Effect of the level of artificial insemination on the genetic gain for a meat sheep breeding program

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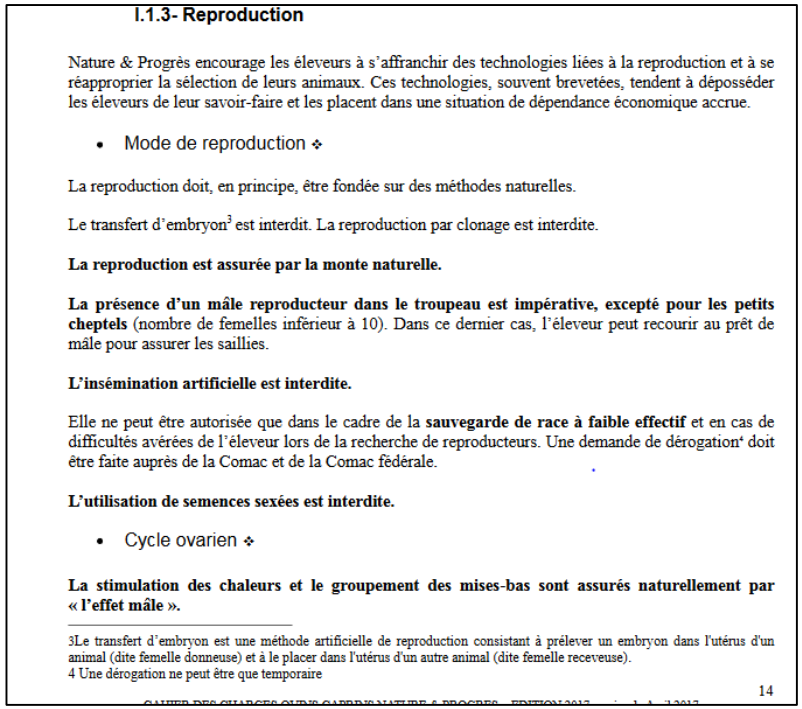
AI and controversy

Specifications of a French Organic Agriculture Association

(« Nature et Progrès » is part of the International Federation of Organic Agriculture Movements)



I.1.3- Reproduction

Nature & Progrès encourage les éleveurs à s'affranchir des technologies liées à la reproduction et à se réapproprier la sélection de leurs animaux. Ces technologies, souvent brevetées, tendent à déposséder les éleveurs de leur savoir-faire et les placent dans une situation de dépendance économique accrue.

- Mode de reproduction ❖

La reproduction doit, en principe, être fondée sur des méthodes naturelles.

Le transfert d'embryon[3] est interdit. La reproduction par clonage est interdite.

La reproduction est assurée par la monte naturelle.

La présence d'un mâle reproducteur dans le troupeau est impérative, excepté pour les petits cheptels (nombre de femelles inférieur à 10). Dans ce dernier cas, l'éleveur peut recourir au prêt de mâle pour assurer les saillies.

L'insémination artificielle est interdite.

Elle ne peut être autorisée que dans le cadre de la **sauvegarde de race à faible effectif** et en cas de difficultés avérées de l'éleveur lors de la recherche de reproducteurs. Une demande de dérogation[4] doit être faite auprès de la Comac et de la Comac fédérale.

L'utilisation de semences sexées est interdite.

- Cycle ovarien ❖

La stimulation des chaleurs et le groupement des mises-bas sont assurés naturellement par « l'effet mâle ».

3Le transfert d'embryon est une méthode artificielle de reproduction consistant à prélever un embryon dans l'utérus d'un animal (dite femelle donneuse) et à le placer dans l'utérus d'un autre animal (dite femelle receveuse).
4 Une dérogation ne peut être que temporaire

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« reproduction is provided by natural mating »

« AI is forbidden »

« the use of reproductive hormones is forbidden »

Consequences on genetic gain of a ban or limited use of AI?

