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Changes in the livestock sector and animal nutrition: the Italian feed industry in the nineteenth and twentieth centuries

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KEYWORDS: **Italy, livestock farming, animal feeding, compound feed.**

JEL CODES: **N54, N63, N93, 013.**

The aim of this work is to study the evolution of the modern feed industry in Italy. Livestock feeding changed during the nineteenth century with the spread of oilseed cakes. In European countries with more advanced agriculture, traditional forages were gradually replaced by a new range of products made from tropical seeds and vegetable oils. Italy was among the European countries that created an industry for the manufacture of oilseed cakes during the nineteenth and twentieth centuries. In the 1930s, zootechnical feeding was modernized with the advent of compound feeds, which have been widely used since the mid-twentieth century. Italy became a European leader in feed manufacture, as the economic boom and increased purchasing power led to greater consumption of meat and dairy products. Though Italian and European production capacity remained high at the beginning of the twenty-first century, a new phase began with the emergence of other feed-producing countries and the impact of the international debate on the negative effects of intensive livestock farming on animal living conditions and ecological balances. The Italian case shows how the history of the feed industry constitutes an important chapter in the modernization of contemporary agriculture.

Cambios en el sector ganadero y la alimentación animal. La industria italiana de piensos (siglos XIX y XX)

PALABRAS CLAVE: **Italia, ganadería, industria de piensos, piensos compuestos.**

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El objetivo de este trabajo es estudiar el nacimiento y la evolución de la moderna industria de piensos en Italia. La alimentación ganadera cambió durante el siglo XIX tras la difusión de las tortas oleaginosas. En los países europeos que tenían una agricultura más avanzada, los forrajes tradicionales empezaron a ser sustituidos por una nueva gama de productos fabricados con semillas y aceites vegetales tropicales. Italia fue uno de los países europeos en los que, entre los siglos XIX y XX, se creó una industria para la fabricación de tortas oleaginosas. En los años treinta la modernización de la alimentación zootécnica se consolidó con la llegada de los piensos compuestos, cuyo uso se generalizó desde mediados del siglo XX. Italia se coloca entre los países europeos líderes en la fabricación de piensos. Son los años del boom económico, y el aumento del poder adquisitivo de las familias conllevó un mayor consumo de carne y de derivados lácteos. A comienzos del siglo XXI, aunque la capacidad productiva italiana y europea sigue siendo elevada, se entra en una nueva fase a causa de la irrupción de nuevos países productores de piensos y del impacto del debate internacional acerca de los efectos negativos que tiene la ganadería intensiva sobre las condiciones de vida de los animales y de los equilibrios ecológicos. El caso italiano demuestra que la historia de la industria de piensos constituye un capítulo importante de la modernización de la agricultura contemporánea.

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1. INTRODUCTION

The history of feed is an important field of research in order to analyse the changes brought about by the industrialization process in agriculture (Federico, 2009). Currently, the livestock sector appears to be dominated by ethical implications and the impact of "meatification" on agricultural ecosystems (Gingrich & Krausmann, 2018; Neo & Emel, 2018) generates clear scientific and cultural contradictions (Weis, 2007, 2013). The literature devoted to the breaking of socio-ecological balances caused by the European animal colonialism in large areas of the planet is also interesting (Anderson, 2004; Crosby, 2015; Fischer, 2015; Woods, 2017; Walker, 2014). Moreover, this issue entails other complex problems due to the fact that the livestock industry quickly started to involve new emerging powers and societies, in a phase of rapid growth in food needs (Sans & Combris, 2015). Livestock production therefore constitutes an open field of investigation as far as the history of nutrition is concerned. Cattle fattening is an essential aspect of the agricultural revolution which began in Atlantic Europe in the late 18th century (Chorley, 1981). The search for livestock unit (LSU) higher yields (milk, meat, eggs, work) led to the introduction of both technological and veterinary innovation and animal nutrition became a relevant subject of scientific research (Matz, 2015).

Although animal energy supply was subject to fodder availability for some time (Garrabou, 2005), in the 19th century, livestock farming proved to be a fertile field of experimentation (Trow-Smith, 2013) and the evolution of animal nutrition is an important chapter in the history of the relationship between agriculture and economic development. If we also take into account environmental history, to the best of my knowledge, there are only a few contributions of economic history that carefully identify phases, actors, tools and results which contribute to the development of the modern feed industry (Coffey *et al.*, 2016; Dean, 1996).

Since the early 19th century, the history of animal feed has intersected the history of fertilizers which many researchers consider to be one of the main factors boosting Western agriculture's decisive leap towards industrialization (Corona & Massullo, 1989; Dixon, 2018; Pezzati, 1994; Smil, 2001). Contact points between fertilizers and feed are numerous to the point of making livestock feeding a central alternative for organic regeneration of the soil. Excrement, powdered bones, skin and plant remains contributed to the enrichment of soils with nitrogen and phosphorus. However, the Western countries' energy demand in agriculture paved the way to the resources provided by international trade. Thus, feed has strengthened the ecological influence of European imperialism (Crosby, 2015). At the beginning of the 19th century, guano-related phosphate-rich minerals arriving in Europe from Peru (Cushman, 2013) together

with the spreading of the oilseed cakes were the first signs of an agro-zootechnical revolution.

However, even after the discovery of chemical fertilizers, the problem of obtaining high-quality manure remained open, as well as the problem of improving the effectiveness of animal origin fertilizers (Pujol-Andreu, 2005). In the 19th century, European agriculture, which was driven by growth of the continental population and a decline in the productive capacity of an increasingly depleted land, had a great need for organic materials (Thompson, 1968). Hence, the efforts by European farmers to regenerate soil fertility represents an indelible mark in agricultural history (Krausmann, 2004). Initially, these organic materials were directly added to the soil to increase the quality of the manure, but they were soon used in livestock feed as nutrient ingredients for the healthy growth of cattle, no matter whether they were used for work, meat, milk or leisure (Brassley, 2000).

It should be mentioned that the 19th century has been considered "the century of animals" (Deluermoz & Jarrige, 2017). In that period, for military reasons, there was a significant increase in the number of horses in England and the United States. The number of cattle and new breeds of pigs, most suitable for indoor breeding and meat production (*i. e.* Large White), also rose in Europe (France, Belgium, Germany) (White, 2011). Consequently, livestock feeding became a strategic issue. Although in the 19th century, European farmers began to obtain a growing share of goods required for agricultural production (machines, fertilizers, feed, seeds) from the industrial market (Grigg, 1994: 136-37; Thompson, 1968), endogenous resources for energy production did not disappear. On the contrary, in the most advanced agroecosystems, mixtures of traditional and new generation feeds increased.

At the end of the 19th century, due to the rapid spread of chemical fertilizers and oilseed cakes, livestock feeding moved from traditional fodder to the use of industrial products. Livestock feeding, previously considered an appendix to agriculture, became a specific sector of the agricultural industry. Hence, oilseed cakes constituted the basis of the modern feed industry for a long time, until the second half of the 20th century, in tandem with the well-established practice of using the residues of mechanical processing of cereals[1], legumes, sugar beets, potatoes, olives and many other agricultural by-products (Galán *et al.*, 2012). As a result, the nascent feed industry intersects with the much more consolidated milling industry. From the first decades of the 20th century, this scenario becomes even richer in terms of solutions due to the advent of compound feed. Production

1. The lower use of waste is also the result of the cultivation of cereal varieties which produce a lower quantity of residues (Carranza-Gallego *et al.*, 2018).

peaked after the Second World War when the per capita meat consumption became equally shared between working and lower classes due to the economic boom and higher household incomes.

