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Spanish agricultural engineers and the international agronomy: the legitimation of a national techno-scientific discipline, 1840-1914

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The Spanish agricultural engineers, a new career established in 1855, were designed as both a liberal profession and a group of experts that had to assess and even work in the public institutions, with the specific aim of leading a new scientific agriculture. Scientific was a key word that related these new professionals to an international community of *savants* in the making, the one of agronomy, turning agricultural engineers into its legitimate mediators in Spain. Engineering was not just a name: it implied the application on agronomy –as it had been done on forestry in 1848- of the concrete model of education and professionalization, developed for civil works and mining between the end of the 18th century and 1830's, on the basis of the French civil engineering, the Spanish tradition of military engineering and politico-administrative needs of the Monarchy¹. It was a rather original, almost unique in Europe in 1848-1855, choice of the Spanish government that was to determine many traits of Spanish forestry and agronomy in the years to come.

From their earliest times onwards, agricultural engineers tried to be up to the expectations of scientific advancement placed upon them. They saw in the supply of scientific outputs the key instrument to consolidate their existence and gain access to a higher professional status and to the setting of a public corps, like the ones of civil, mining and forestry engineers. Agronomy was not until the late 19th century a fully recognized discipline anywhere in Europe: between the 1830's and the 1870's agronomy was in its way to become a techno-scientific knowledge, based upon but separate from chemistry and from biological sciences. Spanish agricultural engineers reinforced with their very existence the construction of the discipline and at the same time imported from their colleagues abroad both technical and scientific objects and organizational and procedural mechanisms, that supported the scientific character of their knowledge. Reading and translating foreign books, attending the international exhibitions (London, Paris, Vienna, Chicago...), visiting experimental and model farms in France, Belgium or Germany, were some of the activities undertaken by many agricultural engineers. However until the beginning of the 20th century, these international contacts remained unsystematic, often dependent on private initiatives –even though they received sometimes the financial support of the State- and oriented either to the study of labour-saving machinery or to the explanation of foreign institutional models.

The latter played a relevant role in a first wave of institutionalization of agricultural engineers in the last decades of the 19th century, when the Great Depression forced a rethinking of agrarian policy. In 1879 the corps of agricultural engineers was established and very soon it

¹. On the traits of civil engineering in Spain in the early 19th century: Martykánová (2009).

was attributed the planning and direction of the first official agronomic centres. But fiscal constraints and a protectionist turn that exhausted agrarian mobilization in the country reversed the development of new agronomic establishments. International references and experiences only acquired a new importance after 1898, both because of a turn in Spanish public policies – that brought with them a relatively rapid display of experimental centres- and because of institutional changes abroad. By the outbreak of the Great War, Spanish agronomy –that is to say, agricultural engineering- represented itself as the national active branch of an international community of experts.

We will discuss in more detail what was meant by international all throughout our period of study, or in other words, who were those international scientists and professionals that validated agricultural knowledge in Spain. But we should not take for granted the other element of our dipole: national, in this case meaning Spanish. It is true as Pyenson has argued that national science is very often a concept that misleads the reader, since most national scientific communities were and are in fact local communities that do not represent the heterogeneous scientific networks that coexist in one country². It can be assumed though, that his rejection of national categories cannot be applied universally and that the representation of a national agronomy in Spain, and for a certain time-period, is an adequate one. It took agricultural engineers a long time to attain the monopoly of agronomy, but by the beginning of the 20th century they were recognized as the scientists of agriculture: political parties, scientific journals and agrarian organizations accepted their technical competence, although this recognition could be coupled with all kind of criticisms. Since agricultural engineers achieved their credentials in a single school located in Madrid and since they were entitled to enter the state service and leave it to work in the private sector, the profession and the administrative corps were totally linked. As civil servants they normally had to follow a *cursus honorum* that took them through different provinces and public establishments: professionals, scientists and administrators of public and private estates or agro-industrial companies were all members of a corporative structure that ensured through the common entrance exams, the five years coexistence at the School, the periodic meetings and the hierarchical levels of offices and centres, an identity that had a Spanish horizon³. Attempts, such as the one of the Catalan *mancomunitat* or regional government, during the Great War, to create its own school of agricultural engineers can be taken as an evidence of the (Spanish) nationalization of the agricultural engineers.

Spanish agricultural engineers and forestry engineers, who were organized in an analogous way, evolved throughout the 19th century in close connection with what they understood as the international disciplines of agronomy and silviculture. They took though, until the 1900's, a limited part in the construction of their international discourses and disciplinary objects. The theories, taxonomies and practical proposals constructed in different centres but transmitted basically through France, were appropriated, developed and diffused locally, often with a very specific objective: justifying the existence of an agricultural technical profession and convincing society and the politicians about the necessity of scientists in the field. A major effort to integrate Spanish applied scientists and professionals, to turn them into active diffusers and creators of “international agronomy”, was triggered in the decades before the Great War by new techno-scientific policies that gave the public sector a fundamental role in the modernization of agriculture and rural society. The actual results of such a policy were to be seen in the 1920's: by then the legitimacy of an agricultural and agro-industrial knowledge society had been imposed in Spain.

1. Spanish agronomy in the 19th century and its international references

Spanish agronomy was born in the 18th century with a double reference: the already established and relatively long tradition of autochthonous agricultural bibliography and the

² . Pyenson (2002).

³ . A general view of the development of agricultural engineering in Spain in Pan-Montojo (2008).

French *nouvelle agronomie*. Even the English “new husbandry” and most of the German language agrarian literature were actually received through the intermediation of French *agronomes*. However, Spanish enlightened authors developed on these bases their own proposals of cultural, technical and political reforms of agriculture and agrarian structures and gave shape to a set of institutions dedicated to botany, that in the last decades of the century became an applied discipline, especially oriented to the needs of agriculture.

