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N68

FEEDING SHEEP

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PRESENTATION

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Subdirector General of Livestock

The Ministry of Agriculture, Livestock, Fisheries, Food and Natural Environment presented the plan for recovery of the sheep and goat sector in Catalonia in mid-2013. This plan, drawn up jointly with the sector, identified the needs of Catalan sheep and goat farms, and defined the priorities for action, which, if implemented correctly, will reverse the negative trend that has affected sheep and goat farming in Catalonia in recent decades.

The plan includes initiatives in the areas of professionalisation, research, improved marketing and promotion of consumption, and reinforcing the environmental potential of sheep and goat farming to enable the sustainable development of the natural environment and guarantee territorial balance. We have identified the risks that affect our sector and we have also defined the actions that will enable it to recover, but we are now faced with the difficult challenge of implementing them and monitoring them.

The document that we present today is part of this series of research and dissemination initiatives which will enable us to improve the training and professionalism of our farmers, in order to improve their knowledge of the field of animal nutrition and enhance the human capital that cares for and manages flocks.

The aspects covered in this dossier must enable a proper management of farms in the feeding of sheep and goats in order to guarantee their profitability and their future. As with other species, feed for small ruminants is the main production cost. This cost varies widely depending on the production system and the increasingly uncertain prices of raw materials. Aspects as important as assessment of the nutritional needs of the flock and consideration of feed costs, as well as management of the flock associated with the potential use of different pasture areas can ensure that feed costs are optimised, without neglecting production or its quality.

Of all Catalonia's livestock sectors, perhaps sheep and goat farming has the least technical and statistical data, which if properly processed and analysed, could provide the necessary information for decision-making in daily flock management. Data relating to feed is crucial for this purpose. That is why this Dossier Tècnic seeks to remedy this shortcoming, although further work will undoubtedly be needed to provide similar tools in other areas.

I would like to thank all the professionals who have participated in the production of this dossier, by contributing their knowledge in a highly practical and understandable manner, for their help. I am convinced that publications like this one, as well as the other initiatives outlined in the Plan, will enable us to recover our sheep and goat farming, so that in the future today's threats will have disappeared and the continuity and growth of sheep and goat farming in Catalonia will be guaranteed.

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Cover photo:
"Flock of sheep grazing". Author: Marc Taüll.

ASSESSMENT OF NUTRITIONAL AND PRACTICAL FOOD REQUIREMENTS IN SHEEP

Photo 1. *Sheep eating a full ration mixed with fodder, whole grains and dehydrated pulp pellets. Author: Gerardo Caja.*

01 Introduction

In addition to being an important part of production costs, food is one of the main factors that determines the productive yield of a flock of sheep. It affects affect both the quantity (fertility of ewes, number of lambs sold, litres of milk, etc.) and the quality of products (fattening of lambs, composition of milk, etc.). Although this idea is accepted by specialists and farmers, who are above all aware of the negative effects of a diet that is unbalanced or insufficient, in practice few sheep farms plan and monitor food thoroughly.

On most sheep farms, monitoring of food is limited to fulfilling or correcting the major seasonal variations in contributions of pasture and forage, and ensuring that potential production is not limited by a poor diet, depending on their financial capacity.

The real situation is complicated because supply and management are closely related in most production systems, and in the agricultural environments where sheep are farmed, and by the fact that genotypes (breeds, varieties and individuals) are not always adaptable or compatible with environmental conditions.

Interestingly, the production (phenotype) is the result of interactions between the genotype and the environment. This means that it is impossible to obtain high production yields without considering both factors together.

The process of calculating a ration suitable for a flock of sheep requires:

• An accurate calculation of the nutritional needs depending on the desired production.

• An accurate prediction of the total voluntary intake of the ration and the forage freely available to the sheep.

• An accurate calculation of the resulting amount of nutrients and food supplements to be provided.

• A comparative assessment of the possible food prices and a selection of the most economical solution.

02 Evaluation of the nutritional needs of sheep (4 core nutrients)

The first problem that arises for the proper nutrition of sheep is to accurately determine their nutritional needs. This is relatively well known in the case of sheep breeds suitable for meat in northern Europe in housed conditions, but few extensive studies have been carried out on sheep native to the Mediterranean area or on dairy sheep. If nutritional guidelines obtained under the conditions and production systems for northern European sheep are used therefore, there may be significant differences in the real

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The basic nutrient needs are expressed in Net Energy (MFU/d), protein digestible in the intestine (PDI, g/d), Calcium (Ca, g/d) and Phosphorus (P, g/d).

needs of sheep native to the Mediterranean region. Pending the availability of data and nutritional guidelines for Mediterranean conditions, the best solution is to adapt the nutritional guidelines to the specific conditions of our farming system.

As with other animals, estimates of daily nutritional requirements for sheep should take into account the four main nutrients which according to the French system INRA (2010) are:

- Net Energy (MFU, milk forage unit)
- Protein (PDI: protein digestible in the intestine)
- Calcium (Ca, g/d)
- Phosphorus (P, g/d)

The daily needs of each of these nutrients are expressed as MFU/d, g PDI/d, g Ca/d and g P/d. Although other nutrients (salt, fibre, S, Se, Cu, vitamin E, etc.) are important and may be critical, they do not substantially change the price of the rations and will not be considered here. Special attention should be given to the lack of Se (myotonic dystrophy or white shoulder in lambs) and Cu deficiency (ataxia) and poisoning. In practice, these nutrients are adjusted after calculating the ration with the four important nutrients mentioned above.

Using the factorial method, the daily needs of each nutrient are calculated based on the respective needs that might arise in a given productive stage of the animal. For sheep, these stages are: rearing, growth and/or weight changes, gestation, lactation and/or milking.

The values for each of these physiological states are summarised in Table 1, in which based on INRA data (2010), various estimates have been made based on the methods used by Caja (1994) and Caja and Gargouri (1995) to facilitate using and adapting the tables to Mediterranean sheep breeds.

The MFU is defined by the French INRA (Institut National de la Recherche Agronomique) system as the net energy contained in 1 kg of raw barley (1 MFU is equivalent to 1.7 Mcal EN/kg). In comparison to conversion into meat, the energy conversion efficiencies of a foodstuff for maintenance (k_m = 0.7) and milk (k_l = 0.6) are parallel and similar depending on the quality (k_f = 0.45), and as such milk was used for both maintenance and lactation during most of the sheep's production cycle. In the official Spanish system of animal feed for ruminants, the AU directly translates as the UF ('unitat alimentaria'), but the UF is how the MFU was formerly expressed, without the modifications to the INRA system made in 1989, 2007 and 2010, which consequently leads to errors. For gestation, the conversion efficiency is very low (k_g = 0.2-0.3), which has been taken into account when estimating the needs, but this also needs to be borne in mind when calculating the nutritional benefits of foodstuffs (which are always overestimated for gestation).

03 Maintenance (variable needs)

Most of the values for the maintenance needs in Table 1 are calculated based on metabolic weight (calculated based on live weight, MW = LW0.75) in housed conditions. An interesting aspect is the relationship between LW and maintenance needs. Because heat losses are a function of body surface area (which is squared) and heat production is a function of body volume (which is cubed), the best relationship with maintenance requirements is obtained as a function of LW with the exponent 2/3 = 0.75.

Taking LW as a reference, the weight of the fasted ewe is taken after birth and with a high level of body reserves. In practice LW varies widely, depending on the physiological state (gestation, lactation, etc.), the quality of the forage (variation in digestive system contents), the state of body reserves, etc. which must all be taken into account.

The protein requirements for maintenance in Table 1 are calculated for ewes with a gross annual wool production of 2 kg. For breeds with higher or lower levels of wool production, it is necessary to apply a correction of 0.14 g PDI/kg of wool produced.

In cases where grazing takes place, the maintenance needs should be increased by a factor or 'grazing coefficient' (GC) which among other things, takes into account the increased

Photo 2. *Intensive sheep farm equipped with conveyor belt feeders. Author: Gerardo Caja.*

energy requirements for maintenance due to displacement, room temperature, the degree of difficulty of the grazed plot, and the density and quality of pastures (between 20 and 60% of the maintenance requirements).

Despite the lack of information available on this subject, the GC should vary between values of 1.00 (when housed) and 1.60 (very rough grazing), as shown in the example in Table 2, for grazing by a flock of Ripollesa sheep with a reproductive rate of 1 birth/year during the autumn. An important conclusion is that contrary to general belief, maintenance requirements are not constant throughout the year and food supplements equivalent to 200-300 g/d of barley are required depending on the type and availability of grass in the pasture. A comparison of maintenance costs for a housed sheep with a grazing sheep shows an annual food supplement of 70-110 kg of barley per sheep, equivalent to an estimated annual additional cost of 12-20 €/sheep (similar to a shepherd's wage for a flock of 1,000 sheep). These values would be higher in sheep with a heavier live weight.

The maintenance requirements should be increased by 10% for rams to account for energy costs when mating and their increased exercise when seeking females in heat.

04 Growth and change in weight (saving with spring grass)

Growth and weight changes (reconstitution and mobilisation of body reserves) can be used to remedy food deficits and surpluses. The values per 100 g of weight variation are shown in Table 1, which shows the magnitude of the increase in adult sheep compared to young (+30 MFU). This is due to the higher fat content of the weight gain in adult sheep (approximately 90% fat) compared to the growth in lambs (approximately 50% fat).

There should be no excessive shortcomings in nutrition (a maximum 80% of maintenance needs of sheep for meat, according to INRA, 2010), i.e. a maximum shortcoming of 0.5-0.6 MFU/d for sheep weighing 50 to 70 kg (equivalent to a saving of 500-600 g/d of barley in the ration) in any period in the sheep's production cycle, in order not to deplete their body reserves.

Table 1. Estimated nutritional needs of sheep (based on INRA, 2010).

Physiological state	Energy (MFU/d)	Protein	Ca (g/d)	P (g/d)
Maintenance per kg of metabolic weight [1]	0.033	2.2	0.19	0.05[2]
Growth per increase of 100 g	0.26	22.0	1.40	0.40
Weight gain, per increase of 100 g	0.56	22.0	-	-
Weight loss, per 100 g lost	-0.26	-22.0	-	-
Gestation, per kg of lamb at birth				
-6 to -5 weeks from delivery	0.015	5	0.50	0.12
-4 to -3 weeks from delivery	0.04	10	0.80	0.20
-2 to 0 weeks from delivery	0.08	13	1.35	0.33
Lactation, per litre of milk				
Lactation, per litre of milk[3]	0.60-0.65	75-88	6.0	1.5
Milking after weaning	0.55-1.05[4]	69-120[5]	6.4-7.0	2.5-2.8

[1] Metabolic weight = body weight$^{0.75}$ ($40^{0.75}$ = 15.9; $50^{0.75}$ = 18.8; $60^{0.75}$ = 21.6; $70^{0.75}$ = 24.2; $80^{0.75}$ = 26.8).
[2] Calculated on body weight.
[3] 1kg gain in the lamb = 5-6 kg milk produced by the ewe which has been suckled by the lamb.
[4] MFU L x 0,0066 = Fat (%) + 0.241 (Molina *et al.*, 1991).
[5] g PDI/L = 1.7 × Protein (%).

Table 2. Annual maintenance needs in Ripollesa breed sheep (55 kg LW) under grazing conditions impregnated in the counter season for the sale of lambs at Christmas (based on Caja, 1994).

Month	J	F	M	A	M	J	J	A	S	O	N	D
Productive state [1]	b	b	M	g1	g2	g3	g4	g5	PA1	A2	A3	D/V
Height and availability of the grass in the pastures	WW	W W	W W W	W W W W W	W W W W W	W W W	WW	WW	W W	W W	W W W	WV
Coefficient	1.4	1.3		1.2		1.3	1.4	1.5	1.3			1.4
Maintenance	0.93	0.87		0.80		0.87	0.93	1.00	0.87			0.93
Variation	+0.26	+0.20		+0.13		+0.20	+0.26	+0.33	+0.20			+0.26

[1] b = inactive, M = mating in late March, g = gestation (five months), P = delivery in early September, A = lactation, D = weaning, V = sale for slaughter before Christmas.
[2] Maintenance requirements in housing: M = $55^{0.75}$ × 0.033 = 20.2 × 0.033 = 0.67 MFU/d.

