"No Protectionism of Prices, but Protectionism of Knowledge"

The nineteenth-century origins of Dutch agricultural innovation in a European perspective

WORK IN PROGRESS

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Abstract

From the early nineteenth century onwards many European states supported agriculture by institutionalizing agricultural innovation. The Dutch state, however, only followed at the end of the century. This paper compares the historical origins of Dutch agricultural innovation with its equivalents in neighbouring countries and answers the following questions: why did the Dutch state for long refuse to institutionalize agricultural innovation and what made the Dutch state suddenly change its policy at the end of the nineteenth century? By delving into nineteenth-century Dutch agricultural periodicals, government records, and parliamentary debates, this paper sheds light on the interplay between state involvement and agricultural innovation, thereby pinpointing the *nature* of agricultural innovation. Before c. 1870, Dutch farmers successfully innovated without state help. Their knowledge was based upon their own observations, while information was exchanged through informal ties. With the influx of artificial fertilizers after c. 1870 the innovation capacity of the Dutch farming community reached its frontier, after which market failures surfaced. Increasing self-organization of farmers during the Agrarian Depression and the enlargement of the franchise made Dutch politicians more receptive for appeals for change. My paper concludes that the Dutch state started regulating agricultural innovation after the market failed to do so.

Introduction

Dutch agriculture in the nineteenth and twentieth centuries was one of the most productive agricultural sectors of its time. Together with Belgium, Britain, and Denmark, the Netherlands was part of the region that reached the highest level of agricultural development in Europe, as by c. 1870 farmers in this region realized the highest production per hectare and per head in Europe.[1] Dutch farmers succeeded in extending this high production into the twentieth century. Dutch production growth during the nineteenth century has been attributed to a rise in land productivity, while production growth during the twentieth century is ascribed to an expansion in labour productivity, which has been estimated to have grown 43-fold between 1810 and 2000.[2]

Historians have presented various explanations for the high level of agricultural development in the Netherlands and in western Europe more generally. One of the possible explanations is the involvement of the state. Since the early nineteenth century, European governments have aimed to create conditions favourable for farming, though in different ways. Some European governments enforced measures to restrict the import of agricultural goods from abroad. Some states made public funds available to improve agricultural education and agricultural research.[3] Also the Dutch government has received credit for stimulating Dutch farming. Dutch historiography has praised the Dutch government for funding research institutes and agricultural experiment stations that developed machineries, inputs, and other innovations, all of which were diffused among Dutch farmers by state-funded extension workers. The educational level of the Dutch farming community was improved by providing state-funded agricultural education.[4]

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[1] J.L. Van Zanden, "The First Green Revolution: The Growth of Production and Productivity in European Agriculture, 1870-1914," Economic History Review, 64, no. 2 (1991): 219. B.H. Slicher van Bath, *Yield Ratios, 810-1820*, AAG Bijdragen 10 (Wageningen, 1963), 16.

[2] Jan-Pieter Smits, "Technological Change, Institutional Development and Economic Growth in Dutch Agriculture, 1870-1939," in *Agriculture and Economic Development in Europe Since 1870*, ed. Pedro Lains and Vicente Pinilla (London: Routledge, 2009), 100. Merijn Knibbe, "Landbouwproductie en -productiviteit, 1807-1997," in *Nationaal Goed. Feiten en cijfers over onze samenleving, (ca.) 1800-1999*, ed. Ronald van der Bie and Pit Dehing (Amsterdam: Stichting beheer IISG, 1999), 37.

[3] Niek Koning, *The Failure of Agrarian Capitalism. Agrarian Politics in the United Kingdom, Germany, the Netherlands and the USA, 1846-1919* (London and New York: Routledge, 1994). Michael Tracy, *Government and Agriculture in Western Europe, 1880-1988* (New York: Harvester Wheatsheaf, 1989). Nadine Vivier, ed., *The State and Rural Societies. Policy and Education in Europe 1750-2000*, Rural History in Europe 4 (Turnhout: Brepols, 2008).

[4] Jan Douwe van der Ploeg, *De verwetenschappelijking van de landbouwbeoefening*, Mededelingen van de vakgroep voor sociologie 21 (Wageningen: Landbouwuniversiteit Wageningen, 1987). D.J. Maltha, *Honderd jaar landbouwkundig onderzoek in Nederland 1876-1976* (Wageningen: Centrum voor landbouwpublikaties en landbouwdocumentatie, 1976). A.P. Verkaik, *Organisatiestructuur landbouwkundig onderzoek en achtergronden van haar totstandkoming* (The Hague: Nationale Raad voor Landbouwkundig onderzoek TNO, 1971). F.J. Dijksterhuis and Barend Van der Meulen, *Tussen coördineren en innoveren. De Nationale Raad voor Landbouwkundige Onderzoek, 1957-2000*, Historia Agriculturae 39 (Wageningen/Groningen, 2007). Harro Maat, "Science Cultivating Practice. A History of Agricultural Science in the Netherlands and Its Colonies 1863-1986" (Wageningen University, 2001). N.B. Goudswaard, *Agrarisch onderwijs in Nederland, 1783-1983* (Culemborg: Educaboek, 1986). Harro Maat, "Het innovatiesysteem voor de Nederlandse landbouw," NEHA-Jaarboek voor economische, bedrijfs- en techniekgeschiedenis, 66 (2003): 233–62.

A close examination of the historical development of state involvement in Dutch agriculture reveals that the role of the Dutch government might require re-evaluation. Dutch farming during the twentieth century was no doubt heavily transformed by government policies, but this cannot be said of the nineteenth century, during which the effect of state involvement on Dutch agriculture was limited. In fact, nineteenth-century Dutch farmers for long had to do without any state help, as agricultural education, experimenting, and innovation was only institutionalized on a large scale at the end of the century. This delay in the institutionalization of Dutch agricultural innovation not only makes the high level of agricultural development in the Netherlands all the more remarkable, but also sets the Dutch case apart from that of its continental neighbours. Instead of actively aiming to advance farming, as was done elsewhere in Europe, the Dutch government for long followed the British example of restricted state involvement.

This paper provides explanations for the relatively late state involvement in Dutch agriculture by answering two questions. First, it is revealed why the Dutch government for long hesitated to become involved. Second, it is explained what made the Dutch government alter its policy during the last quarter of the nineteenth century. By doing so, this paper uses the Dutch case to improve our knowledge of the mechanisms behind agricultural development and agricultural innovation. New light is shed on the interplay between state involvement and the development of agricultural innovation in the past. The paper is structured as follows. The first section compares the institutionalization of agricultural innovation in the Netherlands with developments elsewhere in Europe. The second section presents the development of Dutch agriculture in the nineteenth century, after which explanations for the lack of state involvement in Dutch agricultural innovations – explanations taken from agricultural periodicals and government records – are discussed in the third section. The fourth section discusses the changing nature of agricultural innovation after the introduction of artificial fertilizers, followed by the fifth section in which light is shed on the Agrarian Depression. The paper ends with a conclusion.

I

Institutionalization of agricultural innovation in Europe

Trends witnessed elsewhere in Europe, where after c. 1750 states increasingly intervened in agriculture, were not followed in the Netherlands. The economic theories

of physiocracy in France and cameralism in the German states, for instance, gained popularity among many European state rulers but did not gain a foothold in the Netherlands. As both economic theories saw agriculture as fundamental for a country's wealth and considered progress to be in the authorities' hands, both economic theories resulted in an increased interest in state-sponsored science and education throughout Europe, also where agriculture was concerned.[5] Together with the battle against the rinderpest this prompted authorities throughout Europe to set up veterinary schools. The first were established in France in 1762 (Lyon) and 1767 (Alfort), soon followed by veterinary schools in Copenhagen (1773), Vienna (1777), Dresden (1778), Hannover (1784), Munich (1790), Berlin (1790), and London (1792). The veterinary schools in the Netherlands at Utrecht and in Belgium at Liège were only established in 1824 and 1830.[6]

France had led the way in establishing veterinary schools. Agricultural education at the higher and lower level, however, was first institutionalized by German states. Since the middle of the eighteenth century German universities often provided lectures in agrarian law and agricultural statistics.[7] As these lectures were considered too theoretical, more practical agricultural education was offered on the tertiary level at agricultural colleges (or 'academies'), first established at Celle (1802), Weihenstephan (1803), Möglin (1806), and Hohenheim (1818). Agricultural colleges followed in France at Roville (1819), Grignon (1826), and Trois-Croix (1832), in Italy at Pisa (1834), and in England at Cirencester (1842). Whereas these first colleges were established on a combined public-private initiative, colleges established in later decades were often fully state funded, most notably the *Institut national agronomique* at Versailles (1848), the agricultural college in Aranjuez, Spain (1855), and the Belgian *Institut agricole de l'Etat* at Gembloux (1860).[8]

The German states pioneered in providing agricultural education at the higher level as well as the secondary level. From the 1820s onwards, German farmers' sons

