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Fattening lamb nutrition. Approaches and strategies in feedlot

J.M. Bello[a,*], A.R. Mantecón[b], M. Rodriguez[c], R. Cuestas[a], J.A. Beltran[d], J.M. Gonzalez[e]

[a] NANTA S.A. Ronda de Poniente, 9. 28460 Tres Cantos, Madrid, Spain
[b] IGM-CSIC-ULE. Finca Marzanas, 24346 Grulleros, León, Spain
[c] Departamento de Ciencia Animal, Universidad Politécnica de Valencia, Camino de Vera, Apdo 22012, 46071 Valencia, Spain
[d] Departamento Tecnología de los Alimentos. Facultad de Veterinaria. Miguel Servet 177-50013 Zaragoza, Spain
[e] Gabinete Técnico Veterinario S.L. Isla de Conejera s/n. 50014, Zaragoza, Spain

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ABSTRACT

Several kinds of lamb are currently being produced in the Iberian market and all of them require different feeding strategies. Gender, season of the year, genotype, fattening score and priorities should be kept in mind when planning farm management to achieve not only a good product but also good profitability. Despite the great variability in fattening lamb trials, we can predict technical and economic performance from the initial and final body weight, depending on the sex, genotype and season.

1. Introduction

The sheep and goat meat industry share in Spain accounts for 6.4% of final livestock production and 2.4% of final agricultural production (Rodriguez et al. 2013). In economic terms this means 979.8 million euros.

The marketing of 9,705,178 lambs slaughtered in 2014 in Spain (MAGRAMA, 2014) mainly takes place through lamb typing and classification centres. While some of them only carry out the work of purchasing and classifying (15-20 last days before slaughtering), there are others that fatten lambs for longer periods of time (Bello, 2015).

Several factors linked to feeding, production systems and health influence both performance and meat quality (Beriain et al., 2000a,b; Beauchemin et al., 1995; Terlouw et al., 2008; Kadim et al., 2008; Lloyd et al., 1980; Priolo et al., 2002; Sañudo et al., 1998a,b).

This paper takes a practical approach to the nutrition of feedlot lambs in order to adapt the guidelines from current nutritional models (INRA, 2007; National Research Council, 2007; FEDNA, 2008) to the commercial conditions on this kind of farms.

In addition, some studies on the influence of different aspects (such as genotype, season of the year, sex, initial and final body weight and feed energy) on performance are submitted.

Finally, all these data collected from current farms allow us to implement a tool to better predict and simulate technical indexes and economic results.

2. Kinds of lamb produced in Spain. Production targets

Different kinds of lambs that require differentiated nutritional criteria are produced in the Iberian market (Alcalde and Sierra, 1993; Ruiz Mantecón and Bermudez, 1991). To this end, animals from dairy sheep farms are slaughtered as suckling lambs, producing small carcasses. These animals have been fed almost exclusively on breast milk or milk replacer (animals from 9 to 14 kg in body weight and 5–7 kg of carcass). Concerning this kind of small carcasses, lambs from meat production farms slaughtered at a low body weight and fed on milk and feedstuffs (from 14 to 21 kg body weight and carcasses from 7 to 10 kg) can also be included in this classification. On the other hand, animals from meat production breeds are grown in intensive conditions, reaching weights in line with consumer demand (Tejada et al., 2006) and also depending on breed allometric parameters. In this case, several "genotypes" (although only a low percentage of breeders are logged into the genealogical registration, according to their breed and their ability to produce meat), such as "heavy" genotype

* Corresponding author.
E-mail address: jm.bello@nutreco.com (J.M. Bello).

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Table 1
Figures of different genotypes of lambs slaughtered in Spain in 2013.Source: MAGRAMA/ICEX.

CARCASS WEIGHT	GENOTYPE/BREED	FEEDING	AMOUNT OF ANIMALS
Less than 7 kg	Milk and local breeds	Breast milk/MR	2.293.875
From 7 to 10 Kg	Local Meat	Breast milk/feed stuffs	1.107.138
From 10 to 13 Kg	"Light"	Comp.Feed and straw	3.750.719
More than 13 Kg	"Heavy"	Comp.Feed and straw	2.134.684
Exportation (2013)	"Heavy" (males)	Comp.Feed and straw	921.032

("Merina", "Manchega" and local breeds crossed with heavy breeds, slaughtered at 28–32 kg of body weight and producing carcasses of 13–15 kg) and "light" genotype ("Rasa" and "Segureña" breeds, producing lambs slaughtered at 24–28 kg of body weight and 10–13 kg of carcass) may be considered. In this sense, Iberian lamb meat consumption can be considered to a great extent covered by these two genotypic groups, which require different nutritional strategies.