Since its birth, at the end of the 19th century, modern feed has become the object of interest of many branches of science such as the history of agriculture, the history of livestock and the history of the environment, though links between these fields cannot be exhaustively dealt with here. Most of the available studies address recent phases in the evolution of the feed sector throughout the 20th century (Clar Moliner, 2005, 2008, 2010), whereas there is a lack of insight regarding both its origin and evolution between the 19th and 20th centuries. The main objective of this paper is to demonstrate that Italy is an excellent observation point for examining both the birth and development of the feed industry in Europe. The first part of the paper discusses the diffusion of oil cakes made with vegetable oils mixed with cereals (maize) and agro-industrial waste. In fact, in addition to a solid manufacturing and commercial olive oil sector, Italy had large quantities of industrial residues (from oil mills, mills, dairies, pasta factories) to use in cake manufacturing (Vaquero Piñeiro, 2019) and the Italian economy made a significant contribution to the first globalization of the market of colonial oils to be used in manufacturing animal foods rich in protein.

A second examined phase refers to decades in the 1920s and 1930s and was dominated by fascist policies which strengthened previous trends with a growth in both panel production and export. Furthermore, compound feed production too started to develop in the early Thirties. A central role in this renewal was played by Federconsorzi, the large landowners' association. All these are clear hints of the link between the agricultural institutions' choices and the Italian industrial take-off (Swinnen, 2018). The feed industry took advantage of the protectionist cereal policies imposed by fascism, while technological modernization as well as scientific progress (Nützenadel, 2001) contributed to the development, in the country's primary sector, of one of the main factors of the livestock economy (Aguilera *et al.*, 2015).

The last part of this article deals with the phase of full industrial development which started with the Second World War and continues to the present day. During these decades great changes took place and Italy moved from a traditional agricultural system to an intensification of productivity. Dairy farm mechanization increased and animal feed consolidated market-oriented livestock (Barsanti, 2002). Compound feed dominated the animal feed market and domestic demand replaced exports. Under the pressure of both industrialization and revolution in food consumption (Scarpellini, 2016), Italy catches up with the major European powers in the production of compound feed (Rastoin & Ghersi,

2010). At the beginning of the 21st century, the sector appears to be conditioned by strict EC regulations on animal nutrition[2] and by growing world competition as well as by trends in demand which is increasingly sensitive to ecological sustainability issues. Disputes about the negative effects of chemistry boosted the return to plants as animal feed, thus allowing us to draw an evolutionary line from the 19th century, when farmers began to use flours and cakes made with tropical plants, to the present day.

Without aiming to create a rigid model, a trend is identified from the end of the 19th century, when oil cakes gained popularity, until the triumph of compound feed in the second half of the 20th century. Focusing on the evolution between the two centuries, this study provides new insight into the stages, actors and factors that contribute to the shaping of an industrial sector that was decisive for agricultural modernization.

2. THE BIRTH OF THE FEED INDUSTRY: SEEDS AND OIL CAKES

In a first period, which dates back to the first decades of the 19th century, the reasons for consuming artificial feed were associated with the need to increase the quantity of fertilisers available to farmers. Despite the growing agronomic literature regarding oilseed cakes for livestock and the general debate about the potential benefits of these new feeds, there was scarce evidence on the effectiveness of their use. In particular, the question was to what extent better livestock feeding would have led to a significant increase in the quantity and quality of organic fertilizers. The fattening of the soil resulting from oilseed cake-feed animals was one of the main topics discussed at the Congress of Italian Scientists held in Naples in 1845. However, on that occasion, while a lively debate concerned the use of the oilseed cakes as soil fertilizers, the possibility of using them for livestock feeding was marginally considered (Dorotea, 1845: 28-9).

In the first half of the 19th century, oil cakes fuelled intense trade in Europe. While France was the first producing country, Great Britain and Belgium were the most dynamic import markets. During this century, in England too there was an increase in animal energy (Kander & Warde, 2011) which could be considered a consequence of the spreading of the use of oil cakes. Although French productivity was the result of a consolidated national tradition (Larbalétrier, 1890: 34), the great novelty of the first decades of the 19th century were imports of oily substances from the Tropics through the port of Marseille

2. After the 1996 encephalopathy crisis (BSE), the use of bone meal and animal remains prohibited in EU countries. This decision has generated a strong dependence on imports, in particular of soybean meal.

(Brassley, 2000; Turner, 2004). Taking advantage of its strategical position in the trade of olive oil for soap making, Marseille strengthened its hegemonic role in imports of vegetable oils and substances. Towards the middle of the century, Germany, the Netherlands, Denmark and even the United States followed the British example (Desrochers & Szurmak, 2017). As a result, these countries significantly increased their livestock assets.

Conversely, the spread of oilseed cakes in Mediterranean countries was not so rapid. Despite the progressive agricultural modernization, feeding livestock remained for almost the entire 19th century subject to the availability of pastures and fodder, also in regions such as Lombardy (Cazzola, 1994). Over the turn of the century, Italian dairy and meat cow farms showed a clear interest in oilseed cakes regardless of their structural backwardness, as pointed out by an increasing number of publications and scientific essays (Giglioli, 1905). Another hurdle for the use of oilseed cakes in livestock feeding was the common belief that meat from animals raised using not widely known substances could have a bad taste. It is no coincidence that Law No. 7045/1890, concerning the supervision of food and beverage hygiene, established that meat with unpleasant flavours and smells from animals fed with rancid rapeseed and fenugreek seed cakes was to be destined for sale in "low-quality butchery".

At the end of the 19th century, although in Italy it was a barely incipient reality, it was clear that the industrial feed for livestock trade could be tantamount to the chemical fertilizer one (Giglioli, 1905). In the first decades of the 20th century, when the Italian edible oil industry was consolidated, the market was dominated by "flaxseeds" (Macfadyen, 2018). However, flax was not the only raw material used. Cotton, sesame, coconut, palm, hemp, tomato, walnuts, sunflower seeds, and a long list of plants were also used. The cakes, square or circular in shape as if they were *pizze*, were made by compressing cornflour mixed with residues of oil squeezing (10%) and averaged about 2-3 kg. The cakes were often ground to a fine powder to overcome the initial resistance of animals and get them used to the new flavours of this protein- and lipid-rich feed. In the early 20th century, in Italy, the cost of 100 kg of cakes ranged from 13-14 to 15-17 *lire* (Ministero di agricoltura, industria e commercio, 1898: n. 1, 107-12).

Oilseed cakes made with a single type of oil or compound oilseed cakes resulting from a mix of raw materials could be found on sale. Compound oilseed cakes were the most exposed to manipulation, and therefore producers called for a law that, following the model of the 1896 Belgian regulation, would require sellers to report the type and origin of the raw materials used for the oilseed cakes as well as keep documentation attesting to the performing of chemical analyses, available in their shops. One of the most common counterfeiting practices was the use of flaxseeds from Egypt to replace those from

India, which were much more expensive but of better quality. In addition, oilseed cakes were given special fancy names to attract the curiosity of consumers for marketing purposes. However, at the beginning of the 20th century, in Italy there was no law governing the compound feed industry, thus making it easy to have fraud adulterated sales and packaging of products without any warranty certificate.

