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Title:

Old and New Plants from the Americas to Europe: Potatoes, Corn and the Genetics of Double Hybrid Corn (1800-1940)

Abstract:

Here we discuss the extension of corn and potatoes in Galician Atlantic agriculture during the nineteenth and twentieth centuries as an innovation process that facilitated rapid circulation of a new cattle feed from the Americas to Europe. Specifically, we focus on Galicia from 1890 to 1940, a time of significant scientific interest with regard to genetic improvements. This new science made it possible to develop double hybrid corn plants that became widespread after the 1920s. In this article we will describe the conditions accompanying the introduction and spread of these American crops, as recorded by modernist historiography, then analyse the institutional and social framework – knowledge networks, innovation systems and institutional and social tools – that enabled genetic advances in the twentieth century. To accomplish this, we must trace the journey of seeds and knowledge across the Atlantic from places such as the Connecticut Agricultural Experiment Station (1918) to the Galician Biological Mission (1921), among others.

1. Introduction of plants from the Americas into Europe: Potatoes and Corn from the Seventeenth to the Twentieth Century

The discovery of corn and its introduction into the agricultural system of the Ancien Régime in Europe undoubtedly represents one of the main cultural transfers that resulted from the European conquest of the Americas. Corn entered from the south of the Iberian Peninsula and soon spread throughout that land mass and into Europe. However, since little is known about this process, it remains susceptible to confusion and error. Some authors consider that the severe subsistence crises of Italy (1590-91) and Asturias in north-western Spain (1598-1600) provided the necessary and vital stimulus that transformed corn from a known curiosity to a widespread staple crop.¹ Other cultural and social innovation processes beyond that have not been well-researched or understood. The available literature often contains errors or reflects stereotypical thinking, such as portraying aristocrats and ecclesiastics as innovators with a pioneering role among ignorant peasants.

Historiographical examination uncovers more complex realities. The introduction, acclimation and expansion of corn cultivation in Galicia has been examined in Galician historiography since around 1900², coinciding with the period M. Cabo and L. Fernández Prieto (1998) have described as agricultural technical modernism. However, both authors erroneously tried to ascertain the volume of corn cultivation by examining rent payments. It is well-known that the foral regime was ruled by fixed-term land tenure contracts with a periodicity that reflected the stipulated rent payments but contrasted with the actual dynamics of the crop cultivation system. As corn cultivation spread, the stipulated foral rent payments reflected very little – if any – real crop production. Though justifiable at that time, this limited line of research located the introduction of corn in the early

¹PÉREZ GARCÍA, X.M. (1982): "O millo en Galicia. Un estado da cuestión" (pp. 87-104): *Revista galega de estudos agrarios*. No. 7-8, p. 87.

² An early published reference to corn can be found in the article by Manuel Murguía in the *Boletín da Real Academia Galega*, 1907-1909. In the journal *Prácticas Modernas*, he had addressed the question some years prior, and surprisingly assumed that corn was already being cultivated from the Middle Ages on in some European regions (without excluding the possibility that Galicia was among them). See MURGUÍA, M. "¿Cuándo se generalizó el cultivo del maíz en Galicia?" , *Prácticas Modernas* (No. 63, 1 August 1905 and No. 64, 15 August 1905). Years later Fermín Bouza Brey returned to the topic in 1953, but made no innovative contribution.

seventeenth century, leading to the assumption that it became widespread in the following century. Subsequent bibliography reinforced this conclusion.³

Chronologically, the second historiographic focus that addressed the introduction of corn emerged from the school of Galician modernists, led by professor Eiras Roel. This line of research began in 1973 and can be followed to its conclusion. It did not question when corn was introduced but how it was received, analysing in detail the agricultural transformations that corn may have generated. Rather than examining land tenure payments, they examined post-mortem inventories found in notary protocols. These provided a much more detailed picture of peasant grain storage, making reference to types of grains that had been carefully stored in trunks, sacks, raised granaries and other less common places.⁴ These peasant storage sites began to compete with those of the landowners, but only appeared when there was something to store, thanks to the cultivation of American crops. This article provides an overview of the central corn issue, without forgetting other American crops such as the potato.

1.1. The introduction of American plants into Galicia: corn, potatoes, chocolate, coffee, tobacco, peppers, tomatoes...

'...for Spain the first ear of corn brought for planting from the Americas was more useful than all the silver in the mines of Potosí.'

