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Chapter

Profitability in Rabbit Breeding

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Abstract

Rabbit production must be sustainable. One of the main bases of this sustainability is the profitability of the farms, in which improvement is achieved through the technical and economic management. These managements imply collecting production and economic data, calculating indexes, comparing results with those obtained in other farms, making decisions, and evaluating the consequences of changes. The chapter details the different steps to follow to develop the technical and economic management of the rabbit farms to improve their profitability. Templates to collect data, formulae to obtain different technical and economic indexes, results obtained in different producing countries, and possible techniques to improve profitability are shown.

Keywords: economic management, production costs, profitability, rabbit, technical management

1. Introduction

The order Lagomorpha includes the family Leporidae (rabbits and hares) and Ochotonidae (pikas). The species from the order with the highest interest in farming is the rabbit, with a production of almost 1.5 millions of tonnes of rabbit meat in 2018, which supposes 1.15% of the world pig meat production [1]. Hare is scarcely harvested in some countries, and its industrial production is marginal compared to rabbit meat production, and the breeding of pikas for meat consumption has not been developed. In consequence, the chapter will be focused on rabbit farming.

The main goal in rabbit meat production is to maximize the profitability respecting animal welfare and environmental concerns. The increase of the profitability of the farms is based on the knowledge of the technical and economic results of the farm, which will allow the detection of weak points that should be amended. The chapter will be focused on the procedure to develop technical and economic management in rabbit farms.

Technical and economic management in animal production implies (**Figure 1**):

- Technical and economic data collection
- Calculation of the technical and economic indexes
- Benchmarking: comparison of results obtained with those observed in other farms
- Detection of weak points that could be improved

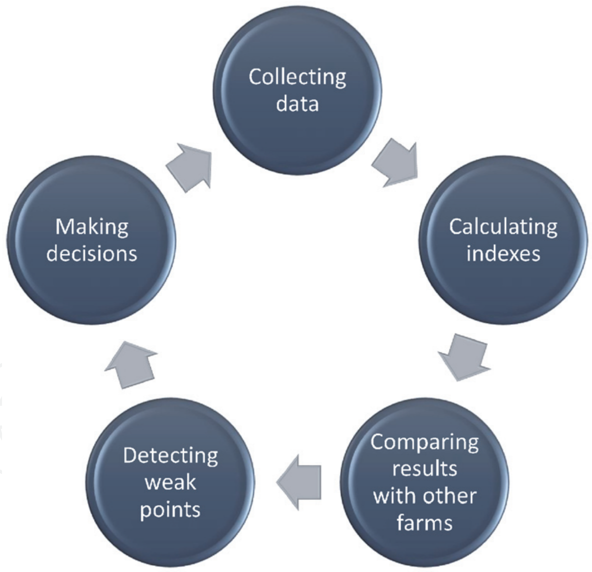

Figure 1.
Technical and economic management continuous process.

- Decision making to overcome the weak points
- Return to the first point for evaluating the effects of the changes applied

These points will be further discussed in the text.

It is essential to remember that technical and economic management are interrelated, and they are continually feeding back; therefore, both management processes have to be developed in the farm, because:

- Best technical indexes do not necessarily imply, surprisingly, the best economic results. Example: the increase in production and incomes obtained when increasing the number of workers might be lower than the increase in labor costs, leading to better technical but worse economic results.
- Economic management will indicate the profitability of the farm, but its improvement will be mainly achieved by the improvement of the technical indexes.

2. Technical and economic management

2.1 Data collection

2.1.1 Technical data

Rabbit females have their first insemination or mating (hereinafter, insemination) at approximately 4.5–5 months old. During their reproductive life, females are usually grouped in batches. Females from the same batch undergo the different events at the same time. That is, all the females belonging to the same batch are inseminated the same day; therefore kindling, weaning, and sale to the slaughterhouse after the fattening period of the young rabbits are achieved at similar dates for all the females in the batch. Moreover, the females of the farm can be all grouped in a single batch or in more than one batch, being displaced in time. **Table 1** shows the number of batches depending on the number of days between

Interval length between delivering and insemination (cycle length) (days)	Interval length between consecutive inseminations (days)								
	7	14	21	28	35	42	49	56	63
Postpartum (31–34)[1]	5				1				
11 (42)	6	3	2[2]			1[2]			
18 (49)	7						1		
25 (56)	8	4		2				1	
32 (63)[3]	9		3						1

[1]*Intensive rhythm; not recommended*
[2]*The most frequent ones*
[3]*Extensive rhythm*

Table 1.
Number of possible batches in the farm depending on the interval length between delivering and insemination and interval length between consecutive inseminations in the farm.

delivering and insemination and number of days between two consecutive inseminations in the farm. For example, when females are inseminated 11 days postpartum, 1, 2, 3, or 6 batches in the farm are possible, and the number of days between two consecutive inseminations will be 42, 21, 14, or 7 days, respectively. When females are distributed in more than one batch, the batches can be treated as single independent batches (the female is assigned to one batch along its whole reproductive life) or multiple batches (the female changes the batch after a negative palpation to shorten the unproductive periods).