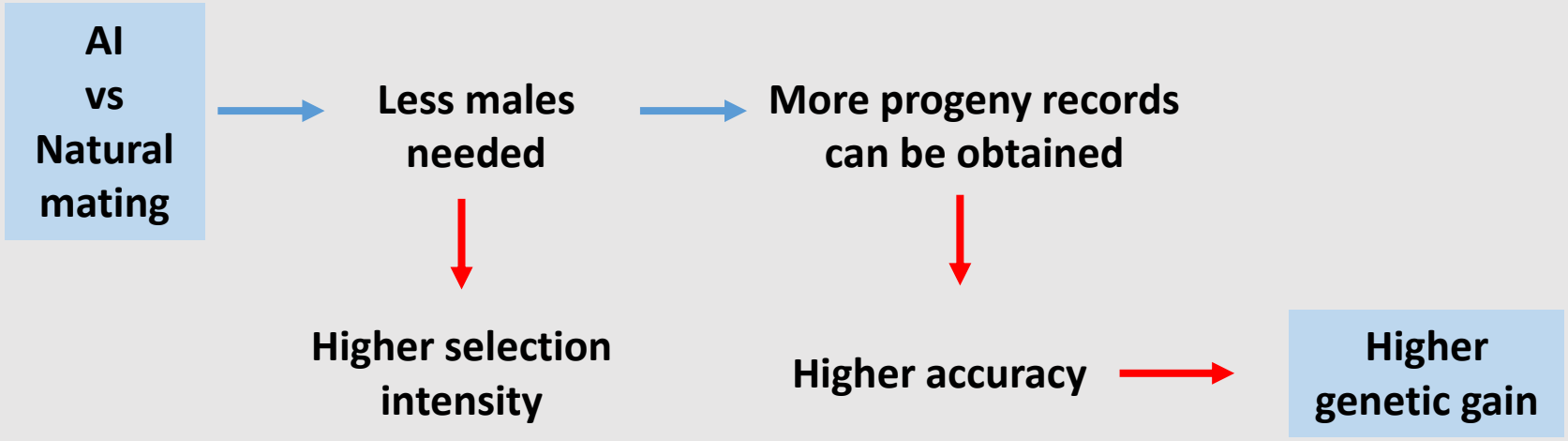
Why do we use AI in breeding programs?

For multiple purposes:

Health (eg limit the circulation of the breeding stock)

Organizational (eg limit the duration of lambing)

Genetics



Previous study about AI and genetic gain

Comparison of breeding programs for dairy Lacaune breed (Barillet and Elsen, 1979)

- ✓ **Deterministic model based on the breeder's equation**
- ✓ **AI versus Natural Mating gave an additional gain of +30%**
- ✓ **Large population, complete pedigree and breeding program based on progeny testing**

AI levels and genetic gain for meat sheep breeding programs

Objective:

Quantify the genetic gain for a maternal trait as a function of the AI level for meat sheep breeding program:

- ✓ **small nucleus**
- ✓ **with or without PT (Progeny testing)**
- ✓ **complete or incomplete pedigree (sire information)**

1) Quantify the genetic gain (ΔG) given an inbreeding rate (ΔF) for various breeding designs (with or without PT) and various levels of AI

2) Study the combined effect on ΔG of the level of AI and the quantity of pedigree information of females

The genetic gain was assessed by stochastic simulations

Method :

Breeding program : 8000 ♀ , 15 flocks, 20 years of selection

True Breeding values (TBV) allocated to each individual

$$TBV_i = 0.5\,TBV_d + 0.5\,TBV_s + \sqrt{0.5\,(1 - \frac{Fd+Fd}{2})}\;MS_i$$

MS(i) ~ $N(0, \sigma^2_G)$ MS=Mendelian sampling

Each year : fertile ♀ have a maternal phenotype (h^2=0.25)

$$P_{i,t} = TBV_i + TPE_i + TFY_t + res_i$$

TPE = True permanent environmental effect

TFY = True flock year effect

Genetic evaluation based on an animal BLUP model using Blupf90 software (Misztal *et al.*, 1999)

Various breeding program designs were assessed

Natural mating

AI without PT (5, 10, 25, 50, 80 % of ewes were mated to an AI sire)

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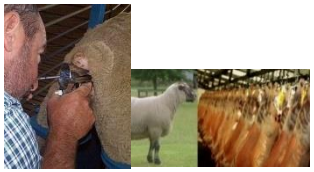
AI with PT (50, 80% of ewes were mated to an AI sire)



