Universiteit Utrecht

History and Philosophy of Science

MSc Thesis

Food for thought;

The practice of knowledge making in Dutch agriculture in the late nineteenth - early twentieth century, shifting dynamics and Joost Hudig as a figure at the intersection.

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“Bij nader inzien blijkt de veronderstelde triomfmars van de wetenschap evenzeer onderworpen aan de ironie van de geschiedenis als alle andere ondernemingen. Hij is in feite een dooltocht vol toevallige vondsten, antwoorden op niet gestelde vragen, verkeerd geplande doorbraken, ongezochte resultaten, halve vervalsingen, slim plagiaat, luid toegejuichte blindgangers en onjuiste inzichten die evenwel binnen een bepaalde historische samenleving bevredigend bleken te functioneren.”

- *Burgerlijk sciëntisme? Over wetenschap en burgerlijke cultuur 1840-1880,* Remieg Aerts.

1. The Long Introduction: Joost Hudig (1880 - 1965) and his place in the scientific landscape.

1.1 Context, the theoretical framework.

There's no shortage of controversy in today's socio-political landscape regarding agricultural science in the Netherlands (or worldwide for that matter). *National Geographic* touts the Netherlands as the "tiny country that feeds the world".[1] An article by the *Washington Post,* referring to the Netherlands as "a bit bigger than Maryland", cites this 'tiny country' as "the world's second largest exporter of agricultural products by value after the United States",[2] as well as one of the largest exporters of agricultural and food technology. Needless to say that agriculture is tightly interwoven into Dutch history, and that any shifts in this field have repercussions on and reflect larger-scale shifts in Dutch society. Those shifts might not have been as conspicuous as the transformation from an absolute to a constitutional monarchy, nor two world wars, but they were most certainly decisive and impactful.

Through the eyes of our protagonist, agricultural chemist Joost Hudig (1880-1967), the ambition here is to catch a glimpse of how people shaped the world of agricultural chemistry in the Netherlands towards the end of the nineteenth and beginning of the twentieth centuries. Having had a long career in the branch and having been involved in field and laboratory, policy and ideology, his movement through these spheres illustrates the tensions that existed between scientists, policy makers and farmers, and to a certain extent the consequences of the rationalisation of Dutch agriculture. Some life will hopefully be breathed into the history of agricultural chemistry by revealing the often malleable if not outright indistinct boundaries between the laboratory, which was represented by institutions and rationalisation, and the field in its inscrutable qualities; Hudig was navigating between these areas through his work and shaping them through his social engagement. His life as an agricultural chemist sheds some light on how these seemingly distinct worlds of lab and field, the rational and the empirical, co-evolved. He was chronologically well-placed to witness certain major shifts in agriculture which followed economic and political transformations, such as the aftermath of the 1875 agricultural crisis, and the two World Wars that took place.

[1] https://www.nationalgeographic.com/magazine/article/holland-agriculture-sustainable-farming

[2] https://www.washingtonpost.com/business/interactive/2022/netherlands-agriculture-technology/

The long introduction proposes to take a look at the central figure himself, an agricultural chemist whose work extended well beyond the laboratory. He could be seen as a fine exemplar of the engaged scientist, having involved himself in not only the scientific aspects of his field through research, but also through his commitment to the more practical aspects of his discipline - the day to day running of lab and field work, publications in the *Chemisch Weekblad* and *Landbouwkundig Tijdschrift* on the ramifications of work in agricultural chemistry as well as publications of his own expressing his more ideological approach to his field. Before that, however, some theoretical context is required in order to clarify some key aspects of the discussion. With a view to clarifying what the position of the agricultural scientist was at the turn of the century, a brief discussion on the lab and field dynamic is essential, seeing as these spaces would be the subject of debate over where the real work was happening.

Nowadays, in the world of product placement, not only are scientists and "science" (usually in the form of dubious statistics) used to confer credibility to pretty much any product, from toothpaste to detergent to baby formula, these scientists are invariably portrayed as a quasi sociologically diverse group with white coats, test tubes and protective glasses. The background is a blindingly white colour with some cold blue, spic and span and sterile. With the advent of nature documentaries we see more and more scientists out in the field, trudging through breathtaking landscapes rife with unseen predators lurking somewhere in the foliage. This latter development is, however, more recent; and even then, the field scientist is expected to do a lot of talking and explaining, whereas the lab scientist is quietly focused on whatever mysterious experiment she or he is conducting, usually reluctant to talk to the camera but having to for the promise of grant money. These images still prevail, and undoubtedly a white lab coat still speaks "science" more than a pair of trekking shoes and a tracking device does.

These images of lab and field science are something historians of science have been working on for decades, and as the sands of knowledge-making shift, so do the ideas around where scientific work resides. This is of interest to our study of Joost Hudig's ideas and agricultural science in the late nineteenth and early twentieth century, since the distinction between laboratory and field emerged right around that time. According to Robert E. Kohler:

> How this all came about we have hardly begun to understand, but one thing at least seems clear: the lab-field border in biology is of recent origin, probably no older than the mid-nineteenth century, when laboratories outgrew museums and herbaria as the premier places of modern science. Indeed, we could say that our concept of the "field" was a by-product of the laboratory revolution of the 1840s to the 1870s.[3]

Joost Hudig was born in 1880, so he was professionally active right at a time when this distinction between field work and laboratory was gaining momentum, if not already in full swing. The distinction is not important for its own sake, it's not just about having two separate methods or areas of working. What's significant is that there was an unequivocal hierarchy between the two, one that gave rise to the still almost-prevailing image of a scientist being someone in a white coat, measuring, designing experiments, comparing results, supervising the younger lab-coat-clad generation. The image of the laboratory went hand-in-hand with the no-nonsense, rationalist, sterile mindset of this new way of doing science. Field work was tied to the more empiricist and observational approach to learning and discovering, it didn't carry the same prestige as the purported abstract-thought world of the laboratory, the embodiment of what the mind-space was supposed to be. Field work quality progressively came to be judged by laboratory expectations (Kohler, 2002), even though their respective cultures remained dissimilar.

Questions of culture are discussed in *De Koe*, where Bert Theunissen offers a lively account of early twentieth century dynamics between cattle farmers and breeders, scientists and politicians in the arena of dairy production. His point is that it was these dynamics which tell the story of increased dairy production over the course of the twentieth century. It wasn't a tale of politicians and farmers implementing wonderful discoveries by people in white coats, discoveries streaming out of laboratories. There were three different cultures at play: that of farming, of science and of politics, and from these cultural exchanges came, for better or for worse, the dairy industry we know today in the Netherlands. Dutch dairy farmers of the late nineteenth and early twentieth century had an approach to cattle which many might deem impractical, even though to the farmer, it was eminently pragmatic. Between farmers and scientists, there were so many areas that overlapped, and so many that came into conflict, that it's impossible to clearly separate them into two camps - making it all the more interesting to study their relationship. They were both strongly encouraged

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[3]E. Kohler, Robert (2003). *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology*. Journal of the History of Biology 36 (3):599-629.

by the government to improve productivity, but how they reacted to this appeal was often conflicting. The farmer's culture of tradition and experience clashed with the analytical approach of scientists and veterinarians, which in turn didn't always respond positively to government ambitions. This is a bird's eye view of the setting in which Hudig was working.

Both Hudig and the farmers' cooperatives were aiming for stability and continuity. Farmers saw it as the cornerstone of their trade, Hudig saw it as the cornerstone of civilisation. Hudig was however more conscious of international economic dynamics, and was concerned about national agricultural independence (ergo productivity). Farmers also wanted international exchange, but on a more practical, commercial level - they seem to have been less concerned with national agricultural independence or international economic dynamics. In this sense, it's as if the laboratory was drawing more boundaries than the field; anything could be examined in a well-equipped laboratory, "placeless" in that the knowledge produced was not tied down to to any local way of thinking (purportedly), the advantage of the analytical approach; however, the laboratory was bound by concerns of productivity and commerce, placing practical limits on its placeless character. In other words, the abstract, "placeless" character of laboratories dedicated to agricultural science were guided by economic and political concerns, greater productivity and agricultural independence. These were not the laboratories of the learned people who were driven by a seemingly pure curiosity. Field work also imposed boundaries of its own as regards productivity. The soil held chemical mysteries of its own which are still being unravelled today, and Dutch soils are very diverse. Weather, water and soil are as difficult to control as future economic and political circumstances. Stability and continuity were based on very different premises for laboratory workers and for farmers. Having spent some time with farmers, Hudig was most likely aware of the conflicting interests of farmers and scientists, conflicts which will be elaborated in chapter three. He remained true nonetheless to his ideal that the laboratory rationale would confer the stability everyone so desired.

The dominant figure that scientists cut in the early and mid 1900's, is more or less a product of their own perspective of themselves and their work rather than an external reality. Hudig the scientist was faced with realities such as that of the scientist-farmer dynamic. Theunissen's dairy farmers are much more active in the knowledge-making of their profession than commonly believed (see chapters 2.3 and 3.1 of this thesis). He was also dealing with issues of the distinctions between the value of work in the laboratory versus that of work in the field. Robert E. Kohler's *Landscapes and Labscapes* dives deeper into the essential conflicts of laboratory and field, dynamics which would be a helpful prism to look through in order to better understand what was going on between farmers and scientists. Joost Hudig also bore the title of *ingenieur*, as well as some initial training in engineering thanks to his studies. This particular position brought with it its own interesting particularities. In *Synthetisch Denken*, David Baneke notes that in the first half of the twentieth century, many scientists were searching for a "synthesis" where science, world view and a vision of society would be united.[4] Engineers were very well placed to bring this synthesis to fruition. Unlike politicians they enjoyed a scientific education which they were taught to apply to real-world situations; with the added advantage that they weren't too engrossed in fundamental research to be able to deal with these applications. In post-war eras they became indispensable to rebuilding the nation. It seems that Hudig was well aware of this and devoted himself not only to his research and teaching work but also to getting the message across of how important it was to build a less "barbaric" (his own words) society. Science was a pre-requisite for this: "*Juist vanwege het ideaal van neutrale en waardevrije wetenschap kreeg wetenschap een sterke politieke en morele lading. Natuurwetenschap werd gepresenteerd als een objectieve en vreedzame manier om ideologische discussies en misverstanden te vermijden*."[5] Physics itself could have been seen at the time as value-free, its application however by engineers was evidently not. In *De Opmars van Deskundigen*, Harry Lintsen and Rienk Vermij maintain that social and moral progress went hand in hand with technical and scientific progress.[6] This led engineers to believe that social leadership required technical knowledge and that the ruling elites fell hopelessly short of it. These old elites, as we will see further on in the world of farming, were mostly made of of people with a legal background, or in any case, studies that fell under a 'humanities' rubric. Engineers then began to sense an increasing confidence in their expertise on questions regarding society; this emerges in Hudig's texts even

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[4]David Baneke, *Synthetisch Denken* p. 14 "In de eerste helft van de twintigste eeuw waren veel wetenschappers bijvoorbeeld op zoek naar een 'synthese', en filosofisch systeem waarin wetenschap, wereldbeeld en maatschappijvisie werden verenigd (zie hoofdstuk 5). Deze zoektocht is alleen te begrijpen in de context van de heersende culturele en maatschappelijke omstandigheden."

[5] Baneke, D., *Synthetisch Denken* p. 15.

[6] van Lunteren, F. H., Theunissen, B., & Vermij, R. (2002). *De opmars van deskundigen: Souffleurs van de samenleving.* Amsterdam University Press.

though, unlike other engineers such as Isaac de Vooys[7], he would not make his political preferences explicit. Agricultural chemists such as Hudig were thus moving through dynamic institutional and cultural landscapes.

Secondary sources used in the analysis are books or articles by authors who wrote extensively about Dutch agriculture in the period examined. A few names are Pim Kooij, Jan Bieleman, D.J. Maltha, Harro Maat, David Baneke, Harm Zwarts, and K. Harmsen. Their writings offer extensive information on the organisation of the practice of agriculture, agricultural education, economics and policy. The insights imparted are indispensable in creating an image of the circumstances in which scientists, farmers and policy makers were moving. Two books on which more of the reasoning is based are, as mentioned above, *De Koe* by Bert Theunissen and *Landscapes and Labscapes* by Robert E. Kohler. The former sheds light on the socio-political situation between farmers, scientists and government, the latter on how dynamics between laboratory and field evolved.

My thesis builds on this secondary literature with a case study of Joost Hudig. Although he is occasionally mentioned in periodicals such as the *Chemisch Weekblad, Cultura* and the *Landbouwkundig Tijdschrift*, his work rarely gets any sustained discussion. The second chapter of this thesis offers an extensive analysis of three of his popular scientific publications, which to my knowledge have not been discussed before. These writings are particularly interesting because he sets out his ideas about what agriculture means to society and how it should be approached. It's in these texts that we notice the person who is trying to bring together science and society - with science at the helm. Analysing them will offer a clearer understanding of the thought processes of a scientist of that era, involved in both agricultural research and education. Our protagonist is standing right at the crossroads of some interesting shifts in scientific thinking, in this case geared towards more real-world applications, so textual analysis can give us deeper insight into his thought processes, and help us see where and how the "scientific nature" of his thoughts emerge. It becomes clear how he argues that the placelessness and abstract nature of science, if applied to

[7]We read about De Vooys in *Synthetisch Denken*, chapter 4. His conviction was that society had become estranged from technological progress and that it was the engineer's task to bridge this gap. Technology had moved too far too fast in the name of profit and that the 'means of production' should be returned to the community. As much as this may sound like something out of a communist manifesto, for De Vooys it meant the rational and efficient use of capital, labor and resources. He was more focused on the problem-solving aspect of what engineering and technology could contribute to society than the political or revolutionary. Both Hudig and De Vooys therefore, believed that engineers were tasked with enlightening society about the benefits of rational thinking. De Vooys' political colours were however more visible.

agriculture, the pillar of society, could aid human civilisation in rising above petty conflicts - a situation which was very relevant to the time he was living in. Even though science in the twentieth century was beginning to accept more applied and less theoretical practices, it was still held as the source from which valuable knowledge originates.

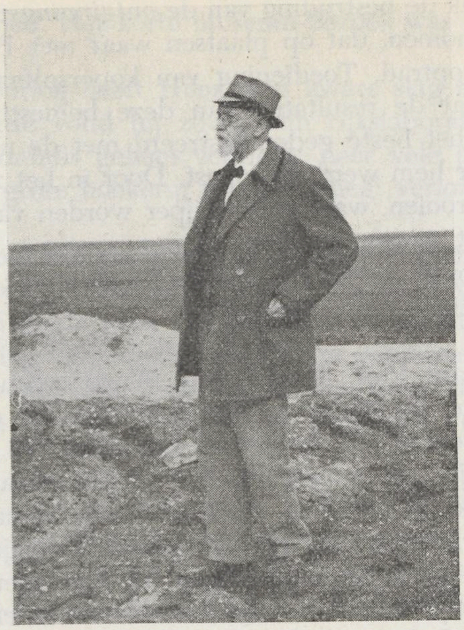
Chapter three will reflect how these ideas evolved in practice in the Netherlands. Even though private initiative was already active in Dutch agriculture in the form of cooperatives and societies of big landowners, the Dutch government eventually did step in and supported the organisation of agricultural experiment stations and agricultural education; not without much back and forth between interested parties as to how it should be organised and to what ultimate purpose. In this again, we see highlighted considerations on what role science did and should play in society and who the actors should be. Although this chapter is mostly based on secondary literature, it also introduces a relevant primary source by Petrus van Hoek (1865-1826)[8], inspector of agricultural education from 1901-1910; it won't be analysed as much as it will be used to highlight certain points about agricultural education in the early 1900s. "Piet" van Hoek had worked for a number of years as an agricultural consultant (landbouwconsulent), as well as state agriculture teacher (rijkslandbouwleraar); this position made him quite popular with farmers thanks to his gift of making agricultural chemistry accessible to them. He, like Hudig, worked on the rational modernising of field work, as well as both the scientific and societal aspects of agriculture. Van Hoek was also heavily invested in agricultural education in his capacity as inspector of agricultural education. The text used, *Hooger Landbouwonderwijs* is a commentary on agricultural education in the Netherlands and a comparison with the German system.