[5] For the connection between cameralism, physiocracy and agriculture, see Peter M. Jones, *Agricultural Enlightenment. Knowledge, Technology, and Nature, 1750-1840* (Oxford: Oxford University Press, 2016).
[6] A. Mathijsen, ed., *The Origins of Veterinary Schools in Europe - a Comparative View* (Utrecht, 1997) and Leen van Molle, "Kulturkampf in the Countryside. Agricultural Education, 1800-1940: A Multifaceted Offensive," in *Land, Shops and Kitchens. Technology and the Food Chain in Twentieth-Century Europe*, ed. Carmen Sarasua, Peter Scholliers, and Leen van Molle, CORN Publication Series 7 (Turnhout: Brepols, 2005), 139–69.
[7] Jones, *Agricultural Enlightenment. Knowledge, Technology, and Nature, 1750-1840*, 21.
[8] E. Porceddu and R. Rabbinge, "Role of Research and Education in the Development of Agriculture in Europe," European Journal of Agronomy, no. 7 (1997): 1–13; Van Molle, "Kulturkampf in the Countryside. Agricultural Education, 1800-1940: A Multifaceted Offensive."; Michel Boulet, "1848, 1960: Two Laws for Agricultural Education in France. Essay on Comparisons between State's Methods of Intervention," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 247–58; Rossano Pazzagli, "From Private Initiative to State Intervention: The Origins of Agricultural Education in Italy," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 231–46.

could receive practice-oriented training at *Landwirtschaftsschule* (agricultural schools) and *Ackerbauschule* (arable farming schools).[9] This example was followed from the 1840s onwards in France, with the creation of *fermes-écoles* (farm schools), *écoles agricoles régionales* (regional agricultural schools), and agricultural orphanages, while in 1849 and 1850 the Belgium government decided to fund no less than twelve secondary agricultural schools, two horticultural schools, and an agricultural mechanical school.[10]

Although many of the Belgian, French, and German colleges and schools came into financial trouble and did not all survive, agricultural education in Belgium, France, and the German states was still more advanced than agricultural education in the Netherlands and Britain. Apart from the Royal Agricultural College at Cirencester (1842), British government funding for agricultural education only expanded by c. 1890, after which by 1907 five agricultural colleges had been established, with nine university departments concentrating on agricultural science.[11] In the Netherlands, the state was hesitant to support agricultural education, apart from the chairs in agricultural economics (*landhuishoudkunde*, literally 'land-household studies') granted to the universities of Groningen, Leiden, and Utrecht.[12] Dutch agricultural societies saw their requests for state-sponsored agricultural colleges declined. The advice of the 1856 state committee on agricultural education to erect a state agricultural college was ignored.[13]

Dutch agricultural education for long had to do without government support. A privately funded horticultural college was opened in 1867 but had to close down in 1894 due to financial troubles and low amounts of students.[14] Other privately funded colleges were rare and short lived. The private colleges in Apeldoorn, Hengelo, Strijp, and Zalk were not more than farms where a few students boarded and received training. These colleges attracted small amounts of students and closed their doors within a few years.[15] The agricultural college in Groningen, which opened in 1842, can be seen as an

[9] Jonathan Harwood, *Technology's Dilemma. Agricultural Colleges between Science and Practice in Germany, 1860-1934* (Bern: Peter Lang, 2005); Volker Klemm, *Agrarwissenschaften in Deutschland. Geschichte - Tradition. Von den Anfängen bis 1945* (St. Katharinen: Scripta Mercaturae Verlag, 1992).
[10] Boulet, "1848, 1960: Two Laws for Agricultural Education in France. Essay on Comparisons between State's Methods of Intervention." Van Molle, "Kulturkampf in the Countryside. Agricultural Education, 1800-1940: A Multifaceted Offensive."
[11] P. Brassley, "Agricultural Education, Training and Advice in the UK, 1850-2000," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 259–74; P. Brassley, "Agricultural Research in Britain, 1850-1914: Failure, Success and Development," Annals of Science, 52, no. 5 (1995): 465–80. For the history of the Royal Agricultural College, see R.B. Sayce, *The history of the Royal Agricultural College* (Cirencester, 1992).
[12] The chairs in *landhuishoudkunde* were no success. The attendance rates of the lectures were low, even after allowing farmers to attend the lectures without any requirements. The chairs were abolished all together in 1876. Harro Maat, "Science Cultivating Practice. A History of Agricultural Science in the Netherlands and its Colonies 1863-1986" (Wageningen University, 2001), 40–42.
[13] J.M.G. van der Poel, *Het Landbouwonderwijs in Nederland tot 1918* (Wageningen: Centrum voor landbouwpublikaties en landbouwdocumentatie, 1976), 32–35.
[14] Goudswaard, *Agrarisch onderwijs in Nederland, 1783-1983*, 156–58.
[15] Van der Poel, *Het Landbouwonderwijs in Nederland tot 1918*, 35–44. Other initiatives for horticultural schools and colleges did not succeed, see Ibid., 53–55.

exception. It was sponsored by a local agricultural society, owned a farm in the nearby village of Haren, and was attended by on average 35 students yearly. It remained active until 1871, when falling numbers of students and complaints about the disappointing level of education prevented necessary new funding and the college had to close down.[16] Private agricultural colleges, and Dutch agricultural education in general, could not survive without government support.

Dutch state support for agricultural education was only extended with the founding of the *Rijkslandbouwschool* (State Agricultural College) at Wageningen in 1876. Table 1 presents a list of the first state-sponsored agricultural colleges of nine European states and shows that the college in Wageningen came much later than state-sponsored agricultural colleges elsewhere in Europe.[17] Although Table 1 does not provide information on the seize of the colleges or the extent of the funding, it is safe to conclude that Dutch state funding for agricultural education came late.

Table 1. State-sponsored agricultural colleges in nine European states, sorted by founding year

State	**College**	**Year**
Bavaria	Weihenstephan	1803
Prussia	Möglin	1806
Württemberg	Hohenheim	1818
UK	Cirencester	1842
Italy	Pisa	1843
France	Versailles	1848
Spain	Aranjuez	1855
Belgium	Gembloux	1860
the Netherlands	Wageningen	1876

Source: Juan Pan-Montojo, "Landowners, Technicians and Associations: The Formation of the Agricultural Public Institutions in Spain, 1847-1936," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 111–34; E. Porceddu and R. Rabbinge, "Role of Research and Education in the Development of Agriculture in Europe," European Journal of Agronomy, no. 7 (1997): 1–13.; Leen Van Molle, "Kulturkampf in the Countryside. Agricultural Education, 1800-1940: A Multifaceted Offensive," in *Land, Shops and Kitchens. Technology and the Food Chain in Twentieth-Century Europe*, ed. Carmen Sarasua, Peter Scholliers, and Leen Van Molle, CORN Publication Series 7 (Turnhout: Brepols, 2005), 139–69. Rossano Pazzagli, "From Private Initiative to State Intervention: The Origins of Agricultural Education in Italy," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 231–46.; Michel Boulet, "1848, 1960: Two Laws for Agricultural Education in France. Essay on Comparisons between State's Methods of Intervention," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 247–58.; Jonathan Harwood, *Technology's Dilemma. Agricultural Colleges between Science and Practice in Germany, 1860-1934* (Bern: Peter Lang, 2005), 111–222.

[16] Goudswaard, *Agrarisch onderwijs in Nederland, 1783-1983*, 101 and 140.

[17] This table only includes a selection of the many German states. Smaller German states followed the example of Bavaria, Prussia and Württemberg and also established state-sponsored agricultural colleges throughout the nineteenth century. See Harwood, *Technology's Dilemma. Agricultural Colleges between Science and Practice in Germany, 1860-1934*, 35–76.

A similar picture trend of the Netherlands following its surrounding countries at a distance can be recognized when looking at agricultural research and experimenting. From the 1750s onwards, estate owners throughout Europe started gathering in agricultural societies to discuss new machinery, techniques, and other farming improvements.[18] These societies often had members reserving fields on their estates to test specific agricultural improvements or funded entire farm holdings to experiment with innovative farming.[19] The first privately funded experimental farms were in Bechelbrom in France (1834) and Rothamstead in Great Britain (1843), which both became models for experimental farms and fields established by agricultural societies all over Europe.[20] The tests and experiments carried out by these experimental farms, for instance checking the effect of crop rotations and new varieties on yields, often lacked theoretical backing. Their scientific value was questionable.

Agricultural experimenting with a more thorough scientific base originated from debates among academics in the 1840s. The writings of the German chemist Justus Liebig (1803-1873) popularized the idea that certain mineral nutrients in the soil – phospherous (P), nitrogen (N), and potassium (K) – are essential to plant growth and pleaded for the use of nitrogen-based fertilizer to compensate for the – falsely – assumed shortage of nitrogen in the air. This interest in nitrogen-based fertilizer integrated chemistry into agriculture and brought about agricultural science.[21] Agricultural science provoked a call to experiment with chemical fertilizers in laboratories at agricultural experiment stations.[22] The first agricultural experiment was publicly funded and was established in the German state of Saxony in 1851, after which other German states swiftly followed. During the 1850s and 1860s, agricultural experiment stations were established throughout the German states, resulting in no less than 44 German experiment stations by 1871.[23]

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[18] The earliest agricultural societies were organized in Rennes (1757), Paris (1761), Amsterdam (1776), London (1804), and Ghent (1808). See Van Molle, "Kulturkampf in the Countryside. Agricultural Education, 1800-1940: A Multifaceted Offensive."

