OSIRIS, a bio-economic model, that allows to define economic breeding goald for ruminants

SMARTER Summer school

30 March 2023

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Agenda

- **Why do we need a bio-economic model?**
- **OSIRIS :A bio-economic model to design new selection objectives**
- **Application to a system in milk sheep**
- **Inclusion of a new trait in osiris : The example of labour**

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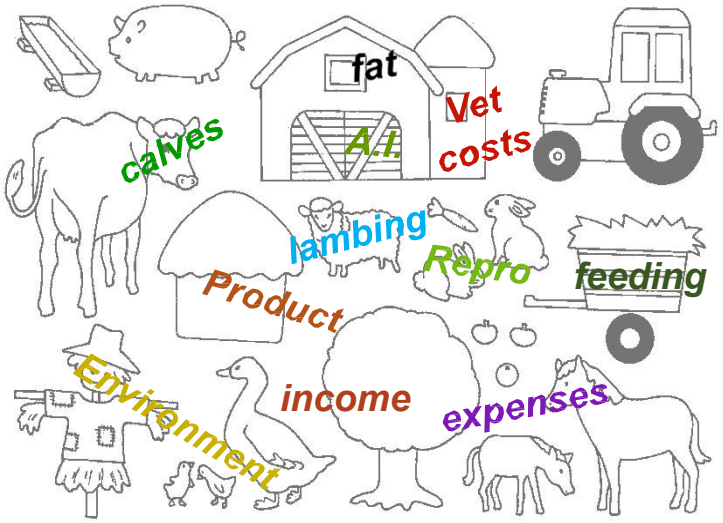
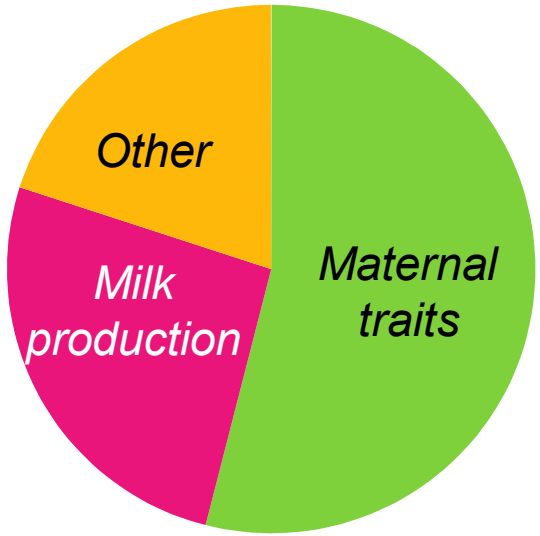
How to rank traits?

Farm systems

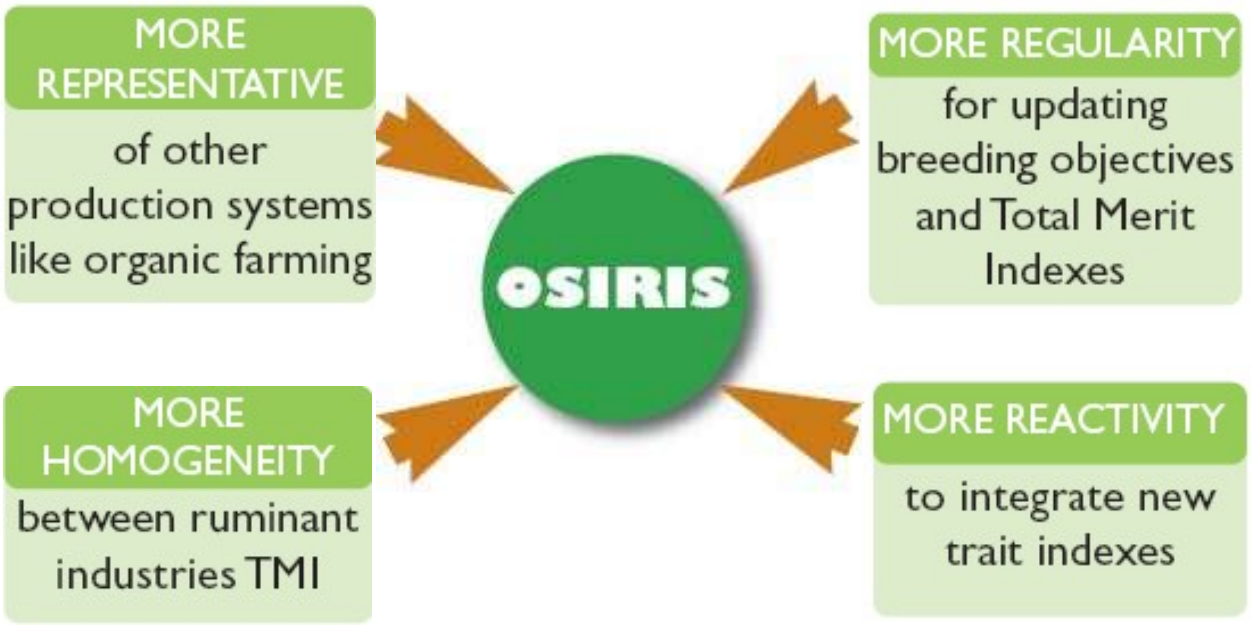


Breeding objectives



A need for economic studies, based on field data

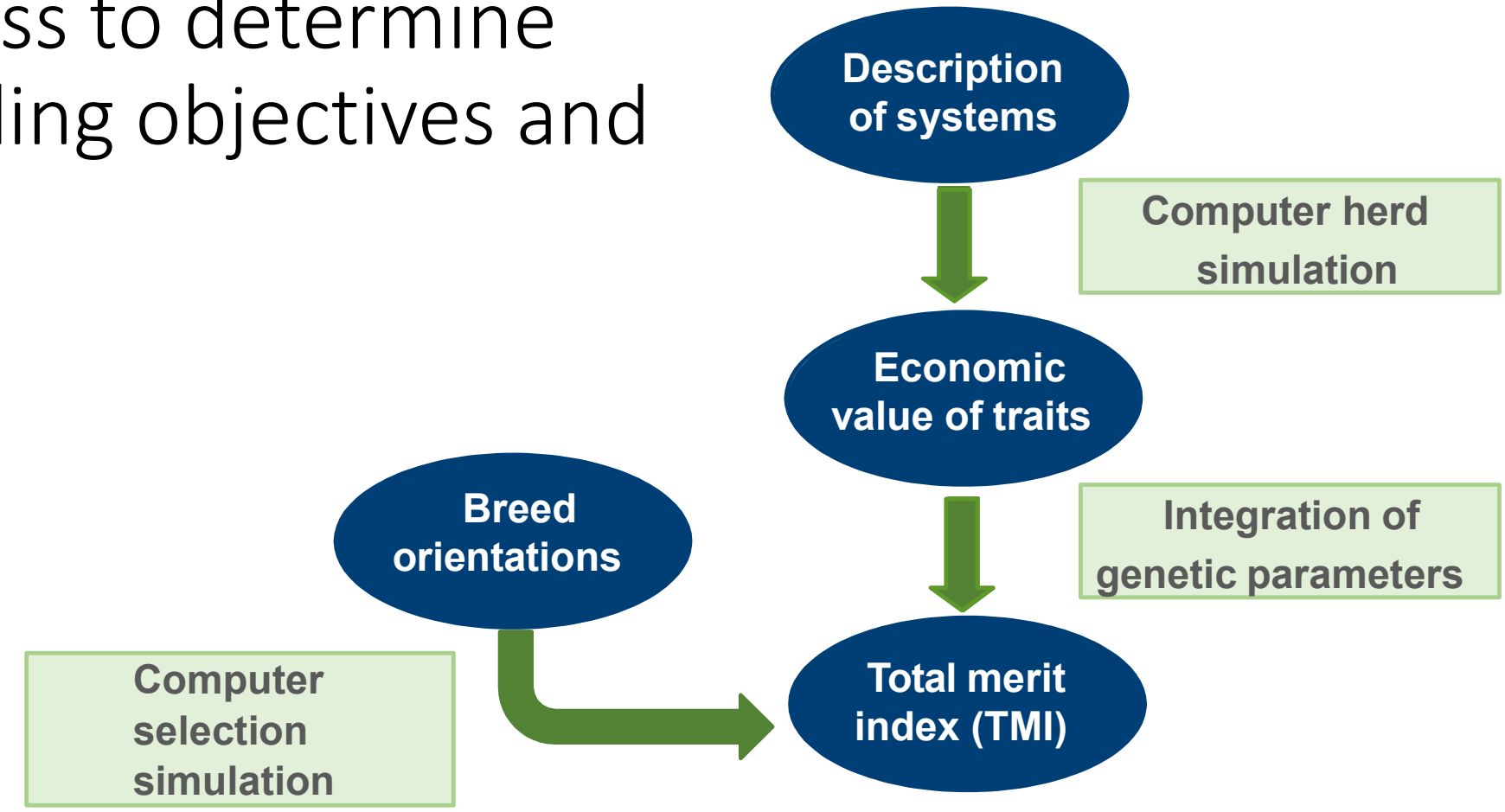
Four reasons for the OSIRIS Project



The OSIRIS Project

- Project over 3 years (2012-2014)
  - In dairy & meat sheep, dairy & meat cow and dairy goat

