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European Agricultural Societies, 1750-1850: experimenting and disseminating scientific 'progress'

Nadine Vivier [1]

[1] *Professeur émérite des universités de l'Université du Maine (Histoire contemporaine), membre de l'Académie d'agriculture de France*

Correspondance
Nadine.Vivier@univ-lemans.fr

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Résumé
Quand agriculture et science furent-elles associées ? Cet article pose l'hypothèse d'une implication de la recherche scientifique dans le progrès agricole à partir du dix-huitième siècle, lorsque les nouvelles théories économiques ont donné à l'agriculture un rôle primordial. Les gouvernements ont demandé aux scientifiques de résoudre les problèmes pour accroître la production agricole. La création de sociétés d'agriculture fut encouragée afin qu'elles diffusent les connaissances. Les premiers membres de ces sociétés appartenaient à l'aristocratie foncière ; progressivement furent recrutés des scientifiques, souvent membres d'académies des sciences. Les sociétés d'agriculture ont d'abord consacré leurs travaux aux réformes des structures agraires comme voie du progrès. Une fois ces réformes acquises avec la Révolution française, leurs travaux se tournèrent vers les instruments agraires et la fertilité du sol. Ce fut l'époque des expériences faites par de grands propriétaires, qui souvent diffusaient aussi leurs résultats. Dans les années 1840, la chimie s'imposa progressivement à l'agronomie, et les sociétés d'agriculture purent prétendre diffuser les acquis de la recherche scientifique en agronomie.

Abstract
When did Science and Agriculture begin to be linked together? This paper posits that scientific research was first involved in agricultural progress in the eighteenth century when a new context increased the value of agriculture which, beyond its source of vital supplies to the population, became also the main source of

wealth for a nation. Hence governments asked for scientific methods to solve agricultural problems and encouraged the creation of agricultural societies aiming at the dissemination of achievements. At the beginning members of agricultural societies were mainly noble landowners; progressively scientists who were also members of academies of sciences were enrolled. Agricultural societies first thought about changing agrarian structures as the way to progress. After the French Revolution that achieved reforms, their works were dedicated to improving tools efficiency and soil fertility. It was the time of experiments by landowners who also tried to disseminate their results. In the 1840s, chemistry gradually subjected agronomy to its authority. From that time on, agricultural academies could claim to be a relay in disseminating scientific research.

Keywords
agricultural societies, academy, agronomy, Europe 18th century

Mots clés
sociétés d'agriculture, chimie, agronomie, Europe 18e siècle

When did science and agriculture begin to be linked together? An initial spontaneous answer is: since the agricultural revolution. But when did this revolution occur? And how should agricultural science be defined and differentiated from experiments? From Columella to Olivier de Serres[1], agronomists were landowners who conducted experiments on their domain and compared their results to those from other farms: they did not use a scientific method in the way we understand it today; nonetheless they thought about the results of their experiments and recorded them in books. Recognized scientists were gradually asked to study soils, crops and their pests. My contention here is that scientific research was first involved in agricultural progress in the eighteenth century when a new context increased the value of agriculture that, beyond its source of vital supplies to the population, became also the main source of wealth for a nation (section 1). This new concern led to the creation of agricultural societies, all over Europe. Studying their members and their actions in the years following their creation and during the revolutionary wars (1792-1815) gives clues about their aims and the role of scientific research (section 2). Then, a look at the years 1830-1850 will show how scientists were increasingly trusted; farmers readily put their results into practice, adapting them to local conditions (section 3).

1. Links between science and agriculture in the 18th century: using science to increase agricultural efficiency

Until the 18th century large landowners in Europe conducted experiments to improve their production and they exchanged sometimes with some acquaintances, but in a sense their own experiments were a kind of secret, since having a beautiful estate was a proof of superiority (Vivier, 2009). A completely new approach arose with new economic theories. As early as the beginning of the eighteenth century, mercantilist doctrines were at the centre of the debates. According to mercantilists[2] (Colbert and William Petty), the wealth of a state emanated from its holdings of precious metal. Boisguilbert in France, and Cantillon[3] in England, challenged this theory and saw wealth derived from both land and work. Then from the 1740's onwards in

1 Columella (4 AD-nearly 70 AD) was the most important writer on agriculture of the Roman empire. Olivier de Serres (1539-1619) was considered in France as the father of modern agronomy.