To sum up, resources are plenty when it comes to reading about Dutch agriculture in the nineteenth and twentieth centuries; the above-mentioned authors, among many others, have furnished rich and valuable accounts of agricultural education and science. They've analysed the agricultural and educational institutions, as well as the social context and role of the state in bringing transition about. The present study proposes a view from the inside, taking a closer look at the cultural variations that surface when they interact. Through textual analysis and comparison, the goal is to catch a glimpse of what science meant to the parties involved and what tensions those meanings created. Our protagonist's role in this is rather special since as an engineer, and one who

[8] http://resources.huygens.knaw.nl/bwn1880-2000/lemmata/bwn3/hoekp

felt a strong investment in society, he had to deal with actors from all sides. This can make for convoluted perspective-taking, but it does shed some light on how the meaning and status of science was evolving at the time, and what that meant for agriculture.

1.2 Biography



Prof. Ir J. HUDIG.

Hoogleraar in de Scheikunde en Bemestingsleer aan de Landbouwhogeschool 1929–1949.

Photo from an *"In Memoriam"* celebrating Joost Hudig's seventieth birthday in the *Landbouwkundig Tijdschrift, 62nd year (jaargang), No, 4/5, April/May 1950. Source:* Delpher. It's interesting to note that he's standing in a field rather than in a laboratory.

Imagine conducting a survey asking people to name a scientist - not necessarily a famous scientist, just *a* scientist. What are the chances of someone replying with the name of an agricultural chemist? How likely is it that someone will come back at you with the name of an early twentieth century Dutch agricultural chemist? It's probably safe to assume that the chances are pretty slim. There's remarkably little on record about the people who contributed so much to putting food on our tables. Biographical details are few and far between at best. The closest we can get to knowing them is through details about their career which are documented through their own writings as well as testimonials of their colleagues - all work related. Even Joost Hudig's daughter Johanna Hudig, who is as close as we'll get to knowing any details about his private life, was known for her long and illustrious career as the Netherlands' first female judge.[9] Here then, is where we abandon Hudig the "person" (outside of his workplace), and encounter the man of science and inasmuch as his ambitions were concerned, the innovator.

Born and raised in Rotterdam in 1880, Joost Hudig descended from a long line of shipowners and ancestors involved in the Rotterdam shipping industry[10], yet chose to follow his own pursuits in more abstract fields. Hudig the young man studied electrical engineering in Hannover, then changed to chemistry which included agricultural chemistry and microbiology. This was the period where scientific fields were mutating into a shape which is more familiar to us, one where the idea of patron has morphed into big private and public institutional bodies, rather than rich and enlightened aristocrats. Paul White posits that these "men of science" were motivated to reach out to a new and wider public "who sought knowledge as a means of social improvement".[11] Following Hudig's career as a person involved in the laboratory, industry and to a certain extent, the field, it becomes clearer how these dynamics evolved.

After completing his studies, he started working at the State Agricultural Experiment Stations in Goes and Maastricht in 1904. The State Agricultural Experiment Stations were founded in 1889 as an indirect response to the 1875 agricultural crisis. The overall goal was to organise and improve Dutch agriculture by fighting corruption in butter trade, and organise agricultural education and research. This last great institution, which survived in its original form until 1945 was tasked with:

> [T]he research of soil and water types, fertilisers, nutrients, seeds and all other agricultural raw materials and products for the benefit of agriculture, at the request of the Government or of special persons or institutions; carrying out cultivation or fertilisation tests on the test fields made available for this purpose by the Government or by special persons and

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[9] https://www.njb.nl/media/4423/njb28_art2-portret-van-johanna-c-hudig.pdf, https://resources.huygens.knaw.nl/vrouwenlexicon/lemmata/data/hudig

[10] https://resources.huygens.knaw.nl/bwn1880-2000/lemmata/bwn3/hudigl

[11] White, P. (2016). The Man of Science. In *A Companion to the History of Science,* B. Lightman (Ed.), p. 174. https://doi.org/10.1002/9781118620762.ch11

institutions; the establishment of scientific investigations of a more general nature concerning agriculture.[12]

1907 saw Joost Hudig working as a research assistant at the Agricultural Experiment Station in Groningen, where he started two of his most fundamental research works, one on soil fertility in the peatlands of Groningen and Drenthe (1909), and one on the grey speck disease in oats (Veenkoloniale Haverziekte) (1914).[13]

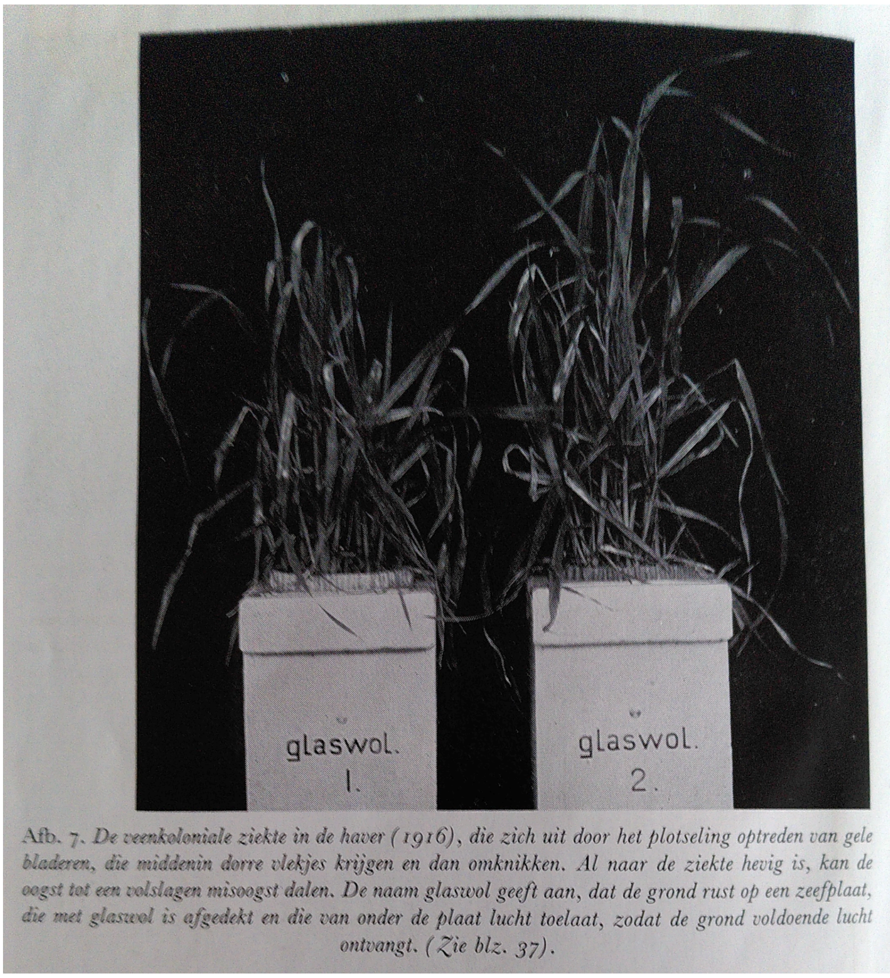

Photo from *Bemesting door de Eeuwen Heen*, "*De Veenkoloniale ziekte in de haver (1916), die zich uit door het plotseling optreden van gele bladeren die middenin dorre vlekjes krijgen en dan omknikken. Al naar de ziekte hevig is, kan de oogst tot een volslagen misoogst dalen. De naam glaswol geeft aan, dat de grond rust op een zeefplaat die met glaswol is afgedekt en die van onder de plaat lucht toelaat, zodat de grond voldoende lucht ontvangt.*"

[12] https://www.archieven.nl/nl/zoeken?mivast=0&mizig=210&miadt=5&miaet=1&micode=726&minr=924159&miview=inv2

[13] Harmsen, K. (1990). *Het Instituut voor Bodemvruchtbaarheid 1890-1990*. Instituut voor Bodemvruchtbaarheid, pp. 23-25

As unassuming as the title may sound it was, according to Karl Harmsen, the beginning of research into soil diseases, results of which led to more tailor-made advice on what fertilisers to use. Grey speck disease is a non-pathogenic disease caused by a manganese deficiency; replacing the manganese shortage through proper fertilising (or acidifying ammonium nitrogen fertilisers to make manganese more available) could save crops. Groningen was an important location for soil and fertiliser research in the early twentieth century in the Netherlands.

As the need for research and development kept growing, the experiment stations were reorganised, and in 1916 Groningen was designated as National Agricultural Testing Station for Arable and Grassland Farming, including a subdivision responsible for sand and peat soil cultures. Hudig was hired as director of this department, but seemed unhappy with his new role and applied for a position at an industrial research lab. He cited a rigid and slow work environment at the experiment station in Groningen as reasons to want to change, as well as limitations on choice and agency. Since industry was more concerned with keeping up with the competition, it did invest in some level of cutting edge research according to its needs. This could possibly be a reason Hudig wanted to leave the State Agricultural Experiment Station to go into a more clearly private sector. Industry and government also sensed a great need for chemical research during World War I: "*Wetenschappelijk en technisch onderzoek was daartoe nodig en de Eerste Wereldoorlog kan dan ook met recht de ontstaansperiode van de industriële research in Nederland worden genoemd. Kleine onderzoekslaboratoria kwamen toen overal van de grond.*"[14] In 1918, he sent a job application letter[15] to A. Ter Horst, then director of the Vondelingenplaat in Rotterdam, one of the companies responsible, as of 1916, for producing chemicals which had previously been imported.[16] As will be made clear in the texts under analysis, he held a strong belief in the independent development of industry; he saw government as being slow, inefficient and not sufficiently engaged in rapid development. This desire for "efficiency" (he uses the English word in his text), led him and

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[14] Schot, J. W., Lintsen, H. W., Rip, A., Albert de la Bruhèze, A. A., & Homburg, E. (Eds.) (2000). *Techniek in Nederland in de twintigste eeuw*. Deel 2: Delfstoffen, Energie, Chemie. Walburg Pers. Techniek in Nederland in de twintigste eeuw No. 2, p. 313.

[15] "*Ik vraag dit in mijn eigen belang, daar ik in de industrie op een onderzoekingslaboratorium emplooi zoek. (...) [V]ooral nu de grootere industrieën tot de instelling van een onderzoekingslaboratorium overgaan, [zou ik] van werkkring willen veranderen. Mede vindt deze wensch oorzaak in het feit, dat de Rijksorganisatie veelal stroef en traag werkt en niet altijd vrije keuze laat voor personen en middelen*'. Brief Hudig aan Ter Horst, 9 dec. 1918, in bezit van dr. A.M. ter Horst, in *Techniek in Nederland in de twintigste eeuw*, Deel 2: Delfstoffen, energie, chemie, p. 313

[16] *Techniek in Nederland in de Twintigste Eeuw*. Deel 2: Delfstoffen, Energie, Chemie., p. 313

his colleague C.W.G Hetterschij to found the Company Laboratory for Soil Research in 1927.[17] Frederick Taylor's *Principles of Scientific Management* was published in 1909 in the United States, outlining principles of efficient production such as simplification, standardisation and cooperation. His ideas took off in Europe as well. It's interesting to note here that Taylor also had a background in (mechanical) engineering. Other key words in the text outlining their goals and echoing Taylorism are "work- and time saving", "quick" and "cheap". Of equal significance is the idea that laboratories need to find ways to manage their own finances, if they're to make any meaningful progress. He takes a subtle jab at government in mentioning their failure to financially support it.[18]

Once that project was underway, he accepted a professorship of agricultural chemistry at Wageningen College (Hogeschool te Wageningen) in 1928, and stayed there for the remainder of his career, where he conducted research into plant diseases next to his teaching duties. Ever the researcher, even after his retirement in 1949, he built a new private laboratory and continued researching organic matter for agriculture. He was also a board member of the Dutch Agricultural Lime Agency Foundation (Stichting Nederlandsch Landbouw Kalk-Bureau), advisor to the Superphosphate Information Service Foundation (Stichting Voorlichtingsdienst Superfosfaat) and advisory board member of the Institute for Rational Sugar Production until shortly before his death.[19]

His motivation to reach out to a public outside of the laboratory never abated, and he produced at least three texts between 1929 and 1965 where he outlined his own thoughts on agriculture and its social profile. They indicate his desire to share his ideas with farmers, policy makers and anyone who was interested in a subject so fundamental to social survival and organisation as agriculture is. Baneke notes that engineers held a unique position when it came to discussions about science and society, and harboured feelings of social responsibility. He also states that at the turn of the century, they played a decisive role in the government's increasing

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[17] Joost Hudig, "Het Bedrijfslaboratorium Voor Grondonderzoek," *Chemisch Weekblad, Orgaan Van De Nederlandsche Chemische Vereeniging En Van De Vereeniging Van Den Nederlandsche Chemische Industrie* 25, no. 32 (August 11, 1928): 1, https://ugp.rug.nl/cw/article/view/33673/31068.

[18] "*Daar het laboratorium geëxploiteerd wordt door een vereeniging, gesticht door de landbouworganisaties, welke de belangen van den landbouw op de zand- en veengronden behartigt, en daar de regeering dit laboratorium niet geldelijk ondersteunt, is dit verplicht, om zichzelf uit de ontvangsten te bedruipen.*" Joost Hudig, "Het Bedrijfslaboratorium Voor Grondonderzoek", p. 501

[19] *Landbouwkundig tijdschrift; maandblad van het Nederlandsch Genootschap voor Landbouwwetenschap*, In Memoriam, jrg 79, 1967, no. 6, 1967, https://resolver.kb.nl/resolve?urn=MMUBWA04:016042006:pdf

involvement in questions of infrastructure, working conditions, spatial planning and many other areas.[20] They were progressively replacing members of the legal profession in key areas of public office, which is very telling about the direction which society was attempting to take in the nineteenth century. The legal profession was shaped by ideas, history, philosophy, the classics. Engineering was rooted in the present and practical, and it was finding its way into public policy and mindset. Its practitioners were ideally positioned between scientists and society.[21]

According to Paul White, during the first half of the nineteenth century, men of science "positioned themselves as critics, educators, and agents of improvement" (White, 2016, p. 156). Towards the middle of the nineteenth century, Dutch higher education institutions were following the German model, which, according to Bert Theunissen, stressed the importance of research.[22] Physics research was blossoming in the Netherlands at the time. As reflected by Dutch scientist Pieter Harting (1812-1885)[23], there was a strong tendency to want to map out future society on models used in physics. He saw the "scientific approach" as the standard to be followed in order to build an enlightened society. This scientific approach would lead to knowledge of reality, one that stemmed from empirical research and the impartial collection of facts. It's the well known model of induction leading to hypotheses, which if confirmed lead to theories and perhaps eventually laws - the laws in which nature's manifestations were firmly rooted. Harting's scientists enjoyed a privileged relationship to this wisdom, and were encouraged to have the ambition to share it with society, in order to enlighten its members. However, towards the end of the nineteenth century, "*The scientist does not, as a matter of vocation, campaign for social and political reform, or engage in moral or religious debate, unless perhaps to defend the very purity of science itself.*"[24] Hudig seems to either ignore or break that trend and revert to the approach of the educator and agent of

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[20] David Baneke, *Synthetisch Denken*, p. 76

[21] See also Paul White, *The Man of Science*, "The role of scientific expertise in government, manufacturing, and the military increased substantially over the course of the century. Yet positions in industrial chemistry, electricity, and so forth were often not regarded as truly scientific. Engineering, one of the new technical professions to emerge in the first part of the century, and one of the most celebrated in the literature on national progress, remained ambiguous in relation to science (Marsden and Smith 2005; Marsden 2013)."

[22] Theunissen, B. (2000). *Nut en nog eens nut: wetenschapsbeelden van Nederlandse natuuronderzoekers, 1800-1900.* Uitgeverij Verloren, pp. 57-70

[23] The word "scientist" lacks a great deal of specificity, but he studied and taught in so many areas that it's hard to find a word from today's vocabulary that encompasses what his fields were, ranging from medicine and plant biology, to physics and zoology, not to mention chemistry and what we would nowadays call pharmacology."Renaissance man" sounds comical, and polymath doesn't quite cover it.