It is usually said that the modern feed industry results from development of the use of milling by-products. This is partly true since for a long time the feed industry has allowed waste from wheat and oil mills to be recovered (Aghina & Maletto, 1979), without forgetting the systematic use of the residues generated by cheese making. Not surprisingly, many feed factories have been created through the transformation of mills. Given these premises, and regardless of the indisputable fact that the feed industry had its starting point in the mills and dairies, with the arrival of oil cakes in the second half of the 20th century, two parallel paths were followed (Landecker, 2019). On the one hand, the traditional use of the residues of the mills continued while, on the other, the spread of cakes created a new possibility based on industrial manufacturing processes and advances in technology. In 1901, the under-secretary of state ordered factories specialized in livestock to carry out studies on the nutritional characteristics of different feeds and their effectiveness on animals. The aim was to obtain the highest level of productivity with the lowest cost and to inform farmers specialized in meat and milk production and cattle traders of the opportunities they had[3].

In quantitative terms, oilseed imports increased from an annual average of 41,577 tons in the decade 1881-90 to 64,253 tons in the first three years of the 20th century. Subsequently, imports dropped to 35,000 tons (Giglioli, 1905: 80). Exports of oil cake, which until 1914 averaged 2,000 tons per year, worth 3-5 million *lire*, suddenly reached 10 million (Istat, 1940: 416). It is evident that with the start of the war, the demand for feed in Europe increased and Italy, a neutral power until 1915, benefited from this.

Seeds used for oil extraction mainly came from tropical and subtropical countries. Europe was only able to produce small quantities of flax oil, rapeseed and turnip rape oil, while the largest amount came from India, Egypt, Turkey, Central Africa and South America (United States Department of Commerce and Labor, 1908). Argentina and India flaxseed exports dominated, while the United States was the biggest exporter of cotton seeds and cotton oilseed cakes[4]. Observing what was happening in Western Europe, the

3. Estimated increase was two litres of milk per day for cows fed with cotton oilseed cakes (*Gli studi in Italia*, 1884: vol. 7, parte 1, 301).

4. For the history of the cotton oil industry in the United States, see Nixon (2005) and Deasy (1941).

story of oilseed cakes is emblematic of how raw materials of colonial origin have been incorporated into the process of industrialization to create a real transnational commodity (Curry-Machado, 2013; Hazareesingh & Maat, 2016). At the same time, it encourages us to reflect on the key drivers of the diffusion of common livestock practices worldwide, including technology and scientific research (Matz, 2015). On a global level, this created a division between producing and consuming countries. The first group included African and Asian countries but also the United States, Russia and Argentina, while Western Europe was part of the second group. Thanks to the growth of livestock farming, the cultivation-transformation chains of oil plants are a stimulating terrain for investigating the role of the periphery in international trade in agricultural and food products (Aparicio *et al.*, 2018).

The oilseed cake trade, overall, has significant novelties? Among them, in the late 19th and early 20th centuries, Italy had a negative trade balance for oil imports, but a trade surplus for oilseed cakes. Indeed, in 1903, Italian imports of oilseed cakes amounted to 500 tons, worth 525,000 *lire*, while exports amounted to 8,903 tons which were worth more than one million *lire*. Since the early 20th century, Italy has been producing oil panels for export. The destination countries were Austria, Belgium, Russia, and Switzerland (Pasqualucci, 1903: 418). In particular, Switzerland shipped the raw materials out to Italy and Italy transformed them into oilseed cakes and shipped them beyond the Alps, thus creating economic integration between the two countries. At the beginning of the 20th century, the Italian industrial system, especially in the northern provinces, had acquired a good international reputation in the manufacturing of oilseed cakes.

If we look at the sector from the domestic consumption perspective, the available data indicate a national consumption of about 50,000 tons of oilseed cakes (*L'Italia Agricola*, 1907: 536); it radically differs from the consumption of other European countries (United States Secretary of Agriculture, 1910: 550). The agrarian organization, the Federazione italiana dei consorzi agrari (Federconsorzi) sold 19,354 tons of cakes in 1911, 70% of which in Lombardy and Emilia (Federconsorzi, 1911). In the north of Italy, there was already a modern dairy industry made up of companies and social dairies in the early decades of the 20th century. Farm milk production increased and national and international rail links favoured butter and cheese production, also due to the rise in demand and prices (Besana, D'Errico, Ghezzi, 2017). This was one of the consequences of the "forage revolution", but it also derived from the use of oil cakes that finally allowed Italian farming to deal with the lack of pastures (Barsanti, 2002: 114). Conversely, in the southern regions, the consumption of oil cake only amounted to 4.2 tons. In the south of Italy, backward farming prevailed which was subjected to both transhumance and forage availability (Tino, 2016).

If we compare Italian oil cake consumption with that of Northern European countries, great differences can be observed. From the point of view of feeding livestock, at the beginning of the 20th century, Italy still appears to be dependent on fresh and dry fodders. Therefore, the creation of a core feed industry mirrors the progressive modernization process that culminated after 1950, when Italy became one of the main European feed powers, which represented a slow change in livestock practices which was however important in terms of industrialization.

Although initially the transformation process appears to be very slow, it should be noted that, at the end of the 19th century, the emphasis on "rational" feeding practices increased significantly. Even though feudal legacies hindered progress in the agricultural field and hampered the growth of the national economy, it was evident that modernization of the primary sector could not have been achieved without renewing the livestock sector. Since the last decades of the 19th century, in Italy, a debate has arisen on the need to boost agricultural production with chemicals or energy inputs as well as on increasing and protecting the livestock population (Galassi & Kauffman, 1997). As mentioned in the introduction, what makes Italy so important does not depend on the quantities, but rather on the fact that it was the only Mediterranean country to enter a commercial sector clearly dominated by the Northern European countries (IIA, 1944: 274-75).

We are facing a somewhat unique agricultural business landscape. The consumption of panels in Italy was relatively low, except in some regions where the sector was quite clearly oriented towards the manufacturing and sale of industrial feed abroad. Since the very early years of the 20th century, Italy has been carving a role in the worldwide sector of oilseed cakes as an importer of raw materials and exporter of processed goods. Consequently, Italy was dominated by two opposite trends. On the one hand, livestock feeding based on artificial feed was advancing slowly compared to other forms of sustenance. On the other hand, the country set up a national industry specialized in importing oily raw materials and selling transformed products abroad. As a result, there was a contradiction due to the greater weight of export-related industrial and commercial interests compared with the interests concerning domestic market supply.

Information on the decades preceding the First World War is fragmented but it still allows us to make a general reflection. The worldwide expansion of tropical oils and cakes spurred the formation in Italy of an industrial sector that was partially linked to the much more solid olive oil sector and also partially new. An industrial frame took shape, open to the international market for the import of raw materials as well as the sale of finished

products. Industrial groups were established in Genoa and Bologna[5]. At the same time, technical innovations encouraged by Federconsorzi in the feed sector are documented, with the association playing a promoting role which was consolidated over the course of the 20th century so that the agrarian association achieved a solid productive and commercial position. However, the main result which needs to be highlighted is the development of a new culture in the feed sector in both the Italian agronomic and commercial environments. Oil cakes are emblematic of this initial phase of innovation; though quantitatively still not very representative, they anticipate the results which can be clearly observed in the years immediately after 1920.