The technical data is usually collected in the farm by filling up a formulary as the different events of the batch occur. **Table 2** shows an example of formulary. The

Date of insemination: 14-06-2019[1]	Data simulation[1,2]
Number of females[3]	750
Number of inseminations	748
Number of positive palpations	592
Number of aborts	19
Number of kindlings	587
Number of total kits born	5870
Number of kits born alive	5518
Number of weaned kits	4861
Number of rabbits produced	4516
Number of dead females	43
Number of culled females	55
Number of nulliparous	104
Kg rabbit produced	9935
Total feed consumed (kg)[4]	32,175

[1]*Simulation of data. Adapted from [2].*
[2]*Artificial insemination at 11 days postpartum, single batch, weaning at 35 days old*
[3]*Rabbit females in the batch between first insemination and culling*
[4]*Total feed consumed in the farm, including maternity, replacement, lactating, fattening, males, etc.*

Table 2.
Template for technical data collection in each batch of the rabbitry.

table shows also a simulation of technical data. Later on, the data will be used to calculate the technical indexes by using different programs that are explained in the next subsection.

It is important to realize that filling one formulary for each batch in the farm is recommended. Collection of data could be simple in farms with a single batch, but it could be more complicated when the farm works with more than one. In those cases, the formulary could collect not the information from one batch but all the data produced in the farm in a fixed period of time. This practice is not recommended for different reasons. When this period of time is short (e.g., 1 month), the indexes calculated induce confusion, since the results obtained for the different events do not correspond to the same group of animals. For example, the number of produced kits per kindling in May will not correspond to the fertility calculated in May, as the inseminations corresponding to the animals produced in May occurred in February. If the period of time is longer (e.g., 6 months), the quality of the calculated indexes improves, but without reaching a full agreement, and, in addition, a huge delay is generated between the early events and the calculation of the indexes and the possible decision-makings. Moreover, problems in one batch could be hidden under the overall results. Finally, even when troubles are detected, there is no possibility of identifying which was the problematic batch.

2.1.2 Economic data

There are many nomenclatures to define the breakdown of production costs. One of them classifies production costs as variable or as fixed ones. The different items in each group and a simulation of economic data can be seen in the example of formulary shown in **Table 3**. This classification is based on whether the cost would vary depending on the level of production, given farm size. In this way, variable costs will depend directly on the level of production. For example, the cost of feed during the fattening period will depend on the number of kits weaned in each batch. On the other hand, fixed costs do not depend on the production. For instance, expenses in telephone and the Internet are supposed to be independent on the level of production. However, it is sometimes difficult to classify some costs according to this criterion.

Recommendations on the length of the period of time for collecting economic data are similar to those for technical management. Collection and calculation per batch are recommended. Nevertheless, in practice, rabbit breeders often match the period considered with the dates established for legal and administrative obligations, recording on the same formulary the data generated every 3 months or even for a year.

There are three fixed costs that deserve a special mention, as they are not always considered when the economic management of the farm is applied. One of the most neglected items is the own (farmer) labor cost. Some farmers do not consider this labor as a cost and get their own earnings from income minus total costs (excluding salary, amortization cost and cost of capital). This practice should be avoided, as it could generate a false appearance of profitability.

Another problematic cost is the amortization because it is an intangible concept and not a monetary payment. This item represents the depreciation of the farm (facilities, machinery, and systems) in a period of time and has to be considered along the whole lifetime of the farm. Many times, the farm is constructed with capital obtained with a bank loan, and the amortization cost considered by the farmer is the capital returned to the bank in the period of time under study. That is, if the farm has a lifetime of 30 years, but the loan has to be returned in a maximum period of eight years, the farmer considers that there is an amortization cost equivalent to the loan repayments during 8 years and null amortization costs during the

Period of time: 01-01-2019 to 31-12-2019[1]			
Variable costs (€)		**Fixed costs (€)**	
Maternity feed	21,900	Own labor	19,200
Fattening feed	45,375	Own social security	4100
Replacement feed	2625	External labor	3775
Other feeds	0	External social security	894
Health	10,725	Manure management	590
Artificial insemination	6518	Energy and communications [2]	8500
Animals for replacement	8850	Corpse removal	700
Other variable expenses	0	Maintenance and repairs	740
		Expendable material	160
		Insurances and taxes	2725
		Financial and banking	0
		Credits and loans	0
		Rental agreements	0
		Other fixed expenses	0
		Amortization plus cost of capital	17,529
Incomes			
Sales to slaughterhouse	154,590		
Sales of alive animals	1150		
Subsidies	560		
Other incomes	0		
Inventory differences[3]	100		