After the long crisis that brought with it the disappearance of the Spanish empire and the beginning of the state building processes on both sides of the Atlantic, there was a fundamental discontinuity in relation to the previous trends: a large part of the programme of scientific development in the 18th century had been created in direct connection with the imperial policy and the end of the empire brought about the collapse of scientific and technical institutions. The political exile of a non negligible part of the *savants*, who took sides with the Napoleonic reformism or with “patriotic” liberalism, and the financial crisis of the curtailed monarchy aggravated the disruption of Spanish scientific establishments. For almost three decades – between 1808 and the end of the 1830’s- Barcelona and Havana became the centres of publications and journals in the Spanish Monarchy, that maintained the tradition and of the 18th century scientific projects. The Jardín Botánico of Madrid, in the concrete field of agriculture, was another although much less active shelter of the enlightened agronomy: its relatively low profile did not hinder though its becoming the recruitment centre of the fathers of the first agrarian bureaucracy.

Despite this major rupture, there were various continuities. One of them was the public policy of sending Spanish graduates to foreign centres, since the system of “pensions” of the 18th century was recovered in the late 1820’s and had a decisive influence in the formation of the liberal intellectual and scientific elites⁴. A second and more general continuity was the fact that the topics and proposals of the *ilustrados* [men of the Enlightenment] became the foundation of liberal agrarian programmes. Amongst them, the creation of an agrarian educational system with a superior level aiming at the formation of scientific agronomists was finally carried out in 1848, with the establishment of a School of Forestry Engineering, and 1855, with the opening of the General School of Agriculture. The *ingenieros de montes* (forestry engineers) were to construct a profession that had in its core the disciplines that were taught at the academy of Tharandt in Saxony, even though the regulation of the profession was very similar to the one of the civil and mining engineers, whose political and social role had been defined through a combination of the example given by the French *école de ponts et chaussées* and the Spanish tradition of military engineering. The *ingenieros agrónomos* were taught a syllabus modelled on the one of the short lived Institut National Agronomique de Versailles (1848-52), but their formation, their professional consideration and even their name were thought according to the by then well consolidated careers of the other engineers, although without an administrative corps of heir own. In 1848 too, the State created the Academy of Exact, Physical and Natural Sciences, that grouped together experts in these fields, including engineers, and published a journal that translated the *comptes rendus* of the Académie des Sciences de Paris, supplying hence the means for a quick reception of the latest works of European science. With the new academy, the opening of the Conservatorio de Artes, the creation of the section of sciences in Philosophy Faculties and the foundation of the engineering schools, a new national, as opposed to the previous imperial, “local scientific infrastructure” came to life in the 1840’s. Applied sciences, useful knowledge, had a central role in its development: for this reason, engineers – techno-scientists and public servants- were to be given a central role too⁵.

The scientific formation of Spanish 19th century agronomists was, as the one of other scientists and of their 18th century predecessors, based upon a mixture of local publications and French books. The fundamental change was that in the context of the new formalized education in a school that produced engineers, physics and mathematics were the core subjects of the

⁴ . García Belmar and Bertomeu (2003).

⁵ . On the Local Scientific Infrastructure: Chambers (1993).

preparatory formation and, after 1869, more than 50 % of the courses were dedicated to them⁶. In 1864, Braulio Antón Ramírez published a *Diccionario de bibliografía agronómica* [Dictionary of agronomic bibliography] that intended to cover all writings on agriculture, veterinary, forestry and rural economy that had been produced in Spain throughout the centuries. Amongst the books and articles printed in the 19th century, he listed 656 authors, of which 150 were foreign or Spaniards who had translated foreign books. Almost 90 % of those 150 were translated from French and out of the other 10 %, nearly a half had reached Spain through the French version. If we consider their contents, French influence was even greater, since many of the Spanish publications described the actual practices of cultivators or defined some kind of canon of good farming skills and management or fostered “rational” administration of the estates, to an urban public that owned land but had a weak relationship to agriculture. Scientific and technical knowledge were developed after the teachings of French authors and what they conveyed of other countries: if local agricultural societies reproduced articles from French journals, at the General School of Agriculture, and after 1869 at the School of Agricultural Engineering, the subject of agronomy was based upon the handbooks of Girardin and Gasparin⁷. This dependency from the French agricultural knowledge corresponded in this particular field to a general cultural, economic and technological dependency of the country on its Northern neighbour: 42 % of the foreign applications for patents in Spain between 1759 and 1900 and 59.11 % of the foreign capital invested in Spain between 1851 and 1914⁸. But French cultural hegemony did not mean total monopoly. In the case of forestry engineering, German scientific literature had a dominant position⁹. Up until the late 1860’s, nearly every year one graduate of the school of Forestry was sent to Tharandt for three years¹⁰. Despite the interruption of these scholarships, the memoirs of Castellarnau in relation to the 1870’s and 1880’s show a thorough knowledge of German developments even though as he reminds the reader -referring to Abbe’s theory of the microscope between 1878 and 1883-, German journals did not reach Spain and he had to get acquainted with their contents through English ones (in his case the *Journal of the Royal Microscopical Society*).

French scientific hegemony in Europe tended to be gradually eroded by the competition from Germany, Great Britain and other countries after 1850. Spain, despite being a semi-periphery in cultural terms of France¹¹, reflected this evolution, which on the other hand coincided with the gradual construction of a national community of scientists and technicians, led by the Academy and the public engineering schools in the 1850’s and 1860’s. The creation of a national network of technicians and scientists entailed a new understanding of Spain’s position in the international arena, very different from the one of the 18th century republic of *savants*, which by its sheer cosmopolitan character could have its centre in any given place. I shall argue that in the case of agronomy, nationalization fostered a wider understanding of international centres: the formation of a Spanish community of experts turned international agronomy, in the eyes of agricultural engineers, into an aggregate of national techno-scientific communities. Of course they were not imagined as a society of equal members; nevertheless, and in accordance with their own self-representation, agricultural engineers tended to accept that “distinguished colleagues” could be working in all the “civilized” nations and therefore considered bibliography published in other languages, apart from French that continued anyway to be the *lingua franca agricola*.

Books and journals were the basis of Spanish agronomy, but personal travels had relevant consequences. As we have said, from the late 1820’s onwards, a regular though not systematic policy of sending young students and civil servants abroad for their academic formation was put into place¹². It recovered the policy of the Bourbons and the initiatives of the Junta de Comercio

⁶ . Cartaña (2005), p. 139.

