PRODUCTIVITY IMPROVEMENT IN SHEEP ASSOCIATING POLYGENIC SELECTION AND DIFFUSION OF THE *FECX^R* ALLELE

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The Cooperative Oviaragón carries out since 1994 a selection program for prolificacy in Rasa Aragonesa sheep, with 205,000 sheep at present. Within this program, a mutation in the *BMP15* gene located in the X chromosome (*FecX^R* allele, ROA®) was discovered in 2007. This polymorphism increases prolificacy in heterozygous carriers (R+) and produces sterility when present in homozygosis.

Due to the productive interest, several researches on its effects have been performed since discovered before large-scale spreading on farms:

- Effects on reproductive and productive traits
- Technical-economic studies
- Electronic identification and computerized control to avoid sterility
- Controlled AI program combining polygenic selections for prolificacy and spreading of the *FecX^R* allele

1. Ovulation rate and prolificacy

Mean ovulation rate and prolificacy of adult Rasa Aragonesa ewes heterozygous for *FecX^R* (R+) or homozygous for the wild-type allele (++), untreated or treated with fluorogestone acetate and 480 IU of eCG

	No eCG		480 IU eCG	
	++	R+	++	R+
Ovulation Rate	1.36^a	1.99^b	2.82^c	3.95^d
Prolificacy	1.34^a	1.69^b	1.55^c	1.85^d
Lambing records	599,160	6,593	62,055	866
LS distribution (%)				
Singletons	67.7^a	42.5^b	52.2^c	35.7^d
Twins	31.0^a	46.9^b	41.1^c	47.1^{bd}
Triplets	1.3^a	9.7^c	6.0^b	14.1^d
Quadruplets	0.054^a	0.77^b	0.63^b	2.8^c
Quintuplets	0.0042^b	0.091^{cd}	0.066^c	0.35^d

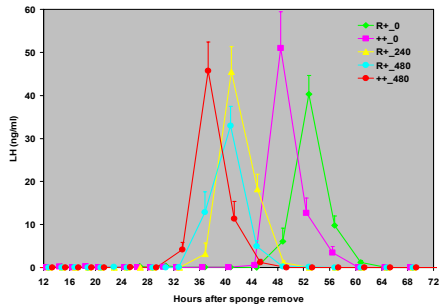
Different letters within a row differ significantly.
Ovulation rate: a,b or c,d P<0.01; prolificacy, singletons, quadruplets: P<0.0001; twins, triplets: P<0.0001 except c,d: P<0.001; quintuplets: P<0.0001 except c,d P<0.01.

2. Follicle size and oocyte competence

++ ovary R+ ovaries RR ovary

✓ Mean follicle diameter of R+ ewes is lower than ++ ewes without affecting developmental competence of their oocytes.

3. Preovulatory LH surge



✓ No significant difference on the time of the preovulatory LH surge between R+ and ++ ewes.
✓ Treatment with eCG significantly advances the preovulatory LH discharge in both genotypes.
✓ No difference between R+ ewes treated with 240 or 480 IU.
✓ Fertility of R+ ewes after AI is similar or slightly higher than that of ++ ewes.

4. Offspring birth weight and lamb growth rates

Birth weight and pre- and post-weaning growth rates of Rasa Aragonesa light lambs by sex and genotype group (LSM±SE)

Lamb's sex	Genotype group (dam/lamb)	n	Birth weight (kg)	ADG1 (g/d)	ADG2 (g/d)	ADG(1+2) (g/d)
Male	++/+	60	3.7±0.1	204.4±0.6	281.7±0.7	240.9±0.4
	R+/+	28	3.7±0.1	216.4±1.6	271.9±1.1	244.6±076
	R+/R	28	3.9±0.2	208.5±1.2	310.1±1.3	249.7±0.9
Female	++/++	62	3.4±0.1	199.2±0.8	230.6±0.9	212.1±0.6
	R+/+	31	3.4±0.1	180.5±1.0	227.9±1.1	204.4±0.7
	R+/R	35	3.3±0.1	189.6±0.8	229.7±1.0	211.6±0.6

ADG1: Pre-weaning average daily gain; ADG2: Post-weaning average daily gain

5. Technical-Economic results

Economic results depending on the percentage of *FecX^R* heterozygous ewes in farms (2006-2008)

	>5% R+	Selection	Non Selection	SIG
Farms (n)	7	18	22	
Lambing/ewe/year	1.28^a	1.19^a	1.03^b	***
Prolificacy	1.57^a	1.36^b	1.29^b	***
Twins (%)	45.9^a	32.8^b	27.8^b	***
Triplets and Higher order (%)	5.5^a	1.5^b	0.8^b	***
Lamb Mortality (%)	11.4	10.4	11.9	
Lambs sold/ewe/year	1.61^a	1.27^b	1.06^c	***
Total income/ewe (€)	150.25^a	125.66^b	106.40^c	***
Total cost/ewe (€)	122.16^a	102.51^b	99.31^b	**
Gross margin/ewe (€)	57.17^a	45.11^a	27.52^b	***
Gross margin/UTH (€)	25,153^a	25,141^a	15,644^b	*

*P<0.05 **P<0.01 ***P<0.001. Different letters within a row differ significantly

6. Controlled AI program

✓ Studies on male fertility over 17,516 cervical inseminated ewes: Similar fertility of *FecX^R* carrier sires (53.2±2.1%) and non-carriers (54.3±2.0%).
✓ Since 2007: Controlled program for spreading the *FecX^R* allele using hemizygous sires by AI (7,500 AI/year).
✓ Double independent genetic evaluation of prolificacy by BLUP: polygenic and *FecX^R* allele.
✓ Increasing population of R+ ewes in farms, up to 8,900 R+ ewes at present..

The *FecX^R* mutation, when present in heterozygosity, produces 0.44 extra ovulations in ewe lambs and 0.63 in adult ewes, that lead to an increase in prolificacy of 0.35 lambs per lambing ewe, with no adverse effect on oocyte quality, preovulatory LH surge, fertility after AI or offspring growth rates and meat characteristics. The R+ ewes show an increased response to eCG that should be taken into account to avoid too high rates of triplets and higher order births. The use of the *FecX^R* allele allows for a very quick increase in prolificacy that results in important economical advantages, meeting the needs of farmers to improve this parameter, although it is essential not to abandon the classical polygenic selection to prevent excessive inbreeding and to improve other productive parameters.

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