Fr. Martín Sarmiento, Eighteenth century

It is generally understood that corn from the Americas first entered the Peninsula through Andalusia around 1500 and rapidly spread throughout southern Portugal, while potatoes seem to have become known later on. This might be linked to the more remote origins of this tuber in places such as the

³ This includes Otero Pedrayo, Vicens Vives, Garcia Lombardero, García Fernández and A. Bouhier. See: PÉREZ GARCÍA, X.M. (1982): "O millo en Galicia. Un estado da cuestión" (pp. 87-104): *Revista galega de estudos agrarios*. No. 7-8, pp. 88-89.

⁴PÉREZ GARCÍA, X.M. (1982): "O millo en Galicia. Un estado da cuestión" (pp. 87-104): *Revista galega de estudos agrarios*. No.7-8, p. 90.

Andean ranges. European explorers did not arrive there until 1532, when they ascended those mountains to conquer what we now know as Cajamarca.⁵

The first clear mention of corn in Galicia dates from 1610 in the Barbanza area, followed by another reference from 1618 in Cangas do Morrazo. By the time corn reached the lower estuaries, or Rias Baixas area, it had already been cultivated for a dozen years in some areas of the northern Cantabrian coastline and in the south of the Iberian Peninsula. What we know of the origins of this plant and the delay in its introduction into Galician areas bordering Portugal (Tui and the Minho) and Asturias (Cantabrian Mondoñedo) suggests that it was probably introduced by sea and not via Portugal or Asturias.⁶

After its appearance, the decisive step toward large-scale cultivation of corn did not take place until the wave of poor crops that occurred from 1626-33. This initiative was not catalysed by farmers who found themselves with excess production, but by those concerned with survival. At that time, farmers throughout most of the Rias Baixas planted and ate corn, known at that time as *mijo grueso* (thick millet), *maínzo*, or *mijo maínzo*. Successful results encouraged rapid expansion; in only about 30 years this new grain became the most important crop in the area. Around 1637 a representative of the Junta do Reino da Galiza expressed that 'the most abundant cereal was corn (...) the houses are full of corn'.⁷ With such good results, corn quickly replaced the autochthonous millet: a grain with similar characteristics and cultivation times. As it was marginalised, it even ceded its name to become known as *millo miudo* (small millet) or *millán*.

Corn in the interior of Galicia was a very different matter, because of the climate. Throughout the seventeenth century, it remained virtually unknown except in sheltered valleys such as the Ribeiro. Corn did not secure significant presence inland until the crisis of 1768 or even the nineteenth century. Until the twentieth century bread was made from barley in the interior of the Lugo and

⁵ MASSON MEISS, L. (1991): "La papa entre las grandes culturas andinas" (pp. 11-72): LÓPEZ LINAGE, J.: *De papa a patata. La difusión del tubérculo andino. Ministerio de agricultura, pesca y alimentación*. Madrid, p.37.

⁶ Inventory of Juan Lampón, 09/10/1610 in: PÉREZ GARCÍA, X.M. (1982): "O millo en Galicia. Un estado da cuestión" (pp. 87-104): *Revista galega de estudos agrarios*. No. 7-8, pp. 91, 97.

⁷ PÉREZ GARCÍA, X.M. (1982): "O millo en Galicia. Un estado da cuestión" (pp. 87-104), in: *Revista galega de estudos agrarios*. No. 7-8, pp. 97-98.

Ourense provinces. Extension of corn was also delayed in the Mariña de Mondoñedo area, the land around Santiago de Compostela and Betanzos.⁸

In the eighteenth century, corn became the dominant cereal throughout the western Galician coastal area, covering eighty to ninety per cent of the land dedicated to grain, while traditional cereals such as barley or wheat only occupied around a tenth of that surface. Millet virtually disappeared in the process. However, in the late eighteenth and early nineteenth centuries, a complex rotation system of European and American grains, including fodder and meadow crops, began to change the landscape (D. Soto, 2006). This new and revolutionary polycrop system – the fruit of innovation with American plants in the two prior centuries – reduced fallow lands, guaranteed food for the population and generated significant increases in income. The careful cultivation, intensive labour and labour force required for corn extended itself to all farming (L. Fernández Prieto, 1992) and the system depended on obtaining sufficient fertiliser, which was assured through the use of waste lands⁹.

In light of this explanation of the evolution and extension of corn, we must ask ourselves how this process affected Galician agriculture and society. First, it disrupted the parallel development of Galicia with many other regions of the Iberian Peninsula and Europe. Also, high profits from corn, especially in the Rias Baixas, led to an increase in population that subsequently accentuated hereditary land division and exacerbated *minifundismo*: the micro-parcellation of lands that would later be so criticised.