2 Colbert (Reims, 1619-Paris, 1683), one of the principal ministers of Louis XIV.
William Petty (Romsey, 1623-London, 1687), a British polymath and a pioneer of econometry.

3 Boisguilbert (Rouen, 1646-Rouen, 1714), a French writer and economist, one of the important precursors of modern economic science.
Cantillon (Ireland, 1680-London, 1734), one of the most significant authors who marked the transition from mercantilism to classical economics.

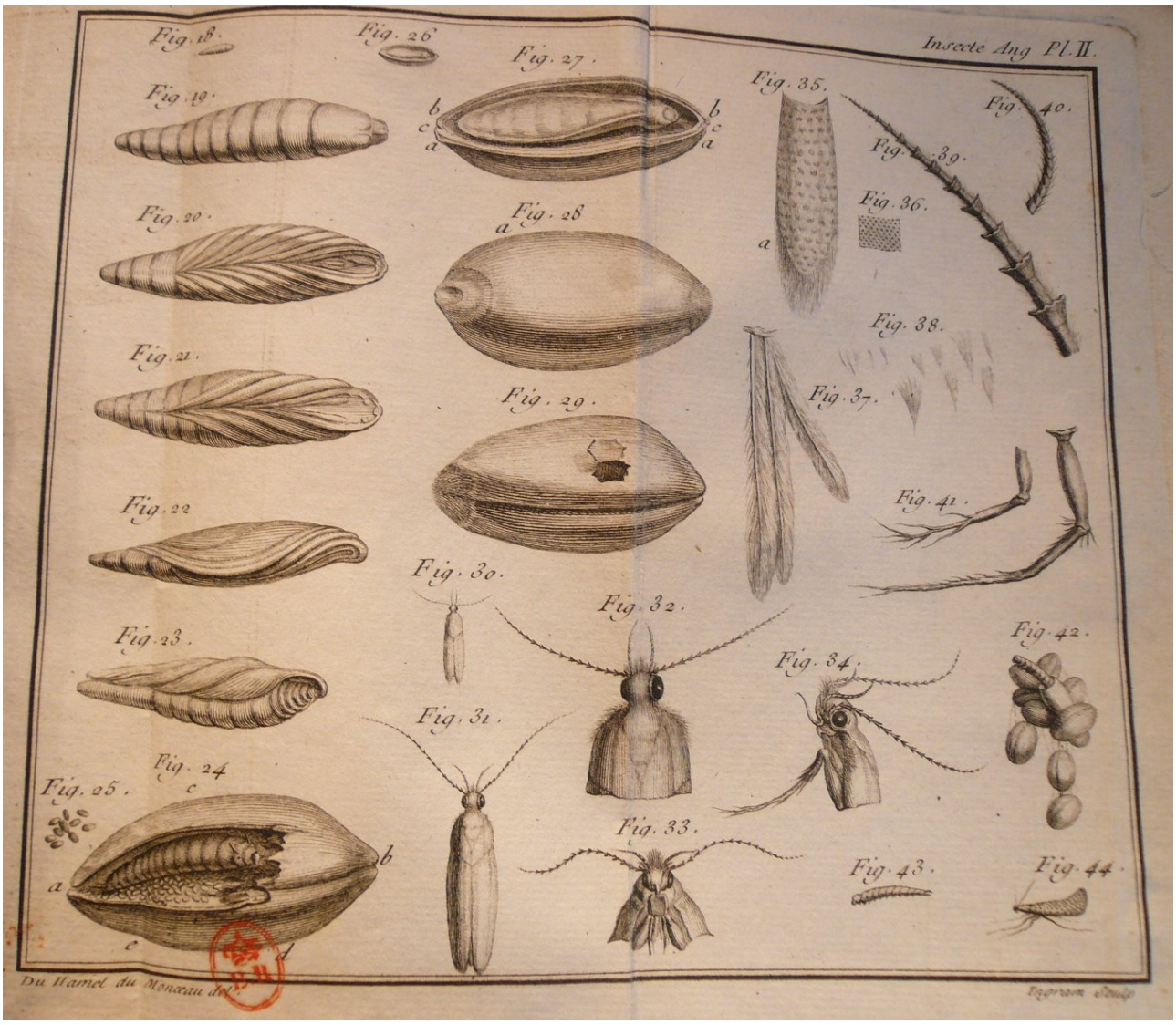

Figure 1. Planche from Duhamel du Monceau and Tillet, 1762. Description of the insect that ate grains in Angoumois. This shows what was a scientific description of the insect and its reproduction.