[1]*Simulation of data. Adapted from [2]*
[2]*Water, power, gas, fuel, telephone, Internet, nest material*
[3]*Feed, animals, etc.*

Table 3.
Template for cost data collection in the rabbitries.

rest of the lifetime of the farm. However, this approach should be avoided, since this will lead to underestimations of the profitability at the beginning of the activity and overestimations at the last years. A more appropriated solution is calculating the real quantity of capital invested in the farm and distributing the cost along the whole lifetime of the farm, for instance, the construction of a farm that involved an investment of 300,000 euros. In the case where the capital was obtained through a business loan and should be returned in 8 years, the total capital investment increases, not only for the interests of the loan but also because of the devaluation of the money (one euro in 2020 will have a higher value than one euro in 2028 in inflation conditions). Therefore, capital investment should be corrected before calculating the cost per year. For example, considering a loan interest of 2.5%, the total capital would increase around 333,200 euros, and annual inflation of 1% for the next 8 years, the total capital would be established in around 361,800 euros. That is, the amortization of the farm will be 12,060 euros per year, but please note that amortization represents the devaluation of the facilities and material, which decreases with time; thus not constant but decreasing amortization must be calculated for each year.

Finally, the most controversial cost is the cost of capital. This intangible cost represents the minimal return that the farmer would expect if he made a capital investment in that farm and not in another investment. For example, the farmer might not invest that capital of money in a farm unless the profit was three times higher than the profit obtained when the capital was invested in a fixed-term deposit. This cost is hardly calculated and considered in the economic management of the farm. However, its mention is mandatory, because its estimation is compulsory not only in the economic management but also before making any investment, for example, in a rabbit farm. As an example, considering 0.75% of annual percentage rate (APR), 300,000 euros would rent 1823 euros in 1 year (after taxes); thus, the farmer could consider the investment in a farm only if a profit of at least three times higher (5469 euros) was expected.

2.2 Calculation of the technical and economic indexes

Once data has been collected in templates similar to those shown in **Tables 2** and **3**, data can be registered in (a) spreadsheets, which will allow the calculation of the results in the farm, or (b) management programs that will allow both the calculation and the comparison with other farms. This section will be focused on the first option, and the second one will be developed in Section 3.

2.2.1 Technical indexes

The main technical indexes calculated in rabbitries are shown in **Table 4**. Indexes related to fertility (apparent fertility, real fertility, and kindling interval) reflect the success in the different litter size components: ovulation rate, fertilization rate, and prenatal survival. It is important to notice that:

- The apparent fertility is calculated with the results of the test of pregnancy of the females, which consists in an abdominal palpation 10–14 days after insemination. When the female is mated or inseminated, the ovula in the follicles are liberated, and the follicles become corpus luteum, which liberate progesterone to maintain the possible pregnancy and prevent new ovulations. In the case of negative pregnancy, at 17 days of mating, the uterus starts the liberation of prostaglandins that eliminate the corpus luteum [3]. Therefore, females with negative palpation can be inseminated again in the next batch as long as inseminations differ in more than 17 days, although the period can be shortened with the inoculation of prostaglandins. In farms with one single batch, the early diagnosis of pregnancy is useless, and palpation is usually developed around 25 days post-insemination to plan the nest arrangement.

- The indexes related to fertility can be calculated per female, as shown in **Table 4**, or per insemination, replacing in the formulae the number of females by the number of inseminations in the denominator. Therefore, it is imperative to compare the results only with farms that used the same formulae for the calculation of the index.

- The kindling interval depends both on the cycle length and real fertility. In farms with a single batch or single independent batches (see Section 2.1.1), the index can be calculated with the data of the batch. However, in farms with multiple batches, females with negative palpation are changed to other batches; therefore the index must be calculated considering the real fertility achieved in all the batches as a whole.