Demographically, in the sixteenth century Galicia had just over 600,000 inhabitants; by 1752 the population had increased to almost 1.3 million people. Galicia accounted for 10.8% of the Spanish population in 1800, and 11.5% in 1860. During those two centuries, the population also shifted from the interior toward the coast and has remained so to the present day.¹⁰

⁸SAAVEDRA, P. (1992): “La Introducción del maíz y la patata en Galicia” (pp. 202-207): *Galicia e América: cinco siglos de historia*. Consellería de Relacións Institucionais e Portavoz do Goberno. Consello da Cultura Galega. Santiago de Compostela, pp. 202-204.

⁹ Forthcoming doctoral thesis of Beatriz Corbacho González, holder of an FPI fellowship and member of the Histagra research group. Departamento de Historia Contemporánea e de América. Universidade de Santiago de Compostela. Galicia-Spain.

¹⁰ Today Galicia represents 6% of the Spanish population: (X. Carmona: 2001), (X. Fernández Leiceaga: 2000), (E. López Iglesias: 2000), also: PÉREZ GARCÍA, X.M. (1982): “O millo en Galicia. Un estado da cuestión” (pp. 87-104): *Revista galega de estudos agrarios*. No. 7-8, pp. 99.

The enormous production per hectare of this new crop with respect to other grains restructured the entire Galician agrosystem. New lands were ploughed and grazing lands diminished as they became reallocated for grain. This affected Galician cattle herds: extensive farming decreased along with the number of beasts and variety of breeds, as they were replaced with cattle better suited to intensive stable methods.¹¹

Until now we have only addressed corn, which brought about agricultural renewal along the Galician coast and in sheltered inland valleys; but it was the potato that transformed agriculture in the Galician interior. Though known in Galicia as early as 1570, when it was planted by the friars of the Herbon parish, the potato did not acquire real significance until the eighteenth century.¹²

For a time, the potato spread throughout the Galician interior, especially in the former the province of Mondoñedo, in a manner more or less complementary to corn. Unlike corn, however, this American tuber encountered serious economic, social and cultural obstacles. The locals received it poorly because it grew underground and seemed more suited to pigs. In the famines of the late eighteenth century, however, potatoes fed the poorest farmers as well as their animals.

Over time, the potato also confounded collectors of proportional rents and tithes.¹³This is reflected in the legal proceedings of court cases involving tithe collectors, which constitute the bulk of eighteenth-century documentation from Galicia. Court cases from that century make it possible to trace the extent of potato cultivation. The oldest reference to a relevant lawsuit dates from 1736, when the priest of Santiago de Bravos (in the former province of Mondoñedo) took legal recourse against his own parishioners, who opposed paying the potato tithe. Most suits involved peasants refusing to pay by claiming they grew potatoes in uncultivated, poor or waste land, rather than in agricultural plots.

Later on, the Miñano and Madoz geographical statistical dictionaries provided estimates of crop cultivation in the nineteenth century, especially the

¹¹PÉREZ GARCÍA, X.M. (1982): "O millo en Galicia. Un estado da cuestión" (pp. 87-104): *Revista galega de estudos agrarios*. No:7-8, pp. 98-101.

¹²SAAVEDRA, P. (1992): "La Introducción del maíz y la patata en Galicia" (pp. 202-207): *Galicia e América: cinco siglos de historia*. Consellería de Relacións Institucionais e Portavoz do Goberno. Consello da Cultura Galega. Santiago de Compostela, p. 204.

¹³SAAVEDRA, P. (1992): "La Introducción del maíz y la patata en Galicia" (pp. 202-207): *Galicia e América: cinco siglos de historia*. Consellería de Relacións Institucionais e Portavoz do Goberno. Consello da Cultura Galega. Santiago de Compostela, p. 206.

first half. Blights also affected the expansion of the potato, especially in the 1850 – 60s. To overcome the crisis, new varieties had to be used that proved more resistant to the *phytophthora infestans* fungus.¹⁴ Beyond the well-known great potato famine in Ireland, these plagues revealed the widespread nutritional dependence on the potato throughout all of Europe.¹⁵

Along with corn and potatoes, other American crops were introduced either through consumption (chocolate, coffee, tobacco) or as garden vegetable crops (tomatoes, peppers). The dietary changes brought about by these crops should not be underestimated. Chocolate and coffee were considered medical remedies for various ailments, while the popular demand for tobacco precipitated the construction of the Real Fábrica de Tabacos da Coruña in 1804.¹⁶ Peppers today are integral to Galician cuisine and essential in any vegetable patch, along with tomatoes.

