

## Economic Growth and Biological Innovation: The Development of the European Dairy Sector, 1865-1940

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**Abstract:** In this article we discuss an aspect of economic growth that has not been the subject of much consideration in economic and agrarian history to date: the effect of biological innovations on farming development between the mid nineteenth century and the 1930s. We have focused on dairy farming for two reasons. Firstly, dairy farming played a relevant economic role in a number of European regions during this period. Secondly, one of its products, liquid milk, was probably the most significant food during the early stages of the European nutrition transition. We present new statistical data for the evolution of dairy farming in different Northern European countries as well as Spain, and evaluate the impact of cattle population and milk yields in each case. We also link milk yields and the availability of fodder, but special attention is paid to the breeds kept and techniques for their improvement. The article shows that cattle improvement played a significant role in Central and Northern Europe from the mid nineteenth century, but that this was not the case in Spain. Improvement through inbreeding was soon discarded in Spain, absorbent crossbreeding failed, and the sector became dependent on foreign imports of bulls and cows, first from Switzerland and later from Holland. By taking these factors into consideration we can better understand why the dairy sector in

Mediterranean Europe did not really begin until the late nineteenth century and why it stagnated in the wake of the First World War.

**Key words:** Agrarian history, Agrarian development, Food history, Biological innovations, Cattle, Europe, Spain.

## **1. Introduction**

In the first half of the nineteenth century, dairy farming was an important economic sector only in the hinterland of major urban centres, and in regions where fodder was readily available and environmental conditions were not favourable for grain production (Orland, 2005: 217-18; Vatin, 1990: 15-34). The development of the sector accelerated in the 1860s, when the implementation of a number of commercial treaties encouraged trade in milk by-products and the dissemination of milk-skimmers significantly increased butter production. This process was supported by transport improvements, particularly in railways, and new technical facilities for milk keeping.<sup>1</sup> Other factors which came into play in the 1880s further boosted this development. Among these were the increase in imports of cereal from overseas, especially wheat for human consumption and maize for cattle fodder, and the increase in income levels, both of which were brought about by the industrialisation and urbanisation processes then in progress (Bieleman, 2005: 229-30; Grigg, 1992; Henriksen and O'Rourke, 2005: 523-5). Another no less important factor was the growing demand for liquid milk that followed scientific improvements in the nutritional value of the product, with increased calcium and vitamin content, and in delaying contamination by harmful bacteria through pasteurisation and refrigeration (Murcott, 1999: 315-27). Knowledge of these advances was disseminated by public institutions, the healthcare sector and dairy firms,

leading to new consumption preferences among the population. In the nineteenth century, proteins and calories were generally regarded as the most desirable nutrients, and for this reason fresh milk was only consumed as part of liquid diets prescribed for health or age reasons, or as a nutritional supplement, mixed with other foodstuffs such as cereals and tubers to increase its energy value, or to facilitate the intake of stimulants such as tea or coffee. In the early twentieth century, however, milk was accepted as a basic food, especially for infants, and demand increased quickly (Atkins, 1980 and 2010; Hartog, 2007: 131-2; Nicolau et al., 2010; Orland, 2007: 164-6).

To date, agrarian and economic history has focused on analysing the dairy sector in those regions where its development was most intense and has connected this with the availability of fodder (Bieleman, 2005; Carmona and Puente, 1988; Henriksen and O'Rourke, 2005; Knibbe, 1993; Pujol, 2002). Our knowledge of the development of the sector in Mediterranean Europe, and of the role played by biological innovations, remains very limited, however.<sup>2</sup> This article presents new evidence relating to these issues, with two objectives: firstly, to reiterate the significance of these innovations on agrarian development from the mid nineteenth century (Harwood, 2012; Kloppenburg, 1988; Olmstead and Rhode, 2008; Pujol, 2011) and secondly, to present new evidence on the environmental and technological limitations which hampered this process in Mediterranean Europe until well into the twentieth century (Pujol, 2011).

The paper is divided into three sections. In the first section, we present new evidence for the development of the dairy sector in different Central and Northern European countries between the mid nineteenth century and the 1930s, and for the belated and limited spread of this process in Spain. This section also details how cattle numbers and milk yields impacted on the sector. After then considering the effect of the

improvement of animal healthcare and the availability of fodder on the development of the dairy sector, the second and third sections will focus on cattle breeds and their improvement. In particular, the second section examines the possibilities and limitations of these improvements in the bovine sector, analysing the progress made in this regard in Atlantic Europe from the nineteenth century. The third section examines the limited impact of these innovations in Spain and the important role played there by the bulls and cows imported from other countries.

## **2. The development of dairy farming in Europe before the Second World War**

As noted above, the significant advances in dairy farming in Central and Northern Europe from the mid nineteenth century have already been subject to systematic analysis elsewhere. Table 1 shows: a) information collected from different authors and institutions concerning the dairy cow population, milk yields and gross milk production in several countries where the development of the dairy sector was significant; and b) our estimates for Spain (for a detailed breakdown, see Appendix 1). Although these estimates may be refined, we believe that they reflect the main trends in the European dairy sector in the study period. Between 1865 and 1900 milk production increased by eight per cent in France; twenty-five per cent in Holland; between fifty and sixty-five per cent in Switzerland and the United Kingdom and nearly one hundred per cent in Denmark. The expansion of the sector in the first third of the twentieth century was no less significant. Between 1900 and the 1930s, milk production grew by almost fifty per cent in the United Kingdom, Holland, France, and Switzerland, and again by nearly one hundred per cent in Denmark. As a result, the availability of milk for human

consumption increased sharply. Towards the end of the nineteenth century, the amount of milk available for general consumption in the form of liquid milk, cheese, butter and condensed milk, was around 130 litres per capita per annum in the United Kingdom; 160 litres in France; between 400 and 470 litres in Holland and Switzerland and nearly 950 litres in Denmark. Shortly before the Second World War, these figures had climbed to nearly 150 litres in the United Kingdom; 250 litres in France; between 490 and 530 litres in Switzerland and Holland, and nearly 1,400 litres in Denmark.<sup>3</sup> It is, therefore, no surprise that the consumption of dairy products was already high in these countries by the late nineteenth century and that this consumption grew even further in the twentieth century, reaching very high levels (Henriksen et al., 2012; Pirtle, 1922: 5). Specifically, the consumption of fresh milk in the 1930s reached nearly 100 litres per capita per annum in the United Kingdom; 130 litres in Holland and Denmark and nearly 250 litres in Switzerland.<sup>4</sup> Milk consumption in urban areas was even higher in some cases. In the 1930s, the consumption of fresh milk was around 100 litres per capita per annum in Paris, London, and Berlin: 140 litres in Amsterdam and Prague; around 190 litres in Oslo and Vienna; between 230 and 270 litres in Copenhagen, Stockholm, Berne and Zurich, and over 300 litres in Lucerne (Bacon and Cassels, 1937: 628; Bulharowski, 1929:7; Llovet, 1934: 15).

<b>Total bovine population (in thousands)</b>							
	United Kingdom	France	Switzerland	Holland <sup>12</sup>	Denmark	Spain <sup>16</sup>	
						Total	Dairy
1865	2,139	6,587 <sup>4</sup>	553 <sup>9</sup>	860	899 <sup>13</sup>	1,332	
1900	2,607	6,738	688	962	1,089		
1910	2,775	7,602 <sup>5</sup>	797	1,084	1,282	1,412	
1920	2,942	7,590 <sup>6</sup>	752 <sup>10</sup>	1,077	1,322 <sup>14</sup>	2,017	1,172
1930	3,159	8,265 <sup>7</sup>	865 <sup>11</sup>	1,341	1,579	2,174	1,175
<b>Average output per cow (in litres per year)</b>							
1865	1,590	1,222	1,938	2,350	1,553	597	
1900	2,135	1,291	2,350	2,659	2,428		
1910	2,540 <sup>1</sup>	1,434	2,893	2,632	2,670		
1920	2,550 <sup>2</sup>	1,647	2,588	2,528	2,736		1,010
1930	2,603	1,694	2,877	3,239	3,216		1,278
<b>Gross milk production (in millions of litres)</b>							
1865	3,401	8,050 <sup>8</sup>	1,071	2,021	1,396 <sup>13</sup>	795	
1900	5,566	8,700	1,617	2,558	2,644		
1910	7,049	10,900	2,306	2,855	3,422		
1920	7,502	12,500	1,948	2,723	3,619 <sup>14</sup>	1,183	
1930	8,222 <sup>3</sup>	14,000 <sup>7</sup>	2,490	4,343	5,077 <sup>15</sup>	1,502	

Table 1: The dairy sector in Europe, 1865-1930.

Notes: (1) 1909-13, (2) 1924-22, (3) 1936, (4) 1881, (5) 1908-12, (6) 1923-27, (7) 1928-32, (8) 1875, (9) 1896, (10) 1918-22, (12) 1928-31, (12) 5-year period averages, centred around the year indicated on table, (13) 1881, (14) 1921-24, (15) 1928-32, (16) See Appendix 1.1.