European countries the conjuncture (bad harvests and wars...) brought about the simultaneous appearance of new ideas and theories: kameralists in Germany, much concerned with economy and finances, illustrados, the liberal agrarians in Spain, physiocrats in France who gained a wide audience across Europe and America between 1755 and 1770 (Steiner, 1998; Vardi, 2012). The physiocrats' theory was also philosophical and put forward the idea of a "natural order", which enjoined governments to respect liberty and property. Whatever the theory, physiocrats thought that the fundamental wealth of society flowed from the consumption elements of production, which could only – or mainly- be provided by agriculture. To the extent that as the wealth of the nation was at stake, a patriotic issue was implied.

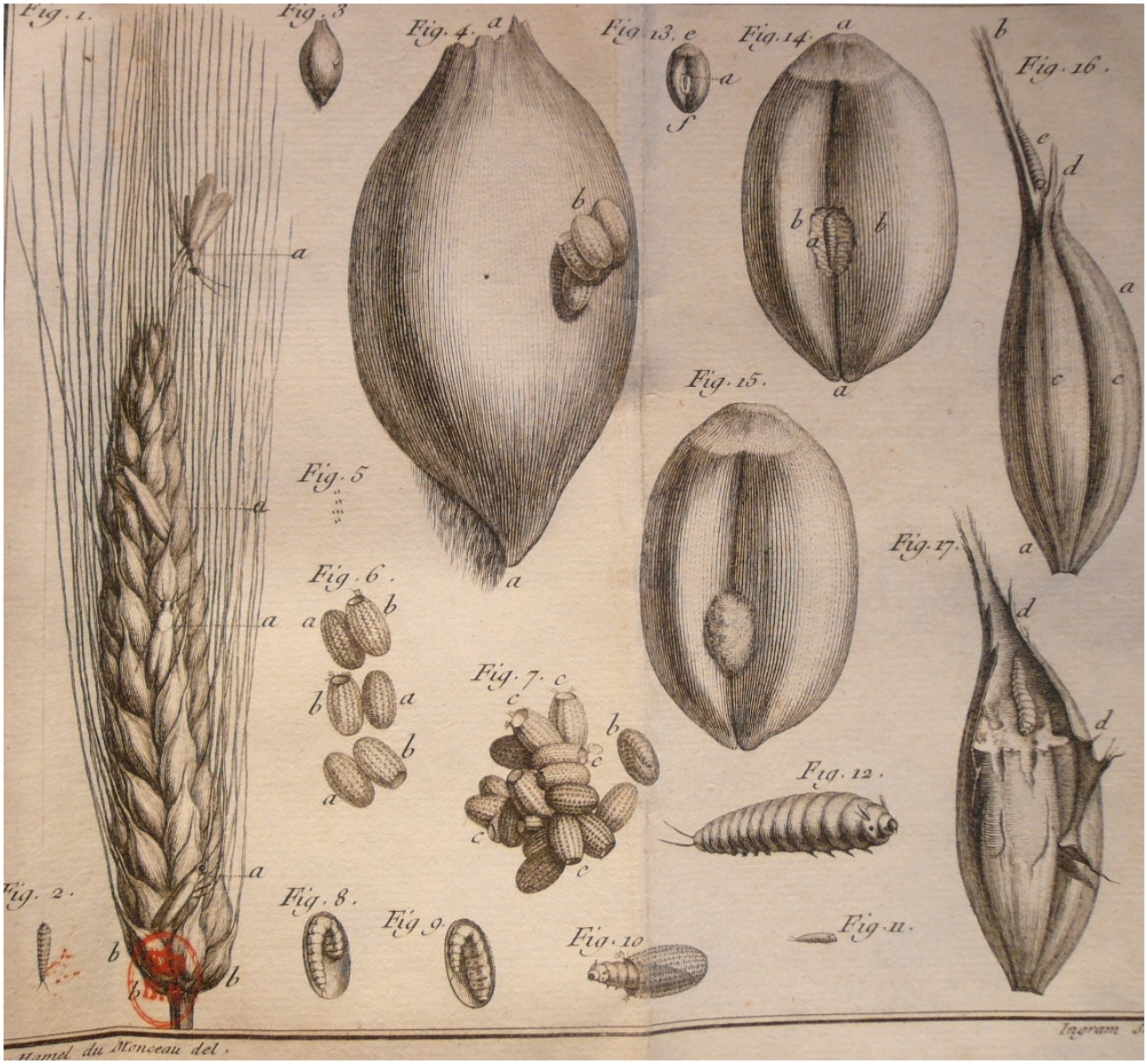

Figure 2. Planche by Duhamel Du Monceau and Tillet (1762): Microscopic description of the insect, its eggs and larvae, and their damage in wheat grains.

These favorable conditions gave rise to the introduction of a scientific approach to agriculture. Governments, aware of the need to increase production, set scientists to work. Let us take the French example. Two kinds of governmental measures led to thinking about the definition of science: the first one was the request to scientists to work on agricultural matters. The second one was the creation of agricultural societies. After the beginning of the eighteenth century, the abbé Bignon (Paris, 1662-1743), chairman and secretary of the Académie des Sciences from 1699 to 1743, asked scientists to study botanical taxonomy, animal breeds, diseases, pests, and forestry (Bléchet, 2002). Agronomy formally became in 1753 a section of the Académie des

sciences. King Louis XV (1715-1774) initiated experiments on clover, lucerne and wheat bunt on his Versailles estate (Trianon), and in 1760 he sent Henri-Louis Duhamel du Monceau (Paris, 1700-1782) and Mathieu Tillet (Bordeaux, 1714-1791)[4] to the Angoumois to study the preservation of grains.

Following Antoine Ferchault[5] de Réaumur's methods (Réaumur, 1734), they identified the insect responsible for wheat bunt and looked for means to eradicate it (washing grain in lime water). Local agronomists were stimulated to further research and the King asked for public demonstrations of steaming spoiled wheat.

The King's concerns also focused on animals. Louis Jean-Marie Daubenton sought to improve sheep breeds, and Louis XVI (1774-1792) asked abbé Henri-Alexandre Tessier, a physician, to create an experimental farm in Rambouillet. Claude Bourgelat and Félix Vicq d'Azyr taught in the newly created veterinary schools of Lyons and Alfort (Bléchet, 2002; Sciences et curiosités à Versailles, 2010)[6].

