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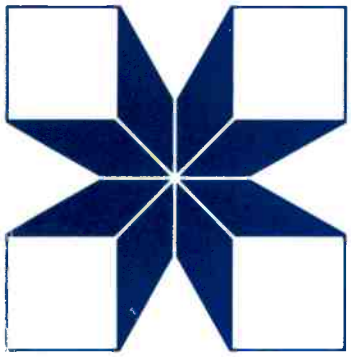

CANADA

# SMALL RUMINANTS RESEARCH AND DEVELOPMENT IN THE NEAR EAST

PROCEEDINGS OF A WORKSHOP

HELD IN CAIRO, EGYPT,

2–4 NOVEMBER 1988

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# SMALL RUMINANTS RESEARCH AND DEVELOPMENT IN THE NEAR EAST

**Proceedings of a workshop
held in Cairo, Egypt, 2-4 November 1988**

Editor: A.M. Aboul-Naga



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## CONTENTS

# SELECTION FOR REDUCED SEASONALITY IN SHEEP

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## ABSTRACT

The choice of the mating period or reproductive system depends on the fodder resources during the year as well as ewe genetic potential. Aseasonality aptitude depends on the reproduction system used. This is measured by criteria which are repeatable but weakly heritable. Various reproduction systems are analyzed. 1) Temporary acceleration of the reproductive rhythm with principal mating in spring (Mérinos d'Arles system) or at the beginning of the season (INRA 401 system) ; 2) continuous mating; 3) systems with 2 or 3 annualy mating periods, i.e. 4 lambing in 3 years or 3 lambings in two years. These various systems require standardization of ewe-lamb mating if one wants to set up a selection programme. Possible criteria may be the fertility of first or first two matings, out of season fertility, or out of season post-partum, or lambing intervals.

Selection on aseasonality aptitude is possible but it must be done with priority and directly on fertility. It must be performed in farms in order to detect hyperfertile ewes. This type of selection can be efficient if the means put at one's disposal are used : indexation of a maximum number of ewes in farms, planned matings of superior dams with the very best rams, performance-test selection, and progeny test of sires. Performance recording in farms is essential if a correct estimation of "ewe index" for aseasonality in the various situations and of the genetic and phenotypic variability of this trait is to be obtained. The estimation of variability in the local breeds is a priority before introduction of a new breed or with respect to crossbreeding.

## PHYSIO-GENETIC DETERMINANT OF SEASONAL AND POST-PARTUM SEXUAL ACTIVITY

1) The sexual activity of females is at the maximum during

the periods of decreasing daylight, but there are large between and within-breed variations in the length of the breeding season, the dates of onset and end of breeding season, and the age at first oestrus (Hafez, 1952; Land et al., 1973; Ortavant et al., 1985; Aboul-Naga et al., 1985; Hanrahan and Quirke, 1986; Notter, 1986; Quirke et al., 1986; Hanrahan, 1987; Lindsay and Thimonier, 1988; Avdi et al., 1988).
Similarly, in adult ram (Ile de France), sperm fertility and morphological abnormalities are more frequent from January to June, with a maximum in March, but with large individual differences (Colas, 1980, 1981; Colas et al., 1988).

2) Within-breed, the breeding season is characterized by an oestrus-ovulation dissociation (silent ovulations) throughout the year, so that ceasing of ovarian activity is observed less often than suppression of oestrus behaviour (Thimonier and Mauléon, 1969).

3) Teasing (reintroduction of rams after a period of isolation) stimulates ewes to ovulate and commence their oestrous cycle. Response to teasing varies according to the stage of non-breeding season, and the breed of ewes and rams (Oldahm et al., 1980).

4) The breeding season of ewe-lambs is shorter than that of the adult (Hafez, 1952; Walrave et al. 1975) but a striking similarity exists between the mechanism governing the onset of puberty in the lamb and the onset of the annual breeding season in the adult (Foster and Ryan, 1979; Foster, 1981), accordingly the sexual activity of ewe-lambs may be a good selection criteria.