Indexes and formulae	Data simulation[1]
Apparent fertility (%)[2]	
$AF\ (\%) = \frac{\text{number of positive palpations}}{\text{number of females}}\ x\ 100$	$AF(\%) = \frac{592}{750}\ x\ 100 = 78.9\%$
Real fertility (%)[2]	
$RF\ (\%) = \frac{\text{number of kindlings}}{\text{number of females}}\ x\ 100$	$RF\ (\%) = \frac{587}{750}\ x\ 100 = 78.3\%$
Cycle length (days)	
$CL = \text{lenght of gestation (days)}$ $+\text{interval kindling to insemination (days)}$	$CL = 31 + 11 = 42\ \text{days}$
Number of batches per year	
$B = \frac{365}{CL}$	$B = \frac{365}{42} = 8.69\ \text{batches}$
Kindling interval (days)[3]	
$KI = \frac{CL}{\left(\frac{RF}{100}\right)}$	$KI = \frac{42}{0.783} = 53.7\ \text{days}$
Abortions (%)	
$A\ (\%) = \frac{\text{number of abortions}}{\text{number of inseminations}} \times 100$	$A\ (\%) = \frac{19}{748} \times 100 = 2.5\%$
Mortinatality (%)	
$BM(\%) = \frac{(\text{total kits born} - \text{kits born alive})}{\text{total kits born}} \times 100$	$BM\ (\%) = \frac{(5870-5518)}{5870} \times 100 = 6.0\%$
Lactation mortality (%)	
$LM\ (\%) = \frac{(\text{kits born alive} - \text{weaned kits})}{\text{kits born alive}} \times 100$	$LM\ (\%) = \frac{(5518-4861)}{5518} \times 100 = 11.9\%$
Fattening mortality (%)	
$FM\ (\%) = \frac{(\text{weaned kits} - \text{rabbits produced})}{\text{weaned kits}} \times 100$	$FM\ (\%) = \frac{(4861-4516)}{4861} \times 100 = 7.1\%$
Kits born alive per kindling[4]	
$BAK = \frac{\text{number of kits born alive}}{\text{number of kindlings}}$	$BAK = \frac{5518}{587} = 9.4$
Kits weaned per kindling[4]	
$WK = \frac{\text{number of weaned kits}}{\text{number of kindlings}}$	$WK = \frac{4861}{587} = 8.3$
Rabbits produced per kindling[4]	
$PRK = \frac{\text{number of rabbits produced}}{\text{number of kindlings}}$	$PRK = \frac{4516}{587} = 7.7$
kg rabbit produced per kindling[4]	
$kgPRK = \frac{\text{kg rabbits produced}}{\text{number of kindlings}}$	$kgPRK = \frac{9935}{587} = 16.9$
Liveweight for sale (kg)	
$LW\ (kg) = \frac{\text{kg rabbit produced}}{\text{number of rabbits produced}}$	$LW\ (kg) = \frac{9935}{4516} = 2.2$
Global feed conversion rate (kg/kg)	
$GFCR = \frac{\text{kg consumed feed}}{\text{kg rabbit produced}}$	$GFCR = \frac{32175}{9935} = 3.2\ kg/kg$
Dead females (%)	
$DF\ (\%) = \frac{\text{number of dead females}}{\text{number of females}} \times 100$	$DF\ (\%) = \frac{43}{750} \times 100 = 5.7\%$
Culled females (%)	
$CF\ (\%) = \frac{\text{number of culled females}}{\text{number of females}} \times 100$	$CF\ (\%) = \frac{55}{750} \times 100 = 7.3\%$
Nulliparous females (%)	
$NF\ (\%) = \frac{\text{number of nulliparous}}{\text{number of females}} \times 100$	$NF\ (\%) = \frac{104}{750} \times 100 = 13.9\%$

Indexes and formulae	Data simulation[1]
Kindlings per female and year	
$KFY = \frac{365}{KI}$	$KFY = \frac{365}{53.7} = 6.8$
Kits born alive per female and year	
$BAFY = KFY \times BAK$	$BAFY = 6.8 \times 9.4 = 63.8$
Kits weaned per female and year	
$WFY = KFY \times WK$	$WFY = 6.8 \times 8.3 = 56.3$
Produced per female and year	
$PRFY = KFY \times PRK$	$PRFY = 6.8 \times 7.7 = 52.3$
kg produced per female and year (kg)	
$kgPRFY = PRFY \times LW$	$kgPRFY = 52.3 \times 2.2 = 115.0$ kg
Replacement rate (%)	
$RR\ (\%) = B \times NF$	$RR\ (\%) = 8.69 \times 13.9\% = 120.8\%$

[1]*Simulation of results calculated with data from* ***Table 2***
[2]*The index is sometimes calculated as the ratio with the number of females rather than the number of inseminations.*
[3]*In farms with multiple batches, the term RF should be replaced by (*$\sum$*(kindlings in n batches))/number of females in the farm), where n is the number of batches in the farm.*
[4]*The index can be calculated per female or by insemination by replacing "number of kindlings" in the formulae by "number of females" or "number of inseminations," respectively.*

Table 4.
Formulae of the main technical indexes calculated in technical management of rabbit farms.

Indexes for mortality of the offspring will be mainly influenced by the sanitary status of the herd, but it is important to remember that these indexes are also highly dependent on the moment the data is collected. In this way, the number of stillborn will be higher if data is not collected just after birth but some hours later, and the number of weaned and produced young rabbits is conditioned to the age at weaning and sale, respectively. Once more, results obtained must be compared with farms with similar management.