At the same time Henri Léonard Bertin (Périgueux, 1720-Spa, 1792), one of the five Louis XV's secretaries, was entrusted of many economic issues including agriculture (1763-1780). He created agricultural societies in France. In 1761, the statutes of the Agricultural Society of Paris specified: "Agriculture will be its unique occupation. It will aim at educating its countrymen mainly through example, […] at studying by constant practice all that could contribute to a flourishing agriculture […]. The Society will be driven only by the love of the country" (Statutes in Passy, 1912). The first appointed members were distinguished landowners concerned with an increase of production. They ought to exchange their observations and diffuse them to the public.

These examples highlight two new features: involvement in agricultural research of famous scientists and a will of dissemination to a wide audience. To meet these goals, results of scientists members of the Académie des sciences had to be completed by the work of the newly created provincial or local agricultural societies devoted to agronomy that can be defined as "the living process of a science, not a sound, accurate, demonstrative and abstract science but a meeting place of the various sciences." It strives towards description, explanation and improvement of agricultural techniques (Bourde, 1967). Division and complementarity of missions were clear in the title of the *Annales de l'agriculture française*, Paris agricultural society's 1798 publication: "containing observations and dissertations on agriculture, on plants, animals, epizootic diseases, the destruction of pests, transactions of fertilizers".

2. Agricultural societies, 1760-1790: experimentation and dissemination

2.1 Proliferation of economic societies

A recent collective research (Stapelbroek and Marjanen, 2012) tries to identify all over Europe those societies that aimed promoting economic development to increase the wealth of the nation. Hence, they often deserved the name of 'patriotic societies', all the more that economic rivalry between European countries amplified. Nonetheless there was a true will of international cooperation. The American politician and agronomist Thomas Jefferson (Shadwell, 1743-

4 Duhamel du Monceau (Paris, 1700-1782), a French physician, naval engineer and botanist; he was member of the Agricultural Society of Paris as soon as April 1761; Mathieu Tillet (Bordeaux, 1714-1791), a French botanist, agronomist and metallurgist; he was associated to the same society in 1761.

