

AN APPROACH TO THE STATISTICS OF WILD LAGOMORPH CAPTIVE REARING FOR RELEASING PURPOSES IN SPAIN

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ABSTRACT: Despite the importance of rearing wild lagomorphs in captivity for hunting and predator conservation in Spain, little is known about this production sector. Taking official data into account, in this work the number and distribution of farms in Spain and the possible number of animals produced were analysed during the period 2005-2010. In 2010, 114 wild rabbit farms were widely distributed throughout the country (especially Cataluña, Galicia, Andalucía and Castilla La Mancha regions), while 21 hare farms were registered, the majority in Extremadura, Castilla La Mancha and Andalucía. A possible production figure of 225 000-265 000 rabbits and 1 034 hares was estimated in 2010. Game farms of wild lagomorphs are established in Spain and placement would be related to a high demand for hunting and predator conservation in certain regions. Although more research is needed, the number of animals produced would be an important part of the total animals released to the wild.

Key Words: game farming, hare, hunting, production statistics, wild rabbit.

INTRODUCTION

The wild rabbit (*Oryctolagus cuniculus*) is a key species for the Mediterranean ecosystems and an important small game species (Virgós *et al.*, 2007; Delibes-Mateos *et al.*, 2008). Due to the drastic declines in populations reported in Spain over the last century (Villafuerte and Delibes-Mateos, 2007), some research projects have been carried out to promote sustainable restocking programs using translocated rabbits (Calvete and Estrada, 2004). However, donor populations can be over-harvested (Cotilla and Villafuerte, 2007), and captivity rearing has been developed with the aim of providing rabbits for releasing and re-establishment purposes (Borrego, 1997).

Although some projects have studied rearing systems (González-Redondo, 2001; Arenas, 2002; González-Redondo, 2006), little attention has been paid to the situation of this production sector in Spain. In addition, captive rearing of Iberian (*Lepus granatensis*) and European (*Lepus europaeus*) hares was started recently in Spain due to steady decline in certain regions, attributed to factors such as habitat loss, intensive farming practices and overhunting (Palacios and Rodríguez, 1997). Unfortunately, relatively little research on captive rearing has been reported so far (Bartolomé *et al.*, 2008).

With a view to providing knowledge about present-day farming of these species, the aims of this research were: (1) to determine the number and distribution of farms in Spain; (2) to assess the possible number of animals produced and released, and (3) to analyse the trend of the production sector over a 6 yr period.

MATERIAL AND METHODS

Data related to number and distribution of farms and animal census were obtained from the REGA (General Register of Animal Farms, as per Spanish ruling RD 479/2004) from the period 2005-2010, kindly provided by the Spanish Ministry of Environment and Rural Affairs (MARM). Although information is available on this topic on-line (MARM, 2011a), data was based only on farms that were operating on December of each year, omitting game properties where animals were captured for translocation, also included in the REGA in some regions. Farms analysed were classified by regions as ‘farms for game purposes’, showing the number of animals according to the official classification: fattening, bucks, does, kits for breeding and other.

For a better understanding of the data, surveys of rabbit ($n=3$) and hare ($n=1$) farmers and official veterinary services from 2 regions were carried out. The only variable contrasted using the survey for this study was the inclusion or not of the number of rabbits sold in the REGA, and in all cases indicated that although the number of animals sold was controlled by farmers, it was not included in the REGA. The number of animals released was partially controlled by the MARM, as this competence pertains to regional Departments of Environmental Affairs. It was thus difficult to make unambiguous statements regarding an accurate source of information on the number of lagomorphs produced. It was suggested that a reliable measure to assess the minimum number of animals produced (n) was to estimate the breeding success of does and kit survival, using the following equation for each year:

$$n = A \times (1-B) \times C \times D \times E$$

where; A was the number of reproductive does, B was the frequency of infertile females, C was the number of litters/yr, D was the litter size and E was the kit survival percentage in the first 6 mo.