In the same way, the number of kits born alive, kits weaned, rabbits produced, and kg of rabbit produced will also depend on the moment of data collection. These data are used to analyze the productivity of the batch per female, per insemination, or per kindling. The indexes per kindling will reflect the success in prolificacy and survival, but the indexes per insemination or female will include also the success in fertilization. Usually, markets demand a fixed weight at slaughter; however, in markets where the produced animals are sold at a fixed age, indexes obtained for kg of rabbit produced will reflect also the success in daily weight gain.

Another summary index, more modern and with a lot of popularity, is the number of kg of rabbit sold per insemination carried out. It includes the successes obtained in both the reproduction and in the fattening sections but is easily increased by slaughtering at higher ages when the market allows heavier carcasses. In Galicia (Spain), 24% of the farms under management produces more than seven rabbits per insemination [4]. In France, the coefficient of variation of the index kg produced per insemination is around 18% [5].

The global feed conversion rate indicates the kg of feed needed to produce a kg of rabbit. The feed considered for its estimation is the total feed consumed by all the animals in the farm, as reproductive females, replacement, fattening, males, etc.

Finally, the productivity of the batch can be also expressed by female and year by extrapolating the information of the batch to the whole year. The indexes will be obtained by multiplying the indexes per female by the number of batches per year (B) or by multiplying the indexes per kindling by the number of kindlings per female and year (KFY).

2.2.2 Economic indexes

It is not enough to know how much money goes in and out. The economic indexes will show the real situation of the profitability of the farm. There are several indexes that are calculated to express the economic situation of the farm.

Incomes include the sale of animals to the slaughterhouse, the possible subsidies received by the activity, and the inventories differences (positive or negative) of the value of the breeders, and the stored feed must also be computed.

One of the most widely used indexes for its simplicity and ease of calculation is the income over feed cost margin (IFCM), which is usually calculated as the difference between incomes and feed cost. This index is frequently calculated and shown in reports of technical and economic management of rabbitries because of two main reasons. First, the index reflects the margin of profitability left after considering the feeding cost, which is the greatest production cost in the rabbitries [2]. Second, its calculation is not complicated because, in general, it only requires operation with the invoices from the slaughterhouse and the feed company.

The economic analysis of the farm must go further than the calculation of IFCM, as there is still a huge range between the index and the real profitability of the farm. From an economic point of view, there are different terminologies to refer to the margins used for benchmarking. An index more accurate is the gross margin, estimated as the difference between incomes and variable costs. These variable costs include not only the feed but mainly health, artificial insemination, and animals for replacement expenses, which should be also reflected in invoices. Therefore, its estimation is also feasible. It does not measure the profit of the enterprise. It shows how well sales cover the direct costs related to the production of goods (especially expressed in percentage of incomes).

The real profitability of the farms is finally obtained calculating the net margin, as the difference between incomes and total costs. This is the quantity earned by the business owner. Net margin is an indicator of the result of the exploitation that must serve to sustain the own salary and remunerate the invested capital. Net margin (without subsidies) is related to farm viability. It shows how profitable the company is when compared to its past self or to other farms, expressed as a rate (by kg of rabbit sold, by number of females, by number of inseminations, etc.). Net margin reflects the company's ability to generate profit for owners. If the farmer cannot save, a situation of decapitalization will occur. It is important to highlight that one of the fixed costs is the salary of the farmer (own labor). Generally, the farmer is also the business owner, getting both the net margin plus the own salary. This profitability is known as family net margin.

These economic indexes are frequently shown not per period of time but per female and year or per kg of rabbit produced. Formulae in **Table 5** correspond to the calculation of the indexes for a given period of time. Data used in the simulation are shown in **Table 3** and correspond to a period of 1 year. The net margin per year and female must be calculated as 1494€/(1year × 750 females), that is, the net margin is 1.99€ per female and year. In the same way, the net margin per kg produced may be obtained as the net margin divided by the number of kg produced in that period of time. For a total production of, e.g., 86,340 kg in 1 year, the net margin will be 1494€/86,340 kg, that is, 0.017€ per kg of rabbit produced.

Indexes and formulae (€)[1]	Data simulation[2]
Variable costs	
$VC = \sum \text{variable costs}$	$VC = 21,900 + 45,375 + 2,625 + 0 + 10,725 + 6,518 + 8,850 + 0 = 95,993€$
Fixed costs	
$FC = \sum \text{fixed costs}$	$FC = 19,200 + 4,100 + 3,775 + 894 + 590 + 8,500 + 700 + 740 + 160 + 2,725 + 17,529 = 58,913€$
Production cost	
$PC = VC + FC$	$PC = 95,993 + 58,913 = 154,906€$
Incomes	
$I = \sum \text{incomes}$	$I = 154,590 + 1,150 + 560 + 0 + 100 = 156,400€$
Income over feed cost margin	
$IFCM = \text{incomes} - \text{feed}$	$IFCM = 156,400 - (21,900 + 45,375 + 2,625 + 0) = 86,500€$
Gross margin	
$GM = I - VC$	$GM = 156,400 - 95,993 = 60,407€$
Net margin	
$NM = I - (VC + FC)$	$NM = 156,400 - (95,993 + 58,913) = 1,494€$
Family net margin	
$FNM = I - (VC + FC) + \text{own labor}$	$FNM = 156,400 - (95,993 + 58,913) + 19,200 = 20,694€$