⁷ . Cartanyà (1991).

⁸ . On patents: Sáiz (2006). On foreign capital: Tortella (2000).

⁹ . Casals

¹⁰ . Casals (2007), p. 443.

¹¹ . Polanco (1989).

¹² . Sala (1989), p. 130.

de Barcelona, an official institution of merchants and industrialists of the Catalan capital, that in the 1820's had put into place its own programme of study grants, giving thus continuity to their intense activity before the Napoleonic War¹³. Subsidized or financed trips to study in European universities and technical schools or visit educational or research institutions existed all throughout the 19th century, although –when superior educational centres opened their doors in Spain- the bulk of the scarce resources were dedicated to official journeys of civil servants, including among them engineers and professors. After the 1860's most of these journeys were short and did not include attendance to schools or universities. Because of this change, very few agricultural engineers –whose first graduates came out of the School in 1861- received grants, in comparison to forestry engineers: one of the first and last ones at the same time was Diego Pequeño who was paid a two-year tour to different centres in France, Belgium and Switzerland to study wine, olive oil and cheese production (Cartaña, 2009, 690).

Congresses, exhibitions and agro-industrial premises (caves, mills or factories) were visited by Spaniards, who in most cases wrote reports of their activities in exchange for the subsidies they received. In 1862, Muñoz y Rubio, who had finished his studies of agricultural engineering the previous year, was appointed member of the commission that attended the International Exhibition of London. His report, published in 1864, gave a systematic account of the agrarian machinery and tools in the Exhibition and, at the same time, analyzed the recent history of the introduction of “modern” engines in Spanish farms and suggested a list of necessary changes to adapt them to local conditions¹⁴. Miguel Bosch, a forestry engineer, was another member of the same commission and published a book on his findings in London in 1863. In the following years other engineers received grants to attend similar events: in the National Library of Madrid, there are more than forty reports on different international exhibitions between 1855 and 1885. And not only engineers: Graells, a natural scientist who devoted a large part of his work to agrarian questions, attended three exhibitions and three congresses between 1866 and 1885, and became member of academies in London, Hamburg, Milano, Lisbon and Moscow, and Luis Justo y Villanueva, an industrial engineer specialized in wine production, was subsidized to attend the exhibitions of London (1862) and Paris (1867), an experience that he used in the organization of the Exposición Vitivinícola Nacional in 1877. Since provincial governments tried to encourage the presence of their provinces in the international exhibitions, representatives of the local “intellectual” elites, and above all, the teachers of Natural History, Agriculture or Chemistry in the provincial institutes of secondary education, were often asked to gather the best products and tools of their provinces and to travel with them to the exhibition. Whenever public money was involved, reports were an obligation and some of them are very intelligent exercises of analysis of local conditions and the possibilities they offered to adopt innovative proposals seen during the exhibitions¹⁵. Beyond the actual changes in agricultural practices brought about by international exhibitions, they clearly had a direct consequence: the multiplication of exhibitions in Spain. Organized by and for the elites and without clear technical aims, most probably they had a very limited impact in productive methods or technologies. Provincial and national exhibitions materialized the social representation of elites as promoters of “progress” and in so doing they contributed to consolidate a discourse favourable to technical innovation, on which agricultural engineers would eventually find a fertile soil to sow their profession¹⁶.

More difficult to trace, even though presumably as frequent if not more, must have been the private –partly professional, partly touristic- journeys of agronomists to other countries. Before the Schools of Forestry and Agricultural Engineering opened their doors, some affluent families sent their children to Grignon or Nancy to study. We do not have any figures but there are various references to such students in the existing literature. Much more frequent were trips to visit the “advanced countries” and see personally the technical innovations. We know that the

¹³ . Martínez Nó (1988).

¹⁴ . Muñoz y Rubio (1864).

¹⁵ . The local impact of attendance to international exhibitions is well described in relation to Córdoba in Luque (2004), pp. 176-192.

¹⁶ . On the agricultural exhibitions and their social role: Veiga (1997).

brothers Rafael and Ramón Guerrero Castro, who finished their studies of agricultural engineering in 1864, did a long trip around Britain and France after their graduation and before they set up a society to promote mechanization in Jerez¹⁷. The agricultural engineer Abela y Sáinz de Andino, who became the editor of the *Gaceta agrícola del Ministerio de Fomento*, the “scientific” journal of the Ministry founded in 1876, frequently referred in his writings to his visits to French model farms and agricultural schools. José Jordana, a forestry engineer, toured Japan, Australia, New Zealand, Algeria and the USA, and published three books on this last country, in which forests and agriculture held a central position (Canals, 2009). Another forestry engineer, Máximo Laguna, wrote his *Excursión forestal por los imperios de Austria y Rusia*, after a long trip in 1864. A third one, Rafael Puig, undertook a journey in the USA, Central America and the Caribbean, after his official commission at the Exhibition of Chicago in 1893, which he described in his *Viaje a América*, in 1894.

A further channel of contact with what engineers considered to be a fundamental element of international agronomy –new agrarian machinery and tools- was provided by commercial representatives of foreign firms. Between 1862 and 1865, at least ten public exhibitions of the working of threshers run by steam engines took place in Spain. In nearly all of them we find similar people involved: big landowners, politicians (in certain cases some of the landowners), local agronomists and representatives of British houses¹⁸. Initially there were some problems with the varieties of wheat cultivated in Spain but by 1865 they had been solved by the producers. The press success of these experiments and the active support of public institutions, agronomists and agricultural engineers encouraged Ramsomes to open an agency of the company in Seville in 1867. However by 1873 his representative became an independent dealer, who sought clients for different companies and mediated the orders to Britain, since the results had been disappointing for its initial employer. In the 1880’s, most British firms signed contracts of representation with local producers of agrarian tools: these Spanish firms would combine in years to come the importation of agricultural machinery (Ramsomes, Marshall, Ruston, Clayton & Suttleworth...) with their own production. Mechanization was very slow. The relatively high threshold point of the new engines –given the low cost of labourers- and the inexistence of workshops and skilled workers in the villages to maintain and repair the machinery, acted against the spread of these labour-saving devices. However there was a steady flow of imports that consolidated the local representatives and turned them into permanent mediators between the Spanish professionals of agronomy and their media, on the one hand, and the international firms, on the other.