5 Réaumur (La Rochelle, 1683-1757) was an active member of the Académie des sciences. His works included the study of insects and he introduced the Réaumur temperature scale.

6 Louis Jean-Marie Daubenton (Montbard, 1716-Paris, 1799), a naturalist and contributor to the Encyclopédie.
Abbé Henri-Alexandre Tessier (Angerville, 1761-Paris, 1837), doctor and agronomist.
Claude Bourgelat (Lyon, 1712-Paris, 1779) a veterinary surgeon.
Félix Vicq d'Azyr (Valognes, 1748-Paris, 1794), a physician, anatomist and naturalist.

Monticello, 1826) highlighted this idea: "These societies are always in peace; however their nations may be at war. Like the republic of letters, they form a great fraternity spreading over the whole earth" (Jones, 2016).

The rise of these economic societies, mainly devoted to agriculture, began with the Honorable Society of Improvers in the Knowledge of Agriculture in Scotland (1723), the Dublin Society of Improvement of Husbandry, Agriculture and other useful Arts (1731), the Royal Academy of Sciences and Arts of Prussia (1744), the Société d'agriculture et du commerce de Rennes (1757), the Bern Economic Society and the Accademia dei Georgofili in Tuscany (1753), which were the main models. In this period almost every province had its own society and they devoted considerable energy to the great agricultural concerns of the time.

Up to 562 societies were busy in the promotion of economic improvement in Europe and overseas. This number included:

- Great-Britain and Ireland: 82 agricultural societies
- France: 20 regional + 29 local branches
- Spain: 70 +14 in Spanish colonies
- German speaking countries : at least 71
- United Provinces: 57 (created in 1777)
- Denmark + Norway: 57
- Sweden 7
- Russia: 1

(Frängsmyr, 1989; Ballesteros, 2004; Stapelbroek and Marjanen, 2012).

All over Europe these societies followed similar patterns of activity. They held regular discussion sessions, and offered annual prizes for essays on a special question of social importance or on agricultural techniques. Information was exchanged between societies at an intense rate. Each had its own correspondents in other provinces and abroad and used them as consultants.

For example, Duhamel du Monceau was a member of agricultural societies of Paris, Leyden, London, Saint Petersburg, Stockholm, Edinburgh, Palermo and Padua. So was it for Arthur Young (Suffolk, 1741-1820), John Sainclair (Scotland, 1754-1835), Giovanni Fabbroni (Tuscany, 1783-1872) and Attilio Zuccagni (Florence, 1754-1807), etc.[7]

Their writings (letters and books) indicate how active were knowledge networks all over Europe, leading to the dissemination of publications, and debates about scientific findings and agricultural practices. The European knowledge network was supplemented by secondary national networks.

The fascination for agricultural science in this period reached also small provincial societies (not included in the count above): members of such societies kept abreast of the most recent research by reading and discussing the agricultural journal publications they received. Some of these societies followed the model of an academy of science: the Royal Society of Sciences and Literature in Nancy elected a botanist, three economists, in order to create an agricultural section in 1766. And when a separate agricultural society was founded in Nancy in 1820, it was chaired by Christophe Mathieu de Dombasle (Nancy, 1777-1843) who created Roville and had outstanding correspondents: the Scottish John Sinclair, the German Albrecht Daniel Thaër (Möglin, 1752-1828) and the Swiss Philipp Emanuel von Fellenberg (Bern, 1771-1844)[8]. Some other societies were "rustic societies", like the Thesmophores in Anjou who claimed in 1776 to be "simple and true men of the countryside" (Follain, 2010; Knittel, 2010). They read books and experimented. Midway between these two cases, the Academy of Arras had an important

7 Arthur Young, an English writer on agriculture, economics, social statistics, famous as soon as 1790 for his agricultural travels in Europe.
John Sainclair, a Scottish politician, writer on finance and agriculture and the first person to use the word statistics in the English langage.
Giovanni Fabbroni, a Tuscan physicist, chemist, agronomist and parliamentarian.
Attilio Zuccagni, a Florentine botanist, secretary of the Accademia de Giorgofili.