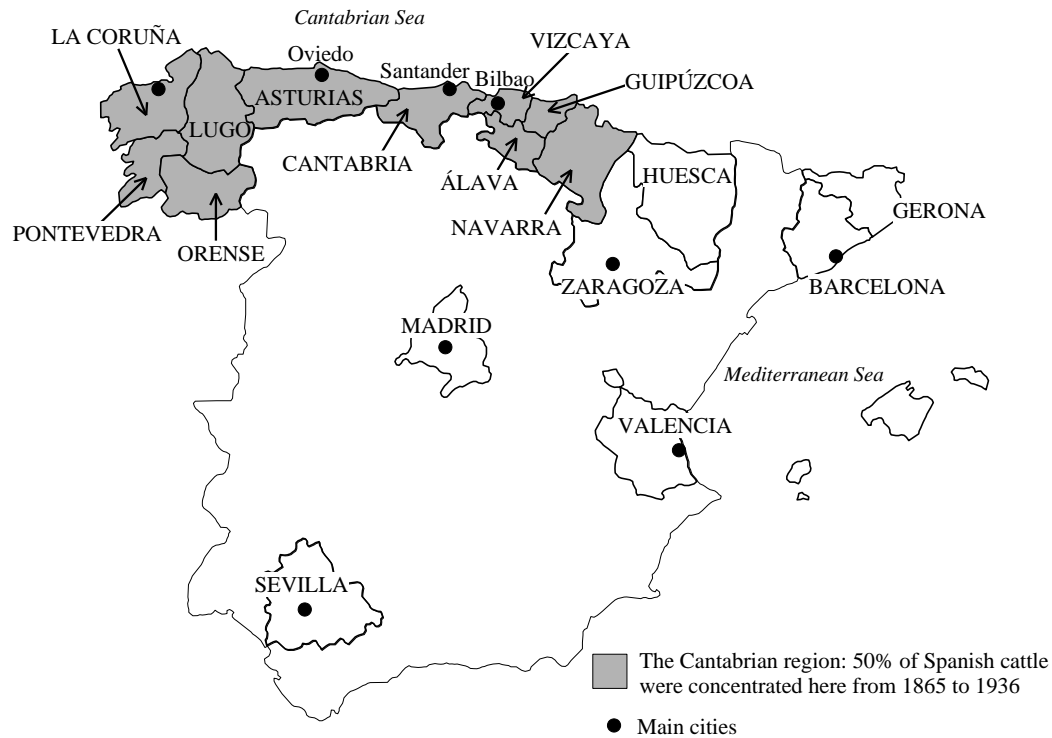
Source: UK: Institut International d'Agriculture, 1940-41: 126-9; Mitchell, 1988: 202-3; Mitchell, 1998: 379 and 383; Pirtle, 1926: 233 and 277; Rew, 1892: 253-4; Taylor, 1976: 596. France: INSEE, 1951: 118-19 and 1946: 93; Toutain, 1971: 1951-1953. Switzerland: *Annuaire Statistique de la Suisse*, 1930: 143-53 and 1950: 118. Holland: Knibbe, 1993: 264-5. Denmark: *Danmarks Statistisk*, 1925: 54 and 1930:38. Spain: see Appendix 1.

Table 1 also illustrates that the growth of the dairy sector in these countries was not only based on the substantial increase in the size of the cattle population, but also on a significant growth in milk yields, especially in the second half of the nineteenth century. According to our calculations,<sup>5</sup> the increase in yields between 1865 and 1930 accounts for over fifty per cent of the growth in gross output in the United Kingdom, France and Denmark, and between forty-two and forty-seven per cent in Switzerland and Holland. We must, however, keep in mind that in the last two countries, yields were already high by the mid nineteenth century (Table 1). Around 1860, the yields were of nearly 2,000 litres per cow per annum in Switzerland, and 2,400 litres in Holland. Also, the impact of yields on the growth of gross output was very stable in Switzerland during the period under consideration, whereas in the other cases the impact was particularly high in the period between 1865 and 1900. During this period, yields account for nearly sixty per cent of gross production growth in the United Kingdom, nearly seventy per

cent in France and Denmark, and around fifty-two per cent in Holland. In the first third of the twentieth century, however, the impact of yields on the growth of gross production was between fifty and fifty-seven per cent in the United Kingdom and France, forty-three per cent and forty-seven per cent in Denmark and Switzerland and only thirty-seven per cent in Holland.<sup>6</sup>

The evolution of the dairy sector in Spain was very different. Firstly, cow's milk production and consumption remained very low until the late nineteenth century. According to our estimations (Appendix 1.1), total production was below 800 million litres, and yields were around 600 litres per cow per annum. Moreover, nearly 550 million litres were used to feed calves, and only 250 million litres were therefore available for human consumption, mostly in the form of liquid milk. As a result, the consumption of cow's milk was uncommon in general and negligible in many regions. The average amount available for human consumption was barely fifteen litres per capita per annum. This figure is supported by other evidence, such as the family budget estimates for the period between 1849 and 1905 and the nearly 200 reports on public health issued by municipal doctors between 1860 and 1910.<sup>7</sup> These studies rarely mention the consumption of cow's milk, and in the few cases where it is mentioned the estimated consumption was in most cases around fifteen litres per capita per annum. Milk consumption was somewhat higher in cities, especially in the north. Around 1900, milk intake was of between twelve and twenty litres per capita per annum in Barcelona and Valencia, nearly thirty litres in Madrid and between forty and sixty litres in Oviedo and Santander (Ayuntamiento de Barcelona, 1902: 526; Calatayud, 2016; Junta Consultiva Agronómica, 1892, volume 2: 260; Luís, 1903: 43; Pérez, 1991: 164-6).





Map 1: Map of Spain and geographical references cited in the text.

Source: Own work.

Secondly, although the situation improved in the first third of the twentieth century, the availability of milk for human consumption remained at low levels with the exception of a few regions (Table 1 and Appendix 1.2 and 1.3). In 1925, total output reached 1.2 million litres, and the amount used for human consumption was a little over 800 million litres, once more almost exclusively in the form of liquid milk. In 1933, total production was nearly 1.3 million litres, 1.1 million of which was used for human consumption. This means that the available average increased from fifteen litres per

capita per annum in the late nineteenth century to thirty-eight litres in the mid 1920s and to a little over forty-five litres ten years later. At the same time, while the availability of milk in the Cantabrian and the Atlantic regions and the Pyrenees in the 1930s was above 100 and even 200 litres per capita per annum, in the central and southern provinces the average was in most cases under twenty-five litres (Appendices 1.2 and 1.3). Within these regions, in only a few cities was the availability of milk above forty-five litres, especially in Barcelona, Madrid and Valencia, where it was over seventy litres. In Seville and Saragossa, which were also important cities, the average was between thirty-three and forty litres per capita per annum (Calatayud, 2016; Doaso, 1931: 26-8; Mas, 1933: 20-1).

Finally, although in the Spanish case the impact of yields and cattle population on output growth cannot be calculated, everything suggests that the impact of the latter variable was much higher than in Central and Northern Europe. By 1890, few Spanish cows were milked regularly, and the relevant statistical data are lacking (Junta Consultiva Agronómica, 1892, volume 1: 160 and 295; volume 3: 442 and 449). According to the engineers working for the National Agricultural Agency (*Servicio Agronómico Nacional*), intensive milking was mostly practised in and around big cities, but the number of cows there was still low. In Madrid and Barcelona, the country's two main cities, yields reached nearly 3,000 litres per cow per annum, but the number of dairy cows was still under 4,000 in total (Luís, 1903: 42-3; Puente, 1992: 34). By way of contrast, in rural areas, in most cases yields were under 500 litres per cow per annum (Appendix 1.1). In 1925 and 1933, however, the number of dairy cows for the whole country was estimated at 1.2 million, and the yields at 1,010 and 1,280 litres per cow per annum respectively (Table 2). At the same time, the number of cows in Madrid and

Barcelona soared to 14,000, but their yields had not grown significantly since the nineteenth century. In Barcelona, the yields were 3,400 litres per cow per annum, and in Madrid 2,700 litres.

In short, the Spanish dairy sector did not begin to develop until the late nineteenth century, and this process was only significant in the northern cattle-breeding regions and the hinterland of the big cities. This process, so our calculations show, was in large part due to the increase in the number of dairy cows. On the other hand, the sector tended to stagnate from the mid 1920s, although the demand for milk kept on growing. In the city of Barcelona, the price of milk in constant 'pesetas' dropped by about fifteen per cent between 1898 and 1920, but climbed up again afterwards to rise above nineteenth-century levels. By the 1930s prices were ten per cent higher than in 1920 (Pujol et al., 2007).

Traditionally, these phenomena have been causally linked with the availability of fodder. It is well known that this increased sharply in Central and Northern Europe from the mid nineteenth century, but in Spain the increase can only be attested from the 1890s, and then only in northern regions and in a few irrigated areas.<sup>8</sup> Outside these regions, environmental conditions severely hampered crop rotation and intensive fertilisation. New evidence also indicates that the availability of fodder in Spain stagnated after the First World War. Fields sown with alfalfa and other fodder increased from 138,000 hectares in 1900 to nearly 385,000 in 1913, and remained stable thereafter. The availability of maize followed a similar trend (Figure 1). Production increased from a little over 400,000 tonnes in the 1890s to 790,000 tonnes in 1914, but then also stagnated. At the same time, maize imports, which had been increasing between 1902 and 1913, dropped significantly during the war and did not recover until

the period between 1921 and 1925. After 1925 they began to fall once again, and by 1935 they were at a very low level.