[19] Nadine Vivier, "European Agricultural Networks, 1750-1850: A View from France," in *A Common Agricultural Heritage? Revising French and British Rural Divergence.*, ed. John Broad, The Agricultural History Review Supplement Series 5 (Exeter: British Agricultural History Society, 2009), 23–36.

[20] Giovanni Federico, *Feeding the World. An Economic History of Agriculture, 1800-2000* (Princeton: Princeton University Press, 2009), 106.

[21] Especially Liebig's classic 1840 *Die organische Chemie in ihrer Anwendung auf Agricultur und Physiologie*, printed in English as *Organic Chemistry and its Application to Agriculture and Physiologie*, caused upheaval among academics and interested. William H. Brock, *Justus von Liebig: The Chemical Gatekeeper* (Cambridge: Cambridge University Press, 1997), 72-93.

[22] W. Krohn and W. Schäfer, "The Origins and Structure of Agricultural Chemistry," in *Perspectives on the Emergence of Scientific Disciplines*, ed. G. Lemaine et al., Maison Des Sciences de l'Homme, Paris Publications 4 (The Hague: Mouton & Co., 1976), 27–52.

[23] Ursula Schling-Brodersen, *Entwicklung und Institutionalisierung der Agrikulturchemie im 19. Jahrhundert: Liebig und die landwirtschaftlichen Versuchstationen*, Braunschweiger Veröffentlichungen zur Geschichte der Pharmazie und der Naturwissenschaften 31 (Braunschweig: Technische Universität, 1989), 248–49.

Other countries hoped to imitate the German model. State representatives were sent to tour the German experiment stations, while Germans were employed by foreign governments to build up German-style experiment stations.[24] In Denmark, Norway, Sweden, Switzerland, and the Habsburg Empire, multiple experiment stations were established in the 1850s and 1860s, of which some eventually developed into fully fledged research institutes and the majority remained small scaled and poorly funded.[25] The Italian government aimed to bolster Italian agriculture by having funded no less than sixteen different experiment stations, located all over the country, by 1877.[26] As the Belgian, French, and British authorities hesitated to become involved, the establishment of experiment stations largely depended on the initiative of large land owners. Belgian large land owners united their interests in one society that guided the establishment of four experiment stations.[27] French and British large land owners, on the other hand, did not invest in new experiment stations but held on to the use of the experimental farms and fields that were established in earlier decades.[28]

Table 2. State-sponsored agricultural experiment stations in six European states, sorted by founding years

State	Experiment Station	Year
Saxony	Möckern	1851
Prussia	St. Nicolas	1855
Sweden	Stockholm	1861
Italy	Udine	1870
Belgium	Gembloux	1871
the Netherlands	Wageningen	1877

Source: Chapter six 'German experiment stations' influence in other nations', in: Finlay, 'Science, practice, and politics' and Pazzagli, 'From Private Initiative to State Intervention: the Origins of Agricultural Education in Italy', 240.

Table 2 shows the founding years of state agricultural experiment stations in six European countries.[29] It reveals that again the Netherlands was late in following the

[24] Mark Russell Finlay, "Science, practice, and politics: German agricultural experiment stations in the nineteenth century" (PhD diss., Iowa State University, 1992), 301–69; Louis A. Ferleger, "European Agricultural Development and Institutional Change: German Experiment Stations, 1870-1920," The Journal of The Historical Society, 5 (2005): 417–28.
[25] Finlay, "Science, practice, and politics: German agricultural experiment stations in the nineteenth century," 308–22.
[26] Ibid., 346–49.
[27] The Assocation for the Founding of Agricultural Experiment Stations (*Association pour la Fondation de Stations Agricoles en Belgique*) established experiment stations in Gembloux (1871), Ghent (1874), Liège (1878), and Hasselts (1878). See J. van der Plaetsen, "Het ontstaan en de ontwikkeling van de landbouwstations en van de rijksontledingslaboratoria in België, 1871-1971," Landbouwtijdschrift, no. 630 (1970): 1461–76.
[28] Finlay, "Science, practice, and politics: German agricultural experiment stations in the nineteenth century," 333–46.
[29] This table only includes a selection of German states. Other German states followed the example of Saxony and Prussia and also established state-sponsored experiment stations during the 1850s and 1860s. Schling-Brodersen, *Entwicklung und Institutionalisierung der Agrikulturchemie im 19. Jahrhundert: Liebig und die landwirtschaftlichen Versuchstationen*, 248–49.

example of other European countries, especially when taking into account that the states mentioned in Table 2 all established new experiment stations shortly after establishing their first station: Sweden opened a second experiment station in Ultuna in 1861; Italy created a network of experiment stations with foundations in Modena, Florence, Milan, and Turin between 1870 and 1875; Belgium opened experiment stations in Ghent (1875), Liège (1878), and Hasselt (1878).[30] The Dutch government waited fourteen years to establish experiment stations other than the *Rijkslandbouwproefstation* (State Agricultural Experiment Station) in Wageningen. The Netherlands was not only slow in institutionalizing agricultural education, also agricultural experimenting for long lacked government support.

II

Dutch agriculture in the nineteenth century

Despite the lack of government involvement, nineteenth-century Dutch agriculture reached a high level of development. This was partly a result of growth that had started in preceding centuries.[31] The agricultural development and relatively high production growth in the Netherlands – and in the entire North Sea area in general – has been attributed to a growing urban demand, as population pressure grew from 1500 to 1650 and again after 1750.[32] Dutch farmers experienced a comparative advantage due to the country's proper infrastructure and its geographical location, close to urban centres such as the Flemish towns, the Holland towns, and London. During the nineteenth century Dutch farmers became the main suppliers of food for industrializing regions in Britain, Belgium, and Germany. A period of economic progress was experienced especially between the 1840s and 1870s, when the prices of agricultural products were high and Dutch agricultural export increased continuously. This period of prosperity ended in the 1870s, when the influx of agricultural products from the Americas caused agricultural food prices to collapse and European agriculture came into a crisis known as the Agrarian Depression. Although the prices of exported products remained low throughout the nineteenth century, Dutch agricultural export regained momentum in

[30] Finlay, "Science, practice, and politics: German agricultural experiment stations in the nineteenth century," 320. Pazzagli, "From Private Initiative to State Intervention: The Origins of Agricultural Education in Italy," 240. Van der Plaetsen, "Het Ontstaan en de Ontwikkeling van de Landbouwstations en van de Rijksontledingslaboratoria in België, 1871-1971," 1461–76.
[31] Van Zanden, "The First Green Revolution: The Growth of Production and Productivity in European Agriculture, 1870-1914," 219.
[32] J.L. van Zanden, "The Development of Agricultural Productivity in Europe 1500-1800," NEHA-Jaarboek voor economische, bedrijfs- en techniekgeschiedenis, 61 (1998): 66–85.

the 1880s, as Dutch agricultural export again increased. By 1900 Dutch agricultural export was five times larger than it had been in 1846.[33]

The economic progress experienced until the start of the Agrarian Depression led contemporaries to accuse Dutch farmers of a lack of innovativeness. As especially the British food market was 'a bottomless pit which can never be filled', it was said that Dutch farmers were becoming 'rich while sleeping'.[34] In reality Dutch farming was far from static. Eighteenth-century Dutch farmers had already innovated their farming by improving their equipment, applying row crop cultivation to their fields, or turning to new cash crops – mainly potatoes, clover, and turnips.[35] Wealthy Dutch farmers started importing advanced machinery and equipment from abroad during the nineteenth century. The so called Eagle plough, which was much easier to pull than the heavier traditional Dutch ploughs, became the most widely used foreign tool and paved the way for more equipment to be imported from abroad, such as threshing machines, cutting machines, and reapers.[36] Information on advanced equipment was passed on by Dutch farmers who had migrated to North America in large numbers during the 1830s and 1840s, and who had remained in contact with their family back home. After receiving positive reviews of new equipment from migrated family, Dutch farmers would order new equipment and examine its usability for Dutch farming. When satisfied, more equipment would be transported from abroad or replicated. In some instances, Dutch farmers were wealthy enough to visit North America themselves, purchasing equipment to sell or replicate once back in the Netherlands.[37]

As for the many small-scaled farmers, who formed the large majority of the Dutch farming population, purchasing advanced equipment such as an Eagle plough was too costly, the diffusion of advanced equipment was probably limited.[38] Less well-to-do farmers found other ways to innovate their farming. They increased production by specializing in specific cash crops, turning to crop rotations requiring less fallowing, and intensifying fertilizing. Because manure from their own livestock was often not sufficient, Dutch farmers had to turn to alternatives. They collected mud, bones, urban