8 Three agronomists who created an experimental agricultural school: Mathieu de Dombasle, in Roville near Nancy; Thaer in Möglin (Brandenbourg) and the Swiss Philipp Emanuel von Fellenberg in Hofwyl near Bern.

French correspondence network, under the direction from 1785 to 1792 of its secretary, Philippe-Ferdinand Dubois de Fosseux (1749-1789) (Berthe, 1969) .

As this model spread across Europe, the publication of economic books and pamphlets expanded. The quantity of printed reading matter related to agriculture dramatically increased in the second half of the eighteenth century. Journals were the forum to which farming experiments were sent (e.g. *Observations*, 1771 published by Abbé Rozier, an agronomist). The highly active European network meant a buoyant translation industry. English and Scottish works were rapidly translated at least in German and French. The interest for everything English was a growing fashion.

Let us mention two kinds of those books. English agricultural writings could be adapted. One of the most influential translations was Jethro Tull's work (Berkshire, 1674-1741). During his tour in Europe, Tull compared the agriculture of France and Italy with that of his own country, and returning home he experimented on his estate some improvements. He described his achievements in 1733 in Horse-hoeing husbandry. He recommended a new more productive system based on the introduction of clover and sainfoin. The author criticized the use of dung and believed that dispensing with fallows and fertilizing the soil by continuous ploughing would produce more wheat. When Duhamel du Monceau was asked to translate the book, he decided to experiment with these principles himself and the result was his *Traité de la culture des terres* (1750) that further popularized Tull's ideas. Even though they became the subject of a long controversy and were subsequently shown to be completely wrong, they were received by a growing audience. (Bourde, 1967)

The "Grand Tour" across the Channel was in great vogue after 1750. Many travelers' accounts - this is a second kind of famous publications - praised the "Norfolk system" because it improved wheat yields. Its success was based on a system of large landed estates let out to farmers on leases; it introduced new methods such as marling to improve the soil and new crops such as turnips, and above all it brought about enclosure and the reduction of communal rights and practices. These criteria seemed to be the prerequisite all the more in that Arthur Young judged every system in the light of the Norfolk. His works gained rapid popularity: *A six months tour through the North of England* published in 1770 was translated in German and in French in 1772-1775; then the *Tour of Ireland* was translated in 1780, the same year of publication (Müller, 1975). *Travels during the years 1787, 1788 and 1789, undertaken more particularly with a view of ascertaining the cultivation, wealth, resources and national prosperity of the kingdom of France*, published in 1792, were translated in French in 1793 and in Italian in 1794. Young was the forerunner of agronomic travels, which became the vogue during the Napoleonic Empire (Brassart, 2016).

2.2. First members and associated members elected: growing importance of scientists

Who was involved in this quest for agricultural progress? At the highest level those most renowned for their scientific work on agriculture became members of agricultural societies, and often they were also members of an academy of sciences. They were joined by senior clerics, administrative officers and large landowners who aimed at experimenting with new practices and testing their adaptation to local conditions of soil and climate (Stapelbroek and Marjanen, 2012) .

Did these societies admit practicing farmers and craftsmen in their ranks? At the very local level, "rustic societies" were composed of well-to-do farmers and smallholders. Some of the great societies did not admit farmers like the Bern Economic Society; some others tried to do so as the Leipzig Agricultural Society. In the Agricultural Society of Paris the first members in 1761 were chosen as representatives of the clergy and the nobility; as soon as the following year were also chosen Pépin, farmer in Montreuil near Paris, and the Duke of Noailles who managed a beautiful estate in Saint Germain and his gardener Claude Richard (Saint Germain-en-Laye, 1705-Versailles, 1784)

became the chief gardener of Versailles (Stenzel, 2002). Then in 1783 entered scientists, also members of the French Academy of Sciences (Daubenton, Thouin, Perronet, Lavoisier, La Rochefoucault, Angivillier, Fougeroux and Abbé Tessier). They were joined in 1784-1785 by five other scientists, a few physicians and postmasters (usually large farmers who had to breed and provide post horses). In 1786, Broussonet, secretary of the Agricultural Society of Paris urged that "chemists be enlisted to better understand plant nutrition,[…] naturalists to enhance stock-raising and botanists". Whether such an evolution can be seen in every society has to be determined. It was probably the case and it would justify their desire of assuming the word Science in their name (Passy, 1912).