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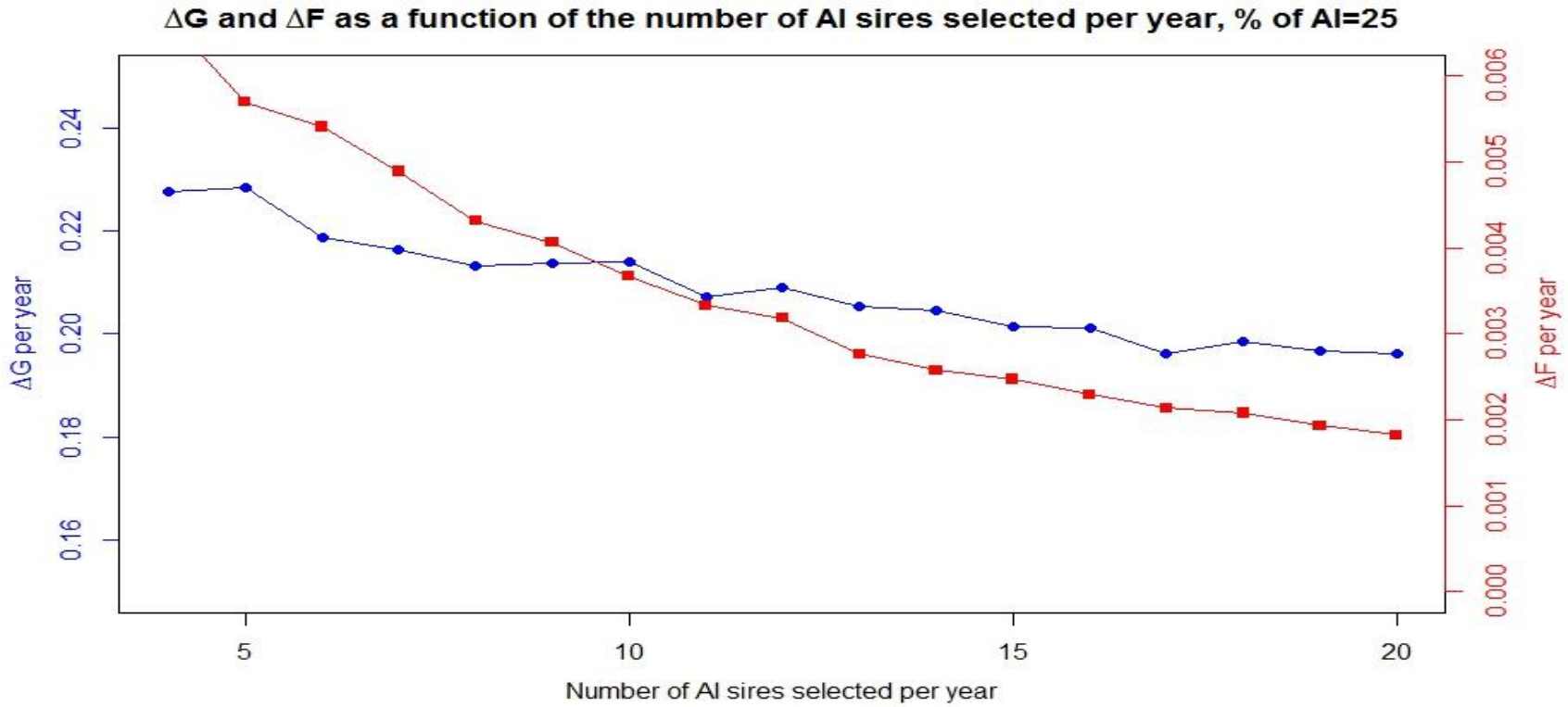
(50 replicates by designs * AI level)

At a given AI level, ΔG and ΔF depended on the number of males selected for AI



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For a fair comparison : choice of the number of AI sires that gave the higher ΔG at a given ΔFmax

«compare the effect of AI level all other things being equal »

