**Defining the breeding goal for a sheep breed using market data**

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**Supplementary Material S1**

*Calculation of energy requirements*

*S1.1 Maintenance energy requirements (em)* calculation was based on the body weight (W) of ewes by means of the following formula (Laimadis, 1988):

em = 54×(W/1.08)0.75+2.3×W (1)

*S1.2 Milk production energy requirements (emilk)* were calculated using formula (2) by taking fat concentration (PQ)(Kalaisakis, 1982):

emilk (Kcal/Kg) = 0.49×PQ + 1.262 (2)

where PQ is fat concentration in milk (1 UFL = 1700 Kcal NEL).

*S1.3 Gestation energy requirements (eg)* were estimated using the following formula (ARC, 1980, CSIRO, 1990)

eg=3.9644 × exp[-11.465 × exp(-0.0643 × t) - 0.00643-t] × (LBW/4) (3),

where the Lamb Birth Weight (LBW) was estimated at 3.9 kg and t stands for the duration of pregnancy (145 days)

*S1.4 Suckling energy requirements (es)* were calculated using formula (4) (Pulina et al., 1989)

$e\_{s}=\frac{\left[251+89.64 × PQ+37.85X\left(\frac{PP}{0.95}\right)\right]×0.001×DMY}{Κ1}$(4),

by taking into account the percentage of fat (PQ=6.77%) and protein concentration (PP=5.45%) (Ploumi et al, 1998) and the number of weaning days (DMY) in each sheep farm (K1 = 0,664)

*S1.5 Replacement energy requirements (er)* were calculated using formula (5) by the CNCPS method (Cannas et al., 2004):

### er= 54 ×(W/1.08)0.75+2.3×W×em (5),

where W is the body weight of the animal and em is the maintenance energy.

**Supplementary Material S2**

*Calculation of revenues and costs*

*S2.1. Calculation of revenues*

The calculation of revenues is straightforward since the farm income stems from the sales of milk and the sales of young lambs and aged ewes.

Hence, the total gross income of the Chios farms is expressed algebraically as follows:

$$N×[f×(\left(m×Pri\_{m}\right)+\left(p×Pri\_{L}\right))-\frac{Pri\_{L}}{long}+\frac{Pri\_{cullL}}{long}]$$

where,

N = number of ewes

f = fertility (lambings per year and ewe)

m = milk yield (Kg per year and ewe)

Prim = milk price (€/kg)

p = prolificacy (lambs/ewe)

PriL= lamb meat price (€/lamb)

Pricull= price for culled ewes (€/ewe)

The Chios sheep farm retains, on average, 58 replacement ewe lambs (25% replacement rate on a 233 ewe flock), which in combination with ewes’ longevity (3.66 years), implies that the flock is replaced almost every three years. The effect of this management practice on the profitability of the farms is captured by the inclusion of the last two terms in the formula.

*S2.2. Calculation of costs*

The total cost, which is expressed in the following formula,

$Ν×\left[e\_{m}×c\_{ufl}+L\_{m}×c\_{L}+ f×\left( e\_{g}×c\_{ufl} +p ×e\_{s}×c\_{ufl} + L\_{L}×c\_{L}+m×e\_{milk}×c\_{ufl}+ n\_{ms}×c\_{L}×Α×ms+M×\left(\frac{m× Loss ×Pri\_{m}}{DM}+\frac{m×Loss×e\_{milk}×c\_{ufl}}{DM}+c\_{M}+L\_{M}×c\_{L}\right)\right)+\frac{e\_{r×c\_{ufl}+L\_{r}×C\_{L}}}{long}\right] $is comprised of the following components:

*S2.2.1 Maintenance cost*

$e\_{m}×c\_{ufl}+L\_{m}×c\_{L}$, where

em = energy for maintenance (UFL/ewe)

cufl= feeding cost (€/UFL)

Lm =maintenance labor (hours/ewe)

cL= labor cost (€/hour), i.e. the weighted mean of the family and hired human labor cost

*S2.2.2 Gestation cost*

$f×(e\_{g}×c\_{ufl})$, where

f = fertility (lambings per year and ewe)

eg=energy for gestation (UFL/ewe)

cufl= feeding cost (€/UFL)