5) The duration and onset of the breeding season of $F_1$ ewes are intermediate between that of the two parents (Hafez, 1952). There is a close relationship (0.36 to 0.80) between the date of first oestrus and breeding season length (Walrave et al., 1975) or the number of heats per ewe/season. Thus for building up strains of sheep to give two lamb crops a year, one would select from individuals of early onset (Hafez, 1952).

6) After lambing, there is also an oestrus-ovulation dissociation: silent ovulations occurs rapidly (Mauléon and Dauzier, 1965; Hunter, 1968), but anomalies in the intervals between the first oestruses can be observed (short cycles of 4 to 9 days and normal cycles : Tchamitchian et al., 1973b), thus fertility is reduced during 40 days post-partum. In the same way, in season or out-of-season, the fertility rate after A.I. following

induced oestrus increases with the interval from parturition to A.I. (Thimonier et al., 1968; Cogni et al., 1975). A breed influence and a breed x treatment interaction on the response to hormonal treatment for percentage of ewes lambing was reported (Laster and Glimp, 1974).

7) Out-of-season post-partum sexual activity (April-May) has an additive determinism (Ricordeau et al., 1976) and there is considerable between and within breed variation in the length of post-partum anoestrus, which could provide scope for selection (Hafez, 1952; Van Niekerk and Mulder, 1965; Ch'ang, 1973). The average estimates of paternal heterosis effects was 1.4 % for seasonal fertility (summer to winter) vs. 29.5% on fertility during spring breeding (Leymaster, 1987). In an 8 months lambing system, the maternal heterosis was 36 % (Visscher, 1987).

8) The capacity of rams to produce a high production of semen all the year can be increased by alternance of short and long days every month (Pelletier et al., 1985; Pelletier et Almeida, 1987). However, the response of ram-lambs, born in Autumn, to a photoperiodic control is more marked in the seasonal breeds (Colas et al., 1987; Poulton and Robinson, 1987).

9) In deer mice, the selection for or against reproductive photoresponsiveness gives significant divergent results in only two generations (Desjardins et al., 1986). That divergence confirms a genetic bases for the variation in reproductive performance and suggests that this trait has a high heritability.

10) In permanent breeding rhythm in ewes, there seems to be an incompatibility between lambing interval and litter size (Brelurut, 1987; Hoeke and Visscher, 1987; Tchamitchian, 1988). This incompatibility exists also in mice between permanent breeding and increasing litter size (Wallinga and Bakker, 1978).

## SELECTION CRITERIA FOR MEASURING OUT-OF-SEASON BREEDING CAPACITY

In theory, it is possible to obtain 2 lambings per year, but it is necessary to select ewes capable of exhibiting oestrus the whole year and of being fertilized rapidly after lambing whatever the season. Permanent oestrus control in non-breeding ewes allows to measure the sexual activity, but it does not give an accurate idea of the animal

productivity, depending on the number of matings, the inhibitory effects of post-partum anoestrus and lactation, and the favourable effects of stimuli such as introduction of the ram. This, the out-of-season breeding capacity can only be measured relative to the reproduction system.

We have to distinguish 3 types of situations :

1) Principal mating early in the season for obtaining one lambing per year.
2) Temporary accelerated mating system with 2 symmetrical alternatives : first mating of ewe-lambs in-season in a system with principal mating out-of-season; first mating of ewe-lambs out-of-season in a system with principal mating in season.
3) Permanent accelerated breeding rhythm, with several mating periods, to obtain lambings with 6, 8 or 9 months intervals.

**A. Principal Breeding Early in the Season**

The date of first oestrous is repeatable and heritable (Table 1). Thrift et al., (1971) showed that selection on date of birth can advance the date of lambing and prolificacy. The number of hogget oestruses is also heritable and can be used for indirect selection on reproduction rate (Dalton and Rae, 1978), but the genetic correlation with hogget weight is variable.