Process to determine breeding objectives and TMI



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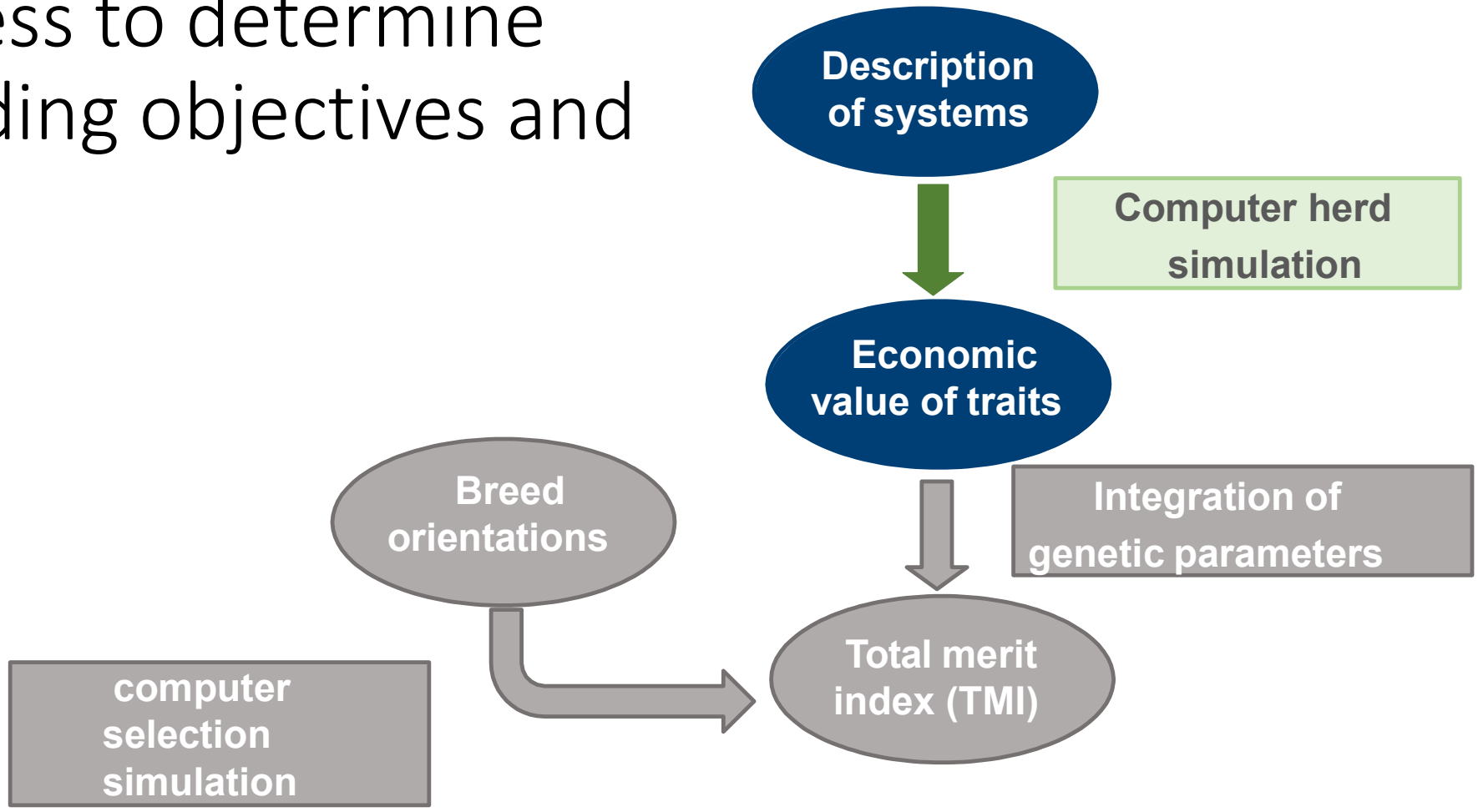


Modelization of the Profit function

- The herd profit (P) is expressed as the **sum** over all animals **of the difference between all the k income (R_{yk}) and m expenses (C_{ym})** for a given ewe of parity y *(y = 1 for a primiparous ewe and y = 2 for a multiparous ewe)*.

$$P = N_1\left(\sum_k R_{1k} - \sum_m C_{1m}\right) + (N - N_1)\left(\sum_k R_{2k} - \sum_m C_{2m}\right)$$

- For each production system, we derive the economic value a_x for trait Y_x as the direct marginal profit, i.e. **the derivative of the profit function $P(Y_1 \ldots Y_n)$** with respect to the trait Y_x, at the point of mean performance Y_{i0} for the n traits as follows

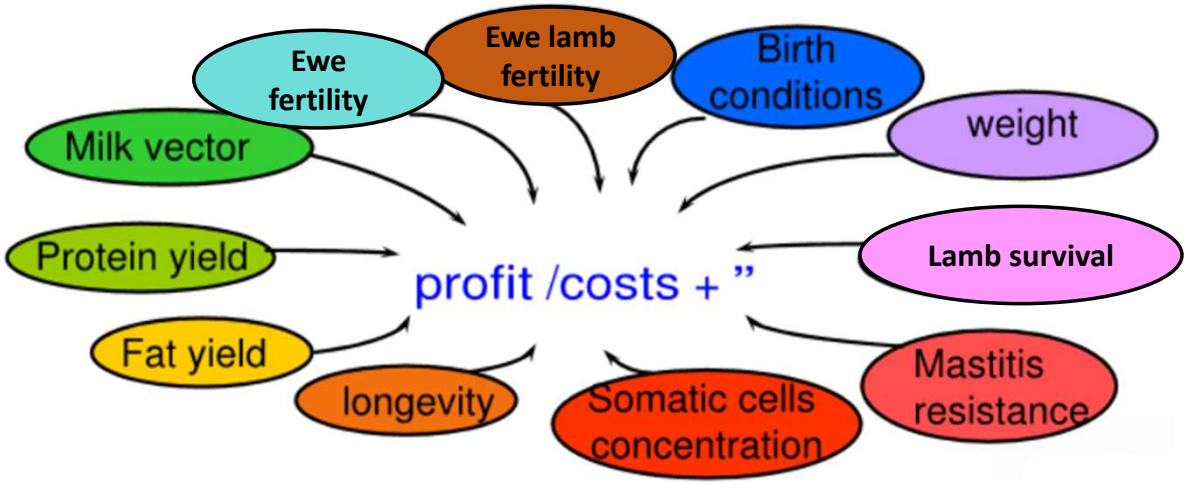
$$a_x = \left[\frac{\partial P(Y_1 \ldots Y_n)}{\partial Y_x}\right]_{Y_{10} \cdots Y_{n0}}$$

- The analytical derivatives were verified by testing the effects of small changes in traits on profit (finite differences).