Despite the diversity of the systems used in the rearing of the species studied, the different genetics of the animals raised, the great variability in reproductive performance and the survival of kits and leverets, the decision was made to use average values for these parameters taken from previous studies. For rabbits reared in cages, values were taken from experiments carried out by González-Redondo (1997, 1998, 2001, 2006, 2009, 2010) and for enclosures from Borrego (1997) and Arenas *et al.* (2006). In hares, it was assumed that the majority of farms in Spain would rear Iberian hares, the most widespread in the country (Gortázar *et al.*, 2007). Though several studies have addressed European hare rearing (Spagnessi and Trocchi, 1979; Santilli *et al.*, 2004), we assumed that reproductive parameters of European hares were not applicable to Iberian ones. Thus, average values of B, C, and D were based on previous work carried out in wild Iberian hares by Alves *et al.* (2002). After studying reproductive parameters during bimonthly periods of the year, this work showed a value higher than 44% for concurrently pregnant and lactating females throughout the year ranging from 10 to 100%. So, it was decided to set a 0.5 frequency for infertile females. Similarly, we opted to fix a leveret survival ratio (E) taking the suggestions of farmers interviewed into account (Table 1).

To our knowledge, the proportion of rabbit farms rearing in cages or enclosures is unknown. In consequence, results for the estimated number of rabbits produced were derived from 2 independent calculations; the first under the hypothesis that all the farms produced rabbits in

Table 1: List of average values used in the estimated number of produced animals' equation.

	Wild rabbit		Hares
	Cages	Enclosures	Enclosures
Frequency of infertile females	0.4	0.25	0.5
Number of litters/yr	4	3.5	1.6
Litter size (No.)	4	4.3	6
Kit survival percentage in the first 6 mo	50	50	50

cages, and the second under the hypothesis that all farms produced rabbits in enclosures. In addition, available hunting bags and data from MARM (2011b), were consulted for the study period. Descriptive statistics and correlations were used to describe farm distribution and the number of animals produced using SPSS (2008).

RESULTS AND DISCUSSION

Number and distribution of farms in Spain

Data from REGA showed that on December 2010, there were 114 wild rabbit farms in Spain. These farms were widely distributed throughout the country, though 72% were located in 5 regions (Cataluña, Galicia, Andalucía and Castilla La Mancha), and no farms were registered in the Principado de Asturias, Murcia, Navarra, País Vasco and La Rioja (Table 2, Figure 1). For hares, 21 farms were registered in 9 regions and the majority were settled in Extremadura (n=6), Castilla La Mancha (n=5) and Andalucía (n=3).

As expected, most wild rabbit farms were located in regions where this species has a high socioeconomic value for hunting, conservation or both reasons. Thus, rabbit rearing in Cataluña and Galicia would be related to hunting (Piorno, 2007), while rabbits reared in Andalucía and Castilla La Mancha could be used for hunting and predator conservation (Moreno *et al.*, 2004), as in these regions some recovery projects of endangered predators, such as Iberian lynx *Lynx pardinus* and Spanish imperial eagle *Aquila adalberti*, are ongoing (MMA, 1999, 2001).

As with rabbits, the majority of hare farms were located in regions where traditional greyhound coursing (*Canis familiaris*) is

Table 2: Number of wild rabbit and hare farms per region in 2010, according to the REGA.

Region	Wild rabbit	Hare
Andalucía	22	3
Aragón	1	0
Principado de Asturias	0	0
Islas Baleares	2	0
Islas Canarias	1	0
Cantabria	3	1
Castilla La Mancha	12	5
Castilla y León	5	1
Cataluña	26	2
Extremadura	9	6
Galicia	22	0
Comunidad de Madrid	6	1
Murcia	0	0
Navarra	0	1
País Vasco	0	0
La Rioja	0	0
Comunidad Valenciana	5	1
Total	114	21