Moreover, the process of gaining/losing weight is clearly inefficient from an economic point of view, as the equivalent of 560 g of barley are required per 100 g of weight gain, while the yield is only 260 g (5.6 kg of barley are needed to gain 1 kg of LW , but the mobilisation of body reserves alone could save 2.6 MFU). In conclusion, it is always preferable to maintain the sheep's LW, and only allow them to lose weight if recovery is possible with very affordable food (e.g. with plentiful spring pasture or summer or winter cereal stubble).

The excess energy intake can be stored as fat to save food for critical periods, but this is not possible with protein, because the body has very meagre protein reserves. This means that rather than an energy deficit, a protein deficit in the diet can have negative effects at all stages of the ewes' production cycle and should be avoided. Protein deficiencies (and mineral deficiencies and stress) can cause ewes to eat wool.

The protein level of the ration also affects the ruminant's voluntary ingestion of food and digestion, due to the needs of microorganisms in the rumen to digest fibre. For this reason, a ration should never have less than 9% of degradable protein. Moreover, providing an adequate level of protein increases the voluntary intake of forages and pasture and hay of poor quality, which could be a profitable feeding strategy.

05 **Gestation (a critical period for quality)**

Nutritional needs after mating can be ignored until the last third of gestation (day 100). From that point, needs increase rapidly to meet the high demands involved in gestation, depending on the number of foetuses (litter size). The figures in Table 1 should therefore be used based on the average number of young and the anticipated birth weight (before suckling of colostrum) (e.g. one lamb weighing 4.0 kg or two weighing 3.5 kg each birth weight).

The last third of gestation (from day 100) is the most sensitive period from the point of view of feeding the sheep, because the increase in needs is linked to a variable decline in intake capacity, which also depends on the type of ration. Rations of poor quality forage (straw) aggravate the problem. For this reason, the best forage should be selected and used during gestation, and care taken with the total concentration of nutrients. High levels of concentrate and poor quality fodder at the end of gestation can lead to vaginal and anal prolapses, especially if the sheep are fat.

Malnutrition at the end of gestation may also lead to other short-term adverse effects in the ewe and lambs (light and weak lambs, gestation toxaemia, lower colostrum production, etc.) as well as in the long term in the lambs (greater fattening and poor conversion, small litter sizes among future ewes, etc.).

Furthermore, there are special nutritional needs at the end of gestation due to the foetus requiring specific nutrients, such as glucose, calcium (Ca) and selenium (Se). A low level of glucose in the lamb's blood, and a high mobilisation of body reserves to cover energy deficits leads to the onset of gestation toxaemia (excess ketone bodies in the blood due to the use of fat as an energy source). Toxaemia is most common in very thin sheep with more than one lamb, or very fat sheep fed with a great deal of straw at the end of gestation. Some breeds, such as the Awassa and the Assaf (with fat tails) also have a predisposition. Moderate overfeeding with high quality protein resistant to degradation in the ruminant is recommended from day 100 of gestation to prevent gestation toxaemia, because the amino acids in the protein produce glucose and also foster the production of high-quality colostrum.

Care must be taken with mineral supplements in late gestation and excess iodine (I) should be avoided because it sharply reduces the absorption of colostrum immunoglobulins (IgG) in the intestines of sheep. Colostrum IgG are critical because they give the lamb protection from birth until they are able to produce their own defences against infection.

For all these reasons, and to provide a safety margin for the estimated nutritional value in gestation rations, the needs calculated using the data in Table 1 should always be considered as the minimum recommended base.

06 **Lactation (a critical period for quantity)**

During lactation, sheep are in the stage with the most needs (in quantitative terms) in their entire production cycle. Sheep's milk production during lactation is very high (including sheep for meat) and depends on the number and vigour of the lambs suckled. In most Mediterranean

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Maintenance requirements increase 10-50% in grazing sheep versus housed sheep, equivalents to 200-300 g/d of barley depending on the type and availability of grass in the pasture.

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The last third of the gestation period is the most critical from the point of view of feeding the sheep. Both pregnancy to lactation should not tolerate deficits exceeding 40-50% of energy needs maintenance.

Photo 3. *Detail of manger and drinking trough for sheep. Author: Gerardo Caja.*

sheep breeds, this production can vary between 1 and 3 L/d and sheep during the first month of lactation, and may continue at between 0.7 and 1.5 L/d throughout the lambs' fattening period (2-4 months).

Estimates suggest that 0.5 to 0.6 litres of milk are needed for every 100 g that the lambs grow (Torre, 1991). In the case of rustic Mediterranean sheep, average milk production for the lactation of 1.2-1.5 lambs per ewe is between 1.4 to 1.7 L/d, allowing an average growth rate of the lambs of 150 to 250 g/d. In practice, this means total milk production amounts to at least 40 to 70 litres for 5 weeks during lactation.

The high nutritional needs due to the milk produced during lactation, which peaks between the second and third week after birth, are partially mitigated by a simultaneous reduction in the milk's fat and protein content, and an increase in the amount of milk produced. For this reason, the average figures in Table 1 must be used for the first and second month of lactation respectively.

However, the onset of nutritional deficiencies in sheep during lactation is unavoidable, but the pathological risks are more limited than those for the end of gestation mentioned above. This is because in this case, sheep significantly increase their intake capacity from birth and depending on milk production, and are able to mobilise their body reserves effectively.

In practice, nutritional deficits above 50% of maintenance needs should not be tolerated in suckling sheep for meat and or deficits of 40% for dairy sheep (Bocquier and Caja 1993; Caja, 1994; INRA, 2010), provided that the ewe is in good physical condition during delivery (the body reserves have not been exhausted during gestation) and its minimum protein and minerals requirements are met. In the case of sheep weighing 50-70 kg, this means a tolerable deficit of 0.2 to 0.4 MFU/d (equivalent to 200-400 g/d concentrates) during lactation, in order to reach weaning without exhausting the body reserves.

07 **Milking (adjusting the ration to body reserves)**

For dairy sheep, milked by machine once or twice daily, it is easier to determine the needs if we know the exact amount and composition of the milk produced. This is one of the advantages of using a net energy system, like the INRA system mentioned above. For protein, it is based on a conversion efficiency of k_p = 0:59 (100 g of total protein in the milk require 170 g PDI in the feed). However, sometimes the quantity and quality of the milk can not be measured with sufficient speed or accuracy, and as such predictive equations are needed for the lactation curve and for standardisation of the milk produced.

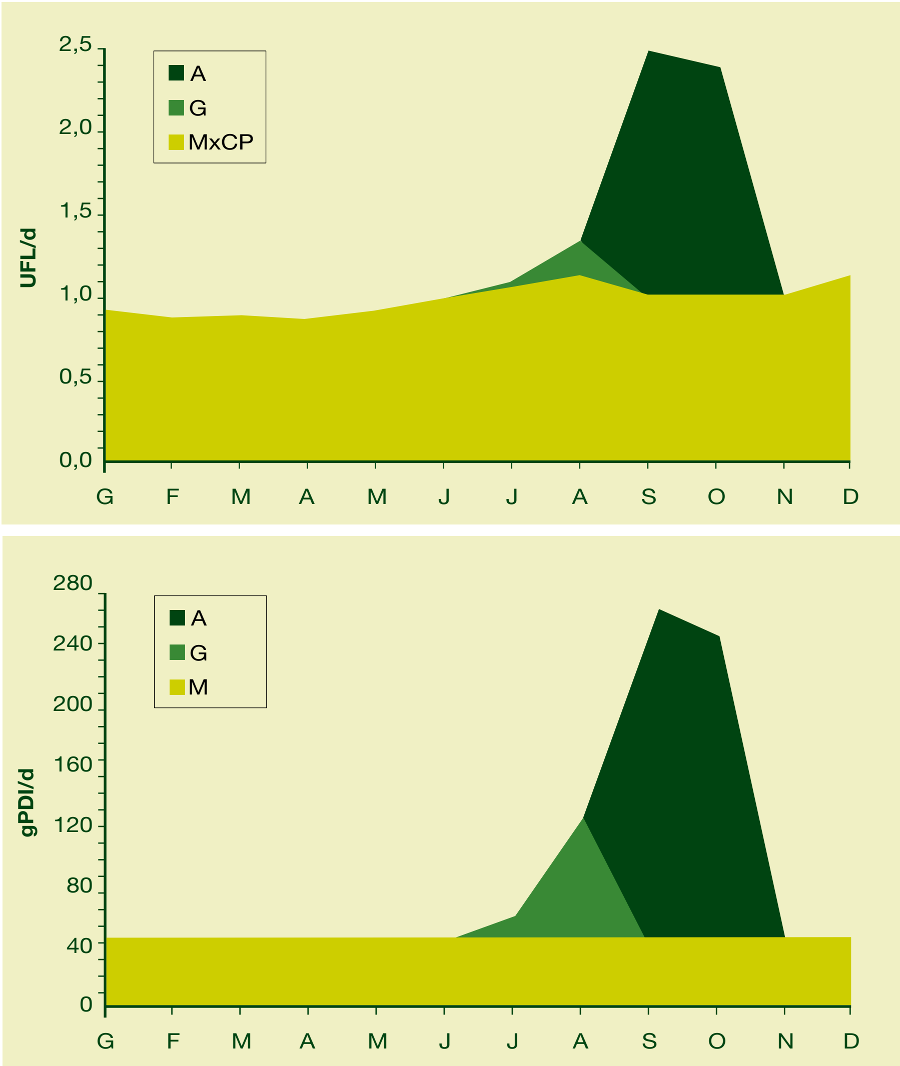

Figure 1. *Changes over the year in the energy needs (MFU/d) and protein needs (PDI g/d) of a Ripollesa sheep (55 kg LW) with a reproductive rate of 1 birth/year in counter season, suckling two lambs (weighing 3.5 kg at birth) slaughtered at 23 kg (90 days old). Needs: M = maintenance; GC = grazing coefficient; G = gestation; A = lactation.*

Some of the most commonly used equations for lactation periods up to eight months (240 d) are:

- Milk production (Y = L/d; t = days; A = milk production level)

$Y = A \cdot 3.75 \cdot e^{-0.008 \cdot t}$

$Y = A \cdot (2.98 - 0.011 \cdot t)$

The values for A vary according to the expected level of milk (400 L = 1.13; 350 L = 1.00; 300 L = 0.85; 250 L = 0.71; 200 L = 0.57; Caja, 2013)

- Composition of milk (G =% fat; P =% protein)

Milk 6%G (0.61 MFU/L) = 0.11 · G + 0.34 (Molina et al., 1991)

Standard milk (0.71 MFU/L) = 0.071 · G + 0.043 · P + 0.22 (Bocquier *et al*., 1991)

Weaning can take place immediately after birth (administering colostrum with a probe or bottle) or after consuming colostrum (when switching to the bottle is more difficult), followed by rearing with artificial milk using buckets with teats or a machine (about 1 kg of powdered milk at a concentration of 220 g/L per 1 kg of weight gain).