[33] Dirk Pilat, *Dutch Agricultural Export Performance (1846-1926)*, Historia Agriculturae 19 (Groningen: Nederlands Agronomisch-Historisch Instituut, 1989).
[34] J. Bieleman, *Five Centuries of Farming. A Short History of Dutch Agriculture 1500-2000*, Mansholt Publication Series 8 (Wageningen: Wageningen Academic Publishers, 2010), 153. J.L. van Zanden and Arthur van Riel, *The Strictures of Inheritance: The Dutch Economy in the Nineteenth Century*, trans. Ian Cressie (Princeton, NJ: Princeton University Press, 2004), 201.
[35] J. Bieleman, *Boeren in Nederland. Geschiedenis van de landbouw 1500-2000* (Amsterdam: Boom, 2008), 141.
[36] J.M.G. van der Poel, *Honderd jaar landbouwmechanisatie in Nederland*, Agronomisch-Historische Bijdragen 11 (Wageningen: H. Veenman & Zonen N.V., 1967), 126–27. Bieleman, *Boeren in Nederland. Geschiedenis van de landbouw 1500-2000*, 318.
[37] Van der Poel, *Honderd jaar landbouwmechanisatie in Nederland*, 125–30.
[38] J.L. van Zanden, "Mest en ploeg," in *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890. Deel I: Techniek en modernisering. Landbouw en voeding*, ed. H.W. Lintsen (Zutphen: Walburg Pers, 1992), 65.

waste, and soil from old dikes, whereas even waste materials from industries such as liquor brewery and soap production were used as fertilizers.[39]

The small-scaled farmers turning to alternatives for animal manure had little knowledge on the exact impact of these new inputs on their fields. The required information was built mainly on their own experience and observations. For most of the Dutch farmers, the diffusion of innovations was largely based on trial-and-error.[40] The innovations applied by the small-scaled Dutch farmers are characterized by their local accessibility. While wealthy Dutch farmers could afford to import advanced equipment from abroad, small-scaled Dutch farmers applied innovations that were locally available, with limited transportation costs. The information on new innovations, such as crop rotations and new cash crops, was passed on between farmers within their village communities. The majority of the nineteenth-century Dutch farmers found their innovations – and the knowledge to apply the innovations – close to home.

While knowledge on innovations was passed on between farmers or came from migrated family, knowledge could also be transferred through local agricultural societies. From the 1750s onwards, wealthy farmers throughout Europe started gathering in agricultural societies. The earliest agricultural societies were founded, mostly by urban elite, in Rennes (1757), Paris (1761), Amsterdam (1776), London (1804), and Ghent (1808).[41] During the 1830s and 1840s, the Netherlands saw an increase of locally organized agricultural societies. The members of these societies jointly pursued to advance farming methods. Competitions were organized in which prizes could be won, e.g. for the highest yield per acre, for breeding the most healthy cattle, and for cultivating the most valuable crops. New varieties, equipment, and other improvements were displayed to the public at exhibitions. Members were encouraged to reserve parts of their land to test new varieties and crop rotations.[42] Because agricultural societies gave their members access to knowledge and innovations, a Dutch agricultural historian has described the Dutch agricultural societies as 'communication communities'.[43]

[39] Ibid., 58.
[40] Ibid.
[41] Vivier, "European Agricultural Networks, 1750-1850: A View from France," 23-36.
[42] Possible missed income for the member conducting tests could be compensated from the societies' funds. One society, for example, reserved 400 guilders for members to test the effect of fertilizers on their field: 'f. 400 beschikbaar te stellen om proeven te doen nemen met verschillende meststoffen, die voor rekening der afdeeling zullen worden verstrekt aan eenige minvermogende landbouwers', citation from the article 'Afd. Vijf-Heerenland, de Ablasserwaard en Arkel beneden de Zouwe der Hollandse M.v.L.', in: *Landbouw-courant* 30:7 (February 17, 1876).
[43] Ronald Rommes, *Voor en door boeren? De opkomst van het coöperatiewezen in de Nederlandse landbouw vóór de Tweede Wereldoorlog* (Hilversum: Verloren, 2014), 34–37.

Other channels to introduce innovations and transfer knowledge were agricultural periodicals. The two main Dutch agricultural periodicals were the *Vriend van den Landman* ('Friend of the Countryman'), appearing weekly from 1837-1873, and the *Landbouw-courant* ('Agriculture Newspaper'), appearing weekly from 1847-1878 and twice a week from 1878-1891.[44] These periodicals contained articles with a wide range of topics, including news reports, statistical reports, communiques of agricultural societies, and notices of innovations. A substantial number of articles was dedicated to the development of agriculture in neighbouring countries. The editors translated foreign articles to republish them in their own journals. The periodicals made their readers familiar with debates about agriculture taking place in the Netherlands and abroad. The *Vriend van den Landman*, for instance, published various opinion essays from French and German periodicals, which praised the high agricultural developmen5t of British agriculture and portrayed British agriculture as the standard to be copied.[45] The *Vriend van den Landman* as well as the *Landbouw-courant* kept their readership informed in detail on the rise of agricultural education in neighbouring countries, especially in the German states.[46]

It is difficult to assess the influence and range of the agricultural societies and periodicals. Contemporaries complained about the societies being too elitist to attract large numbers of ordinary farmers. The societies were regarded too locally organized to speak with one voice and too weak to influence government policy.[47] Jan Luiten van Zanden claims that by c. 1880 the total membership of the main nine provincial agricultural societies reached a peak of 30,000 members, which is a relatively low number when taking into account that there were approximately 100,000 Dutch farmers owning at least one horse. Moreover, part of the societies' membership lived in the cities – local politicians, academics, large estate owners, and other elite – who did not farm

[44] Other weekly periodicals were the *Boerengoudmijn* ('Farmers' Gold Mine'), appearing from 1855-1863, and the *Nieuwe Boerengoudmijn* ('New Farmers' Gold Mine'), which was an appendix to the *Landbouw-courant* and appeared from 1864-1878. The *Maandblad voor den Nederlandschen Landbouwer* ('Monthly journal for the Dutch Agrarian') appeared every month from 1857-1891 and contained extracts from other periodicals. All these periodicals are to be found at the Special Collections of Wageningen University Library.

[45] See for instance J.G. Booth, 'Hoe beuren wij onzen landbouw op? Beschouwingen over den toestand van den landbouw in Groot-Brittannië en proeve om de oorzaken aan te wijzen, waardoor dezelve den hoogen trap bereikt heeft, waarop hij staat, en die elders bereikt worden kan', in: *Vriend van den Landman* 6 (1842), 596-633; 'Schotland en Engeland als voorbeelden hoe de landbouw verbeterd kan worden', in: *Vriend van den Landman* 15 (1851), 722-732; 'De landbouw in het hoekje van den haard. De Engelsche landbouw', in: *Vriend van den Landman* 23 (1859), 385-390.

[46] See for instance E.C. Enklaar 'Het landhuishoudelijk onderwijs in Duitschland', in: *Vriend van den Landman* 19 (1855), 740-743; 'Overzicht der landhuishoudelijke leer-inrigtingen in Pruissen', in: *Vriend van den Landman* 20 (1856), 181-182. The *Landbouw-courant* always started its issues with a column on reforms in agricultural education, both in the Netherlands as abroad.

[47] See for instance 'Provincialisme in de 19e eeuw', in: Landbouw-courant 22:41 (October 8, 1868).

themselves. It can be safely concluded that Dutch agricultural societies were dominated by the wealthy few rather than the ordinary farmer.[48]

The influence of the agricultural societies on Dutch farming was limited, and the same can be said for the agricultural periodicals. Because data on the periodicals' readership is lacking, it is difficult to assess the importance of the periodicals as vehicles to transfer knowledge. The articles in the periodicals were often highly theoretical, consisting of scientific formulas and the chemical composition of fertilizers.[49] Many articles were reviews of expensive equipment. Occasionally the editors would copy foreign articles without a translation, presuming the audience could read French or German.[50] The periodicals' audience was probably well-of and highly educated, which the bulk of the Dutch farmers was not. The range of the Dutch agricultural periodicals and their influence on Dutch agricultural innovation should therefore not be overestimated.

The agricultural periodicals as well as the agricultural societies often advocated what they called 'scientific agriculture'. Adherents of 'scientific agriculture' pleaded for the rationalization of farming by the use of theories from the natural sciences. Especially chemistry, it was thought, should be used to for instance determine soil fertility and identify the right fertilizers.[51] 'Scientific agriculture' seems not to have become widespread among the ordinary, small-scaled Dutch farmers, who did not have sufficient education. The majority of the Dutch farming community innovated successfully on a traditional way. For them, innovation was still largely a process of trial-and-error rather than science. In a 1984 article, George Grantham has argued that for a large part of the nineteenth century, German agricultural innovation consisted of what he has labelled 'traditional innovation'. German farmers were able to reach higher yields by finding locally-available new inputs, acquiring knowledge by trial-and-error and through 'traditional' networks within families or villages and by providing their sons with practical farm training at home. For large parts of the nineteenth century the counterpart of 'traditional innovation', which Grantham has conceptualized as 'scientific

[48] Van Zanden, "Mest en ploeg," 54–56.
[49] See for instance 'Onderrigt in het beproeven van Guano', in: *Landbouw-courant* 9:13 (March 29, 1855).
[50] In 1864, the editor of the *Nieuwe Boeren Goudmijn* published a five-page long French text, see *Nieuwe Boeren Goudmijn* (1846), 99-104.
[51] E.C. Enklaar, the editor of the Vriend van den Landman, held a speech to a local agricultural society in 1842 entitled 'Treatise on the scientific practice of agriculture' ('Verhandeling over de wetenschappelijke beoefening van de landbouw', Zwolle 1842).

innovation', was not needed.[52] Dutch agricultural innovation in the nineteenth century was largely based upon 'traditional innovation'.