*S2.2.3 Weaning cost*

$f×(p×e\_{s}×c\_{ufl})$, where

f = fertility (lambings per year and ewe)

p = prolificacy (lambs/ewe)

es= energy for suckling (UFL/lamb)

cufl= feeding cost (€/UFL)

*S2.2.4 Lambing cost*

$f×(L\_{L}×c\_{L})$, where

f = fertility (lambings per year and ewe)

LL= lambing labor (hours/ewe)

cL= labor cost (€/hour)

*S2.2.5 Milk cost*

$f×\left(m×e\_{milk}×c\_{ufl}+ n\_{ms}×c\_{L}×Α×ms\right)$, where

f = fertility (lambings per year and ewe)

m = milk yield (Kg per year and ewe)

emilk= energy for milk production (UFL/kg of milk)

cufl= feeding cost (€/UFL)

nms= number of milkings per ewe and year

cL= labor cost (€/hour)

Α= number of workers per milking per ewe

ms = milking speed (minutes per ewe and milking)

*S2.2.6 Mastitis cost*

$f×\left(M×\left(\frac{m× Loss ×Pri\_{m}}{DM}+\frac{m×Loss×e\_{milk}×c\_{ufl}}{DM}+c\_{M}+L\_{M}×c\_{L}\right)\right)$, where

f = fertility (lambings per year and ewe)

M = mastitis incidences per ewe

m = milk yield (Kg per year and ewe)

Loss = number of days during which the milk is not sold due to incidence of mastitis occurrence

Prim = milk price (€/kg)

DM = days of milking

emilk= energy for milk production (UFL/kg of milk)

cufl= feeding cost (€/UFL)

cM=medical cost for mastitis treatment (€/incidence)

LM= labor requirements for the treatment of a mastitis incidence (hours per ewe per incidence)

cL= labor cost (€/hour)

*S2.2.7 Replacement cost*

$\frac{e\_{r×c\_{ufl}+L\_{r}×C\_{L}}}{long}$, where

er= energy for replacement (UFL/replacement ewe lamb)

cufl= feeding cost (€/UFL)

Lr= replacement labor (hours/replacement ewe lamb)

cL= labor cost (€/hour)

long = longevity (lactation periods per ewe expressed in years)

**Supplementary Table S1** *Derivatives of profit function*

|  |  |
| --- | --- |
| Traits | Corresponding partial derivatives of profit function with respect to each trait |
| Milk production | $$\frac{∂f}{∂m}=Ν×\left(f×(Pri\_{m}-e\_{milk}×c\_{ufl}-M×(\frac{Loss×Pri\_{m}}{DM}+\frac{ Loss×e\_{milk}×c\_{ufl}}{DM})\right)$$ |
| Fertility | $$\frac{∂f}{∂f}= N×\left(\left(m×Pri\_{m}+p×Pri\_{L}\right)-\left( e\_{g}×c\_{ufl}+ p×e\_{s}×c\_{ufl} + L\_{L}×c\_{L}+m×e\_{milk}+ n\_{ms}×c\_{L}×Α×ms+M×(\frac{m Loss Pri\_{m}}{DM}+\frac{m×Loss×e\_{milk}×c\_{ufl}}{DM}+c\_{M}+L\_{M}×c\_{L}\right)\right)$$ |
| Prolificacy | $$\frac{∂f}{∂p}=Ν×f×\left(Pri\_{L}-e\_{s}×c\_{ufl})\right)$$ |
| Longevity | $$\frac{∂f}{∂long}=\frac{1}{long^{2}}×Pri\_{L}-\frac{1}{long^{2}}×Pri\_{cull}+\frac{(e\_{r}c\_{ufl}+ L\_{r}c\_{L})}{long^{2}}$$ |
| Milking speed | $$\frac{∂f}{∂ms}=-f×n\_{ms}×c\_{L}×Α$$ |
| Mastitis occurrence | $$\frac{∂f}{∂M}=N×\left(-f×\left(\frac{m×Loss×Pri\_{m}}{DM}+\frac{m×Loss×e\_{milk×}c\_{ufl}}{DM}+c\_{M}+L\_{M}×c\_{L}\right)\right)$$ |