Linking the costs and revenues to traits

- **Incomes = milk + lambs + culls + subsidies**
- **Costs = feed + lambing + A.I. + mastitis + other health costs+ fixed costs**

Profit= revenues – costs



Example with ewe fertility : + 1 %

Culls

Replacement ewes

Multiparous ewes
Primiparous ewes

Revenues from lambs

Revenues from milk

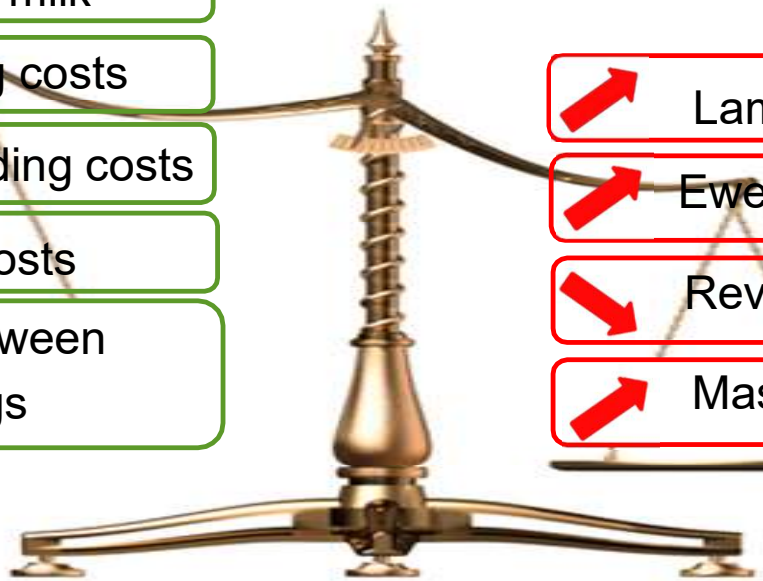
Difficult lambing costs

Ewe lambs feeding costs

Reproduction costs

Interval between lambings

+1,55 €



Lambs feeding costs

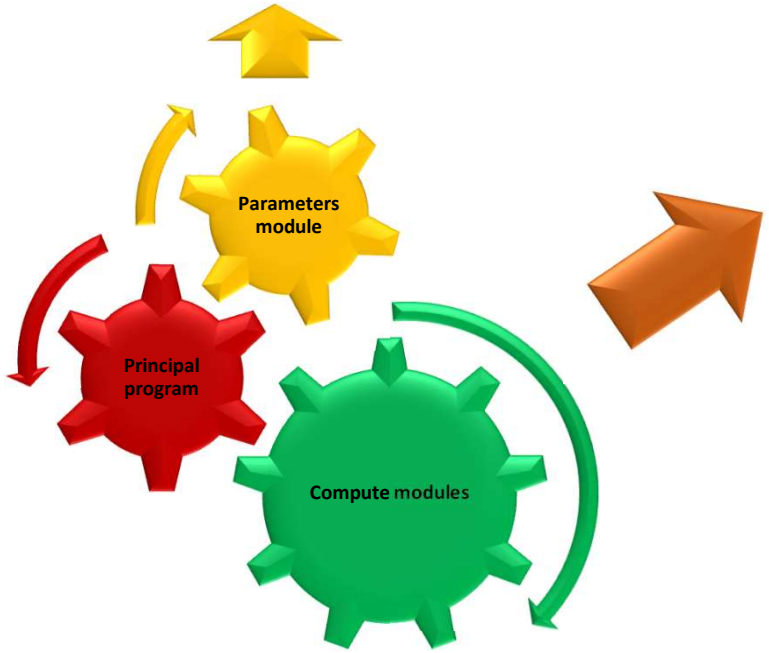
Ewes feeding costs

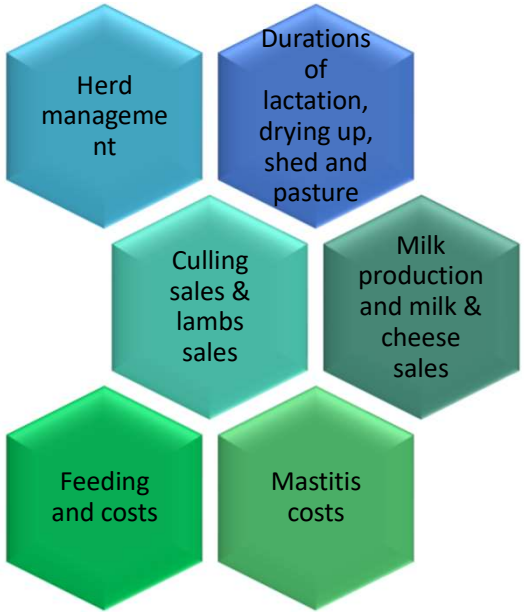
Revenues from culls

Mastitis costs

Global architecture

- **Herd demography** (nb of ewes mated, % of 1st lambing, …)
- **Reproduction** (grouped mating, duration of gestation and ideal lactation, …)
- **Milk income** (Quantity, milk price, nursing duration, …)
- **Feeding** (food prices, food values, duration in shed or pasture, …)
- …

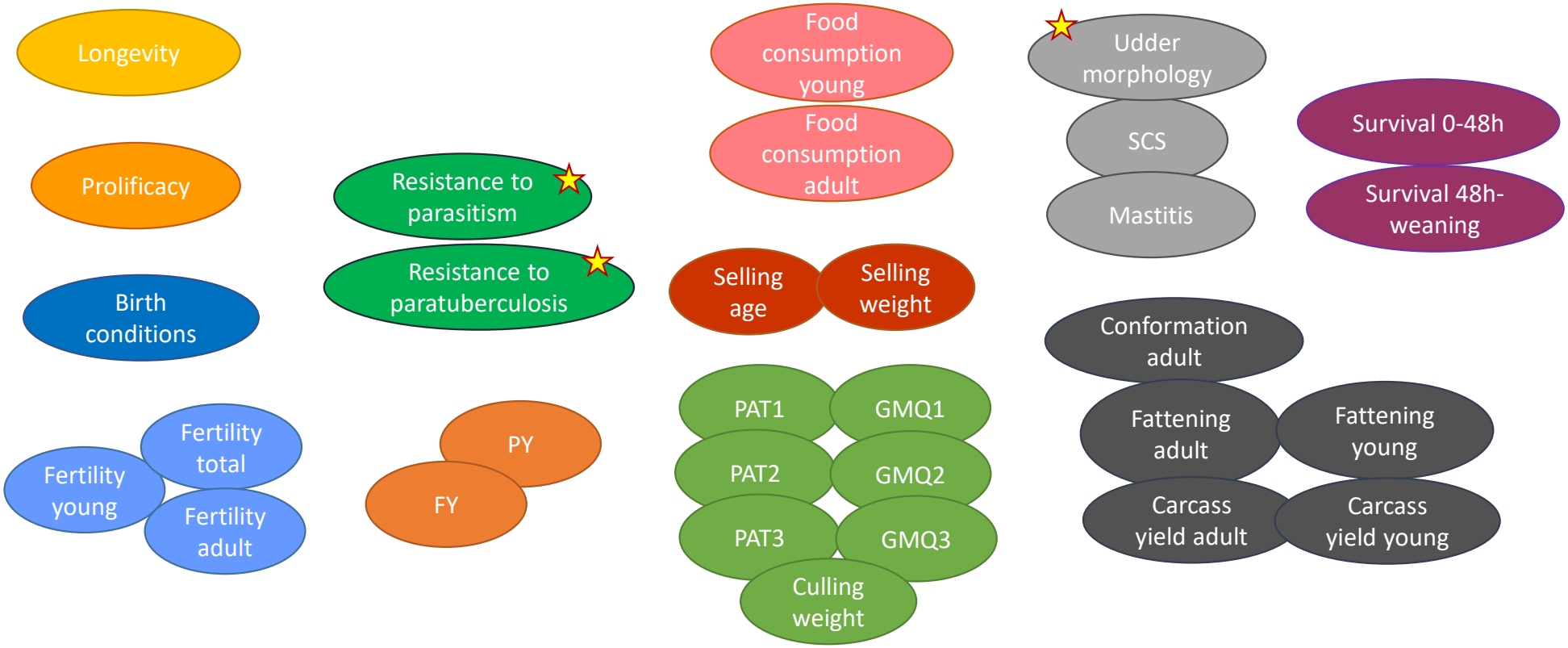




- Common modules for all ruminants species and specific modules
- Developed in SAS-IML