3. THE TAKE-OFF OF THE FEED INDUSTRY UNDER FASCISM

Figure 1 indicates that, between 1930 and 1937, Italian oil cake production averaged 270,000 tons, with a peak of 360,000 tons in 1937. Compared with the beginning of the century, trends in the first half of the 1930s confirm the formation in Italy of a solid industrial system which was up to the task of positively facing the recessive phase which followed the 1929 crisis. Furthermore, from the early 1930s, the production of compound feed made a start (Tassinari, 1941). With regard to raw materials, oilseed cakes and flours extracted from cotton (82%), soybeans (82%), sunflower (67%), and flax (62%) were predominant. Unfortunately, we do not have territorially disaggregated data and therefore do not know the regional distribution of oil cake consumption. Nonetheless, we can hypothesize a further strengthening of the zootechnical cluster (Lombardy and Emilia) where the integration between livestock and agriculture was stronger.

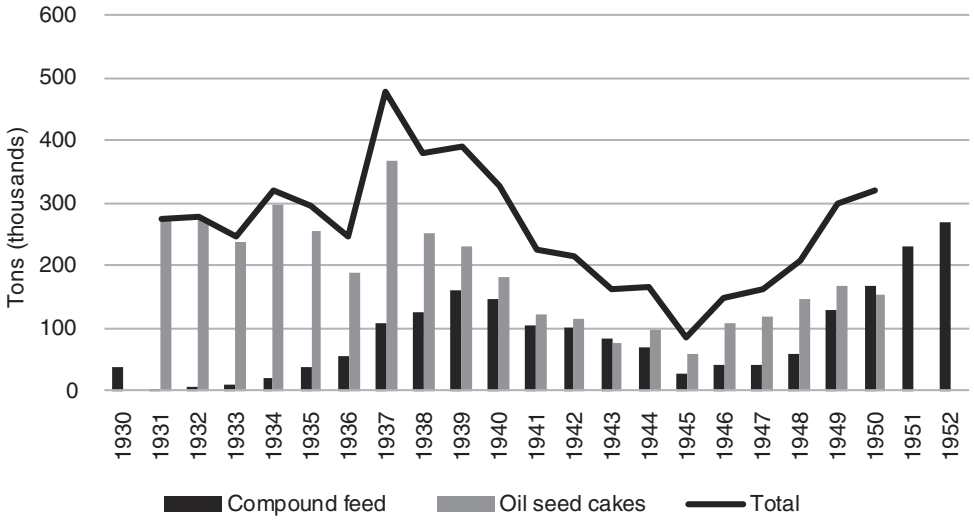
When examining oilseed cakes export trends (Fig. 2), a considerable strengthening can be noted before the 1930s. Indeed, official data confirm the growth in foreign sales of oil cakes as soon as the World War ended. Exports increased from 12,502 million *lire* to 120,887 million between 1920 and 1928 (Istat, 1948: 416-17). Foreign demand boosted exports to 150,000 tons. The fascist cereal policy as well as the "battle of wheat" (Chiapparino & Morettini, 2018; D'Antone, 1981; Fano, 1975; Vaquero Piñeiro, 2015) ensured abundant raw materials (wheat and waste). In the same period, maize imports increased to 500,000 tons which amounted to almost 20% of the 2.9 million tons of domestic production. Therefore, public intervention, trade and national agriculture created the conditions in the 1920s for strengthening of the Italian feed industry. After 1930, the value of exports fell due to price contraction on the world market. The lowest point

5. Archivio Centrale dello Stato (ACS), Ufficio centrale brevetti, http://dati.acs.beniculturali.it/mm/local/

was reached between 1935 and 1936 when, due to both autarchy and international trade contraction (Brassley, 2012), seed oil imports dropped from 390,000 tons to almost half this figure. To revive the sector, a producers' association as well as voluntary storage were created, but the performances of the oil cake market did not improve (Confederazione fascista degli agricoltori, 1941: 355). The only positive data came from the compound feed market. The main market for oil cakes produced in Italy was Germany but also Norway, Hungary, Denmark and curiously, the United States (Istat, 1938). In 1940, at the onset of the Second World War, oil cake production volumes were reduced at first to 200,000 tons and then fell to 150,000 tons between 1942 and 1948.

FIGURE 1

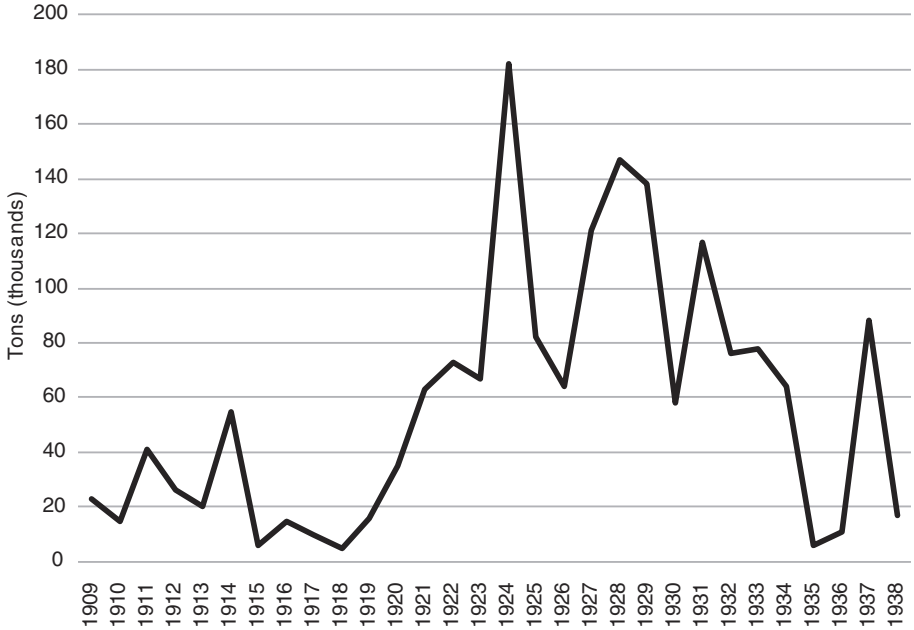
Production in Italy of oilseed cakes and compound feed, 1930-52. Tons (thousands)



Source: Assalzoo (1952).

At this point, it should be noted that, after the First World War, in Italy a decisive quantitative as well as qualitative recovery of the zootechnical patrimony took place which started with a rise to 28 million in 1926. This increase was followed by a phase of stabilization and slight contraction, due to a collapse in prices and the closure of international trade. By attempting an explanation of trends in livestock at the turn of the 1929 crisis, prevailing historiography (Barsanti, 2002: 115-19) usually does not take into account Italian production in the industrial feed sector. In fact, the main estimations were expressed exclusively in terms of forage availability though, on the eve of the Second World War, the fattening of animals had already entered a new phase.

FIGURE 2
Italian Exportations of oil-cakes (1909-1938). Tons (thousands)



Source: *Industria degli olii vegetali* (1940): 149.

