Heritability of persistency traits and their genetic correlations with milk yield and udder morphology in dairy sheep.

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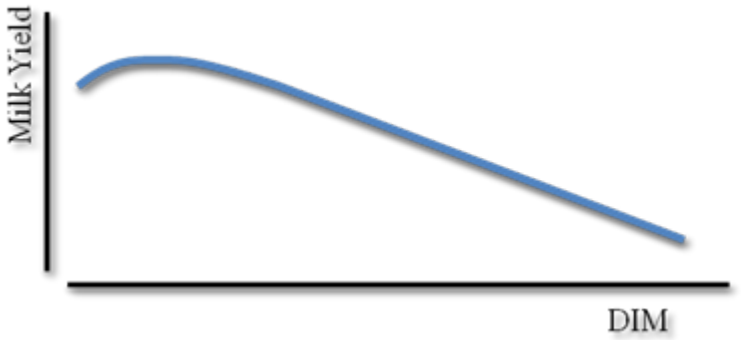
Introduction

- In dairy cattle persistency is usually defined as the **ability of a cow to continue producing milk at high level after the peak yield**

(Gengler, 1996; Grossman et al., 1999; Cole and VanRaden, 2006; Togashi et al., 2009).



- Economic reasons for improving persistency are related to **reduction of feed, health and reproductive costs**

(Solkner and Fuchs, 1987; Dekkers et al., 1998; Muir et al., 2004; Harder et al., 2006).