Economic weight for each trait

Traits already considered in OSIRIS



Various information sources

France Génétique Elevage

RESEAUX D'ELEVAGE

INSTITUT DE L'ELEVAGE idele

INRAE

Etc…

FranceAgriMer
ÉTABLISSEMENT NATIONAL
DES PRODUITS DE L'AGRICULTURE ET DE LA MER

UMT STAR
Sélection génétique pour la Transition
Agroécologique des petits Ruminants

UPRA LACAUNE

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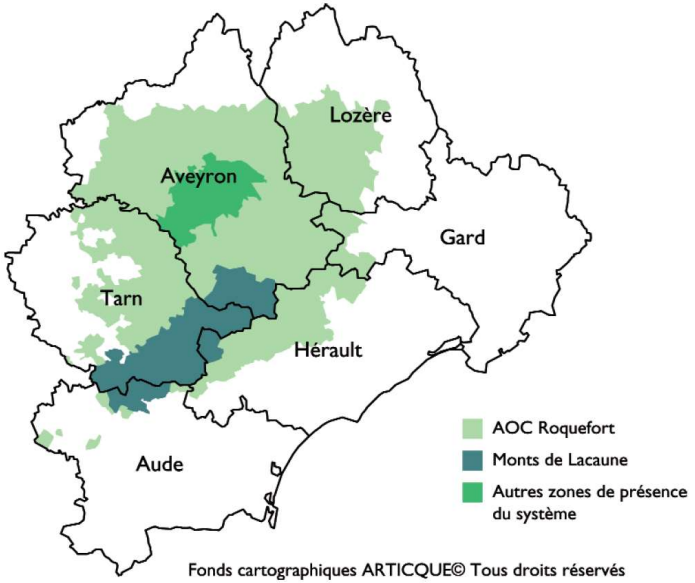
Study case ROQ01



- Mountain area favorable to grass growth in spring

➔ Forage system 100% grass (110d in shed)

- Ventilated alfalfa & dactyl hay, + ray grass hay and et natural grassland dried on the ground
- Concentrate feed : barley (self-produced) + meal

Organisation of the study case

370 ewes bred (incl. 100 ewe lamb)

357 ewe having lambed (incl. 96 primiparous)

Milk

343 brebis milked

106 000 L of milk produced
≈ 300 L / ewe milked
≈ 215 days of milking

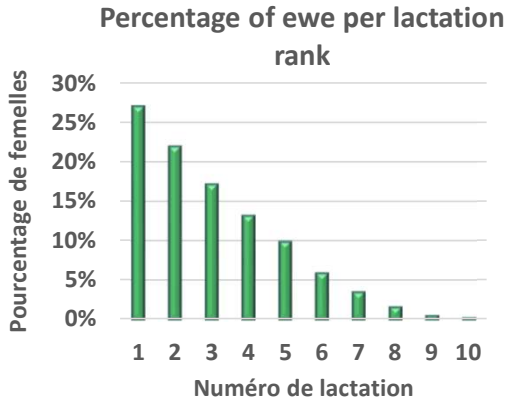
Meat

582 lambs born

542 lambs reared

442 lambs sold
40 dead lambs
90 culled ewes

100 ewe lambs for replacement(27%)



Average longevity : 3,98 years

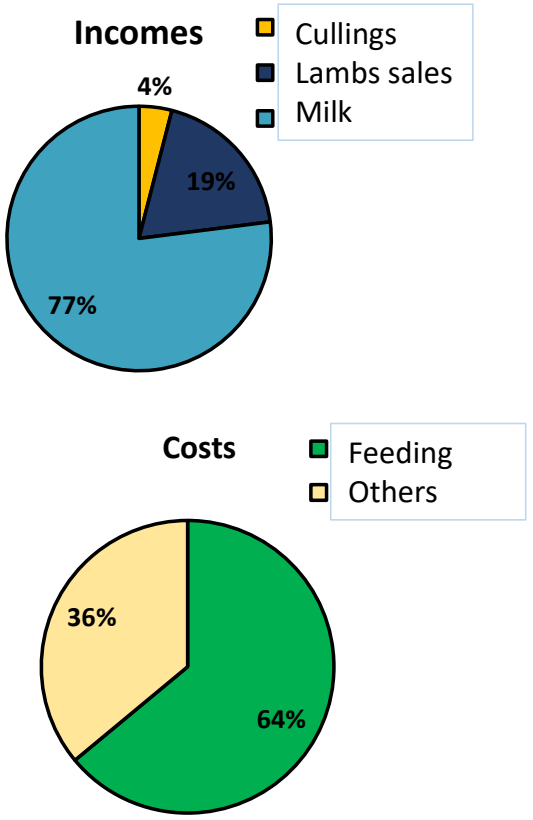
Modelisation of the study case

- **Incomes : 128 000 €** (study case : 124 000 €)
  - Cullings : 4 %
  - Lambs sales : 19 %
  - Milk : 77 %

- **Costs : 34 000 €** (study case : 29 000 €)
  - Feeding (≈ 900 kg MS / ewe / year) : 64 %
    - 522 kg MS of dry forrage
    - 171 kg of barley
    - 21 kg of meal
    - 204 kg MS of grazed grass
  - Others (health, repro, breeding costs) : 36 %

➔ **Benefit : 94 000 € (**study case **: 95 000 €)**

= 255 € / ewe put for reproduction (study case : 256 € / ewe)



Economic impacts of selection traits

- Longevity : +1% of replacement rate
  - ↗ cullings → cullings incomes ↗ et longevity ↘
  - ↗ replacement rate → lambs sales↘ et feeding costs of lambs ↗
  - ↗ % of young females → ↘ milk incomes

  → ↘ benefit : -2€ per ewe put for reproduction / year

- Milk quantity: +0,01 kg / month of lactation
  - ↗ milk incomes
  - ↗ feeding costs

  → Benefit similar to the basic modelisation

Economic impacts of selection traits

- FY : +0,01 kg / month of lactation
  - ↗ milk incomes
  - ↗ feeding costs
  - ➔ ↗ benefit : +6€ per ewe put for reproduction / year

- PY : +0,01 kg / month of lactation
  - ↗ milk incomes
  - ↗ feeding costs
  - ➔ ↗ benefit : +6€ per ewe put for reproduction / year

Economic impacts of selection traits

- SCS : +0,01 point of SCS
  - slight ↘ of milk incomes

  ➔ Benefit similar to the basic modelisation

- Mastitis : +1 % of mastitis
  - ↘ milk incomes
  - ↗ mastitis costs, health et breeding costs
  - ↗ of cullings for mastitis:
    - ↗ culling incomes
    - ↘ longevity
  - ↗ replacement rate to compensate cullings :
    - ↘ incomes for lambs sales
    - ↗ feeding costs of lambs