Among possible explanations for the popularization of one of the main inputs in the livestock sector, we must first recall the driving role of Federconsorzi, the owner of numerous feed mills *(panellifici)*. Indeed, the association of landowners and landlords has been defined as the most dynamic agrarian force in Italy (Ventura, 1977: 709) and it played a fundamental role in the manufacturing of oil feeds, thus favouring the interests of capitalist agriculture in the northern regions of the country (Sereni, 1977). In 1938, cooperative sales of feed amounted to 106,127 million *lire* in Lombardy and 45,874 in Emilia, 80.5% of national ones, while in the southern islands, they amounted to around 7 million (Istat, 1940: 456). These figures clearly point out two different models of the livestock economy. Not only did the agricultural consortium play a decisive role in the growth of the Italian feed industry before the Second World War, but private industries also found fertile ground on which to expand their business. The Gaslini group for instance, one of the strongest ones in the seed oil sector (Rugafiori, 2009: 30-6), was established in Genoa and the phenomenon involved other cities in the north (Monza, Milan, Pavia and Turin).

During the 1930s, in addition to the industrial plants in the peninsula, some attention should be paid to the processing plants built in the colonies. In Eritrea, the cultivation of

oil palms allowed the production of oil cakes, while in Somalia there were two seed processing mills, one in Mogadiscio and the other one located in the village of "Duca degli Abruzzi" (Piccioli, 1934). In Somalia, the feed mills processed 1,000 tons of seeds annually in order to produce 6,000 tons of oilseed cakes and 150 tons of oil (IACI, 1914: 87). At the end of the '30s, the manufacturing of oil panels was strongly diversified in Italy on a territorial basis with regards to the origin of the raw material used in production. Main oilseed suppliers included British India (peanuts, sesame, copra), Argentina (flax), Brazil (castor), Manchuria (soy), the Belgian Congo, the Dutch East Indies (palm oil) and Zanzibar (copra) (Istat, 1940: 432).

The spread of industrial feed cannot be separated from the technical-scientific debate that took place in Italy during the 1930s concerning the application of science to agriculture and the creation of new standardized organisms (Saraiva, 2011; Tyler, 1956). This topic has been studied above all with regard to chemical fertilizers and cereals but, as this work demonstrates, between the 1920s and 1930s, the Italian industrial system took a big step forward in the even more innovative terrain of feed compounds[6] which had become an object of experimentation and technological modernization (Bonadonna, 1948). With the advent of the so-called "commercial" feed and due to their success, a new industry was developed: the *formula feed* industry. The name was coined to convey the message that the feed that was promoted was the result of formulas and scientifically tested mixtures. Official data indicate that in Italy the production of compound feed began in around 1930. At a first glance, it is evident that for the years 1930-33, the average annual production ranged from 3.7 to 9.5 tons. Notwithstanding, in 1936, the production capacity of this new generation of livestock feed rose to 50,000 tons and soared in 1938-40 to reach 100,000 tons. The production centres were managed by Federconsorzi and the new generation of feed was presented by the fascist regime as a concrete demonstration of the technological and scientific modernization of the country's agriculture[7].

Despite the clear progress made, at the end of 1930, the animal feed sector was still little known and, therefore, not always reported by official statistics, *e.g.* surveys and census. At the time of the 1937 industrial census, it was observed that the oilseed milling sector had progressed much more than initially thought (IPZS, 1940: 96-9). In particular, the final report highlights that, although there were numerous artisan/traditional/small-scale workshops, many other seed-crushing factories had a commercial industrial imprint.

6. The first compound feed bag was produced at S. Louis (Missouri) in 1910 by Donald Danforth of the Raiston Purina company (Pederson, 2000).

7. For historiography on the fascist theocratic mentality in agriculture, see Fernández-Prieto, Pan-Montojo & Cabo (2014).

In fact, the labour force was made up of almost 920 workers and many factories had machinery suitable for processing thousands of tons of raw materials. Overall, and despite being a young industrial system, there were 256 active factories in Italy, 142 of which were located in Lombardy, 40 in Piedmont and 35 in Emilia. However, with the onset of the war, all the transformation processes suddenly stopped and data on oilseed cakes show a progressive downsizing. Nonetheless, the Second World War as well as the post-war years imposed a drastic setback, also for compound feed. The 1930s therefore stood out as a period of transition: while Italian oil cake production was strengthening, compound feed manufacturing began, two products which were bound to mark two different eras in the history of feed.

4. COMPOUND FEED IN THE WAKE OF THE ECONOMIC AND CONSUMPTION BOOMS

After the end of the war, agriculture strove to go back to a market economy after years of strict public control (Fabiani, 2015). Against this backdrop, the Italian feed sector successfully met this challenge, thus helping to rank the country among the world's leading economic powers. During the first years of reconstruction, the most notable increases in Italian production concerned the oil cake sector which reached 150,000 tons in 1948 (Fig. 1). This was due to the fact that the national production system benefited from consolidated expertise in this mature production sector. An important step towards this leadership was the birth, in 1945, of Assalzoo (National Association of Livestock Food Producers). The world of the compound feed industry appeared firmly dominated by the United States (33 MT), followed by the UK (5.5 MT), France (2.7 MT) and Denmark (1.3 MT). The bottom group included Belgium (800,000 tons), the Netherlands (800,000 tons) and Italy (270,000 tons). Leaving aside the peculiarities of each nation, it is clear that, since the mid 20th century, the industrial feed sector, along with the fertilizer, pesticide and machinery sectors, strongly contributed to final consolidation of the industrialization of agriculture (Brassley, Martiin & Pan-Montojo, 2016: 12). In the 1950s, the structure of Italian agriculture changed radically as a result of public investments in reclamation, irrigation and land improvements. Until the stabilization imposed by the EU agricultural policy, the Italian primary sector speaks of "disorderly growth" stimulated by the policy of prices and the search for internal political consensus (Fabiani, 1986: 164-69).

In 1952, in the Italian peninsula, the livestock food production sector accounts for 2,069 mills which included a great variety of subjects (agrarian consortia, compound feed industries and a series of rice farms?, oil mills, farms, etc.) (Assalzoo, 1952). The sector still appeared to be dominated by the production and export of oilseed cakes. At the be-

ginning of the 1950s, production was close to 200,000 tons and exports amounted to 35,000-45,000 tons, the majority of which were low-nutrient feeds (rape, sunflower, tobacco, tomato, cotton).

The effects of the European Recovery Program on technical modernization of Italian agriculture started to be investigated and, specifically, programs for livestock and breeding improvements encouraged by the Marshall Plan, which allowed the European farmers to discover the excellent results of the corn hybrid (Bernardi, 2014; Godley, 2014; Byerlee, 2020)[8]. Italy become one of the main European producers of the new generation of compound feed, despite its lagging structural conditions. It was a momentous turning point in the Italian economic miracle. In the middle of the 20th century, mills and factories specializing in feed and pasta productions (De Bernardi, 2019: 211-18) started to cooperate and be more spatially concentrated. The result was a vertically integrated sector of flour, pasta, and feed companies. Many producers felt the need to activate a communicative and marketing strategy to leverage the interdependence between the new generation of feed and agri-food productions, especially dried pasta, an archetype of the Italians' well-being and healthy diet. Alongside this feature, which was crucial to giving the sector a precise profile, another peculiarity was the family-run economic dimension of factories during the 1950s. In this respect, the development of the latest generation of feed industry, although barely present when speaking of the country's industrial evolution, confirms what has been written about Italian family capitalism (Colli, 2006). From this point of view, in fact, Italian capitalism does not match the model imposed by American companies. In the mid 20th century, there was a solid base of mills and pasta factories in Italy, many of them built in the first decades of the century which allowed the country to move towards industrial feed.