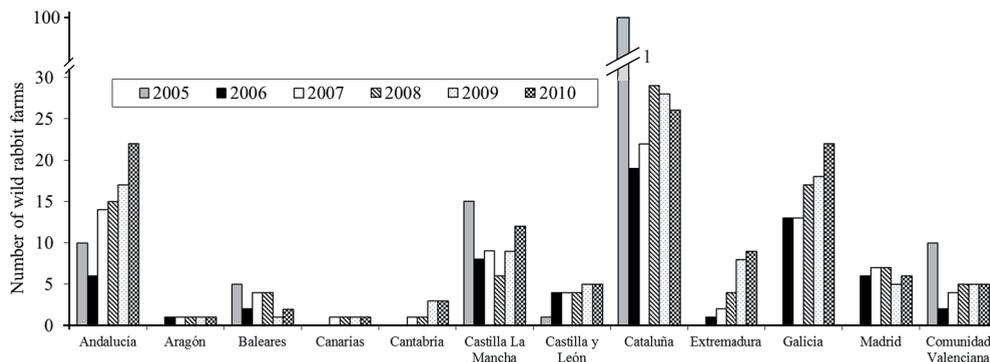


Figure 1: Distribution and evolution of wild rabbit farms in Spain during the 2005-2010 period, according to REGA. ¹In 2005 there were 100 farms registered in Cataluña.

quite popular (Bartolomé *et al.*, 2008). Although data from REGA did not distinguish between different hare species, we are led to believe that farms in Cataluña, Cantabria and Navarra ($n=4$) reared European hares, also distributed in the wild in these regions (Gortázar *et al.*, 2007). Overall, our results are in agreement with a previous study of red-legged partridge farm distribution (Sánchez-García *et al.*, 2009), the most important small game species in Spain, which confirms that farms are located where there is a high demand for animals. However, we cannot rule out that some regions, such as Cataluña and Galicia, might sell animals to others where there are no farms or local farms are unable to supply the number of animals demanded.

Table 3: Number of wild rabbit and hare farms, total census considering categories and number of animals produced in the 2005-2010 period.

	No. of farms ¹	Fattening	Bucks	Does	Kits/leverets for breeding	Other	Total census ¹	No. produced cages ²	No. produced enclosures ²
Wild rabbit									
2005	141	0	629	5 489	1 946	12 165	20 229	26 347	30 979
2006	62	700	777	5 791	2 081	11 776	21 125	27 797	32 683
2007	82	7 147	744	4 856	450	42 320	55 517	23 309	27 406
2008	94	29 530	16 130	26 977	2 978	13 840	89 455	129 489	152 251
2009	101	31 894	4 349	19 311	3 716	15 002	74 272	92 693	108 986
2010	114	29 686	32 045	46 965	4 565	15 620	128 881	225 432	265 059
Hares									
2005	30	680	0	200	0	66	946		480
2006	10	0	37	442	0	60	539		1 060
2007	14	25	52	450	0	1	528		1 080
2008	17	50	279	488	64	8	889		1 171
2009	22	20	269	326	42	40	697		782
2010	21	30	285	431	308	46	1 100		1 034

¹ REGA. ² Estimated using the equation proposed by the Authors.

Table 4: National hunting bag and estimated number of released animals (50% of provinces) according to the MMARM (Anuario de Estadística Forestal) during the 2005-2008 period (MARM, 2011b).

Year	Wild rabbit		Hares	
	Hunting bag (No.)	Released (No.)	Hunting bag (No.)	Released (No.)
2005	3 543 782	87 586	869 562	206
2006	4 006 666	69 978	1 006 830	86
2007	5 282 700	74 105	984 510	583
2008	6 327 406	277 416	1 064 250	4 442

Our data partially differ from those presented by the Ministry (MARM, 2011a), but these statistics were updated on June of each year and the source did not distinguish between farms and private game properties where animals were captured for translocations, which could increase the total number of farms.

Number of animals produced

In 2010, farms declared a total census of 128 881 wild rabbits and 1 100 hares (Table 3). Taking data from the whole study period, a high percentage of rabbits were classified into does (28%) and others (28%), while minor percentages were obtained for fattening (25%), bucks (14%) and kits for breeding (5%). For hares, the majority of animals were does (50%) and bucks (19%), followed by fattening (17%), leverets for breeding (9%) and other (5%). After using the equation based on does, a possible production figure of 225 432-265 059 wild rabbits in 2010 was established, depending on the type of rearing proposed, and 1 034 hares.