In addition, an emergent market is developing: the "export market", mainly based on fattened male lambs with heavy body weight for export, alive or in carcass, to Muslim countries.

Figures for each of these different markets are detailed in Table 1. (Slaughtered Lambs in 2014. MAGRAMA, SPAIN).

Animals from these three groups are raised on intensive farms with lambs collected from different sources. All of this requires a special diet adapted to these conditions.

3. Different types of feed

Normally the main purpose of these farms is the fattening and classification of lambs for sending to the food chain. Their feeding system consists of supplying ad libitum compound feed and straw. Feed is currently supplied automatically and straw, manually.

Depending on the working priority of the farms, they may be classified as follows:

- Classification farms – Lambs are collected, fattened and then classified by body weight (sometimes also by sex) in order to be slaughtered within 21 days. These farms usually provide only compound feed throughout the process (normally one product).
- Fattening farms – Animals are purchased very young, just weaned, normally at less than 20 kg of body weight. They are classified and then fattened up to the slaughter body weight. Sometimes in spring, grazing lambs, fed only on forage, are purchased at different body weights depending on rainfall conditions and the amount of grass in the fields. In all cases, animals stay on the farm for more than 3 weeks. Mixing animals from different areas intensifies and diversifies the microbial load, which favours digestive and respiratory pathology linked to these farms (Nash et al., 1997; Luzón and De las Heras, 1999). Consequently, two or three different feeds are supplied: adaptation feed (sometimes a starter to promote early feed intake in young animals, or a high fibre content feed in order to adapt the forage diet to the concentrated one), medicated feed (if required by veterinary prescription) and current growth feed. In addition, some farmers may sort the animals into male and female groups, with different nutritional requirements (FEDNA, 2008), so feed management becomes more difficult due to all these circumstances.

Table 2
Average nutritional values in lamb feed (Iberian market from 2001 to 2015 database). Energy content expressed in UFC according to feed evaluation system NANTA-CSIC (based on INRA 2007 equations). Source: NANTA S.A.

NUTRIENT	FEED CONTENT
% Crude Protein	15%–20.4%
% Crude Fibre	3.1%–5.9%
% Crude Fat	2.9%–4.5%
% Ashes	5.1%–7.4%
UFC (Net Energy)	0.94–1.04

Based on statistical data from a database of 127 different feeds for lambs (NIR analysis and label information) sold in Spain and Portugal (2001–2015) involving 39 firms, we drafted Table 2, showing the average nutritional profiles of lamb feeds currently manufactured in the Iberian market.

A similar classification, where predictable performance indexes are available, has been set up by the FEDNA (Table 3).

Cereals and soya bean meal are the raw materials most used in lamb compound feed composition (FEDNA, 2008). Current feed industry by-products are barely used. Useful information on suitable use of ingredients in compound feed formulation for lambs is available on the FEDNA website (www.fundacionfedna.org).

For the current lamb genotype, the nutritional contents in crude protein (% CP) and energy (UFC according to INRA, (2007) feed evaluation system) of different feeds are shown in Table 4.

Nevertheless, in addition to these nutritional recommendations, some evaluation related to different production approaches and targets set by farmers in several situations should be carried out.

Table 3
Predictable zootechnical indexes according to different types of lambs. Source: FEDNA 2008.

LAMB TYPE		SMALL CARCASSES		HEAVY CARCASSES
CARCASS WEIGHT (Kg)		8.5–11.5	11–14	13–15
BREEDS		Local	Local	Foreign breeds and crossing
TARGET/WEIGHT	TARGET	Meat&Milk	Meat&Milk	Meat
	WEIGHT	Small	Small	Heavy
ADULT BODY WEIGHT (Kg)	MALES	65	85	115
	FEMALES	45	60	85
WEANING BODY WEIGHT (Kg)		12–15	14–16	16–18
SLAUGHTER BODY WEIGHT (Kg)	MALES	20–24	24–18	30–35
	FEMALES	18–22	21–25	25–30
AVERAGE DAILY GAIN (gr/day)	MALES	250–290	280–350	360–420
	FEMALES	220–250	230–270	290–340
DAILY FEED INTAKE (gr/day)		750–800	850–900	950–1050

Table 4
Nutritional values of feed in terms of lamb genotype and sex. Energy expressed in UFC according to INRA 2007 feed evaluation system. Source: NANTA S.A.

	HEAVY GENOTYPE	
	% Crude Protein	UFC
MALES	18%	1.02–1.04
FEMALES	17%	1.00–1.02
BOTH	17.5%	1.01–1.03
	LIGHT GENOTYPE	
	% Crude Protein	UFC
MALES	17.5%	1.00–1.02
FEMALES	16.5%	0.98–1.00
BOTH	17.0%	0.99–1.01
	EXPORT	
	% Crude Protein	UFC
MALES	16%	0.94–0.96

UFC: Net Energy (INRA 2008).