The upward trend of compound feed was very similar to that already seen for oilseed cakes. In 1960, Italy produced less than one million tons of compound feed, far less than Great Britain (10 MT) and the Netherlands (4 MT). We have few official data on individual producers, but it is clear that Federconsorzi alone accounted for 70-75% of concentrated feed coming from 40 feed mills distributed throughout the country (Barbadoro, 1961: 108), thus being the biggest manufacturer of concentrated feed. Nevertheless, not even ten years later, Italian production capacity rose to 3.6 MT and reached and even exceeded 10 MT by the end of the 1970s. These years were characterized in Europe by accelerated technological renewal in agriculture which triggered overproduction. The Cold War pushed the potential of the primary sector to a maximum under the leadership of the United States (Bernardi, 2016; Fabiani, 2015: 186-195). The

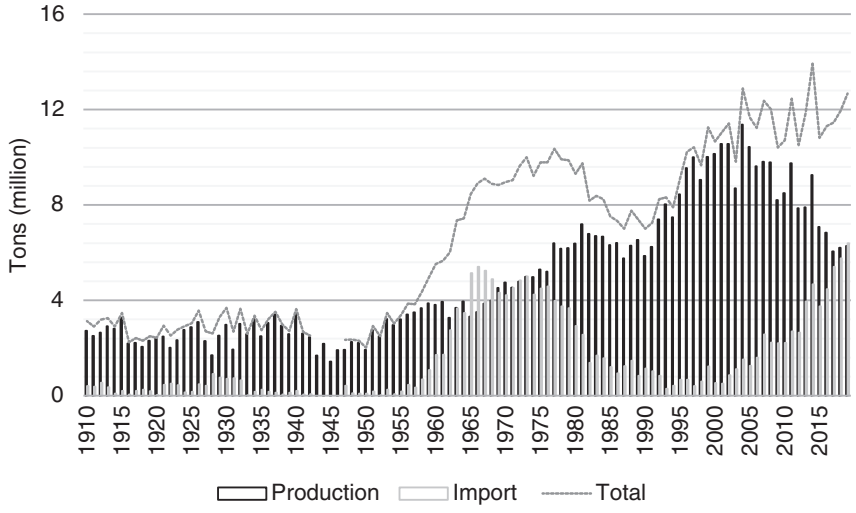
8. In Italy, the production of hybrid corn seeds began in 1948.

impetuous growth of animal feed reveals the formation of an industrial apparatus that stimulated the international exchange of raw materials for animal feed: Italian soybean imports went from 204,640 tons in 1961 to 2 MT in 1965, at the same time as, between 1959 and 1968, maize imports took off (from one to 4.7 MT), thus contributing to the strengthening of a national production that has grown sharply since 1950 (Fig. 3).

Starting from the early Sixties, there has been a slow reduction in areas dedicated to corn growing in Italy, which went from over one million hectares to about 950,000, thought it was offset by an increase in productivity per cultivated hectare: from 3.1 tons in 1961 to 7.2 tons in 1980 (*Fao. Faostat*). In actual fact, imports of corn, a traditional part of Italian animal feed, only exceeded domestic production between 1965 and 1968, thus demonstrating that national agriculture, driven by both modernization and the EU protectionist agricultural policy (Fabiani, 2015: 200-12), managed to satisfy a large part of the Italian need for raw materials. In 1972, hybrid corn cultivation reached 93% of corn crops (705,000 hectares) and, in 1968, at the peak of the growth of feed industry raw material availability, for the first time cattle and buffalo stocks in Italy exceeded the ceiling of 10 million head of cattle (*Istat. Serie storiche*).

FIGURE 3

Import and production maize in Italy, 1910-2019. Tons (million)



Sources: Istat. Serie storiche; Fao. Faostat.

In the other European countries, for example, Spain, during the Sixties and Seventies the idea of a "Fordist consumption model" in the feed industry, based on massive corn and

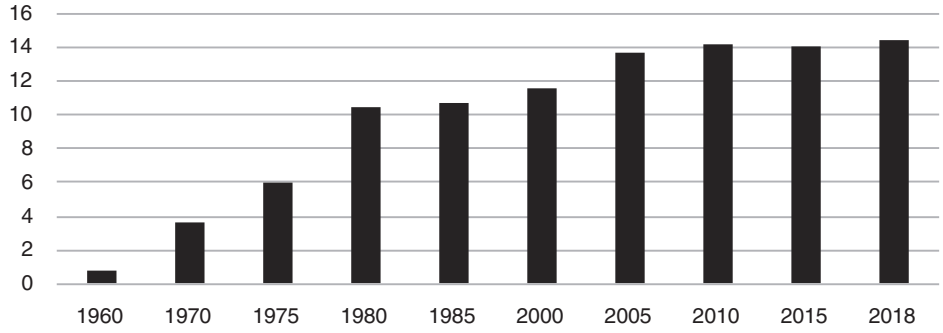
soy imports, gained popularity (Clar Moliner, 2008). An analysis of the Italian case, however, reveals that a modern industry was already taking shape during the 1920s and that the acceleration that took place during the economic boom derived from previous advances in the sector which had evolved in order to adapt to food market expansion as well as to the establishment of large international agri-food groups. Considering these major changes in demand (Quirino, 1991) gives us a better understanding of how successful the feed sector was in facing the multiplication of farms and production rates (Lucifero & Giorgetti, 2002). Given the importance acquired by the sector, the Organic Law 281 dated 15 February 1963, amended in 1968, for the first time entirely regulated feed manufacturing and trade. The law was further amended in 1986, based on the European Economic Community's directives concerning both the production and marketing of simple and compound feed.

In the mid 1980s in Italy, about 1,532 feed mills employed a total of 12,000 people, the equivalent of fixed investments of 100 billion lire. The national feed industry was characterized by an extreme high number of small companies, a reduced labour force, relatively modest investment in machinery and, at the same time, a strong need for capital. When analysing regions, the highest number of factories was in Emilia-Romagna (430), Lombardy (211), and Piedmont (188). In practice, 64% of the factories were distributed among the regions located in the north of the country (Moschini *et al.*, 2018), the central area of the peninsula accounted for 22%, while the remaining 13% was in southern as well as insular Italy. This highlights the uneven spatial distribution across Italy and suggests that livestock farms were mainly located in the so-called "landless" livestock areas in north-central Italy. From the beginning of the 20th century, the feed sector contributed to the consolidation of intensive livestock farms located in Lombardy and Emilia. This phenomenon increased in the second half of the 20th century (Lucifero & Giorgetti, 2002). The less productive native breeds were located in the mountain areas, while the lowland areas of the Po valley were allocated to dairy cattle breeding. The latter was able to guarantee the raw material used to make cheeses such as Parmigiano Reggiano and Grana Padano which have become the economic spearhead of the Italian agro-food system.