The ewe-lambs are generally mated at 8 or 18 months, except in the "INRA 401 mating system" (B2)

**B. Temporary Accelerated Mating System**

**1) Principal breeding season in May (out-of-season), with "cleanup" breeding in September for ewes failing to conceive in May (Fall lambing system)**

In this system, the ewe-lambs are mated for the first time in September (in season) at the age of 1 year (lambing in February-March of the following year) and are bred again together with adults, in May. This system can be applied to transhumant hardy breeds (Merinos d'Arles : Prud'hon and Denoy, 1969; Mountains Merinos : Timko, 1974) as well as to some lowland breeds (Ile de France). However, in the latter case, the farmers may advance the date of first breeding to obtain lambings in January and stagger the spring breeding to obtain maximum fecundity.

With this system, selection is made on fertility at the first two matings : the first one measures the precocity,

TABLE 1

Repeatability (r) and heritability ($h^2$) estimate for breeding season

| Traits | r | $h^2$ |
|---|---|---|
| Data of onset breeding season, or date of 1st oestrus | 0.33 (6 est.) (0.12 to 0.52) | 0.22 (5 est.) (0.06 to 0.40) (1) |
| Oestrus in the first 16 d mating | | 0.32 |
| Cessation of breeding season | 0.25 (3) | 0.25 |
| Duration of breeding season | 0.30 (3) | 0.30 (2) |
| Fertility at natural oestrus | | 0 ; 0.11 (4) |
| Fertility at synchronized oestrus | | 0 (5) |

(1) Ricordeau, 1982; Hanrahan and Quirke, 1986; Owen et al., 1986;
(2) Quirke and Hanrahan, 1985; (3) Quirke et al., 1986;
(4) Aboul-Naga et al., 1985; (5) Shrestha and Heany, 1987.

the second one the out-of-season post-partum fertility. The analysis made on 63 progeny-tested rams Merinos in an extensive production system, showed that the heritability of fertility at 1 year was 0.27, and that the $h^2$ of post-partum fertility in May-June in lactating hoggets was low (0.17) but significant (Razungles et al., 1975).

This system has been tested in the U.S.A. and in Canada (Thrift and Whiteman, 1969) and selection has been made of two synthetic lines : Finnish x Dorset (Ringwall et al., 1980); 1/2 Dorset, Leicester, Suffolk (Fahmy et al., 1980).

**2) Principal breeding season in July-August (beginning season), with a first out-of-season mating in April (INRA 401 mating system).**

All the ewes are maintained in an accelerated mating system up to 3 years of age, without hormonal treatment, according to the following programme : born in December-January; first mating at 15 months in April-May and lambing in Sept-October; second post-partum mating in Oct-November and lambing in March-April; third and following matings in July-August. The two first matings are without

monitoring paternity; the following matings are reserved for replacement. Fertility is respectively 86,82 and 97%, with litter size of 1.7, 1.9 and 2.1. The heritability of fertility at the two first matings are 0.06 and 0.03, the $h^2$ of litter size being of 0.13 and 0.08 (Ricordeau et al., 1982 b,c; Razungles et al., 1985; Tchamitchian et al., 1986).

## C. Permanent Accelerated Mating Systems

### 1) Continuous breeding system

A mean lambing interval of 7 months has been observed on Djallonké (Vallerand, 1979), Tabasco (Lazo et al., 1983) and Pelibuey ewes (Gonzales et al., 1987). In the other situations, this system does not allow to obtain a higher annual fertility than that registered in the system with 3 annual breeding periods (Ricordeau et al., 1972; Valls Ortiz, 1981). Terril and Lindahl (1975) obtained the first lambing interval of 316 days in their selection experiment started in 1966 with crossbred ewes (Morlam sheep). In Spain, the heritability of interval between lambings varies from 0.06 to 0.35 (Mallard and Mariné, 1983; Gabina, 1986).