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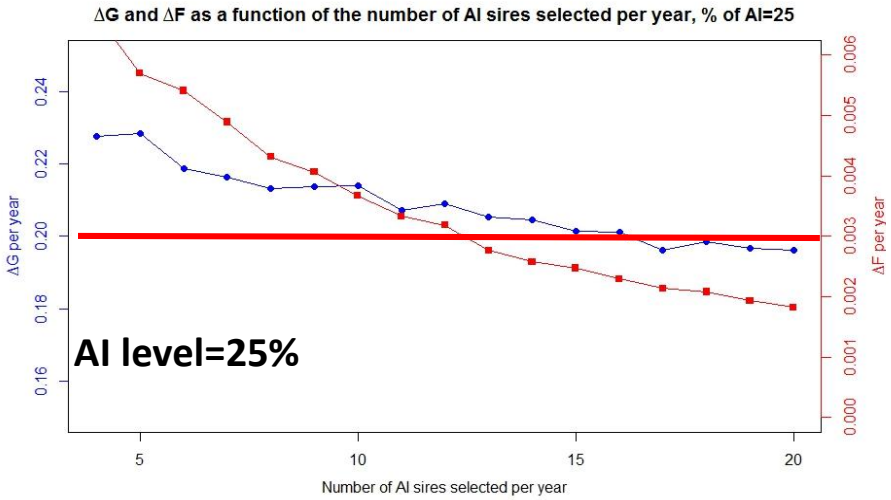
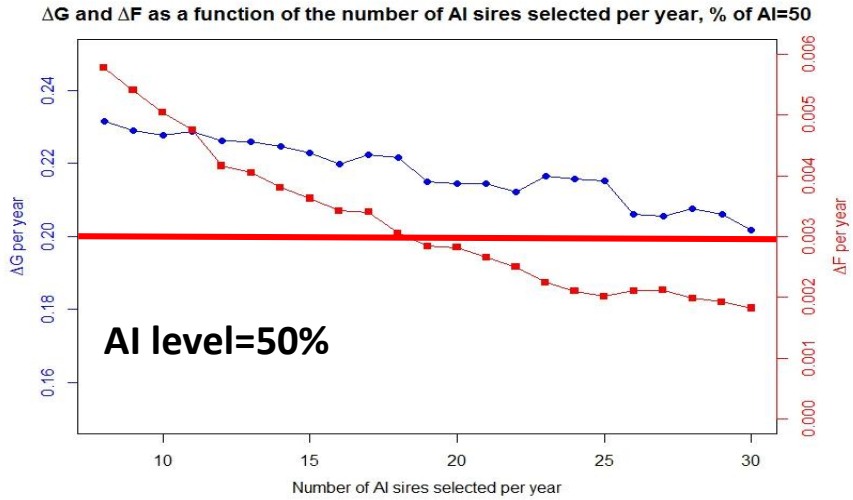
For a fair comparison : choice of the number of AI sires that gave the higher ΔG at a given ΔFmax