III

State involvement before c. 1870

Dutch agricultural innovation before c. 1870 occurred without state regulation. Apart from the veterinary school in Utrecht, no state-funded institutes were found. The Utrecht veterinary school was established during a short period in the early nineteenth century in which the Dutch government vigorously intervened in the economy. During the reign of King William I (1815-1840), the first monarch of the unified and centralized Low Countries after the Restoration, the Dutch state invested in the economy and agriculture. Provincial 'Committees for Agriculture' (*Commissies van Landbouw*) were established to promote agriculture. They did not succeed and were abolished again in 1851.[53] The reign of King William I brought the Dutch state in financial difficulties. After 1840, government expenses had to be cut to limit the public debt. Liberals, advocating a small state, started dominating Dutch politics. By abolishing trade restrictions and tariffs the Netherlands followed the liberal *laissez faire* policies of Britain, where the Corn Laws had been appealed in 1846. State investments were kept to a minimum.[54] It is no coincidence that both Britain and the Netherlands followed other European states at a distance where state involvement in agriculture is concerned.

Since the dominance of liberalism in Dutch politics after 1840, the Dutch state for long did not alter its passive position towards agricultural innovation. The agricultural periodicals reveal that the Dutch farming elite had an ambiguous stance towards the state's agricultural policy. On the one hand it was acknowledged that the *laissez faire* policy of the government was beneficial for the trade in agricultural products.[55] It was argued that a more active state would eventually result in a higher tax burden which would hit farmers hard. In 1860, for example, a reader of the *Landbouw-courant* commented that Dutch butter should receive a state-authorized quality mark, thereby guaranteeing the quality of the product for British consumers.[56] In the next issue of the

[52] George Grantham, "The Shifting Locus of Agricultural Innovation in Nineteenth-Century Europe: The Case of the Agricultural Experiment Stations," in *Technique, Spirit and Form in the Making of the Modern Economies: Essays in Honor of William N. Parker*, ed. Gary Saxonhouse and Gavin Wright, Research in Economic History 3 (Greenwich and London: Jai Press, 1984), 191–214.
[53] Bieleman, *Boeren in Nederland. Geschiedenis van de landbouw 1500-2000*, 305.
[54] Van Zanden and Van Riel, *The Strictures of Inheritance: The Dutch Economy in the Nineteenth Century*, 186.
[55] W.H. Vermeulen, *Den Haag en de landbouw. Keerpunten in het negentiende-eeuwse landbouwbeleid*, Staatkunde en Burgerschap 5 (Assen: Van Gorcum, 1966), 46.
[56] J.R. van Maanen, 'De Nederlandse boterhandel, met betrekking tot Engeland', in: *Landbouw-courant* 14:16 (April 19, 1860).

periodical, another reader quickly answered that the quality of butter should be guaranteed by Dutch farmers themselves, without government interference. A growing state bureaucracy, he argued, would only intensify the tax burden, increase the price of butter, and ultimately ruin the international competitiveness of the Dutch dairy sector, especially on the British market.[57]

While the passive position of the state towards agriculture received praise, some argued that the neglect by the state caused Dutch agriculture to be underdeveloped. When the agricultural periodicals report about colleges or experiment stations being installed abroad, the periodicals would always post the question why the Dutch government did not follow this example. The periodicals made international comparisons to plea for more state involvement. Apart from comparisons with French, German, and British agriculture, developments in Belgium were followed with large interest. The Dutch presumed backwardness towards Belgian agriculture was describes as particularly humiliating.[58] Gaining independence from the Netherlands in 1830, it was said that Belgium had surpassed the Netherlands not only in agriculture, but also in technology and industry in general.[59] Compared to the neighbouring countries, it was argued, the state of Dutch farming was a shame.

The agricultural periodicals used the international comparison to strengthen their plea for 'scientific agriculture'. Dutch politicians, however, were not receptive for the given arguments. In 1863 the Dutch parliament confirmed the Secondary Education Act (*Wet op het middelbaar onderwijs*), which prescribed public funding for lower and higher education in various professions, such as technology, engineering, and trade.[60] The parliamentary debates prior to the confirmation of this Act reveal the vision of politicians on the state of Dutch agriculture and the need for higher agricultural education. The debates make clear that a majority of national parliament, dominated by liberals adhering to *laissez faire* and restricted state intervention, had no faith in 'scientific agriculture' and saw higher agricultural education as unnecessary. Farmers

[57] J.P. van Amersfoordt stated that 'I fear all interference of the state in my profession. [...] I fear state officials, state formalities [...].' ('Ik voor mij vrees alle bemoeijing van het Rijk met mijne nijverheid. [...] ik vrees Rijks-ambtenaren, Rijksformaliteiten [...]') . From J.P. van Amersfoordt,'Certificaten van oorsprong voor boter', in: *Landbouw-courant* 14:19 (May 10, 1860).

[58] See for instance J. Wttewaall, 'Scholen voor Land- en Tuinbouw in België', in: *Landbouw-courant* 4:1(January 5, 1850); 'Belgische Landbouw Scholen', in: *Landbouw-courant* 5:35 (May 4, 1851); 'Wat er door de Belgische regering voor den landbouw gedaan is', in: *Vriend van den Landman* 17 (1853), 686-689.

[59] J. Wttewaall wrote that 'while the Dutch were still thinking about the formation and necessity of railroads, the Belgians were already passing us by ...', ('Terwijl de Nederlanders nog zaten te peinzen over de mogelijkheid van oprigting en over de noodzakelijkheid van spoorwegen, reden de Belgen ons reeds voorbij ...'), cited from J. Wttewaall, 'Scholen in België tot het vormen van goede warmoeziers en bloemisten', in: *Landbouw-courant* (December 6, 1860).

[60] H.W. Lintsen, ed., *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890. Deel V: Techniek, beroep en praktijk* (Zutphen: Walburg Pers, 1994), 119.

would see no good in education in 'scientific agriculture'.[61] It was thought that farmers would rather put their sons to work than have them educated in physics and chemistry.[62] One liberal parliamentarian argued that skills in 'practical agriculture' – which he contrasted to 'scientific agriculture' – had for centuries been successfully passed on from generation to generation without any formal education and had brought Dutch agriculture success – so why change?[63] The politicians stated that the presumed success of 'scientific agriculture' in neighbouring countries should be attributed to effort of large estate owners rather than public higher education.[64] It was agreed upon that Dutch small-scaled farmers, who were the backbone of Dutch farming, were not in need of higher education.

Although the Secondary Education Act of 1863 did not oblige the state to fund higher agricultural education, it did prescribe state support for lower agricultural education, with which non-theoretical, 'practical' farm training for young boys was meant. Towns and villages were welcomed to apply for government grants to erect agricultural schools. Although various towns requested for governmental funding to erect agricultural schools, only two agricultural schools opened, in Warffum (1870) and Wageningen (1873), of which only the Wageningen school survived for longer than five years.[65] With only one agricultural school for lower education, Dutch agricultural education still lagged behind.

One of the problems the schools in Warffum and Wageningen encountered within the first months of their existence was that there were no teachers available. As a result, Dutch politicians agreed that a college for higher agricultural education was needed, though not primarily to diffuse 'scientific agriculture' among ordinary farmers, but to strengthen lower education in 'practical farming' by educating teachers. After proposals to combine an institute for higher agricultural education to the Utrecht veterinary school

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[61] '... Het zal nog veel moeijelijker zijn om den boer te bewegen zijne jongens wetenschappelijk onderrigt te doen geven. Let slechts op het bezoek der lagere school ten platten lande. Zoodra de kinderen eenigzins kunnen meewerken, worden zij van de school afgenomen'. Cited from 'Handelingen Tweede Kamer 1862-1863, 54e zitting, zitting van dinsdag 10 maart 1863', 592.

[62] 'Het voornaamste bezwaar ligt in de neiging van onzen landbouwers- en ambachtsstand om de kinderen zoo vroeg mogelijk door handenarbeid iets te laten verdienen.' Cited from 'Voorloopig verslag der Commissie van Rapporteurs voor het Ontwerp van Wet tot regeling van het middelbaar onderwijs' (December 12, 1862), 503.

[63] 'De zoons van landbouwers zullen de praktijk altijd veel beter te huis leeren, en anderen, die bij 't vak overgaan op eene boerderij bij praktikale landbouwers, om aldaar zelf het boerenwerk, de gereedschappen en landbouwwerktuigen te hanteren.' Cited from 'Handelingen Tweede Kamer 1862-1863. 55e zitting, zitting van woensdag 11 maart 1863', 607.

[64] Of men in het algemeen wel als axioma kan stellen dat de groote verbeteringen, die de landbouw in het buitenland heeft, enkel zouden zijn toe te schrijven aan die hoogere scholen, ik geloof dat men dit eenigzins zou kunnen betwijfelen. In andere landen, bepaaldelijk ook in Engeland, heeft het groote landbezit daartoe zeer veel bijgedragen. Die groote landbezitters exploiteren daar zelven op groote schaal, hetgeen wij hier slechts op kleine schaal zien.' Cited from 'Handelingen Tweede Kamer 1862-1863, 54e zittingen, zitting van dinsdag 10 maart 1863', 594.