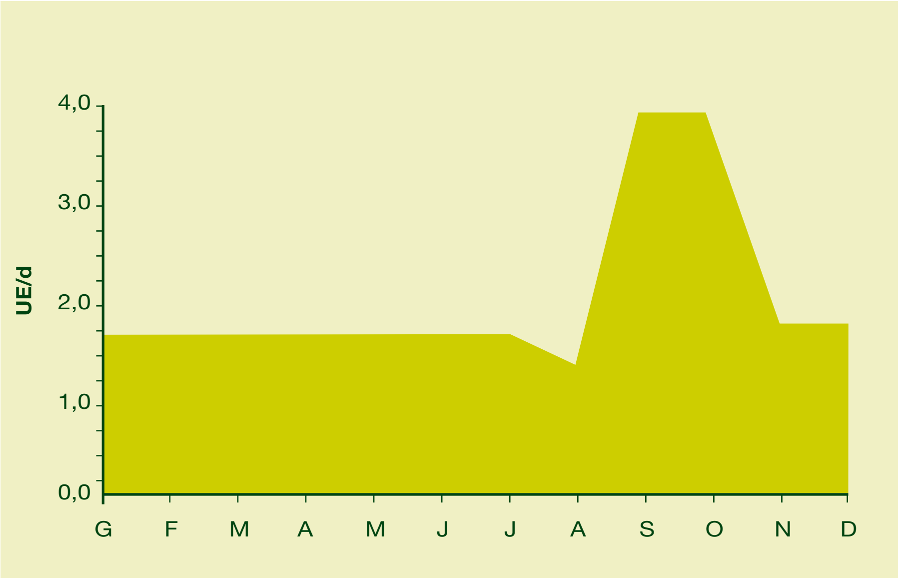

Figure 2. *Changes over the year in the intake capacity (MFU/d) and protein needs (PDI g/d) of a Ripollesa sheep (55 kg LW) with a reproductive rate of 1 birth/year in counter season, suckling two lambs (weighing 3.5 kg at birth) slaughtered at 23 kg (90 days old).*

08 Total needs

Figure 2 shows the total daily needs of a Ripollesa sheep reared for meat using the data in Table 1 and Figure 1.

As is apparent from the curves in Figure 2, the nutritional requirements of the ewe in the example increase (x 2.5 for the MFU and × 6 for protein) as a result of gestation and lactation, with a marked peak in September. As for the PDI/MFU relationship, the values are approximately constant from November to June (48-63 g PDI/MFU), which could be covered with low-quality forage, but they double (from 88 to 105 g PDI/MFU) between August and October, when they reach the nutritional concentrations of very good quality forage or concentrates.

These figures are especially important when there is one single ration for the entire flock, and a basic ration with feed supplements in batches are administered.

Furthermore, if the sheep are to be covered 3-4 months after weaning the lambs, there must be no significant weight loss, or it will be impossible to mate the ewes at the same benchmark weight, which will reduce their fertility and future litter sizes. A weight loss of 5-10 kg would lead to a need to recover about 50 to 100 g/d, equivalent to a supplement of 0.28-0.51 MFU/d (approximately 300-500 g/d of concentrate for 3 months).

09 Intake capacity and body reserves

The feed intake capacity (IC) in the INRA system is defined as the potential voluntary intake of a benchmark food and is expressed in fill units (FU). According to the INRA, the reference food is a grass hay meadow of medium quality (15% protein and 65% digestibility) with unrestricted availability (ad libitum) with a rejection of 10% (1 FU = 1 kg of reference dry grass hay).

Concentrates have no filling effect (FU = 0) but have a substitution effect on forage intake. Forage ingestion must be reduced by an average of 0.4-0.5 FU per kg of concentrate added to the ration. In practice, giving rations with more than 50% concentrate is not advisable because it will reduce the total amount ingested and problems related to subclinical or clinical acidity in the ruminant will start to appear.

Estimating a sheep's IC with the FU system compared to the direct use in kg of dry matter has the advantage of being independent of the food's nutritional value and quality, and depends solely on the sheep's needs and physiological state.

In practice, the IC is expressed in FU by weight (PV kg), the state of body reserves (BC, body condition) and standardised milk production (SMP, L/d), according to following equations:

- Dry ewes or in early gestation:

$IC = (0.104 - 0.007 \cdot BC) \cdot LW0^{0,75}$

- Lactating or milking ewes:

$IC = 0.024 \cdot LW + 0.9 \cdot SMP$ (INRA, 2010)

Table 3. Recommended levels of body condition (BC) determined by palpation in the lumbar region (ribs) during the production cycle of sheep .

Production stage	BC score	Observations
Maintenance	>2.0	Weak muscle and fat cover. Easy palpation of the intervertebral spaces in the transverse and spinous apophyses. The fingers easily pass beneath the transverse apophyses.
Mating	>3.0	Medium fat and muscle covering. Palpation of the intervertebral spaces in the transverse and spinous apophyses only apparent with strong pressure. Difficulty passing the fingers beneath the transverse apophysis.
Gestation (>100 d) Single Multiple	 3.0-3.5 3.5-4.0	This fat and muscle covering. No palpation of the intervertebral spaces in the transverse and spinous apophyses. The fingers cannot pass beneath the transverse apophysis.
Lactation	>2.5	Avoid significant weight loss (deficit > 80% maintenance; BC < 2.0)
Milking	3.5	Avoid highly concentrated rations and BC close to 4.0

1 BC unit = 7-9 kg live weight .

The IC is lower in sheep experiencing their first delivery (-30%), those in the last month of pregnancy (-20%) with higher average temperatures (> 25 °C = -10%) in addition to the negative effect of supplementation with concentrate mentioned above. Figure 3 shows the IC in a Ripollesa sheep suckling two lambs.

Comparison of the IC values with the energy needs (0:52-1:06 MFU/FU) and protein requirements (27-93 g PDI/d) calculated above show the wide variation and the importance of the concentration of nutrients in the dry matter ingested throughout the sheep's production cycle. As a result, the final month of gestation (August) is when nutrient concentrations are at their highest (1:06 MFU/FU and 93 g PDI/FU), at levels close to those of a concentrate. The lactation period (September to November) with 0.60-0.63MFU/FU and 58-67 g PDI/FU could be dealt with using very good quality forage (green ryegrass or alfalfa hay) or reduced contributions of concentrates.

Although the ration administered must ensure an appropriate balance between needs and the supply of nutrients, it is also very important to monitor the body reserves, as the onset of temporary deficits in various stages of the sheep's production cycle is almost inevitable.

Photo 4. *Direct use of corn stubble in winter. Author: Montse Bellet. ATS (Agricultural Training School), Vallfogona de Balaguer.*

A simple way to assess the level of body reserves in the production cycle of sheep is to use the well-known body condition (BC) grade proposed by Russell et al. (1969). The BC grade is determined by palpation according to the state of fattening and muscle development in the lumbar region of the sheep (ribs). Table 3 shows the recommended BC values for the entire production cycle of meat and dairy sheep.

In general, a BC loss of over 0.6 to 1.0 units in sheep for meat and 0.5 units in dairy sheep should not be permitted for a period of 4- 6 weeks. In practice, this means that the sheep must maintain an approximate BC = 3, meaning that it will be necessary to assess the flock's BC at least once a month to achieve a good production.

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The voluntary feed intake capacity (IC) is expressed in fill units (FU) equivalents to kilos of dry matter intake of grass hay meadow or medium quality alfalfa-grass hay.

10 **Useful information**

BOCQUIER, F., BARILLET, F., GUILLOUET, P. (1991). 'Prediction of gross energy content of ewe's milk from different chemical analysis: proposal of an energy corrected milk for dairy ewes' . 12 Symp. Intern. Energy Metabolism of Farm Animals. *EAAP* Publ. 58, 345-348.

BOCQUIER, F., CAJA, G. (1993). 'Recent advances on nutrition and feeding of dairy sheep'. Actes 5e Int. Symp. on Machine Milking of Small Ruminants, Budapest, Maig 14-20. *Hungarian J. Anim. Prod*., 1 (Suppl.), 580-607.
CAJA, G. (1994). 'Valoración de las necesidades nutritivas y manejo de la alimentación de ovejas lecheras de raza Manchega'. In: *Ganado ovino de raza Manchega*, L. Gallego, A. Torres i G. Caja (Eds.), Mundi-Prensa, Madrid, p. 137-159.

CAJA, G. (2013). 'Curso de producción ovina y caprina'. Faculty of Veterinary Medicine, Universitat Autònoma de Barcelona, Bellaterra, Barcelona.

CAJA G., GARGOURI, A., 1995. Orientations actuelles de l'alimentation des ovins dans les régions méditerranéennes arides. Cahiers Options Méditerran. 6:51-64.

INRA (2010). 'Alimentation des bovins, ovins et caprins. Besoins des animaux-Valeurs des aliments. Guide pratique'. Éditions Quae, Versailles, France, 312 pp.

MOLINA, M. P. , CAJA, G., TORRES, A., GALLEGO, L. (1991).' Energía bruta de la leche de ovejas de raza Manchega y bases

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The ratio between nutritional needs and intake capacity varies more by protein (27-93 g PDI/FU) than by energy (0:52-1:06 MFU/FU) throughout the sheep's production cycle. The final month of gestation is when nutrient concentrations are at their highest (1:06 MFU/FU and 93 g PDI/FU), at levels close to those of concentrates, but contributions of more than 50% of concentrate should be avoided.

Photo 5. *Flock. Author: Montse Bellet. ATS, Vallfogona de Balaguer.*

para su estandarización energética.'. *ITEA: Prod. Animal*, 11 (vol. Extra), 277-279.

RUSSEL, A. J. F., DONEY, J. M., GUNN, R. G. (1969). 'Subjective assessment of body fat in live sheep'. *J. Agric. Sci.*, Camb. 72, 451-454.

TORRE, C. (1991). "Características productivas de ovejas de raza Ripollesa en pureza y en cruzamiento industrial con moruecos de raza Merino Precoz y Fleischschaf". Tesi Doctoral. Facultat de Veterinaria. Universitat Autònoma de Barcelona, Bellaterra, Barcelona. 262 pp.

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COSTS OF FEEDING SHEEP FLOCKS IN CATALONIA

Photo 1. *Sheep and lambs grazing natural meadows in spring. Author: Gerardo Caja.*

01 Importance and problems of the price of raw materials

Feed is the most important cost on sheep farms, whether they produce meat or dairy products. The total cost of feed on a sheep farm varies considerably, depending on both the production system and the prices of the raw materials used to make up the ration.

In general, the more intensive the production system, the higher the total feed cost. This is a direct result of the reduction in grazing and therefore the more limited use of natural pastures, crop and stubble fields, which are the staple diet on farms using extensive production systems.

As is well known, the price of the raw materials used in cattle feed are highly volatile due to unstable production and low levels of price elasticity in the demand. Indeed, the volatility of these agricultural commodities has been much more marked in recent years due to a number of factors, including the globalisation of markets, high demand from emerging countries, competition due to biofuel production, major changes in the agricultural policies of developed countries and finally, speculation. In many cases, these factors exert upward pressure on prices, and as such many forecasts agree that in the medium term, the price of raw materials and consequently the cost of animal feed will increase. Figure 1 shows the sharp increase in the price of feed for sheep and lambs in recent years, with stability in the average annual prices for sheep products.

02 Feeding sheep on meat-producing farms

In Catalonia, on most meat-producing sheep farms, the staple food is grazing of the forage resources grown on the farm (primarily alfalfa, annual Italian ryegrass, sainfoin and vetch-barley) and cereal stubble, natural grass and forest areas that either belong to the farm, or are leased to neighbouring farms for this purpose. The grazing schedule varies according to the seasons. In the winter the animals go out once, between approximately 11 am and 5 pm. In the summer, to avoid the hottest hours, they usually go out either once in the evening or for a short time in the morning and again in the evening.

The areas grazed in each season of the year are:

• Areas cultivated with alfalfa, sainfoin, vetch/barley and ryegrass predominate in the spring. The use of areas with other tree species is also common.

• During the summer, the stubble is usually used after harvest of the winter cereals (barley, wheat, oats). In some cases, and increasingly less often, transhumance takes place in the natural pastures of the coastal and inland mountain ranges, and in the Pyrenees. Forage from irrigated land is rarely used for grazing due to the limited profitability for the flock of meat sheep.