[24] "There are important continuities between the man of science and the modern scientist, especially the heroic depiction of great discoverers or theorists, the public image of purity, and the more private sense of a vocation whose main motive is truth. In the late nineteenth century, however, this ethos began to be detached from the individual "man" and identified instead with a highly formalised and impersonal system of training, and relocated within new research institutions that defined themselves as havens from commercial and political interests.", P. White, p. 161.

improvement, as was common for engineers in the early twentieth century. He wasn't out to look for ways to unite field and lab methodologies; in his mind there was a clear hierarchy to all of this. He did however, strongly encourage cooperation between all parties concerned: scientists, farmers, industrials and government, attributing a role to each. A harmonious organisation and attribution of roles would, from his perspective, not only improve Dutch agriculture but would also rebuild world societies on more solid and peaceful ground.

2. Inside Joost Hudig's world view

There were many reasons for Hudig to be worried about harmony, living from the end of the nineteenth to the middle of the twentieth century. He was born not too long after the Franco-Prussian war of 1870-1871, which although it did not directly affect the Netherlands, might have been a reminder to be wary of their neighbours with the vast and seemingly eternally expanding empire. Then of course there was World War I which, again, left the Netherlands untouched but not financially unscathed. World War II broke out only a few decades later, a war which did profoundly affect the Netherlands; it would be safe to presume then that his own view on social matters were not unaffected by these events. He also desired a less "barbaric" society, and the role science would play in achieving this was, in his view, not a small one. It wasn't quite Harting's dream where Plato's philosopher would be replaced by the scientist and his positivist approach to knowledge; Hudig's view was far more practical, rooted in the present, more interested in results than in catering to the ambitions of lofty intellectual elites. Hudig was motivated to change the practice of science in society outside of the walls of universities.

This outlook reflects in three texts he authored at different points in his career, where he contemplates the importance of agricultural science, how it should be organised and the significance of the scientific method in doing this. The first text, *De Taak van de Landbouwscheidkunde in het Heden en in de Toekomst*, written while his career was well under way, aims to be a source of inspiration to colleagues and students by setting out what the task of the agricultural chemist is, a person so ultimately fundamental to the well-being of any society and essential in uniting science, field and government to this end. The underlying theme of *Bemesting door de Eeuwen Heen* (1955) is similar, although he puts the emphasis on soil preservation and does so by composing a brief review of agricultural history. His last known meditation on agricultural science, *Liebig's Oorspronkelijke Inzichten*, was written in 1965, where he seems to have more resolutely landed in the camp of scientific knowledge-making (more laboratory than field) and discarded any pretence of regard towards empirical methods.

2.1 De Taak van de Landbouwscheidkunde in het Heden en in de Toekomst (1929) - a bid for social progress

On the sixteenth of February 1929, Engineer Joost Hudig gave an acceptance speech for the position of professor of Agricultural Chemistry at the Agricultural College of Wageningen, one of the first higher education establishments in the Netherlands teaching Agriculture. The story of higher agricultural education in the Netherlands is a long and interesting one, Wageningen academy having only attained the status of college a few years prior to his nomination, and having moved on to gain the position of top academy not long after the Second World War.[25] Hudig was presumably aware of the shifting dynamics in this area of education and development, as well as the Netherlands' strengths in and long tradition of agriculture. Reflected in his speech is the need to set out an agenda for the long-term future of agriculture in the Netherlands, and in addressing his future students and colleagues, he broaches the topic of the role of the scientist in establishing a better society.

The agricultural chemist should become aware of what his true calling is as a scientist, and to shed light on what this calling is, Hudig outlines what he thinks agricultural chemistry is in the most abstract sense: a science in its own right, borrowing from and offering to the other more widely recognised sciences as well. Agricultural chemistry is not a subset of any other science such as microbiology or biology, instead it's a place where these, physics, chemistry and even economics meet. D. J. Maltha, writing almost fifty years later in 1976, also acknowledges this: "*Het is een algemeen erkend feit dat het landbouwkundig onderzoek gebruik moet maken van de resultaten van vele takken van wetenschap, niet alleen uit de groep natuurwetenschappen, maar ook uit de groep maatschappijwetenschappen*."[26] Agricultural research, in Hudig's view, is geared towards solving problems of a practical nature in instances where fundamental knowledge is yet incomplete; more essentially, the circumstances of agricultural research such as climate factors are not easy to control by humans and not uniform. It requires, therefore, an approach which although different than those of theoretical and experimental physics and chemistry, uses the knowledge offered to them by these

[25] Kooij, P. (2008). Het landbouwonderwijs in de twintigste eeuw. In M. G. J. Duijvendak, E. H. Karel, & P. Kooij (Eds.), *Groen onderwijs : terugblik en uitzicht naar aanleiding van het 100-jarig betsaan van de Vereniging voor Hoger Landbouw Onderwijs (1906-2006)* (pp. 9-42). (Historia agriculturae; No. 41).

[26] Maltha, D. J. (1976). *Honderd jaar landbouwkundig onderzoek in Nederland*, 1876-1976, p. 9. Pudoc. https://edepot.wur.nl/210148. Also, "Reeds hieruit blijkt dat het landbouwkundig onderzoek zeer complex van aard is en sterk verweven met talrijke andere takken van wetenschap. Tracht men 'het eigene' van dit onderzoek te beschrijven, dan komt men voor moeilijkheden te staan."

sciences. In Hudig's speech, at the outset, the unifying and all-encompassing status of agricultural chemistry is made clear - it's above and beyond partial sciences in their little respective bubbles, setting it presumably in a more socially relevant position. Hudig however anticipates the somewhat vague nature of this assertion and brings up the counter argument to this statement, namely, the question of how one is to determine what the correct points of contact between the sciences are, not to mention the question of finding a scientist who can embody these diverse fields of knowledge. As long as "science", his imagined opponents say, is doing its job, then something good will come out if it. There's nothing wrong with isolating the different sciences, he responds, as long as the compartmentalisation remains within the sphere of operation of agriculture. Put more clearly, as long as one uses "Agriculture" - the overarching activity - as a starting point, then the details of how the different sciences will work together and where they will meet is less relevant. He strongly wants to argue here, that people need to realise that agriculture is the foundation of our existence as humans. Once that realisation is reached, then people can see that the sciences work together in a dynamic flow. This is far removed from the idea of discovery that so often defines science in popular literature and in conversations. Discovery implies that the universe is built in a certain way, and that all we have to do is to uncover its underlying structure and components. In this speech, science, all the while safeguarding its seriousness, is an activity which participates in its own creation. Agricultural chemistry is unique in that it's tied to society in a way that other sciences are not; it does not benefit from being segregated from other sciences or from activities such as field work. This is relevant to the aforementioned lab-field hierarchy; even though Hudig doesn't argue for it himself, this association of different fields of sciences and field practices does require blurring of boundaries between both worlds.

Hudig therefore, is not as concerned with the practicalities of uniting these sciences as he is with advocating for a more rational approach to agricultural chemistry - inclusive of empirical, field-work methods, yet above all analytical: "*Er is derhalve alles aan gelegen, dat de landbouwscheikunde zich intensief gaat bemoeien met het meer rationeel aanwenden van de kunstmestzouten, de grondstoffen der productie.*"(p. 15). His justification for this rests on the stark contrast between a highly efficient fertiliser industry, and the much less efficient application of agricultural products in the field. Here we encounter the worlds of lab and field as wholly different. In *De Grond als Productie-Apparaat en de Middelen om zijn Waarde te Bepalen*[27], he depicts the

[27] Hudig, J. 1941. *De Grond Als Productie-Apparaat En De Middelen Om Zijn Waarde Te Bepalen*. s.n. 1941

world of the laboratory as a space where the laboratory worker can control all parameters, whereas the farmer is at the mercy of nature's whims:

> Hij moet zich dus aan deze klimaatsfactoren aanpassen en trachten zijn grond in den best mogelijken toestand te bewaren. In dat opzicht staat hij in technisch opzicht ver achter bij den industrieel, die zich onafhankelijk heeft gemaakt van uitwendige invloeden en die er op let de omstandigheden, waaronder zij apparatuur loopt, geheel te beheerschen. De plantenproducent heeft bovendien het nadeel, dat hij tamelijk gewelddadig in het natuurlijke proces moet ingrijpen.[28]

This part of his text is quite interesting since he touches upon something we today call biodiversity. He explains that what we do know is that soil and plant interactions are extremely complex and go far beyond the idea that soil contains nutrients that plants take up. He even speaks out against what we know today as monoculture, stating that this delicate soil and plant equilibrium is disturbed by the way farmers are expected to grow plants, that is, using monocultures and adding elements - fertilisers - to the soil according to the needs of that one plant. The "violence" therefore that the farmer commits by disrupting these natural balances is done in ignorance of what he is truly doing, rather blind to the system he is engaging with. This stands in stark contrast to the industrial who knows and controls all the parameters he is working with. Hudig sees the farmer in this sense, as being at a disadvantage; this says quite a deal about his view on science and the world. For Hudig, even though he was clearly a scientific actor in agricultural chemistry, and presumably not taken by any metaphysical ideas about agriculture, he didn't see science and agriculture as a top-down dynamic where laboratory results were justified in dictating farming practices. There was a give and take between laboratory and field. Rational thinking was a must, but it wouldn't lead to anything within the confines of the laboratory. Empirical methods were necessary, but not without the guidance of methodologies developed by scientific way of thinking, that is analytical thought, searching for causal links. Again we find echoed here this need for harmony and balance, this aversion to chaos that keeps on resurfacing in his writings. Industry represents, at the surface at least, this control and harmony. It is, however, far from enough, in a complex world such as ours. Industry does not share the same goals as farmers.

[28] Idem p.4

The industry's ambition is to sell as much fertiliser as possible, while there is no direct relation between increased quantities of fertiliser and increased production. Hudig asserts that soil is far too complex for such a linear approach, and more fertiliser can even prove detrimental to production. The agricultural chemist therefore, finds himself between a rock and a hard place, trying to help industry in the name of national interests and 'progress', all the while dealing with the soil and the people working with the soil who cannot, despite their best will, respond to industrial growth. It's up to the experimental stations to iron this situation out, by working out how to use fertilisers in a rational way; neither industry nor famers approach soil chemistry rationally. As previously mentioned, the industrial is out to produce and sell as much fertiliser as possible, without regard to the intricacies of chemical interactions in the soil. The farmer is making the best out of his circumstances using empirical methods which Hudig seems to have developed a distaste for. Empirical methods don't allow for structure, which is a prerequisite for progress. Neither the industrial nor the farmer keep in view the greater good of serving society, they need to cater to their own more immediate interests to survive. Rational thinking, in Hudig's view, offers the analytical tools necessary for both parties to reach an equilibrium which would serve society as a whole, beyond their respective interests. It's a form of thinking which carries with it an aura of disengagement, impartiality, necessary to re-balance partial interests in an otherwise turbulent society.

So what would this more rational approach to agriculture imply? Apparently up to his day and age, or so he claims, the soil was seen as a sort of "container" for nutrients, and the view of the soil as a production machine was strongly reminiscent of the mechanistic mindset. Research that he and his colleagues pursued seemed to prove that soil-plant interaction worked otherwise: "*Door deze ondervinding, waarvan men de omvang nog zeer onvoldoende doorziet, is de bodem niet meer het magazijn, dat voedsel opbergt en weergeeft, maar hij is een individuele factor geworden, een regulateur, een apart orgaan van den plantengroei.*" (p. 17) On more than one occasion in his speech he likens the task of the agricultural researcher to that of a doctor and makes medical analogies.[29] Klaas van Berkel states that "*De herleving van de Nederlandse natuurwetenschap heeft dus veel te danken gehad aan de 'vernatuurwetenschappelijking' en het streven naar maatschappelijke stijging van de medisch doctoren in de jaren veertig en vijftig van de negentiende*

[29] This reappears in *De Grond als Productie-Apparaat* as well, (p.8): "Even zoo goed als de medische wetenschap er in geslaagd is de hygiënische basis der maatschappij aanzienlijk te verbeteren, zal de landbouwwetenschap dit voor de plantenproductie moeten doen."

eeuw."[30] Hudig seems to have inherited some measure of belief in this parallelism between how nature and the human body work - it's not enough to understand the separate components, one must grasp the inner workings of the system as well. Much like the human body, optimal plant growth is likened to ideal human health, and understanding plant growth requires analytical knowledge of how the different components function in interaction with each other. Agriculturists, then, are faced with the question not of how much fertiliser goes into the soil or gets leached, but how different types of soil carry these nutrients to plants, and solving this problem requires a more qualitative and analytical approach than simple metrics.

There is, of course, no royal road to success; it is always beset with certain dangers that the assiduous agricultural chemist should avoid. Set out is a list of scientific methods (although he seems to describe them as if they were behaviours or habits) that rely too much on a mental re-shaping of agriculture, and would need grounding in field work if any desirable results are to be produced: "het eindelooze geschrijf pro- en contra", the deductive method, haphazard observations and a multitude of opinions to name a few. Agricultural science is not entirely amenable to the more deductive methods of scientific work. Too much "science" slows things down, stands in the way of real-world progress. For Hudig it's not possible to know "enough" before going out into the field: "*En zoo zal men tastenderwijze moeten voortschrijden, langs overwegingen en het controleerende experiment*". For every scientific consideration there is an experiment that should be designed ("gestadige afwisseling van experiment en hypothese"). The advantage of stepping into the world of field work without too much theoretical baggage is, according to the author, an uncovering of new experiences and observations.

In his writings, Hudig follows a structure whereby lengthy socio-philosophical discourse is abruptly followed by an enumeration of experiments and events proving his point. It is then after having set out some initial ideas about the task of the agricultural chemist, that Hudig starts expounding the methodical yet sometimes awkward description of better procedures for performing agricultural chemistry, where he outlines what he sees as the future of agricultural chemistry. This future is strongly determined by the direction the fertiliser industry is going in, that is, a more divided one. Fertiliser companies are specialised each in their own type of fertiliser (potassium, phosphor or nitrogen), and doing their own research and development to improve their

[30] K. van Berkel, *Citaten uit het boek der natuur*, p. 160

product. For the author, this will result in a specialisation of agricultural science; and this is where his speech comes full circle. After all, why would science necessarily have to follow the industrial lead? Not just for funding, of course. He argues that the Netherlands needs greater agricultural independence - a very sensible argument to make in the wake of the First World War. The Netherlands had been importing far too much fertiliser, not only for the metropolis, but for its profitable sugar cane industry in Indonesia. How much more profitable it could be, and how much more security it could guarantee if only it could be agriculturally independent, especially in a free market economy where industry was expected to strive for high quality products at low cost:

> Wanneer het onheil ons zou overkomen, dat het buitenland de grenzen sloot, of den invoer ging belemmeren, om de eigen productie op hoog peil te brengen, moet in Nederland een organisatie van deskundigen klaar staan, die de techniek volkomen beheerscht en die in staat is om de productie door intensievere werkmethoden billijker te maken, teneinde verder gelegen markten te zoeken of aan de belemmering weerstand te bieden.[31]

Hudig's brand of agricultural chemistry is first and foremost anchored in social progress. His vision reflects the task many scientists before and after him had set themselves: promoting a specific variety of forward thinking social progress. In Hudig's case this would include a cooperation of different fields of science across the board - economics included - and the hard labour of people working out in the field. Unfortunately the scope of this speech does not allow for further clarification on questions pertaining to the value of letting industry lead the way for scientific research (which he never explicitly states but strongly implies). It's hard to tell whether he took free market economies for granted in their alleged capacity as society's benefactors, or whether even wondering about that was a luxury due to the urgency of setting up Dutch agricultural independence: "*Ja, ik meen, dat de tijd om van de 'beteekenis' in abstracten zin van onze wetenschap te spreken voorbij is, en dat veeleer de landbouwscheikunde een taak is opgelegd, een plicht ten opzichte van de samenleving.*" (p.25)

This speech was written in 1929. Only two years prior had he founded together with colleagues, and become director of, the Company Laboratory for Soil Research (Bedrijfslaboratorium voor Grondonderzoek), which in all probability would be an ideal setting for

[31] Hudig, J. 1929. *De Taak van de Landbouwscheikunde in het Heden en in de Toekomst*. Jaarboek Van De Landbouwhoogeschool Te Wageningen, 11. Wageningen, p. 25

combining laboratory and field work with the larger goal of restructuring agriculture altogether. Similar themes arise in Bemesting door de Eeuwen Heen, except that here the urgency seems to lie more in the field of preserving soil fertility; which will, of course, be achieved with good scientific practices, order, rationality and a free peasantry according to is author.