  ➔ ↘ benefit : -3€ per ewe put for reproduction / year

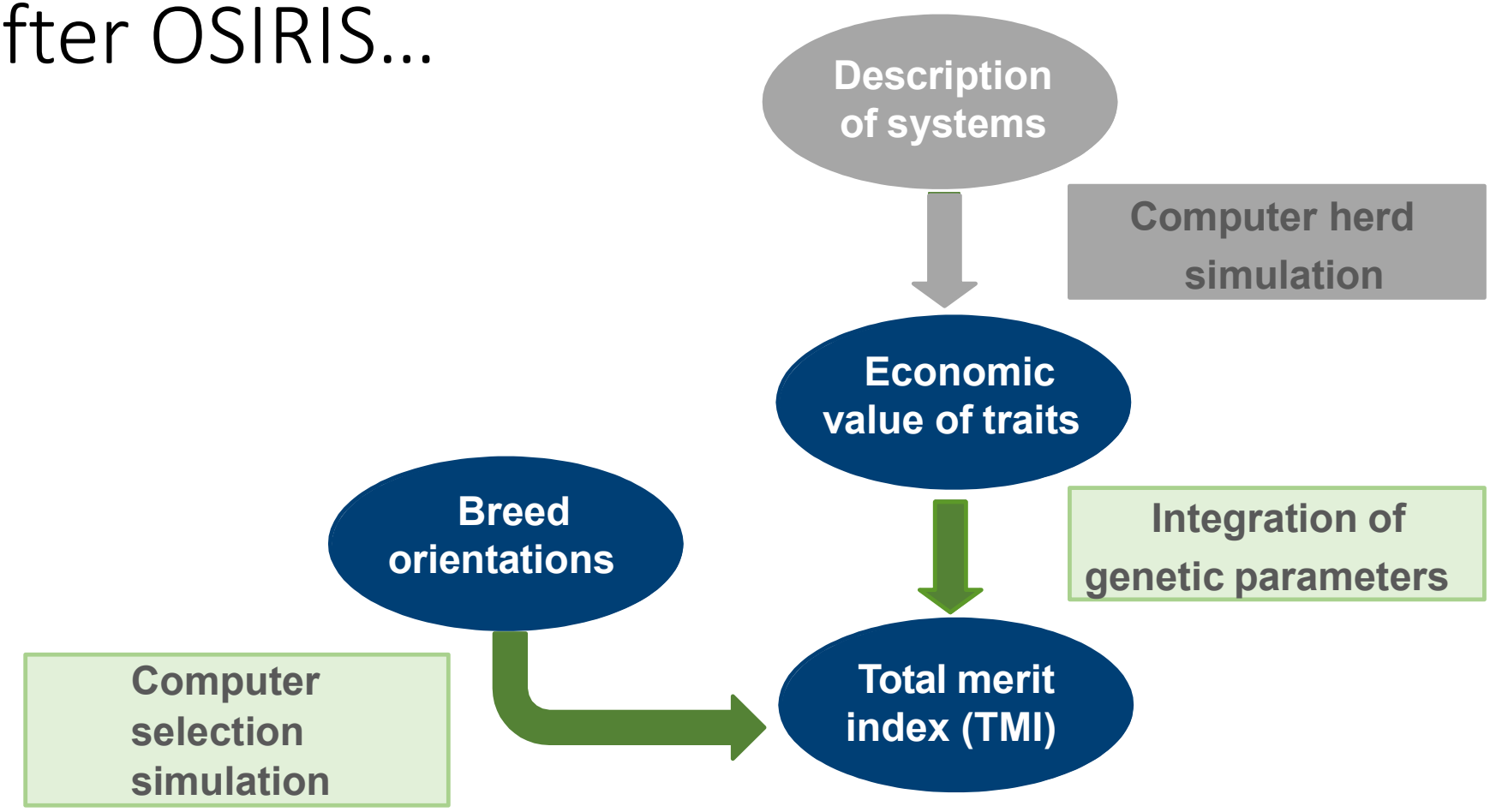
Economic weights of traits

- Represents the gain (in €) by improving the trait of 1 STDg

(€ per genetic standard deviation)

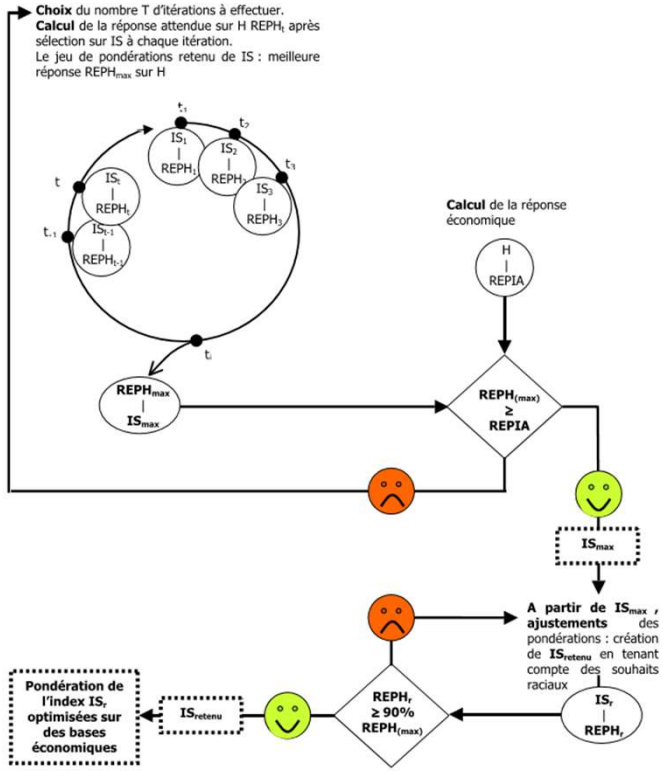
Caractère	Pondération économique
Longevity	7,43 €
MY	-0,07 €
FY	7,92 €
PY	4,40 €
SCS	1,25 €
Mastitis	15,91 €

And after OSIRIS…

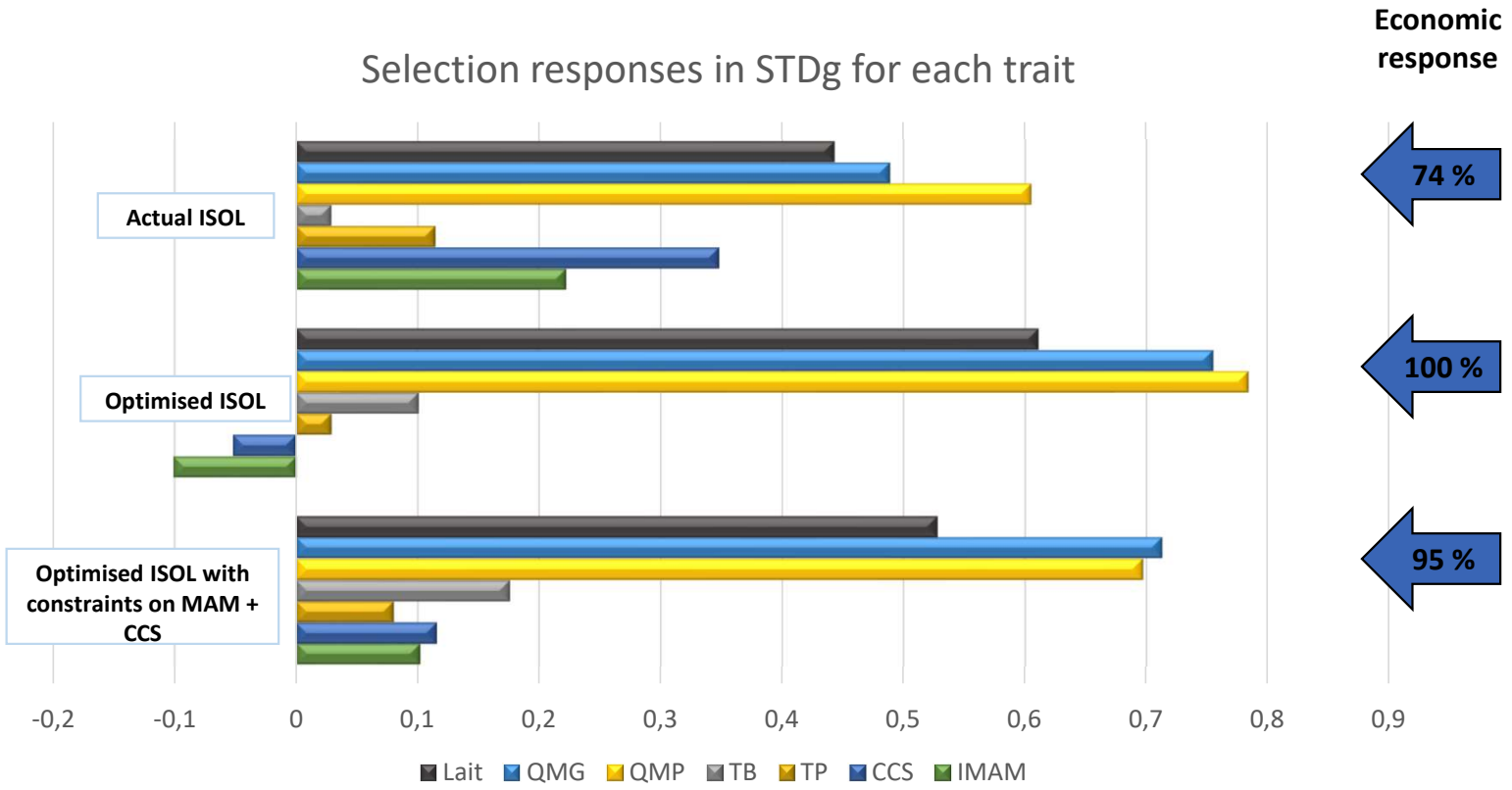


Optimisation of the TMI's weightings

- Use of the economic weights and a dataset of indexes
- Random selection of weightings -> iteration until finding the one which will maximise the global profit
  - Monitoring of the selection responses (on selected traits and others)
  - Discussion with breedings associations
  - Definition of constraints to avoid the degradation of some traits