• In the autumn, areas cultivated with forage that can no longer be reaped (sainfoin, alfalfa, ryegrass) are grazed, as well as stubble from corn and other irrigated crops. At this time of year, forest areas are used to a large extent, and where they are available, other areas occupied by woody crops (vines, fruit trees, etc.).

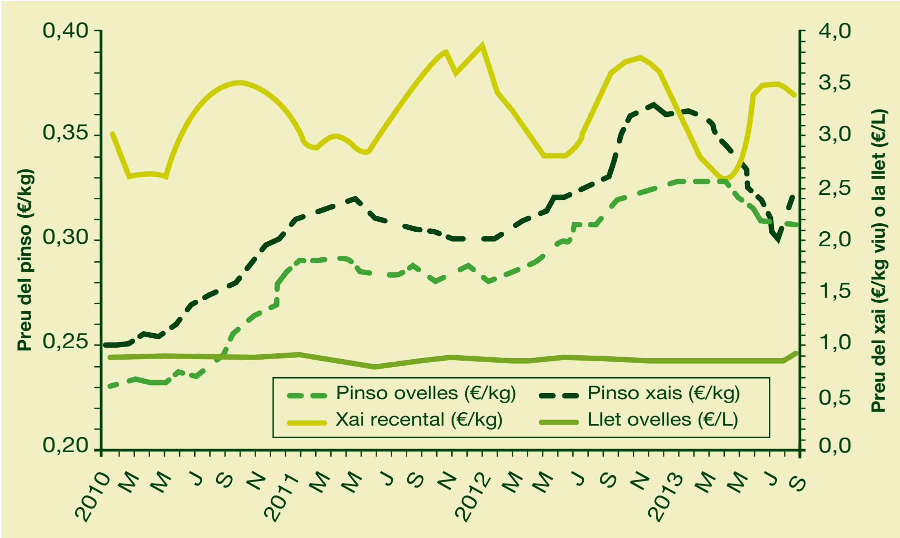

Figure 1. *Prices of feed and sheep products, 2010-13*

• In winter, grazing takes place in areas used for ryegrass crops and in forest areas.

Grazing resources in Catalonia are at their most scarce in the months of late autumn and early winter (December-January) and at the end of the summer (August).

Sheep are usually given a dietary supplement in the pen, as well as straw. This supplement usually consists of cereal grain (very occasionally of legumes), compound feed, farm mixes made with different types of grain, and dried forage. Green or silage forage (pre-dried wet bales or silos) is occasionally given, but to an increasingly lesser extent.

A dietary supplement is given throughout the year in approximately 10% of cases, although the amounts provided are not uniform throughout the year and often vary depending on the animal's physiological condition. The most common involves giving supplements only at certain times, particularly in winter and summer, when pasture areas are at their most scarce.

As mentioned above, the quantity and quality of the supplements must cover the various needs according to the animal's physiological condition. The most common supplements are given at the beginning of lactation, to sheep delivering one lamb (200-300 g of concentrate) and those delivering two lambs (400-500 g of concentrate). Supplements before mating (flushing) are only given occasionally in flocks where mating takes place intermittently. In some cases supplements are also given at the end of gestation, although this is not widespread and in many cases animals reach delivery in poor physical condition, which has negative consequences for the ewes and lambs. .

Feed for the lambs, which are usually reared with the mother and not weaned until slaughter, is based on commercial feed freely available until they are sold. The total average amount of feed consumed by lambs until sale is about 35-40 kg/lamb. The lambs also receive a high volume ration ad libitum composed of straw and/or alfalfa hay. The average weight when sold is 23.3 kg live weight. With an average birth weight of 3.8 kg, the conversion rate is approximately 2.1 kg of feed per kg of live weight.

03 **Feed cost of farms producing sheep for meat**

In a study carried out on flocks of Ripollesa breed sheep (Dkhili, 2012) in Catalonia, with average flock sizes (554 ewes and 20 rams) and moderate litter sizes (1.28 lambs/delivery) and productivity values (1.18 lambs sold/ewe), the average total revenue was 146.8 €/sheep per year, mostly from the sale of lambs (61.8%), followed by subsidies (36.2%). Average total costs were 136.1 €/sheep per year, with feed costs being the most important cost (43.2%), followed by labour costs (40.9%). These costs are in the upper range of feed costs reported by Fantova et al. (2007) on sheep for meat farms in Aragon, with values of 35-63 €/sheep per year. As a result, there was an average net margin of 10.7 €/sheep per year in Catalonia.

Table 1 shows the theoretical annual food requirements of a productive Ripollesa breed ewe with a live weight of 55 kg, delivering an average of 1.3 lambs per year and the litter sizes and productivity levels mentioned above, in grazing conditions (pasture coefficient = 1.25) consistent with the coefficient mentioned by Caja and Gargouri (1995).

Meanwhile, the average amount of supplements given to sheep on these farms is 234 kg of dry forage and 60 kg of feed, which amounts to approximately 160 MFU, of which 60% is forage and 40% is concentrate. Food supplements thereby cover 38% of the animals' energy needs, and the rest (62%) is obtained from grazing.

Figure 2 shows the close relationship between the costs of feeding sheep and their productivity (lambs sold/ewe per year) so that for each extra lamb produced in a year, the feed cost per sheep increases by €19.1.

04 **Feed for sheep on dairy sheep farms**

The production system on dairy sheep farms is much more intensive than on meat farms. The sheep's food needs increase according to the amount of milk and the duration of lactation (150-240 d). In this case, more careful management of the supply needs than in sheep for meat is essential. The amount of concentrated feed provided during lactation is therefore between 0.5-2.0 kg/d depending on

Table 1. Theoretical annual energy needs of a Ripollesa breed sheep.

MFU[1] Maintenance	MFU Mating	MFU Gestation	MFU Rearing	Total (MFU/year)
316.3	7.9	15.1	84.5	423.7

[1] Milk forage unit according to the INRA (2007).

milk production and the availability and quality of forage. Giving an amount of feed exceeding 50% of the total needs is not recommended.

As with sheep for meat, on some of these farms a significant proportion of the feed comes from grazing home-grown forage. The most common grazing seasons are the spring (alfalfa, ryegrass and fallows), summer and autumn (corn stubble), in accordance with the Mediterranean rainfall pattern.

05 **Feed cost of dairy sheep farms**

In a study carried out on flocks of Assaf breed sheep in Castile and Leon (Milán et al., 2014), with average flock sizes of 592 ewes and productivity values of 316 litres of milk per ewe per year, the average total revenue was 327.6 €/sheep per year, mostly from the sale of milk (78.6%), followed by lambs (13.2%). The average total costs were 320.2 €/sheep per year, with feed costs the highest (61.6%), followed by labour costs (18.2%).

The same study quantified the cost of feed to meet the average maintenance needs of herds (26%), needs during mating, pregnancy and lactation (65%) and feeding needs for replacement sheep (9%) within total feed costs. Other studies reported feed costs in flocks of dairy sheep ranging from €123 per sheep (57% of total costs according to De la Fuente et al, 2006), €145 per sheep (68% of total costs according to Mantecón et al, 2006) and €160 per sheep (62% of total costs according to Sánchez et al, 2004).

The result was a profit of 7.4 €/ewe per year and an average net margin of 52.4 €/ewe per year (opportunity costs are not included in this case).

Table 2 shows the theoretical annual food needs of a productive Assaf or Lacaune breed ewe with a live weight of 80 kg, producing an annual average of 0.9 l/d (325 litres per year), delivering an average of 1 lamb per year and litter sizes and productivity rates of 1.5 lambs delivered and 1.2 lambs sold per ewe per year.

La figura 3 mostra una relació força estreta entre els costos de l'alimentació de les ovelles i la productivitat lletera (litres de llet/ovella i any) de manera que, per cada litre produït més a l'any, els costos d'alimentació per ovella augmenten 0,247 €.

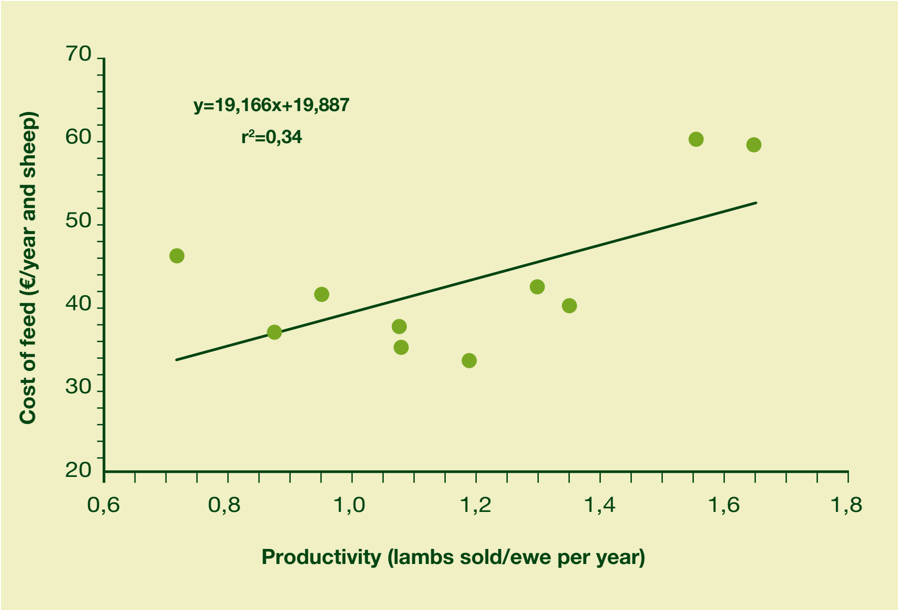

Figure 2. *Relationship between feed costs and productivity of Ripollesa breed dairy sheep farms in Catalonia.*

Given the anticipated price fluctuations for raw materials for animal feed, the calculations show the relationship between food prices and the price of sheep's milk so that dairy sheep farms have zero profit, and a 10% increase in the price of concentrate would have to be offset by a 5.2% increase in the price of milk in order not to incur losses. Similarly, a 10% increase in the price of forage would require a 2% increase in the price of milk. As the prices of feed are related, if we assume that both the price of concentrate and of forage increase by 10%, then the price of milk would have to increase by 7.2% in order not to incur losses.

06 **Bibliography**

CAJA, G.; GARGOURI, A. (1995). "*Orientations actuelles de l'alimentation des ovins dans les régions méditerranéennes arides*".

De la Fuente L. F., Gabiña D., Carolino N., Ugarte E. 2006. The Awassi and Assaf breeds in Spain and Portugal. 57th Annual Meeting of the European Federation of Animal Science (EAAP), Antalya, Turkey (available online).

DKHILI, N., 2012. *El aumento de la prolificidad en el ganado ovino: efectos económicos en las explotaciones y fisiológico-nutritivos en corderas de raza ripollesa*. Tesi de Màster de *l'Instituto Agronómico Mediterráneo de Saragossa*. 147 pp.

FANTOVA, E., PARDOS, L., BRÚ, C. H., BUÑUEL, M., SANTANDER, L., MORENO, J., 2007. "Influencia del coste de alimentación y la productividad por oveja en los resultados económicos de explotaciones ovinas de carne en Aragón. *XXXII Jornadas Científicas de la Sociedad Española de Ovinotecnia y Caprinotecnia (SEOC), Mallorca", p. 117-120.*

MANTECÓN, A. R., VILLADANGOS, B., DÍEZ, P., MARTÍNEZ, Y., LAVÍN, P., 2006. Gestión

Table 2. Theoretical annual energy needs of a Lacaune breed sheep (compared to a meat sheep according to the values in Table 1)

MFU[1] Manteniment	MFU Cobriment	MFU Gestació	MFU Lactació	Total
321.2	6.1	11.6	227.5	566.4
(102%)	(77%)[2]	(77%)[2]	(269%)	(134%)

[1] Milk forage unit according to the INRA (2007); 2 For a lamb weight similar to birth weight.