4. Production approaches

The most important objective in feedlot lambs is the sale of live animals or carcasses. This means purchasing, classification and fattening of lambs to achieve the homogeneity and quality demanded by consumers. To reach this goal, the priority production approach for each farm should be defined and a suitable feeding strategy has to be established.

Production approaches are mainly (although some of them may be important at the same time, the farmer should define the priority ones):

- High Feed Efficiency (good performance indexes) – Feed should be focused on achieving high body weight gained with the lowest feed intake possible, reaching a suitable carcass fat content and meat quality. Maximum protein and energy content in feed must be used (Thos, 1976; Preziuso et al., 1999).
- Rumen Health – Assessment of pathology and welfare situation of the farm should be taken into account. With high disease incidence, low level of welfare (temperature, stress) (Russell and Rychlik 2001; Gonzalez et al., 2001) or low rumen pH level measured at the slaughterhouse (Bello et al., 2010), feed should be focused on avoiding acidosis. The right strategy is to keep suitable crude fibre levels and include buffers in the feed.
- Meat Quality (low fat content) – Feed strategy should focus on achieving a suitable fat content in carcasses (Preziuso et al., 1999; Beriain et al., 2000a,b), particularly in predisposed seasons (autumn). Fat carcass score evaluations should be performed at the slaughterhouse to correct high fat content if required. Reducing energy and crude fat in feed are good strategies to achieve this aim. Variation in fat carcass scores throughout the year from a database of 5137 carcasses (2002–2015, by sex) is detailed in Fig. 1.
- Carcass Yield (%) Improvement – Slaughter firms usually look for an increase in profit by reducing fixed costs and achieving a higher amount of meat per slaughtered animal. Thus, the feeding strategy should be focused on increasing the fat content in carcasses without detriment to their commercial acceptability, increasing energy levels and reducing those of crude protein (Kemp et al., 1976).

Table 5
Nutritional profile proposal in feed composition according to priority production approach. Energy content expressed in UFC according to INRA 2005 feed evaluation system. Source: NANTA S.A.

PRODUCTION APPROACH	Crude Protein.	Crude Fiber.	Crude Fat.	UFC
FEED EFFICIENCY	17.5%–18.5%	3%–4%	3.5%–4.5%	1.02–1.04
RUMEN HEALTH	17%–18%	3.5%–4.5%	2.5%–3.5%	0.98–1.00
MEAT QUALITY	16%–16.5%	5%–6%	2.2%–2.7%	0–94–0.96
CARCASS YIELD	16%–16.5%	3.5%–4%	4.5%–5.5%	1.03–1.04

UFC: Net Energy (INRA 2008).

Proposals for nutritional profiles in compound feed, regarding these production approaches, are detailed in Table 5 (both males and females).

5. Factors affecting zootechnical indexes

The zootechnical indexes most used to assess efficiency in the fattening lambs industry are "Average Daily Gain" (ADG) and "Feeding Index" (FI), which is defined as the amount of feed required to gain a kilo of live body weight.

To quantify the incidence of some of the most important factors affecting these indexes, a study based on 369 trials with fattening lambs (involving 64 farms (Spain and Portugal) and 20 compound feed manufacturing firms) was carried out from 1992 to 2011 (Bello et al., 2013). More than 15,097 body weight measurements were taken during the study. Variability in trial results regarding sex, genotype ("heavy" and "light") and season ("summer" and "winter") were analysed. The influence of factors such as energy intake and initial and final body weight was also studied. This work was published in the 2013 SEOC Congress edition.

Initial and final body weight influence.- These factors had no great impact on the average daily gains reported (at least in terms of body weight of animals currently produced in the Iberian market), but did affect the feed intake per kilo of meat produced. Initial body weight was statistically less significant in terms of Feeding Index

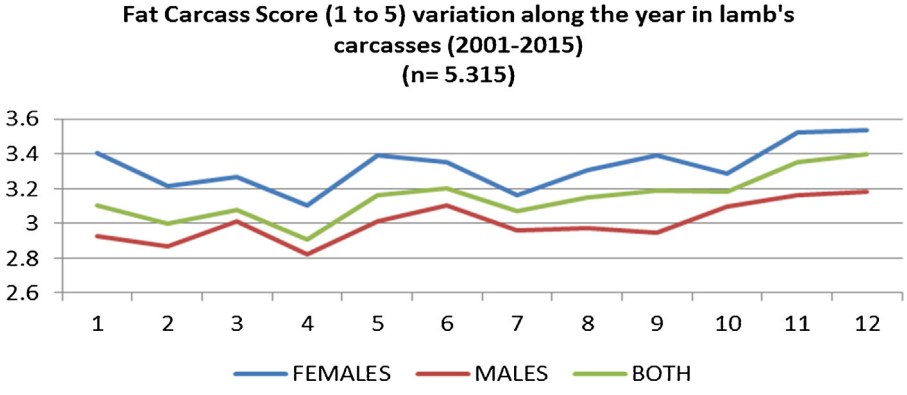

Fig. 1. Fat Carcass Score (1–5) variation throughout the year by sex, at slaughterhouse. Database from 2001 to 2015 (n = 5.137). Source: NANTA S.A.