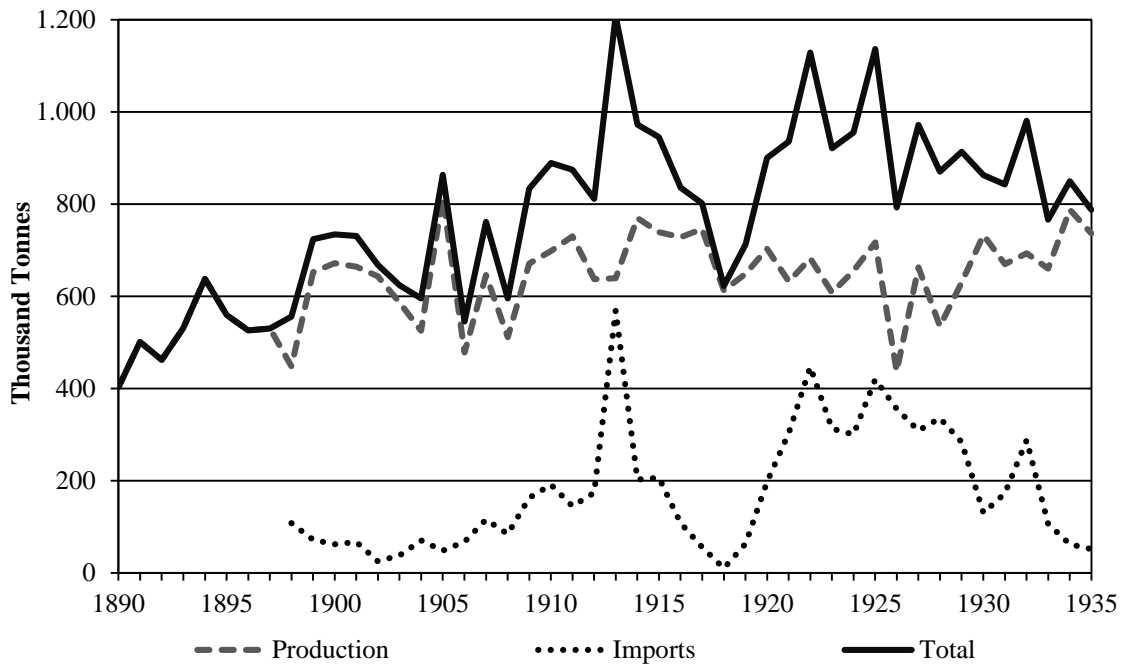


Figure 1: Availability of maize in Spain, 1890-1935.

Source: Barciela et al., 2005: 306-7 and 326-7.

The development of the dairy sector was, however, also affected by other factors. Although the availability of fodder had a direct impact on yields and the number of dairy cows that could be kept, there were other important influences. In particular, yields were increased by better treatment of animal diseases (foot and mouth, contagious bovine pleuro-pneumonia, rinderpest, bovine tuberculosis and brucellosis), and by changes in the breeds used and their enhancement, especially through improvements in mammary gland function (Simm, 1998; Womack, 2012). In the following section, we shall focus on breed innovations. This does not mean, however,

that we disregard the impact of developments in animal health-care on yields. These developments are well documented in Western Europe, especially in Great Britain (Fisher, 1980 and 2003; Spinage, 2003; Woods, 2004 and 2011) and must have had a beneficial impact on the improvement of breeds. For example, increased animal survival would allow better selection of breeding bulls and a more precise evaluation of the milk yields of pregnant cows.

### **3. Innovation in dairy cow breeds in Central and Northern Europe**

The innovation in cattle breeds, as with other biological innovations, is linked to agrarian developments, many of which were well-known in Europe before the turn of the nineteenth century. Furthermore, some studies have suggested that early innovations could have had multiple causes, including cultural factors. With the intensification of trade and competition, economic reasons gained in importance, and innovations accelerated. The objectives pursued were still varied, including greater disease resistance in animals and the changing fat content in milk, but increasing milk yields was always a key target.<sup>9</sup> In this context, however, it is necessary to clarify two points. First, in contrast with wheat and other seeds, experimentation with large farm animals was not economically viable. These animals were expensive, costly to maintain and slow to produce offspring. Moreover, as was later pointed out by geneticists, the number of genes involved in milk production was too high. For these reasons, the decision to improve these animals by inbreeding was endorsed by these specialists. Under natural reproduction conditions, inbreeding was the most suitable method for the elimination of recessive traits which have a negative effect on milk yields and/or the fat content of the milk. This method however, was not free from controversy, especially at

the beginning, and was costly and time-consuming (Theunissen, 2008: 656-7 and 660-3). For these reasons, experts only recommended it in areas where milk yields were already high. Where this was not the case, and milk demand increased rapidly, the obvious alternative was to adapt more productive breeds from other regions. The success of this type of innovation was not, however, guaranteed, since yields were determined not only by the particular breed, but also by the environmental conditions to which that breed had been adapting for generations. As well as temperature, this could involve the impact of disease and the morphology and nutritional characteristics of the fodder, which could vary widely between regions. If the process of adaptation did not work, the only alternative was to try to improve local breeds by cross breeding, which was an even more complex, costly and uncertain process (Derry, 2003; Matz, 2011; Wood and Orel, 2001).

Second, the selection of studs remained problematic until the 1950s. For the identification of a good stud, the productivity of the cows that had been bred needed to be ascertained, and often, by the time this information was known the studs had aged or died. Their breeding life was short, at between eight and ten years, and the number of fecundations limited. Moreover, studs were frequently slaughtered when still young, especially in small farms. In these cases, farmers often selected fast-growing studs to sell for meat when they were between three and four years old and their price was still high (Theunissen, 2008: 661-4).

Despite these limitations, considerable success was achieved in Lucerne and Zurich (Switzerland), Drenthe, Friesland and Overijssel (Holland), Jutland (Denmark), Northumberland, Durham and York (England), Ayr (Scotland) and Jersey and Guernsey (Channel Islands). The contribution of new specialists in zootechnics and the work

carried out by a large number of public agencies and agricultural associations were both important in this regard. Zootechnicians and veterinarians helped to better define the physical traits desired in the breeds that were to be improved. Public and private agencies promoted new laws and regulations aimed at encouraging innovation and its spread. Examples include the periodical organisation of cattle fairs in which prizes were awarded for the best studs and cows; occasional bans on the importation of foreign breeds, which aimed to protect the ‘purity’ of local breeds and/or prevent the dissemination of illnesses; and the establishment of herd books. This last innovation helped to define, as early as the second half of the nineteenth century, the main dairy breeds which remain in use now: Brown Swiss, Jersey, Guernsey, Ayrshire, Milking Shorthorn, and especially the Friesian/Holstein (Bieleman, 2005: 230-2; Orland, 2003: 175-7; Porter, 2007).

Country	Variety	Herd book	
		Year	Name and year of foundation of the associations which managed the herd books
Switzerland	Simmental	1806	Red and White Spotted Simmental Cattle Association (1890)
United Kingdom	Shorthorn	1822	Shorthorn Society of Great Britain and Ireland (1874)
United Kingdom	Jersey	1866	Royal Jersey Agricultural and Horticultural Society (1866)
United Kingdom	Norfolk and Suffolk	1874	The Red Poll Cattle Society (1888)

	Red Poll		
Holland	Friesian-	1874	Netherlands Cattle Herd Book Society (1874)
	Holstein	1879	Friesland Cattle Herd Book Society (1879)
Holland	Meuse-	1874	Netherlands Cattle Herd Book Society (1874)
	Rhine-Yssel	1905	Meuse-Rhine-Yssel Cattle Herd Book (1905)
Holland	Groningen	1874	Netherlands Cattle Herd Book Society (1874)
		1908	Groningen White Headed Cattle Herd Book (1908)
United Kingdom (Scotland)	Ayrshire	1878	Ayrshire Cattle Society (1877)
United Kingdom	Guernsey	1878	Royal Guernsey Agricultural and Horticultural Society (1842)
Switzerland	Brown Swiss	1878	Brown Swiss Cattle Society of Switzerland (1897)
France	Normande	1883	Association Normande (1830s)
United Kingdom	South Devon	1891	South Devon Herd Book Society (1890)
United Kingdom	Shetland	1912	Shetland Cattle Society (1910)

Table 2: Herd books of the main varieties of dairy cows, 1806-1912.

Source: Own work based on Friend, 1978; Porter, 2007; Oklahoma State University, Breeds of Cattle (<http://www.ansi.okstate.edu/breeds/cattle/>).



The herd book registered the animals belonging to the selected breeds and their genealogies and evaluated their 'purity' according to the physical parameters set forth in the regulations. In this regard, the associations played another role by contributing to eliminate the recessive traits caused by random crossing over time. These registries also offered cattle breeders better opportunities for commercialisation, and more quality guarantees for their customers. In short, the herd book resulted in a significant, but hard to calculate, reduction of transaction costs in the emerging livestock markets (Orland, 2003: 180; Theunissen, 2008: 651-4).

Innovations in Switzerland and, especially, Holland were particularly influential on Spanish dairying. The improvement of Swiss cows began in the early nineteenth century, with early cattle exhibitions organised in Berne (1807), Lucerne (1811) and Appenzell (1846). With the support of new regional organisations, these meetings soon became annual events. As a result, newly improved cattle breeds were presented in the universal exhibitions in Paris (1855) and London (1862). Finally, in 1879, the Swiss Brown Race breed was defined and the corresponding herd book, valid for the whole of Switzerland, established. During this process, the breed was introduced into Germany, Italy, France, Russia and Spain, and also the United States (1862), where the Brown Swiss Breeders' Association was created in 1880 with its own herd book (Orland, 2003: 176-8; Pirtle, 1926: 42).