The evolution of ISOL (milk sheep TMI)



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Inclusion of labour in breeding goals

Objective for SMARTER W7.3

Estimate the economics of labour use in new R&E traits

- We included labour costs for R&E traits chosen according to work done on previous WPs and WP7 tasks

- Labour is included not as a trait itself, but in the values of other traits
  - Literature about labour use in small ruminants systems
  - Description of the links between labour and the traits modelled in OSIRIS
  - Several hypotheses about the levels of labour use
  - Achieving a breeding goal including labour

Resilience and Efficiency traits

Choice modelling

Coherent with traits used in the survey

Labour-related traits

Traits uncluding labour that can be quantified

Parasitism

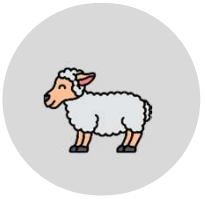
Gatrointestinal parasitism

Mastitis

Clinical and subclinical mastitis

Food efficiency

Ability to optimise the use of ingested food while maintaining physiological functions



Prolificacy

Number of lambs born per farrowing

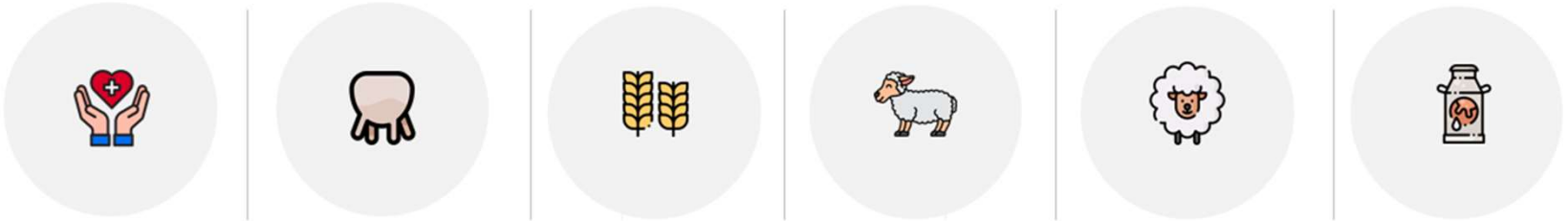
Longevity

True longevity : productive lifetime

Milk quantity

Amount of milk per ewe

Links between R&E traits and labour



Parasitism

Treatment time per year, material preparation time and grouping of animals

Mastitis

Mastitis monitoring and treatment times

Food efficiency

Time to produce feed and time to feed animals

Prolificacy

Assistance with ewe lambing, management of litters (0-30 days) and lamb monitoring

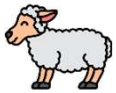
Longevity

Time to raise ewe lambs (feeding, supervision, etc.)

Milk quantity

Milking time in its entirety (preparation, cleaning, moving the animals, etc.)

Example of the prolificacy



Prolificacy

Time_diff_lambing et Time_medium_lambing

Time spent for difficult or medium lambing (h/lambing)

Rate_diff_lambing et Rate_medium_lambing

Proportion of difficult or medium lambing in the herd

Time_mngt

Time spent managing lambs eaveryday (food, monitoring, etc.) (h/d/lamb)

Nbr_days_mngt

Number of days for lambs management

Watch_time

Time spent on lambing monitoring during the lambing period (h/d)

Nbr_watch_days

Number of days for the lambing period on the farm

Care_time

Time spent in post-natal care for lambs (h/lamb)

nbrMB

Total number of lambing in the herd

Example of the prolificacy

Prolificacy

Time_diff_lambing et Time_medium_lambing

1h for difficult lambing / 10 min for medium lambing

Rate_diff_lambing et Rate_medium_lambing

1% of difficult lambing / 6% of medium lambing

Time_mngt

4h/d for all lambs

Nbr_days_mngt

30 days

Watch_time

22 hr per day

Nbr_watch_days

6 days

Care_time

4 min per lamb

nbrMB

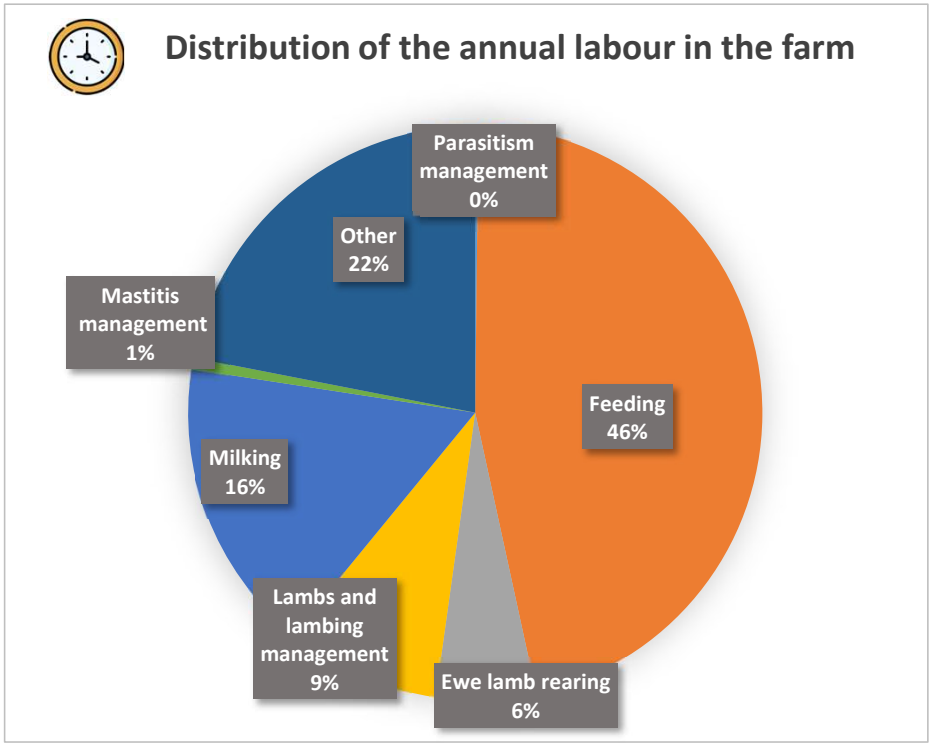
357 lambings

Time_lambing = Time_diff_lambing x Rate_diff_lambing x nbrMB + Time_medium_lambing x Rate_medium_lambing x nbrMB

Time_prolificacy = Time_lambing + Watch_time x Nbr_watch_days x Nlambs + Time_mngt x Nbr_days_mngt + Care_time x Nlambs

- Development and integration of the equations and labour-related data in OSIRIS
- Calculation of the benefit of the system and then the breeding objective

Main results



78% of the annual labour in the farm are explained by the 6 R&E traits chosen

Minority

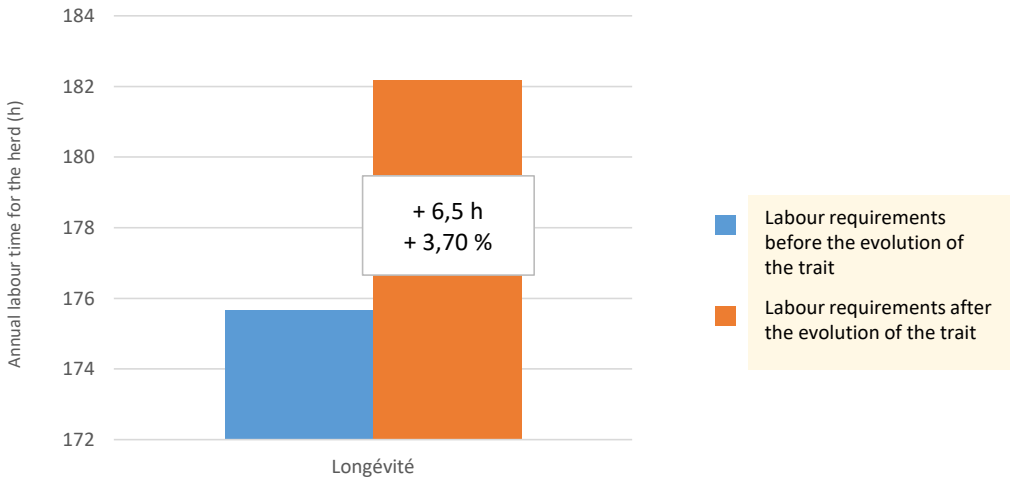
The time dedicated to **mastitis** and **parasitism** is very low, less than 1% each