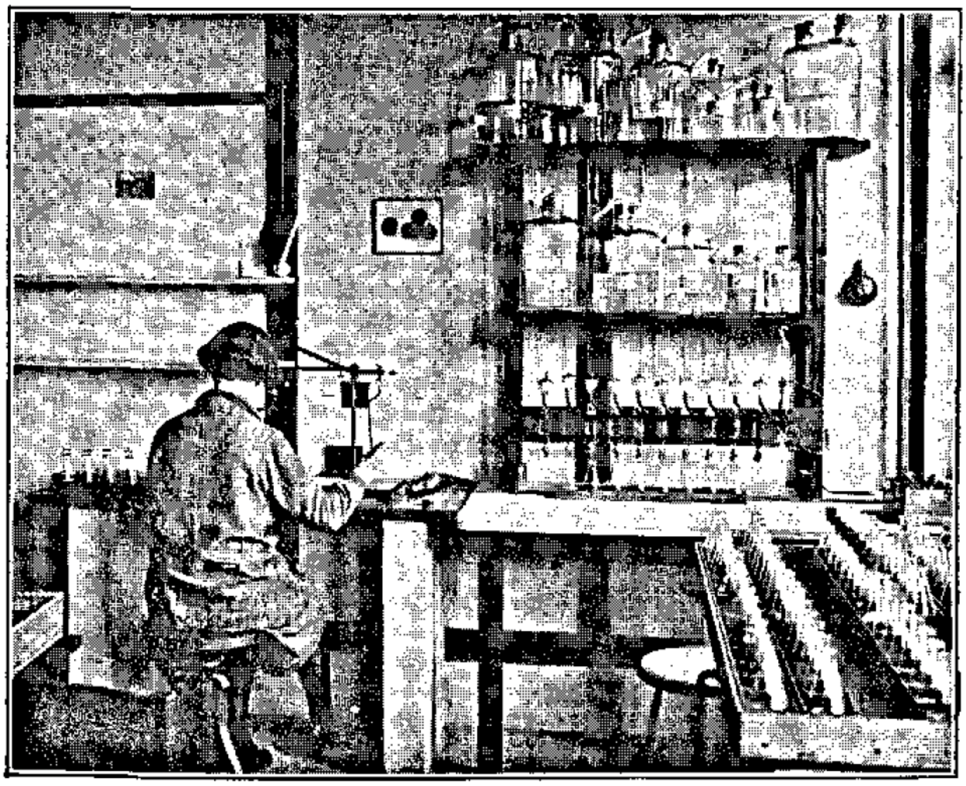

Fig. 8. Filtreer- en Meetlaboratorium.

Image Taken from *"Het Bedrijfslaboratorium voor Grondonderzoek"* by J. Hudig and C.W.G. Hetterschij

2.2 Bemesting door de Eeuwen Heen (1955)[32]

Kunstmest strooien met de hand op een van de proefvelden van de voorlichtingsdienst voor superfosfaat.

From *Bemesting door de Eeuwen Heen*, "*Kunstmest strooien met de hand op een van de proefvelden van de voorlichtingsdienst voor superfosfaat*"

In this concise (barely 50 pages) pamphlet, Hudig is trying to bring attention to the issue of preserving soil fertility. Again on a background of promoting rational, scientific enterprise, with the occasional nod to experience, he writes out his version of the history of mankind's relationship to agriculture. In this story, so much war, strife and displacement over the millennia resulted as the consequence of people living on infertile lands, needing to move to where the grass was quite

[32] Hudig, J, and Stichting Voorlichtingsdienst voor Superfosfaat (Wageningen). 1955. *Bemesting door de Eeuwen Heen*. Wageningen: Stichting Voorlichtingsdienst voor Superfosfaat.

literally greener. Through this it's his intention to show that optimal agricultural practices can lead to a peaceful society.

He's writing this for the farmer of his day and age who's trying to get the most out of the soil; for countries with a population surplus as well as for countries with plenty of land where people live off of overexploitation. Towards the end of his pamphlet, he uses the word "harmony", to emphasise the significance of harmonious agricultural practices, and although he doesn't state it explicitly, it seems to move in parallel with social harmony. Harmony implies order in how agriculture is practised, and balance between the different methodologies - laboratory research, field work and with concern for the long-term.

Chapter one quickly brushes over ancient history, and briefly recounts the story of how ancient civilisations grew and flourished along river banks rich in muddy deposits. It was too soon to understand fertilisers which appeared "much later", yet when they did appear (a point in time the author is not very clear on), they brought with them the idea of circularity (kringloop). Circularity manifests under an immaterial guise in his text, not just in the form of organic matter in the soil. There's the "fathers and sons" dynamic, where one generation should ensure that their means of producing food should be one that does not deprive the next generation of fertile soils. The eighteenth century saw a rise in productivity because marl had been discovered as an ideal fertiliser, and the "humus theory" (organic fertilising) had been set aside. The success, however, was only short-lived. His point is that this chapter in the history of agriculture "*demonstreert, dat een tijdelijk voordeel de mensen verblindt. Het doorwerken bij zo'n tijdelijk succes, zonder kennis van oorzaken, is uiterst gevaarlijk. Toen sprak men van 'rijke vaders en arme zonen'.*"(p.32) Again he's stressing the importance of building the foundations for durable agricultural practices, through analytical reasoning.

These foundations are primarily scientific, as his use of the term 'scientific' seems to imply. He doesn't lean heavily on the hypothetic-deductive model which had already been established as the quintessential scientific method, and his only support of empiricism appears to be in the methods of laboratory work such as that carried out by Justus von Liebig, who is generally accepted as one of the grandfathers of agricultural chemistry.[33] His words for empiricism come across as rather harsh: "*Het was de Duits arts Albrecht Thaer die op zijn eigen bedrijf ervaring had opgedaan en begreep, dat de landbouw uit het gebied van de ervaringssleur moest opgeheven worden. Zijn beroemd geworden boek 'De Grondslagen van de Rationele Landbouw' bracht een omwenteling in het denken over de grondproductie.*" (p. 29). His only explicit reference to the scientific method is in his use of the word "rational", which comes up quite often in any of his more philosophical texts. 'Rational', or as historians of science would refer to as 'rationalised'[34] farming is crucial to any sensible agricultural policies. It's dependent on laboratory work as well as on scientists working at the helm. It's above all farming practices that go far beyond the trial and error methods that people were content to struggle with for millennia. The scientific practice of agriculture is, therefore, not 'rational' in its most common acceptance of following deductive, logical thought processes. The rational thought processes Hudig is referring to are interwoven into a much larger circular framework of what might be characterised as 'advanced common sense', a blend of logical thought and intuition, corroborated or invalidated by experience and observation. He remains faithful to the idea of dynamic cooperation between the different areas of agriculture, yet seeks to advance the cause with a new, unifying intellectual approach to the whole enterprise.

This is where his social analysis comes into the picture. How did farmers manage for so many centuries? Not as well as they could have if only they had had more 'insight' (another term left for the reader's best judgement to interpret). Using the example of Egyptian civilisation, he outlines the idea that they had the sludge along the Nile to thank for their successful agriculture, and by extension their prosperity. There's an assumption that there was nothing by ways of intelligent intervention on the part of the Egyptian people to thank for their well-being. Romans and Etruscans were using farm manure, which led to their great civilisation and as a consequence to hungry barbarian hordes invading them: "*(...) daardoor werd alle redelijke kans op een ordelijke samenleving voor eeuwen verstoord. Van landbouw hoort men tijdens die catastrofe niets meer. Het moet in Europa een vreselijke tijd geweest zijn.*" (p. 17) Another concept that goes hand in hand

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[33] D.J. Maltha notes that "Algemeen wordt aangenomen dat de doorbraak kwam bij Liebig (Liebig, 1846 en 1855), die als eerste (scheikundige) onderzoeker het landbouwkundige experiment zou hebben ingevoerd. Maar men moet toch deze stelling met enige voorzichtigheid hanteren: een scherpe cesuur is niet aan te geven. Vóór Liebig had reeds J. B. Boussingault in Bechelbronn (Elzas) in 1834 een soort landbouwproefstation gesticht." For our purposes however, we shall retain Liebig as the first serious experimenter in agriculture since Hudig refers to him in his texts.

[34] "Rational" is defined as "based on clear thought and reason", by the Cambridge dictionary. Its connotation in the world of science points however, to logical thinking as opposed to metaphysical. "Rationalised" however is broader in scope, used outside the world of science and logic and indicates a more efficient way of doing something.

with rationality for Hudig is order. In this sense he doesn't have many kind words for the Middle Ages either: "V*oor de landbouw is rust en orde noodzakelijk, maar er was in de vroege Middeleeuwen nog een factor, die de productiviteit van de grond mede beïnvloedde: dat is het volslagen gebrek aan inzicht in de plantengroei.*" (p.17). Exception made for Charlemagne, who put order into the agriculture of his day and age thanks to ruling with an iron fist, and thus becoming one of the greatest rulers in European history (in Hudig's view). It's worth noting that Hudig was thirty four years old when World War I broke out and sixty at World War II. It might not be too absurd to suppose that those two periods greatly influenced his outlook on society and agriculture, even though he makes very little mention of them in his texts, and even then, not explicitly. Leitmotifs such as harmony, circularity, peace and order most likely echo concerns linked to senseless violence and warfare. "Social order hinges on the food problem" he seems to be saying.

Another term that resurfaces quite often in this text and remains a problem even today is overexploitation ("roofbouw"). This would be the counterpoint to the idea of circularity mentioned earlier. How Hudig reconstructs history to prove his point that agricultural policies would do well to look for circular structures rather than indiscriminately exploit free land as, for example, was done in the United States, is probably much less rigorous and methodical than the work he carried out in the laboratory. However, the problems he sets forth did bear out long after he had written his speech and up to today. In his 1965 text, he puts an even stronger emphasis on how the science that would improve agriculture should be implemented, and it was to be led by the logic of the laboratory.

If one were to speculate on the reasons why the laboratory assumed greater credibility than field work, there could possibly be elements that tend to appeal to human societies at certain times in their history, such as that which is timeless, placeless ergo eternal and ubiquitous, to respond to any needs cultures may express for those qualities. Fields are "messy", they're highly variable, difficult to control, transient, a place where any human, scientist or other, is confronted with a situation where their work and existence seem inconsequential. In *Bemesting door de Eeuwen Heen*, the reader notices Hudig's call for an orderly society, and in his 1929 speech his invitation to keep agricultural science above all rational. His efforts to unite laboratory and field work also echoed this requirement to keep the laboratory at the helm. His ideal society was more of a lab than a field, not in that it produced knowledge, but in that goods were distributed rationally, and where nature was under control.

As Kohler also mentions, labs were run by qualified people, generating a sense of trust. For Hudig again these were the scientists, who were trustworthy because they could establish causal relations. Once the causal relations in agricultural chemistry were established, it would be possible to control outcomes and ensure a more stable future. If left to the farmers with their trial and error methods, who knows what would be next? Improved plant production would be a matter left to chance, and no rational, advanced and above all peace-loving society would leave things to chance. Bert Theunissen's farmers didn't see themselves at all as leaving things to chance. Although they were not particularly concerned with establishing causal relationships between milk production and cow breeding, they relied on observation and experience, which qualified scientists still do today, out in the field - and it does yield results. The farmer's trial and error approach lacked the kind of "view form nowhere" structure aimed for in laboratories, yet that could be appreciated as an advantage, since, relying on their own judgement, they never pretended to remove the human element from the work.

This is where one of the greater cruxes of the issue presents: next to the lab and field there was also the socio-economic dynamic. Dutch farmers would learn very different lessons than, say, French or American farmers would. Soils are different, climate is different, available technologies and traditions vary from region to region, regardless of national boundaries. An Alsatian farmer would have more to learn from a German farmer a few kilometres away than from a fellow countryman in Bretagne. Time scales could also differ. Farmers working on a certain type of soil and climate for many generations would know more about it than farmers who had only arrived fairly recently. Field work carried a great deal of culture and history with it, whereas laboratory worked aimed to establish something more eternal. The twentieth century was one where national economic borders were slowly opening. Technology allowed for greater movement of products, while two world wars created an impetus for countries to establish a greater presence in international trade. This was a scenario that resonated well with the placeless, timeless ambitions of laboratory work. Farmers needed to standardise their products and augment their production level if they were to be a part of this - sink or swim. There was no time for showing interest in local phenomena or adhering to regional cultures. How much corn is being produced across the Atlantic and why can't we keep up? Hudig was very well aware of this and quite keen on making sure that Dutch agriculture was up to par. In this sense, all due respect to farmers, but for Hudig they had to follow the scientific lead if the Netherlands was to hold its own in such an unstable world. The laboratory was a real response to a very real national need; and if government policies were going to support this then it was of the essence to follow suit.

Kohler mentions that *"the boundary between lab and field cannot be demarcated by a line, as political boundaries are drawn; rather, it is a zone of mixed practices and ambiguous identities (as are also boundaries between disciplines)"* .[35] In the case of Hudig's era, and location (time and place, history is better suited for field work apparently), the demarcation had to, at least according to him, be clearly drawn. There's a sense of urgency in his writing that betrays a need for order, a need arising from the chaos of an agricultural crisis and two world wars. In *Bemesting* he goes so far as to project that necessity to the past, recreating the history of humanity as a tale where people would only wage war because of unscientific agricultural practices. The past is reconstructed as a cautionary tale for future generations who would be so foolish as to organise agriculture, and hence the foundation of human civilisation, in a non-rationalist way.

2.3 Liebig's oorspronkelijke inzichten bevestigd. De phosphaatbemesting de basis voor het vruchtbaarheidsonderhoud van de grond. (1965)

This text was written after a long career in teaching and research. Speaking on behalf of agricultural chemists, Hudig asserts that the current state of soil treatment and plant nutrition is too strongly based on empirical knowledge. The entire text is again one long plea for the scientific method, a method based on analysing a long series of events, interlinked in a complex three-dimensional dynamic, in order to discover causal chains which would allow an improved manipulation of objects and phenomena. In this vision of 'real' science, the trial and error method of practitioners doesn't even scratch the surface, let alone say anything about the 'how' of soil chemistry. The saviour of agricultural chemistry in this story, is the development of knowledge about how phosphate works for plant growth - as he calls it later in his text, the "skeletvormer" (skeleton former) of plants. The properly scientific development of this knowledge allowed

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[35] Kohler, R. E. (2002). *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology*, p. 18

agricultural chemistry to escape the empirical rut it was stuck in. It would thus be necessary to share this knowledge with 'developed' farmers (as opposed to those who were set in their ways).

A sizeable chunk of his text consists in lengthy and detailed descriptions of experiments in trial fields, aiming to prove his point that analysis is imperative to understanding the chemistry behind agriculture. He mentions vitalism only in passing (page 5, "vitaliteitstheorie"), but it's a significant point in that it seems to stand in contrast with what he considers to be proper science. It's worth taking a moment to briefly examine what these vitalist ideas were, since they do pop up in the history of the life sciences quite often and appear in many a debate from antiquity to nowadays.

The history of vitalism goes back to Aristotle, but for our purposes we shall focus on natural scientists somewhat closer in time to Joost Hudig. Bechtel and Williamson define vitalism as holding

> (...) that living organisms are fundamentally different from non-living entities because they contain some non-physical element or are governed by different principles than are inanimate things. In its simplest form, vitalism holds that living entities contain some fluid, or a distinctive 'spirit'. In more sophisticated forms, the vital spirit becomes a substance infusing bodies and giving life to them; or vitalism becomes the view that there is a distinctive organization among living things.[36]

A vocal supporter of vitalism was the German biologist Hans Driesch (1867-1941), largely cast aside by the scientific community for his metaphysical views. Driesch, presents vitalism as being the more scientific approach:

> The relation between pure nature-philosophy and its attendant Vitalism, is about the same as between Plato and Aristotle. With Plato the link between idea and reality was wanting, and for us, therefore, he does not come into consideration; Aristotle established the connection, and thus becomes important biologically, and this in the direction of Vitalism.[37]

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[36] Bechtel, W., Richardson, R.(1998). Vitalism. In The Routledge Encyclopedia of Philosophy. Taylor and Francis. Retrieved 2 May. 2023, from https://www.rep.routledge.com/articles/thematic/vitalism/v-1. doi:10.4324/9780415249126-Q109-1

[37] Driesch, Hans, and C. K. Ogden. *The History & Theory of Vitalism*. Rev. and in Part rewritten for the English ed. by the author. London: Macmillan and Co., limited, n.d. https://www.biodiversitylibrary.org/item/165575.