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The meat sheep farm higher costs of production are feed (43%) and work (41%). The average net profit margin in Catalonia is close to €11/sheep and year.

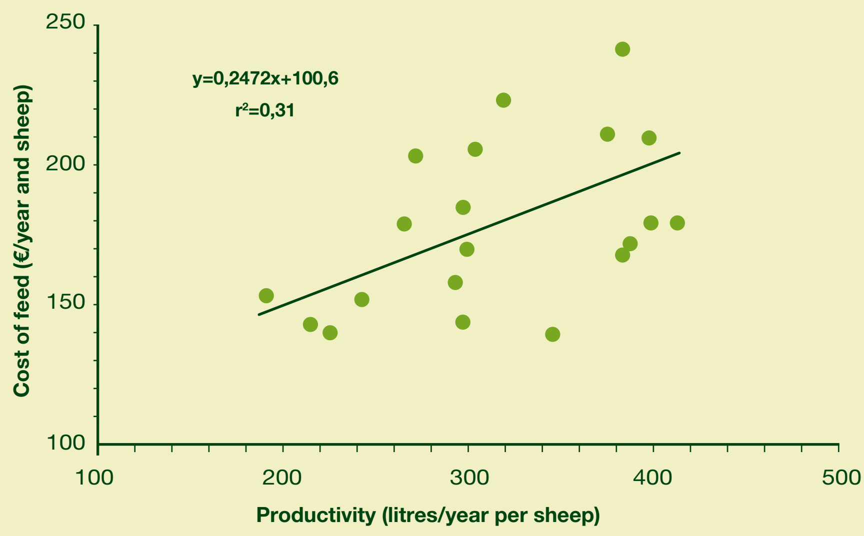

Figura 3. *Ratio between sheep feed costs and productivity on milk sheep farms.*

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The milk sheep farm higher costs of production are feed (62%) and, far less important, work (18%). The average net profit margin is approximately € 52/sheep and year.

económica en ovino de leche. *Mundo Ganadero 191:50-56.*

MILÁN, M. J., FRENDI, F., GONZÁLEZ-GONZÁLEZ, R., CAJA, G., 2013. *Cost structure and economic assessment of Spanish Assaf dairy sheep farms.* Journal of Dairy Science 96 (Suppl. 1):259.

SÁNCHEZ, M., GÓMEZ, J., SANTOS, R., GIL, M. J., DE LEÓN, E., 2004. "Indicadores económicos financieros de la explotación tipo de ovino lechero COVAP". *XXIX Jornadas Científicas de la Sociedad Española de Ovinotecnia y Caprinotecnia (SEOC), Lleida, p. 342-344.*

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SELECTIVE CROP GRAZING WITH SMALL RUMINANTS

Photo 1. *Conditioned-taste-aversion-to-vine Ripollesa sheep breed grazing in El Penedès. Author: Maristela Rovai.*

01 The importance of grazing

One of the most important characteristics of sheep and goats is their ability to take advantage of natural resources in regions where they are scarce and the weather conditions for agriculture are extreme. Various authors have highlighted the importance of small ruminants, not only from the point of view of production, but also from other standpoints, such as their ability to use resources that otherwise would be unused and their contribution to the maintenance of certain ecosystems.

Sheep and goat farms which use by-products of cereal crops (fallow) and shrub pastures are very important agro-pastoral systems in the Mediterranean basin. The lack of rainfall and its variability year on year affects agricultural production and pastureland, and makes planning its use difficult. This can lead to overgrazing, which leads to degradation and loss of plant cover, increasing damage due to erosion and the disturbance of the habitat of the wildlife that live there. It can also lead to undergrazing, which has even worse effects on the environment.

Grazing has a number of beneficial effects on soil, such as increased fertility, acceleration of the nutrient cycle, increased biological activity and animal and plant diversity, a lower risk of forest fires, etc. During grazing, cattle feed on high grass, while sheep seek grass that has resprouted, which is generally rich in protein, which is why using sheep for grazing maintains and improves pastures. For this reason, it is not surprising that over the centuries farmers have produced grazing systems in which livestock has contributed to controlling weeds, in cleared areas, olive groves and orchards.

02 Woody crops and grazing

The major problem with Mediterranean woody crops, such as vineyards and olive groves, which in Spain occupy 27% of the cultivable agricultural land (MAGRAMA, 2013), is soil erosion. This is due to the action of water and wind, as a result of the slope of the land, seasonal rainfall and traditional practices of cultivating uncovered soil.

An alternative with very good practical results that has been proposed is plant cover between rows of crops, thus preventing erosion, improving water infiltration and retention, helping to fix carbon and nitrates, and maintaining production levels similar to those obtained with traditional techniques (Alonso and Guzmán, 2006). Keeping adventitious plants (weeds) under control, especially in the spring, is an important concern for farmers because they compete for water and nutrients, which means that this plant cover must be cut back.

Grazing of plant cover has been considered as an alternative to the traditional system for clearing fields of adventitious plants, because it can reduce the use of labour and machinery, herbicides and compaction of the ground by machinery (Hatfield et al, 2007). Moreover, sheep and goats can prevent damage to woody crops arising from the use of mowers, and even can graze in rainy conditions. Replacing tractors with sheep and goats can reduce the soil erosion caused by agricultural machinery as it does not leave the soil completely bare, and thereby facilitates the growth of vegetation.

Another aspect to consider is that the droppings of small ruminants in the field are good fertiliser for the soil. Due to their shape (pellets) and their moisture level, they are easily and quickly attacked by the microorganisms responsible for the mineralisation and humification of the soil, which leads to its fertilisation. Furt-

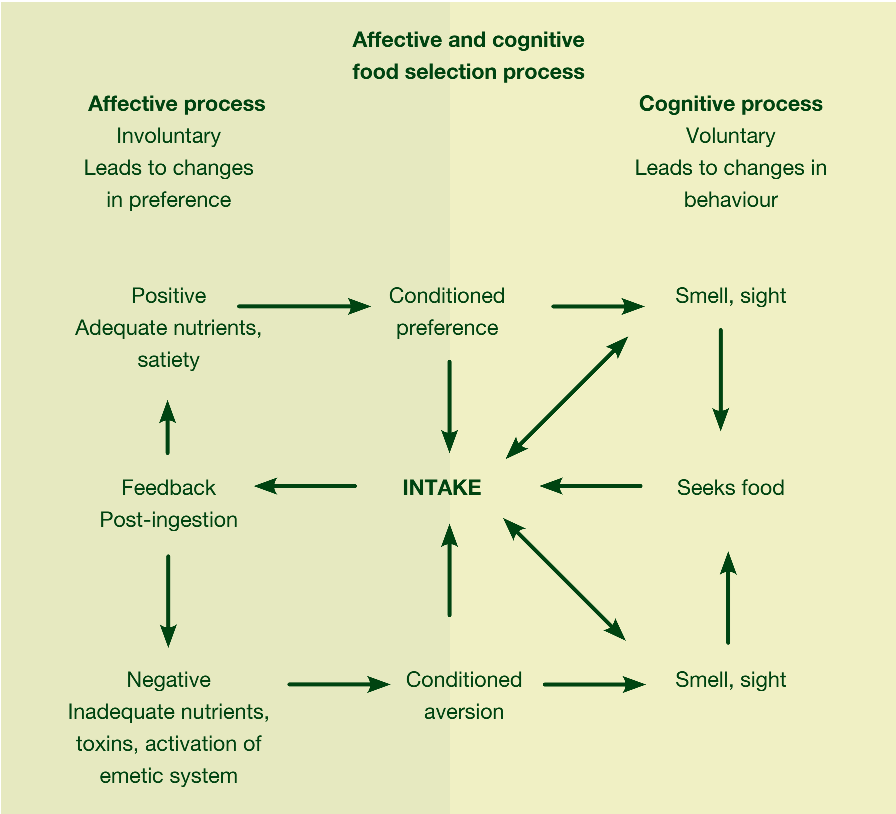

Figure 1. *Diagram of the affective and cognitive food selection process (Howery et al, 1998).*

hermore, the animals scatter them around the field on a more or less uniform basis without damaging the vegetation layer and the microfauna in the soil.

The disadvantage is that the leaves and buds of woody crops are very attractive food for sheep and goats, although this problem could be avoided by using selective grazing techniques.

03 **Selective sheep and goat behaviour**

Small ruminants are able to select their diet from the foodstuffs offered to them, and are more selective than cattle. As a means of adapting to the variation in plants' characteristics (toxicity and nutritional quality) over time and space, animals learn which foods are 'good' and 'bad' through trial and error. This process is known as the 'Affective and cognitive food selection process' (Figure. 1; Howery et al, 1998).

When consuming a type of food, the animal receives feedback post-ingestion which, if positive (it covers its needs, it has a feeling of satiety), gives it a preference for that foodstuff. On the other hand, if the feedback is negative (excess of nutrients or toxins, or digestive problems) this leads to a food aversion; this leads to an increase or decrease in its intake of that foodstuff, as appropriate.

They can thereby 'consciously' select or avoid certain foods based on smell, taste and appearance, leading to changes in their feeding behaviour.

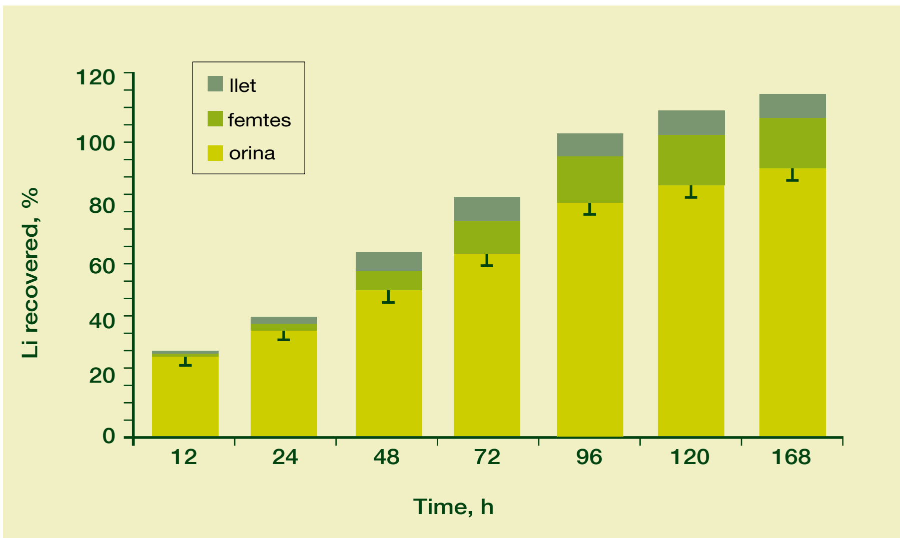

Figure 2. *Cumulative percentage of Li recovered after administration of a dose of 200 mg LiCl/kg LW in goats. (C.L. Manuelian, unpublished data).*

04 **Conditioned aversion to food**

Manipulating animals' food selection process to change their dietary preferences has been called 'conditioned taste aversion' or CTA. CTA is a type of conditioning in which an animal learns to associate a target food (the food to which an aversion is to be established) with a feeling of nausea or gastrointestinal distress caused by a drug (Provenza, 1995).

Lithium chloride (LiCl) is a white water-soluble salt which is used in human medicine and at the correct doses creates feelings of nausea and vomiting in animals, with no other side-effects. Its use in livestock is currently experimental (Manuelian et al., 2010). It is a product that is widely used in CTA due to the good results that have been observed in terms of the level of aversion and its persistence. Moreover, it is easy to measure and administer to animals orally with a worming gun (Photo 1). Lithium is metabolised in a similar way to sodium (Na), and excreted mainly by the kidneys in urine (90%) with a negligible part in stools. To avoid possible contamination by the faeces and urine of treated animals, it is advisable to wait between 9-11 days before letting the animals into the field, or consuming their milk and/or meat (Manuelian C.L., unpublished results), although 66% of the dose is excreted during the first 48 hours (Figure. 2).