The spread of the phylloxera in Spain after 1877 fostered the multiplication of nurseries that in the 1880’s brought from France American vines. Nursery owners from the early 1850’s had an intense relationship with France, even though in the Mediterranean coast they often imported plants from America¹⁹. In the 1880’s they very often utilized the commercial circuits developed by French commissioners who bought Spanish wine for the French wine producers, turning those circuits into a new channel of arrival of agricultural biological innovations. Nursery owners and hardware dealers shared the new business of fertilizers that started to be imported in meaningful terms in the last two decades of the 19th century, even though there had been a long tradition, started in the 1840’s, of importing “guano”, especially in the Mediterranean regions. In the case of fertilizers, as in the one of new breeds and plants –much more than in the one of machinery and tools- the introduction of innovations demanded careful analysis and selection and adaptation to local conditions. These principles, unanimously defended by engineers and by the few existing agricultural societies, was partly a realistic approach to agrarian innovation, and partly a conviction born out of collective interests: agricultural engineers saw themselves, and expected the social elites, within and outside agricultural societies, to see them as the necessary mediators between agrarian scientific progress and agrarian change.

¹⁷ . Cabral (2000), chapter III.

¹⁸ . The information on the introduction of agricultural machinery in Spain in Martínez Ruiz (2000).

¹⁹ . Calatayud (1999), pp. 113-114.

Liebig's vision of the experimental stations, as institutions dedicated to apply to particular cases the general chemical laws, had been received all together with two of his major works, and defended by the Chemistry Professor, José Torres Muñoz de Luna, who had worked with Liebig in Germany in 1852. A Catalan agrarian association, the Instituto Agrícola Catalán de San Isidro, opened an agricultural laboratory in 1867 that introduced some of the practices of the *Versuchstationen*. In 1877, a German, Otto Wolffenstein, became the director of the first establishment to be called "Estación agronómica", created in Valencia by a the Sociedad Valenciana de Agricultura. This *Estación Agronómica* dedicated a large part of its work to the analysis of fertilizers, especially of guano imported from America. But it was an agricultural engineer, Muñoz y Rubio, the most influential promoter in the 1870's of the creation of a public network of experimental stations, which were expected to reproduce in Spain the German *Versuchstationen* and the French *stations agronomiques*, aiming like them to develop concrete solutions for agriculturalists, through the combination of research and systematic analysis of soils, waters, fertilizers and agrarian products²⁰. Even though an *estación agronómica* opened in the School of Agricultural Engineering of Madrid in 1875, it did not work as an experimental station for various reasons until the 20th century. Nevertheless the project inspired many specialized provincial centres in the 1880's: the *granjas escuela experimentales* [experimental school farms] established in 1887 tried to combine the *Versuchstation* with a primary and secondary agrarian educational centre. Other agricultural centres had been created between 1879 and 1882, *granjas modelo* and *estaciones vitícolas y antifloxéricas*, although with some exceptions they had a very unstable and unproductive existence²¹. To gain support for these projects and institutional developments, Spanish agricultural engineers and their allies wrote conspicuously on the examples of neighbouring countries, amongst them, and apart from France, Italy that was considered to be a state with very similar cultural, political and agrarian traits, and therefore an adequate model for Spanish policies, occupied a central position. In 1888, a Spanish diplomat published a book commending Italian technical and commercial policy in relation to wine, and many articles echoed the diverse policies of diffusion undertaken by the Italian government²².

Experimental stations and other centres of adaptation or diffusion of innovations were not the only institutions imported and appropriated from other European countries. In 1881, agricultural engineers played a leading role in the creation of the AAE, Asociación de Agricultores de España [Association of Spanish Agriculturalists], that following the path of the Société d'Agriculteurs de France, tried to put into place a lobby of landowners and technicians to counterbalance the associations of industrialists and promote a more active agrarian policy. The AAE did not become an active force in political terms until the 1910's but it contributed to spread among the elites what can be called –as some landowners did- the "discourse of engineers", the thesis that there could be no agrarian progress without a systematic application of the latest techno-scientific knowledge.

By the end of the 19th century, when according to Boulaine (1996) the second agronomic revolution was taking place, Spanish agronomy had come of age and consolidated itself as the leading profession for agrarian development. International, especially French, agronomy and the institutions that supported it in Central Europe, the USA and France, as well as the different resources that had been created in other countries, were a permanent reference that both legitimized the discipline and its practitioners, agricultural and forestry engineers. A more or less immediate knowledge of the state of the art and clear acquaintance with international developments, ensured by the readings, exchange of letters and travels of agricultural and forestry engineers and by an expanding agricultural press, that summed up or reproduced the contents of technical and economic journals in other European countries, contrasted with the weak position of national research and experimental centres: this unbalance was one of the clues of the low technological level of agriculture and forestry, according to the engineers.

²⁰ . Muñoz y Rubio (1876).

²¹ . Cartaña (2000) and Pan-Montojo (2005), pp. 126-140.

²² . Dupuy de Lôme (1888).

2. The new approach to international agricultural knowledge: the turning point of 1898

Science acquired a new place in the Spanish public arena in the last decades of the 19th century. It ceased being one of several spheres of cultural production to become, at least for growing sectors of the middle classes, the axis of any project of collective change. The so-called “polémica de la ciencia española” (a public debate on the relationship –incompatibility- between the national character and scientific production that had started in the 18th century) was eventually left behind and all the tendencies of the cultural and political elites coincided in stating that the development of scientific formation and scientific research was necessary in order to overcome Spanish backwardness²³. The relationship between scientific institutions and industry in countries like Germany, France, Italy or Japan, was reminded to a growing audience by the press, the engineers and the scientists, who underlined that “science for the sake of science” was the pre-condition of economic development. Darwin, Pasteur and Edison became well known scientists, whose achievements were associated with experimental methods, popularized by different books and by the newly established scientific societies.

