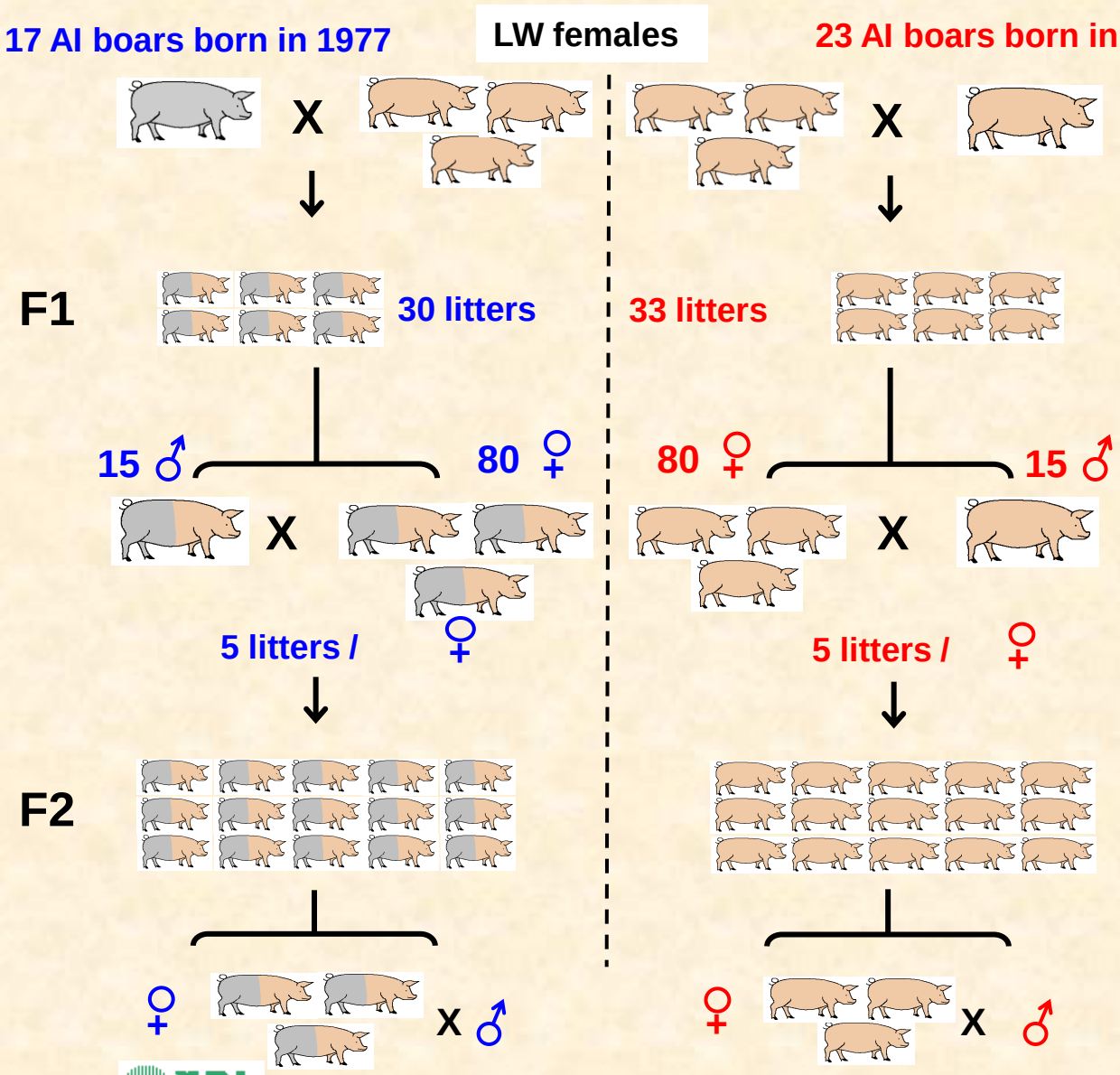
Experimental design



- growth, backfat thickness
- puberty ♀, intensity of oestrus
- Sexual development ♂
- Semen production

- Ovulation rate
- Litter size at birth and at weaning
- Piglet weight at birth & weaning
- colostrum & milk composition
- Milk production, ...

- Growth & carcass traits
- Tissue characteristics & quality
- Teat number
- Disease resistance
- Piglet maturity
- Leg and bone quality

- Maternal behaviour

Estimated genetic trends – reproduction (1)

Trait	Estimated genetic trend
Age at puberty (d)	-9,2 ns
Ovulation rate	4,0 **
Prenatal survival (%)	5,3 ns
Total number born	2,9 **
Number born alive	2,1 *
Number of stillborn	0,7 *
0-21 d survival rate	-4,2 ns

Ns =not significant; * P<0.05; ** P<0.01

Estimated genetic trends – reproduction (2)

Trait	Estimated genetic trend
Birth weight (g)	74 ns
Adjusted (T NB) birth weight (g)	182 **
Standard deviation(birth weight) (g)	76 ***
ADG 0-21 d /piglet genotype (g)	-10 ns
ADG 0-21 d /sow genotype (g)	-22 *
Total teat number	0,4 *
Functional teats	1,8 ***

Ns =not significant; * P<0.05; ** P<0.01; *** P<0.001

Estimated genetic trends – production (1)

Trait	Estimated genetic trend	
	Large White	Landrace
ADG from 10 to 22 wk	206 ***	130 **
Food conversion ratio	-0,44 ***	-0,10 ns
Daily feed intake (kg/d)	0,18 ns	0,22 ns
Estimated lean content	7,1 ***	5,1 ***
Dressing %	-3,1 *	-0,9 ns

Estimated genetic trends- production (2)

trait	Estimated genetic trend	
	Large White	Landrace
pH 30 mn	0,02 ns	0,12 ***
pH (DM) 24 h	-0,26 **	O,O ns
Water retention (%)	5,6 ***	-3,3
Water losses	1,O ns	-4,4 **

Conclusion

- Animal breeding in France
- Close relationships between research, development and breeding organisations
  - Innovations are quickly used in practise
- Participation of the ministry of agriculture
- Strong concurrency
- Objective comparisons (terminal products)