[65] Towns and villages that unsuccesfully applied for grants were Alkmaar, Apeldoorn, Breda, Dokkum, Franeker, Goes, Groningen, Haarlemmermeer, Nijmegen, Sneek, Tiel, Wieringerwaard, Winschoten, Winterswijk, and Zierikzee (15 in total). Van der Poel, *Het Landbouwonderwijs in Nederland tot 1918*, 104–11.

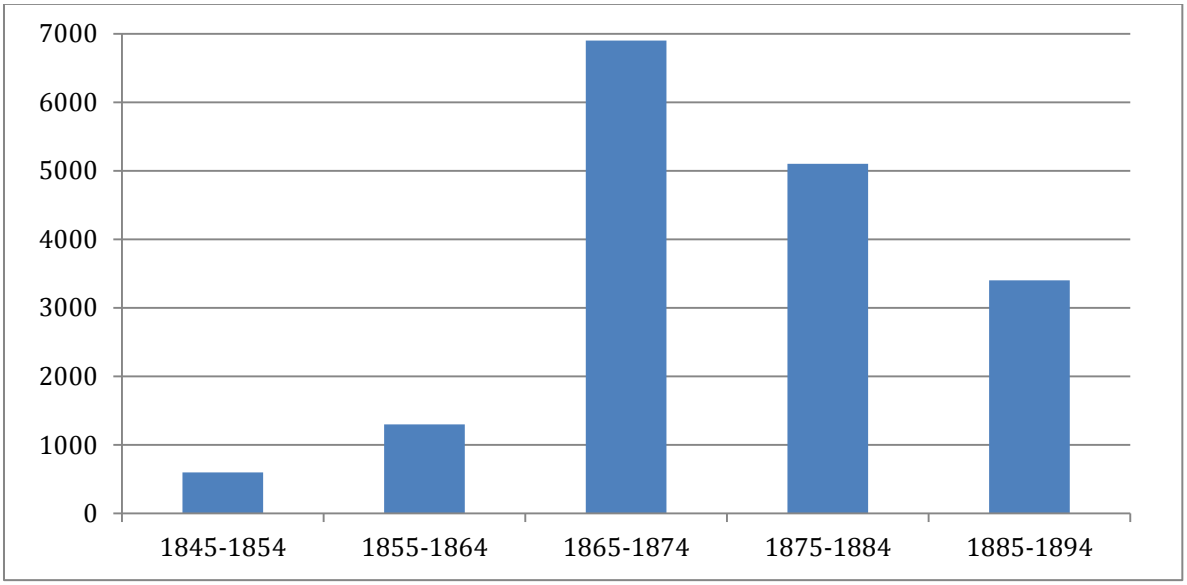
or to the university in Utrecht were declined, agreement was found to upgrade the Wageningen agricultural school, thereby keeping the costs low. The Wageningen agricultural school was finally elevated to the status of the country's single *Rijkslandbouwschool* (State Agricultural College) in 1876.[66]

IV

The influx of artificial fertilizers

Dutch historiography has described the last three decades of the nineteenth century as pivotal for the development of Dutch agriculture. Prior to c. 1870 agricultural innovation for the many small-scaled Dutch farmers was limited to new cash crops, advanced crop rotations, and finding substitutes for manure. All these novelties were locally available. Knowledge was easy accessible and transferred through tradition – usually informal – networks. This orientation on locally-available innovations changed with the introduction of guano – the birds' excrement found on the Peruvian shores – which was first introduced in the Netherlands in 1843. Being nitrogen-rich and leaving behind almost no weed, guano was an interesting substitution for animal manure, urban waste, and other fertilizers. Small portions of guano were often enough to enhance fertility substantially, making its transportation relatively cheap.[67]

Graph 1. Ten-year averages of Guano import, 1845-1894 (in tons).



Source: Van Zanden, "Mest en ploeg", 58

[66] J. Van der Haar, *De geschiedenis van de Landbouwuniversiteit Wageningen. Deel I: van school naar hogeschool, 1873-1945* (Wageningen: Landbouwuniversiteit Wageningen, 1993), 57.
[67] Van Zanden, "Mest en ploeg," 59.

Graph 1 presents the ten-year averages of Guano import in the Netherlands between 1845 and 1894. It reveals that the import of guano expanded especially during the 1860s. From 1865 to 1874, almost 7,000 tons of guano were imported on average yearly. Hereafter this average declined again, as the popularity of Peruvian guano made way for less nitrogen-rich types of guano, usually Peruvian guano mixed with other excrements. Poor quality guano caused the popularity of guano to gradually diminish. Guano eventually lost ground to cheaper yet more reliable fertilizers, such as salpeter from salinations in Chile (hence *chilisalpeter*), potassium from Germany imported from the 1870 onwards, and phosphate imported from Germany from the 1880s onwards. Lastly, so called 'Thomas smeg' (*thomasslakkenmeel*), a by-product from smelted metal, also found its way from Germany to Dutch fields. Since 1870 guano had made way for many artificial fertilizers to be imported by Dutch farmers.[68] Table 4 reveals that, while only 1 kg of chemical fertilizers was used per hectare of Dutch farmland in 1880, this amount rapidly expanded to 146 kg per hectare of farmland in 1913. Dutch agriculture developed from a small user of chemical fertilizers in 1880 to the largest user of chemical fertilizers in 1913. The second largest user, Belgium, used less than half of the amount of chemical fertilizers. Chemical fertilizers were crucial for Dutch farming.

Table 3. Use of chemical fertilizers in six European countries, 1870-1913 (in kg per ha of farmland).

Countries	**1870**	**1880**	**1910**	**1913**
the Netherlands	0	1	36	146
Belgium		9	47	65
Germany		4	29	47
UK	5	7	9	26
France	2	2	11	18
Denmark	0	1	9	18

Source: Van Zanden, "The first green revolution", 224; Knibbe, "Feed, Fertilizer and Agricultural Productivity", 55.

As there was little knowledge on chemistry and the capacity to conduct chemical tests with fertilizers was largely absent, the enormous increase in the usage of chemical fertilizers cause many difficulties.[69] The *Vriend van den Landman* and the *Landbouw-courant* contain various articles warning for traders selling forged fertilizers. When suspected of fraud, some Dutch fertilizer traders would sent samples to Belgian or

[68] Bieleman, *Boeren in Nederland. Geschiedenis van de landbouw 1500-2000*, 282–84. Merijn Knibbe, "Feed, Fertilizer and Agricultural Productivity in the Netherlands, 1880-1930," Journal of Agricultural History, 74, no. 1 (2000): 39–57.
[69] H.A.M. Snelders, "Landbouw en scheikunde in Nederland in de vóór-Wageningse periode (1800-1876)," AAG Bijdragen, 24 (1984).

German experiment stations to have their fertilizers qualified as reliable and thereby safeguard their share on the market.[70] Because Dutch farmers had limited access to chemical knowledge, the fertilizers were often used in a wrong way. The wrong type of fertilizer was used on the wrong cash crop, or the farmer simply applied too large quantities of fertilizers on his farmland. Some areas were too wet for the optimal use of fertilizer, with fertilizers washing away or ending up in the groundwater. Grantham argued for Germany that the introduction of fertilizers caused the flaws of traditional methods of innovation and knowledge transfer to come to light.[71] The same applies to Dutch agriculture, where chemical fertilizers were even used more intensively than in Germany. The diffusion of chemical fertilizers among Dutch farmers outgrew traditional ways of innovation.

The market imperfections of 'traditional innovation' that came to the fore due to the import of guano and other artificial fertilizers had two main results. In the first place, Dutch small-scaled farmers were forced to cooperate. Throughout the nineteenth century, elite farmers had gathered in agricultural societies. From the 1880s onwards, also ordinary farmers started organizing themselves, which can be seen in the growing numbers of agricultural co-operatives. These co-operatives gave their members the opportunity to purchase large quantities of fertilizers against lower prices. Equally important was that the growing self-organization of the Dutch farming community gave Dutch farmers more capacity in the search for reliable inputs and gave more strength in the struggle against fraudulent fertilizer traders

A second result of the market imperfections in the fertilizer trade was the founding of the first agricultural experiment station in the Netherlands, the *Rijkslandbouwproefstation* (State Agricultural Experiment Station), which opened in 1877 and which was connected to the Wageningen agricultural college established the year before. The experiment station was founded not only to conduct quality control – though this was its prime task – but also because the government had doubts that the curriculum of the new agricultural college would be too theoretical and would prevent Dutch farmers from sending their sons to Wageningen. An experiment station connected to the college would alter the image that the state college was exclusively theory-

[70] See for instance 'Dr. Petermann's gunstig oordeel over de "opgeloste-Peru-guano" van Ohlendorff & Co. te Rotterdam', in: *Landbouw-courant* 27:11 (March 13, 1873).
[71] Grantham, "The Shifting Locus of Agricultural Innovation in Nineteenth-Century Europe: The Case of the Agricultural Experiment Stations," 193.

oriented.[72] The first director of the experiment station was therefore also affiliated to the agricultural college as a lecturer on chemical experiments.[73] In the first years of its existence, the Wageningen experiment station was both an experiment station as laboratory of the agricultural college. It was still small scaled, with a limited effect on Dutch agricultural innovation.