For these reasons and because of the difficulties of agriculture under the Great Depression, an agrarian policy of technical change took shape after 1876²⁴. That year a Law of Agrarian Teaching foresaw a set of inexpensive, and inefficient, measures of diffusion of agronomic knowledge such as the monthly lectures in provincial capitals by the agricultural engineer and the reading of a chapter of an agricultural handbook in lesser urban centres. But beyond these symbolic steps, that enhanced the prestige of the agricultural engineers, there were other practical decisions. As we have mentioned new centres such as experimental stations and laboratories were planned and in certain cases opened, with the financing of the State or local and provincial authorities. In the 1870’s and early 1880’s agricultural engineers, whose first promotion left the General School of Agriculture in 1861, were especially productive in publications that aimed basically at presenting themselves before society as mediators between an expanding international discipline and the needs of Spanish agriculture.

This praise of a Spanish agronomy produced by professionals of agriculture and applied scientists, and its ambitious institutional projects –under the strong impact everywhere of the German establishments- coincided with a parallel professionalization and institutionalization of agricultural research in other Western countries such as the Netherlands or France and the first steps of higher agricultural education in Britain²⁵. Agronomy became an established discipline in most European and American countries and developed in a very rapid way its own international channels²⁶.

As table I shows, the growth in the number of agrarian publications in the 1870’s was short lived. Agricultural engineers, once they achieved their administrative corps in 1879 and saw it consolidated in 1882, started to have other practical administrative and political endeavours: the display and control of statistical mechanisms and the creation of a network of agronomic establishments were the central tasks of their active lobbying, which led them to encourage and direct the creation of the Asociación de Agricultores de España (Pan-Montojo, 2007). The technological policies designed in these years, and embodied in the projects of creation of agronomic centres, had a limited impact. The difficult financial conditions of the 1880’s and the colonial war after 1895 acted as effective barriers against the involvement of the State in the development of the mechanisms, that were almost universally in Spain deemed necessary to

²³ . There is an anthology of the most relevant texts of this public debate in *La polémica de la ciencia española* (1970).

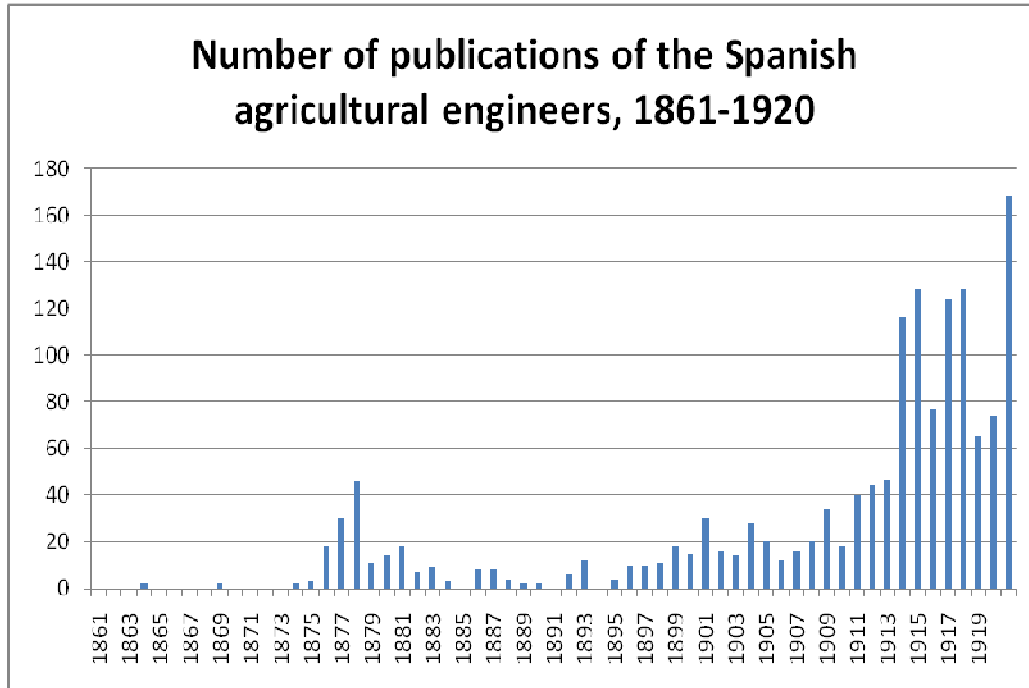
²⁴ . Pan-Montojo (2005).

²⁵ . Collins (1994), Jas (2001), Brassley (2008).

²⁶ . Denis (2007).

overcome the scientific and technological gap between the country and other European states. The war against the USA in 1898, the Spanish defeat and the loss of the overseas provinces of Cuba, Puerto Rico and the Philippines changed radically the situation.

Table I



The consensus on the providential power of science to regenerate society was transformed, after the colonial crisis, into a process that has been called by López Ocón (2003), the “cajalización” of Spain. “Cajalizacion” is a term derived from Santiago Ramón y Cajal, the Spanish professor of Histology who in 1906 was awarded the Nobel Prize. Ramón y Cajal already in 1897, a year before the defeat in the war, argued in a lecture under the title “Duties of the State regarding scientific production” that was published as a brochure and had a large public impact, that science, both because of its potential in economic and social terms and because of its moral values (truthfulness, serious and silent analysis or reality, hard work...) was the recipe for a regeneration of Spanish society, anchored –according to him- in poverty, ignorance and political corruption. In 1900, Ramón y Cajal received the Moscow Prize of the International Congress of Medicine, an award that pushed the Ministry of Education to fund a Laboratory of Biological Research in 1901, to be directed by him. Five years later, the concession of the Nobel Prize to Ramón y Cajal decided the liberal Minister of Education to create in 1907 the Junta de Ampliación de Estudios, a commission headed by the Nobel laureate to sponsor research and study grants abroad for academics, school teachers and specialized workers. Ramón y Cajal became a social symbol of science, a figure that attracted many middle class youngsters and had a strong political influence in the first three decades of the century. Despite his obvious importance as symbol of a new era, the “cajalización” –the extension of a new discourse on science and scientific tasks as central paths towards national recovery- was not the consequence of a story of individual success. “Europeanization” had become a key concept in the numerous writings that analyzed the situation of the country in the aftermath of the 1898 crisis and “Europeanization” was essentially linked to science and technology, the main ingredients, for the generations that had been brought up under the impulse of positivist hegemony, of the “rise of the West”.