3. 1800-1850: scientific research stand out in agronomy

3.1 Until the 1830s, experiments carried out by large landowners

In the 1780s, agricultural thinkers wanted to maximize the area of land under cereals cultivation and they were infatuated with the Norfolk system. This included a reform of agrarian structures: sharing out commons and suppression of collective rights was a process that induced in depth changes and that had heavy social consequences. Politicians were well aware of it: in Spain Gaspar Melchor de Jovellanos (1744-1811) and Pedro Rodriguez de Campomanes (1723-1802)[9] understood it and wondered whether it was possible to reform agrarian structures without changing the structure of social domination (Luna, 2012). After the revolutionary period, either land reform was undertaken (Denmark, Sweden, France...) or governments strove to avoid it (Prussia, Austria, Russia) (Jessenne and Vivier, 2016). It seemed better to improve cultivation than to plough up waste land for cereals. Greater attention was paid to other crops, fodder crops, potatoes…

Figure 3. The moto of the Royal Agricultural Society of England.

So agricultural societies moved away from an interest in changing agrarian structures and concentrated on improving tools, manures and soil fertility. The questions set for their competitions no longer addressed great theoretical issues but practical problems. After 1800, the new generation of agricultural scientists had to support their theories with successful examples that could be replicated elsewhere. Pioneers of this method included John Sinclair, Albrecht Thaer, Emanuel von Fellenberg and Christophe Mathieu de Dombasle (Knittel, 2009). So did Cosimo Ridolfi (Tuscany, 1794-1865) who achieved agronomic experiments on his estate in Meleto and disseminated through the Accademia de

9 Jovellanos and Campomanes were both Spanish statesmen and economists, major figures of the Illustrados. Jovellanos wrote in 1784 and it was published in 1795: *Informe sobre la ley agraria* (A report on the dossier of the Agrarian Law).

Figure 4. Monument to Jean-Baptiste Boussingault by Jules Dalou (1895), in the courtyard of the Conservatoire National des Arts et Métiers in Paris (CNAM: National Conservatory of Arts and Crafts). The monument is now in the garden of CNAM in la Plaine Saint Denis. Chemistry, teaching the farmer, is embodied in its two ways of dissemination: research and publication (book), experimentation (retorts) .

Georgofili and the first agronomic institute in Italy (Pazzagli, 2008). They managed an estate, carrying out experiments on manures, on ploughing, crop rotations and methods of storing grain. Of course, scientific research was taken into account. The agronomist Adrien de Gasparin (Orange, 1783-1862) compared the farm with "a factory, a manufacture of organic products, supplied with capital and aiming at transforming the capital in order to increase it". For this, different means were to be used: science like chemistry, agricultural practice and observation in order to adapt cultivation to climate and soils (Gasparin, 1843). They also welcomed pupils for a vocational agricultural education. All these agronomists exchanged views on the results obtained on their model farms. They quickly rallied to their methods some large landowners and farmers called "practical farmers". They aimed at disseminating their knowledge in a wide variety of books: farmers' magazines, almanacs, calendars. Agricultural societies encouraged writing manuals for primary schools and for small farmers. Generally speaking, the ambition of such books was to popularise knowledge considered necessary to agricultural progress. They offered knowledge, techniques, and rhetorical strategies that helped train small- and medium-sized landowners (Depecker and Joly, 2015a,b).

3.2. 1830-1850: the rise of chemistry?