Dutch cattle were also improved during the nineteenth century, and some animals were already enjoying a good reputation by the 1850s, especially the Friesians, whose yields oscillated between 3,000 litres and 4,000 litres per cow per year (Houghton, 1897: 38-41). This prestige encouraged the introduction of the breed in

other countries, especially the United States, where a herd book was established in 1872. A few years later, in 1885, the Holstein-Friesian Association of America was constituted, and the breed, which came to be known as the Holstein, was vastly improved with regard to its yields, to the detriment of the milk's fat content. The Friesian breed was also introduced into Canada, where a new herd book was established (1891), and several European countries, including Spain. During this process, one herd book was created in Bohemia (1872) and three in the United Kingdom (1909, 1914 and 1919) (Bieleman, 2005: 230-1; Porter, 2007: 57 and 341). In Holland, the first herd book was established in 1874. This register was national in scope and included three breeds: Black and White or Friesian, Meuse-Rhine-Yssel and Groningen. Four years later, in 1879, a specific herd book for the Friesian breed was created; a similar step was taken for the Meuse-Rhine-Yssel breed in 1905, and in 1908 for the Groningen breed. As a result of these actions, in some cases yields reached 4,000-5,000 litres per cow per annum in the late nineteenth century (Bieleman, 2005: 232). Yields from other breeds also increased, but not proportionately as much (Table 5).

		<b>1890-1900</b>	
		<b>Gross</b>	<b>Net</b>
United Kingdom	Devon and Shorthorn	2,728	2,346
	Shorthorn	2,485	2,124
	Shorthorn and	2,273	2,091

	Channel Islands		
Scotland	Ayrshire	2,164	1,718
	Crosses	2,311	1,648
	Shorthorn	2,219	1,501
France	Normand	2,910	
	Flemish	2,640	
	Maroillaise	2,425	
	Ferrandaise	2,328	
Holland	Friesian	4,500- 5,000 <sup>1</sup>	
	Groningen	3,000- 4,000 <sup>2</sup>	

Table 3: Yields of dairy cows, 1890-1900 (litre per cow per annum)

Notes: (1) In Frisia; (2) In Groningen.

Sources: United Kingdom and Scotland: Rew, 1892: 253-4; France: Pirtle, 1926: 317;

Holland: United States Consular Reports, 1888: 512.

Following these advances, innovation focused on three targets in the first third of the twentieth-century: the improvement of the genealogical and visual information of the herd book, including the addition of photographs; the organisation of better breeding services; and, especially, the improvement of stud selection processes with the creation of milk production registries (Pirtle, 1926: 293; Orland, 2003: 180-3). In some cases, new, highly reputed studs were also obtained, such as the bull Adema 197 in Holland,

but this only occurred towards the end of the period under consideration (Theunissen, 2008: 648-9).

The first milk register (Cow Testing Association or Milk Control Association) was created in Denmark in 1895. This example was followed in Holland in 1896 and in Germany in 1897. These associations soon multiplied (Orland, 2003: 183; Pirtle, 1926: 221, 264, 265, 279, 293 and 346). By 1914 there were 792 such associations in Germany, including a grand total of nearly 350,000 registered cows (3.4 per cent of the total); by 1933 there were 2,897. By the mid 1920s the number of such associations was 553 in Holland and 1,038 in Denmark (in this case with 394,181 registered cows, thirty per cent of the total). In England these initiatives started later and did not develop quite so fast. The first association was created in 1914, and nine years later, by 1923, there were fifty-five, which included 104,000 registered cows, only 3.5 per cent of the national herd total. Alongside these associations, Bull Societies, aimed at establishing pooling fecundation services on a local level, were also created, although we know little of their activities. By the early 1920s there were 519 in Holland and 1,274 in Denmark.

Despite these initiatives, yields did not increase again significantly until after the Second World War (Figure 2), that is, until new diets gave a boost to animal care and a new technological framework opened up the possibility of further improving the breeds in use to a significant degree. These included the introduction of the Holstein-Friesian breed from the United States, the spread of artificial insemination with frozen sperm and antibiotics, and the development of new fecundation strategies following advances in animal genetics (Bieleman, 2005: 235-9; Foote, 2002: 3-6; Porter, 2007: 57-8, 95 and 340-1; Woods, 2007).

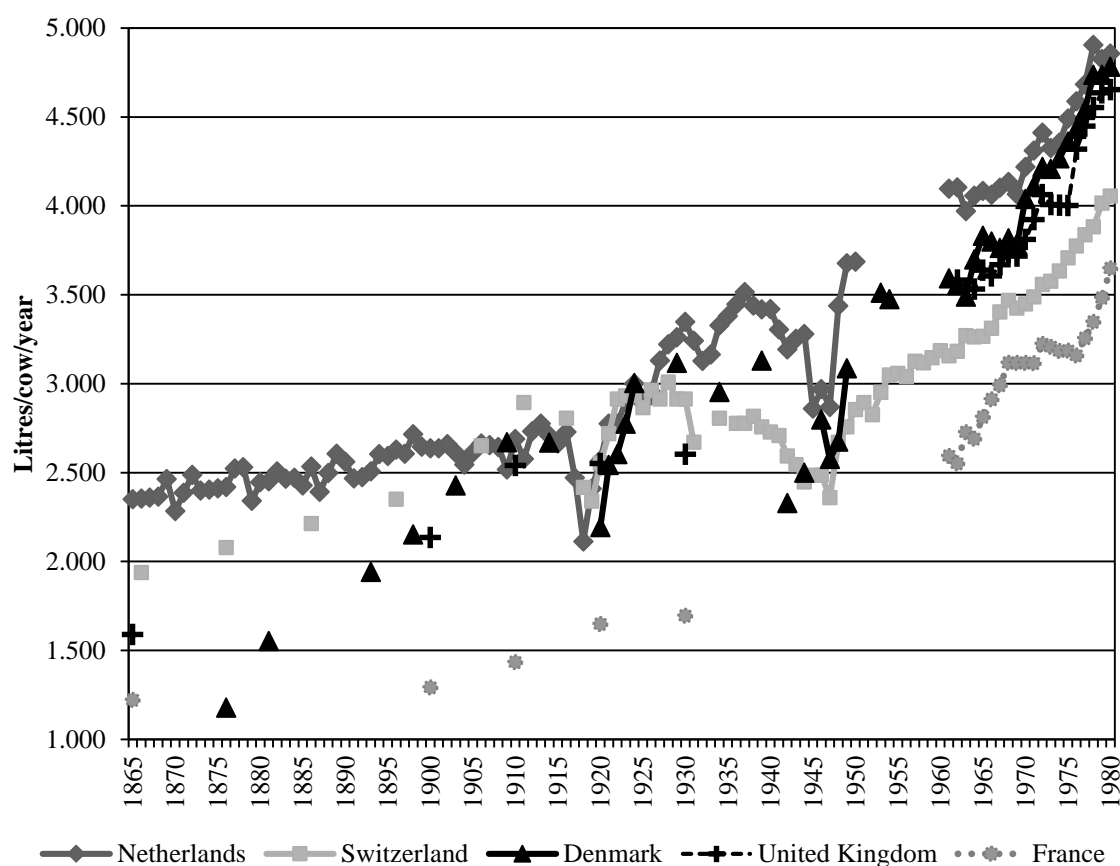


Figure 2: Milk yields in Western Europe, 1865-1980.

Sources: faostat.com; Knibbe, 1993: 264-5; Table 1.

#### 4. The new breeds in Spain

The development of the dairy sector in Spain also involved important biological changes. These changes were, however, very different from those discussed in the previous section. For generations, Spanish cattle had been adapted to their use for work, and, once the animals had gone past their working age, for meat. Only in a few regions,

notably in Galicia, were calves specifically bred for meat (Domínguez, 2003: 466; Martínez, 1991: 9-11; Puente, 1992: 93-4, 190-2). As late as the 1890s, calves were castrated shortly after birth, and cows were undernourished, because farmers considered them a cause of expenditure rather than a source of income. This was even the case with the breeds with higher yields, such as Tudanca, Pirenaica, Pasiega, Campurriana or Campoo and Asturiana de los Valles.<sup>10</sup> When milk demand began to increase in the late nineteenth century, few breeders and technicians supported the use of inbreeding to improve these varieties of cattle. As noted above, this was a costly and slow process, and the chances of success in Spain were considered limited.<sup>11</sup> It was attempted in Guipúzcoa with the Pirenaica breed from 1905, but the initiative was all but abandoned a few years later. By the end of the First World War, no mention of this attempt can be found in the sources (Mendizabal et al., 2005: 42-8; Echevarria and Asarta, 1976: 230-1). Moreover the demand for meat had also been rising since the late nineteenth century, especially, once more, in cities, and until well into the twentieth century, transport infrastructures in Spain were much better prepared for the commercialisation of cattle than of milk from cattle-breeding areas (Puente, 1992: 169-70; Pujol and Nicolau, 2005). In contrast with other European cities, where railways freighted over seventy per cent, and sometimes as much as ninety per cent, of the milk consumed,<sup>12</sup> in Spain, as late as the 1930s, only about seventeen per cent of the milk consumed in Madrid, and thirteen per cent in Barcelona, arrived by train. The rest was produced in urban dairies or by farmers located within distances of under sixty kilometres (Ayuntamiento de Madrid, 1929: 248; Doaso, 1931: 27; Mas, 1935: 25; Vila, 1979: 124-5).

In this context, it is hardly surprising that dairy producers and cattle breeders opted to introduce improved breeds from abroad. The target was twofold. Dairy

producers, who were mainly located in cities and their hinterland, aimed to develop more efficient ways to meet the new milk demand, while cattle breeders sought to adapt these animals to their regions and improve local breeds by absorbent crossbreeding.