In the 1980s, the value of the feed production was 4,394 million lire. The feed industry was at the peak of its expansion. Raw materials represented by far the most significant costs (about 80%), followed by logistics and delivery management. In 1985, the most important industrial group operating in Italy in this sector was Federconsorzi (33 feed mills) with 1,170 MT (11% of national production). In general, a national market strongly divided by geographical areas predominated. It was evident that the national feed industry, almost at the end of a period of rapid growth, was characterized by extreme frag-

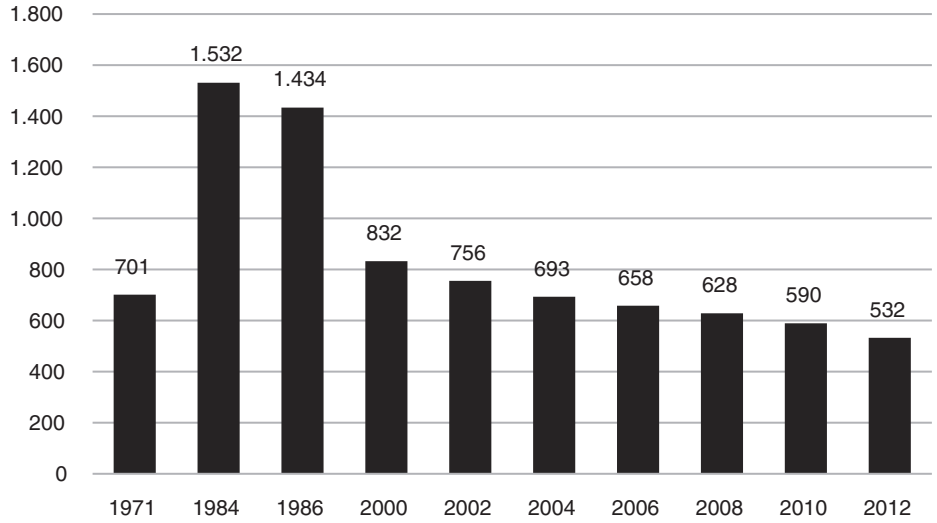
mentation resulting from the existence of a large number of small companies operating in local markets, each of them with a single production centre.

FIGURE 4
Production of compound feed in Italy, 1960-2018. Tons (million).



Source: *Assalzoo. Annuario* (1960-2019).

FIGURE 5
Feed mills in Italy, 1971-2012



Source: *Assalzoo. Annuario* (1971-2012).

After the 1980s, the national feed industry underwent a process of radical downsizing. The compound feed production capacity was around 14 million tons (Fig. 4), but there was a drastic reduction in the number of feed mills. This was the case for pasta factories. Pro-

ducers tried to be undersized to withstand the competitive challenges posed by globalization. Once the sector had reached its highest level, it was impossible to increase the production volumes to compensate for the increase in costs (energy, transport) and profit (De Bernardi, 2019: 222-23). In Italy, the downward trend continued during the first decade of the 21st century (Fig. 5). At the end of the 20th century, there were approximately 800 active feed mills, in 2003, 714, in 2012, only 532, and in 2018 they were reduced to 417. In percentage terms, there was a loss of around 70% in just 30 years though total feed production remained stable. This decrease favoured concentration processes that strengthened the most solid industrial groups. The same phenomenon occurred to farms which started to decrease in number despite unchanged livestock levels or even an increase in the number of animals raised per farm, especially dairy cattle (Moschini *et al.*, 2018: 379). However, Italy continued to maintain a leading position in the European feed industry. The apparent contradiction depends on the fact that the dramatic reduction in production feed mills was also the result of the implementation of cooperatives and industrial mergers.

This quantitative redefinition of the sector almost equally involved all regions which maintained their position on the ranking scale. Looking at regional distribution, feed mills dropped in Emilia-Romagna from 430 to 146 and in Lombardy from 211 to 88. In this process, the smaller feed mills with a predominantly local dimension paid the heaviest price. Many operators disappeared and big industries operating in large geographical areas using multiple production feed mills grew stronger. Although available data on the feed industry structure are poor, they show that the Italian market structure was an imperfect oligopoly. In 2008, more than half of production was controlled by only ten companies and the gap continued to become wider with fewer leading companies. The Veronesi Group, which controlled from 17 to 22% of the market with an average annual production of 2.5 MT, led the way. The group was set up in 1956 as a feed industry and from 1968 onwards, it became a livestock-feed operator, thus combining feed production and breeding with the processing and sale of packaged meat products. Currently, the Veronesi Group is the fourth largest group in the Italian agri-food sector for economic weight, but in the last few years, we have seen a strengthening of foreign capital in the sector. Another sign of the Italian feed industry transition towards the international agribusiness system is the penetration of multinational corporations in the country. American Cargill, for instance, managed to acquire some historical brands and control eight companies with a total number of 700 employees[9]. Behind these changes which gave the sector a new identity, it is important to assess the impact of bovine spongiform encephalopathy ("mad cow disease") that spread in Britain in 1986 (Dean, 1996). Due to a drop in consumption, in

9. https://www.cargill.it/it/chi-siamo

fact, many small producers disappeared. Due to financial and capital constraints, they were unable to deal with the modernization of the production cycle and ensure the safety of the animal food supply chain.

Looking at the 28 countries of the European Union during the 2001-18 period, production capacity was 160 million tons and the number of factories increased from 3,053 to 3,923 (+28%) (*Assalzoo. Annuario*, 2019: 35)[10]. Nevertheless, national trends differed. While Italian production considerably declined, Germany and France only suffered a slight decrease, from 433 to 323 feed mills (-30%) and from 343 to 289 (-16%) respectively. In the Netherlands and Great Britain, the reductions accounted for around 30%. On the contrary, in Spain, in the first decade of the new century, feed mills rose from 323 to 854 with an increase of 64%[11]. This upward trend probably depended on the fact that Spain was one of the few countries in the EU that systematically practiced both the cultivation and processing of genetically modified plant species, especially maize. Another country that saw an increase in its production capacity in the compound feed sector was Poland. However, the Italian feed industry, despite having experienced a drastic reduction in operators, continues to be important for the European economy and characterized by a considerable number of factories and a substantial production capacity which levelled off at around 13-14 million tons[12]. At the beginning of the 21st century, both Italian imports and exports of cereal-based compound feed were very low, around 600,000 tons, a figure which is a long way from the national production capacity which was entirely devoted to domestic demand.

In 2019, the Italian feed industry processed 20.5 MT of raw materials, and especially corn (9 MT), oilseed flours (5 MT) and bran (3 MT) (*Assalzoo. Annuario*, 2020: 112). After reaching a peak of 5 MT in 1965, corn imports collapsed to 400,000 tons in 1997 before rising again to 10 MT in 2015 (Fig. 3). From the Seventies to the Nineties, reduced imports were balanced by a production increase which reached 11 MT in 2004[13].

Today circumstances appear to have changed. The feed sector in Italy depends on imports: more than 50% of maize and wheat come from Ukraine and Hungary and 85-90% of soybeans from Paraguay and Argentina. By combining this dependence on raw mate-

10. For soy, see Langthader (2020).

11. In other European countries, development of the manufacturing industry was the result of the import of cereals (Soto *et al.*, 2016).

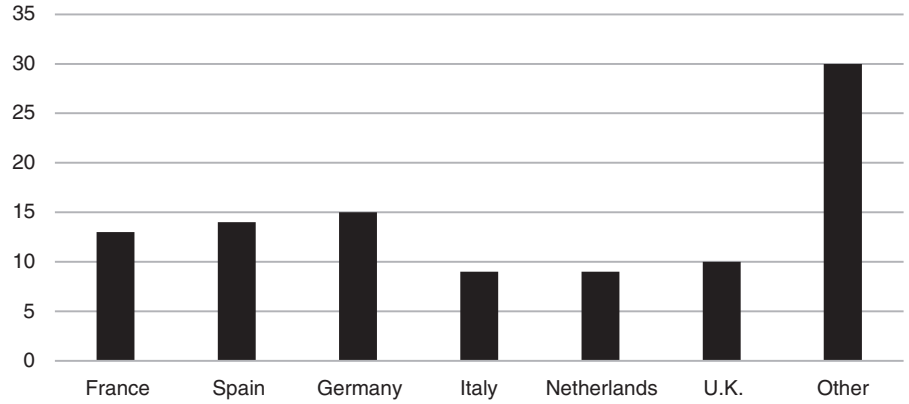
12. Compound feeds involve the use of multiple raw materials and are divided into «complete» and «complementary».