In order to establish CTA, the fasted animal is offered the plant to which aversion is to be established, and the appropriate dose of LiCl is administered orally after the animal has ingested

Photo 2. *Conditioned-taste-aversion-to-vine sheep grazing in a El Penedès vineyard in spring. Author: Gerardo Caja.*

an appreciable amount of the foodstuff. It is very important that the target plant is completely new to the animal, i.e. it has never consumed it before in its life; this makes it easier for the animal to establish a more intense and persistent aversion (Burritt and Provenza, 1989).

Conditioned aversion has a close dose-effect relationship due to the degree of discomfort caused by LiCl, i.e. higher doses cause more intense and longer-lasting CTA (Egber et al, 1999). In order to be able to allow flocks to graze on plant cover in fields with woody crops, it is necessary to establish a complete aversion toward that plant, which lasts at least during the period in which the plant cover is used (spring and autumn). With these requirements in mind, an optimal dose of LiCl 200 mg/kg LW for goats and 225 mg LiCl/kg LW for sheep has been established. A study of sheep breeds showed that doses below 225 mg may lead to shorter aversion periods, and the need to administer further doses to the animals, with at least two doses over subsequent months (Table 1).

Table 1. Percentage of sheep requiring two administrations of LiCl according to the dose used and the breed. (C.L. Manuelian, unpublished data).

Breed	Dose of 200 mg LiCl/kg LW	Dose of 225 mg LiCl/kg LW
Manchega	60	20
Lacaune	40	0
Ripollesa	0	0

05 Application of selective grazing to practical cases

05.01 Olive tree

Goats have a big appetite for olive trees because of their 'browsing' feeding behaviour. The study conducted at the Autonomous University of Barcelona found that untreated goats placed in an olive grove with plant cover preferred to eat the olive tree and climb them to reach the highest and most tender parts of the tree (PHOTO 2). However, CTA goats which had been subjected to aversion with LiCl refused to eat olive leaves during all the tests carried out over 14 months, and especially those which had received a dose of 200 mg LiCl/kg LW (AV2).

On average, the untreated (control) goats' contact time with olive trees was 51%, while among the treated goats (AV2) it was only 3% (Fig. 3). The study also showed that AV2 goats did not attempt to climb trees during the tests, indicating little interest in olive trees resulting from CTA.

05.02 Grapevine

The most difficult time of year for controlling plant cover in vineyards is the spring. This is when the stocks sprout and prepare to produce grapes. A study carried out by the Autonomous University of Barcelona established CTA towards the leaves and shoots of vines in Manchega and Lacaune sheep breeds using a dose of LiCl 225 mg/kg LW. During the first year the aversion effect was evaluated in a simulated vineyard (PHOTO 3), which showed how the sheep in the (untreated) control group had a strong appetite for the vine, while the CTA sheep did not consume any leaves at all (Figure 4). In order to provide some insight into managing a CTA flock in the long term, aversion among the same sheep was assessed the following spring. The CTA sheep were moved to a commercial vineyard in the Penedès region to control the plant cover for 10 days (4 h/day under surveillance) in various plots. At the end of this period, because the plant cover was scarce and of poor quality, the sheep occasionally began to consume leaves from the vines, and the aversion was reinforced with another dose of LiCl so that the CTA persisted. However, the consumption of vine leaves was insignificant and did not affect grape production. The experience was repeated the following year in another commercial vineyard in the Penedès region with spontaneous plant cover. On this occasion, the sheep were left in the pasture permanently for 24 h/d and were moved from each field when the plant cover had been grazed (PHOTO 4). Selective grazing led to a 70% reduction of initial plant cover with no effects on grape production.

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Conditioned taste aversion is an interesting tool to control plant cover in woody crops, and compatible with sustainable farming practices.

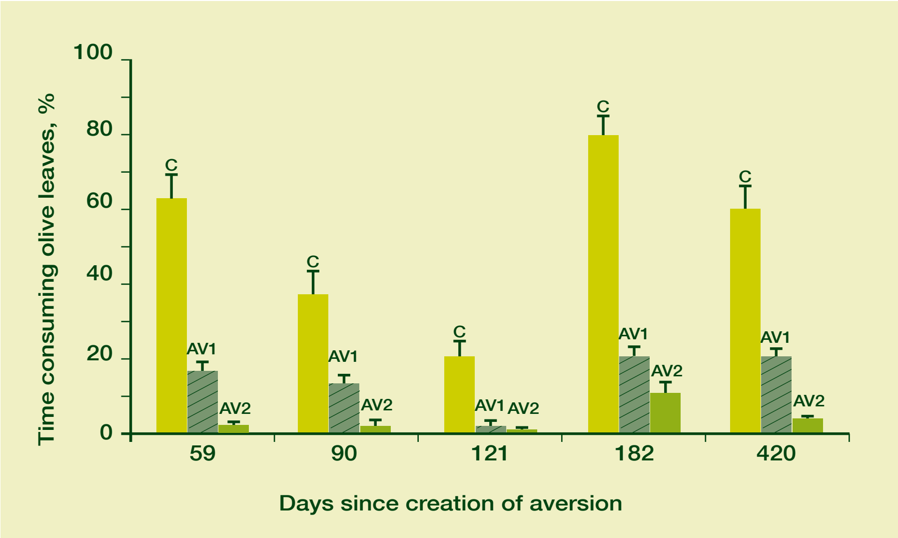

Figure 3. *Percentage of time spent on the consumption of olives in commercial field tests on goats. Each test lasted 30 minutes. The groups were: C: control; AV1: dose of 175 mg LiCl/kg LW; and AV2: dose of 200 mg LiCl/kg LW (C.L. Manuelian, unpublished data)..*

Figure 4. *Consumption of vine leaves in the first year of aversion among Lacaune (Lc) and Manchega (Mn) sheep breeds. Each test lasted 30 minutes. Control groups (Lc-C and C-Mn); Aversion groups (Lc-AV and Mn-AV) (CL Manuelian, unpublished data).*

06 **Conclusions**

Conditioned aversion in sheep and goats is therefore an interesting and feasible tool in practice to control plant cover in woody crops. Aversion must be established the first time that the animal consumes the food, and can be maintained for years using an annual booster dose.

The dosage with the best results (in terms of degree and persistence) is 200 mg LiCl/kg LW in goats and 225 mg LiCl/kg LW in sheep. Good management of the plant cover is also very important, since the animals must have a good quality alternative food (pasture) to prevent accidental consumption of the woody crop needing protection, which could damage the crop.

07 **Bibliography**

ALONSO, A. M., GUZMÁN, G. I., 2006. *Evaluación comparada de la sostenibilidad agraria en el olivar ecológico y convencional*. Agroecol. 1:63-73.

BURRITT, E. A., PROVENZA, F. D., 1989. *Food aversion learning: ability of lambs to distinguish safe from harmful foods*. J. Anim. Sci. 67: 1732-1739.

EGBER, A., LANDAU, S., PEREVOLOTSKY, A., SHLOSBERG, A., BELAICH, A., 1999. *Using lithium chloride to elicit conditioned feed aversion in ewe-lambs: preliminary results with vetch hay*. Options Mediterran., Sér. Cahiers 39:179-182.

HATFIELD, P. G., LENSSEN, A. W., SPEZZANO, T. M., BLODGETT, S. L., GOOSEY, H. B., KOTT, R. W., MARLOW, C. B., 2007. *Incorporating sheep into dryland grain production systems III. Impact on changes in biomass and weed density*. Small Rumin. Res. 67:216-221.

HOWERY, D. L., PROVENZA, F. D., RUYLE, G. B., JORDAN, N. C., 1998. *How do animals learn if rangeland plants are toxic or nutritious?* Rangelands 20:4-9.

MANUELIAN, C. L., ALBANELL, E., SALAMA, A. K. K., CAJA, G., 2010. *Conditioned aversion to olive tree leaves* (Olea europea L.) *in goats and sheep*. Appl. Anim. Behav. Sci.128, 45-49.

MANUELIAN, C. L.; ALBANELL, E., SALAMA, A. K. K.; CAJA, G. (2014). "Effect of breed and lithium chloride dose on the conditioned aversion to olive tree leaves (Olea europaea L.) of sheep". Appl. Anim. Behav. Sci. http://dx.doi.org/10.1016/j.applanim.2014.03.002

PROVENZA, F. D., 1995. *Postingestive feedback as an elementary determinant of food preference and intake in ruminants.* J. Range Managem. 48:2-17.

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PRODUCTION, NUTRITIONAL QUALITY AND HERD LOAD FOR INTERMEDIATE PASTURES IN HUMID AND SUB-HUMID CLIMATES IN CATALONIA

Photo 1. *Flock of sheep grazing in a mixed downy oak woodland and pasture area. Author: Marc Taüll.*

01 **Introduction**

Grass pastures occupy 153,277 ha in Catalonia, which is equivalent to 7.53% of the country's total land area, according to the third edition of the land cover map (2005). However, most of the pastureland is in mountain areas, and mainly in the Pyrenees and Pre-Pyrenees. On agroforestry farms in medium-level mountainous areas with livestock and without access to high mountain pastures, it is necessary to recover areas usable for livestock and improve the farm's feed self-sufficiency. A study organised by the Forest Ownership Centre and carried out by the Centre Tecnològic Forestal de Catalunya found that between 2004 and 2007, 650 ha of forest was cleared for pastureland on privately owned farms under the terms of the Technical Plan for Forest Improvement and Management, with the main tree species in these areas being Scots pine, downy oak and holm oak, with a final average density of 477 specimens/ha^{-1}.

To assess the pasture potential of these cleared areas in intermediate mountain areas, we used a sample with a selection of a total of nine areas (homogeneous areas of pasture), six of which were in humid climates and 3 in sub-humid climates, with a tree canopy cover of between 40% and 60% in all cases. Besides the climate, the areas were defined by the following factors:

- type of pasture: mesic and xeromesic pastures in humid climate areas. Both types of pasture are dominated by grasses which resprout

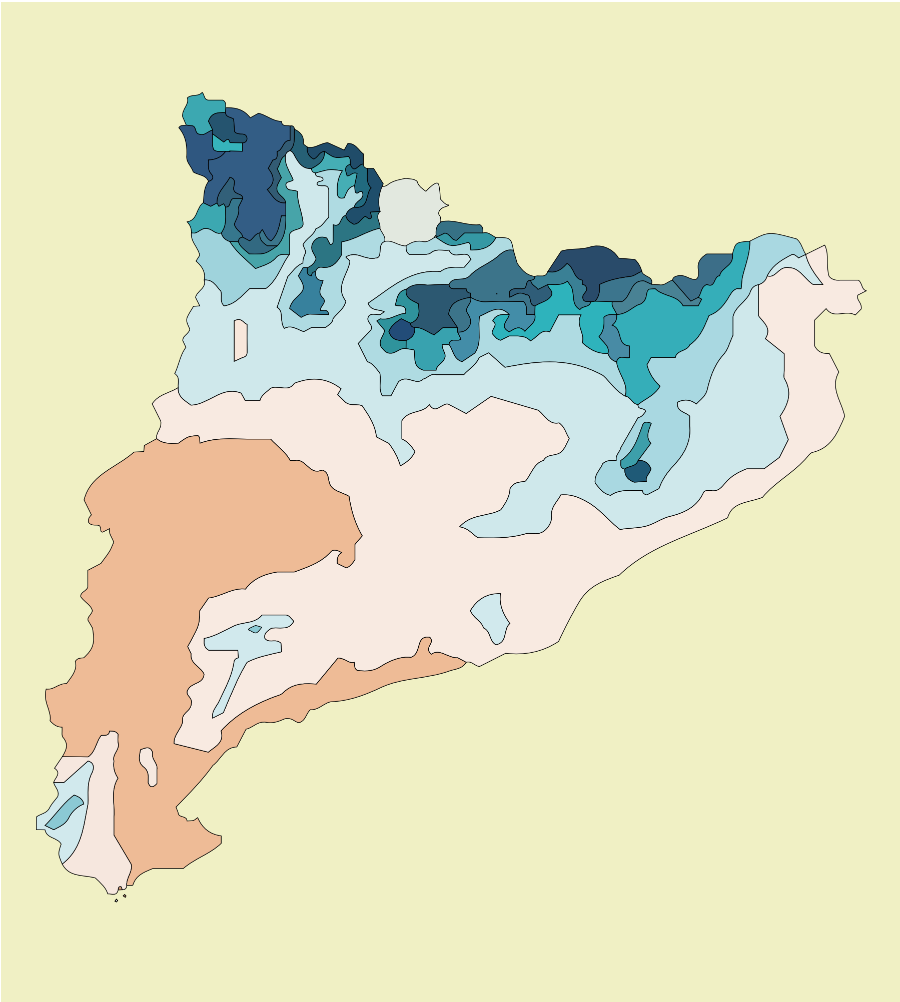

Figure 1. *Climate types in Catalonia. The areas in light blue have a sub-humid climate, while other the areas in blue have a humid climate.*

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Forest converted into pastureland and pastures in humid climates can provide a good stocking density. However, in sub-humid climates, the density is low or very low.