In the first instance, the Friesian breed was the most common choice because it adapted well to the environmental conditions at low altitudes and its yields were higher.<sup>13</sup> In the second case, the Swiss breed was often chosen because it was the same type as the local breeds (Alpine), and it made better use of short-stemmed mountain pastures (Rossell, 1923: 23). New breeds did not, however, adapt well, absorbent crossbreeding attempts failed, and the Friesian breed eventually displaced the Brown Swiss because of the pressure posed by urban demand. Ultimately, the sector ended up depending on Friesian cattle and a wide range of mixed varieties which provided higher yields than local breeds due to their hybrid vigour, but the reproduction of these varieties rested upon the periodical import of bulls and cows from abroad.<sup>14</sup> It is still uncertain whether a different institutional framework could have corrected this situation. Besides, agronomic engineers and veterinarians stressed on several occasions that imports did not bring the best cattle and that crossbreeding with native breeds generally lacked the necessary technical supervision (Dirección General de Ganadería, 1932-1933: 48). In addition, Spanish public agencies were seldom aware of this type of innovation: the first herd books and Cattle Yield Testing Regulations were not issued until 1935 (*Reglamento de Libros Genealógicos y Comprobación de Rendimientos del Ganado Vacuno*), and the second not until 1960.

In Guipúzcoa the imports of Brown Swiss began in 1843 but did not become significant until 1863, when local government agencies imported eight bulls and a cow and promoted crossings with the Pirenaica breed by creating new stud depots (148 in

1883) (Mendizabal et al., 2005: 40-1). In the following years, this activity was carried out intensively, and by 1917 there were 30,399 new Swiss x Pirenaica; 17,055 Pirenaica; 542 undetermined and 138 Friesian cattle in the province.<sup>15</sup> This practice soon spread to Vizcaya and Álava (also in the Basque Country), Navarre, Huesca, Asturias, Galicia and Santander. In the Basque Country and Navarre this also involved the active participation of local government agencies such as the Guipuzcoa, Vizcaya and Navarre Provincial Councils.<sup>16</sup> In Santander, imports began in 1865 and crossings with the Tudanca, Pasiega and Campurriana were carried out. Catalonia was also an important destination for these imports. In this region, however, the earliest imports supplied urban dairies in Barcelona (1860) while cattle-breeding areas in the north of the region did not start importing until some years later (1885) (Rossell, 1919: 63).

In Asturias and Navarre the crossing of local breeds with Swiss was soon abandoned. In both regions, the first generations of hybrid cows presented poorly defined traits, and their yields did not exceed that of the local breeds (Junta Consultiva Agronómica, 1920, volume 2: 8 and 37). In Galicia and Huesca, these practices yielded similar results, and the Swiss breed and absorbent crossbreeding were abandoned as early as the 1890s (Junta Consultiva Agronómica, 1892, volume 2: 213 and 345).<sup>17</sup> Sooner or later, the new cattle's ability to produce milk also decreased in Santander (where this occurred with fourth generation animals), the Basque Country and Catalonia. As a consequence, the interest in Brown Swiss rapidly waned (Junta Consultiva Agronómica, 1920, volume 2: 75).

After these failures, the Friesian breed, which was the most sought after in urban dairies, also expanded to cattle-breeding regions, where it replaced the Brown Swiss. In Santander, for example, the bovine population in 1935 included 92,132 Friesian and



40,729 Brown Swiss or derivatives of this breeds; 35,255 Tudanca; 17,268 Campurriana, and 16,576 undefined cattle.<sup>18</sup> The substitution of Swiss for Friesian was even more acute in Catalonia, mostly because of the high milk demand in the largest city, Barcelona. By 1922, the estimation was that for every twelve Brown Swiss animals in the region there were 100 Friesian or related cows (Rossell, 1923: 29).<sup>19</sup>

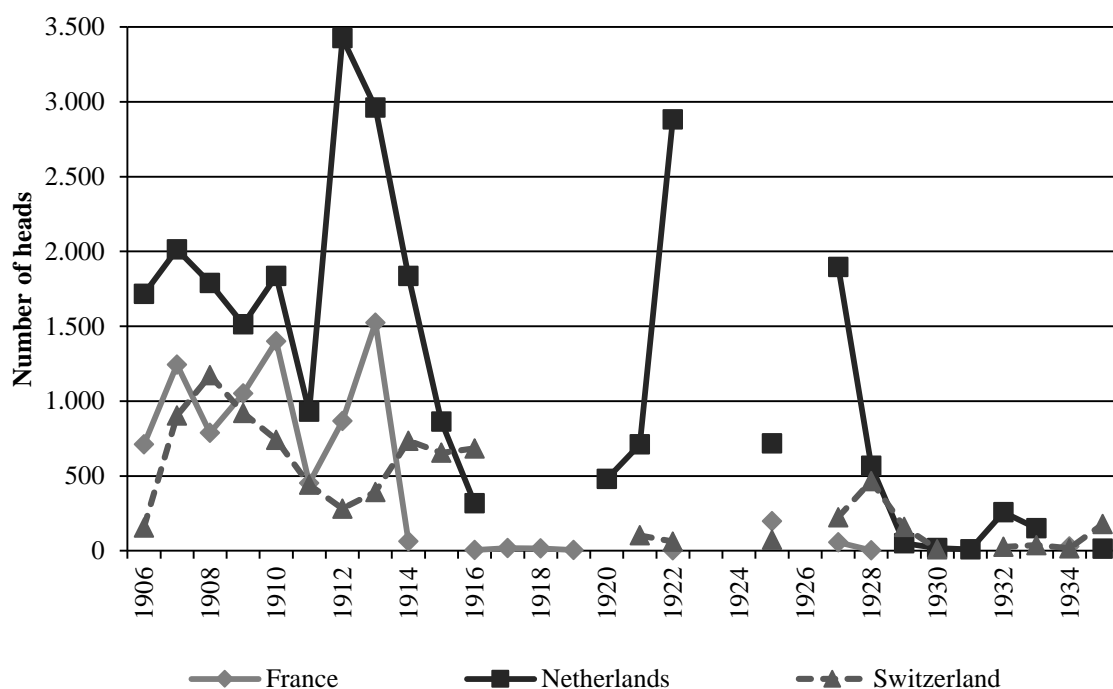


Figure 3: Imports of dairy cows (1905-35).

Sources: Dirección General de Aduanas, 1870-1935 (Statistical Foreign Trade Statistics of Spain).

Foreign trade statistics provide further evidence for this trend, even though they do not include stud-specific information and the country of origin of dairy cows is only recorded from 1906 onwards. As shown in Figure 3, imports of Friesian cows were already predominant in the early twentieth century. Furthermore, this was almost the

only breed whose import continued after the First World War, despite these imports being discontinuous (Domínguez and Puente, 2009: 143-6). In contrast, imports of Swiss cows, which were still high in the early twentieth century, nearly disappeared from 1916 onwards. Figure 3 also shows the sharp drop in 1927 that affected Friesian cows, to the point that imports ceased almost completely in the 1930s. This coincides with the above mentioned stagnation of the dairy sector.

Thereafter, and as could be expected, the Spanish dairy sector was split into two areas: on the one hand, cattle-breeding regions in the north, which specialised in rearing dairy cows for the supply of consumption centres,<sup>20</sup> and on the other hand, milk production centres, mostly located in the cities and their hinterland, which specialised in dairy production. As a result, the number of dairy cattle in cities and their hinterlands was lower, but their yields were higher (Figure 4).

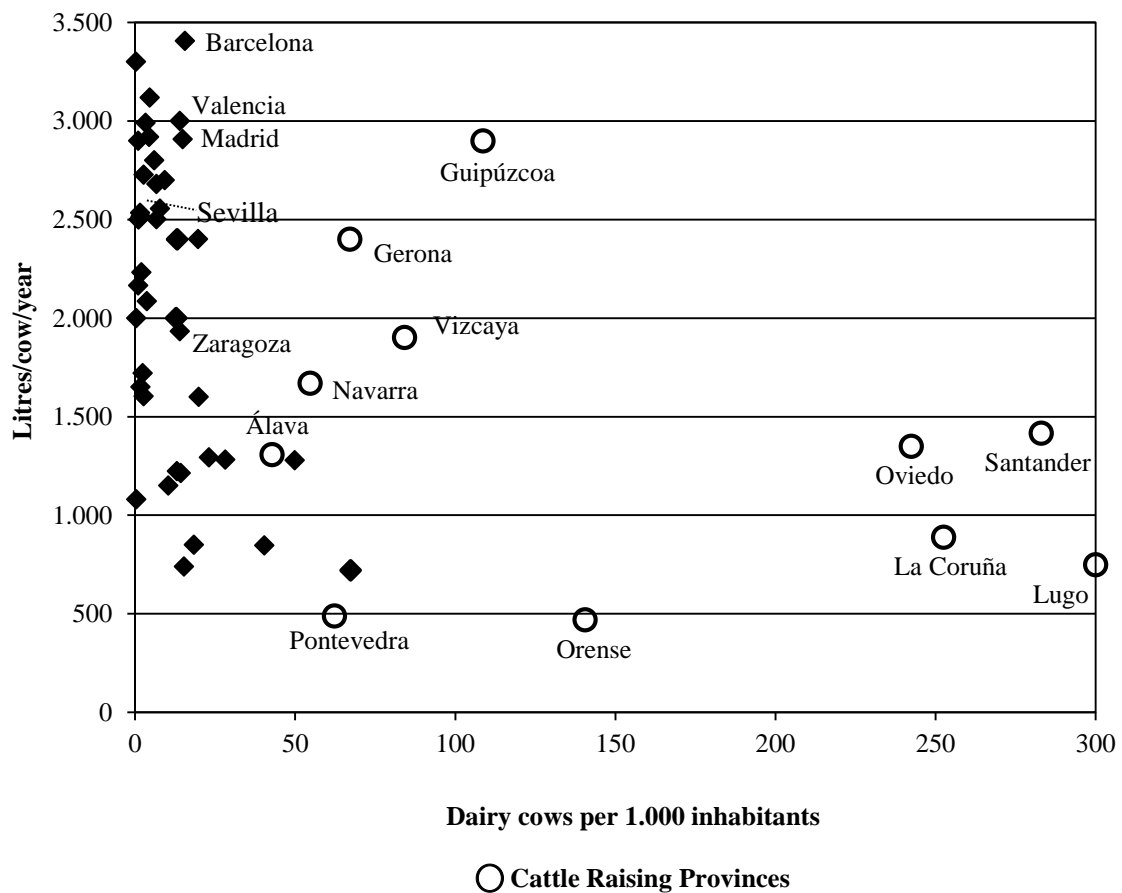


Figure 4: Yields and cows per thousand inhabitants, Spain, 1933.