[1]*All the indexes are also frequently calculated: (a) per female and year by dividing the value obtained along 1 year by the number the females in the farm; (b) per kg rabbit produced by dividing the value between the number of kg produced in the period of time considered.*
[2]*Simulation of results calculated with data from **Table 3***

Table 5.
Formulae of the main economic indexes calculated in economic management of rabbit farms.

3. Detecting weak points: index evolution and benchmarking

3.1 Evolution of the technical and economic indexes

The first tool to detect weak and strength points in a farm with technical and economic management is observing the evolution of the results along time, which will show changes between batches. These changes will be a consequence of variation in:

- External factors that cannot be controlled, as high variations in the climate conditions along seasons, market prices, etc.
- Factors that might be controlled, as problems in the insemination process, quality of the water, feed composition, etc.

And always bearing in mind that there is also a "natural" variation between batches: the same farmer, with a similar climate, diet, and husbandry, may have slight variations between the indexes of two twin rabbitries.

The main objective when analyzing the evolution of the indexes will be to distinguish if the factor affecting the results can be controlled to improve the situation.

3.2 The importance of comparing with others

The absence of variations in the technical and economic index evolution might not necessarily imply the inexistence of weak points that could be improved. These points can be detected by comparing the results with those obtained in other farms. This technique is called benchmarking. Benchmarks are reference points that you use to compare your performance against the performance of others. Benchmarking is commonly used to compare costs or technical and economic performances.

The first step for the comparison might be complicated as it implies access to the results from other farms:

- The technical and economic management is highly important in the rabbit farms but is less common than expected. Some reasons could be the lack of observing the advantages of the management at a short term and the false convincement of knowing the real situation of the farm just doing management in their head.
- Rabbit farmers doing management are sometimes reticent to show their indexes, probably due to fear to negative valuations that other people may make and/or the fear of promoting the competence among colleagues.

As commented along Subsection 2.2.1, the indexes obtained in the farm must be compared to the indexes obtained in farms with similar characteristics:

- Size: in large farms a part of the fixed costs is diluted, although it can strongly increase the labor costs.
- Market conditions: there are differences between countries in input prices and in the weight and price of live rabbits at the time of sale.
- Socioeconomic conditions: it makes no sense to compare an industrial farm with a backyard production.
- A similar management: for example, the number of total born per female and year must not be compared between two farms with 42 and 49 days of cycle length, as the number of cycles per year is higher in the former, and the mortality during lactation must not be compared between two farms weaning at different ages, as it is not possible to distinguish if differences are due to health problems or to the length of the lactation.
- A similar data recording and calculation process: for instance, some farms do not inseminate the females that do not show a favorable state of the vulva; therefore the indexes per insemination will be overestimated and cannot be compared with farms where all the females are inseminated regardless of the color of the vulva.

Obtaining technical and economic indexes from the farm will provide a valuable material to detect weak points and make decisions to improve the profitability of the farm. It is important to realize that the main and most important tool to analyze and make decisions is the specialists in cuniculture who are in direct contact with the farm, such as technicians and veterinarians.

In general, comparisons between farms with different management techniques should not be made. However, in some cases, these comparisons could be very useful comparing indexes that involve the information of total productions over long periods of time. For example, farmers with different lengths of the reproductive cycle should not compare the total born alive per female and year but the total number of fryer rabbits (or kg) produced per year.

If a farmer detects that one or more of his/her technical indexes are worse than in other similar farms, it is mandatory to be able to discover the possible causes, which can be multiple: they could only differ in one management technique, although it could also be due to a state of health different between herds or to variations in environmental control.

3.3 Programs allowing the comparison of results

The best option for technical and economic management is the use of collective management programs that allow the comparison of the results with those obtained by other rabbit breeders. Usually, the user has no access to the indexes obtained in one specific farm but to the mean obtained in a reference group, which is formed with an ensemble of rabbitries with similar characteristics to the farm under review. These platforms usually have the following characteristics:

- The farmer has access to templates for data collection that can be printed or filled up online.
- Indexes are calculated automatically by the platform.
- Results can be compared immediately with those obtained in reference groups.
- Frequently, the farmer has personal advice from the developer of the platform or associated technicians in the detection of weak points and the search for possible solutions.