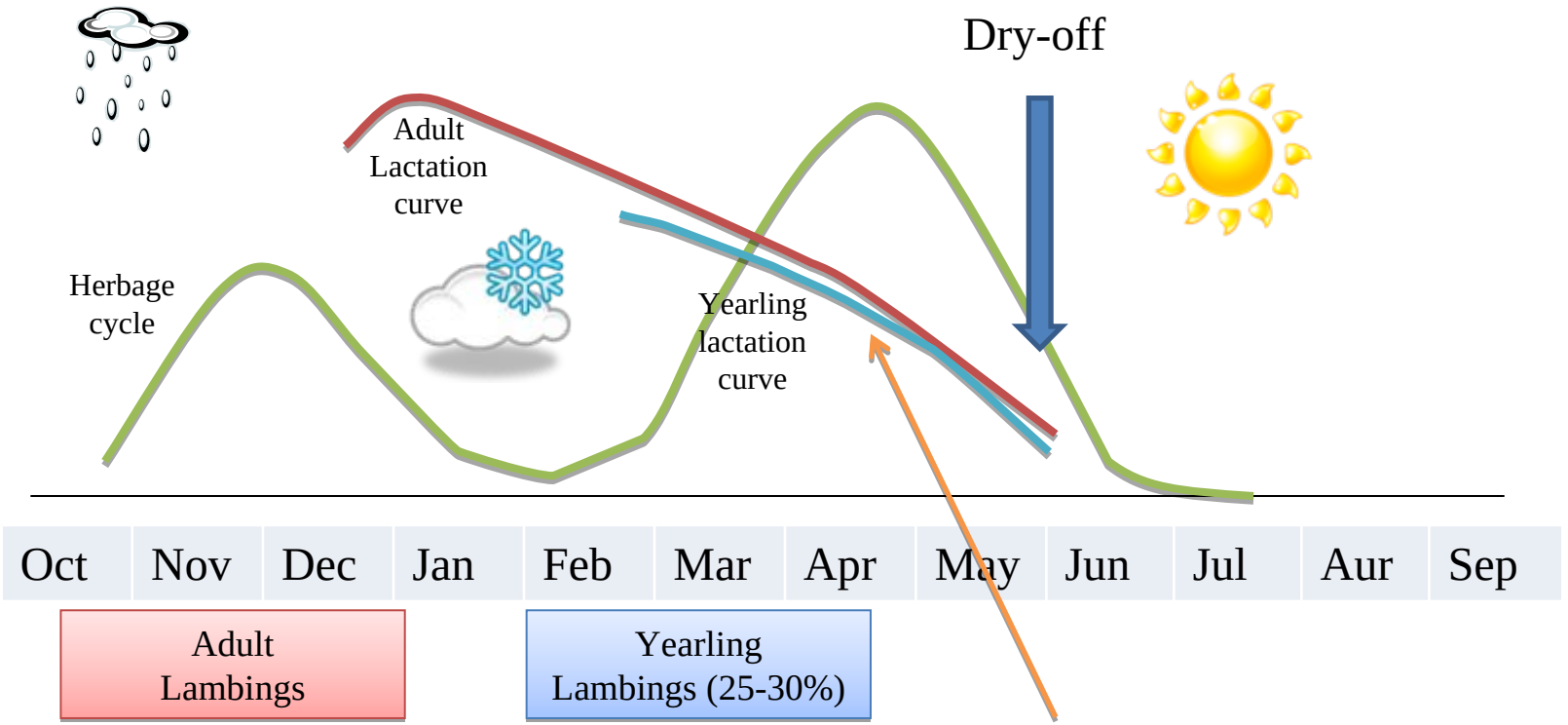
Measures of persistency

(Swalve and Gengler, 1999):

1. measures expressed as a **ratio of yields**,
2. measures derived from **variation between test day yields**,
3. measures based on **parameters of lactation curves** estimates from mathematical models
4. measures based on the application of **random regression** test day models

Estimates of heritability range from under 0.05 to over 0.30 according to criteria of persistency used.

The typical dairy sheep productive cycle in Mediterranean area



Persistency in dairy ewes in the MED area can be defined as the ability of an adult ewe to recover a significant milk yield level late in lactation in spring

Aims

• To identify a **measure of persistency** of lactation to appraise the ability of an ewe to show high milk yields **late in lactation in spring in Mediterranean conditions** by using a **Principal Component** approach on TD milk yields (Macciotta et al, 2006)

• To estimate **heritability and genetic correlations** with **production** and **udder** morphology traits

Material and methods

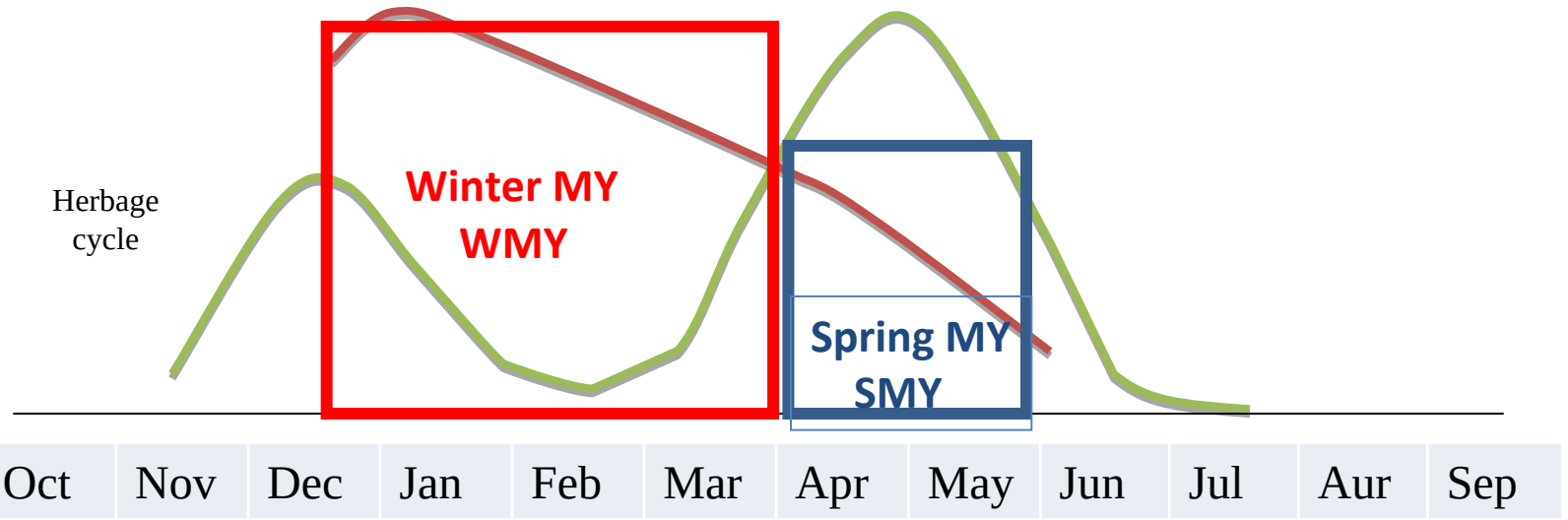
- TD recorded from 2000 to 2012 in a farm located in the southern part of Sardinia.