The potato thus became a virtual insurance policy against hunger and a guarantee of nourishment if rains –which only made the potato bigger–destroyed the corn. In many cases, due to a legal loophole regarding the payment of rents in species, harvesting potatoes in winter reduced the consumption of corn, which could then be used to feed more cattle or even exported.¹⁷

These crops indicate agricultural growth in Galicia, which was reflected in an increasing population and greater demographic weight vis-à-vis the rest of Spain in the early nineteenth century. Unsurprisingly, for some time now relevant research has associated potatoes with population increase. Examples include the classic studies of economic history in Ireland (R. N. Salaman, 1943; K. H. Connel, 1962; M. Drake, 1963) or more recent research by C. Ó Gráda, R. Paping and E. Vanhaute, (2007). However, corn drove the great population increase in the mid-

¹⁴ DOPICO, F., RODRÍGUEZ GALDO, M.X. (1980): “Novos cultivos e agricultura tradicional: a pataca en Galicia nos séculos XVIII e XIX” (pp. 11-35): *Revista galega de estudos agrarios*. No. 3, pp. 15, 21 and DOPICO, F., RODRÍGUEZ GALDO, X.M. (1981): *Crisis agrarias y crecimiento económico en Galicia en el S.XIX*. Do castro, Sada, p. 61.

¹⁵ Ó GRÁDA, C., PAPING, R., VANHAUTE, E.: *When the potato failed: causes and effects of the 'last' European subsistence crisis, 1845-1850*. Brepols, Turnhout, 2007.

¹⁶ SAAVEDRA, P. (1992): “La Introducción del maíz y la patata en Galicia” (pp. 202-207): *Galicia e América: cinco siglos de historia*. Consellería de Relacións Institucionais e Portavoz do Goberno. Consello da Cultura Galega. Santiago de Compostela, p. 207.

¹⁷ DOPICO, F., RODRÍGUEZ GALDO, M.X. (1980): “Novos cultivos e agricultura tradicional: a pataca en Galicia nos séculos XVIII e XIX”, (pp. 11-35): *Revista galega de estudos agrarios*. No. 3, p. 20, 31.

eighteenth century, especially along the Atlantic coast: an area where its presence was earlier and more prevalent.¹⁸

1.2. Genetic improvements and agricultural intensification in the first third of the twentieth century

We have examined the introduction, expansion and consolidation of American plants in the Galician agricultural system. At this point, the focus shifts to the changes that took place in the late nineteenth and early twentieth centuries.

In Galicia, corn and potatoes reached their maximum territorial extension in the nineteenth century, most notably in the second half, while the region gradually stopped importing and began to export agricultural products in the 1820s. By the end of that century, the intensive Galician polycrop system was firmly established and also provided wine, legumes and other products.¹⁹ However, in the 1870s and 1880s, the fin-de-siècle crisis set in as European producers began to feel the effects of cheap agricultural imports of grains and frozen meat from the Americas. European agriculture in general, including Galicia, was faced with the need to intensify, specialise or reorient production towards new markets. Liberal nation-states abandoned laissez-faire policies and began to intervene, attempting to protect their producers from low American prices. State intervention measures included tariffs and the development of an agricultural research and innovation system that would facilitate the necessary productive renewal.²⁰ In 1877, the Spanish state set out to implement the French model of experimental Farm Schools. Several were established, including the A Coruña Farm School in 1888.

The new State determination involved a logic that explains the establishment of research institutions for agronomic engineering, forestry, and genetics. One of these was the Galician Biological Mission, established in 1921 and directed by Cruz Gallástegui. The State approach basically involved imitating technological innovation models wherever they existed. Countries such as the United States had

¹⁸ DOPICO, F., RODRÍGUEZ GALDO, X.M. (1981): *Crisis agrarias y crecimiento económico en Galicia en el S.XIX*. Do Castro, Sada, p. 38.

¹⁹ DOPICO, F., RODRÍGUEZ GALDO, M.X. (1980): "Novos cultivos e agricultura tradicional: a pataca en Galicia nos séculos XVIII e XIX", (pp. 11-35): *Revista galega de estudos agrarios*. No. 3, pp. 11-12.