These platforms are usually free and are developed and managed by:

- Agricultural technical institutes from governmental entities. Examples of these platforms in France are RENALAP and RENACEB, by the Aviculture Technical Institute (ITAVI). RENALAP was developed in 1983 for farms where not the batch but the individual data generated per female was recorded, and RENACEB was created in 1995 for farms with management in batches [6]. Other examples in Spain are the **bdcuni** (Rabbit Sector Database), which was developed in 2008 by the Valencian Institute of Agrarian Research (IVIA) [7] for farms with management in batches, and the management program developed by the Institute for Agrifood Technology and Infrastructures of Navarra (INTIA) [8].
- Companies that provide the service to the farmers buying their products or agricultural cooperatives which offer the platform to their partners.

3.4 Technical and economic indexes in different countries

Rabbit meat is mainly produced in China (865,477 tonnes), Spain (55,824 tonnes), France (43,886 tonnes), and Italy (43,109 tonnes) (data from 2018 [1]). Management and markets differ between countries, and this is reflected in the technical and economic performances obtained.

	[4]	[8]	[9]
	Spain	Spain	France
Year	2018	2018	2017
No. of farms	88	12	697
No. of females	57,816	11,307[1]	454,444[1]
No. of females per farm	657	942	652
Replacement rate (%)	125		
No. of nulliparous rate per batch (%)			14.1
No. of total born per kindling			10.8
No. of born alive per kindling	10.90[2]		10.2
Apparent fertility (%)	85.2		
Real fertility (%)	78.4		82.5
Mortinatality (%)			5.6[1]
Lactation mortality (%)	11.41		15.6[1]
Fattening mortality (%)	9.8		8.7[1]
No. of weaned per kindling	9.66[1]		8.60
No. of weaned per insemination	7.57[1]		7.13
No. of produced per kindling	8.71[1]		7.85
No. of produced per insemination	6.38		6.48
kg produced per insemination	14.44		16.01
No. of produced per female and year		53.3	52.3
Mean slaughter weight (kg)	2.261[1]	2.13	2.47
Global feed conversion rate (g/g)	3.52		3.34
Age at sale (days)			73.4
No. of kindlings per female and year			6.66

[1]*Estimated*
[2]*Number of born alive and considered as viable*

Table 6.
Mean technical indexes in some management programs.

Tables 6 and **7** include a relation of differences in technical and economic results in Spanish and French programs. In general, results shown belong to databases with farms working mainly with a cycle of 42 days. In general, rabbit breeding techniques are quite similar in France and Spain, but there are few differences in both management and markets that have to be considered:

- French consumers demand heavier carcass weight than Spanish ones; the higher slaughter weight in the French rabbitries supposes an increase of the profitability.

- Official data on technical management in the Spanish rabbit sector is lacking. Huge databases generated in Spanish farms are probably owned by private sector firms, and the accessible published data is scarce, and data shown in the text is data from regional associations. Meanwhile, France is collecting and reporting technical information from a large and therefore more representative

	[8]	[9]	[2]
	Spain	France	Spain
	2018	2017	2012
	€/kg	€/kg	% total costs
Incomes	**1.834**		
Sales of young rabbits to the slaughterhouse	1.834	1.75	
Variable costs	**1.191**		
Feeding	0.935	0.89	45.2
Zoosanitary products	0.160		6.9
Insemination, renewal, and other	0.097		9.9
Fixed costs	**0.412**		
Labor and social security (external and owner)			18.1
External labor and social security (external and owner)	0.148		
Consumptions (water, power, gas, fuel, telephone, Internet, etc.)	0.075		7.0
Administration			3.1
Amortization and cost of capital			9.8
Amortization and rental agreements	0.100		
Others	0.089		
Total production costs	**1.603**		
Margins			
IFCM[2]	0.899[1]	0.92	
IFCM[2] (€/doe and year)	102.1[1]	119.5	
IFCM[2] (€/insemination)		14.84	
Feed cost respect to kg rabbit sold		0.89	
Feed cost respect to total production cost (%)	58.3[1]		
Feed cost respect to rabbit sale income (%)		50.8	
Gross margin	0.643[1]		
Net margin	0.231		
Net margin (€/rabbit)	0.490		

[1]*Estimated from other indexes*
[2]*Income over feed cost margin*

Table 7.
Outputs of economic management programs.

database through its program RENALAP and RENACEB [9]. The economic results are, however, scarce in both countries.

Comparison of results with those found in other countries has to be done prudently, as the management system in each market can clearly condition the values obtained. An example might be the case of Belgium, which has observed an increase of mortality during fattening with an associated decrease of the number of rabbits produced per female and year when changing from cages to park system [10].

4. Making decisions

4.1 The process of making decisions

Once the weak points are detected, the farmers and technician need to make decisions to increase profitability by the improvement of the technical indexes.

There are at least two ways to find out which techniques might lead to an improvement:

- The comparison with other farms with similar management will show which indexes should be improved, but the comparison with the means of an ensemble of farms that differ at least in one management characteristic might indicate an improvement in the results if the difference in management is applied in the farm.