Majority

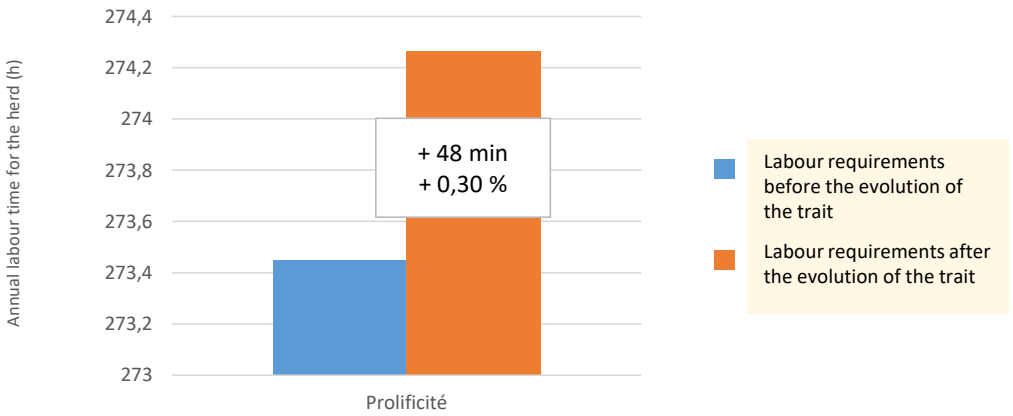
Feed efficiency is the most time consuming trait followed by **milking**. **Prolificacy** and **longevity** respresent even so in total 15% of the annual labour

Main results

Evolution of labour time after reducing the herd **longevity**

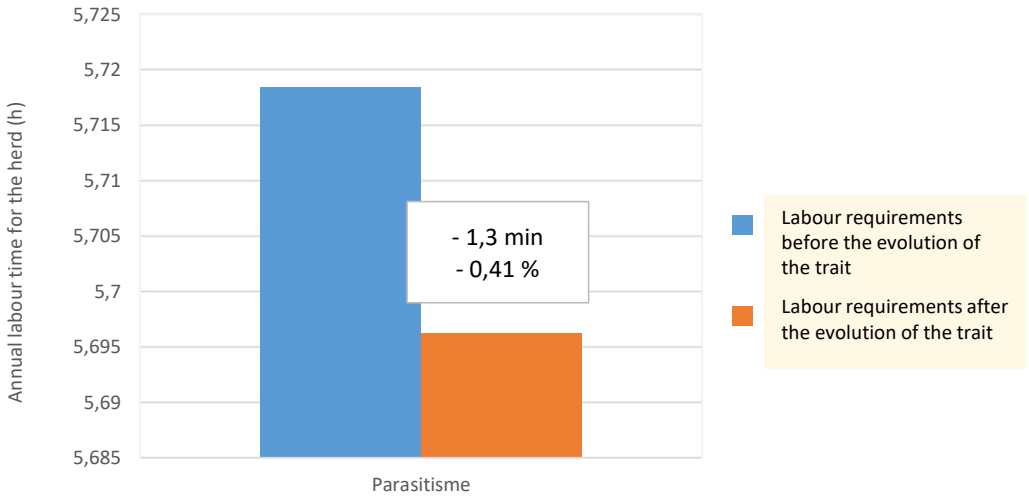


Evolution of labour time after increasing the herd **prolificacy**

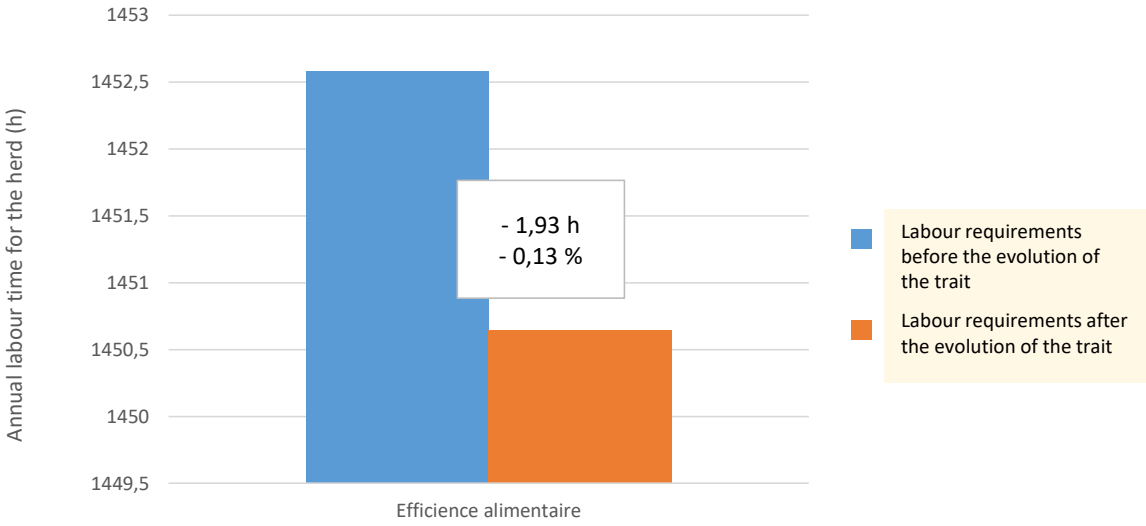


Main results

Evolution of labour time after increasing **Resistance to parasitism**

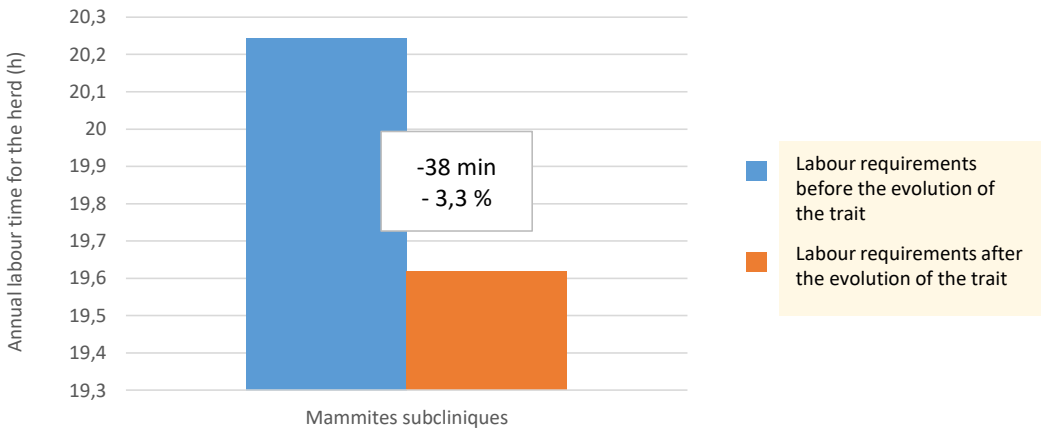


Evolution of labour time after increasing **feed efficiency**

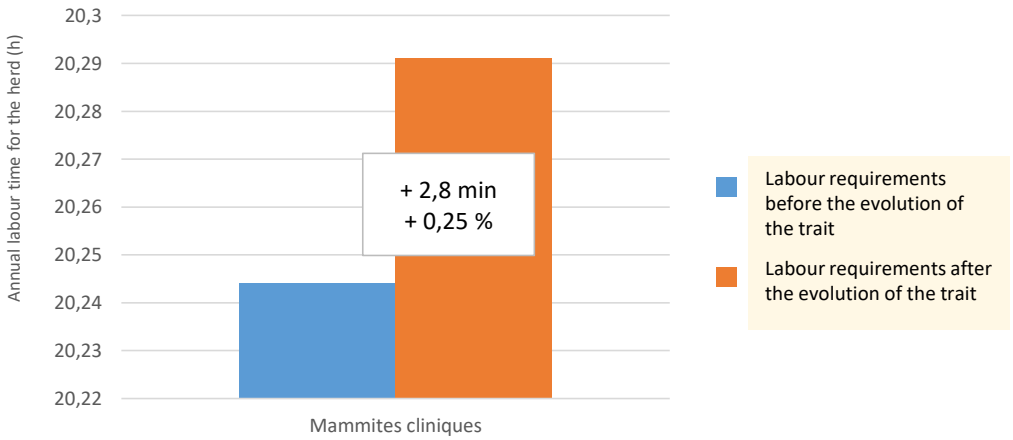


Main results

Evolution of labour time after increasing de la **resistance to subclinical mastitis**