Sources: Ministerio de Agricultura, 1934: 98-9.

## 5. Conclusions

In this article we put forward new evidence for the development of the dairy sector in Great Britain, France, Holland, Denmark, Switzerland and Spain between the mid nineteenth century and the 1930s. In Central and Northern Europe, the development of the sector was continuous and intense, and was based, especially in the second half of the nineteenth century, on the increase of yields. In Spain, on the other hand, the process did not begin until the 1890s and tended to stagnate after the First World War.

Furthermore, progress can only be detected in the northern cattle-breeding regions and some big cities and their hinterland. Also, in contrast to Northern and Central Europe, the development of the dairy sector in Spain was mostly due to the increase in the number of dairy cattle. In order to explain these divergent trajectories, the availability of fodder has been considered, but special attention has been paid to the breeds in use and their improvement. It is likely that improvements in animal healthcare also had a lot to do with this, but a detailed analysis of this aspect is beyond the scope of this article.

Concerning breed improvement, we have shown that this sort of innovation had a very different impact in both regions. In Northern and Central Europe, innovations in cattle breeds progressed quickly in the nineteenth century, and the main dairy cattle breeds that are still in use now had already been defined by 1870 to 1900. In the first third of the twentieth century, although innovation continued at a brisk pace, the increase in milk yields started to slow down in some cases, probably as a result of the limitations of inbreeding methods based on natural fertilisation. In Spain, in contrast,

the impact of these activities was negligible. Inbreeding improvement was deemed inappropriate for the native breeds, absorbent crossbreeding failed, and breeds developed in Northern and Central Europe adapted poorly to Spanish conditions. As a result, the sector ended up depending on periodical imports of bulls and cows from these other countries (first Swiss and then Friesian). We have also seen how the ultimate predominance of the Friesian breed was caused by the high demand for them in urban areas, and we noted that the progressive reduction of imports from 1927 also contributes to better explaining the eventual stagnation of the Spanish dairy sector thenceforth.

In summary, this article has presented a new case study that has two important implications for rural, agrarian and economic historians. First, we presented the new analytical possibilities that can result from the consideration of innovation in seeds, plant, and animal varieties in these fields. Second, we discussed the relevance of environmental and biological restrictions in the development of the agrarian sector from the mid nineteenth century. Obviously, our conclusions do not question the role also played by institutional factors. In order to gain a better understanding of the development of the agrarian sector in Europe in the period under scrutiny, however, the interaction between technological and institutional conditions should be more considered.

### **Acknowledgments**

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## Appendix 1

### Cow's milk production and consumption in Spain, 1865-1933

A: Number of cows (in thousands)

B: Number of dairy cows (in thousands)

C: Daily average milk output per cow (in litres)

D: Duration of productive period (in days)

E: Days of the productive period reserved for breastfeeding calves

F: Average gross output per cow per annum (in litres)

G: Gross output (in millions of litres)

H: Amount of milk reserved for rearing calves (in millions of litres)

I: Net production (in millions of litres)

J: Net production for direct consumption (in millions of litres)

K: Net supply for direct consumption per capita per annum (in litres)

#### 1.1.Cow's milk production and consumption in Spain, 1865-1890

	A <sup>(1)</sup>	B	C <sup>(2)</sup>	D <sup>(3)</sup>	E <sup>(4)</sup>	F (CxD)	G (FxA)	H (CxE)	I (G-H)	J <sup>(5)</sup>	K
Álava	10.9	-	5 <sup>a</sup>	180	90	900	9.8	4.9	4.9	4.1	41.6
Albacete	2.5	-	3 <sup>b</sup>	150	120	450	1.1	0.9	0.2	0.2	0.9
Alicante	1.9	-	3 <sup>b</sup>	150	120	450	0.8	0.7	0.2	0.1	0.4
Almería	3.8	-	3 <sup>b</sup>	150	120	450	1.7	1.4	0.3	0.3	0.9
Ávila	37.2	-	3.5 <sup>c</sup>	150	120	525	19.5	15.6	3.9	3.3	19.3

Badajoz	26.7	-	3 <sup>b</sup>	150	120	450	12.0	9.6	2.4	2.0	5.0
Baleares	3.7	-	4 <sup>d</sup>	150	120	600	2.2	1.8	0.4	0.4	1.4
Barcelona	4.5	-	4 <sup>d</sup>	150	120	600	2.7	2.2	0.5	0.5	0.6
Burgos	25.6	-	3.5 <sup>c</sup>	150	120	525	13.4	10.7	2.7	2.2	6.6
Cáceres	31.2	-	3 <sup>b</sup>	150	120	450	14.1	11.2	2.8	2.3	8.0
Cádiz	39.9	-	3 <sup>b</sup>	150	120	450	18.0	14.4	3.6	3.0	7.7
Canarias	15.1	-	3 <sup>b</sup>	150	120	450	6.8	5.5	1.4	1.1	4.8
Castellón	0.8	-	3 <sup>b</sup>	150	120	450	0.3	0.3	0.1	0.1	0.2
Ciudad Real	10.3	-	3 <sup>b</sup>	150	120	450	4.6	3.7	0.9	0.8	3.1
Córdoba	20.5	-	3 <sup>b</sup>	150	120	450	9.2	7.4	1.8	1.5	4.3
Coruña (La)	127.3	-	3 <sup>e</sup>	150	90	450	57.3	34.4	22.9	19.1	34.3
Cuenca	3.8	-	3 <sup>b</sup>	150	120	450	1.7	1.4	0.3	0.3	1.2
Gerona	18.4	-	4 <sup>d</sup>	150	120	600	11.0	8.8	2.2	1.8	5.9
Granada	7.2	-	3 <sup>b</sup>	150	120	450	3.2	2.6	0.6	0.5	1.2
Guadalajara	6.0	-	3 <sup>b</sup>	150	120	450	2.7	2.2	0.5	0.5	2.2
Guipúzcoa	42.1	-	5 <sup>a</sup>	180	90	900	37.9	19.0	19.0	15.8	97.3
Huelva	12.1	-	3 <sup>b</sup>	150	120	450	5.4	4.3	1.1	0.9	5.1
Huesca	9.9	-	3.5 <sup>c</sup>	150	120	525	5.2	4.2	1.0	0.9	3.3
Jaén	10.0	-	3 <sup>b</sup>	150	120	450	4.5	3.6	0.9	0.8	2.1
León	72.7	-	3.5 <sup>c</sup>	150	120	525	38.2	30.5	7.6	6.4	18.7
Lérida	17.0	-	4 <sup>d</sup>	150	120	600	10.2	8.2	2.0	1.7	5.4
Logroño	2.8	-	4 <sup>f</sup>	150	120	600	1.7	1.4	0.3	0.3	1.6
Lugo	101.2	-	3 <sup>e</sup>	150	90	450	45.5	27.3	18.2	15.2	35.1

Madrid	13.3	-	3.5 <sup>c</sup>	150	120	525	7.0	5.6	1.4	1.2	2.4
Malaga	12.9	-	3 <sup>b</sup>	150	120	450	5.8	4.6	1.2	1.0	2.2
Murcia	4.6	-	3 <sup>b</sup>	150	120	450	2.1	1.7	0.4	0.3	0.9
Navarra	30.1	-	5 <sup>a</sup>	150	90	750	22.6	13.5	9.0	7.5	25.1
Orense	83.5	-	3 <sup>e</sup>	150	90	450	37.6	22.6	15.0	12.5	34.0
Oviedo	173.7	-	5 <sup>g</sup>	180	90	900	156.3	78.1	78.1	65.2	120.6
Palencia	12.6	-	3.5 <sup>c</sup>	150	120	525	6.6	5.3	1.3	1.1	5.9
Pontevedra	75.2	-	3 <sup>e</sup>	150	90	450	33.8	20.3	13.5	11.3	25.6
Salamanca	41.3	-	3.5 <sup>c</sup>	150	120	525	21.7	17.4	4.3	3.6	13.8
Santander	64.9	-	6 <sup>h</sup>	180	90	1080	70.1	35.1	35.1	29.2	133.0
Segovia	17.9	-	3.5 <sup>c</sup>	150	120	525	9.4	7.5	1.9	1.6	10.7
Seville	32.5	-	3 <sup>b</sup>	150	120	450	14.6	11.7	2.9	2.4	5.2
Soria	12.5	-	3.5 <sup>c</sup>	150	120	525	6.5	5.2	1.3	1.1	7.3
Tarragona	0.9	-	4 <sup>d</sup>	150	120	600	0.5	0.4	0.1	0.1	0.3
Teruel	4.4	-	3.5 <sup>c</sup>	150	120	525	2.3	1.8	0.5	0.4	1.6
Toledo	7.5	-	3 <sup>b</sup>	150	120	450	3.4	2.7	0.7	0.6	1.7
Valencia	0.6	-	3 <sup>b</sup>	150	120	450	0.3	0.2	0.1	0.1	0.1
Valladolid	2.3	-	3.5 <sup>c</sup>	150	120	525	1.2	1.0	0.2	0.2	0.8
Vizcaya	33.2	-	5 <sup>a</sup>	180	90	900	29.8	14.9	14.9	12.4	73.8
Zamora	40.3	-	3.5 <sup>c</sup>	150	120	525	21.1	16.9	4.2	3.5	14.2
Saragossa	3.1	-	3.5 <sup>c</sup>	150	120	525	1.6	1.3	0.3	0.3	0.7
TOTAL	1.332.2	-				597	795.4	505.8	289.6	241.5	15.4

Notes:



(1) Data from 1865 have been used because those from 1891 are heavily underestimated (Grupo de Estudios de Historia Rural (1978)), and we assume that animals under thirty months amounted to fifty per cent of the population of calves.