To our knowledge, this is the first paper to describe the wild lagomorph production sector and determine the possible number of animals produced in Spain. Previous research has suggested that from thousands to half a million translocated rabbits were released every year in Spain (Calvete *et al.*, 1997; Moreno *et al.*, 2004) and the Ministry (MARM 2011b) reported the number of released animals in some regions from 2005-2008 (Table 4), ranging from 69 000 to 277 416 rabbits on a yearly basis. After comparing these data with the number of produced animals calculated in this study (Table 3), the proportion of released rabbits that would be reared in captivity could reach values from 35 to 54%, depending on the year.

Results showed that a small number of hares were produced per year (Table 3), which could be attributed to a lower demand in comparison to rabbits. This is not surprising, as hares are not endangered (Ballesteros, 2007; Carro and Soriguer, 2007) and translocation might be able to supply animals required for hunting or re-establishing purposes. Contrary to data obtained in rabbits, the number of hares produced was higher compared to the number released (Tables 3 and 4), suggesting that there was a high proportion of releases that were not controlled, though in 2008 the number of released animals increased dramatically (Table 4).

Despite the limitations of the equation used here, our results reflect that the number of lagomorphs released to the wild would be an important percentage of the total amount of animals released. However, for both species, further research is needed to clarify which proportion of released animals is reared in farms.

It would be interesting to compare our data with those from regional Environmental and Rural Departments, as wild fauna releases are controlled by these agencies. In agreement with

Villafuerte and Castro (2007) and Bartolomé *et al.* (2008), we consider that there are many farms not registered yet and a significant percentage of animals would be released without authorisation from local governments.

Production sector evolution (2005-2010)

A decline in number of rabbit (20%) and hare (30%) farms was observed for the whole study period (2005-2010), but taking into account the number of reproductive does and number of animals produced, a steady increase in wild lagomorph rearing was observed from 2006 to 2010 (Figure 1, Table 3). Moreover, the number of breeding does for the whole period, which was the basis for the calculation of number of produced animals, was increased dramatically for both rabbits (+855%) and hares (+215%). Interestingly enough, the number of declared does in rabbits was not correlated to the number of farms ($r=0.21$; $P=0.64$), whereas a significant negative correlation was found between the number of declared breeding hares and the number of farms ($r=-0.8$; $P<0.05$).

Despite the short period of time studied and the variation reported in the number of farms between 2005 and 2006, an increase in the estimated number of animals produced was reported in this study. The general increase in the number of does and consequently the number of produced animals could be ascribed to a higher demand, explained by the long-term decline of both species in some regions, especially the wild rabbit (Moreno *et al.*, 2007). Some authors warn about the negative consequences of translocations for the donor populations (Cotilla and Villafuerte, 2007), and perhaps hunting societies and predator conservation projects might prefer buying reared animals rather than using translocated. To our knowledge, the success of restocking practices using reared animals has not been studied.

This study confirms that wild lagomorph game farms are established in Spain, but to date it has been difficult to estimate the number of farms and animals produced and released accurately, as there was a lack of information on this activity in official databases, which was the primary limitation of this work. We are led to believe that these official statistics are clearly inaccurate and underestimate the real production of wild rabbits, which hampers the development of this game farming sub-sector. One could conclude from these results that, although regional and national agricultural and environmental agencies have carried out efforts during the last year, a significant proportion of captive rearing in Spain still remains uncontrolled. A reliable system of statistics should distinguish between reared and translocated rabbits, which would help to understand the evolution of this sub-sector.

CONCLUSIONS

Wild lagomorph game farms are established in Spain, with a significant number of farms distributed throughout the country, especially in the case of wild rabbits. A minimum production of 225 000 rabbits and 1 034 hares was estimated in 2010.

Despite the importance of captive rearing of rabbits and hares for hunting and predator conservation, this sector is not well developed yet and further research should investigate a wide range of topics, especially husbandry, nutrition, reproduction, handling, survival and spatial behaviour of those released to the wild.

Acknowledgements: Data from REGA were kindly provided by the *Subdirección General de Explotaciones y Sistemas de Trazabilidad de los Recursos Agrícolas y Ganaderos* (MARM). We are indebted to Pedro Luis Rodríguez Medina and Julen Susperregui for their comments on early drafts and Courtnee L. Henry for her linguistic comments. Carlos Sánchez-García received support from a post-doctoral grant from the Fundación Caja Madrid (Spain). We are indebted to anonymous referees for their comments and suggestions.

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