Not that he supports every manifestation of the idea; Driesch was careful to validate his arguments by dispraising thinkers such as Lorenz Oken (1779-1851)[38] whose views he disparages as being "wild nonsense", or Johann Christian Reil (1759-1813)[39] whose idea of irritability seemed interesting but simple. He criticises a number of authors for not adopting the correct approach to vitalism. Authors Driesch prefers liken the *vis vitalis* to an immaterial force, much like those described by physicists (ergo, another reason to accept its validity. After all, why is the idea of gravity acceptable and the vital force seen as magic?).

At its core, vitalism postulates that that which distinguishes the living from the non-living is a force which non-living entities do not possess, and which itself is not visible, but is perceptible through its manifestations. "Life" as we intuitively know it cannot be reduced to a series of chemical reactions: "Materialism can explain only details, *but never their relation to the whole*"[40] (emphasis by Hans Driesch). Vitalists over the millennia have argued over what the "life force" is and how it manifests, and as we approach the twentieth century, its explanatory model runs in parallel with those harboured by physics and chemistry. Both vitalist and anti-vitalist camps seem to try to earn validity by drawing some kind of comparison to thinking processes proper to physics and chemistry, both sciences having already long established their legitimacy. Driesch avowedly quotes Johannes Mueller in drawing this parallel to the advantage of vitalism: "*The relation of soul and organism can in general be compared with the creation of every physical force of a general nature to the matter in which it is manifested as, for instance, light and the body in which it appears. The enigma is the same in both cases*."[41]

Driesch might not be vitalism's most brilliant representative, but his text sets the stage for highlighting Hudig's own standpoint, which is much closer (although certainly not entirely on par with) the mechanistic approach. Hudig invokes past giants of chemistry such as Saussure[42] and

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38 German natural philosopher, a "Romantic" opposed to the mechanistic x of newtonian natural philosophy. He believed in a plan of creation and holism. Mullen, P. C. (1977). The Romantic as Scientist: Lorenz Oken.

39 German physician, famous for having coined the term "psychiatry", believer in the "vital force" driving living beings to survive.

40 Idem, p. 110

41 Driesch did not add any reference to this quote. I included it to reflect Driesch's standpoint, not Mueller's.

42 Nicolas Théodore de Saussure (1767-1845), Swiss chemist.

Davy[43], who had postulated the importance of "components" (bestanddelen) such as ash (which we now know contain carbon, magnesium, phosphorus, calcium and potassium) for the development of plant life. Justus von Liebig, ever the hero, designed the experiments to prove their importance. Hudig argues that the science of plant production was brought to life thanks to chemistry.[44] He also indulges in some level of hyperbole when stating that an "endless series of new discoveries" were brought about by chemistry, rendering the legitimacy of agricultural chemistry indisputable. Hudig's chemistry is a product of lab and field work, but nowhere does he allude to any "forces" nor does he seek (at least in his writings) ultimate causes or reasons for how nature works. The results that chemistry has to offer speak for themselves, there's no need for some teleological justification.

Garland E. Allen describes quite clearly the kind of practices which Hudig considered to be properly scientific: "*In the early twentieth century Philosophical Mechanism became the foundation of a 'new biology' that sought to establish the life sciences on the same solid and rigorous foundation as the physical sciences, including a strong emphasis on experimentation*."[45] This mechanistic model was also the underpinning of chemistry, and so much of what Hudig stood for in his work, especially in his later years. Its no-nonsense, hands-on nature was better suited to the goal-oriented work of the Rijkslandbouwproefstations or the Bedrijfslaboratorium voor Grondonderzoek.

Famers as described by Theunissen felt subject to the laws of nature as they saw them, somewhat mysterious and beyond control, whereas scientists adhered to a more optimistic standpoint. Complicated it was, impossible not. It was all about the method for Hudig and those who shared his views: lab, field, analysis, experiment, trials, assessments, input, output, all moving around in dynamic cooperation to find out more about how the soil worked. Hudig does not express concern in these texts about whether we can know everything about agriculture, but we can certainly learn enough to progress and improve. He didn't seem enchanted by vitalist ideas or nature's mysteries. The farmer saw himself as a man who was practical in his field using knowledge he'd accumulated over years and inherited from previous generations. The scientist and

[43] Humphry Davy (1778-1829), British chemist.

[44] "Ik moest U een oogenblik terugvoeren, naar die jeugdjaren der landbouwscheikunde om duidelijk te maken hoe de wetenschap, die zich bezighoudt met de plantenproductie werkelijk door de scheikunde is ter wereld gebracht. En was het wonder, dat toen de scheikunde een eindelooze reeks van nieuwe ontdekkingen aan het licht bracht en de industrie langs zuiver chemischen weg met toenemend succes, het plantenvoedsel „de kunstmest" in het groot ging aanmaken, dat in zoo'n tijd niemand aan de rechtmatigheid van den naam landbouwscheikunde kon twijfelen?", p. 7

[45] Allen G.E. Mechanism, vitalism and organicism in late nineteenth and twentieth-century biology: the importance of historical context. *Stud Hist Philos Biol Biomed Sci.* 2005 Jun;36(2):261-83. doi: 10.1016/j.shpsc.2005.03.003. PMID: 19260192.

Theunissen′s farmers both saw themselves as the ones whose knowledge was of greater validity and use; which is surprising since their goals were very similar at the baseline.

When it came to improving the quality of their cattle as they saw it, farmers were open to technological developments; possibly crop farmers moved along the same lines. Dairy farmers were happy to apply new technologies developed for control and prevention of disease as well as major improvements in breeding techniques. Crop farmers were also receptive to new types of fertilisers despite the potential risks involved. Some scientists and veterinarians would in their turn show respect and understanding for the farmers' dilemmas and conclusions. More than once was it the case that scientists would, after much experimentation and deliberation, come to a conclusion that farmers had already known for ages, conferring to the farmer an aura of "I told you so". Hudig did understand the importance of field work, and always included it in his descriptions of improved agricultural performance; it's just that his convictions in how to attain this resided within a scope which was less immediate in its practical preoccupation, and wider in its political and economic views. The day-to-day of someone working in the laboratory was on a different space and timescale than that of someone working in the field. Much like the laboratory itself, it maintained a quality of detached practicality, a long-term view that moved forward. The farmer's practicality was grounded and anchored in slower, smaller and more repetitive loops. Is it really possible to conclude that either of them were right?

This brings us back to his phosphate question, one essential to agricultural chemistry as it is one of the major plant nutrients in soil. Hudig argues that farmers were taking for granted that it was the quantity of phosphate that was important to plants, whereas in fact what was essential was resolving the problem of its solubility - a problem that was entirely within the remit of laboratory workers. A farmer's empirical "hit and miss" approach would say nothing about the mechanisms of nutrient uptake, and to Hudig it was these mechanisms which held the key knowledge that could be useful. Field work certainly was important in its own right. It came in as a tool to prove or disprove hypotheses, possibly make new discoveries, uncover new mechanisms; it was, however, never a starting point. He also mentions that field experiments should be carried out by "qualified personnel"- never quite spelling out who this qualified personnel is. Whatever farmers did manage to uncover was validated by the progress of biochemistry.[46] In chapter two, Hudig even goes so far in his attempt to confer a scientific veneer to agricultural chemistry, as to throw in the idea of quantum mechanics, briefly stating that knowledge of it would be required for the reader to fully understand the biochemical structure of plants; and then leaves it at that.[47] Towards the end of his article, in the closing remarks, he argues that plant growth tends to be considered by other scientists as a "purely materialistic" (by which one might suppose he means "mechanistic") phenomenon (p. 62), and then in a few short lines briefly refers to ideas such as "genes", "mutations", "carbon bonds", "cosmic radiation" and the ionosphere without any clear connection with anything else he wrote, except to mention how puzzling and wonderful it all is. It comes across as a renewed attempt to distance himself from the vitalist camp which tends to give the dismal impression that certain mysteries of nature will forever remain as such.

Conclusion

As Hudig's career progressed over the decades, his views seemed to anchor more deeply into the mechanistic-scientific camp, one at the service of industry. Less lenience would be shown towards other players in the field, such as anyone involved in the actual, empirical practice of agriculture. His line of reasoning is one that alternates between speaking to the scientist in one paragraph, and to the general public in the next, and where the enumeration of ostensively scientific names and methods replaces a more profound analysis that might have been used to defend the scientific method in its substance. Hudig does give the impression of wanting to reach as wide a public as possible. But how did this reflect in the reality of what was going on during his years at the Bedrijfslaboratorium or at the University? Which institutions were responsible for implementing agricultural policies and how did they go about it? What was the fate of the "field practitioners", otherwise known as the farmers? These questions are very broad in their scope, but having looked at the stance of a person who was so deeply involved in the scientific aspect of agricultural development in the Netherlands, it would be interesting to explore some of these points a bit further. A more focused approach would be to take a look at other actors in the field and how they

[46] P. 21 *Liebig's Oorspronkelijke Inzichten* , "Dank zij de snelle vorderingen der biochemie, kan veel van de vroegere inzichten verklaard worden en tegelijk de weg aangewezen worden, welke van de vroegere inzichten, door empirie verkregen, men aan kan houden en welke men verlaten moet."

[47] *Liebig's Oorspronkelijke Inzichten* p. 21, "In deze verhandeling is het niet mogelijk de biochemische opbouw van de plant te beschrijven; omdat men voor het begrijpen daarvan over een behoorlijke kennis van de organische chemie dient te beschikken. Maar ook van de physica, omdat men dan met de quanten-mechanica te maken krijgt, die de energie-overgangen beheerst, welke bij de „autogene" reacties de leiding hebben. Voorwaar geen geringe eis. Daarom is het nodig in dit hoofdstuk duidelijk te maken in welk opzicht de bemestingskundige van de nieuwe biochemische kennis kan profiteren. Daartoe zij een poging gewaagd."

contributed to shaping the evolution of Dutch agriculture. They were the actual farmers which Hudig only mentions in passing, the people working in the Rijkslandbouwproefstations as well as, importantly, the educators - the "wandelleraren" who did the work of outreach to those working in the fields excluded form the laboratory.

Een groep jongemannen uit Roden en omgeving die een cursus landbouwkunde volgen bij meester Riemersma, met boven en v.l.n.r. Piet Venema en Albert Gleisteen uit Leutingewolde, Leo Scholten, Sip van der Heide uit Foxwolde, niet bekend en Piet Ipema uit Lieveren, 2e rij: Egbert Polling uit Lieveren, Geert Vogelzang, Paulus van Wijk van de Peizermade, Jacob Liewes uit Roderwolde en Geert Ipema uit Lieveren, voor meester Riemersma en Jan Luinge van de Peizermade. 1932. Courtesy of the Drents Archief.

3. How these ideas evolved in the real world: State Agricultural Experiment Stations and Agricultural Education.

For the most part, the nineteenth century was a peaceful and prosperous time for Dutch agriculture. Farms were small, large-scale farms were not yet the norm. Markets were mostly local, as was the knowledge. Knowledge was passed down from father to son and was neither globally shared nor systematic. Farmers were left to conduct business following their own best judgement and an implicit liberal policy arose from the absence of government intervention, a situation both the government and the farmers seemed to be quite satisfied with. Business was good! The European population was growing, restrictions on imports were being lifted and prices for agricultural products were rising.[48] Dutch farmers of course benefited from these circumstances as exports rose. Technological advances in transport such as improvement in design of steam ships and trains also helped the market grow, initially. Soon enough though, European markets were being flooded with imports, negatively affecting prices. The Agricultural Crisis of 1875 was in large part due to these technological developments which the European agricultural market was not prepared for. Not only were grain prices plummeting but, according to Bieleman, European dietary habits were shifting to other food sources, causing grain prices to remain low. A change in agricultural model was urgently needed, and farmers were struggling to face this challenge on their own. Whether either party - government or farmers - liked it or not, some level of government intervention was necessary. If anything, the fact that both parties were hesitant to abandon the liberal approach did contribute to minimal government intervention, which in the long-term helped rebuild Dutch agriculture. As a side note, this is something Hudig pleads for in *Bemesting* as well - the freedom of farmers to organise their business as they saw fit. The focus of chapter three will be how the Dutch government dealt with the agricultural crisis and how this changed the landscape for Dutch agriculture. Chiefs matters will be the State Agricultural Experiment Stations and agricultural education, which both had a significant impact on Dutch agriculture and covered two main concerns of Hudig, that of the further development of scientific methods to improve agriculture, and of making the results of the research available to people working in agriculture.

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[48] Bieleman, J. (2010). *Five centuries of farming : a short history of Dutch agriculture 1500-2000*. (Mansholt publication series; No. vol. 8). Wageningen Academic Publishers. https://edepot.wur.nl/138557

3.1 Government intervention and the context for setting up the State Agricultural Experiment Stations.

Prins Hendrik verlaat het Westfries Museum aan de Rode Steen. Hij verrichte de officiële opening van het Rijkslandbouwproefstation aan het Keern, 1901. Courtesy of Westfries Archief.

State support for agriculture was not entirely new. Harm Zwarts mentions the 1799 Cattle Fund (Veefonds), which was followed in 1805 by the Agricultural Fund (Landbouwfonds) "*which financed, among other things, the publication of agricultural statistics and the provincial 'Committees for agriculture' (Commissies van Landbouw). The members of these provincial committees, mostly large landowners, were to advise the government on agricultural progress in their provinces.*"[49] Shortly thereafter, the government of the United Kingdom of the Netherlands made attempts at promoting agricultural education in the form of chairs in agricultural economy (landhuishoudkunde)[50], with some level of scientific content thanks to courses such as chemistry, natural history and physics; to little avail - the public response was minimal as was the government's

[49] Zwarts, H. (2021). *Knowledge, networks, and niches: Dutch agricultural innovation in an international perspective, c. 1880-1970.* [internal PhD, WU, Wageningen University]. Wageningen University. https://doi.org/10.18174/517286, p. 64

[50] "Agricultural economy" is my own translation, with in mind the original meaning of the word economy as "the laws which rule the home" rather than today's definition pertaining to finances. In my view this is the most accurate translation.

enthusiasm for such enterprises. In Science Cultivating Practice, Harro Maat points out that the agricultural societies demanding this specific reform in the middle of the nineteenth century were comprised mostly of larger landowners. Small farmers only played a marginal role in these pressure groups, and didn't necessarily share the same interests as their richer counterparts.[51] These societies however, did try to convince government that agricultural education, along with reliable statistics and experiment stations (which Germany, France, Belgium, Denmark and Britain already had quite a few of), were necessary for progress in agriculture. Despite its relatively comfortable position, the Netherlands were lagging behind other European countries in the development of their agrarian sector. These agricultural societies would organise *Landhuishoudkundig Congres*, annual meetings where they would share information and discuss issues pertaining to Dutch agriculture.[52] The first meeting took place in 1846 where the idea was suggested that existing university laboratories should analyse agricultural inputs (soils, fertilisers, seed, dairy products). This was no small matter since in the mid-eighteen hundreds, over forty percent of the Dutch labour force was active in the agricultural sector.[53] Such an initiative could potentially have a great impact on the Dutch economy.

Government intervention was deemed necessary since first of all, it was unlikely that most famers would be able to afford chemical analyses of their soils. As for agricultural education, only few of the small farmers could even afford to send their sons to agricultural schools, nor did farmers see the interest in formal education - theoretical and disconnected from their own experience. Private enterprise in agricultural education met a similar fate in its early days, after sporadic attempts to set up schools. Early attempts to raise Dutch agricultural science to the level of their German and British neighbours floundered, and it took the Agricultural Crisis to set things into motion. In the wake of the crisis, many farmers did start to plead for more protective measures.[54] A compromise between protectionist and liberal measures was reached by investing more in innovations such as fraud and quality control, education and research - thereby lending a helping hand without directly intervening in pricing and production. Schools were partially subsidised by

[51] Harro Maat, *Science Cultivating Practice* p.34: "Nevertheless, the Dutch government was not entirely indifferent to the situation in the countryside and a shared interest of the government and the societies was, for example, the disintegration of commons (marken) in the eastern provinces. Especially the landowners wanted to transform their share in the marken into marketable real estate and improve the productivity of the land. Smaller farmers and tenants were opposed to this division because for them the commons formed a considerable source of income."