13. http://www.ismea.it

rial international markets (Lassaletta *et al.*, 2014) with what has been said above on production costs, one of the major critical issues in the sector emerges. It is no coincidence that, during crises that prevent normal access to foreign supplier countries, the feed industry faces a rise in prices, also due to the Italian law that prohibits the cultivation of genetically modified plants. This rigidity, in particular, negatively affects the feed industry in developed countries: on the one hand, due to the dependence of third countries on raw materials supply and, on the other, due to the controversial use of GMOs, with all its consequences in terms of environmental impact, sustainability and, last but not least, food safety for animals and people (Delgado *et al.*, 2002).

FIGURE 6

Top feedstuff-producing countries in the EU, 2017. Percentage



Source: *Assalzoo. Annuario* (2019: 99).

Despite structural changes, the feed sector demonstrates continuous solidity and Italy continues in feedstuff production to rank firmly among the first European Union countries after Germany, France, and Spain, all of them placed above 20 MT. Considering the last few years, in 2017 and 2018, the turnover of Italian production averaged 6-7 billion euros and employed between 8,000 and 9,000 workers; exports were around 650-700 million euros and imports more than 800 million euros, thus generating a negative trade balance of about 171 million euros (*Assolzoo. Annuario*, 2019: 31). Nevertheless, since the feed industry is particularly branched, it must be said that in addition to the next generation compound feed, Italy produces about 22 MT of simple feed made of cereals for livestock use, flours and oilseed cakes which amount to about 4.6 MT (*Assolzoo. Annuario*, 2018: 32). It is therefore not coincidental that in Italy the feed industry represents, in terms of turnover, the fifth sector of the food industrial system which, in turn, is the second sector of the Italian manufacturing industry after the metalworking industry (Belluzzi *et al.*, 2014: 276).

When looking at the "livestock revolution" (Delgado *et al.*, 2002), we can see that the European and U.S. primacies, firmly preserved during the 20th century, have been called into question in recent years by China which has established itself as the world's leading feedstuff producer, thus breaking traditional balances, as well as by other emerging economies such as Mexico and Brazil (FEFAC, 2011) which has also achieved good results. Overall, and considering the different development of the industrial feed systems in different areas of the world, it is possible to observe countries with very limited development margins because their industrial productions have reached their maximum, and countries whose industrial productions are still in their infancy (Belluzzi *et al.*, 2014: 271-72).

Going beyond the quantitative aspects and leaving aside the consolidation of new producers worldwide, the feed sector at the turn of the millennium faces a wide range of qualitative issues. It is clear that the evolution of the feed industry in Italy intersects with transformations of the livestock sector. The production value of Italian livestock in 2015 exceeded 16 billion euros, over a third of the total agricultural production (Macrì, 2017). Most of the feed production is localized in the same regions where two thirds of the livestock are concentrated (Piedmont, Lombardy, Veneto and Emilia-Romagna). Lombardy raises 27% of the national bovine herd and 36% of dairy cows as well as distinguishing itself for the average farm size in terms of cattle (on average 127 per farm). Historical reasons therefore explain this zootechnical concentration which has been accentuated in recent times by the existence of a favourable framework in terms of logistics, financial and vertical integration, including an increasing presence of feed industries offering both advice and technical assistance to farmers (Moschini *et al.*, 2018: 380).

5. CONCLUSIONS

The feed industry holds a significant economic position in the agri-food chain. This industry processes and employs numerous raw materials and by-products recovered from other animal feed supply chains and the connection between agro-industrial production and livestock has been consolidated over time. Currently, the feed industry is undergoing a complex phase of renewal in Western countries, where the mature industrial system is forced to face the challenges deriving from changes occurring in both livestock management and production (Steinfeld *et al.*, 2006). Animal health, food safety and environmental protection are indeed some of the new paradigms in the debate on circular economy and industrial symbiosis (Ghosh, 2020).

Notwithstanding the seriousness of the problems affecting the feed industry, a more modest goal of this study has been to retrace the main stages of development of the Ital-

ian feed industry. The Italian study case demonstrates that several issues currently present in the livestock sector are a direct consequence of changes occurring during the 19th and 20th centuries in terms of availability of a growing number of substances used in animal nutrition. Although the zootechnical nutrition revolution only took place in Italy at the end of the 19th century, radical changes quickly took place in the country in the wake of the Northern European countries. Together with green and dry fodders, a major innovation came from concentrated foods (oil cakes and flours) that provide a high nutritional level of energy and proteins. This was a turning point in breeding because, for the first time, European animal husbandry found a way to break the stringent balance imposed by an agriculture that was especially attentive to human nutrition. With the spread of oily cakes, the general picture underwent a radical change since it became possible to breed even without land. The spread of oily cakes in Italy created the conditions for an industrial and agricultural transformation which strongly influenced the subsequent phases.

As in the case of chemical fertilizers, science also contributed to radically modifying the feed sector at the end of the 19th century. "Formula feed" was devised and popularized in the 1930s. The Italian experience confirms the central role played by research labs in the animal nutrition sector. Consequently, product and breed standardizations spread. As transhumance started to be marginalized, breeding increased. After the Second World War, the sector was ready to enter a new phase and compound feed production took off. Moreover, the evolution of the feed sector mirrors the changes that were taking place with the farms. Many of the small farms in the 1950s and 1960s were replaced by larger companies and, consequently, several local feed mills disappeared or were incorporated by industrial groups with greater production capacity.

Over the century, important innovations occurred with regard to plant production capacity although, as for raw materials, the sector continued to depend on international trade and oil seed nutritional supply. Corn, among the cereals, was irreplaceable, but flax, cotton, soy and sunflower, initially traded in the form of panels and then pellets, were equally precious. These products drew a line of continuity from the 19th century to the present day. As in many other European countries, on the threshold of the 21st century, animal feed in Italy appears to be a mature sector, conditioned by the high costs of imported raw materials as well as by the low profit margins of produced goods. The feed industry has therefore recently specialized in selling scientific, financial and marketing consultancy services to farmers forced to work in a complex, competitive scenario.

To conclude, feed production is influenced by several factors, including the number of farmed animals, the general trends in consumption of farming products (meat, milk,

cheese) and the market dynamics of raw materials. Several issues still need to be addressed more in depth by scholars and only at the appropriate time, research will be able to assess the ability of the agri-food supply chains, with their multifaceted features, to adapt to the current economic situation. There are many unknowns about the future of both supply and demand and, for the moment, only hypotheses can be advanced. It will be necessary to observe the future dynamics of the international exchange of raw materials, including first and foremost cereals, as well as the development of trade policies, price trends and consumer social practices. All these variables will certainly affect the evolution of the feed sector in the near future. More than ever, therefore, scientific conclusions appear to be conditioned by dynamics which are shrouded in an uncertain future.

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