Table 6
Summary of variance analysis results (SPSS) with initial and final body weight as covariates. Source: NANTA and CSIC León.

FACTORS	Initial Body Weight	Final Body Weight	Average Daily Gain	Fedd Index	Days in feedlot	Feed Intake
Initial BW			ns	**	***	***
Final BW			ns	***	***	***
Season	ns	**	ns	ns	+	ns
Genotype	*	**	***	*	+	ns
Sex	***	***	***	***	**	**

ns: (Non-Significant), ($p > 0.05$), + ($p < 0.10$), * ($p < 0.05$, ** ($p < 0.01$), *** ($p < 0.001$).

Table 7
FI (Kg feed/Kg BW gained) prediction equations (y = a x1 + b x2) depending on initial body weight (x1, kg) and final body weight (x2, kg). Source: NANTA S.A. and CSIC León.

	a ± e.s.	b ± e.s.	R^2
"Heavy" genotype	0.095 ± 0.0089	0.058 ± 0.0068	0.9760
"Light" genotype	0.101 ± 0.0138	0.055 ± 0.0104	0.9761
Winter	0.089 ± 0.0114	0.064 ± 0.0087	0.9742
Summer	0.101 ± 0.0098	0.052 ± 0.0074	0.9781
Male groups	0.082 ± 0.0080	0.059 ± 0.0059	0.9880
Female groups	0.096 ± 0.0233	0.074 ± 0.0186	0.9742
Both sex groups	0.093 ± 0.0111	0.061 ± 0.0083	0.9761
TOTAL	0.097 ± 0.0075	0.057 ± 0.0057	0.9761

(FI) than final body weight. The feeding Index goes up if both of them do, but the initial body weight had more influence on FI than the final weight did.

- Season influence – Normally feed intake goes up in winter and falls off in summer. Therefore, more energy concentration in compound feed is commonly used in summer in order to avoid negative effects of heat stress on feed efficiency. Statistically significant differences in energy levels were found between seasons in the feeds studied.
- Genotype influence – Better genotype does not affect feed intake at the same live body weight, but significantly influences the ADG and FI.
- Sex influence.- More feed intake values were found in males, so males reach better ADG than females. Males also need significantly longer fattening periods. Higher FI scores were obtained in females.
- Feed energy level – In general, the more feed energy level there is, the more ADG we achieve, but given the considerable variability in animals (health status and body fat content), statistically significant differences cannot always be found. Nevertheless, higher energy levels lead to significantly less feed intake and, consequently, a lower FI.

A summary of the effects of these factors in the zootechnical indexes studied is provided in Table 6.

6. Prediction of technical results in fattening lambs

Because of a huge variability in performance, due to health status and differences in feeding (rainfall, feedstuff prices, amount of grass. . .), heterogeneity should be kept in mind when predicting technical and economical results in fattening lambs.

Nevertheless, work previously carried out allows us to make predictions about FI calculations through multiple regression analyses from initial and final body weight figures. Regression coefficients of prediction equations, either for the entire database or each group of factors set, are shown in Table 7. As an example, for a set final body weight of 24 kg, the FI would be 2.7, 3.0, 3.3, and 3.5 for an initial body weight of 14, 17, 20 and 23 kg, respectively.

Better results can be achieved in "heavy" genotype than in "light", thanks to a better average daily gain. In terms of gender, males reach a better FI than females (as well as better ADG). Although no significant differences in season of the year were found, better FI was obtained in winter than in summer in our study.

In addition, we would like to point out the greater impact of the initial weight than the final one on FI figures, according to the equation coefficients.

7. Conclusions

This article provides an overview of the different kinds of lamb produced in the Iberian market and the types of feed used. We also put forward some recommendations on the most suitable feed composition according to sex and genotype.

On the other hand, feeding strategies should be adapted to the priority target of each farm, either to achieve good performance or to focus on rumen health, or even to obtain less or more fat on the carcass. Protein, energy, fat and fibre are the key nutrients to design the best option to achieve the goals set.

Sex and genotype have a considerable influence on performance, whereas the effects of environment (season of the year) can be offset by diet.

In spite of the high variability in zootechnical results currently obtained in feedlot lambs, some predictions can be made to calculate FI according to the initial and final body weight depending on sex, genotype and the season of the year.

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