²⁰ FERNÁNDEZ PRIETO, L. (1992): *Labregos con ciencia. Estado, sociedade e innovación tecnolóxica na agricultura galega, 1850-1939*. Xerais, Vigo, p. 422.

well-established research institutes, thanks to specialised agricultural colonization efforts there. Gallástegui visited the Connecticut Agricultural Experiment Station in 1918 to receive training under its director, D.F. Jones, who became his mentor.

The Galician Biological Mission and the A Coruña Farm School formed part of the Spanish State institutional framework from the Restoration era through the Primo de Rivera dictatorship and into the Second Spanish Republic. They served to channel efforts at introducing new crops and improving traditional ones.²¹ Both institutions were highly active from 1921 to 1935. The 1933 establishment of the IIA (*Instituto de Investigaciones Agrarias*) best symbolizes the growth of innovation structures and their financing, along with historical experience accumulated in the application of science to agriculture.²²

1.2.1. The work of Cruz Gallástegui and double hybrid corn

To speak of Cruz Gallástegui Unamuno, one must necessarily speak of the birth of the Galician Biological Mission in 1921, when the *Junta de Ampliación de Estudios* decided to create a biological research centre and designated the young Gallástegui as its director.²³ Attempts to improve the performance of corn through hybridization began in this institution. With the fin-de-siècle crisis, new global agricultural product markets needed competitive edges that could only be achieved by applying scientific innovation to agriculture. Both Gallástegui at the Biological Mission and Ricardo de Escauriaza at the A Coruña Farm School worked on the priority issue of increasing corn production, which Gallástegui finally achieved with the double hybrid seed.

This geneticist of Basque origin explained the need to increase corn production:

There are regions that overcome the backwardness of their agriculture with industrial advances, such as the Basque Country and Catalonia. Others overcome it

²¹ FERNÁNDEZ PRIETO, L. (1992): *Labregos con ciencia. Estado, sociedade e innovación tecnolóxica na agricultura galega, 1850-1939*. Xerais, Vigo, p. 423.

²²FERNÁNDEZ PRIETO, L. (2007): *El apagón tecnolóxico del franquismo. Estado e innovación en la agricultura española del siglo XX*. Tirant lo Blanch, Valencia, p. 137

²³POUSA ANTELO, A. (2005): "Don Cruz Gallástegui. O home dos millos híbridos" (pp. 9-12), in: *Murguía*. No. 5, p. 9.

by the vast extension of their land, as in the central plains and Andalusia. Galicia can do neither as it has no industry or equivalent surface, and with a growing population must intensify its agricultural and cattle crops to ensure that its economy keeps up with the times.

In the same speech, he defended seed potato selection: 'I experimented with 69 varieties of potatoes. Some produced 4,600 kilos per hectare while others produced 54,000 kilos per hectare. Eleven times more. Ragis potatoes, which today are known world-wide, were at the bottom of the productivity list in Galicia'. Gallástegui expressively indicated the goal of his work:

Galicia does not produce enough corn to meet its own demand, but does produce about half the Spanish total of between 550,000 and 600,000 tonnes. So Galicia produces 300,000 tonnes and must import 20,000 while the rest of Spain produces another 300,000 tonnes and must import 200,000 more. Free market imported corn is used to feed cattle in the rest of Spain and sinks the price of Galician corn. Cheap corn lowers the price of meat in provinces that compete with Galician cattle production. If there are problems with importing corn, then they buy Galician corn, and Galicia risks losing the corn needed to feed the local population. This problem can be solved if the Mission can increase the productivity of Galician corn; we could not only be self-sufficient but could even export to the rest of Spain, which would provide added wealth to our farmers.²⁴

At first, Gallástegui used the land of the Santiago Veterinary School for corn research, seeking to establish the best distance between plants and study the depth at which the seeds should be planted. Other early experiments were also done to ascertain the best fertilizer by mixing different types used by farmers, including manure, super phosphates and complete mineral fertilizer.²⁵

Soon after those first efforts, he began to persuade farmers in the Pontevedra province that better seed was needed: "There is a great difference between one type of corn and another. Some varieties yield 1,800 kg/hectare while

²⁴GALLÁSTEGUI, C. (ed. 2005): "Esbozo do programa agraira para Galiza" (pp.13-28), in: *Murguía*. No. 5 (2005), pp. 10-21.

²⁵POUSA ANTELO, A. (2005): "Don Cruz Gallástegui. O home dos millos híbridos" (pp. 9-12): *Murguía*. No. 5, pp. 10-11.

others planted and cultivated in the same way produce 5,000 kg/hectare. The reason for this difference is nothing more than the choice of one seed over another.²⁶ In the first stage of the Santiago Mission (1921-26), 46 varieties of Galician corn and 26 varieties of US corn were studied.²⁷ Research efforts were also aimed at obtaining and maintaining pure strains for commencing hybridization, in order to achieve simple hybrids that would later allow the production of the double hybrid seed.²⁸ More specifically, seed improvement research in the 1920s and 1930s focused on selection and degeneration.