[52] Harro Maat, p. 46

[53] Zwarts, H. (2021). *Knowledge, networks, and niches* p. 70

[54] Idem, p. 47

the central government, while regional governments were expected to foot most of the bill. It was important that experiment stations be attached to education (which was within the purview of the government), since primacy was given to the "objective" nature of research. Despite the liberal economic climate in the Netherlands, research was not meant to serve the interests of private enterprise. It was also taken for granted that farmers and private initiative would be incapable of bringing the scientific element into agriculture on their own, they didn't have the background. In fact, few people did; it was difficult to find people qualified to teach or do research in agriculture in the Netherlands. The first director of the State Agricultural Station was Adolf Mayer (1843-1942), from Germany.

This is, in broad strokes, the context within which the State Agricultural Experiment Stations arose. Other European countries were leading the game. Dutch farming was very localised rather than centralised, meaning that it would take time and impressive organisational skills to create a more or less unified agricultural industry. This centralisation had to occur without too much government intervention - just enough to get the ball rolling. Private enterprise was expected to adhere to national rather than just purely self-serving interests, even in a world where the economy was going through major transitions. Putting all of this together was a tall order, and one that eventually came with its own series of complications. This was new to the Netherlands, and the only road map they had was the German model, which couldn't serve as a exact blueprint since the government organisation, the demographics and the soil were different to those in the Netherlands. The necessity to bring more science into agriculture - and in passing hopefully unify the system, as Hudig would have undoubtedly wanted - became obvious. Even farmers weren't loudly protesting against it. Also as Hudig would have wished, the scientific approach to agriculture would not only build bridges between agriculture, government and the private sector, it would eventually allow the Netherlands to stand its own ground in international commerce. The word "scientific" could be replaced with the word "rational" as those two were seen as being synonymous; rational, controllable, un-empirical. These ideals did prevail to a certain extent and the setting up of experiment stations was one of its most prominent manifestations.

Bert Theunissen mentions how the three different cultures of politics, science and farming come together and how these formed what was to become Dutch dairy industry, with the protagonists being the farmers and the scientists. It's worth taking a closer look at how Theunissen analyses the dynamics between these groups since they are not those that one might expect, and since they illustrate much about how the scientific landscape was evolving in the early twentieth century. Chapter four of *De Koe* expands on the divergence between the dairy farmer's approach to dairy farming and the scientist's. In the camp of dairy farmers and cattle breeders, working with cattle was more of a vocation, even an art form ("kunst", p. 62). Not that economic gain wasn't a concern, of course it was. There was, however, a strong element of pride involved. The cow had to live up to certain aesthetic standards, and that implied a great deal more than just being pleasing to the eye. Beauty went hand in hand with value. It was an outward sign of internal quality. A breeder or dairy farmer's prestige was at stake and a fine cow or bull was testimony to his good judgement and insight. Two words that could be used to describe a dairy farmer's long term vision were "stability" and "continuity". Breeding cows geared to produce increasing quantities of milk didn't fit into that approach. Traditional wisdom favoured a median, "let's not get ahead of ourselves" process for optimal dairy farming. Cows that were bred purely with the goal of producing more and more milk would become weak they predicted, also endangering the business in the long term. A healthy, beautiful cow, rather than an optimised milk machine, was a guarantor of stability and continuity for the dairy business. As it turns out, they hit the mark with surprising accuracy on that point.

Kampioenmelkkoe uit Zutendaal, 1932. *"Tot ver na WO II blijft de koe in de eerste plaats belangrijk voor haar melk. goede melkkoeien worden in de bloemetjes gezet, zoals Witkop die op 8 maanden 5000 liter melk heeft gegeven".* Courtesy of Centrum Agrarische Geschiedenis

It would be overly simplistic to portray this story as one where the 'good' farmer was struggling to hold his own against big "farma", that is, scientists and government who were desperately trying to convince the single-minded farmer to squeeze more milk out of his cow for the sake of greater productivity. There was some overlap between the two opposing parties. The opposition however intensified after the second world war, when governments were seeking to apply more liberal economic policies, and many scientists were trying to promote them. All this talk of beautiful cows came across as nonsense to many - but not all - scientists. How did farmers establish that a beautiful exterior revealed anything? Unimpressed by the "fokkersmystiek" as one veterinarian disparagingly called it (p. 62), they tried convincing farmers to take a more rational approach. It's interesting to note here that famers saw themselves as very practical, down-to-earth people; even their cows were expected to look 'austere' (soberheid) and 'robust'. That was, however, not the same as being rational. The word 'reductionist' wasn't being widely used at the time among farmers as far as can be established, but that *is* a term we might use nowadays to describe what farmers perceived as being an ineffective way to approach dairy farming; you couldn't assess cattle just by measuring and weighing. Ultimately, they were right.

One of the approaches some scientists used to work out bovine internal mechanisms, was trying to figure out which hereditary laws ruled them. The initial assumption was that hereditary laws would confer a rational foundation to knowledge-making in milk production; it led nowhere in the end, not to mention that genetically 'improved' cows were more expensive to maintain, rendering the economic argument moot. Artificial insemination turned out to be a more successful endeavour, one farmers appreciated for its practicality. Not only did it make the business of breeding cattle easier, it also helped to keep bovine sexually transmitted diseases under control. Dairy farmers weren't dead set against science; they were quite open to it when it promised tangible results. Other attempts such as breeding cows to produce milk with a higher fat content rather than more milk, or breeding cows to be more milk than meat productive were not crowned with success. You would start breeding with a bull whose lineage seemed excellent, sell him or his seed for astronomical amounts of money, only to see the force of his lineage peter out or be replaced by the next best bull.

Another interesting situation to point out here is how the all-important lineage disappeared from the picture altogether, only to be replaced by "breeds". Breeds themselves were not an officially established thing before commercial interests came into the picture.[55] The idea was put together by an inspector of the Dutch Cattle Syndicate (Nederlands Rundvee Syndicaat), Iman van den Bosch, in 1906. One breed was designated as being more "dairy typical" (melktypisch), one more "meat typical" (vleestypisch) and one in between. I'm assuming that farmers moved from the lineage model to the breed model when production and trade became more impersonal and extensive. With a growing and more competitive market, as well as with stronger farmers' cooperatives, the logistics of having to keep up with cattle lineage would have made things so much more complicated. According to Theunissen, van den Bosch's aim was to offer breeders guidelines for types of cows to produce that would be recognisable by the foreign market. After the wheat crisis of 1880, the Dutch government began implementing policies to stimulate agriculture. The goal was making agriculture more independent and reliable in the long-term. This tendency was catalysed by the Second World War. If the farmers weren't embracing this with great zeal, it's that their idea of good farming was built upon the idea of responsible breeding, and they did not take lightly to being accused of "sportfokkerij" by certain scientists (there were also those who understood and empathised the farmer's viewpoint to a much greater extent). They also saw "super production" as going against their economic interests. They were up against the challenge of breeding cattle that were physically resilient to diseases such as bovine tuberculosis, and that meant making some compromise on their capacities to produce milk.

It seems to me that for both government and science, a mechanistic, control-oriented approach was the obvious system to implement - seeming obvious in that even though it's never explicitly mentioned, it's how policies were carried out. That's why the scientists were called in, it's also why nationwide attempts were made to bring education to farming (or farmers' sons to educational institutions). Farmers on their own side had been organising themselves into cooperatives, meaning that they also desired some level of control and organisation of their trade. So indeed, the dairy farming landscape was being formed by cooperations and collisions between three different cultures. Scientists and government were working closely, and the desire of scientists to push for greater milk production was linked to government policy; however, government didn't express any explicit concern about rational farming as scientists did. Also, it's not that farmers refused to produce more milk, but they realised that cattle were not perfectible in quite the same ways that machines are.

[55] Actually, I couldn't find any indication in the text about how the studbooks (stamboeken) were kept; the author mentions cattle "race" but lineage seems to be just as important.

3.2 The Rijkslandbouwproefstation

Het internaat- De Rijkslandbouwschool met proefstation- De boerderij der Rijkslandbouwschool, 1890. Courtesy of Gelders Archief.

As mentioned earlier, education and experiment went hand in hand: the first Rijkslandbouwproefstation emerged from the Rijkslandbouwschool in Wageningen. Before we get there however, we should bring Justus von Liebig back into the picture since he's considered to be one of the forefathers of agricultural experiments; he brought chemistry proper into agriculture and more importantly, what we now know as the scientific method:

> According to von Liebig a proper experiment required a theory that provided insight in the conditions under which a hypothesis could be rejected or accepted. Until then, the main approach to agricultural experimentation was if a changed variable resulted in a better performance or higher yield. Von Liebig rejected such experiments and argued that true experimentation was based on a theory of the cycles of chemical substances, a theory he had published in 1840. One of the implications of von Leibig′s theory was that experimentation

> was not just a matter of trying out some innovation like a new fertiliser in the field, but analysing the chemical compound and active substances in a laboratory and experimental fields near the laboratory.[56]

This is a clear explanation of the ideal Hudig subscribed to. What Hudig and his collaborators wanted to bring into agriculture was a theoretical framework, allowing not just for a control of multiple factors, but also deeper understanding into the mechanisms of plant and environment interaction. Their insight was that this would catalyse agricultural knowledge, in a world where so many socio-economic variables were gaining momentum.

Agricultural education and experiment needed to build on each other. Especially since the main matter of contention amongst farmers and government officials was that the educational aspect of agriculture was too theoretical - what were farmers supposed to do with knowledge of natural history and chemistry? Experimentation would hopefully bridge that gap. Wealthy landowners in the Netherlands already had some fields of their own dedicated to testing, but they were also working on a trial and error model - not solid enough to catapult Dutch agriculture into a fast-paced twentieth century. When discussing field work, D. J. Maltha distinguishes two types.[57] The first one starts out with comparing existing situations in the soil or in society for example, within certain time frames and geographical locations, and tries to gain insight into what factors influence their evolution. The other type consists in creating certain circumstances where parameters can be modified and the outcomes compared. This is how the "proefvelden" (experimental fields) worked.[58]

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[56] Harro Maat, p. 32

[57] Maltha, pp. 18 - 20

[58] Maltha, p. 20

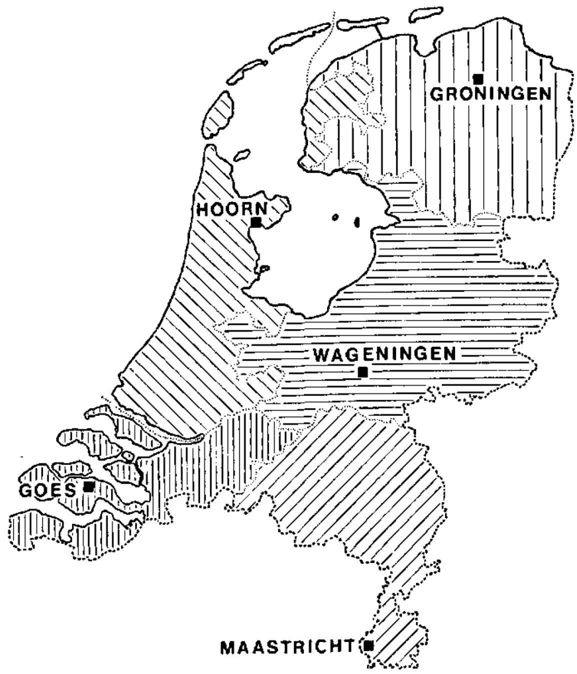
Afb. 6. *Een proefveld (1926), waar de fatale werking van zwavelzure ammoniak op een tamelijk kalkarme grond wordt aangetoond en de herstellende werking van chilisalpeter. De twee open vierkante veldjes ontvingen bij normale bemesting de stikstof in de vorm van zwavelzure ammoniak. Het fors opgroeiende gewas kreeg dezelfde hoeveelheid stikstof in de vorm van chilisalpeter. (Zie blz. 36).*

From *Bemesting door de Eeuwen Heen.*

The first official Experiment Station was built in Wageningen in 1877.[59] It was associated to the State Agricultural school (Rijkslandbouwschool) and was meant to be a space where students could gain practical training in doing experimental research, to the benefit of the farming community. It would analyse samples of seed, feed, fertiliser, soil and dairy products, all the while acquiring more knowledge about the dynamics of soil and plant chemistry. It was however, understaffed, leaving the door open for companies producing fertilisers to sell their products without undergoing quality control. More experiment stations were necessary and the coming decades saw their growth, expansion and more importantly transformation. Having one centrally located experiment station, in approximately the middle of the Netherlands (Wageningen), was too centralised and insufficient. In 1886 the Agricultural Commission (*Landbouwcommissie*) advised the Ministry of Water Management, Commerce and Industry (*Waterstaat, Handel en Nijverheid)* to open three more stations in Groningen (North), Hoorn (Northwest) and Breda (Southeast - which eventually moved to Goes, in the Southwest). This led to the Regulation for State Agricultural Experiment Stations (Reglement voor Rijkslandbouwproefstations) of 1889 which paved the way for the building of

[59] According to Maltha, the first unofficial experimental garden (proeftuin) was built in Deventer in 1860, on private initiative.

these stations, each with its own jurisdiction and set of tasks, since every region had its own particular agricultural settings and needs.



Figuur 1. Ressorten der Rijkslandbouwproefstations omstreeks het begin van deze eeuw.

1. RLPS Wageningen: Gelderland, Overijssel en Utrecht.

2. RLPS Groningen: Groningen, Drente en het oostelijk deel van Friesland.

3. RLPS Hoorn: Noord-Holland, Zuid-Holland (behalve Goeree en Overflakkee) en het westelijk deel van Friesland.

4. RLPS Maastricht: Limburg en het oostelijk deel van Noord-Brabant.

5. RLPS Goes: Zeeland, het westelijk deel van Noord-Brabant, en de eilanden Goeree en Overflakkee.

From Karl Harmsen, *Het Instituut voor Bodemvruchtbaarheid 1890-1990*

They were tasked with auditing and research duties, according to the Royal Decree (Koninklijk Besluit) of 1892[60]:

[60] Harmsen, K., 1990. *Het Instituut voor Bodemvruchtbaarheid 1890-1990.* Uitgegeven door het Instituut voor Bodemvruchtbaarheid, Haren, p.15

a) The investigation of land and soil for the benefit of agriculture water types, fertilisers, nutrients, seeds and all other agricultural raw materials and products, on request of the Government or of particular persons and institutions;

b) Carrying out cultivation or fertilisation tests on the by the Government or by special persons and institutions test fields made available;

c) The institution of scientific investigations of more general nature, concerning agriculture.

The departments were assigned as indicated in the following table.[61]

I. MESTSTOFFEN

1. Onderzoek op stikstof.
2. Onderzoek op fosforzuur.
3. Onderzoek op kali.

II. VOEDERMIDDELEN

1. Bepaling van eiwitachtige stoffen.
2. Bepaling van vet.
3. Bepaling van minerale bestanddelen.
4. Bepaling van ruwe celstof.
5. Vochtbepaling.
6. Bepaling van de zuiverheid.

III. ONDERZOEK VAN SUIKERBIETEN

1. Suikergehalte.

IV. ONDERZOEK VAN MELK

1. Bepaling van droge stof.
2. Bepaling van vet.
3. Bepaling van het soortelijk gewicht.

[61] Harmsen, K., 1990. *Het Instituut voor Bodemvruchtbaarheid 1890-1990.* Uitgegeven door het Instituut voor Bodemvruchtbaarheid, Haren., p.13

V. ONDERZOEK VAN BOTER

1. Bepaling van het verzadigingsgehalte van de vluchtige vetzuren.

ZADEN

Zuiverheid.