V

The Agrarian Depression and beyond

The diffusion of chemical fertilizers coincided with the Agrarian Depression. From 1878 to 1895 large imports of agricultural products from the Americas caused the European agricultural goods market to collapse. The low prices of agricultural goods resulted in poverty, unemployment, and bankruptcies.[74] The market integration that had started after the appeal of the British Corn Laws in 1846 was soon restrained. Most European states left their *laissez faire* policy by imposing import restrictions and spending vast amounts of their state budgets on support for agriculture. Together with Britain and Denmark, the Dutch government largely held on to its liberal policy. Despite economic decline, these states restricted their interference in trade.[75]

Although the Dutch government received criticism for holding on to the *laissez faire* policy, the farming community for long was unable to persuade the government to change course. The farming community itself could not agree about the solutions for the Agrarian Depression. In 1885 the *Landbouw-courant* published a letter in which the editor of the periodical was accused of partiality. If the editor is so concerned about farmers as he claims to be, the writer asked, why not argue for protectionism? The editor defended himself by publishing a list of agricultural societies, newspapers, and experts that stood against protectionism. Farmers with a preference for protectionism, the editor argued, were still a minority.[76] It seems that even during the Agrarian Depression the government's decision to not introduce protectionist measures was agreed upon by the farming community. The Dutch government could hold on to its *laissez faire* policy without much opposition.

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[72] Van der Haar, *De geschiedenis van de Landbouwuniversiteit Wageningen. Deel I: van school naar hogeschool, 1873-1945*, 54–55.
[73] Maltha, *Honderd jaar landbouwkundig onderzoek in Nederland 1876-1976*, 49–56.
[74] Bieleman, *Boeren in Nederland. Geschiedenis van de landbouw 1500-2000*, 208.
[75] Koning, *The Failure of Agrarian Capitalism. Agrarian Politics in the United Kingdom, Germany, the Netherlands and the USA, 1846-1919*, 84–85. Tracy, *Government and Agriculture in Western Europe, 1880-1988*, 23.
[76] H.D.S. Hasselman, 'Graanrechten of bescherming', in: *Landbouw-courant* 39:52 (June 28, 1885). This article includes the postscript in which the editor defends himself.

The Dutch farming community could not speak in one voice, as the many different agricultural societies, organizations and co-operatives did not collaborate on the national level and as the interest groups were weak. The agricultural periodicals often complained about the passiveness of the Dutch rural elite. The periodicals often envied the neighbouring countries, claiming that the rural elite elsewhere was more active in promoting agricultural progress. Indeed, large estate owners, as for instance the British landed gentry, the Prussian *junckers*, and the Spanish *propietaros*, were rare in the Netherlands.[77] A national society to lobby for the agricultural sector, such as the Royal Agricultural Society in England, did not exist in the Netherlands. The periodicals complained that agricultural societies were only active on a local level and represented local interests only.[78] Indeed, the agricultural societies often disagreed which each other, as for instance on the location of the state agricultural college.[79]

During the 1860s and 1870s various initiatives to establish a national agricultural society that could act as an interest group for the entire agricultural sector had found no support.[80] The agricultural periodicals published various pleas to establish a Chamber of Agriculture (*Kamer van Landbouw*), a state institute that would act as intermediary between the government and the agricultural sector (based on the Prussian model), but with no result.[81] The Agrarian Depression gave a new impulse for this ideal. A central, national body that represented all agricultural societies at the highest political level was finally established in 1884. This Dutch Agricultural Committee (*Nederlands Landbouw-Comité*) quickly gained influence during the 1880s. While agricultural interest groups in the Netherlands had been weak throughout the nineteenth century, the Dutch

[77] Brassley, "Agricultural Education, Training and Advice in the UK, 1850-2000." Juan Pan-Montojo, "Landowners, Technicians and Associations: The Formation of the Agricultural Public Institutions in Spain, 1847-1936," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 111–34. Jonathan Harwood, "Research and Extension in Political Context: Rural Unrest and the Origins of the Prussian Chambers of Agriculture," in *The State and Rural Societies. Policy and Education in Europe 1750-2000*, ed. Nadine Vivier, Rural History in Europe 4 (Turnhout: Brepols, 2008), 135–57.

[78] See for instance 'Provincialisme in de 19e eeuw', in: *Landbouw-courant* 22:41 (October 8, 1868).

[79] Agricultural societies in the northern province of Groningen did not agree on the Wageningen agricultural school being elevated to state college. They tried to influence the establishement by requiring higher preconditions, an experiment station, education in foreign languages, and perfect facilities. See 'Buitengewone vergadering ...', in: Landbouw-courant 30:30 (July 27, 1876).

[80] J. Nagel, 'Een landbouw-maatschappij voor geheel Nederland', in: *Landbouw-courant* 18:8 (February 25, 1864); 'Over 't voorstel van ééne landbouwmaatschappij over geheel Nederland', in: *Landbouw-courant* 18:9 (March 3, 1864); 'Welk lot in eene commissie, uit de Geldersche Mij. van Landbouw, de ontwerpen tot oprigting eener "Algemeene Landbouw-vereeniging" ondergingen', in: *Landbouw-courant* 20:32 (August 9, 1866); 'Een voorstel aan alle landbouw-vereenigingen in Nederland', in: *Landbouw-courant* 23:15 (April 15, 1869); 'Wat op het congres te Kampen over eene centrale landbouw-vereniging gezegd is', in: *Landbouw-courant* 24:12 (March 24, 1870); 'Nederlandsche landbouwers-club', in: *Landbouw-courant* 24:24 (June 16, 1870); G. Reinders, 'Kan het Congres niet tot eene blijvende maatschappij vervormd worden?', in: *Landbouw-courant* 32:12 (February 10, 1878). Calls for a Chamber of Agriculture continued into the 1880s, see Vermeulen, *Den Haag en de Landbouw*, 59.

[81] 'Kamer van Landbouw', in: *Landbouw-courant* 28:28 (July 9, 1874). The government regarded a Chamber of Agriculture too costly, see 'Pruissen bezit een ministerie van landbouw; de magtige "Royal Agricultural College" in Engeland wenscht het – en de Nederlansche Tweede Kamer der Staten-Generaal weigert f. 1200 voor een rijks-collegie van landbouw', in: *Landbouw-courant* 31:3 (January 18, 1877). The editor of the Landbouw-courant cynically published an *in memoriam* for the Chamber of Agriculture initiative: 'In Memoriam!', in: *Landbouw-courant* 30:51 (December 21, 1876).

Agricultural Committee of 1884 was the start of a successful collaboration between the agricultural sector and the government that lasted deep into the twentieth century.

The Agricultural Committee of 1884 convinced the Dutch government to install a special state committee that would look into the role the state could play in recovery from the Agrarian Depression. The 1886 State Committee on Agriculture (*Landbouwcommissie*) consisted of members of the Agricultural Committee, representing the farming community, and consisted of experts, including the director of the Wageningen experiment station. The minutes of the State Committee on Agriculture reveal that the committee members quickly agreed not to advise the government to take protectionist measures. Calling for protectionism, it was argued, would only cause discontent with politicians and damage the interest of the Dutch farming community.[82] It was advised that the state could contribute to economic recovery by removing the obstacles to economic improvement, such as the dependency of Dutch farmers on fertilizer traders.[83] Quality control for fertilizers, seeds, and other inputs was needed. It was argued that the need for quality control could not be satisfied by the rather small state agricultural experiment station in Wageningen alone. More agricultural experiment stations conducting agricultural research were needed.[84]

The first conclusions of the State Committee were discussed in parliament on December 22, 1887 and found support. The State Committee was praised for not advocating protectionism. Improving farmers' knowledge on fertilizers and other inputs was described as 'healthy protectionism' or 'protectionism of knowledge', which was presented as an alternative to the regular trade protectionism, namely 'protectionism of prices', which would only increase the price burden on the Dutch consumers. More knowledge for the Dutch farmer would increase his international competitiveness.[85] The fear that the experiment stations would be too theoretical and would primarily conduct scientific experiments was removed by arguing that the experiment stations would only conduct experiments that directly protected farmers from deceit in fertilizers and other

[82] NL-HaNA, Landbouwcommissie, 2.11.25, inv. nr. 3. See the minutes of September 17, 1890.
[83] '... dat hier altijd 2 partijen zijn, landbouwer en koopman en de landbouwer gewoonlijk aan 't kortste eind trekt als hij te doen heeft met particulier initiatief'. NL-HaNA, Landbouwcommissie, 2.11.25, inv. nr. 3. See the minutes of September 13, 1887.
[84] 'Verzameling van adviezen door de Landbouwcommissie ingesteld bij Koninklijk Besluit van 18 september 1886, No. 28 aan de Regeering uitgebracht, voor zoover deze in de verschillende nummers van de Staatscourant zijn gepubliceerd'. See NL-HaNA, Landbouwcommissie, 2.11.25, inv. nr. 6.
[85] 'Hier hebben wij nu eens een geval van gezond protectionisme, niet een protectionisme dat de groote meerderheid benadeelt door kunstmatige verhooging van prijzen, die ten gunste van enkelen komen, maar een protectionisme dat den landbouwer in staat stelt, door zeer reëele verhooging van kennis, de concurrentie met buitenlanders te aanvaarden en te volbrengen.' 'Handelingen Tweede Kamer 1887-1888, 40e zitting, zitting van donderdag 22 december 1887', 627.

inputs.[86] Besides, it was stated that farmers themselves had the responsibility to turn to the experiment stations for help.[87] Some parliamentarians wandered if quality control of chemical fertilizers should not be a private activity, without state involvement. This critique was dismissed by arguing that the reliability of quality control could not be guaranteed by traders and entrepreneurs themselves.[88] It was decided that quality control, and agricultural innovation as such, could not be left to the market. The state had to step in as an objective arbitrator.