What changed between 1830 and 1850? Three figures and three moments highlight the increasing role played by chemistry in agronomy. In 1836 appeared an early alliance of farm and research laboratory. On his estate of Pechelbronn in Alsace, the chemist Jean-Baptiste Boussingault (Paris, 1801-1887) set up a laboratory to analyse soil, fertilizers and plants. He published in 1843 his results in a bulky report: *L'Économie rurale considérée dans ces rapports avec la chimie, la physique et la météorologie*. This influential book comforted the influence of French agronomy in Europe in the 1840s and 1850s. John Bennet Lawes (Harpenden, 1814-1900) adopted the same method on his estate of Rothamsted in Hertfordshire; he created an experimental farm employing analytical chemistry (Jas, 2001). Lawes discovered and patented a manure formed by treating phosphates with sulfuric acid and thus initiated the artificial manure industry; he enlisted the services of a chemist, Joseph

Henri Gilbert (1817-1901). Boussingault was the pioneer and great discoverer of many advances in soil and plant chemistry. He discovered that plant growth is proportional to the amount of available assimilatory nitrogen, which in practical terms allows greater plant growth from the simultaneous application of phosphorus and nitrogen (Boussingault, 1843). Boussingault is a symbol of this period 1840-1850 when chemistry submitted agronomy to its authority.

Second key character, Justus von Liebig (Darmstadt, 1803-München, 1873) published in 1840 *Organic Chemistry in its Application to Agriculture and Physiology*, a book widely translated, highly influential but much criticized. While Liebig was not the discoverer of plant mineral nutrition (due to the German botanist Carl Sprengel, 1787-1859), he drew attention of the agronomists on the "Law of the Minimum", stating that plant growth is not determined by the total resources available, but by the scarcest available resource. A plant's development is limited by the one essential mineral that is in the relatively shortest supply (Brock, 1997). Lawes and Gilbert took part in the debate with Liebig who asserted that nitrogen was of little value in fertilizers, only minerals mattered. Based on Boussingault's painstaking experiments, Lawes proved that the proportion of nitrogen in fertilizer determined its value (Jas, 2001) .

Last significant moment was Boussingault's appointment to the chair of agriculture of the Conservatoire des Arts et Métiers in Paris. The chair was previously held by Leclerc-Thouin (1798-1845)[10] who wanted to improve agricultural practice by various means and not only experimental sciences. This appointment showed that the time of "practical farmers", of "empiricism" was over. But there was no rupture because those chemists never neglected the practical farmers' achievements. *A contrario*, Liebig in Germany had no regard for farmers' knowledge, he only trusted work in the laboratory and this can explain the opposition of the German population to chemists' power and the necessity or the experimental stations that were created after 1850.

10 He also was secretary of the Royal Agricultural Society in Paris, 1843-1845.

The use of the term "science" by the agricultural societies reflected this evolution. It was clear at first that they were devoted to agronomy, i.e. practical knowledge. But the *Annales de l'agriculture française* changed its title in 1830 to *Annales administratives et scientifiques*. They returned to the previous title in the following year, without any justification. Nonetheless, a paper included in the 1831 issue asserted: "Science is not yet arrived to always claim that practice must be humble before it"[11]. It was too early to show pretensions to scientific activity. In 1840 the Royal Agricultural Society of London adopted a moto: "Practice with Science" (Brassley, 2008).

From this time onwards, sciences and agriculture could be officially associated and no more be separated, probably thanks to the place seized by chemistry. Science percolated to farmers via local farm-schools, a few high agricultural schools and experimental stations, books, comices (Marache, 2005). Farm-schools and scientific books did not reach a broad audience, only a small proportion of farmers. Comices, local associations in link with the agricultural societies, could more widely disseminate new findings. They often tried new fertilizers, the same way they had encouraged the crossbreeding of cows and sheep. The results were offered publicity during the annual contest, when the best farmers, successful with new methods, were rewarded (Vivier, 2011). The multiplication of institutions aiming at disseminating agricultural 'progress' led to a reform of some of the missions assigned to agricultural societies and turned them to a new role from the 1850s onwards.

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11 « La science n'est pas encore venue à pouvoir toujours prétendre que la pratique doit s'humilier devant elle »

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Hervé This, AgroParisTech-Inra International Centre for Molecular Gastronomy, membre de l'Académie d'agriculture de France.

Rapporteurs

Peter Jones, Emeritus Professor of French History University of Birmingham.

Corinne Marache, Maître de conférences en histoire contemporaine, UFR Humanités, Université Bordeaux Montaigne.

Malcolm Hadley, membre de l'Académie d'agriculture de France.

Paul Vialle, membre de l'Académie d'agriculture de France.

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Nadine Vivier est professeur émérite des universités de l'Université du Maine (Histoire contemporaine), membre de l'Académie d'agriculture de France.