Kiemkracht

In the January 1893 *Nederlandse Staatscourant*, a list of requirements was set out determining what needed to be researched.[62]

It's interesting to notice that most research is geared towards determining (bepaling) the content of agricultural products, except for fertiliser. Fertiliser was expected to be researched ("onderzoek op"). This seems to imply that there was already sufficient knowledge in all fields of agriculture under examination except for fertilisers. It could suggest that this was a direct reflection of the idea, only a few decades old at the time, that there was still much to be researched about how nitrogen, phosphorus and potassium interacted with plants. If this was the case then it might be safe to assume that the plea for a scientific approach to agriculture was already finding its place in government policy.

Most of the work, however, ended up being largely taken up by auditing duties. How or why this was the case is not made explicit. Up to then, if companies producing fertilisers needed samples analysed they would send them to Germany or Belgium.[63] There was an increase in the use of artificial fertilisers as of the 1870s so an increasing number of farmers required quality control of the products they were putting in their soil. If government support for research was indeed minimal, then auditing work was most likely the only source of income for the experiment stations. Hoorn and Groningen, where Hudig was working, were the two stations where most of the experimental work was being done, while Wageningen, Maastricht en Goes continued auditing. It was nevertheless decided that it would be best to split the experiment stations into ones that did the

[62] Idem

[63] Zwarts, H. (2021). *Knowledge, networks, and niches* p. 77

auditing and ones that focused on experimentation only. This led to another Royal Decree in 1907 stating that every experiment station should be divided into auditing and experimental divisions with a director heading each. The scientific research department would conduct culture and fertilisation trials, feed trials, plant physiology trials, bacteriological research, and research in dairy products. The Auditing department would chemically analyse fertilisers, feed nutrients, sowing seeds and also dairy products. Parallel to that the auditing division would also develop methods for chemical, botanical and microscopic research.[64]

Hudig worked for the experiment station in Groningen, which as mentioned earlier was geared toward research and whose geographical scope covered Eastern Friesland, Drenthe and Groningen. An important part of the research there was done on the influence of soil and fertiliser on the chemical composition of crops which was to a large extent related to what Hudig was working on.[65] Hudig's work on grey speck disease in oats contributed to the chemical analysis approach of soil and plant interaction, giving credibility to the idea that causal analysis of plant diseases was worth the investment in research. By 1915, another Royal Decree designated Groningen as a centre responsible for carrying out research and conducting experiments in the fields of arable farming and grazing. The experimental station Groningen became an establishment dedicated to studying the soil. According to chemist P. Bruin who worked at the experiment stations, "*Eigenlijk was het Rijkslandbouwproefstation te Groningen door zijn geografische ligging reeds in 1890 voorbeschikt deze taak toebedeeld te krijgen. Immers de in de provincie Groningen gelegen inpolderingen van wisselende ouderdom, het veenkoloniale gebied, de daartussen gelegen overgangsgronden, de heideontginningen en de esgronden nodigden de onderzoekers als het ware uit zich aan de studie van de vruchtbaarheid van deze gronden te wijden.*"[66] It made sense to organise research centres according to local specificities, and Groningen enjoyed a diversity in soil types. In 1916, D.J. Hissink became director of the Groningen experiment station and soil research intensified. A year later Hudig was promoted to director of the division for sand and peat soil cultures, but as we saw, it

[64] K. Harmsen p. 16

[65] K. Harmsen (1990),p. 27. Titles of the articles published in the Reports on Agricultural Research at the State Agricultural experiment Stations (*Verslagen van Landbouwkundige Onderzoekingen der Rijkslandbouwproefstations (VLOR)*) with the collaboration of J. Hudig. V. (1909) Onderzoek naar de oorzaken van de vruchtbaarheidsafname van enkele gronden in de Groningse en Drentse, X (1911) Het drainageproefveld te Uithuizermeeden in de jaren 1900-1910, door J. Hudig en H. Welt., XII (1912) Het ontstaan van schadelijke afwijkingen in humusrijke zandgronden als gevolg van bemesting met minerale stoffen, door J. Hudig., XII (1912) Het stikstofgehalte van regenwater, door J. Hudig., XV (1914) Over het optreden van de zogenaamde 'Veenkoloniale Haverziekte' op zand- en kleigronden, door J. Hudig., XVI (1915) Over de oogstvermeerderende invloed van mangaanverbindingen, door J. Hudig en C.Meijer.

[66] K. Harmsen (1990), p. 30, citing Drs. P. Bruin - no indication of source!

took barely two years before he had had enough of the slow and rigid public sector work environment and was looking for better career perspectives in the private sector.

Rijks landbouw proefstation Groningen, 1904. Courtesy of Beeldbank Groningen

The public - private sector dynamic in the Netherlands is an interesting one. Mentioned at the beginning of this chapter is the notion that never entirely abandoning a liberal approach to matters concerning agriculture eventually helped Dutch agriculture in the long term. The Dutch government did impose some protectionist measures during the Great Depression, but less than other European countries. According to Harm Zwarts, it opted to continue to support the intensification of knowledge of Dutch Agriculture "as a solution to falling prices and increasing international competition".[67] It was a long-term solution that carried on through the World War II and has continued since by all appearances. It wasn't all plain sailing, but it seems that public policy did support the survival of agriculture and its unification with other sectors of society, not to mention international trade.

So how *did* the State Agricultural Experiment Stations contribute to the overall landscape of Dutch agriculture at the dawn of the twentieth century? It could be argued that their origins were to be found in an economic issue, as a quasi-liberal solution to the problem of keeping Dutch

[67] Harm Zwarts, p. 84.

agriculture in step with rapid industrialisation. Government did not wish to be burdened with the gargantuan task of rebuilding or saving the agricultural sector, yet private initiative did not have the gift of cooperation required for bringing so many sparse elements of one sector together. Experiment stations were initially designed to improve farming itself, on a wide scale, thanks to both the analytical and 'neutral' - maybe better defined as intersubjective - nature of its work methods and objectives. They went further than that nonetheless, by bringing together public and private interests, farmers and scientists. In this sense they contributed, albeit modestly, to a more solid and unified national structure - something Hudig had expressed a great wish for. In doing this they also created the foundation for work, research work, that would ensure greater continuity in agricultural development in the long run, also something that was high up on Hudig's agenda. Of course there were intellectuals and government officials bemoaning the lack of practicality in bringing science to farming, they were proved wrong, just as they were proved wrong in doubting the importance of bringing education to agriculture, as will be discussed in the next chapter.

3.3 Agricultural Education. - Landbouwonderwijs

Harmonie : tuin : herdenking van het 25-jarig bestaan van de Rijkslandbouw winterschool : groepsfoto, 18/10/1918. Courtesy of Beeldbank Groningen.

Setting up an agricultural school is of course no simple affair, there's much to consider by way of logistics, results and… culture. In the great debates between parliament ministers in the mid-19th century in the Netherlands over agricultural education, one bone of contention was the question of whether agricultural colleges should be built in cities. This was not, as one might imagine, a financial or logistical issue. The matter at hand was the 'corruption' of the young farmer's spirit in the decadent megalopolis. The divide between city dwellers and country folk is far from new, and takes on interesting incarnations in each era. It was such an important distinction in the mid-19th century, that it became fodder for arguments about how to organise agricultural education. Who was it being organised for and to what end were two of the big questions at hand, once it had been agreed upon that it would indeed contribute to improving Dutch agriculture. That in itself was a thorny issue that required quite a bit of lobbying from the agricultural societies at the time, who were not necessarily representative of smaller farmers. Harm Zwarts points out that although these agricultural societies were pressing the Dutch government to stimulate scientific agriculture, "*a majority of the Dutch parliament, dominated by liberal politicians adhering to limited state intervention, had little faith in scientific agriculture.*"[68] Initially, the investment in scientific agriculture and education was regarded as too costly and unnecessary. No Chamber of Agriculture was set up as in the neighbouring countries. Up until the agricultural crisis of 1875, it was considered that the Dutch farmer was doing just fine. He enjoyed a certain 'salt of the earth' quality which did not sit well with the ideal of the learned man, in a 'proper' university, with its theory-laden education and laboratories. The farmer was a practical, hands-on person; there was no insight as to how he could or should be burdened with all sorts of theoretical knowledge. At most, a son of a wealthy landowner could be destined for this sort of education, inasmuch as he had to deal with the odd and occasional practical matter - most likely not enough to get much dirt under his fingernails. In reality however, small farmers were having a hard time keeping up with with the increase in inputs such as fertilisers and seed. These inputs required knowledge that wasn't covered by the traditional, empirical knowledge they had been accustomed to acquiring. The Dutch government lacked the tools to test and control these new inputs as well. It took some time before these realities were translated into applicable policies.

[68] H. Zwarts, *Knowledge, Networks and Niches* p. 73.

Landarbeiders op de Vrouwenpolder, 1930. Courtesy of Beeldbank Zeeland.

It was in the early 1800s that debates arose about whether a higher educational institute was necessary, idea set forth by the Vereniging voor Hoger Landbouwonderwijs in Groningen. Wageningen was seen as too practice-oriented, and it would take an institute more focused on science - research, theory - to unify the somewhat scattered Dutch agricultural landscape, a 'higher' institute. A few words to introduce Petrus van Hoek whom we mentioned earlier, would be appropriate at this point, seeing as he was also a figure whose activities traverse the worlds of farming, science and policy making.[69] Most notably, he was Director General of Agriculture as of 1910, but his roots were in farming as he was raised on and worked in a farm. He made his way through the agricultural education system of the time and became a popular and influential teacher and agricultural consultant (landbouwconsulent) at the Noord-Brabantsche Maatschappij van Landbouw. He taught farmers about the better use of seed and fertiliser, rational animal feeding and dairy farming, farming cooperations as well as breeding and control unions. Farmers appreciated being addressed by someone who understood their work. In his function of inspector of agricultural education in 's Gravenhage, together with H.J. Lovink he reorganised the State Agricultural school

[69] https://resources.huygens.knaw.nl/bwn1880-2000/lemmata/bwn3/hoekp

(Rijkslandbouwschool) in Wageningen and the State Veterinary school in Utrecht. As Director General of Agriculture, he drafted many laws on agriculture and was involved in the reorganisation of the State Agricultural Experiment Stations as well as the Agricultural Information Service. He even found time to write a book on chemistry in 1897.

The words 'systematsich' and 'stelselmatig' pop up in his book *Hooger Landbouwonderwijs* when referring to what the aforementioned private initiative from Groningen had in mind. Middle (middelbaar) school was not a bad idea, but it was not enough to keep up with what they said was the demand from big landowners and famers. City inhabitants would leave Wageningen school with nothing that could be of use to them - farming was not something one just took up out of interest, it was the birthright of famers' sons. A higher institution, it was thought, could break down some of these barriers. It would be public, financed by the state, accessible to anyone. It also took quite some arguing to convince a government that was dragging its feet, not really understanding what the fuss was all about when Wageningen was doing just fine. Why would agricultural education need to be elevated to a science? It's difficult to assess the point to which the Dutch government was aware of Germany's advantage in agricultural education and research, or whether they just considered that the Netherlands had its own particular needs which did not require anything out of the ordinary. Groningen however, was much more preoccupied with keeping up with the neighbours, probably stemming more from a belief in the potential to elevate Dutch agriculture than from competitiveness. Whatever the initial motivation, there was at least some consensus as to the need for organising agricultural education, and rooting that organisation in a way of thinking proper to the sciences.

We could go all the way back to Albrecht Thaer (1752-1828), a German agronomist, if we want to trace the roots of "scientific thinking" in agriculture. He's touted as the one who brought science to agronomy, and proposed to introduce agriculture into the educational system. His name is bound to show up in any study on European agriculture of the eighteenth and nineteenth centuries; Van Hoek writes about him, but Thaer, like Liebig, is referenced extensively in texts on the history of European agriculture. For Thaer, an agricultural academy would ideally be built on a large piece of land, as he describes in *Einleitung zur Kenntnis der englischen Landwirtschaft (1798-1804)*, which is something he brought to life on a farm of his own which he turned into an experimental station. Thaer, originally trained as a doctor and inclined to rational thinking and to favouring the scientific method, seems to have had the intuition that even though agriculture could develop more systematically with the help of science, field work would be equally important.[70] His farm in Celle, Germany would become the first institution for agricultural education in Germany in 1802. He did have a lot of literature to go on as farming had already been an object of study in Germany and elsewhere, but it didn't satisfy his desire to make something available to famers to guide them on the road to more efficient farming. Agricultural education wasn't new, in the 18th century there were a number of agricultural chairs in Germany; however, these studies led to work in managing large estates, and the courses were taught by lawyers and philosophers. From a twenty-first century perspective, it's as if the only thing missing from late eighteenth- early nineteenth century agricultural studies was the actual agriculture.

It begs the question of the social status of farmers and if that had any influence on how farming itself was managed. Were they seen as little more than serfs? Lowly manual labour naturally incapable of managing the same land and animals they had been working on for millennia? This reflects later on in how the educational system was slowly built up in the Netherlands. Baneke points out that "*In de loop van de negentiende eeuw hadden ze [de universiteiten] zich gevestigd als hoeders van de wetenschap, verantwoordelijk voor het opleiden van de Nederlandse elite.*"[71] Famers were earth-bound, whereas scientists were working in higher spheres of intellectual labour, largely disconnected from mundane, practical matters. Sorting out who belonged where, as well as how scientific or not agriculture was, kept Dutch government officials and professors busy for quite a few decades. Importantly, it changed peoples' perspectives on what 'real' science and 'real' learning were, partly by bringing agricultural science a bit closer to its telluric origins, and in a rather original way at that.

The Royal Decree of the fifteenth of August 1815 declared that theology students were to follow courses in agricultural economics (landhuishoudkunde) if they were to complete their doctoral studies and become members of the Reformed Church.[72] The idea behind this was that

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[70] Hoek, P. van, *Hooger Landbouwonderwijs*, pp. 1-2

[71] David Baneke, *Synthetisch Denken*, p. 76.

[72] "Tot het doctoraal examen in de theologie werd, volgens artikel 83, onder 3°, gevorderd het bewijs, dat men onder meer de lessen der algemeene gronden van landhuishoudkunde met vrucht had bijgewoond, terwijl volgens artikel 116 niemand bij het hervormd kerkgenootschap tot den predikdienst als predikant toegelaten zou worden, wanneer hij, naast het bezit van den graad van candidaat in de letteren en dien in de theologie, onder meer niet het bewijs kon overleggen van met vrucht gedurende twee jaren de lessen in landhuishoudkunde te hebben bijgewoond.", Hoek, P. van,*Hooger landbouwonderwijs*, p. 37.

since preachers were in touch with the people of the land they could pass the knowledge and maybe even the desire to learn to them. The selling point to the theology students was that it made sense to acquire deeper knowledge of God's creation, not just people but the land and its fruit as well. This was not an unmitigated success. Chairs in agricultural economics were created in the universities of Utrecht, Groningen and Leiden, but the theology students didn't display much enthusiasm for such a secular course. Somehow professors ended up not attracting enough students (did theology students decide to go study elsewhere?), and therefore not ensuring enough income.[73] In 1838 the Minister of Interior Hendrik Merkus baron de Kock proposed to offer professors a stipend, as long as non-students were allowed to follow the courses as well - a more successful move since more people did start to follow the courses.[74] Another fortunate tactic was giving the courses during the winter months when farmers had plenty of free time on their hands. For professor H.C. van Hall of Groningen University, this looked like a good opportunity to start up an independent school for agricultural economics - in Groningen, of course. Location is important because not a small amount of debate would develop around where the schools should be established and why; cities so they can be close to "proper" universities and research facilities, or in the countryside where students could practice on land? Thought or practice? Those two suffered a difficult relationship in the nineteenth century, and had few people like Hudig arguing that they weren't mutually exclusive. Of course there was no discussion in the early days of agricultural education of starting out with an agricultural university outright. Even if there had been a consensus - which there most certainly wasn't - there were too few qualified people to teach. Van Hall proposed a "hogeschool" which would be linked to the university of Groningen, even held ambitions to raise it to an institutional level with promotional rights, the time was not ripe however and internal politics laid those dreams to rest.

From the 1820s to the 1860s, different attempts were made by the Dutch government to include vocational training into universities, but the most decisive move changing the circumstances for agricultural education came in 1863 with Thorbecke's Law on Middle Education (*Wet op Middelbaar Onderwijs).* It's worth sharing a few words on Thorbecke's background for context. At the time of the Law on Middle Education, Johan Rudolph Thorbecke (1789 - 1872) was prime minister of the Netherlands. After completing his studies in humanities in Leiden, he spent four years working as a *privatdozent* in Germany where he was influenced, according to Bastiaan

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[73] At the time, professors were still being paid directly by the students enrolled in their class.