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In areas with a humid climate, mesic pasture types have much higher levels of grass production than xeromesic types. There are no differences depending on the relief.

after grazing by livestock. Mesic grasses grow more deeply in the soil, and consequently are able to retain more water. Indicator species and herbaceous cover are used to distinguish between them on the ground. In a sub-humid climate the pastures are jonquil meadows, or dry pastures dominated by annual herbaceous plants or brachypodia.

- aspect: shady or sunny.

- relief: flat/terraced areas or hillside.

- main tree species: those belonging to the genus Quercus were distinguished from those that did not, due to the acorn production in the former group.

The methodology used in the field was to cut the herbaceous biomass just before the cattle entered the stand. Grass production was determined by drying in an oven at 60°C for 48 hours, and the nutritional value of the pasture was analysed at the Laboratori Agroalimentari de Cabrils (Cabrils Agri-food Laboratory), based on the following parameters: gross protein, net protein, gross fibre, acid detergent fibre, neutral detergent fibre, acid detergent lignin and minerals (phosphorus, magnesium, calcium, potassium). The Animal Units were determined with the help of the Department of Animal Production at the University of Lleida, using specific equations for each type of pasture according to their protein and fibre values. The stocking density was obtained using a notebook completed by the livestock farmer, noting the days of arrival and departure in each stand (with fractions of up to half a day), and the requirements of the animals (based on the INRA method) depending on their physiological stage.

The agronomic management characteristics of the stands selected were: a high immediate load during grazing, a very high consumption of the herbaceous layer in each period of time (with no large patches rejected after grazing by the animals) and tree cover of less than 5%. For stands in a humid climate, rotational grazing also took place (at least three times on each patch between April and November), which could not be guaranteed for the patches in the sub-humid climate, due to their exposure to long-term drought.

02 **Pasture potential of cleared areas**

The main factors that clearly determine the range of forage available in a cleared stand are (in order of importance): climate, type of pasture, relief and predominant tree species.

In areas with a humid climate the stocking density may vary between 0.42 LU ha-1 year-1 and 0.90 LU ha-1 year-1, depending on the other structural factors. In general, converting forest into pastureland in humid climates is advisable because the yield achieved is high.

In areas with a sub-humid climate, the maximum stocking density that can be achieved is around 0.3 LU ha-1 year-1, and it may be almost zero in years of low production. Management of these pastures is difficult, because if it is used for both pasture and crops in years of drought, the pasture does not provide nutrition to alleviate the lack of forage from crops, while in glut years the animals have a vast energy supply in the cultivated areas, and when they come to pasture they may be in very advanced phenological stages with a very low nutritional value. Creating structures of cleared areas for forests in sub-humid climates is therefore not advisable.

03 **Production of pastures**

Annual herbaceous production (kg ha-1 year-1) for different categories of potential pasture is shown in the Table. Production in areas with a direct effect of light (between trees) is clearly higher than in areas under trees in all cases. In humid climate regions, mesic pasture types have significantly higher grass production levels than xeromesic types ($p < 0.000$). However, there are no differences in production between flat and terraced areas and hillside areas.

There are also no significant differences between production according to aspect (sun/shade). A careful analysis of the data shows that production peaks in sunny areas in the spring, while in the shade production is fairly constant throughout the entire growing season.

Acorns are produced every two years, and production can be quite high in sunny areas. As a result, in the three-year period that was monitored, acorn production in the various stands fluctuated between 140 kg ha-1 and 1,583 kg ha-1. Sampling after the passage of livestock quantified the efficiency of use (acorns eaten by the livestock) at around 65%.

In sub-humid climates grass production was always less than 2,500 kg ha-1 year, with strong annual fluctuations. In years with little rainfall, production is highly seasonal and only one passage of livestock through the stand was possible.

04 **Nutritional quality of pastures**

The relief is a key factor explaining the difference in quality for some agronomic mana-

TYPE OF CLIMATE	TYPE OF PASTURE	PHYSIOGRAPHIC FACTORS	DOMINANT SPECIES *	STOCKING DENSITY (LU ha^{-1} $year^{-1}$) **	PASTURE POTENTIAL
HUMID	Mesic	Flat / Terraced	Oak	0.74 - 0.90	A1
		Flat / Terraced	Non-oak	0.74 - 0.80	A2
		Hillside	Oak	0.60 - 0.82	B1
		Hillside	Non-oak	0.60 - 0.72	B2
	Xeromesic	Flat / Terraced	Oak	0.60 - 0.73	C1
		Flat / Terraced	Non-oak	0.60 - 0.63	C2
		Hillside	Oak	0.42 - 0.63	D1
		Hillside	Non-oak	0.42 - 0.53	D2
SUBHUMIT	Dry pasture	Flat / Terraced	Oak	0.00 - 0.30	E1
		Flat / Terraced	Non-oak	0.00 - 0.20	E2

* The dominant species factor is taken into consideration due to the contribution of acorns; the effect of the dominant species on the herbaceous layer is not considered.
** For areas with predominant oak species, apart from the sampling performed, we considered an increase in stocking density of between 0.00 to 0.10 LU ha-1 year-1 compared to stands where the genus Quercus is not predominant.

Table 1: *Structural factors with the greatest impact on the stocking density of a stand. The potential of the stands is listed in decreasing order according to their stocking density.*

TYPE OF STAND	PASTURE POTENTIAL	OVERALL GRASS PRODUCTION (kg ha^{-1} $year^{-1}$)	PRODUCTION UNDER TREES (kg ha^{-1})	PRODUCTION BETWEEN TREES (kg ha^{-1})
Humid climate, mesic pasture, flat/terraced	A1; A2	4.151 ± 227 a	2.911 ± 297 a	4.919 ± 329 a
Humid climate, mesic pasture, hillside	B1; B2	4.304 ± 313 a	2.696 ± 341 a	5.388 ± 726 a
Humid climate, xeromesic pasture, flat/terraced	C1; C2	2.543 ± 464 b	2.315 ± 126 a	3.038 ± 101 b
Humid climate, xeromesic pasture, hillside	D1; D2	2.456 ± 190 b	2.092 ± 120 b	3.562 ± 218 b
Sub-humid climate, dry pasture, flat/ terraced	E1	< 2.500		

Table 2. *Annual herbaceous production under trees and between trees (average for the years 2009, 2010 and 2011 ± standard error) according to the pasture potential of each type of cleared area. Different letters indicate significant differences between the types of stand for the variables concerned.*

TYPE OF STAND	PASTURE POTENTIAL	ENERGY VALUE (AU ha^{-1})	AREAS BETWEEN TREES (AU ha^{-1})	AREAS UNDER TREES (AU ha^{-1})
Humid climate, mesic pasture, flat/terraced	A1; A2	0.65 – 0.70	0.68 – 0.75	0.60 – 0.68
Humid climate, mesic pasture, hillside	B1; B2	0.55 – 0.60	0.55 – 0.62	0.50 – 0.55
Humid climate, xeromesic pasture, flat/terraced	C1; C2	0.54 – 0.60	0.54 – 0.60	0.54 – 0.60
Humid climate, xeromesic pasture, hillside	D1; D2	0.50 – 0.56	0.50 – 0.56	0.50 – 0.56

Table 3. *The overall average energy value, AU ha-1 for all the pastures during the growing season for 2009 and 2010 for areas under trees and between trees, according to types of pasture potential.*

TYPE OF STAND	PASTURE POTENTIAL	GP (%sms)	DP (%sms)	GF (%sms)	ADF (%sms)	NDF (%sms)	ADL (%sms)
Humid climate, mesic pasture, flat/terraced (herbaceous layer)	A1; A2	18.43	12.38	22.15	28.31	47.20	5.19
Humid climate, mesic pasture, hillside (herbaceous layer)	B1; B2	15.72	9.96	25.48	32.47	52.17	4.68
Humid climate, xeromesic pasture, flat/terraced (herbaceous layer)	C1; C2	12.32	7.77	27.08	36.30	56.65	5.61
Humid climate, xeromesic pasture, hillside (herbaceous layer)	D1; D2	11.44	7.22	26.99	34.93	57.29	5.51
Acorn (fruit)		6.61	5.30	5.85	10.20	17.19	4.17

Table 4. *Mean protein and fibre values for 2009 and 2010, weighted according to the tree coverage of the stand, and the average for all the grazing during the growing season.*

gement conditions and types of pasture. In mesic pastures, areas on flat/terraced land therefore have a significantly higher quality than hillside areas ($p < 0.048$). In xeromesic pastures, the quality values of the pastures are slightly better for flat areas than for hillsides, although the differences are not significant. The nutritional quality of the grass does not differ according to aspect.

The grass under the canopy has a slightly higher proportion of fibre than the grass in open areas ($p < 0.146$).

The acorn values show how the fibre content is low (lower than in grass), but also how its protein provision is very good (greater than the herbaceous layer). With this nutritional quality, the energy provided by acorns may be around 0.5 kg AU kg-1, a similar value to the levels mentioned by authors who have worked on cleared areas in south-western Spain. The highest level of acorn production found (1,583 kg ha^{-1}), with an efficiency of use of 65%, and the values of protein and fibre in the table can give a stocking density ranging between 0 and 0.10 LU ha^{-1} $year^{-1}$.

Photo 2. *Nursing sheep, grazing with their lambs, in a mixed downy oak woodland and pasture zone. Author: Marc Taüll.*

Photo 3. *Flock of sheep and some goats grazing in a slope. Author: Marc Taüll.*


Photos 4 and 5: *Sheep grazing in a mixed downy oak woodland and pasture zone. Author: Marc Taüll.*

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The energy value of the pasture is between 0.50 and 0.70 AU ha^{-1}, depending on the pasture potential.

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In areas with a humid climate, mesic pasture types have much higher levels of grass production than xeromesic types. There are no differences depending on the relief.

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The quality of the pasture in flat areas is higher than on hillside areas.

05 **Further reading:**

CASAS, C.; MARCÉ, A.; PLA SANZ, A. (2012). "Producción de pastos herbáceos en el municipio de Tavertet". *Actas de la LI Reunión Científica de la SEEP*, p. 453–460. Pamplona.

LÓPEZ–CARRASCO, C.; ROIG, S. (2007). "Efecto de la disposición espacial del arbolado sobre los pastos herbáceos en una dehesa: producción de materia seca". *Actas de la XLVIII Reunión Científica de la SEEP*, p. 565-571. Editorial Neiker, Vitoria-Gasteiz.