All this research took place in very poor financial conditions that created job insecurity, which made the necessary long-term project planning difficult if not impossible. The situation improved slightly during the Republican regime that was established in Spain in 1931. The Mission moved to the city of Pontevedra, where the Seed Producers Trade Union was created, an endeavour that benefitted from Gallástegui's 1929 visit to the Svalof seed station in Sweden. Prior to that, Gallástegui and the Pontevedra group had indicated the need to ensure seed distribution apart from the seed distribution companies. Demand had been increasing annually since 1924 and exceeded the production capacity of the Mission in 1928. After Gallástegui returned from Sweden in 1930, the Seed Producers Trade Union was created to meet the demand for hybrid corn seed.²⁹

The seventeen founders of this trade union in 1930 were clearly members of the elite: four parish priests, leaders in Pontevedra society who also served on the governing board of the Mission, and founders of the Salcedo and Lourizan farm schools. However, by 1935 membership had increased to 259, including individuals and several agricultural societies. From 1933-36 this syndicate also published a Bulletin to disseminate knowledge and make known pertinent innovations (Cabo, 1997: 114).

The Seed Producers Trade Union was responsible for distributing double hybrid corn seed to farmers willing to use it. Historian Fernandez Prieto affirms

²⁶POUSA ANTELO, A. (2005): "Don Cruz Gallástegui. O home dos millos híbridos" (pp. 9-12): *Murguía*. No.5, p. 11.

²⁷CABO VILLAVERDE, M. (1997): "O labor da Misión Biolóxica de Pontevedra ata 1936 e a reforma da agricultura galega en Cruz Gallástegui Unamuno" (pp. 103-152): *Cuadernos de estudios gallegos*. Vol. 43, No. 109, p. 107.

²⁸FERNÁNDEZ PRIETO, L. (1992): *Labregos con ciencia. Estado, sociedade e innovación tecnolóxica na agricultura galega, 1850-1939*. Xerais, Vigo, p. 428.

²⁹*Ibidem*.

that demand for double hybrid seed increased from 16 metric tonnes in 1930-31 to 70 metric tonnes in 1934-35. However, most of the seed production was destined to supply demand outside Galicia.³⁰ The varieties selected were the yellow *Pepita de Oro* and the white *Reina Blanca*.³¹ The following table shows in greater detail the distribution of hybrid corn seed by the Trade Union:

Table 1

Years	Seeds (kg)	Hectares sown
1930-1931	16,000	400
1931-1932	28,000	700
1932-1933	10,000	250
1933-1934	30,000	750
1934-1935	70,000	1,750

Source: Author's own based on FERNANDEZ PRIETO, L. (1992, 430)

The notable decrease in 1932-33 was partially due to a genetic correction to the seeds based on the first actual results of hybrid corn in real crop conditions. The hybrids had to be adjusted and adapted since the fertilizing requirements were at times beyond real farming conditions.³²

Corn innovation was not always well-received among relevant peers. Evidence points to a surprising lack of coordination among the various agricultural experimentation centres in Galicia at that time and to professional rivalry between Gallástegui and Ricardo de Escauriaza, Diretor of the A Coruña Farm School. He disparaged the actual effectiveness of Gallástegui's double hybrid strains:

Given the growing period of the *Pepita de Oro* and *Reina Blanca* hybrids, if the summer is cool and humid they do not mature well and if it is dry they require irrigation, which is not common here. Because of their height, they are easily blown down by the wind and their large cobs are mostly uncovered at the end,

³⁰CABO VILLAVERDE, M. (1997): "O labor da Misión Biolóxica de Pontevedra ata 1936 e a reforma da agricultura galega en Cruz Gallástegui Unamuno" (pp. 103-152): *Cuadernos de estudios gallegos*. Vol. 43, No. 109, pp. 114-115.

³¹CABO VILLAVERDE, M. (1997): "O labor da Misión Biolóxica de Pontevedra ata 1936 e a reforma da agricultura galega en Cruz Gallástegui Unamuno", (pp. 103-152): *Cuadernos de estudios gallegos*. Vol.43, No. 109, p. 121.