### 2) Twice yearly lambing system

This system gives very good results in the D'man breed in Morocco, since the mean lambing interval is 192 days (Bouix and Kadiri, 1973, 1975). However, with European breeds, especially the prolific Finnish and Romanov breeds, the experiments have not given the expected results (Land and McClelland, 1971; Goot and Maijala, 1977; McNeal, 1978; Tchamitchian et al., 1973a, 1981).

### 3) Three lambings in two years

In 1973, More O'Ferral (1981) began a selection on Finnish x Dorset ewes, with matings in July, March and November, without hormones : the replacement rams were generally the latest born rams from the March mating and the earliest from the July mating. With this type of ewes, the anoestrus period ranged from April 12$^{th}$ to August 30$^{th}$, with a higher fertility in March than in July (70 vs 49%).

This system is applied in Spain (Valls Ortiz, 1981), in Egypt (Aboul-Naga and Aboul-Ela, 1985) and in Southern France, where the breeds with a prolonged breeding season are located : Préalpes du Sud, Lacaune and Caussenarde du Lot in particular (Tchamitchian and Ricordeau, 1974). It gives a supplement of 0.5 lamb/ewe vs. one lambing per year (Marzin et al., 1979; Notter, 1981; Valls Ortiz, 1983;

Gabina, 1986; Iniguez et al., 1986; Brelurut, 1987).

Breeding of ewe-lambs and genetic parameters: the 3 annual mating periods are schematically (February, June, October). Females used in reproduction are born in July and November, thus allowing the first mating at the age of 11 months in June or October, or more seldom at 7 months. Fertility at 1$^{st}$ mating varies with age and breeding season (Tchamitchian et al., 1981). Within breed, genetic variability is not easy to demonstrate : in the Caussenarde du Lot breed, only few A.I. are practised and matings are made with several rams to obtain a maximum post-partum fertility, the sire of the lambs is therefore often unknown. In the meat Lacaune breed, A.I. is practised on adults in March and June, and the rams are progeny tested. A fertility index and a prolificacy index are calculated for each sire according to the performances of their daughters mated in June, at 11 months. The correlation between these two indexes is between 0 and 0.21 (Bodin et al., 1979; c.p.); this means that to improve both fertility and litter size, it is necessary to select on both traits.

The capacity of breeding at an accelerated rhythm is repeatable since in March-April (out-of-season) ewes that lambed 2 to 4 months before breeding had 30% higher conception rate than ewes that lambed at least 7 months before breeding (Tchamitchian et al., 1981; Notter and Copenhaver, 1980). According to the estimates of repeatabilities of conception rate in crossbred ewes (Finnish x Rambouillet) with matings in April, August and November, Notter (1981) showed that decisions to improve fertility should probably be based on out-of-season (April) or early season (August) breeding performance.

**4) Four lambings in three years**

This system is being developed since 1982 in Caussenarde du Lot breed, which have a long breeding season (VAUR et al., 1984). This involves a principal mating in Spring (from April 25$^{th}$ to June 15$^{th}$) where all ewes present are mated, and the Autumn mating (from October 15$^{th}$ to December 5$^{th}$) only for ewes fecundated during the first 20 days of the last mating period. We thus avoid progressive slipping of the flock towards the Autumn mating period. The ewe-lambs born in Autumn are reserved for replacement and are mated at one year with a fertility rate of 90%. With this system, the possible rhythm is 1.33 lambings per ewe and per year but theoretically 2 lambings a year can be achieved by the best ewes.

This system is much more economical and has less work

involved since the whole herd can spend the summer on the dry pastures of the CAUSSE region without supplements. On the other hand it requires a good mastery of the techniques of natural synchronization of oestrus : flushing, ram effect after lamb-weaning (Tchamitchian, 1988).