(2) From J.C.A. (1892: volumes 1-3), we reproduce results for (a) Vizcaya, (b) Badajoz, Cádiz, Cuenca and Ciudad Real, (c) Soria, León and Huesca, (d) Barcelona, (e) La Coruña, Lugo and Orense, (f) Soria, (g) Oviedo, and (h) Santander.

(3) For Santander, Oviedo, Álava, Guipúzcoa and Vizcaya, J.C.A. (1920: 32, 55), for the remaining provinces, J.C.A. (1892: volume 1, 304; volume 2, 89; volume 3, 461).

(4) Authors' own estimation based on the use of the animals and their feeding, from J.C.A. (1892: volume 1, 160, 295, 379 and 384; volume 2, 47-8, 235, 345, 421, 557 and 604-5; volume 3, 65, 117, 216 and 602).

(5) Coefficients from 1925 have been applied: eighty-four per cent of the net production for direct consumption and sixteen per cent for the elaboration of cheese and butter.

Sources: Authors' own from Junta General de Estadística (1868), Junta Consultiva Agronómica (J.C.A.) (1892), Asociación General de Ganaderos (1925), and Powell, Norman and Dickinson (1975: 1723-6).

## 1.2. Cow's milk production and consumption in Spain, c.1925

	<b>A<sup>(1)</sup></b>	<b>B<sup>(2)</sup></b>	<b>F</b>	<b>G</b> <b>(BxF)</b>	<b>H<sup>(3)</sup></b>	<b>I</b> <b>(G-H)</b>	<b>J<sup>(4)</sup></b>	<b>K<sup>(5)</sup></b>
Álava	13,3	3,4	720	2,4	0,2	2,2	2,1	20,8
Albacete	1,9	0,2	635	0,1	0,0	0,1	0,1	0,3
Alicante	5,4	0,3	2.434	0,8	0,1	0,7	0,7	1,3
Almería	1,8	0,1	2.814	0,1	0,0	0,0	0,0	0,1

Ávila	17,1	2,8	707	2,0	0,1	1,9	1,4	6,6
Badajoz	41,6	1,5	2.079	3,1	0,3	2,8	2,8	4,1
Baleares	9,5	6,5	1.579	10,2	0,5	9,7	4,9	14,0
Barcelona	33,3	23,8	2.821	67,2	6,0	61,2	60,3	39,0
Burgos	27,4	5,9	1.831	10,9	0,8	10,1	7,9	22,9
Cáceres	52,8	1,2	768	0,9	0,1	0,9	0,9	2,0
Cádiz	42,4	2,6	2.695	7,2	0,6	6,6	6,1	11,2
Canarias	30,1	14,2	1.168	16,5	0,9	15,6	9,5	19,3
Castellón	2,2	1,2	1.738	2,2	0,2	2,0	2,0	6,4
Ciudad Real	10,9	0,5	1.618	0,9	0,1	0,8	0,8	1,7
Córdoba	36,7	0,7	3.240	2,3	0,2	2,1	2,1	3,5
Coruña (La)	230,6	144,9	555	80,4	5,7	74,8	57,3	77,8
Cuenca	1,9	0,1	1.939	0,3	0,0	0,2	0,2	0,8
Gerona	23,6	5,0	1.395	7,0	0,6	6,3	6,1	18,6
Granada	11,4	0,9	1.853	1,6	0,1	1,5	1,4	2,4
Guadalajara	4,8	0,4	2.087	0,8	0,1	0,8	0,8	3,7
Guipúzcoa	51,3	37,6	1.703	64,0	5,5	58,5	55,6	197,2
Huelva	8,1	0,5	630	0,3	0,0	0,3	0,3	0,8
Huesca	8,4	3,2	3.021	9,6	0,8	8,8	8,1	33,4
Jaén	17,4	0,3	1.054	0,3	0,0	0,3	0,3	0,5
León	92,6	43,8	659	28,9	1,5	27,3	15,5	36,6
Lérida	22,6	3,7	1.754	6,4	0,5	6,0	4,6	15,0
Logroño	6,9	2,4	1.986	4,8	0,4	4,4	4,3	21,3

Lugo	321,1	268,0	558	149,5	8,5	141,1	85,6	183,6
Madrid	20,8	15,1	2.732	41,3	3,7	37,6	37,3	32,2
Málaga	15,6	0,7	1.647	1,1	0,1	1,0	1,0	1,7
Murcia	5,4	0,2	1.766	0,3	0,0	0,3	0,3	0,4
Navarra	32,9	18,4	1.368	25,1	2,1	23,0	21,2	62,1
Orense	74,7	74,7	440	32,9	2,6	30,3	26,1	62,3
Oviedo	247,7	239,1	1.117	267,1	16,4	250,7	165,8	223,7
Palencia	27,1	1,7	1.620	2,8	0,2	2,5	2,3	10,6
Pontevedra	47,8	41,3	685	28,2	2,2	26,1	21,9	40,0
Salamanca	56,3	1,1	2.134	2,4	0,2	2,2	2,2	6,6
Santander	173,8	141,2	1.291	182,2	11,1	171,2	111,9	324,5
Segovia	7,6	1,2	2.701	3,1	0,3	2,8	2,8	16,5
Sevilla	36,1	2,3	2.201	5,0	0,5	4,6	4,6	6,1
Soria	11,4	0,8	1.174	1,0	0,1	0,9	0,8	5,5
Tarragona	0,8	0,6	1.894	1,2	0,1	1,1	1,1	3,0
Teruel	5,2	0,5	2.119	1,0	0,1	0,9	0,9	3,7
Toledo	7,5	1,3	1.904	2,5	0,2	2,3	2,2	4,8
Valencia	5,6	4,3	1.923	8,2	0,7	7,5	7,4	7,4
Valladolid	6,2	3,5	3.027	10,5	0,9	9,6	9,5	32,4
Vizcaya	50,7	42,5	1.648	70,1	6,2	64,0	62,3	141,3
Zamora	46,3	0,8	2.074	1,6	0,1	1,4	1,4	5,2
Zaragoza	10,8	5,6	2.701	15,0	1,3	13,7	13,6	26,7
TOTAL	2.017,4	1.172,3	1.010	1.183,4	82,9	1.100,5	838,1	37,7

Notes:

(1) For La Coruña, Lugo, Orense, Pontevedra, Barcelona, León, Oviedo, Canarias, Santander and Vizcaya, we have used the 1929 census because the data for 1925 are heavily underestimated.

(2) For the same reason, the data for 1929 have been used for La Coruña, Lugo, Orense, Pontevedra, León, Oviedo and Santander, and for 1924 for Cádiz.

(3) Estimations in this column have followed the same procedure used for the 1914 data: from the gross output (G: Gross output), we subtract the milk used for industrial purposes, based on the coefficients indicated, and nine per cent for calf feeding.

(4) From G we subtract the quantities of milk destined for industrial uses and the calves.

(5) The population of the province has been calculated by linear interpolation between the 1920 and 1930 censuses.

Sources: Author's own from Ministerio de Fomento (1924), Asociación de Ganaderos del Reino (1925), and Ministerio de Economía (1930).

### 1.3.Cow's milk production and consumption in Spain, 1933

	<b>A</b>	<b>B<sup>(1)</sup></b>	<b>F</b> <b>(G/B)</b>	<b>G<sup>(2)</sup></b>	<b>H<sup>(3)</sup></b>	<b>I</b> <b>(G-H)</b>	<b>J<sup>(4)</sup></b>	<b>K<sup>(5)</sup></b>
Álava	9,7	4,4	1.309	5,8	0,6	5,3	5,0	46,8
Albacete	3,9	0,3	2.900	1,0	0,1	0,9	0,9	2,5
Alicante	5,6	0,6	2.500	1,4	0,1	1,3	1,3	2,2
Almería	2,0	0,1	1.080	0,1	0,1	0,1	0,1	0,3
Ávila	40,0	2,9	1.223	3,5	0,4	3,2	3,2	13,3
Badajoz	39,0	1,9	1.604	3,1	0,3	2,7	2,7	3,9