Agricultural engineers, forestry engineers and veterinary doctors were at the same time active producers and clear beneficiaries of the discourse of “regeneración” [regeneration]. Agriculture, the main economic activity of the country, had to be modernized and scientists, i.e. agricultural engineers, forestry engineers and veterinaries, were the ones called to lead its modernization. Political instability, financial restraints –since the war debt had to be repaid if the credit of the country was to be recovered- and corporative disputes among the different technicians related to agriculture were clear obstacles in the process of development of the ample institutional structure that, following the French and German organization, had already been foreseen in the previous decades. Foreign examples were a fundamental argument in the political offensive of the technicians. In this context we should understand the publication, by the Ministry in charge of agriculture, of a book that compiled the information on *La enseñanza y la organización agrícolas en el extranjero* [Agricultural teaching and organization abroad]. Its introduction presented as a matter of fact important elements of the public discourse of engineers. First of all the association between progress and agrarian centres:

“In all the countries that head in the present day civilization and progress, preferential attention is paid to the sciences and arts of agriculture, and everyday expands the number of institutes dedicated to the different branches of the secular trunk under which peaceful and beneficial shade grow at the same time the social improvement and the prosperity and greatness of nations”²⁷.

In the second place, the introduction underlined the backwardness of Spain in these fields:

“The short consideration that have been made, and even more the news summed up in this book on agricultural education in the principal nations of the world, prove how far behind lags Spain and how difficult and long it is the way that must be pursued to reach a height at least comparable with the one in which are situated the least advanced of those countries in the scale of rural improvements”²⁸

Thirdly, it proposed a model of education directed by engineers, since all the references to science were tantamount in the Spanish context to them, who monopolized the techno-scientific knowledge in their fields:

“With regards to teaching, we will have to insist that the only spirit that lies behind this organization is science, showing at the superior level all its splendour, and to test and apply its principles exist the other degrees of agricultural teaching; it should not be thought in any case, and given the examples that we are supplied with, that without the vivifying influence of knowledge progress can come true, as life in a man cannot go ahead when the heart stops beating”²⁹

Finally, the introduction linked technical change and “civilization” of rural society with the threat of the “social question”, described as an urban phenomenon.

“Let the winds of civilization fill in the lungs of the peasant and the air of the fields renovate and purify the unhealthy atmosphere of the big capital cities”³⁰

In 1907, the Liberal government that had established the Junta de Ampliación de Estudios fell. Its conservative successor did not leave behind the new institution but slowed down its development since it did not trust the large role given to a network of intellectuals and scientists

²⁷ . Ministerio de Fomento (1907), p. v.

²⁸ . Ministerio de Fomento (1907), p. vii.

²⁹ . *Ibidem*

³⁰ . Ministerio de Fomento (1907), p. viii.

that were situated in the left of the political spectrum and outside the limits of Catholic orthodoxy (Sánchez Ron, 1987). Despite this delay of the initial project, conservatives shared the view that public investment in technical progress was necessary. They just adjusted in the short run public expenditure to their priorities, shifting funds from basic to applied sciences and from public intellectuals and university academics to engineers: on the 16th of June, 1907, a Royal decree ordered that 15 newly graduated engineers (Agricultural, Forestry and Mining ones) were to be given a grant every year to study abroad for 3-6 months in specialized research centres to be designated by their professors at the engineering schools. In 1910, the grant system was partially reformed and the destination of two of the agricultural engineers was determined: Bordeaux, and its Station Agronomique et Oenologique, to study vine and wine-growing, and either the Station Agronomique of Marseilles or the Scuola Superiore di Agricoltura of Portici (Naples).

These sojourns in research and diffusion centres had an immediate purpose: acquiring the necessary know-how to run the Spanish model-farms and experimental establishments. In 1900 there were 8 (seven model and experimental farms and one oenological station), whereas twenty years later 76 centres plus a set of laboratories and special institutes attached to the School of Agricultural Engineers in Madrid were operating. Nearly all the range of establishments that had been developed in the previous years in other countries and planned more than established in Spain (model fields, experimental agro-industrial stations for wine, dairy products, silk, olive oil or rice, agronomic stations...) were created. At the same time, in 1907 the Instituto Central de Experiencias Técnico Forestales [Central Institute for Technical Forestal Experiences] was established as an annex to the School of Forestry Engineering. This Institute aimed at fostering Spanish dasonomy and forestry industry, through experimental plantations in an estate in the mountains of Ávila, hence promoting the experimental method, alien to the Spanish tradition of forestry engineers³¹. In those two decades, therefore, the agrarian disciplines were given the institutions recognized by international agronomists (German, French, Italian, North-american...) as the necessary instruments to produce local applications techno-scientific knowledge. Spanish agronomists had at their disposal the instruments for systematic experiments in various fields (dry-farming, wine and olive-oil production, phytopathology, machinery, rice cultivation...) and forestry engineers could test different schemes of plantation and different types of trees. As a result of this new institutional framework and for the first time in the history of the profession, a group of agricultural and forestry engineers could start a specialization in applied research, which would have been unthinkable in the previous years. The results of these trends in terms of publications and applicable outputs were to be seen in the 1920's and 1930's. It would be in those years too, when a pure research centre –backing and coordinating the various experimental establishments- was set up: it cannot be a coincidence that the creation of the Instituto Nacional de Investigaciones Agronómicas y Forestales in 1927 followed the one of the French Institut de Recherche Agronomique, in 1924. France was a late-comer to the institutionalization of agricultural research in relation to Germany, as Reichratt (1991) has studied and explained. Spain being a late-comer too, the remarkable phenomenon is that by the 1920's its national agronomic institutions were able to catch up with France –at least formally- with such a short delay.