The sudden change in the receptiveness of the Dutch parliament to be involved in agricultural innovation can not be explained by the Agrarian Depression alone. Prior to the 1880s, the agricultural periodicals had often published complaints about Dutch politicians. They were said to be excessively concerned with trade rather than farming. Only few members of parliament, it was argued, truly represented the cause of farmers.[89] During elections the periodicals called their readers to vote for candidates favourable of agriculture.[90] Dutch political historians have made clear that the Dutch ruling class indeed consisted of urban elite, having an interest in trade rather than agriculture, and that agriculture was not a much debated topic, not in ordinary newspapers nor in parliament.[91] During the last two decades of the century, however, the Dutch political environment changed drastically. Dutch political historians have characterized the end of the nineteenth century as the period in which the dominance of classic liberalism in Dutch politics came to an end and in which various social groups – factory workers, Catholics, orthodox Protestants – emancipated. As the franchise was

[86] 'Maar ik weet toch ook, dat het bij uitnemendheid practische zaken zijn. De landbouwers worden zeer dikwijls door den handel gefopt; koopen zij zaden, meststoffen, lijnkoeken en dergelijke zaken, dan kunnen zij die laten onderzoeken aan de proefstations en zich op die wijze tegen bedrog wapenen'. Cited from 'Handelingen Tweede Kamer 1887-1888. 40e zitting, zitting van donderdag 22 december 1887, 634.

[87] Als iemand de hoedanigheid van zijn grond wil kennen, als hij wil weten hoe hij dien kan verbeteren, wat hij er op moet verbouwen, dan richt hij zich tot de proefstations. Als de landbouwer meststoffen noodig heeft voor een gewas, hij wint den raad in van de proefstations. Als hij zaaizaad wil hebben dat geschikt is voor zijn grond, hij wendt zich tot de proefstations'. Cited from 'Handelingen Tweede Kamer 1887-1888. 40e zitting, zitting van donderdag 22 december 1887', 628.

[88] 'Maar hier zijn de particuliere inrichtingen niet te vertrouwen, want zij laten zich omkoopen door handelaars in zaden en meststoffen. Hier kunnen alleen ambtenaren de noodige zekerheid verschaffen.' Cited from 'Handelingen Tweede Kamer 1887-1888. 40e zitting, zitting van donderdag 22 december 1887', 632.

[89] 'Over den achterlijken toestand van den landbouw, in vergelijking met dien van handel en fabrijken', in: *Vriend van den Landman* 3 (1839), 556-571. 'De landbouwer en de staat', in: *Landbouw-courant* 16:29 (July 21, 1864). 'Het nieuwe ministerie en de Landbouw', in: *Landbouw-courant* 25:2 (January 12, 1871). 'Er is immers geen ambtenaar voor landbouw bij Binnenlandsche Zaken?' in: *Landbouw-courant* 30:39 (September 28, 1876).

[90] 'Verkiezingen van leden voor de Tweede Kamer der Staten-Generaal', in: *Landbouw-courant* 16:23 (June 9, 1864). In the article 'Verkiezingen. Een woord ter overweging', in: *Landbouw-courant* 18:20 (May 17, 1866) the editor even mentions names of candidates on which his readership should vote. The next issue published a letter in which a reader complained that a periodical should not give voting advice. 'Geen politiek in de Landbouw-courant!', in: *Landbouw-courant* 18:21 (May 24, 1866). The editor's voting advice was defended in a next letter by a reader who argued that politics should have a place in agricultural periodicals, because farmers should participate in politics much more to defend the interests of the agricultural sector. 'Politiek in de Landbouw-courant', in: *Landbouw-courant* 18:25 (June 21, 1866). Later issues of the *Landbouw-courant* that year even contain advertisements in which readers are called to vote for members of parliaments with a background in agriculture.

[91] R. Van der Laarse, *A Nation of Notables: Class, Politics and Religion in the Netherlands in the Nineteenth Century*, Occasional Papers in the Contemporary History and Politics 3 (Salford: European Studies Research Institute, 2000). Vermeulen, *Den Haag en de landbouw. Keerpunten in het negentiende-eeuwse landbouwbeleid*, 50.

broadened step-by-step, Dutch politicians and political parties had to establish a firm foothold among the voting public. As a result, politicians were willing to reform education, social rights – and agriculture.[92]

The Dutch government followed the State Committee's advice, after which the institutionalization of agricultural innovation expanded rapidly during the 1890s. New experiment stations opened in Groningen, Hoorn, and Breda in 1890. The Wageningen experiment station was disconnected from the Wageningen college and was released from its educational duties in 1892. It grew swiftly and was divided into two separate experiment stations in 1899. Both stations were located in Wageningen, where one analysed seeds and the other conducted quality control.[93] An experiment station had also opened in Maastricht in 1898.[94] By 1900, the Netherlands had no less than six agricultural experiment stations. This sudden expansion of Dutch agricultural experiment stations and Dutch agricultural experimenting in the 1890s coincided with the growth of the Dutch agricultural education, as the Dutch state let go of its inactive position towards agricultural education. During the parliamentary debates about the Secondary Education Act in the early 1860s it was argued that the sons of ordinary, small-scaled farmers were in need of training in 'practical agriculture', which was thought to be best taught at home. Education in 'scientific agriculture', as proposed by some, was regarded useless. Within thirty years this opinion totally changed. From the 1890s onwards, the Dutch government expanded the Wageningen college, extended funding for lower agricultural education, and hired growing numbers of agricultural extension workers to advise farmers. Once deemed unnecessary, more profound agricultural education had now become one of the solutions to the problems Dutch agriculture was facing.

Conclusion

This paper has discussed the late institutionalization of agricultural innovation in the Netherlands by pinpointing at the *nature* of the innovations. Prior to c. 1870, innovations were diffused in traditional ways. Large scaled farmers purchased machineries and had access to information on these machineries through agricultural

[92] Remieg Aerts et al., *Land van kleine gebaren. Een politieke geschiedenis van Nederland 1780-1990*, 9th ed. (Nijmegen/Amsterdam: SUN, 2009), 149–53.
[93] Maat, "Het innovatiesysteem voor de Nederlandse landbouw." Maltha, *Honderd jaar landbouwkundig onderzoek in Nederland 1876-1976*.
[94] The experiment station in Breda moved to Goes in 1893 and was eventually dissolved in 1922. Maltha, *Honderd jaar landbouwkundig onderzoek in Nederland 1876-1976*, 105.

periodicals and their membership of agricultural societies. Small-scaled farmers improved yields mainly by intensifying fertilizing, and therefore shifted to substitutes of animal manure. Their knowledge was based on their own observations and what information they could gather through informal ties. Prior to c. 1870, the development and diffusion of innovations was regulated by the market. State interference was not regarded necessary.

From c. 1840 onwards artificial fertilizers gradually became widespread among Dutch farmers. From the 1870s onwards the use of artificial fertilizers increased rapidly and transformed Dutch agriculture. With the introduction of artificial fertilizers the traditional ways to gather information proved to no longer be sufficient. The capacity of the Dutch farming community to acquire new knowledge had reached its frontier. Traders profited of the farmers' neglect by selling poor quality fertilizers, while the missing know-how often resulted in the wrong use of the fertilizers. Because these market imperfections could not be solved by the farming community itself, the Dutch state had to step in. However, prior to the Agrarian Depression the Dutch farming community was not able to persuasively communicate the claim for state involvement in agricultural innovation. A representative body of self-organized ordinary farmers was lacking. The Agrarian Depression gave an impulse to agricultural self-organization and the collaboration of agricultural societies, culminating in the founding of the Agricultural Committee in 1884. The lobby of this interest group, together with a changing political context, resulted in a rapidly expanding network of institutes, a network providing education, knowledge, and quality assurance of innovations.

This paper has used the case of Dutch agricultural development to comment on the relationship between state involvement in agriculture and agricultural innovation. State involvement in Dutch agricultural innovation only became necessary after the rise artificial fertilizers drastically changed the *nature* of agricultural innovation. The transition from 'traditional innovation' to more knowledge-intensive innovation could not be made without state support and without the lobby of agricultural interest groups.

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