Baleares	12,7	10,3	1.281	13,2	0,9	12,3	7,9	20,8
Barcelona	30,9	28,0	3.406	95,3	8,9	86,4	80,1	45,2
Burgos	34,4	14,3	846	12,1	1,0	11,1	8,8	24,4
Cáceres	59,1	4,7	1.150	5,4	0,5	4,8	4,5	9,9
Cádiz	45,7	3,4	2.501	8,5	0,8	7,6	7,6	14,2
Castellón	2,4	1,4	3.118	4,4	0,4	4,0	4,0	12,6
Ciudad Real	5,6	0,8	2.533	1,9	0,2	1,7	1,7	3,4
Córdoba	26,8	1,3	2.231	3,0	0,3	2,7	2,6	3,9
Coruña (La)	216,5	193,8	890	172,5	13,8	158,7	124,2	147,3
Cuenca	1,3	0,3	2.166	0,6	0,1	0,6	0,6	1,8
Gerona	43,6	21,8	2.402	52,4	5,2	47,2	46,6	140,9
Granada	10,6	1,5	1.720	2,6	0,3	2,3	2,3	3,4
Guadalajara	7,6	0,8	2.086	1,6	0,2	1,4	1,4	6,7
Guipúzcoa	50,0	32,8	2.900	95,2	9,3	85,9	83,7	277,7
Huelva	10,7	0,6	1.650	1,0	0,1	0,9	0,9	2,4
Huesca	12,3	1,4	2.800	4,0	0,4	3,7	3,4	13,2
Jaén	12,3	0,3	2.000	0,5	0,1	0,5	0,3	0,5
León	93,9	27,5	489	13,5	0,8	12,7	6,8	14,4
Lérida	21,0	4,1	2.400	9,9	0,6	9,3	5,3	17,0
Logroño	7,5	1,6	2.555	4,0	0,4	3,6	3,6	17,2
Lugo	322,0	266,0	750	199,5	12,2	187,3	109,5	208,9
Madrid	35,9	20,6	2.907	59,9	5,9	54,0	53,4	39,3
Málaga	21,1	1,1	2.516	2,7	0,3	2,4	2,4	3,8

Murcia	13,7	0,2	3.300	0,6	0,1	0,5	0,5	0,8
Navarra	37,8	18,9	1.670	31,5	2,9	28,6	26,3	74,8
Orense	121,8	59,9	470	28,1	2,8	25,3	25,3	53,3
Oviedo	253,1	191,9	1.350	259,1	19,4	239,7	174,9	209,5
Palencia	8,2	3,8	849	3,2	0,3	2,9	2,7	12,6
Palmas (Las)	22,2	11,0	1.600	17,6	1,5	16,1	13,9	51,4
Pontevedra	49,4	38,2	720	27,5	2,4	25,2	21,4	33,5
Salamanca	70,7	6,7	2.400	16,1	1,6	14,5	14,5	39,7
Santa Cruz T.	8,6	7,9	1.214	9,6	1,0	8,7	8,6	26,2
Santander	172,8	103,0	1.417	145,9	9,3	136,7	83,5	222,4
Segovia	24,8	2,2	2.000	4,5	0,4	4,0	4,0	21,8
Sevilla	44,8	5,4	2.680	14,5	1,4	13,0	13,0	15,8
Soria	11,6	3,6	1.293	4,7	0,4	4,2	3,9	23,9
Tarragona	0,3	0,9	2.727	2,6	0,3	2,3	2,3	6,7
Teruel	4,1	0,8	6.560	5,5	0,5	4,9	4,9	19,4
Toledo	9,0	2,1	2.919	6,2	0,6	5,6	5,5	11,3
Valencia	16,8	14,6	3.000	43,7	4,4	39,3	39,2	35,7
Valladolid	5,9	2,8	2.700	7,5	0,8	6,8	6,8	21,4
Vizcaya	55,8	40,8	1.903	77,6	7,6	70,0	68,8	141,1
Zamora	44,6	4,3	739	3,2	0,3	2,8	2,8	9,8
Zaragoza	14,0	7,5	1.933	14,5	1,3	13,1	12,1	22,6
TOTAL	2.174,4	1.175,0	1.278	1.501,9	123,3	1.378,6	1.109,7	45,7

Notes:

- (1) For Barcelona and Madrid we have used the 1929 estimations because those for 1933 do not include data for urban cows.
- (2) The production from the urban dairies in Barcelona and Madrid has been added up (29 and 20 million litres respectively).
- (3) According to the sources, it was ten per cent above the production reserved for direct consumption.
- (4) As in the source, the milk reserved for rearing calves has been deducted from the production reserved for direct consumption.
- (5) The population of the province has been calculated by linear interpolation between the 1920 and 1930 censuses.

Source: Authors' own, based on García (1927: 959), Ayuntamiento de Madrid (1929: 248), Ministerio de Agricultura (1934), Mas (1935:25) and Ministerio de Economía (1930).

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### Notes

<sup>1</sup> Concerning supply and transportation, see Atkins (1980), Hernández y Pujol (2016), Orland (2005).

<sup>2</sup> For Holland and Switzerland, see Bieleman (2005), Orland (2003), Theunissen (2008).

<sup>3</sup> We estimate that the percentage of milk used to feed calves between 1900 and 1930 amounted to 11.5% of the total output in the United Kingdom, 23.7% in France, 7.5% in Denmark and 4% in Holland. In Switzerland, milk used for this purpose amounted to 16.6% of the total production in 1900 and to 19.8% in 1930 (Annuaire Statistique de la Suisse, 1930: 153; Institut International d'Agriculture, 1940-41: 126-9; Toutain, 1971: 1951). The international trade in dairy products has not been taken into consideration; at any rate, it is a factor with no effect on our arguments.

<sup>4</sup> Annuaire Statistique de la Suisse (1930: 153), Institut International d'Agriculture (1940-41: 126-129), League of Nations (1937: 34), Toutain (1971: 1951). Population data in Rothenbacher (2002). The consumption of liquid milk in the form of condensed milk has not been taken into consideration.



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<sup>5</sup> We presume that  $r_p = r_r + r_v + r_r \cdot r_v$ , where  $r_p$ ,  $r_v$  and  $r_r$ , are, respectively, the increase rate of production, number of cows and milk yields. Then, we calculate the impact of yields on production increase with the formula:

$$\left( \frac{r_r}{r_p} \left[ 1 + \frac{r_v}{2} \right] \right)$$

<sup>6</sup> France deserves a specific analysis because yields in this country were low, but higher than in Spain. It is likely that this has to do with the environmental variability of France compared to Holland, Denmark, Switzerland and Great Britain.

<sup>7</sup> On family budgets, see Ballesteros (1997: 190-211), González and Guzmán (2006: 458), Junta Consultiva Agronómica (1892). References to these reports are in Urteaga (1980) and Vallribera (2000) and, especially, in section 14.2 of the database available at [www.proyectonisal.org](http://www.proyectonisal.org).

<sup>8</sup> For Central and Northern Europe see Grigg (1992), Henriksen and O'Rourke (2005: 545-7), Knibbe (1993: 154-5). For Spain see Simpson (1995) and Pujol (2002).

<sup>9</sup> For cultural and social motivations see Orland (2003) and Ritvo (1987: 45-81).

<sup>10</sup> In these cases, average output oscillated between eight litres and twelve litres per day, but only if cows were stable-fed and milked intensively, as was common practice in cities (Junta Consultiva Agronómica, 1892).

<sup>11</sup> In Guipúzcoa, for example, although the engineers working for the *Servicio Agronómico Nacional* (National Agricultural Agency) were initially favourable to the crossing of the Pirenaica and the Swiss varieties, many farmers were from an early date in favour of replacing the Pirenaica variety '*por la suiza*' ('with the Swiss cows') (Dirección General de Agricultura, 1913: 16; Rossell, 1923: 9 and 23-4; Santiago, 1922: 8).

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<sup>12</sup> Eighty per cent of the milk consumed in London in 1891 was transported by train, seventy per cent in Paris in 1870 and seventy-two per cent in Berlin in 1902.

<sup>13</sup> Initially, other varieties were also imported. In 1891, the dairies of Saragossa, for example, also used the Ayrshire (Scotland), Suffolk and Jersey (England) breeds, alongside some French varieties (Norman, Bretonas, Comtoises, Aubracs and Tarentaises) (Junta Consultiva Agronómica, 1892, volume 1: 508).

<sup>14</sup> Carlos Santiago, who was in charge of *Servicio de Higiene Pecuaria* (Livestock Hygiene Service) in Santander, claimed that many farmers in the region of Pas started by replacing local cattle breeds with Brown Swiss, but ‘later realised that the exploitation of the Dutch variety was much more profitable and, little by little, introduced these animals, which have now taking over the whole region of Pas’ (Santiago, 1922: 2-4). See also, Rosell (1923: 14) and Langreo (1991: 90).

<sup>15</sup> Dirección General de Agricultura (1913: 19), Junta Consultiva Agronómica (1920, volume 2: 69-70 and 75), Santiago (1922: 6). Another set of statistics dating to 1913 estimated the number of Pirenaica at 19,500, of Swiss at 15,000, and of Swiss x Pirenaica at 15,500 (Mendizabal, Ibarbia and Etxaniz, 2005: 47).

<sup>16</sup> Dirección General de Agricultura (1913: 12, 19-22), Echevarria and Asarta (1976), Junta Consultiva Agronómica (1920, volume 2: 54 and 57-8), Langreo (1995: 89-90), Mendizabal et al. (2005), Nagore (c.1920: 23-7). For crossings with Schwitz, see Santiago (1922: 6-8).

<sup>17</sup> For Huesca, the Agronomist Engineer of the Province declared that ‘taking the geographical and topographic conditions of the Swiss Republic into account, we tried to adapt the sort of animals that works there in the Pyrenees. The experiments, however, were not successful, both for pure and crossed breeds, no doubt because of the

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meteorological rigours of the region' (Junta Consultiva Agronómica, 1892, volume 2: 345).

<sup>18</sup> During this process, Santander harbour became the main gateway for the import of Friesian cows in Spain (Junta Consultiva Agronómica, 1920, volume 2: 8; Sanz, 1935: 345).

<sup>19</sup> This can also be observed in other regions, such as Valencia, where the provincial farming agency decided in the early twentieth century to 'have in stock studs with good aptitudes to breed good dairy cows ... for which purpose it started the import of pure Dutch bulls, of which 38, between 18 and 22 months old, have already been' (Dirección General de Agricultura, 1929: 16).

<sup>20</sup> Junta Consultiva Agronómica (1920: volume 2, 13); Puente (1992: 151-94); Santiago (1922: 3).