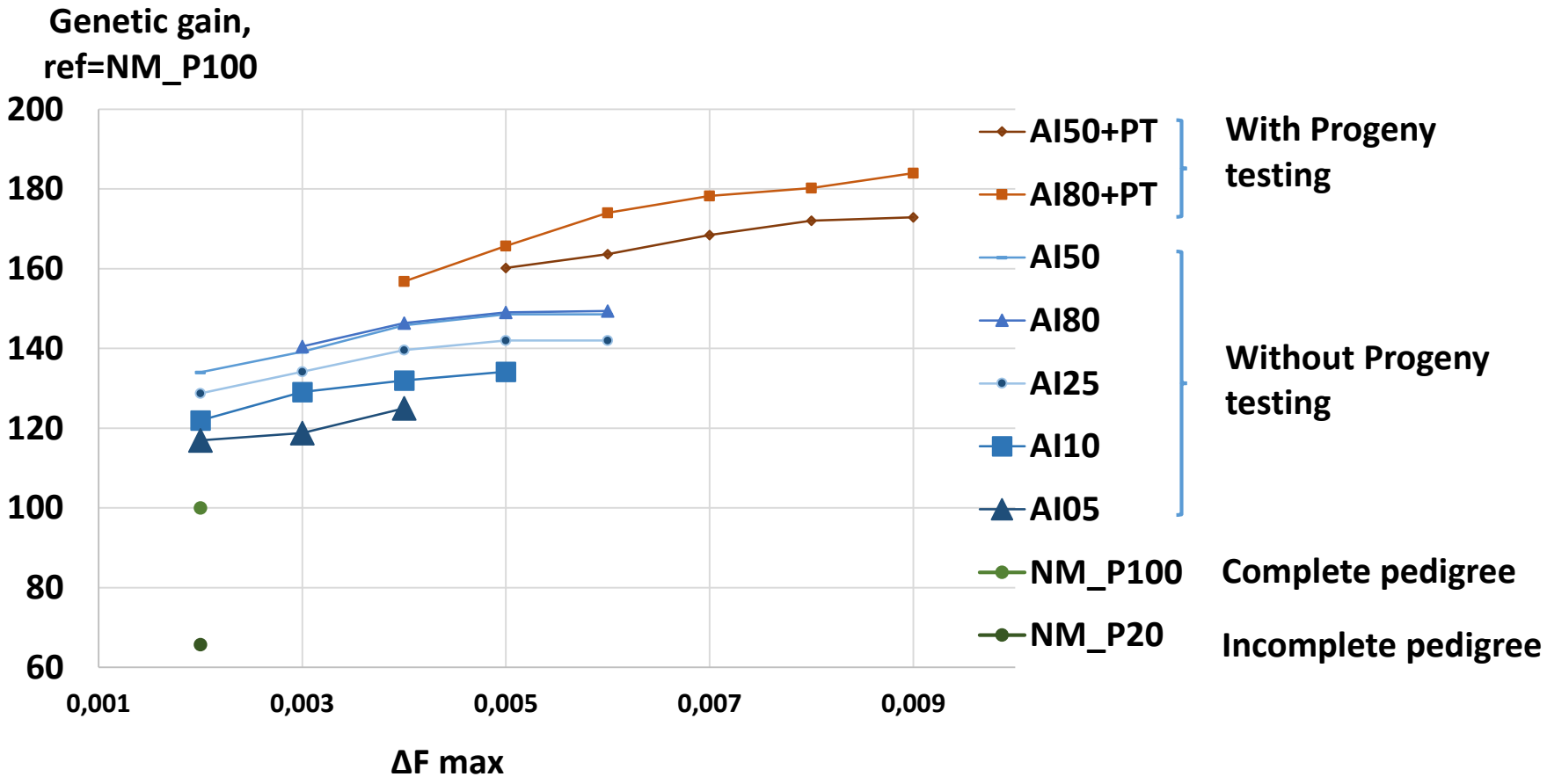
Example : ΔFmax=0.003/year





The number of selected males was adjusted to compare ΔG at a given ΔFmax

Genetic gain according the desing and the AI level as a function of the inbreeding rate



Quality of EBV and estimates of year flock effects

For breeding programs without PT according the AI level

Reference = Natural Mating

%AI	QD (index)	Pearson correlation year*Flock	QD year*Flock	ΔG
80	0.4	1.00	0.01	148
50	0.5	1.00	0.01	147
25	0.5	1.00	0.01	143
10	0.5	1.00	0.01	134
5	0.5	1.00	0.01	125
0	0.5	1.00	0.01	100

QD: mean of the quadratic differences between the simulated value and its estimation based on a BLUP

Pearson correlation between simulated year flock effect and its estimation based on a BLUP

Accuracy and bias of EBV and estimates of year flock effects

For breeding programs without PT according the AI level and the % of females with a sire information

Reference = Natural Mating, complete pedigree

% AI	% of NM ♀ with a sire information	QD - Index ♀		Correlation year*Flock	ΔG
		with sire	without sire		
0	100	0.5		1.00	100
0	50	1.6	2.8	0.96	77
25	100	0.5		1.00	145
25	50	2.5	5.1	0.93	138
5	100	0.5		1.00	125
5	50	2.4	4.5	0.93	114

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-23 %

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5	50	2.4	4.5	0.93	114	-8.8 %

Conclusion

The level of AI had a strong effect on genetic gain

AI without PT gave from +17 to +50% compared to NM based designs

AI with PT gave from +10 to +36% compared to AI without PT designs

Connectedness across flocks can be obtained by natural mating

as long as male replacement was exchanged (no self-replacement)

Incomplete pedigree affected

- ✓ the quality and bias of the estimation of the flock year and genetic effects
- ✓ the genetic gain

In case of incomplete pedigree, AI

- ✓ had a positive effect on genetic gain
- ✓ did not improve quality of the estimation of flock year and genetic effects

Thank you !