Institutional development led to a new demand for international interaction. The field and laboratory agronomists and their colleagues in the administration, in politics or in business sought a full integration in the international agronomic and agricultural community. In 1911, the 9th International Congress of Agriculture took place in Madrid, thanks to the combined effort of the Asociación de Ingenieros Agrónomos [Association of Agricultural Engineers] and the Asociación de Agricultores de España [Association of Spanish Agriculturalists], the corporatist association of landowners founded as we have seen in the 1880's, which kept strong links with agricultural engineers. Jules Méline, one basic reference of agrarian corporatism and “agrarism” in continental Europe, who had been the key man behind the setting up of the international commission of agriculture in 1889 and thus of the international congresses of agriculture, could

³¹ . Casals (1996), pp. 281-285.

not attend the meeting but sent a text to be read at the opening session. The author of *Le retour à la terre* stressed the need to stop rural emigration and even restore population to the countryside and complained against “statism” (étatisme), that “devours agriculture, in the same manner it devours public budgets”³². The highly political content of Méline’s intervention connected with the speech of the Spanish minister of Fomento, Gasset, who quoted Méline, Vandervelde, Balboin and Longstaf, in a long defence of the virtues of rural society and the dangers of urban growth. Gasset was a liberal politician who displayed a technocratic discourse and demanded engineers to lead the modernization of Spain: given his position, his conservative stance before the Congress cannot be understood unless we consider it a text conceived to please an audience that was made up of landowners –some of them representing the largest associations in Europe, including the BdL, the SAF, the SAI...-, agrarian politicians and agronomists. In fact the congress did not include any agronomic or technical topic: the workforce in the countryside, agricultural education, agrarian cooperatives and credit and creation and conservation of small farms were the issues of a meeting that, despite its constant praise of the social and economic role of the small peasant, considered rural society from the point of view of big landowners... and agronomists. Scientific education, specialization of the workforce or adoption of the latest technological devices under the close inspection of experts were among other the conclusions of a Congress. The large presence of agricultural engineers in the executive commission of the Congress (15/65 members) and in the main posts (3/5 vice-presidents and one out of two secretaries) turned them into the face of Spanish “active” agriculture and enabled their establishing dense contacts with agronomists and civil servants of Portugal, France, Italy, Belgium and Portugal, the countries with a higher presence in the sessions of Madrid. After the war, since its outbreak led to the cancelation of a congress on rice cultivation in Spain, more specialized and technical congresses –with a growing participation of Spanish experts- took place. By then, in the 1920’s, the symbiosis with landowners’ lobbies was not so relevant. However, a similar alliance between technical elites and social rural elites, with positive results for agricultural engineers, had set the basis a few years before for one of the first permanent international public institutions of the modern times: the International Institute of Agriculture.

3. International technicians and international agriculture

The International Institute of Agriculture (IIA) was founded in 1905, after a long campaign of a USA citizen, Lubin, who obtained the backing of the king of Italy and a wide support, even though unequal in its objectives, from a coalition of European agrarian forces. David Lubin, a successful American businessman who invested in agriculture in California in the 1880’s and lost a lot of money, dedicated much time and energy in the final decades of the 19th century to study the causes of the high risks involved in agricultural ventures. He concluded that the main problem was the unbalance of power between agriculturalists and other economic sectors, an unbalance that was in its turn deeply rooted in the asymmetry of information about crops and prices between farmers and dealers and industrialists³³. His diagnosis was more or less shared by many of the agricultural organizations that had been created all over the European and American countries during the years of Great Depression, 1873-1895. On the contrary, his solution, the establishment of a permanent organization aiming at uniting agrarian interests and strengthening their position through the collection and publication of data and studies in different fields, did not find any support, until he managed to encounter and convince Vittorio Emanuele III in 1904. The Italian king put his kingdom’s diplomacy to work in the service of the project and a founding conference met in Rome in May 1905. In Madrid, the Ministry in charge of agriculture received a letter explaining the proposal in January, 1905. The king of Italy summed up the aims of the organisation, by then more his and the Italian government’s

³² . *IX Congreso* (1912), p. 88.

³³ . A very short biography of Lubin and his role in the development of the IIA in Wu (2005).

organisation than Lubin's, in the following manner: facilitating knowledge; removing hindrances to agrarian trade; and creating opinion "in the agricultural classes, that is to say, in that section of the public opinion that prevails in nearly all civilized countries and which remains so far the most disunited"³⁴. The IIA was therefore justified as a platform for international lobbying of the national agrarian interest groups.

Before the founding conference in Rome started, a restricted preparatory meeting took place in Vienna in March, 1905. We know about it, thanks to the information of a Spanish diplomat who lived in Austria, the count of Bager, asked by the Ministry to find out about the event and participate if possible³⁵. The meeting was summoned by Prince Auersperg, the president of the *Landwirtschaftsgesellschaft*, and attended by the leaders of this Austrian agricultural association, as well as by count Pallavicini, president of the Hungarian National Agricultural Society (OMGE), three representatives of the *Bund der Landwirte* and three representatives of the *Società degli Agricoltori Italiani*, apart from David Lubin and the Count of Bager³⁶. The Germans, who reminded their partners that since the mid-nineties there had been an international union of agricultural associations, the *Bündniss der Landwirthe*, accepted nevertheless supporting the project of Lubin and the Italian king, as long as the new organization was manned with people chosen "with entire liberty" by national associations and acted as an international agrarian lobby. During the conference in May, this proposal voiced by the Austrian and Belgian delegates (and supported by the two members of the Spanish delegation who had been appointed by the *Instituto Agrícola Catalán de San Isidro* and the *Asociación de Agricultores de España*), was defeated by the representatives of France, the USA and other countries (including the Spanish ambassador) who argued against any interference in the autonomy of governments to designate their own delegates in the future permanent institutions, that was going to be financed by public funds³⁷. The defeat of the landowning aristocratic-corporatist front turned the International Institute of Agriculture into a cooperative international institution that gathered data, published comparative works and supported congresses³⁸. It was conceived as an "organ of state" and, especially after the Great War, its members tended to be diplomats, rather than technicians, a fact that, along with other structural problems, seriously limited its accomplishments, according to the USA representative in the 1920's and author of a very critical study, Asher Hobson³⁹.