[74] Kooij, P. (2008). *Het landbouwonderwijs in de twintigste eeuw*, p. 11.

Willink, by Humboldtian educational ideals. Wilhelm von Humboldt (1767-1835), was the "architect of the new German higher education" where "scientific research was free from thoughts relating to practical application."[75] Although some authors assert that Thorbecke carried this into his educational policies,[76] the actual text of the law on middle education seems to attest to a more grounded approach.

It was an interesting time to be uniting both idealist and practical goals into government policy. Thorbecke made a name for himself by leading a commission set up to review the Dutch Constitution, in the wake of the European uprisings of 1848 aimed at stripping European monarchies of their power. It was King Willem II himself that appointed Thorbecke to preside over the committee, in order to protect his own position as monarch. Thorbecke belonged to the liberal wing of government, which in the nineteenth century meant pro-parliamentary and pro-industry rather than monarchical and conservative. He appointed another consummate liberal - and professor of physics - P.L. Rijke to write out the new law for middle education.[77] Aerts points out that lower and higher education at the time were very fragmented, and that there were few institutions offering middle education. This new law introduced "middle education" which, as the name might suggest was neither entirely focused on cultivating practical skills, nor fully theoretical. Thorbecke however, had no wish to create a "middle layer" just for the sake of filling in some vague, educational gap.[78] Debates had already been going on for a while among professors on what sort of education belonged in universities. Baneke indicates that in the case of Delft university and Wageningen, it was considered that their intellectual climates would not be suitable for the academic formation of students, due to the lack of an arts faculty and the associated cultural activities.[79] Thorbecke however, recognised and was more preoccupied by the fact that the higher schools ("hoogescholen") with their roots in ancient languages and humanities, and the universities did not immediately respond to more practical needs in Dutch society: "*Er moest een breed*

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[75] "Er moesten nieuwe Duitse universiteiten komen, te beginnen met die van Berlijn (1809), waarin wetenschappelijk onderzoek vrij was van gedachten aan toepassingen en verbonden met onderwijs, dat een grote rol toekende aan zelfwerkzaamheid.", Vermij, R. (1999). B. Willink, *De tweede Gouden Eeuw. Nederland en de Nobelprijzen voor natuurwetenschappen 1870-1940*, p. 26

[76] Eric Palmen, *Johan Rudolph Thorbecke (1798-1872), of hoe Duits wij zijn* https://biografieportaal.nl/recensie/thorbecke-wil-het-remieg-aerts/, Vermij, R. (1999). B. Willink, *De tweede Gouden Eeuw*, p. 27.

[77] Remieg Aerts, *Thorbecke Wil Het,* p. 594

[78] Idem

[79] *Synthetisch Denken* p. 80, "Een ander bezwaar was dat Delft en Wageningen geen goed geestelijk klimaat zouden bieden voor de academische vorming van de studenten. Dat kwam door het ontbreken van faculteiten zoals letteren en de daarmee samenhangende culturele activiteiten."

vormende, nuttige, op maatschappelijke toepassing gerichte scholing komen voor de burgerstand. (…) *Het middelbaar onderwijs was bedoeld voor 'die talrijke burgerij, welke, het lager onderwijs te boven, naar algemene kennis, beschaving en voorbereiding voor de onderscheidene bedrijven der nijvere maatschappij tracht'.*"[80] Most of what was taught in schools and universities was included in the curriculum, but adjusted to the needs of an industrious society - dare one call it, "future-proof"? It was sacrificing the "deeper insight" into the world for the sake of more active participation in it.

More than just a shift in policy, it reflected a change in how Dutch society was organised and what direction it intended to take in the international scene. Roles were being altered as well, and the place of the scientist was proving to be mutable:

> De hogescholen werden, meer nog dan de universiteiten, heen en weer getrokken tussen hun wetenschappelijke ambities en toepassingsgerichtheid. [...] De discussie over de inrichting van de hogescholen was een discussie over de wetenschappelijke status van hogescholen, maar tegelijk over de verhouding tussen wetenschap, techniek en maatschappij. Uiteindelijk ging het steeds over de vraag wat de maatschappelijke taak van wetenschappers was.[81]

Significantly, it blurred the lines between social classes though offering a wider range of options in education to a larger group of people (ergo social mobility), and ever so slightly unsettling the foundations of university education.

It could very well be this more practical mindset that eventually helped elevate agricultural education to higher levels, and make research, both in the laboratory and the field, an integral part of higher education, even though that was not the initial goal. It did the ground work, making agriculture's usefulness visible to society - all levels of society. It brought farmers, ergo lived experience, into the picture. Agricultural education seems to have organised itself, from the moment it had the support to do so, thanks to advocates such as Hudig. Much of the initiatives taken for agricultural education, both on smaller local scales as well as larger scales (as in the cases of big cities such as Groningen) were taken by the private sector, in this case agricultural associations.

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[80] Remieg Aerts, *Thorbecke Wil Het* p. 594-595

[81] David Baneke, *Synthetisch Denken*, p. 76

Government chimed in eventually after much commotion - Thorbecke's government by arguing about where agricultural education belonged and later governments trying to figure out how to make it profitable.

These last decades of the 19th century saw a significant transformation in the discourse of who could do science and what science was. For Hudig, science was where an analytical mindset and the tools (laboratories, fields) to apply it were. Science could be done by those who had access to these. In Hudig's generation, the agricultural sector and its need for restructuring became more prominent. The liberal economy was gaining momentum in Europe, mercantilism and static social structures were fading into the background, and the necessity to draw defining lines between higher and lower education was losing some if its relevance. The government started to subsidise middle education schools, and in 1873 the Hogere Burgerschool in Wageningen acquired a programme for agricultural education.[82] In the ten years intervening between the law for middle education and and this first step towards improved agricultural education, not much was done to get it off the ground, mostly due to lack of infrastructure and internal disputes. It took some time, but the new inspectors for education managed to work their way around these questions and start introducing agricultural education into the state educational system.

The agricultural crisis of 1875 did help give the Dutch government and private institutions a certain impetus to move past these existential polemics and work to reform the system into something that could respond to more immediate needs. By 1886 an Agricultural Commission (Landbouwcommissie) was set up to advise the government on agricultural policy. The Commission opted for a liberal approach and suggested that economic recovery could be reached by improving the quality standards for export products, solving market imperfections in the trade of inputs and increasing the educational level of Dutch farmers.[83] This led to a series of measures unofficially referred to as the "OVO-drieluik"[84] (the Research, Information Service and Education triptych), mostly focused on setting up winter schools (1893) and appointing state agricultural consultants to each province. The winter schools were their own brand of lower-tier education, designed to respond to the needs of people already working on farms. They were held in the winter months

[82] Harro Maat, *Science Cultivating Practice* p. 86

[83] Harm Zwarts, *Knowledge, Networks and Niches* p. 91

[84] Onderzoek, Voorlichting en Onderwijs drieluik.

when farm work was at its least intense, and offered practical courses such as hoof shoeing, beekeeping, horse, cattle and dairy knowledge, as well as horticulture and vegetable growing.[85] In some provinces such as Gelderland, wandelleraren - wandering teachers, a method imported from Germany - were more affordable, and as such more successful.[86] A network of state agricultural teachers, sometimes referred to as consultants (landbouwconsulent), was slowly building up, taking on tasks of teaching, organising and writing newspaper articles. Even though the central government had decided to take the initiative in promoting agricultural education, it was mostly left up to the provinces, under the auspices of the Provincial Agricultural Societies (Provinciale Landbouwgenootschappen), to set up agricultural education as they saw fit.[87] The cultural and agricultural landscape was not sufficiently homogenous to allow for the application of one consistent policy. This more "organic" approach to educational development was indeed successful and flourished into institutions of lower, middle and higher education which nourished the evolution of independent farmers as well as farm managers.[88] The commission's original goal was, among other things, to give shape to agriculture as an independent element of education, reflecting agriculture as an indispensable element of Dutch industry and society:

> Zij acht dit onderricht noodig in de eerste plaats voor de vorming van de leeraren voor het middelbaar landbouwonderwijs; in de tweede plaats zullen zoons van groote landeigenaren, die zelf hunne goederen willen exploiteeren, gelegenheid verkrijgen voor hoogere wetenschappelijke opleiding, terwijl ten derde – en hieraan hecht de commissie veel waarde, – de landbouwkunde, meer dan thans mogelijk is, zal worden bestudeerd in eene richting, welke voor de geheele ontwikkeling van onzen landbouw van onberekenbaar nut kan worden.[89]

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[85] Schuurman, Anton. (2006). Van wintercursus tot wetenschap. Onderwijs, voorlichting en onderzoek voor de landbouw.

[86] Winand Staring (1808-1877), Dutch geologist, agriculturist and inspector for agricultural education and one of the driving forces behind the establishment of the Rijkslandbouwschool in Wageningen. P.J.P. Zuurbier writes that Staring took issue with the name "wandelleraar", preferring "omgaande leeraar". P.J.P. Zuurbier, *Besturing en Organisatie van de Landbouwvoorlichtingsdienst*, p. 26

[87] "De financiering van deze voordrachten was mogelijk dank zij de betaling door de Maatschappijen van Landbouw en een aantal subsidies waaronder die van het Rijk (400 gulden), de Provinciale Staten en plaatselijke verenigingen." P.J.P. Zuurbier, *Besturing en Organisatie van de Landbouwvoorlichtingsdienst*, p. 27

[88] Bieleman, J. DBNL, (2000), *De landbouw en het sociaal-economische krachtenveld,* Techniek in Nederland in de twintigste eeuw. Deel 3. Landbouw, voeding

[89] Hoek, P. van,*"Hooger Landbouwonderwijs*". p. 61

However, as Harro Maat points out, as agricultural education developed, its target group changed.[90] Agricultural institutions such as the experiment stations were growing, and the requirement for scientifically trained personnel was increasing as well. Between 1896 and 1905 the educational programme changed direction, from one geared towards teaching farmers how to improve their product and productivity, to one that served private industry and the state at a larger scale. Were farmers getting the short end of the stick again? The "information" segment of the triptych was turning its attention to the experimental fields and away from the actual teaching and keeping farmers informed of the latest progress.

Conclusion

The Dutch government therefore did have a history of supporting efforts to improve agriculture through direct (partial) funding and education. The agricultural crisis of 1875 however catalysed these efforts to not only face the crisis but also to keep up with developments in neighbouring countries. Small farmers couldn't afford to make any major improvements on their own, even before the crisis. Agricultural societies represented by large landowners, intervened at the state level on behalf of the wider farming community to advocate for experimental stations and more agricultural education. The Dutch state responded to the crisis by investing in innovative measures rather than drawing back. Nonetheless, these investments were built on a strongly mechanistic and productivist framework that didn't always sit well with farmers as was the case with cattle breeders.

Setting up the State Agricultural Experiment Stations also came with its own set of challenges. What was initially meant to be a place of scientific experiment and discovery, quickly became overwhelmed by demands for control and auditing, which farmers required in order to be able to integrate new technologies and keep up with demands for production. The agricultural experiment stations were reorganised, and in the long run contributed to unifying interests of farmers, scientists and the state.

Attempts to get agricultural education off the ground were slow and piecemeal but in the end successful, in large part thanks to greater shifts in the Dutch state and legislation, rendering

[90] Maat, Harro. (2003). *Het innovatiesysteem voor de Nederlandse landbouw*, p.12

agricultural education more accessible to people actually working in the sector. These alterations in the Dutch agricultural and social landscape allowed for an intensification of relationships between social and professional fields.

Conclusion

"De landbouw is de eerste economische sector in Nederland waar kennisverwerving en techniekontwikkeling in breed organisatorisch verband werd opgezet."

-Harro Maat, *Het Innovatiesysteem voor de Nederlandse Landbouw* (p.2).

Is it really possible to separate the different groups and interests discussed into distinct categories? Add a "vs" in between them? Rather than allow us to understand, such an approach would set up artificial boundaries and leave more unanswered questions. There were tensions between different professions, but not insurmountable ones. There were conflicts of interests, not impossible to manoeuvre around however. A vitalist might perceive a great "plan" in all of this, possibly label it "progress" (or "downfall" depending on their perspective); hindsight, it's said, is 20/20. Nevertheless, there's always an air of the contrived in these histories.

In this story there's an individual, Joost Hudig. As an agricultural chemist who had studied electrical engineering, and as a man with a vision for society, it's easy to place him at the crossroads of the events examined. Was he equally representative of the groups involved as might be expected of someone who's oeuvre was peace and stability? Not entirely. The "march of progress" didn't seem to preoccupy farmers as much as it did our protagonist. Their preoccupations were more localised in time and space, their concerns more immediate. Hudig was speaking for their welfare with much benevolence, but little understanding for their day-to-day concerns or even their occasional wariness about liberal policies. As a scientist he still saw himself as having the upper hand, thanks to the self-evident utility of the scientific method. It wasn't experience alone that was going to allow society to avoid further conflicts as far as he was aware.

There are also groups in this story, the State, the Scientists and Industry. Hudig was closer to these worlds. It was where he came from and where he remained. The State didn't quite fit the bill when it came to implementing progressive policies as he saw it. Scientists and engineers had the required knowledge and know-how, and were the prime movers when it came to bringing science to agriculture in the form of State Agricultural Experiment Stations; industry had the outlook it took to progress. All in all, Hudig's was not an unusual stance for someone living in his era. "Progress" was another self-evident concept that had taken considerable proportions since the industrial age and later the creation of nation-states. With every war, cold or otherwise, it took on a set of new qualities. Science and engineering remained staples in these stories. Every setback required more progress to remedy it, and people such as Hudig, Thorbecke, De Vooys and many others were more than willing to set things in motion.

What's interesting is that education was brought into the equation - maybe even more fascinating that it hadn't been considered more seriously before. Bringing education to groups of people for whom it had previously been considered useless, tends to create great shifts in social dynamics throughout history. It breaks barriers and creates new avenues for exploration. In the midst of an economic crisis, the Dutch government could have ultimately decided that middle education for farmers was a luxury issue that could be put off for days of greater affluence. Instead it took the leap and decided to invest in education, and research and development. Moreover, nowadays it might seem obvious that scientists should be implicated in agricultural education. It was nevertheless, a slow shift for agricultural education to transfer into the hands of the laboratory scientists, from people who studied law and large landowners. The State helped make it affordable, the farmer's societies and the provinces footed most of the bill, farmers were willing to go along. The driving force for education was, for all parties involved, better productivity, be it on a national or international scale. It was not the science of the great thinkers of yore, yet it was more than just applied science. It brought disparate fields together such as chemistry and economics, laboratory and field - would the term "real-world" science be a fitting approximation? It added on to existing models of thinking based on the paradigms offered by physics, which were often limited by mechanistic interpretations (prevailing at least in some influential circles). Farmers helped achieve this expansion by showing that their field experience was not to be relegated to the sidelines of agricultural development. Hudig himself indulged in quite a bit of non-rationalist speculation when drawing sweeping (and entirely correct) conclusions about how the soil was a system. He, Thorbecke, Piet van Hoek and their German predecessors dabbled in some mild philosophy (read, ethical concerns and assumptions) which served as guidelines for their programmes. Society's problems don't lend themselves to the same rationalisation, disengagement and impartiality as scientific problems allegedly do. The society they wanted to transform was a much larger field than any number of laboratories could study, analyse or control.

An image of how people and institutions shaped agriculture at the turn of the twentieth century would most certainly be a dynamic one. It wouldn't make sense to assign specific roles. It was the circumstances forming the people as much as the other way around. This period does seem though to mark an era of increased cooperation: farmers amongst themselves with their cooperatives, scientists with farmers, industrials and statesmen, farmers with industrials. As for laboratory work, even though it was gaining prestige over field work in the sciences, the building of Rijkslandbouwproefstations proved that that wouldn't work for agricultural science. Another interesting feature of this story is that greater cooperation was never really the intended goal; it was judged a necessity to pull individuals and groups out of times of crisis, notwithstanding liberal economic policies. It did eventually succeed in centralising agriculture - it's up to the reader to decide how much of a positive or negative evolution that was.

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