³²FERNÁNDEZ PRIETO, L. (1992): *Labregos con ciencia. Estado, sociedade e innovación tecnolóxica na agricultura galega, 1850-1939*. Xerais, Vigo, p. 431.

which leads to rapid growth of mould. Their long stalks bend so that the cobs touch the ground, where they get wet and stay wet, which also contributes to the growth of mould. Finally, their great need for fertilizer, the cultivation system recommended and the high price of the seed increase the cost of production extraordinarily. These are the reasons why they have not extended throughout the province, but does not give cause to deny that in the centre and south of Spain they yield excellent results.³³

1.2.2. Selection and improvement of the potato

At this point, we will address another American crop of particular interest to innovation experts at that time. Potatoes were a staple food for farmers and could be adequately commercialized to supply urban demand. On this point there was agreement between Gallástegui and L. Hernández Robredo, the predecessor of Escauriaza at the A Coruña Farm School.³⁴ However, potato research at the Biological Mission was never more than intermittent, due to a lack of consistency of the person responsible, B.F. Osorio-Tafall. His political activities took time away from consistent in-depth research. Also, unlike corn experimentation that involved genetics, the potato research only involved ascertaining which varieties were more resistant to plagues.³⁵ Similarly, the area of research dedicated to experimentation with the American tobacco plant never became practically successful.³⁶

From 1930 to 1935, the Biological Mission experimented with 146 varieties of Spanish, Dutch, German and Scottish potatoes, to discover which could be best adapted to Galician climate and soil conditions. Though none of them seemed ideally suited, in 1939 four late varieties and two early ones were adapted. The Seed Producers Trade Union also worked on developing varieties resistant to plagues and degeneration, which limited potato production at that time. Seed

³³CABO VILLAVERDE, M. (1997): "O labor da Misión Biolóxica de Pontevedra ata 1936 e a reforma da agricultura galega en Cruz Gallástegui Unamuno" (pp. 103-152): *Cuadernos de estudios gallegos*. Vol. 43, No. 109, p.146.

³⁴ BERNÁNDEZ SOBREIRA, A. (1999): *Planificación agraria na Galicia autárquica 1939-1955*. Consellería de Agricultura, Gandería e Política Agroalimentaria, Santiago de Compostela, pp. 50-51.

³⁵CABO VILLAVERDE, M. (1997): "O labor da Misión Biolóxica de Pontevedra ata 1936 e a reforma da agricultura galega en Cruz Gallástegui Unamuno" (pp. 103-152): *Cuadernos de estudios gallegos*. Vol. 43, No. 109, p.122.

³⁶CABO VILLAVERDE, M. (1997): "O labor da Misión Biolóxica de Pontevedra ata 1936 e a reforma da agricultura galega en Cruz Gallástegui Unamuno" (pp. 103-152): *Cuadernos de estudios gallegos*. Vol. 43, No. 109, p.126.

potato degeneration was a long-standing problem that intensified with the introduction of high-yield varieties. Though such species had been introduced in the late nineteenth century, degeneration issues did not become acute until after the First World War. Gallástegui indicated that in the second half of the 1920s seed potatoes had to be purchased annually.³⁷

The Mission decided to make this a priority project and sought a potato variety resistant to blight caused by humidity. The ideal potato would be the most productive, of sufficient quality and easily stored.³⁸ However, as the objective of combining quality with quantity was not always easily attainable, Gallástegui decided to emphasize the latter, 'which is what the farmers are most interested in here'. Eventually, they found satisfactory varieties, which were produced and commercialised by the Seed Producers Trade Union (17,255 in 1933, 22,000 in 1928).³⁹ The following table shows the evolution of land dedicated to potatoes in Galicia.

Table 2

Year	Hectares cultivated
1902	37,899
1910	45,590
1922	88,575
1926	64,960
1927	69,762
1928	78,818
1929	93,612
1930	78,940
1933	110,173
1933	110,740
1934	111,773
1935	110,784

³⁷ FERNÁNDEZ PRIETO, L. (1992): *Labregos con ciencia. Estado, sociedade e innovación tecnolóxica na agricultura galega, 1850-1939*. Xerais, Vigo, p.434.

³⁸ *Ibidem*.

³⁹ FERNÁNDEZ PRIETO, L. (1992): *Labregos con ciencia. Estado, sociedade e innovación tecnolóxica na agricultura galega, 1850-1939*. Xerais, Vigo, p.435.