TAULL, M.; CASALS, P.; SEBASTIÀ, M.T. (2005). "Valoración de los recursos pastorales de la comarca de la Alta Ribagorça (Pirineos Centrales, Catalunya): repercusión sobre el proceso de conversión a ganadería ecológica". Pastos XXXV (1): 59–76. http://polired.upm.es/index.php/pastos/article/view/1699/1701

06 **Thanks to**

Forest Ownership Centre.

07 **Author**

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OFFICIAL ANIMAL FEEDING CONTROL PROGRAMME

Photo 1. *Ewes in Prat de Boldú. ATS (Agricultural Training School), Vallfogona de Balaguer. Author: Montse Bellet.*

Regulation (EC) No 178/2002 of the European Parliament and of the Council laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety, aims to **ensure a high level of protection of human health** and of the interests of consumers. The tools to be used include the development by the Member States of a **system of official checks** covering all stages of the food chain.

This same regulation defines **feed** as any substance or product, including additives, whether processed, partially processed or unprocessed, intended to be used for oral feeding to animals. The term **feed** can therefore include raw materials, additives, premixes, compound feed and medicated feed.

Regulation (EC) No 882/2004 of the European Parliament and of the Council on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules, establishes the standardised European Union framework for the **organisation of official checks**, which must be implemented on a scheduled and regular basis in all stages of the feed chain and must be based on the risk categorisation of each establishment.

In Catalonia we have established the **Official Animal Feeding Control Programme (AFCP)**, which takes into account the regulatory requirements for the production and marketing of feed, as well as:

- Alerts detected and actions taken by the rapid alert system for food and feed.
- The recommendations of the European Commission and the Food and Veterinary Office of the European Commission.
- The agreements of the National Coordination Commission on animal nutrition by the Ministry of Agriculture, Food and the Environment.

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All DAAM (Ministry of Agriculture, Livestock, Fisheries, Food and Natural Environment) initiatives aim to improve the situation in the animal feed sector and consolidate its strong presence in the country.

Photo 2. *Vaccination. Prat de Boldú. ATS, Vallfogona de Balaguer. Author: Montse Bellet.*

- The recommendations of DAAM internal audits.

- Studies and other publications by official and renowned bodies.

The scope of application of the AFCP includes **two subprogrammes:**

1. The **Programme for checks at establishments** checking compliance with Annex II of Regulation (EC) 183/2005 concerning feed hygiene and sampling at the following establishments:

- Manufacturers, including livestock farms that produce feed for the needs of their own farm and which use additives or premixes other than those from silage.

- Intermediate establishments

- Carriers

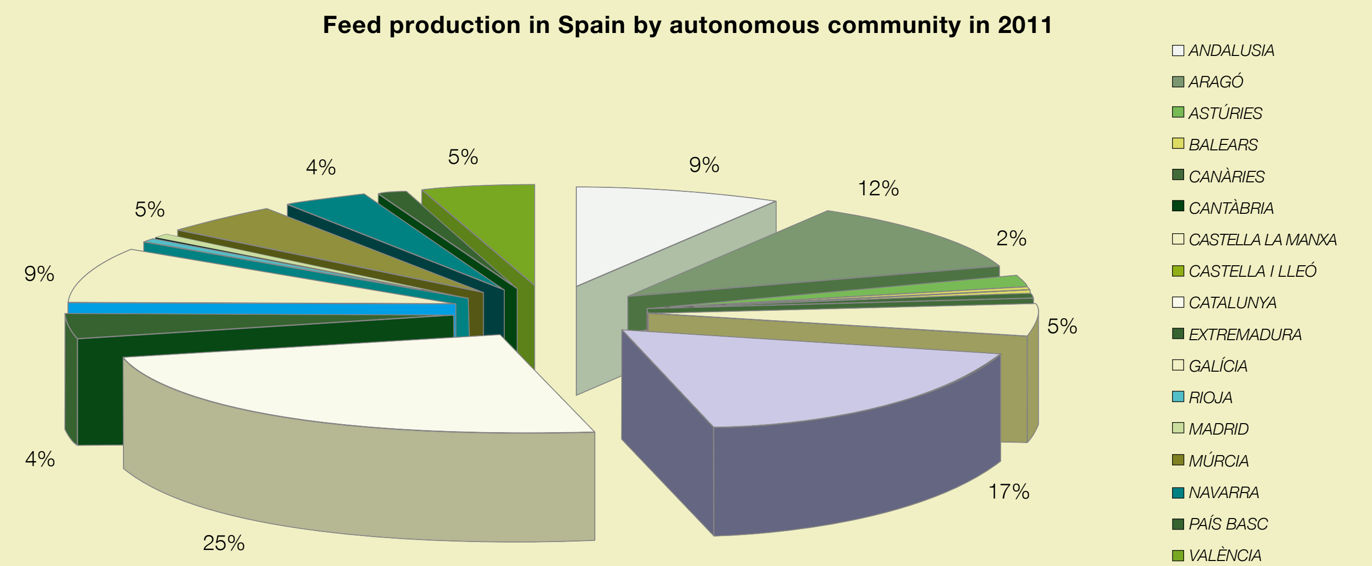

Figure 1. *In Catalonia, the production of feed for pigs, poultry and cattle accounts for more than 90% of the total; the remaining 10% is distributed among pets, rabbits, sheep/goats, equines and others, in that order.*

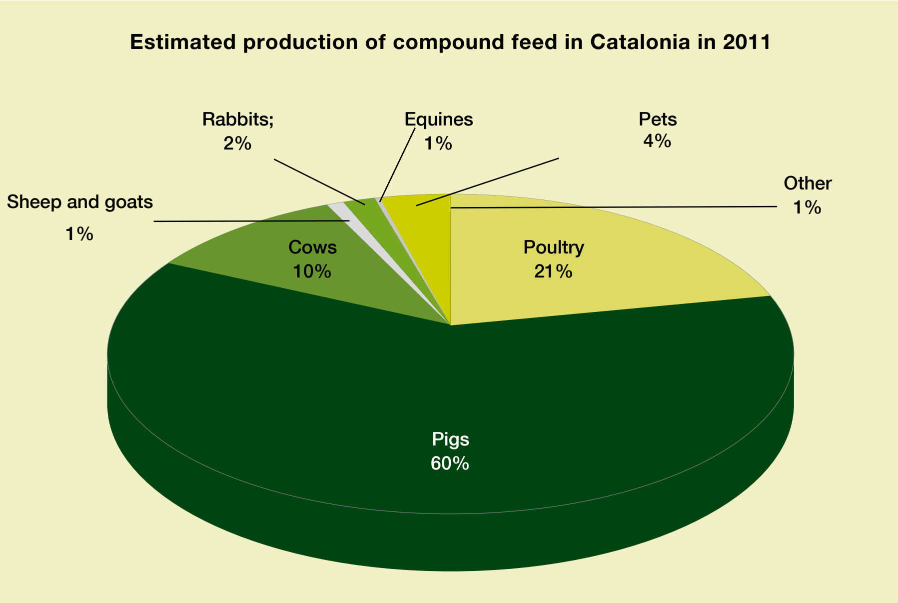

Figure 2. *Source: DAAM (Ministry of Agriculture, Livestock, Fisheries, Food and Natural Environment).*

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In Spain as a whole, Catalonia is the top-ranked autonomous community in terms of the volume of feed production with 25%, and within the EU, Spain is the third largest producer of feed behind Germany and France.

Photo 2. *Prat de Boldú. ATS, Vallfogona de Balaguer. Author: Montse Bellet.*

2. The **Programme for checks at livestock establishments**, checking compliance with Annex II of Regulation (EC) 183/2005 and sampling. This takes place on farms.

In practice the AFCP makes around **900 inspections every year** all over Catalonia, as well as those made as a result of a complaint, a food alert or any other situation where it is considered necessary.

The **analysis** carried out on samples collected from the inspections, include the tests included in Directive 2002/32/EC of the European Parliament and of the Council of 7 May 2002 on undesirable substances in animal feed, as well as microbiological tests and those for genetically modified organisms.

Finally, it should be pointed out that all DAAM initiatives aim to improve the situation in the animal feed sector and consolidate its strong presence in the country. In Spain as a whole, Catalonia is the top-ranked autonomous community in terms of the volume of feed production with 25%, and within the EU, Spain is the third largest producer of feed behind Germany and France.

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THE INTERVIEW

Francesc Batalla Camarasa
President of the High Quality Sheep and Goat Producers Association of Catalonia.
Balaguer (Noguera).

"THE ADVICE OF OUR NUTRITION EXPERT IS ESSENTIAL FOR THE FARM"

Excerpt from the interview published on www.ruralcat.net

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Francesc Batalla has a degree in Business Science and has worked in the sheep meat sector for over thirty years. He has been president of the President of the High-Quality Sheep and Goat Producers Association of Catalonia (APROC) since 2008.

Food is one of the most decisive factors in the success of a livestock farm, because it affects both product quality and the viability of the business. In this interview we talk to Francesc Batalla, president of the Sheep and Goat section of APROC, about a feeding model based on local products and innovation.

When and why was APROC founded?

The Association was founded in 2008 and we launched it at the San Miquel Fair in Lleida, at a ceremony that was attended by the then Minister of Agriculture and Livestock, Joaquim Llena.

There were various reasons that led us to form the APROC, but the primary one was to create a quality product and a brand to differentiate it from the rest.

In Catalonia, three out of every four sheep that are eaten are from elsewhere in Spain, Europe and even other parts of the world; it is very difficult to determine the traceability. This meat is not consumed as much as others for several reasons – for example because the price makes it expensive or because you can't do as many barbecues any more or because people are not used to cooking it in other ways.

Furthermore, if a consumer has had a bad experience, when comparing it, they do not have a brand to avoid or another one to change to; so they feel cheated or deceived and stop consuming.

We want to change all that using a brand they can trust. We offer a local product with complete traceability, full identification, high-quality, with all the necessary health guarantees which is adapted to the tastes of local consumers. We give consumers the security that they cannot find anywhere else.

How did you do it? What are the members objectives and requirements?

There are currently nine livestock farmers, all from Les Terres de Ponent (The Western Lands) of Catalonia. We all had sheep before we formed the association but we established certain requirements, including the genetic base and the food. That was the only way we would achieve the same flavour and the same texture and quality of product.

The genetic base we chose was a cross of the Lacaune and Xisqueta breeds. The first one has very good meat composition and the second one is local and rustic, but has more fat. Crossing them gives meat with just the right amount of fat and less cholesterol. It also gives fast-growing lambs which on average reach 12-13 kg/channel when they 65-70 days old and they are suckled until they are 40-45 days old. So the meat doesn't have much fat and it is very tender, which are two highly prized qualities in our market.

Meanwhile, feed has been a very important factor...

What were the feed criteria you established to obtain a product like "our lamb" and how did you do it?

The success of our lamb depends a great deal on the feed that the lambs receive. That's why the quality is very important. Our feed is based on cereals, including wheat, barley, corn and oats. If the client wants, we have also carried out a study so that we can offer GM-free food.

Furthermore, our sheeps' feed is based primarily on the production from each livestock farm. On the farms we normally produce forage from vetch, oats and alfalfa; and sometimes, but only occasionally, from sainfoins and triticale. Our crops are conventional.

"At the moment, in order to be competitive when selling a product and obtaining a greater profit margin, farmers can only try and cut production costs. In recent years the prices of forage and cereals have risen sharply, and consuming our own local produce has helped us obtain a margin"

How has the influence of feed on production costs and the sale price changed in recent years? What advantages does the APROC have in this area?

At the moment, in order to be competitive when selling a product and obtaining a greater profit margin, farmers can only try and cut production costs. In recent years the prices of forage and cereals have risen sharply, and consuming our own local produce has helped us obtain a margin.

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