Evolution of labour time after decreasing **resistance to clinical mastitis**



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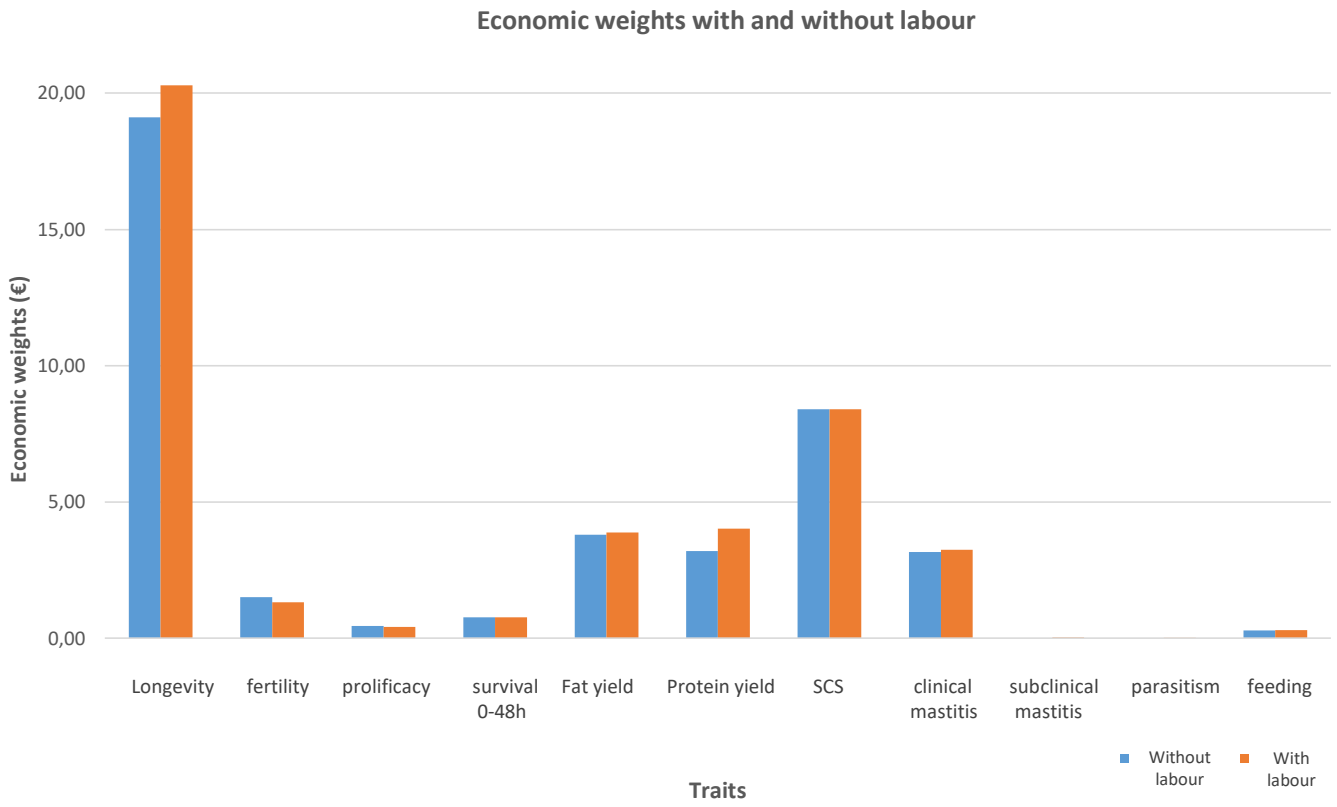


Longévité

If the longevity of the herd increase, the number of young in the herd is reduced, so the costs related to their feeding and their health is also reduced. The labour requirement related to ewe lambs rearing therefore decrease and so the economic weight is important

Resistance to clinical mastitis

When decreasing the rate of clinical mastitis in the herd, the treatments costs also decrease. The culling rate decrease and less youngs are kept. The labour costs decrease slightly.

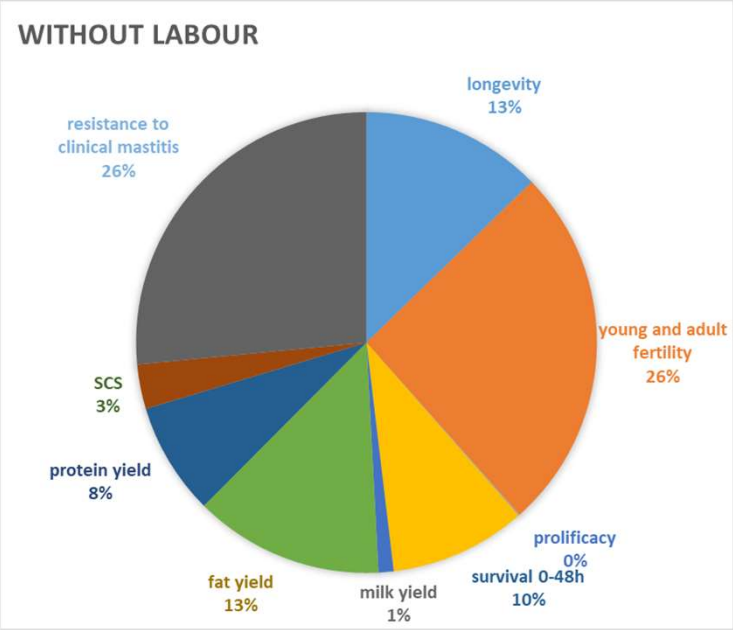
Resistance to subclinical mastitis, feed efficiency

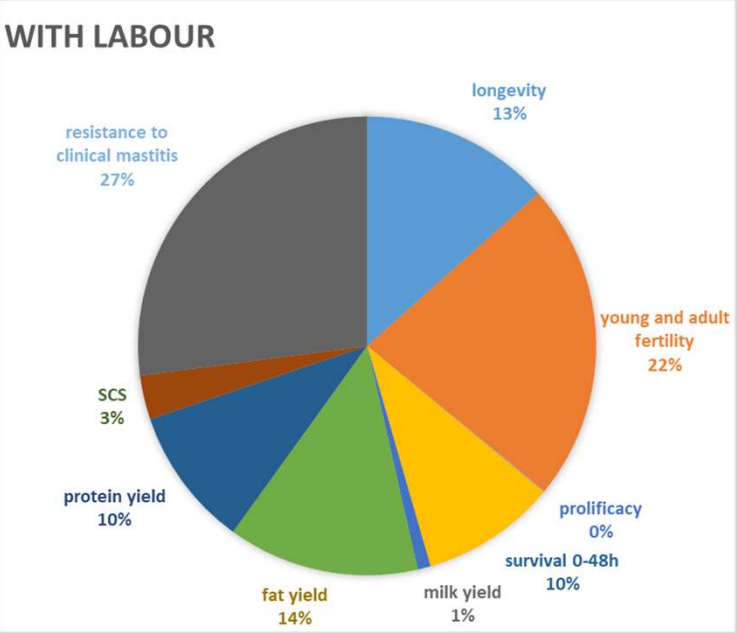
These traits were not included in the model. Here, they are considered by including labour in the model. So, the economic weights of these traits increase with the labour costs.

Prolificacy

By increasing the number of lambs in the herd, the number of lambs increase in the herd and the sales revenues of lambs increase slightly. But the labour requirements also increase.

The final breeding objective





- Results in economic weights that include labour for a milk sheep breed
- The same assessment is ongoing for a meat sheep breed

Evolution of the benefit with labour costs

But very few changes in the economic weights and the breeding objective

No re ranking of trait EWs – might impact breeding program

Thanks for your attention