TABLE 2

Repeatability and heritability of traits measured in accelerated mating system (according to Tchamitchian, 1988)

| (System) Breed | Traits | r | $h^2$ |
|---|---|---|---|
| (B1) Mèrinos d'Arles | Fertility at 1 year in sept. | | 0.25 |
| | Post-partum fertility in May | | 0.17 |
| (B2) INRA 401 | Fertility at 15 months in April | | 0.06 |
| | Post-partum fertility in October | | 0.03 |
| (C1) Spanish,Morlam | Lambing interval | 0.13;0.25 | 0.06 to 0.35 |
| (C3) Aragonaise | Ram introduction-fec. Interval | | |
| | in season | 0.09 | 0 to 0.30 |
| | May or July | 0.20 | 0.20 to 0.40 |
| | January or March | 0.18 | 0.15 to 0.30 |
| | Fertility at these matings | 0 | 0 |
| (C3) Finn crossbred | Fertility in April | 0.18 | 0 |
| | " " August | -- | NS |
| | " " November | -- | NS |

**EARLY CRITERIA AND MARKER GENES**

According to Lee and Land (1985), selection for testis growth has a favourable effect on the fertility at first service at 19 months. In the Lacaune breed, we observed a positive correlation between the testis diameter of young males at 120 days and the fertility of their daughters at 11 months in June, but that correlation was close to zero after correction for the live weight of males.

In Icelandic sheep, the allele $A^{wh}$ for white or tan colour, suppressed the occurrence of out-of-season breeding activity and lowered the incidence of repeated out-of-season breeding of individual ewes (Dyrmundsson and Adalsteinsson, 1980). However, in the INRA dam line, Ricordeau et al. (1982a) observed no or little differences in April or July.

## DISCUSSION AND CONCLUSIONS

Selection for reduced seasonality is possible, however, a certain number of conditions come into account.

1) The reproductive system must be well-adapted to environmental conditions (adjustment of fodder production to the needs of the ewes and lambs).

2) If we wish to make a selection upon the aptitude of aseasonality (or follow an accelerated rhythm), this characteristic must be considered first. Often selection is done on other criteria : Prolificacy, milk production, conformation...) and aptitude of aseasonality is not really taken into consideration, therefore, no real progress is made on this trait. In certain schemes, fertility performances are even lower, causing breeders to return to a reproduction system close to that of annual mating.

   Having been defined, the reproduction system must not be modified and ewe-lamb mating conditions must be standardized. Male and female reproductive indexes will be calculated with respect to female fertility during the first one or two matings.

3) Whatever the reproductive system is, in order to achieve planned matings of the best ewes and to produce the ewe-lambs necessary for replacement, a maximum number of ewes must be mated out of season.

4) Selection must be done in farms, in order to use maximum genetic variability and to retain the lambs born from hyperfertile mothers. Selection within closed experimental flocks is not desirable since these flocks are always of a limited number of animals and have reduced genetic variability. The performance recorded in the farms may consist of a single test of reproductive aptitudes (mating, lambing, litter size, including if possible a measurement of ewe milk production by the average daily gain 10-30 days of suckle lambs).

5) Depending on the goal to be achieved, various selective criteria can be retained : fertility at the beginning of the season or out of season, post-partum fertility out of season, fertility during the first or first two matings (or interval between first mating and second lambing). However, in all cases, the criteria retained must be measured before two years are up in order to avoid bias due to eliminations and to rapidly index the ewes and rams. This may incite breeders to improve sexual precocity, but it is not wise to mate ewe-lambs before the age of 10 months except under very favourable breeding conditions.

6) Direct selection of ewe fertility is the most efficient solution if one uses the means put at one's disposal : recording of performances in farms in order to detect hyperfertile females which produce young males; planned matings of the best parents; selection of young males into performance-test stations to measure their growth rate and semen production; progeny-test the rams by I.A. in order to obtain females from each sire in the various flocks. I.A.'s other concern is to create genetic "connections" between flocks, thus making indexes comparable and improving the efficiency of the various steps of selection.
If aseasonality aptitude depends on a major gene, selection of hyperfertile dams will be efficient and the analysis of their daughters will bring useful data.

7) Cross-breeding should only come about after exploring genetic variability of local breeds and taking into account their aptitudes on the whole (zootechnical performances, but also resistance to climatic conditions, to parasites, to diseases...)

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