Notwithstanding the failure of the "International of the Agrarian Elites", planned in the Vienna meeting, and the shortcomings of the inter-state agency actually created (which must be judged bearing in mind that it was the first of its type in the 20th century), the IIA played relevant roles although not necessarily those that had been attributed to it in its founding charter. If Hobson saw in its political character one of its main draw-backs, Spanish agricultural engineers most probably thought otherwise. Spain was permanently represented in the IIA by them –occasionally in collaboration with forestry engineers–, and they could turn their presence in a mechanism to upgrade the status of agronomy and rural economy and link agrarian policy to agronomic technicians. The Spanish delegates became the guarantee of an active participation of their colleagues in international events like the phytopathological conference held in Rome in 1914 or in institutions indirectly supported by the IIA like the Office Internationale du Vin,

³⁴ . AMAAEE (Arhive of the Ministry of Foreign Affairs, Madrid), Tratados, Negociaciones, 0089-02, Convenio sobre la creación de un Instituto Internacional de Agricultura en Roma, TR 346, Carta del rey de Italia, 15.02.1905.

³⁵ . AMAAEE (Arhive of the Ministry of Foreign Affairs, Madrid), Tratados, Negociaciones, 0089-02, Convenio sobre la creación de un Instituto Internacional de Agricultura en Roma, TR 346, Informe del conde de Bager, 22.3.05, al Exmo. Sr. D. Wencelao de Villaurrutia sobre reunión sostenida en Viena para preparar la de Roma.

³⁶ . On the main traits of all these associations, see Malatesta (1989), pp. 352-359.

³⁷ . AMAAEE (Arhive of the Ministry of Foreign Affairs, Madrid), Tratados, Negociaciones, 0089-02, Convenio sobre la creación de un Instituto Internacional de Agricultura en Roma, TR 346, Informe del embajador español (A. de Castro) en Italia (8.VI.1905)

³⁸ . On its activities before the First World War: *International Institute of Agriculture* (1914).

³⁹ . Hobson (1931).

created after the Great War. They used the name of the IIA to convey through the Spanish agricultural press certain images of scientifically and internationally validated institutions and mechanisms such as the agrarian statistical services or the regulation on rural credit and cooperation. In this double exchange, Spanish agronomists used the IIA to complete a more symmetrical and multilateral relationship with a redefined international agronomic community, consolidating thus a model of creation and public utilization and diffusion of techno-scientific knowledge dressed up in administrative mechanisms, which they had developed in the previous seventy years.

Conclusions

Techno-scientific institutions in the Spanish monarchy underwent with the end of the Empire a profound crisis. In the transition from the Empire to the new European national state, the dense network of savants who had developed the Spanish agronomy in the 18th century was weakened by the exile of many of its members, the destruction of centres and the lack of replacement of its losses. However there were certain elements of continuity and by the 1850's a new local techno-scientific infrastructure had been rebuilt. International contacts and exchanges existed, and in certain cases were even strengthened in these troublesome times, and Spanish forestry and agricultural engineers, defined by law as the experts in agriculture, had from their very creation a profound intellectual connection with, respectively, Germany and France, even though the latter country acted as the cultural metropolis of Spain.

Agronomy in Spain became a branch of engineering after 1855, but a secondary one since on the one hand it lacked an administrative corps or clear outlet in the private sector and on the other, its discipline –agronomy- was not yet consolidated as an autonomous field of knowledge. Spanish agricultural engineers dedicated most of their efforts in their first 25 years of existence to find a professional space: their task demanded a continuous reference and appropriation of foreign, initially French but then increasingly plural, scientific and organizational objects. Translations and travels, to attend the exhibitions and visit the agricultural establishments, were the means of a relationship that remained unsystematic and tended to be unilateral. The fact that Spain pioneered the development of an institute for superior agricultural education was the most relevant contribution of an obviously and consciously semi-peripheral country to the international development of the discipline, constructed as expected in the hypothesis of the science-world, through the unbalance interaction among many centres⁴⁰.

Lafuente and López-Ocón (1994) have suggested a classification of the networks of circulation of techno-scientific knowledge in three levels: networks of patronage, that link scientists and technicians to political and economic actors; networks of co-responsibility that unite scientists and technicians among themselves; and networks of dissemination, that connect scientists and technicians to their social audience.

Spanish agricultural engineers soon found out in the political class their only possible employer or customer of their services and centred their action for many years in lobbying to achieve the support of the social elites for an active technical policy in agriculture: constructing their networks of patronage demanded a restricted although influential network of dissemination, a tight and closed network of co-responsibility at the national level and a very basic development of the network of co-responsibility in the international arena, based upon a passive and distanced appropriation of technical objects and an active one of organizational proposals. Cultural changes that enhanced the value of techno-scientific knowledge and the impact of the Great Depression caused a rapid institutionalization of agronomy as an administrative corps with a wide range of functions, in the late 1870's and 1880's. The success of the networks of patronage the agricultural engineers had constructed proved however very

⁴⁰ . Polanco (1989).

limited and the new corps stagnated whilst everywhere in Western Europe and America, agronomy was becoming a recognized discipline and experimental establishments were spreading under the direction of its practitioners. After 1898, agricultural growth became a key element in a political agenda reconstructed under the central concept of Europeanization, which implied a new role for science and techno-scientists. Under the new circumstances, the creation of a new system of experimental agronomic centres was combined with a special effort to strengthen and diversify both the networks of co-responsibility and the networks of dissemination. The multiplication of international contacts and the search for a more balanced exchange with the centres of agronomy became a permanent policy which was to have relevant results in the 1920's and 1930's in terms of technoscientific and political outputs: agricultural engineers finally became the agricultural technocrats, the public intelligentsia of agriculture they had always sought to be. International networks and international institutions like the IIA, especially suited because of its being an "organ of state" to the political needs of Spanish agricultural engineers, were the basic elements in an evolution that would turn agronomic technical knowledge into the main determinant of rural life during the rest of the 20th century.

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