Source: Author's own based on FERNANDEZ PRIETO, L., (1992, 443)

1.3. Epilogue

As in so many other areas, the Spanish Civil War (1936-39) interrupted corn and potato innovation and the associated institutions. Cruz Gallástegui was targeted by the repressive mechanism of the regime but managed to disassociate his work from any political agenda or affinity with the Republic. Allegations that he belonged to the Partido Galeguista were dismissed as personal disputes and professional rivalry with agronomic engineers.⁴⁰ Others in the Biological Mission suffered different fates: Alexandre Bóveda, a leader of the Partido Galeguista who worked as an accountant there, was executed in 1936; B.F. Osorio-Tafall ended up in exile. The Biological Mission was absorbed by the CSIC (*Centro Superior de Investigaciones Científicas*), and languished due to serious financial shortcomings throughout the 1940s.⁴¹

The Seed Producers Trade Union was quickly destroyed by the new Falangist trade union organizations. Its eradication was so complete that when hybrid corn was later extensively commercialized during the Francoist *desarrollismo* era, imported varieties from the US were used rather than those that had been developed by the Mission and distributed by the extinct Seed Producers Union.⁴²

To conclude, the Francoist context was one of significant civil repression, precarious economic conditions that stalled innovation, international isolation, a lack of basic raw materials, absence of political pluralism, weak defence of farmers' interests and the return of a portion of society to rural life. Agricultural objectives during the Franco era were different from those that enabled the main changes and innovations in American crops that we have examined here.

⁴⁰FERNÁNDEZ PRIETO, L. (2007): *El apagón tecnológico del franquismo. Estado e innovación en la agricultura española del siglo XX*. Tirant lo Blanch, Valencia, pp. 291-292.

⁴¹FERNÁNDEZ PRIETO, L. (2007): *El apagón tecnológico del franquismo. Estado e innovación en la agricultura española del siglo XX*. Tirant lo Blanch, Valencia, p.226.

⁴² FERNÁNDEZ PRETO, L., LANERO TABOAS, D. and CABO VILLAVARDE, M. (2014): "La lucha por el poder en el primer franquismo: la integración forzosa del Sindicato de Productores de Semillas en la Organización Sindical" (pp. 201-220) in: FERNÁNDEZ PRETO, L., ARTIAGA REGO, A.: *Otras miradas sobre golpe, guerra y dictadura (1944-1946)*. La Catarata, Madrid.

2. Conclusions

This article has provided a historical overview of the introduction and expansion of American plants in Galician agriculture from the sixteenth through the early twentieth century. These crops brought about changes of an enormous magnitude in Galician agriculture. The rapid and high corn yields obtained mainly in Galician coastal areas explain population growth and re-distribution towards those areas. The demographic increase in Galicia vis-à-vis Spain led to the massive Galician migrations of the nineteenth and twentieth centuries and also explains the origins of micro-parcellation problems in areas where corn was introduced more rapidly and completely.

In the Galician interior, the potato became extensive in the eighteenth century and spread throughout Galicia along with corn, reaching maximum territorial extension in the mid-nineteenth century. By the end of that century, the features of the Galician polycrop system had been fully defined and also produced wine, legumes, meat and milk.

The fin-de-siècle crisis made agricultural change and innovation necessary in Galicia and throughout most of Europe. State economic intervention involved both tariffs to protect farmers from cheaper American agricultural imports and attempts to innovate in order to discover competitive advantages in a globalised agricultural market. This logic explains the rise of research institutions that sought productive renewal in agriculture and other areas by involving agronomic or forestry engineers and geneticists, such as Cruz Gallástegui Unamuno at the Galician Biological Mission. Founded in 1921, this institution and the A Coruña Farm School (established in 1888) were responsible for the main technological advances in agriculture.

Double hybrid corn was developed through selection of American and Galician varieties. Gallástegui held that Galician economic development required intensive agriculture and the first step was to increase corn production as a key crop for the entire peasant economy. His objective: to provide adequate nourishment for the population as well as sufficient feed for cattle destined for export to Spanish cities. Within this strategy, the potato was also considered a food

that could be commercialized. The Biological Mission experimented and selected potato varieties, but the results were neither as intense nor as consistent as with corn. This was most likely attributable to the political activity of Osorio-Taffal, head of potato research at the Mission.

Data from the Seed Producers Trade Union, an institution established by the Mission to distribute double-hybrid seed and the most suitable potato varieties, indicates a degree of success in transmitting these innovations to the farmers. However, the work of Gallástegui and the innovation institutions came to a swift demise with the Spanish Civil War. This conflict began an era of censorship, suppression and repression of many things in society: institutions, knowledge, associations, financing and even people.

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