- Previous studies may indicate how to improve some indexes. Some examples are detailed in the next section.

4.2 Possible management techniques to improve technical indexes

As mentioned, the main assistance should be the advice of the veterinarians and technicians. However, some examples of possible measures or recommendations to improve the technical indexes are detailed below:

Fertility: the index can be affected by (a) body condition (lower when the percentage of fat is too low or too high); (b) physiological status (lower fertility in lactating females); (c) parity order (lower fertility in primiparous); (d) health status; and (e) reproductive rhythm (lower in intensive than in semi-intensive rhythm, thus, lower with inseminations during the first week postpartum than at 11 days postpartum) [11].

Prolificacy: the indexes are conditioned by the genetic origin of the crossbred females. Maternal lines under genetic selection, for example, line Prat, selected for litter size at weaning at IRTA, have nowadays 2.68 weaned rabbits per litter more than in 1992 (personal communication).

Mortality at birth (also known as mortinatality) is usually associated to prenatal survival of the genetic line and mistakes in management, for example, as no nest disposal or stress at first parity (water stress, noisiness) that may increase cannibalism.

General mortality indexes: they are obviously conditioned by the health of the herd, which should be improved by the increase of biosecurity. Some techniques that have been seen to reduce sanitary problems are:

- All-in/all-out system: this technique avoids cohabitation of animals from different ages and physiological states in the same location, and it seems to favor the technical indexes and the reduction of use of antibiotics [9, 12].

- Single batch or multiple independent batch management (the female does not change to another batch when a negative palpation is detected) reduces the incidence of health problems because it avoids rearing of animals of different ages and physiological status in the same location. Moreover, management with one single batch increases the possibility of practicing the all-in/all-out system.

Mortality during the fattening period is mainly associated with digestible disorders, especially since the beginning of the twenty-first century when the epizootic rabbit enteropathy (ERE) appears as a pandemic disease. The ERE affects especially after weaning, when the young rabbit is changing from milk to solid feed with a still immature digestive system and under the stress of the weaning. In these circumstances, the ERE increases mortality and morbidity of the young rabbits. The agent causing the ERE is not yet determined, and the incidence of damage may be reduced with different techniques as (a) variation of feed composition (additives, the reduction of protein level in the feed, etc.); (b) feed restriction during the 2–3 weeks after weaning; and (c) delay of the age at weaning.

Mean slaughter weight: the index can be rarely changed, as it is fixed by the demands of the market. However, the number of days and the quantity of feed needed to achieve that weight can be reduced by using rabbit sired with bucks from paternal lines selected by growth or feed efficiency with lower conversion index during the fattening period. For instance, line Caldes, selected for growth rate in IRTA during the fattening period, presents at 60 days of age a food conversion rate 8.3% lower than a line selected for reproductive criteria [13].

Global feed conversion rate: it is one of the most important technical indexes. It represents the number of kilograms of feed consumed to obtain 1 kg of fryer rabbit for sale and summarizes success in fertility, prolificacy, and survival. The global feed conversion rate should be as low as possible since feed costs represent more than 70% of variable costs. There are many factors that affect this index:

- Health status: morbidity and mortality in all the steps will increase the global feed conversion rate, especially when mortality occurs at the end of the fattening period.
- Mortinatality.
- Food composition:
    - If the prevalence of health problems in fattening is high, feeds with low protein and energy levels prevent digestive problems and could reduce the global feed conversion rate. This involves lower mortality and lower cost per kg of feed, although consumption would increase.
    - If the prevalence of digestive problems is low, feeds with high levels of energy and protein, with a higher price, require less consumption and shorter periods of fattening, which would also reduce the global feed conversion rate.
- Genetic lines: lines selected for growth rate and/or feed efficiency and prolificacy will reduce the global feed conversion rate.
- Environmental conditions: a balance must be struck between savings in environmental control (heating, ventilation, etc.) and feed consumption. A low temperature in the fattening rooms increases the consumption of feed for thermoregulation and therefore increases the global feed conversion rate.
- Semi-intensive reproductive cycles, shorter than the extensive ones, and high fertility rates reduce global feed conversion rate.

5. Conclusions

Management is necessary as a source of information to detect weak points for improvement, make decisions, and evaluate the technical and, above all, economic consequences.

There is information on technical management programs (especially in Spain and France), but economic analyses of rabbit production are very rare. Feed is the main cost, and the global feed conversion rate gives an idea of production efficiency, as do other indexes such as the production expressed by insemination that also includes reproductive efficacy. Within our reach, the most important traits related to economic profitability are conversion rate, litter size, fertility, and kitten survival. We must not try to save on genetics, energy, or preventive veterinary measures since they only represent a small percentage of production costs.

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Conflict of interest

The authors declare no conflict of interest.

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