37,814 milk test day yields (TD) recorded fortnightly at the two daily milkings on 2,513 ewes between 2 and 4 years old and with lambing from November to January.

- **Adult lactations of lambings after January and lactations from yearlings were excluded from the analysis.**

- **Only lactations longer than 150 DIM were selected.**

Percistency traits : ratio between spring and winter yield :SWR=SMY/WMY



Percistency traits : PCA

Principal components (PC) extracted from the correlation matrix of **TD milk yields at fixed DIM** (from 60 to 150 by 15 days) were selected according to the explained portion of original variance.

Other traits

Lactation traits:

•**MY: milk yield in the milking period only** as mature ewe equivalent

Udder morphology traits:

•**teat placement (TP)**

•**udder depth (UD)**

•**degree of separation of the 2 halves (DS),**

•**degree of suspension of the udder (SU).**

•**udder volume (VOL)** derived by multiplying the score of udder depth by the square of the degree of suspension of the udder

Genetic parameters estimation

multiple-trait models.

The repeatability animal model for **lactation and persistency traits** was:

$$\mathbf{Y_{ijklm} = \mu + YM_i + YA_j + a_k + pe_l + e_{ijklm}}$$

where Y_{ijklm} was equal to MY, WMY, SMY, SWR and retained PCs; μ was the overall mean; YM_i was the fixed effect of the interaction of year and month of lambing; YAS_j was the fixed effect of the interaction of year of lambing, age, and litter size; a_k was the random additive genetic effect of animal; pe_l was the random effect of permanent environment; e_{ijklm} was the random residual.

The repeatability animal model for **udder morphology** traits was:

$$\mathbf{Y_{ijklm} = \mu + LS_i + YC_j + a_k + pe_l + e_{ijklm}}$$

where Y_{ijklm} was equal to TP, UD, DS, SU and VOL; μ was the overall mean; LS_i was the fixed effect of lactation stage; YC_j was the fixed effect of year-classifier, a_k was the random additive genetic effect of animal; pe_l was the random effect of permanent environment; e_{ijklm} was the random residual.

The pedigree file comprised 4,262 individuals with 322 sires and 1,427 dams without records.

Results

Descriptive statistics of lactations

Variable	n	Mean	SD	Min	Max
MY (L)	5402	241	49	84	414
WMY (L)	5402	164	43	34	364
SMY (L)	5402	83	22	22	174
SWR	**5402**	**0.540**	**0.206**	**0.184**	**1.900**
TP	5379	7.7	0.9	3.0	9.0
UD	5306	5.8	1.0	2.0	9.0
DS	5121	6.4	1.1	1.0	9.0
SU	5402	4.6	1.4	1.0	8.0
VOL	5306	167	88	4	567
PC1	5402	0.026	2.313	-7.740	8.600
PC2	5402	-0.003	0.950	-4.655	3.214

The mean of MY was in the range of values reported for dairy sheep in Mediterranean area

WMY and SMY were on average 58% and 29% of MY respectively.

On average, SMY was calculated between 118 and 179 DIM.

Results

Eigenvectors and associated eigenvalues of the first (PC1) and second (PC2) principal component issued from the correlation matrix between milk yields at fixed DIM.

	Eigenvectors	
Variable	**PC1**	**PC2**
M060	0.363	-0.435
M075	0.380	-0.414
M090	0.393	-0.283
M105	0.398	-0.053
M120	0.394	0.236
M135	0.373	0.453
M150	0.341	0.544
Eigenvalues (%)	5.43 (77.5)	0.90 (12.9)

90.4% of the whole original variance

PC1 showed similar correlations with TD yields independently from DIM

PC2 showed negative correlations with the first and positive correlations with the last part of lactation

Results

Additive genetic (σ^2_a), permanent environmental (σ^2_{pe}), residual (σ^2_e) and total variance (σ^2_{tot}), heritability (h^2) and repeatability (r) of traits.

Trait	σ^2_a	σ^2_{pe}	σ^2_e	σ^2_{tot}	h^2	r
MY (L^2)	889	413	616	1919	0.46	0.68
WMY (L^2)	385	173	447	1005	0.38	0.56
SMY (L^2)	141	63	124	329	0.43	0.62
SWR	**0.0018**	**0.0007**	**0.010**	**0.0126**	**0.15**	**0.20**
TP	0.412	0.120	0.277	0.810	0.51	0.66
UD	0.457	0.124	0.296	0.877	0.52	0.66
DS	0.449	0.272	0.520	1.241	0.36	0.58
SU	0.914	0.204	0.518	1.637	0.56	0.68
VOL	4377	1058	1828	7263	0.60	0.75
PC1	1.967	0.86	1.478	4.305	0.46	0.66
PC2	**0.113**	**0.056**	**0.387**	**0.557**	**0.20**	**0.30**

h^2 of persistency concerned mainly dairy cattle and ranged from 0.01 to over 0.30 (Gengler et al., 1996).

In dairy sheep h^2 ranged from 0.10 to 0.15 for 3 different measures (Kominakis et al., 2002)

Results

Genetic (r_g) and phenotypic (r_p) correlations of measures of persistency with lactation and udder traits.

	Parameter			
	Genetic correlation		Phenotypic correlation	
Trait	PC2	SWR	PC2	SWR
MY	**0.10 (0.097)**	**0.31 (0.106)**	0.06 (0.018)	0.13 (0.017)
WMY	-0.25 (0.091)	-0.05 (0.118)	-0.11 (0.017)	-0.28 (0.016)
SMY	0.33 (0.090)	0.53 (0.091)	0.27 (0.016)	0.50 (0.013)
SWR	**0.92 (0.042)**		0.37 (0.013)	
TP	**-0.04 (0.095)**	**0.07 (0.111)**	-0.01 (0.019)	0.01 (0.018)
UD	**0.11 (0.096)**	**0.02 (0.114)**	0.07 (0.019)	0.02 (0.018)
DS	**-0.16 (0.109)**	**0.04 (0.125)**	-0.01 (0.018)	0.001 (0.017)
SU	**0.09 (0.093)**	**-0.05 (0.108)**	0.00 (0.019)	-0.01 (0.018)
VOL	**0.12 (0.091)**	**0.003 (0.108)**	0.05 (0.020)	0.01 (0.018)

CONCLUDING REMARKS

PC2 shows:

- high correlation with SWR
- higher h^2 than SWR
- a weak correlation with MY
- negligible correlations with udder traits

CONCLUSIONS

The direct selection for SWR is limited by the low h^2 and the not negligible positive correlation with MY

Selective breeding for PC2 may produce a **high favourable** correlated response on the **ability of an ewe to exploit favourable environmental conditions late in lactation** in the traditional Mediterranean farming system.

As far as the relationships between persistency and udder traits are concerned, both phenotypic and genetic correlations were low suggesting that **external udder morphology does not affect the ability of an ewe to produce late in lactation.**